Analyzing Built Environment Affecting Sense of Safety: Case of Urban Areas in Guwahati, Assam

Thesis submitted by

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PROFORMA – I

"Statement of Originality"

I, Namrata Talukdar, registered on 3rd May, 2018, do hereby declare that this thesis entitled "Analyzing Built Environment Affecting Sense of Safety: Case of Urban Areas in Guwahati, Assam" contains a literature survey and original research work done by the undersigned candidate as part of Doctoral studies.

All information in this thesis has been obtained and presented by existing academic rules and ethical conduct. I declare that, as required by these rules and conduct, I have fully cited and referred all materials and results that are not original to this work.

I also declare that I have checked this thesis as per the "Policy on Anti Plagiarism, Jadavpur University, 2019", and the level of similarity as checked by iThenticate software is 01 %.

Namrata Talukdar

Signature of Candidate:

Date :

Certified by Supervisor:

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PROFORMA – 2

Certificate from the Supervisor

This is to certify that the thesis entitled "**Analyzing Built Environment Affecting Sense of Safety: Case of Urban Areas in Guwahati, Assam**" *submitted by Namrata Talukdar, who got her name registered on May 3rd, 2018 for the award of Ph D. (Engg.) degree of Jadavpur University is based upon her work under the supervision of Dr. Mainak Ghosh and that neither her thesis nor any part of the thesis has been submitted for any degree/ diploma or any other academic award anywhere before.*

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Namrata Talukdar.

Namrata Talukdar,

Guwahati

March, 2025

List of Abbreviation

ADC	: Additional District Commissioner
ATM	: Automated Teller Machine
BSNL	: Bharat Sanchar Nigam Limited
CCTV	: Closed Circuit Television
CID	: Criminal Investigation Department
CPTED	: Crime Prevention Through Environmental Design
DBH	: Diameter at Breast Height
DC	: District Commissioner
DESA	: Department of Economic and Social Affairs
DIY	: Do it yourself
DUAC	: Delhi Urban Art Commission
GIS	: Geographic Information System
GMA	: Guwahati Municipal Area
GMC	: Guwahati Municipal Corporation
GMCA	: Guwahati Municipal Corporation Area
GMDA	: Guwahati Metropolitan Development Authority
GNB	: Gopinath Bordoloi
GPS	: Global Positioning System
MG	: Mahatma Gandhi
NCRB	: National Crime Records Bureau
NEN	: North East Network
NGO	: Non-Governmental Organization
NUA	: New Urban Agenda
OSM	: Open Street Map
PS	: Police Station
QOL	: Quality of Life
SDG	: Sustainable Development Goal
UN	: United Nation
WHO	: World Health Organization

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Abstract

People's perceptions of safety are shaped by their surrounding environment. The behavior of the surroundings directly influences the activities of the city's residents. The purpose of the study is to examine the physical components of the built environment in urban settings and evaluate them in relation to two distinct localities of Guwahati City. According to investigations, the two localities—Uzan Bazar and Hengrabari—are among the safest and most dangerous in the city, respectively, are considered as study areas for the analysis section of the research. Taking into account the strengths and flaws noted from the case studies, urban design strategies are developed and, then, explained in context to the safe and unsafe localities, which validates their relevance, feasibility, and applicability in real-urban situation.

This study identifies five built components, fifteen indicators, and twenty-one evaluation criteria. Frequency of appearance, and expert opinion survey methods are used to identify and prioritise the mentioned components and indicators. The study areas are analysed with respect to each of the evaluation criteria and a comparative discussion is carried out to find out the physical status of the built environment. Data classification and a perception survey were helpful in understanding the sense of safety of people; formula-based computation method (eg. rated scoring of safety criteria) and their results' percentage distribution were helpful in the criteria-specific analysis; expert evaluation and digital content analysis are used in the analysis to obtain the score system. To support the overall analysis, urban design maps are created using ArcGIS, AutoCAD and Photoshop software showing the spatial condition of the case study areas. Additionally, in order to highlight the current shortcomings, the strategies are, also, investigated in both case studies using in-depth photographic analysis and on-ground data.

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CHAPTER 1: INTRODUCTION

1.1 Preamble

Urbanization is accelerating the problems related to physical and social infrastructure. Approx. 3.5 billion people in the world are living in urban areas which is predicted to rise to 5.2 billion i.e. 68% of the total world population by 2050 (Alexandratos & Bruinsma 2012). The Population Division of the United Nations Department of Economic and Social Affairs, UN DESA (2018) has predicted India, China, and Nigeria to absorb almost 35% of the total projected increasing urban population of the world by 2050. Such population expansion uplifts the urban development, and, also, causes residents to lose a sense of place in their surroundings. Moreover, the distribution of population and infrastructure in countries like India is not uniform and balanced. Such a situation gives birth to the vulnerable areas within the cities in terms of physical, social, economic, and environmental inequalities. Crime against women, sexual harassment, trafficking, vehicular accidents, discomfort for pedestrians, disparities in physical and social infrastructure, physical and psychological issues related to children, old age people, or physically disabled people, etc., are some of the real-life problems in Indian cities.

To address such problems in urban areas to create inclusive cities, safer city agendas and initiatives are emerging from the global to the local level. The common objective of these initiatives is to achieve a safer city where habitats, including poor, youth, and women from different socio-economic statuses, genders, races, ethnicities, or religions can participate fearlessly in the social, economic, and political activities as well as city making and development process (Un-Habitat 2012). The New Urban Agenda by the UN (2016) targets to build a 'Global Network' through built environment design, social integration, and formulation and management of safe-city policies. CPTED (2007) advocates for a safer urban environment through proper planning and design of physical elements that integrate a natural monitoring approach. It has been believed that good built environment design and sensible spatial planning are tools that help lessen urban safety and security concerns and inspire residents to lead happier, more satisfying lives together. Therefore, this study is an attempt to identify the physical components of the built environment that contribute to the sense of safety of the people in urban areas. A few of the residential localities from Guwahati are taken as case examples to analyse the roles of the components and understand the safety status. The primary survey of the site, and secondary surveys from a variety of different sources, such as books, newspapers, journals, websites, magazines, etc., aid in the

identification of various components from the standpoint of urban design. The scope of the study is limited to the physical components of the built environment only.

The structured visual of the Introduction Chapter has been shown in the Fig. 1.1.

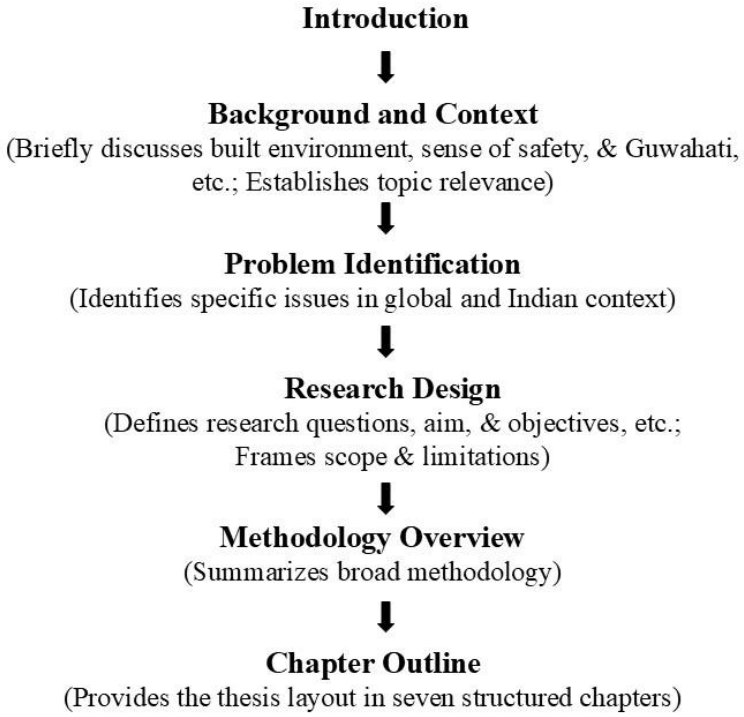


Fig. 1.1: Outline of the Chapter

1.2 Background study

1.2.1 Built Environment

The tangible elements that comprise our surrounding physical environment in which we live, celebrate, and perform our lives directly and indirectly contribute to the physical components of the built environment. The 'built environment' can be better comprehended by acknowledging the role that humans play in daily living. Because human actions in their immediate surroundings have evolved into the built environment. The built environment, in urban terms, is the man-made setting or backdrop in which people perform life's activities for their well-being (Butterworth 2000). The buildings and the spaces between buildings are the components of human constructed environment. The parks, transportation system, and other infrastructure, utilities, etc. that are meant for the ease of human actions contribute to the elements of the spaces of the urban built environment. People have a genuine tendency to socialize to build bonding and create a sense of community; they use it to express their senses and emotions, perform physical activities, work for livelihood, and travel for communication

ease in the surrounding environment. A report prepared by the Provincial Health Service Academy (2008) found density and mixed land use, easy connectivity, convenient public transit system, adequate recreational facilities, access to safe food, functional public infrastructure, affordable housing, safe and age-friendly environmental designs for children, women, etc. as the indicators to define the relationship between human health and the surrounding built environment (Plouffe & Kalache 2010). Each of the elements of the built environment exists as a result of human needs, thoughts, and actions; that's why the built environment is "*of people, for people, and by people*" (Valcárcel, Murias & Rodríguez 2018). Another report by the Public Health Dept. of Ireland (2006) discusses the impact of buildings and public spaces on health in terms of air quality, temperature, safety, light, space, accessibility, immediate surroundings, locality, social networks, attractiveness, housing condition, etc. (Hunter et al. 2019, p.104923). The factors like well-lighted neighbourhoods, habitable spaces connected with open spaces encouraging social interaction, reduced crime and violence, streets facilitated with tracks for cycling and walking, low-rise safer apartments connected to the ground, etc. can cause strong public health physically and psychologically and reduce the risks of depression, obesity, psychological disorders i.e mental illness of city people (Sanchez 2010). In research, Pickett and Cadenasso (2008) have identified three major components of urban built structure namely- vegetation, buildings, and surfaces. Vegetation helps in achieving social benefit and mental calmness; reducing crime and conflicts; whereas the buildings along with the ground surfaces allow the infrastructural development and balancing of built and unbuilt ratio in the urban environment.

1.2.2 Sense of Safety

A sense of safety is a fundamental human need that shapes how people experience and interact with urban environments. Abraham Maslow (1943) discovered six hierarchies of human need which are responsible for the surrounding habitat. According to this, territoriality, shelter, a sense of community, and mental health are the indicators of safety-security and bodily protection that fulfil human psychological and physiological needs. Within this context, safety needs are concerned about creating structure, order, and certainty in the society. Designed spaces with proper transparency, clear visibility, and accessibility help ensuring safety, whereas poorly maintained, and chaotic pubic areas create insecurity and anxiety. Thus, Maslow's safety needs establish a link between safety perception and surrounding environment.

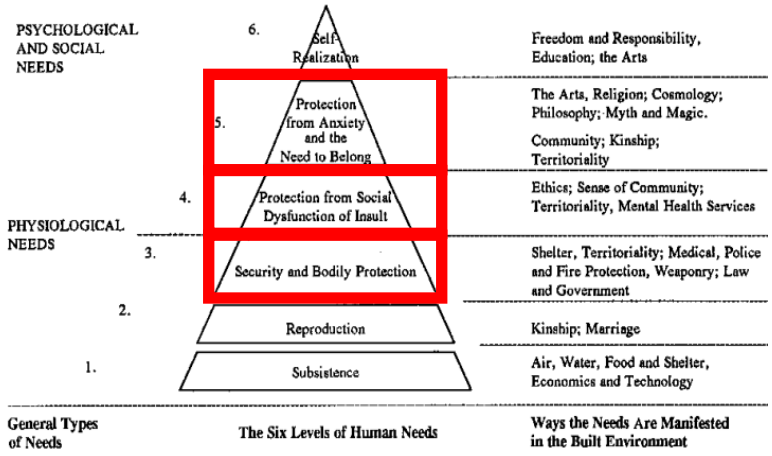


Fig. 1.2: Marshlaw's Need Pyramid

Source: Bartuska 2010, Wendy & Bartuska 2007

Centre for Urban Safety (Spectra, Centre of Excellence n.d.) addresses urban safety as a fact to achieve environmental quality which should ensure not only the physical safety of people but the psychological safety also. Un Habitat has defined the safe city movement as a city-level approach to address crime, violence, conflict, and insecurity for all groups of people in the cities and their settlements through proper urban design and planning. Li, Liu, and Sang (2012) discussed surreal building styles and unnatural materials as architectural problems related to creating feelings of unease in urban environments. Therefore, urban safety can be defined as a combination of a few urban factors including geophysical, geographical, climatic, geochemical, etc.; architectural; social factors like demography in terms of diseases, life level indices, mortality rate, life span, etc.; ecological; infrastructural development in the field of public transportation, services, and physical-social amenities, etc. (Rastyapina 2016).

New Urban Agenda (2018) defines urban safety as given by New Urban Agenda to be the degree to which a city's residents can safely live, work, and engage in urban activities without the risk of harm. This definition has been discussed in terms of Myanmar by Roberts (2018) through the safe and inclusive design of transport, green public spaces, lighting systems, sidewalks, infrastructure, etc., and works through mitigation of urban problems like broken and discontinuous footpaths, unmanaged electrical wires over roads, crime, and feeling of unsafe, lack of community participation, territorial mismanagement, etc. which are mainly related to the physical environment of the urban habitat.

Some studies show a substantial correlation between safety ratings and incidences of crimes (Weitzer 2003) (Clarke & Eck 2016). Many times, both have a direct impact on physical

elements and an indirect influence on social facts (Bhargav 2021, p.44). The surrounding built environment is the reflection of primarily group activities of human beings and their social norms and plays an important role in making people feel safe and overcome the fear of crime (Zeng et al. 2022, p.2). The crimes that can happen due to ill-built environments are pity pickpocketing, thief, kid's abuse, robbery, rape, murder, terrorism, social conflicts among neighbourhoods, etc. (Setiawan 2017). This concern for the use of social and physical elements to guarantee city safety takes into account both CPTSD, a non-physical method that emphasises socio-cultural viewpoints, and CPTED, which discusses the physical elements of the urban environment towards safety and security.

1.2.3 Sense of Safety in the context of India

Indian cities are found to witness a sharp rise in unlawful activities against women, children, the elderly age etc., in outdoor spaces such as empty streets, public parks, crowded marketplaces and other public areas (Roy & Bailey 2021) (Plouffe & Kalache 2010). The NCRB (2020) report has mentioned Tamil Nadu as the highest crime-rated state of India, whereas the northeastern states like Nagaland, followed by Manipur and Sikkim, are the lowest crime-rated states. The same report states Delhi is the most unsafe for women. Among the reasons behind the crimes against the weaker sections, the contributing part in the context is not only the physical factors of the outdoor spaces but also the psychology of a group of people whose resistant minds are not open to accepting new ideas and changing their preconceived notions. Numerous literature sources about history provide evidence of women's exclusion from many public occasions (Roy & Bailey, 2021). Assam is the second-ranking state with the highest reported on crimes against women after Delhi. The most common crimes in Assam that are reported are rape, kidnappings, and domestic violence (Devi 2013).

1.2.4 Guwahati

Guwahati, being the most populated city of Assam, having approximately 1.5 million in 2022, with a growth rate of 1.86% (Guwahati population 2022), surely will invite more population in the future. Almost 25% of Assam's urban population belongs to only Guwahati, which is a significant integer (T&CP, Assam). With a total of 60 municipal wards, if the city keeps on expanding this way, the World Population Review Agency has estimated that the growth rate of Guwahati will double (i.e. 2.06%) by the year 2025. Such growth of people due to migration in the last few decades has led to the urban sprawl in the city (Talukdar

2018). This expansion has affected aspects like encroachment of buildings in inhabitable spaces, lack of open spaces, physical and psychological safety, infrastructural mismanagement, etc. As per Borthakur's study, urbanisation is, undoubtedly, transforming the geography and characteristics of the landscape of Guwahati, significantly influencing its existing biotic diversity (Borthakur & Nath 2012).

Moreover, uncontrolled migration brings physical changes due to rapid social differences (Gilbert 1999). Though the education and health systems are improved in the cities, adults are more exposed to criminals, drug addicts, prostitution, etc. Also, the senior citizens are not exposed to fresh air, barrier-free parks, etc. Guwahati, also, does not stand as an exception in this regard. Eve teasing, and child abuse, the city is seen to face an increased crime occurrence in recent years causing psychiatric problems (Bhowmik & Chaliha 2011). Among all groups of people, women of 11-22 years of age are more vulnerable to sex crimes (Baruah, Haflongbar, & Chaliha 2015). Studies indicate that mistreatment of the elderly, such as financial crimes, robberies, vandalism, etc., reduces their confidence to spend more time outside (Saikia et al. 2015, pp.279).

1.3 Topic relevance

It is an absolute necessity for a metropolitan city like Guwahati to have liveable built spaces for its people so that they can live their lives safely with dignity and without any fear of getting harmed (Handy, Cao & Mokhtarian 2006). Several recent studies have examined how people choose to reside and visit the built spaces that they perceive as safer and satisfactory (Hong & Chen 2022). So, how people perceive a built environment finally depends on how long they want to spend there and how often they are going to visit again (Chan & Li 2022). The interdependency between a safe built environment, the sense of safety of individuals within that environment, and the travel behaviour of city residents influences how people navigate urban spaces, with well-designed environments enhancing both actual and perceived safety, thereby encouraging more frequent and diverse mobility patterns. (Hong & Chen 2022). Thus, a secure urban environment can be said to be one step ahead to becoming a liveable city with an improved quality of life.

Numerous studies have been found discussing the connections between the built environment and sense of safety, preferring personal safety as a criterion to infer life satisfaction (Heller, Watson, & Ilies 2004) (Tiberius 2024). However, urban design components of the physical environment influence people's sense of safety in an urban area, which is still a topic of

discourse. Also, very scant studies are found where such contexts are brought up regarding a metropolitan city of North-East India, such as Guwahati. To address this gap, the present research attempts to investigate the physical components of an urban built environment that affect the sense of safety of its people. In this regard, it considers case studies of Guwahati city to evaluate its physical status.

1.4 Problem Statement

The safety and security issues in Indian cities are now common and this has been considered as one of the key factors in any discourse regarding the inclusive city planning. World Bank's (2020) safer city approach tries to strengthen the local authorities to use good governance and appropriate urban planning and designing in the prevention of crime and violence improving quality of life. Crime and harassment, vehicular accidents, and social and physical aspects of urban issues are considered in SDGs to design better lives for vulnerable groups of society such as children, old age people, differently-abled people, etc. External life-saving instruments like CCTV, sensors, etc., are not sufficient in India, a country of 1.48 billion people, but if the built environment itself serves the defense of the people it can be the best out of all. Well-designed communities improve both physical and mental safety by having accessible public areas, safe housing, and effective transit, are resilient and built aspects like active streets for pedestrian and vehicles, compact land uses, etc. Therefore, designers need to comprehend and acknowledge the necessity of people's safety in urban areas and devise strategies to reduce discomfort.

1.5 Research Questions

1. How does the built environment connect to people’s sense of safety?
2. What are the physical components of the built environment that effect the sense of safety?
3. What are the indicators related to the physical components that help make people feel safe in an urban area like Guwahati?
4. How do built environment components influence the sense of safety in urban localities?

1.6 Aim

To study the physical components of the built environment affecting the sense of safety, understand the issues related to these components, and analyse them in context to the cases of urban areas in Guwahati, which could be relevant to other cities.

1.7 Objectives

- To identify the physical components of the built environment affecting the sense of safety.
- To understand the effect of the components on people's sense of safety.
- To prioritise the most relevant components.
- To analyse the selected components with respect to the case studies of Guwahati city.
- To infer the outcomes and provide strategies which may be relevant to other cities.

1.8 Scope and Limitations of the Research

- The scope of this research considers study on the physical built components which are found to be effective in people's sense of safety according to numerous literature available.
- The study compares different urban localities in the context of Guwahati to assess the nature of the built environment affecting the sense of safety.
- A mixed-method approach is used, including spatial survey, perception study and expert evaluation method to achieve components scores as well as conclude the major findings. Broad recommendations are inferred to make use of the research in future.
- The study is limited to the physical components of the built environment.

The study focuses on the overall sense of safety of urban localities rather than being specific to any particular group or gender.

1.9 Broad Methodology

For this study, descriptive and observational approaches are used as the methodology. The methodology of the study is designed so that it employs systematic approach to fulfil each of the objectives. It ensures a thorough investigation of the subject by outlining the procedures for data gathering, analysis, and interpretation. The qualitative method is the main focus of the research methodology in order to provide thorough insights. This section of the first chapter provides an explanation the tools, methods, and procedures adopted at each stage of the research.

Initially, a detailed background study is conducted, which helps understand the connection of the built environment to people's perceived safety. Different relevant topics are studied such as community interaction, public health, life satisfaction, safety as a personal need, psychological impact, etc. in order to get into a dipper knowledge about the main subject matters. The physical aspects of the surrounding environment that must be studied for a

research topic like this thesis were discovered through a variety of government websites, publications, departmental reports, research papers, etc. Such thorough review of existing literature helps in resulting a set of built components and their indicators that help build people's perceptions. The physical components and indicators are selected through 'frequency-based selection', and evaluated separately both for components as well as indicators. An additional 'expert-opinion survey' has been conducted with nine different experts relevant to the field through a questionnaire to understand their points of view on the components. The following part of the literature study reveals a group of evaluation criteria for each of the indicators to be able to assess them in the selected study areas of Guwahati.

In the subsequent phase, the study areas are chosen for the ease of evaluation of the built environment in Guwahati's context. To achieve that, the crime data from the different police stations (PSs) are collected. This investigation reveals the crime-ridden areas of Guwahati during the years 2018, 2019 and 2020 according to the number of crime occurrences. The data overlapping of all the consequent years in the heat map represents Dispur and Latasil as the highest and lowest crime-rated PS jurisdictions, respectively. Here, a perception survey through a short questionnaire in the Dispur and Latasil jurisdictions' areas, respectively, helps the researcher to assess sense of safety and identify the most unsafe locality in the Dispur area and the safest locality in the Latasil area.

The evaluation criteria of each indicator of built components are assessed and analysed in each of the localities to understand their effects on people's sense of safety. A mixed method has been adopted for documentation and analysis of the components which results in a set of detailed qualitative insights and research outcomes. These methods for the documentation process include expert evaluation, user's perception survey, social media analysis method etc. which incorporate field observation, note taking, thematic mapping, interviews, oral narratives, ethnographic study, sketching, etc. The data collected are analysed, incorporating recurring patterns through thematic analysis, converting observed data into maps, charts, and tables, and establishing connections between attributes using the equal interval technique and data categorization method. The major findings, broad recommendations, and strategies after the documentation and analysis of the spatial data, finally, contribute to the outcome of the research and draw the conclusions.

The following is the flowchart of the methodology adopted for the research. A detailed discussion of the research methodology has been provided in Chapter 3 of the report.

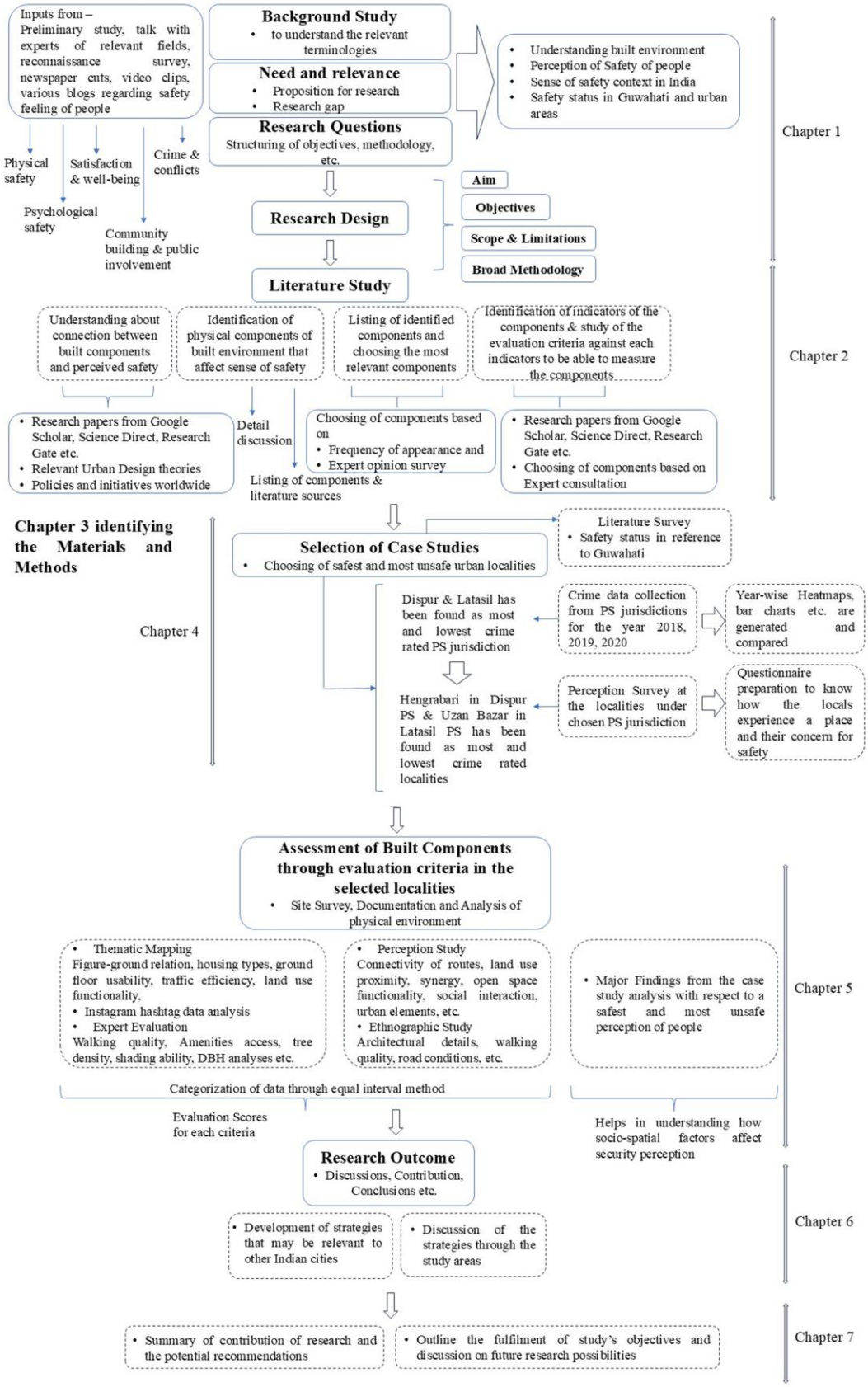


Fig. 1.3: Diagrammatic Representation of Research Methodology

Source: Prepared by Researcher

1.10 Structure of the Report

The thesis will consist of seven chapters starting from the Introduction and finishing with the Conclusion.

Chapter 1 presents a brief introduction about the subject matter. The terminologies used in the title of the project are discussed to establish the relevance of the research. Consequently, the problem statement and research questions are discussed. The aim, objectives, and broad methodology are also framed and defined in this chapter.

Chapter 2 discusses the review of literature which provides detailed research about the inter-linked topics related to the key-terms 'built environment', and 'sense of safety', such as community interaction, quality of life, safety satisfaction, etc. This chapter demonstrates the connection between the nature of the surrounding environment and peoples' sense of safety when present in it. It compiles various reasoning from books, research articles, reports, etc. and the researcher's opinions through discussions. Towards the end of the chapter, it systematically identifies key components of the built environment, their indicators as well as evaluation criteria for all of these and organizes them together for further in-depth analysis.

Chapter 3 includes the detailed research methodology adopted for the research. This chapter includes in-detail discussion on methods and techniques of primary and secondary surveys at various stages and representation strategy that associated with them. The techniques used are backed up by literature to demonstrate the strength of the research.

Chapter 4 focuses on the detailed methodology to select the study areas for the assessment of built components in the upcoming chapter. It, also, provides a brief about the city of Guwahati and its safety status along with a discussion on the characteristics of the selected study areas.

Chapter 5 discusses the site survey, data collection and analyses of the study areas concerning each of the evaluation criteria discussed in Chapter 2. The documented data are represented in different maps, tables, bar charts, etc. and analyses of those inferred major findings that help achieve the research outcomes.

Chapter 6 highlights the contribution of the research. This chapter develops some strategies and discusses those with the help of the study areas.

Chapter 7 concludes the research with a detailed conclusion on the achievement of research objectives at different stages. It provides broad recommendations and discusses future research possibilities.

Chapter 2: Literature Review

2.1 Chapter Overview

The literature review is a significant step in a research methodology which involves an in-depth review of previous research on particular topics to understand the existing knowledge, information, methods, etc., and accordingly, to shape the research. A well-framed, comprehensive literature review helps gain insights related to different methods, components, indicators and evaluation criteria previously used for specific research (Kiteley& Stogdon 2014).

Here, in this chapter, the literature review has been done "section-wise" based on the information and knowledge required to conduct the research. The following flowchart (Fig.2.1) describes the structure of the chapter.

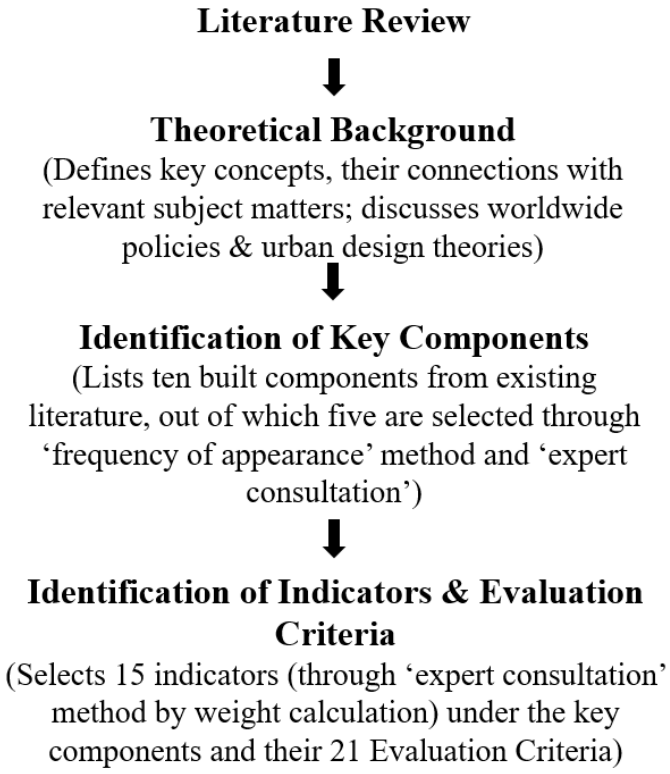


Fig. 2.1: Outline of the Chapter

As shown in the above figure, the literature study has been done in three sections - the primary section that deals with understanding theoretical backgrounds related to the research, followed by a section where the researcher has identified components and indicators of built environment affecting safety; and the final section that includes identification of the evaluation criteria that are to be used in the evaluation of study areas. The detailed method of

literature review has been discussed in the Materials and Methods chapter (refer to Chapter 3).

The initial section of this chapter discusses the terminologies that are used in the title of the research such as built environment, and sense of safety. This section aims to describe the terminologies used, discuss the relationship between these terminologies and broaden the knowledge base of the researcher. It justifies the relevance of the topic of research by conducting an extensive literature investigation on related topics such as 'the physical components of the built environment', 'how they affect people's safety', and 'how these two terms i.e. 'built environment' and 'safety' are related to the overall quality of life. Thus, numerous existing literatures has introduced various physical aspects of the environment that affect the sense of safety of people, resulting in broadening the domain of the research.

The second section of the literature review focuses, first, on identifying the components and selecting those that are relevant to the research. This research by using the 'frequency of appearance' method and conducting an 'expert opinion survey' has tried to narrow down the unnecessary components and to select those components that are vital for a focused, pinpointed research. To do so, the components are, first, listed and later, prioritised and selected for further investigation. The identified components from the existing literature are arranged sequentially in an Excel sheet along with the names of the authors suggested. The components that are found to occur more frequently in the literature review are considered to be the most significant physical components relating to public safety. After identification, to testify the selected components as well as to choose the most prioritized components among all the selected, an expert opinion survey is conducted (for details refer to Chapter 3). The experts have chosen the top five physical components of the built environment that have a substantial effect on people's sense of safety. This will not only help the present research but also help future researchers by saving time and effort by neglecting unnecessary components and prioritising vital components for similar studies.

Once the key components are achieved, a review of existing literature was done to find out the indicators of the selected components which have been discussed in the later portion of this chapter. Several indicators for each of the key components, are identified from the available literature and preferred to adopt a few of those which are selected through another expert opinion survey of the same group of experts.

The experts are chosen from fields like urban design, planning, geography, economics, etc., based on experience in that field for both the steps i.e. for selection of components and selection of indicators. The expert opinions on the selection of components and indicators are collected through specific questionnaires.

In the final section of the chapter, a listing has been done to highlight the evaluation criteria of each indicator selected for this research. This is how, the combined method of selection, finally, results from the set of five components, fifteen indicators, and twenty-one evaluation criteria that collectively represent the built environment.

This chapter accomplishes the initial portion of the research aim and addresses the first three research objectives (as stated in Chapter 1) with the content mentioned above. Along with this outcome, this chapter discusses the legitimate research gaps that exist in the field of this research. Also, the chapter stands out as a compilation of different research published in national and international journals, books, govt. Reports, theses, etc., which will be helpful for future researchers in the field.

2.2 Understanding Built Environment

The understanding of the built environment demands a multidisciplinary approach that incorporates the physical environment surrounding a human being and the spaces where people live, work, play and leisure (Ghosh 2020). The built environment plays a crucial role in shaping the quality of life of people by providing spaces for interaction, community gathering, recreational spaces and healthy working environments. The built environment is responsible for shaping the urban environment, and impacts ecology, socialization, community sense, personal safety etc., thus affecting the livability of a space (Getz 2018). The upcoming sub-sections of the chapter will discuss the relationship of the built environment with community interaction, health, and life satisfaction to generate a comprehensive idea of the built environment and its significance.

2.2.1 Built Environment and Community Interaction

The built environment plays a significant role in deciding the nature of human activities in public spaces (Matsuoka & Kaplan 2008) (Gehl 2013). The built environment not only shapes the identity of cities but also acts to enhance life quality, social engagements, and social cohesion, developing belongingness among the citizens (Nursanty, Rusmiatmoko & Widiantara, 2024).

The quality of the built environment is measured by how much the public values the built environment and its features and the way the community uses the public spaces (Gehl 2011). The buildings and the spaces between the buildings, which include parks, streets, footpaths, etc.; create attractive environments to play, recreate, and commute, which shapes the relationship between human activities and the built environment (Matsuoka & Kaplan 2008) (Gehl 2013). Jan Gehl observed a significant reciprocal relationship between the physical environment and outdoor human activities.

A high-quality built environment is interlinked with health, economy, social and environmental aspects (Nursanty, Rusmiatmoko & Widiantara, 2024). Social engagements, cultural intermix and cohesion can be considered as a by-product or output of a well-built environment (Dempsey 2009). However, measuring the design quality of the built environment that affects human life, directly or indirectly, has been a challenge, as mentioned by Gann & Whyte (2003).

However, few design elements of the physical environment, such as an attractive façade, a landmark building, or an appealing landscape, can encourage people to roam around, shop nearby, sit and spend time with friends and families. People of all ages can be encouraged to use public places and lead to active use of outdoors by creating built environments that cater to specific age groups, such as parks and yoga grounds for the elderly; sports facilities, dedicated bike lanes, public selfie spots for teens and young adults; interactive learning areas for children etc. Moreover, the utilisation of the existing built environment is driven by people's personal and social benefits. For example, a selfie stand in a public space is widely used by the youth to click selfies to gain social media attention. Similarly, people gather around community spaces for civic engagement and develop cultural and traditional bonds, professional networking, etc. In research, Li and his team (2021) have mentioned factors such as "street greenery" and the "type of public amenities" that affect the amount of time people choose to spend in outdoor spaces. The researchers in the available literature have suggested the need for pleasing and attractive outdoor spaces that attract people to actively use city spaces. Molana & Adams (2019) discussed the spatial arrangements, layouts etc. in "architectural design" as the factors that enhance the opportunities for human interaction in residential neighbourhoods resulting in the development of a higher sense of community and belongingness. Butterworth (2000) valued sociocultural norms and traditions in the architecture of a place that collectively encourages creating interest for the public in outdoor spaces.

Dempsey (2008) in his article examines the quality of the built environment based on the elements introduced by Carmona i.e. visual, social, and place-making. The concept of 'place-making' adds association value to a public space, and fosters a sense of belongingness through the components such as mixed land uses, accessibility, connectedness, permeability, legibility, attractiveness, maintenance, and safety. The sense of belongingness comes from the 'identity' and 'familiarity' of a place which collectively contribute to the 'legibility' of the place.

Thus, the built environment has a profound impact on the use of public space and community interaction in public spaces.

2.2.2 Built Environment and Healthy Life

The built environment has a significant contribution to public health (Booth 2016); both in physical as well as mental health (Berglund, Westerling & Lytsy 2017) (Villanueva et al. 2013, p.1). The built environment can contribute positively to the health of citizens through improved physical activity, social capital, and community connections (Renalds, Smith & Hale 2010) and by affecting environmental elements such as the quality of air, and water, noise and traffic hazards (Perdue, Stone, & Gostin 2003). A well-designed built environment fosters a healthy life by reducing environmental stressors.

Butterworth (2000) in his research claims that the built environment can bring out the enthusiasm of humans in building social relationships, and community interaction resulting in positive effects on mental health. The research paper has analysed the role of aesthetics of the place, legibility, and architectural features like the orientation of buildings, built form and transportation in achieving improved health outcomes. Papas and his team (2007) have found a direct connection between physical health to the environment a person is exposed to such as in residential neighbourhoods, workplaces, and spaces that are frequently visited. The surrounding environment of a human being directly or indirectly influences physical and mental health. This research has advocated the importance of air quality, access to natural light, green spaces, and quality infrastructure and services like housing, water supply, sewerage connections etc.; all of which impact physical and mental well-being.

The characteristics of land use mix, street accessibility, and pedestrianization are associated with the increased risk of health abnormalities. For example, high-rise residences are vulnerable to children, women and the elderly as such apartments disconnect people from the ground and divide them into floors with fewer chances for playing, breathing fresh air, social

interaction, etc. The lack of social interaction, scarcity of public spaces, and unavailability of green landscape areas compelled people to stay inside the home which in turn elevates psychological distress and results in serious mental illness (Evans 2003). When children spend more time indoors, with negligible interaction with the natural environment; diseases like asthma, lead poisoning, etc. are diagnosed at an early age (Cummins & Jackson 2001).

Zhong and team (2022) have discussed the dynamic relationship between health and the built environment focusing on mediating the effects of the built environment and final health outcome.

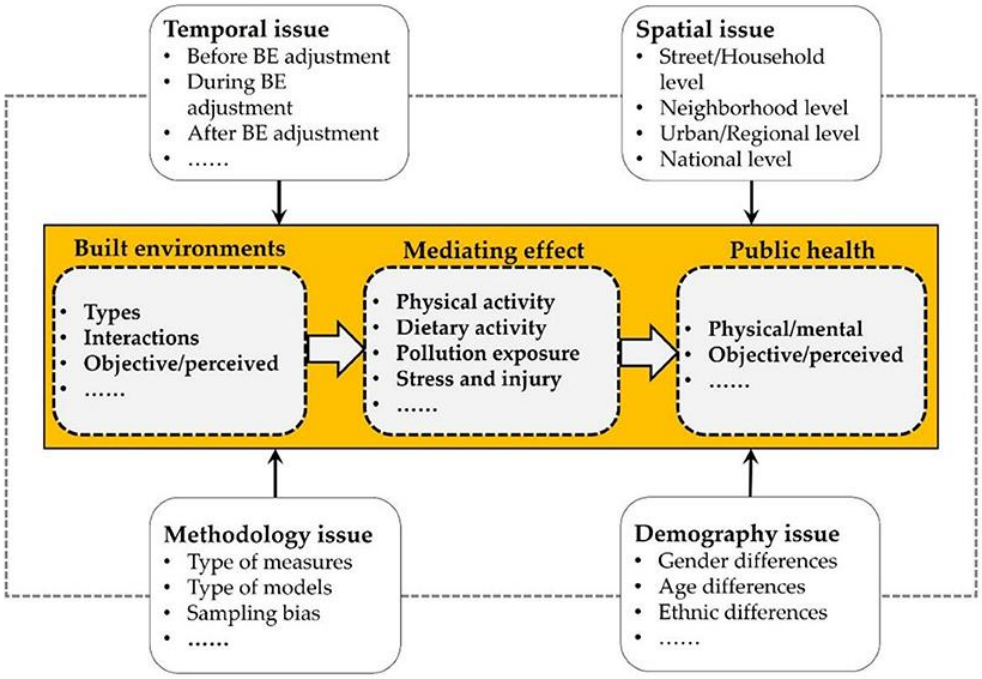


Fig. 2.2: Relationship between health and the built environment

The research highlights four types of issues such as temporal issues (before, during and after the built environment adjustments), geographical scale issues (such as household level, Neighbourhood level, Urban/regional level, and National level), and Methodological issues (Methods, criteria of evaluation, measurement) and demographical issues (Gender, Age and Ethnic differences) that affects the health outcomes (both objective and perceived).

2.2.3 Built Environment and Quality of Life

The built environment significantly influences the quality of life (QOL) by shaping daily experiences, mobility, and health. Sarmiento and team (2010) discussed the connection between the built environment, physical activity and quality of life and mentioned the positive significance of land use heterogeneity and the density of a settlement. The

relationship between the built environment and quality of life is complex and dynamic and changes in different geographical settings, for example in urban settings compactness and land use diversity can affect QOL (Sarmiento et al. 2010, pp. S181) whereas in rural middle-income settlement connection of people, social cohesion, street connectivity can be driving factors for positive QOL (Engel et al. 2016, p.3). The association of green spaces with QOL has been discussed by Kodali and team (2023). Their research had been conducted in three built environment settings namely; green and blue spaces of a neighbourhood, infrastructure presence in a neighbourhood and perception of the neighbourhood. The result of the research shows a high correlation between neighbourhood satisfaction and QOL among children, emphasizing the significant contribution of green spaces in the QOL.

Loo and his team (2017) in their research have highlighted the interrelation between the built environment and QOL focusing on the individual and its surroundings such as the home environment, neighbourhood-built environment and built environment of urban macro scale. The paper highlights neighbourhood cohesion, culture and identity as significant aspects of mental well-being and connectivity, and accessibility as physical aspects that ultimately combine to result in a positive contribution to QOL.

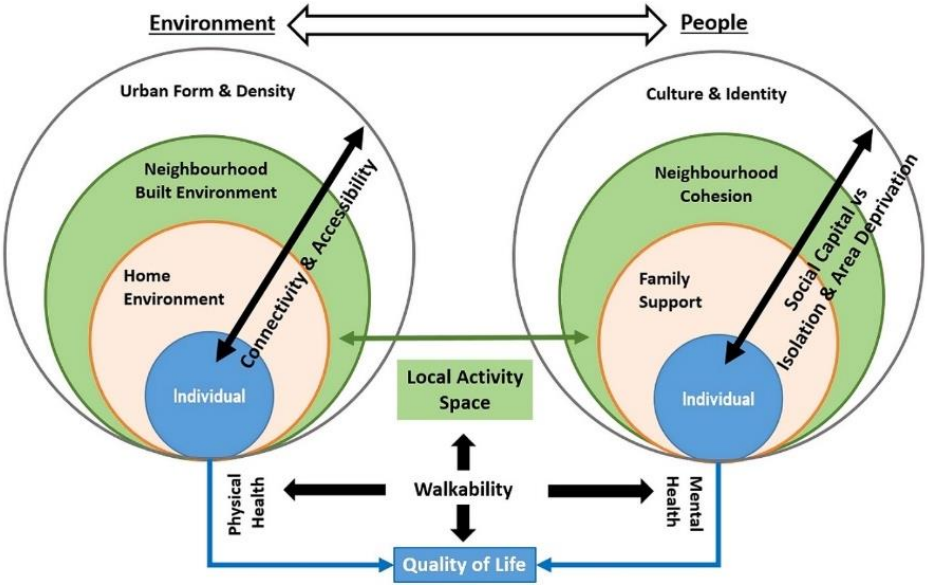


Fig. 2.3: Relationship Between Built Environment and Quality of Life

Moreover, the built environment not only affects individual QOL but also influences the community's well-being. The community well-being or community QOL is a combination of individual QOL or can be regarded as "*greater than the sum of its parts*" and appears from the interaction of people in the shared common spaces (Lach et al. 2022, p. 1193).

The built environment should be designed carefully to enhance the QOL of people as well as the community by ensuring safety, sustainability, accessibility, connectivity and well-being.

The following discussion highlights the aspects of a built environment that affect people's quality of life.

Building Block Design: The quality of building design elements such as façade treatment, layout, enclosure and aesthetic attributes effect peoples' comfort and visual needs as well as impact the QOL of people of all ages. Moreover, reseach shows that poor design of building blocks, directly and indirectly, affect the elderly population to catch respiratory diseases (like Asthma, Pneumonia etc.,) cardiovascular diseases (like Hypertension and heart disease etc.,) and Neurological and Cognitive Disorders (like dementia). (Parker et al. 2004, p.941) (Fleming et al. 2016, p.663)

Open Space Design: Parks, gardens, streets, landscape areas, and vacant plots provide people with fresh air to breathe, relax, and interact with others enhancing their quality of life. The open spaces, greeneries and landscapes have health, social, economic, and environmental benefits that combine to impact quality of life (Mensah et al. 2016, p.1). also, landscape areas act as breathing space for a city which decongests the chaos and disorderliness of it.

Balance of built-unbuilt: Residential neighbourhoods with adequate heating and ventilation provide their occupants safer, healthier, and much higher quality of life (Fleming et al. 2016, p.663). Poor-quality surroundings with minimal left-over spaces around living areas may be responsible for depression in children as well as the elderly population. These may create emergency situations at times due to fire, disaster, etc.

Development pattern: The types of usage of land, whether mixed-use, commercial, or residential predominate zones; encourage a range of activities to promote social interaction and reduce unnecessary commuting. However, development pattern and QOL are context dependent for example higher density and mixed land use are correlated with higher QOL in research conducted by Yang (2008) on the contrary dense settlements in Jakarta perceived high QOL in research by Komalawati & Lim (2021).

Accessibility and Connectivity: Smooth access to the physical and social infrastructure and other services encourages people to perform daily life activities. Accessible and connected spaces provide ease of movement and upgrade overall well-being (Moore 2021) (Nury & Haykal 2023).

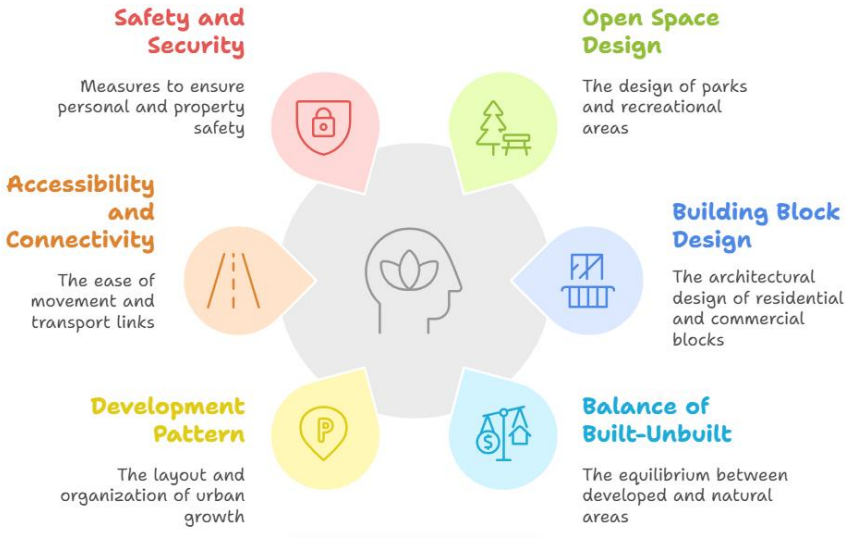


Fig. 2.4: Aspects of Built Environment Influencing Quality of Life

Source: Author (Prepared using https://app.napkin.ai/)

Safety and security: Safety and security are closely interrelated (Momani, Alduraidi, & Zaghmouri 2023) and positively influence in quality of life (Sheykhi 2022). More people on the road ensures 'eyes on the street' and face-to-face communication among them, creating a higher possibility for getting help in emergency needs. Well-lit streets, clear signage, etc. provide security in public spaces and enhance experiential quality.

Life Satisfaction: The physical and psychological well-being of people of all age groups is associated with happiness and comfort of life (Medvedev & Landhuis 2018). Life satisfaction is an individual assessment or judgement (López-Gómez, Chaves & Vázquez 2020) on feelings, happiness and attitude of one's own life (Chaturvedi & Singh 2013) and a significant aspect of QOL of people.

Such aspects collectively determine how the built environment supports a high quality of life, making urban areas more liveable and sustainable.

2.2.4 Impact of Built Environment on Feeling of Safety

Numerous urban design theories, such as Jan Gehl's "Cities for People", "Space Syntex Theory", "Inclusive Cities", Oscar Newman's "Defensible Spaces", etc., are constantly showing concern for a safe and comfortable built environment for people to use, especially the outdoor public areas. The significance of such theories is appreciated due to the human tendency to assume places as safe or unsafe based on the way they perceive these spaces. Therefore, the arrangements of the buildings (Butterworth 2000), the road network (Rashid, Wahab & Rani 2017), the streetscape (Harvey et al. 2015, p.18), the vegetation (Jorgensen, Hitchmough, & Calvert 2002), etc., are a few components that influence human cognition as

of when human being get involved and interacts with these components. The human interaction with these components registers an image of the area resulting in developing perception regarding the safety. A place might be familiar to a visitor if its elements are legible and possess the ability to form a clear and accurate image in the minds of people. The image of the built environment can be perceived through viewing, using and enjoying the physical elements (such as building blocks, road networks, open spaces, infrastructural facilities etc.,) and realizing the cultural identity they reflect (Akın 2020). The lifestyle and characters of people, norms and rituals related to tradition, and human senses of touch, hearing, smell etc. also help construct the mind-image (Lynch 1960). Based on this perception, people tend to distinguish certain spaces as safe or unsafe. Hale (2008) talked about the inclusion of the idea of "community-led urban design," which values the opinions of the general people and encourages them to participate in the design process of a safer built environment for their communities.

Saputra & Widyasmara (2014)'s research discusses the need for mobility arrangements like availability of modes of transportation, connecting vehicles and the way people use these i.e. the behavioural aspects of humans are connected to the general feeling of safety. The managerial aspects of mobility arrangements (for example, ensuring compliance with safety norms, safety audits, emergency response facilities etc.,) affect daily commutes impacting largely the feeling of safety.

There are varied approaches and research to answer the question of how to make spaces safe for people. A few approaches advocate "restrictive" use of spaces whereas a few researchers support preventive measures (Turner et al. 2006, p.451). Richard A. Gardiner (1979) has discussed the theory of 'Urban fortress', which can be considered a restrictive theory that focuses on building walls, barriers, gates, etc., to segregate the neighbourhoods from the outer world to achieve higher safety and security. Whereas Newman (1996) suggested territory, building placement and juxtaposition, building height and size, barriers (real or perceptual), the hierarchy of spaces (like individual's private zone, private apartments, and communal spaces) etc., as aspects that develop a higher sense of safety.

The elements of the built environment impact differently on diverse populations based on age groups, sex, and ethnicity of people. The report "*Guidelines for Planning for Older People in Public Open Space*" by Wendy Sarkissian and Beauford Stenberg has discussed safe spaces for the elderly population. The book discusses visual cues (landmarks, signage, etc.) and tactile cues (handrails, wall and path texture changes) as necessary elements in public spaces

that ensure safety for older people. The frequent use of outdoor spaces by children, adults and older populations demands the built environment to be more sympathetic; ensuring universal accessibility and safety to these groups.

The feeling of safety develops through "natural surveillance" and "visibility of open spaces" (Sarkissian 2013). Traditional Street networks with higher presence, activities and interaction of people on the roadside enhance the sense of safety (Ariff et al. 2021, p.64). However, with the advancement of technology along with natural surveillance, surveillance through community participation a third dimension of surveillance has been discussed by Raj & Patil (2023), which includes Technology and innovation, physical design and geo-political & socio-cultural divisions.

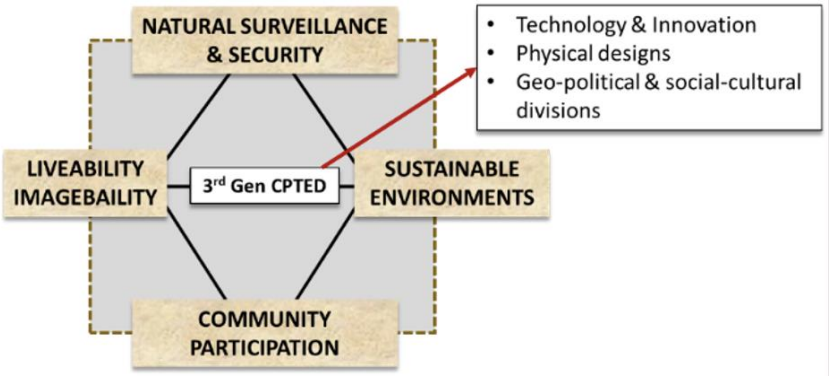


Fig. 2.5: Evolved Structure of CPTED

Source: Raj & Patil 2023

2.3 Sense of Safety

2.3.1 Personal Safety is a Human Need

Feeling safe in everyday environments - whether at home, in public spaces, or at the workplace - fosters confidence, social interaction, and productivity. Personal safety is a fundamental need and essential for creating inclusive and resilient communities where people can thrive without fear. In this context, Abraham Maslow's (1970) hierarchy of needs emphasises that personal safety becomes essential after physiological needs are met, which provides security and stability for psychological well-being and self-fulfilment. Wendy (2007) has structured down the needs for human development in which shelter, territoriality, etc., are found to be human's physiological needs looked upon for bodily protection and security whereas, community, kinship, sense of community, etc. are to be human's psychological needs. This psychological safety is associated with life satisfaction (Varela et al. 2020, p.1489). On the contrary, a lack of personal safety can result in anxiety, panic, and a

continuous state of attention, all of which have a detrimental impact on one's ability to live carefree.

2.3.2 Safety and Sense of Safety

WHO's definition of safety has pointed out two dimensions of safety – the "objective" which can be seen as behavioural and environmental factors and the "subjective" dimension which the human feeling of safety can appraise. The objective dimension can be easily attributed and measured (such as crime statistics, accident rate, etc.) whereas the subjective dimensions of safety are difficult to measure (including perception, experiences, beliefs, etc.) because they vary from person to person and depend on multifaceted factors such as age, sex and economic and social condition. The subjective dimensions are frequently guided by the objective dimensions. Therefore, psychological safety is not just influenced by the absence of unlawful acts but also by the presence of an inclusive environment which can connect to people and their behaviour. The study aims to address issues of safety about criminal activities, such as theft, burglary, vandalism, etc.; mobility safety, such as accidents and harassment experienced by walkers and cyclists; and 'exclusion insecurities' and 'psychological discomfort' due to lack of areas designated for children's play, elderly people's walking, pregnant women's comfort, etc. Accordingly, this safety perception or feeling of safety does not consider structural safety, disaster safety, web safety, legal safety etc., even if they are important aspects of urban safety.

The feeling of safety varies from person to person depending on how their psychology perceives the surrounding physical features such as buildings, roads, lighting, benches, landscape, etc. (Karunananda, Rajapakse, & Rathnayake 2018). Such an outdoor environment and the elements create insecurity for the public, then people do not intend to visit that particular place and as a result, the space becomes less active or inactive. Hami and Emami (2015) found that a familiar place is always people's preference in a city. The repetition of familiar trees, low-density plants of favoured flowers, and landscapes with water features may contribute to creating a familiar space. A familiar space is generally perceived to be safe as in an emergency, people can easily find escape routes or suitable safe spots. In the case of non-familiar spaces, the streetscape elements, people and activities cannot connect and interact with its visitors resulting in insecurity. Therefore, a strong relationship can be observed in between the urban space, its various elements, and peoples' sense of safety, which establish a connection even in an unfamiliar place (Jayasinghe, 2016).

The fear of being harmed can prohibit people from getting involved in public activities and visiting those urban spaces frequently. According to Loewen and team (1993), a sense of safety is directly related to the fear of crime. High-rise elevated designs with less visibility, and repetitive, gloomy, and narrow spaces increase the sense of fear. The study by Jayasinnghe (2016) claims that visibility, boundary, and enclosure of landscaped spaces play significant roles in providing psychological comfort to use the space; subsequently developing a sense of safety.

2.3.3 Safety and Built Environment

2.3.3.1 Neighborhood Design and Sense of Safety

A safer neighbourhood is always a priority for people when selecting a place to live in urban areas. Safety in a neighbourhood is directly dependent on the relationship among the neighbours and their behaviour within the space (Sakip, Johari & Salleh 2013, p.384). Neighbourhood design, in an urban context, has become one of the prime concerns among planners and designers to enhance the quality of public life. As a basic planning unit, neighbourhoods seek particular attention as people perform day-to-day activities in the neighbourhoods.

The neighbourhoods differentiate the two housing typologies – Gated communities and non-gated neighbourhoods. Various researchers have claimed that the privatism of guarded neighbourhoods in the case of gated communities is the reason behind social segregation which eradicates the traditional form of communities seen in non-gated housing areas (Roitman 2010). The increased fear of crime and expectation of comfortable living brought about the concept of gated communities. People in non-gated neighbourhoods are attempting to live in or buy houses in the housing townships and apartments with security gates for permanent dwellings. Edward Blakely in His book “Fortress America: Gated Communities in the United States (1997)” has mentioned the false sense of security in gated communities because of the self-centric lifestyle each person carries. Though the neighbours’ houses are closer and they share the same facilities like a gym, club, etc., lack of desire is seen to interact among themselves. Burke’s (2001) types of gated communities are namely – urban security zones, secure apartment complexes, secure suburban states, secure resort communities, and secure rural-residential estates that focus mainly on safety and security from occurring crimes to achieve pedestrian-friendly neighbourhoods. Rafiemanzelat (2016) believed that gated communities are meant for specific groups of people to reduce social diversity and increase

social inequality. The gates, walls, and guards make the public spaces of these areas private, restrict the mixing of different groups of people, and cultural exchange, and encourage economic segregation. In gated communities opposite to the traditional non-gated communities high class division can be observed among poor and middle-upper-class people. The researchers (Blakely and Snyder 1998) have discussed three different magnitudes in the context of gated neighbourhoods likely 'Lifestyle' which depicts the amenities within such as clubs, gardens, resorts, etc.; 'Prestige' where the high walls and gates signify people's richness and high standard of living; and 'Security' that is being fulfilled by the guards and the gates. According to the researcher, the expectation of people to achieve a luxurious lifestyle, Prestige living and Security encourages people to choose gated communities.

Another research by Weidemann & Anderson, (1982) introduced the concept of 'housing satisfaction' that has a direct dependence on the safety and security of the neighbourhood, which ultimately depends on the quality of design of the built environment. The design of housing, in the context of gated communities also in non-gated residential plotted developments needs to address the safety factor. Crime and violence against human beings, especially women, children, old people, pregnant ladies, and physically disabled people have increased peoples' demand for safe residential areas. The feeling of safety inside a residential area fosters productivity, whereas insecurity in the neighbourhoods affects the health and well-being of its residents, and hampers comfortable life activities, thus restricting human development as well as the society.

2.3.3.2 Community Building and Safety

A safer physical environment helps people in community building through engagement in daily activities with their neighbours, interaction between people and sharing of the common facilities of the cities. Jan Gehl (2013) mentioned about three different types of activities for which people interact with the surrounding built environment – "necessary activities" that don't have any other option but to perform, eg. Going to the office; "optional activities" are the fun events such as outings in a restaurant; and "social activities" which are common events of the society such as festivals. The more people feel safe and secure being in an urban environment, the more they come out from home to perform different activities. A safe and quality-built environment enables its residents to actively participate and enjoy life activities fostering a strong sense of collective responsibility (Bell 1998). Interaction of people with the built environment is not only restricted to designated places like restaurants, community halls, etc., but extends to places of transportation, recreation and also to the work

environments, therefore, safe place design should incorporate all these spaces with which people interact while performing day-to-day activities.

2.4 Worldwide Policies Related to Safety of the Built Environment

2.4.1 New Urban Agenda (NUA)

The New Urban Agenda, in 2016, adopted by 167 countries, explicitly included safe and sustainable mobility and affordable housing as elements in making cities more sustainable and equitable. NUA's (2017) focus is to build safe urban spaces where all groups of people participate inclusively without any discrimination in the urban development process, aiming towards liveability and sustainability. Accessibility to both social and physical infrastructure and basic services, as well as encouraging interaction among people of different cultures and backgrounds on safer streets, quality public spaces, and a healthy environment, are a few of the concerns of NUA. Appropriate strategies for the prevention of crime and violence, training programs for strengthening sustainable transportation, bicycle mobility, and pedestrianisation are the commitments of the new agenda towards urban development. Road design, affordable drinking water, adequate sanitation and hygiene in terms of safety and security with special attention to the needs of women, girls, youths, children, older people, persons with disabilities, and other vulnerable groups are also the objectives lying behind this global agenda.

2.4.2 Sustainable Development Goals (SDGs)

SDG, goal 11, about Sustainable Cities and Communities, targets to "*make cities and human settlements inclusive, safe, resilient, and sustainable*".

The targets of Goal 11 are concerned with safe housing with basic facilities like health, education, etc., available in the near vicinity, accessibility of facilities, and articulation of cultural aspects in the built environment. Here, the public transportation system and its station points are aimed at building a safe and usable system for all, regardless of the abilities of the public, i.e. encouraging universal accessibility. Target 11.7 focuses on building safer public spaces for women and girls so that they can equally use the city without fear of being harmed; learning outdoor environment for children; working environment for the working population; barrier-free measures on public spaces to fulfil inclusive design criteria (SDGs 2015).

Table 2.1: SDG Goals and their Targets

Target No.	Targets	Indicators
11.1	By 2030, to ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.	The proportion of the urban population living in slums, informal settlements, or inadequate housing.
11.2	By 2030, to provide access to safe, affordable, accessible, and sustainable transport systems with special attention to women, children, persons with disabilities, and older persons.	The proportion of the population that has convenient access to public transport is disaggregated by age group, sex, and persons with disabilities.
11.7	By 2030, to provide universal access to safe, inclusive, and accessible, green and public spaces, in particular for women and children, older persons, and persons with disabilities.	-The average share of the built-up area of cities that is open space in public use for all disaggregated by age group, sex, and persons with disabilities. -Proportion of women subjected to physical or sexual harassment by perpetrator and place of occurrence.

Source: New Urban Agenda 2017

2.4.3 UN's Safer City Program

Fig. 2.6: Safer City Program by UN

Source: UN Habitat

UN's Safer City program since 1996 has focused on building inclusive policies promoting well-connected and networked compact city spaces to encourage physical interaction among people, and common group activities so that they can live fearless lives. The provisions for inclusive, interactive spaces have been a benchmark for evaluating the performance of local governance. Institutional crime and violence prevention – promoting the role of local government in providing safety and security for their inhabitants, and alternative forms of policing (community policing and problem-oriented policing), social crime prevention, and the physical environment –are the three pillars discussed in the report.

All public bodies who have launched global programs of QOL (Quality of Life) mandate safety as one of the main objectives of their initiatives and decided to take action at the local level taking into consideration the ground realities. Michaud and Paquin (2002) have pointed out local partnership approaches for best public policies to empower women in society. According to Michaud and Paquin (2002), the survey design process for public policies must be multi-disciplinary and decentralised, involving groups of people from different professions and backgrounds, such as municipalities, the police, health services, schools, and other social services, etc.

2.4.4 UN Women Global Flagship Program

UN's Safe Cities and Safe Public Spaces: Flagship Programme is committed to investing in the safety and economic viability of public spaces, respecting the gender-responsive aspects to prevent sexual violence in public areas. It supports a gender approach to city design and ensures that the needs of women and men are taken into account during decision-making.

This approach also includes investments towards public infrastructure such as safe portable water, improved sanitation, lighting, creation of market stalls, provision of training on financial literacy and economic upliftment, focusing on opportunities for women's empowerment. The program commits to changing social norms to promote women's rights to enjoy public spaces without the fear of violence (UN Women 2023).

2.4.5 Other Reports and Guidelines

2.4.5.1 UN's Global Report on Human Settlements Enhancing Urban Safety and Security (2007)

This report focuses on major safety issues faced by the city people and contributes to solving these to create *social, environmental, and cultural systems* around people that ultimately aim to protect the freedom and dignity of citizens. This report identifies urban crime and violence as one of the key issues in terms of safety and security in urban areas, affecting the freedom and mobility rights of people. As per this report, global crime incidences have increased by 30% throughout 1980-2000 i.e. from 2300 to 3000 crimes per 1,00,000 inhabitants. With this increase in incidents of crime, the concern to mitigate the issues of safety and security has risen from not only national and local levels but also individual levels as crime hamper victims' lives, family as well and overall development.

Poverty, unemployment, inequality, etc. are the underlying reasons behind crime and violence, as stated in the report, and results are related to robberies, burgeries, terrorism,

corruption, homicide, child abuse, and organized crime like kidnapping, drug, arms, human trafficking, etc. victimizing urban poor, slums, squat, tenants, women, children, elderly, ill people, migrant workers, minor groups, indigenous people, refugees, etc.

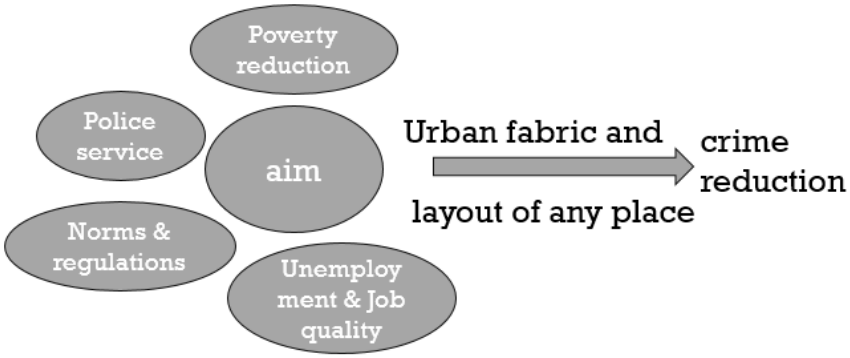


Fig. 2.7: Objectives of UN's Global Report

To mitigate such crime status, the program aims to revive public belief in public services such as the police service system by improving the norms and regulations. Along with this, the program suggests robust urban design and governance of the cities engaging a public participation approach to improve life quality. Urban fabric and layout of any place are a few of the physical components that, as mentioned, need to be looked upon in this regard (Enhancing Urban Safety and Security 2007).

2.4.5.2 Crime Prevention through Environmental Design (CPTED 2007)

The CPTED 2007, provides guidelines for the strategies supporting a safer urban environment through the proper design of physical elements of the built environment. The principles it follows such as *natural surveillance, natural access control, territorial reinforcement, legibility, vulnerability, and maintenance.* Here, the term 'natural' means the built environment itself should restrict the bad deeds to occur and enhance the safety and security of such areas. That means the CPTED approach is more dependent on the planning of physical components of the built environment than the after-designed ornamented safety measures like CCTV cameras, sensor alarm devices, etc.

It has provided general guidelines for various typologies of buildings like residential houses and neighbourhoods, educational buildings, shopping malls, stores, office buildings, industries, parking areas, ATM boots, as well as landscape and lighting systems in terms of site condition, architectural style, accessibility, circulation, visibility, public places, floor plans, materials, etc. (Virginia Municipal Centre 2000).

The key term, CPTED, has been introduced in the context of safety assurance through built environment design as well as which the basic principles of the approach are discussed below:

(a) Natural Surveillance

Natural Surveillance is a 'passive' means of surveillance. This means a built environment designing approach in which the physical environment, itself, is designed in a way that offers safety measures to the public using it. The concern factors are such as -

- The design should allow to have constant eyes on public spaces like streets, plazas, parks, etc., and concentrate on encouraging more people in such spaces to walk and interact.
- Mixed land use is encouraged so that different activity goes hand in hand.
- It will encourage cultural diversity and thus, safe streets day and night.

Fig. 2.8: Natural Surveillance in Public Places

Source: Ennead Architects, (available at: www.thorntontomasetti.com)

(b) Legibility

Paths, landmarks, edges, nodes, and districts are the important features contributing to forging the imaginary appearance of cities in the mind, which helps them to remember the city images (Lynch, 1960). Jen Gehl (2013) emphasised creating legible first and ground-floor facades as these floors frequently catch the public's eye. This way, the places become

familiar to people to make them feel safe and secure. The types, patterns, organisation, and orientation of urban landscapes play an important role in making the identification of different zones possible to ensure legibility in public spaces (Antrop 2005) (Peng et al. 2019, p.765).

Gordon Cullen and Jane Jacobs (1961), too preferred the cities with streets full of activities so that people don't hesitate to visit those again and again making the public spaces lively. Designing public corridors, arcades, and frontages of landmark buildings by following appropriate guidelines for set-backs, heights, signage, public art, zoning, and land use necessarily makes people less stressed and confused and helps to roam around with confidence on the streets, public plazas, parks, sidewalks, etc.

Fig. 2.9: Signage of the Cities

Source: Pavegen.com. (2024)

(a) Territoriality

Territory refers to *'ownership - individual and community ownership';* provides people the feeling of dominion, creates a 'sense of belongingness', attachment to the place, and

encourages safety. It allows natural surveillance and helps create the public realm for the elderly, women, ethnic and cultural groups, youth, disabled, etc. (Queensland report CPTED 2007)

(b) Vulnerability

'*The vulnerable spots'* in the environment include the dark corners of the streets, the vacant plots used for throwing garbage, unused spaces under the flyovers and footbridges, unnecessary corners created by the wrong orientation of buildings, underground parking areas, bus stations, phone booths, public toilets at night, dilapidated premises, etc., is regarded as vulnerable spots possessing opportunities of crime and violence, fire incidents, land encroachment, etc. Kushwah and Rathi (2017) mention that such unused open spaces are generated inside the cities due to three different reasons namely vacant plots due to poor planning; plots/spaces that are not in working condition though were designed to be used; and other areas that are left due to the geographical condition of the cities. The issues of dealing with such vulnerable spaces as taken for neglected spaces with no activities and no accessibility, an unattractive and unwelcoming environment (Rathi & Kushwah 2017). Designing such areas creatively with proper lighting, furniture, landscape, public art, walls, fences, tunnels, bridges, etc., can make a huge change in creating safe and vibrant urban areas.

(c) Permeability

Permeability is the feature which defines the places that are accessible to people and can offer them the choice of mobility from one place to another. In other terms, it can be said as how easily one can move through a particular place. The *'quality of permeability'* depends on the alternatives of approach to a particular place and how they link together within the defined blocks. It clarifies mobility, accessibility, and connectivity in both ways 'physical and visual both. The visual permeability, within the block boundary, plays an important role in this context (Bentley et al. 1985). People feel secure being there when a location is visually porous, if not physically, because they can read it without much struggle.

The figure below shows permeability measures of different typologies of blocks where heterogeneous mix blocks (E) are seen as the highest permeable and large blocks (D) as the lowest permeable in contrast to other blocks. The heterogeneous blocks foster higher visual connections and thus ensure a higher level of safety as compared to large or elongated blocks.

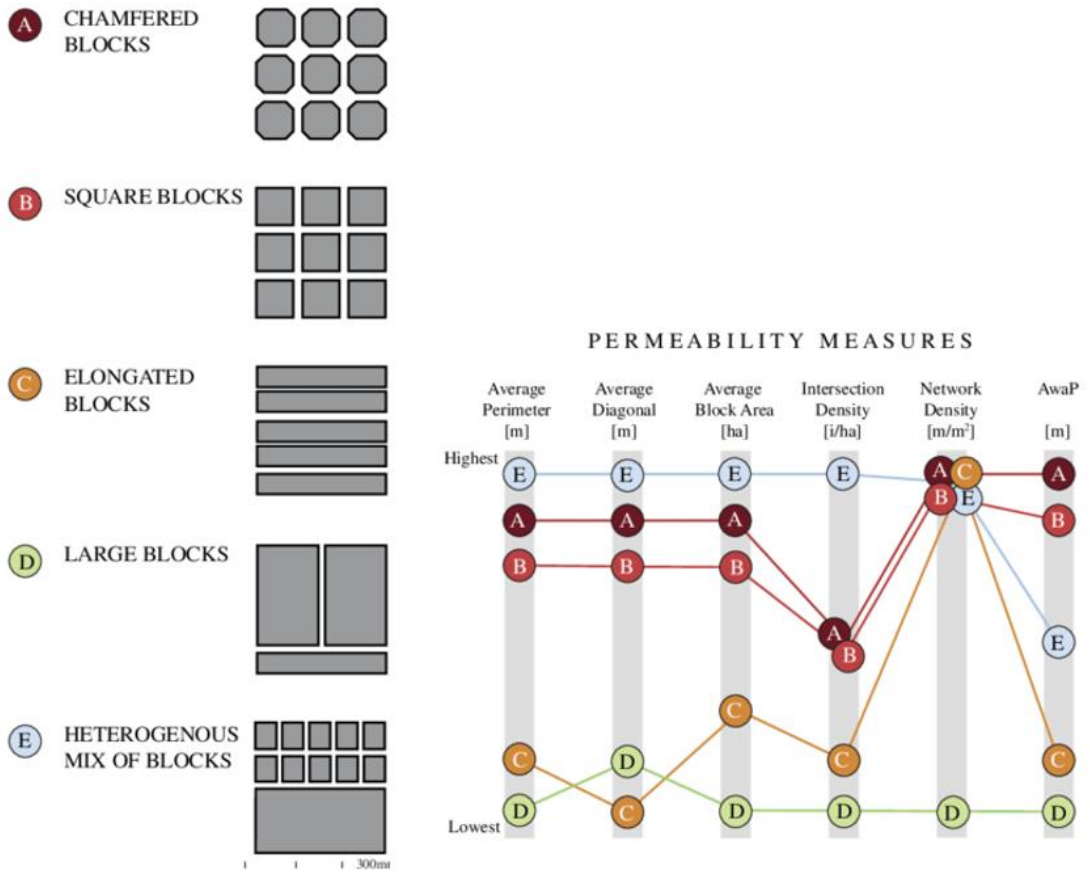


Fig. 2.10: Level of Permeability in Case of Different Block Arrangements

Source: Pafka & Dovey 2017

(a) Orientation:

Building orientation and street orientation in the cities allow a variety of people to come together. Solar orientation adds the orientation of the buildings in an urban area should consider at least two basic criteria – minimal disruption and greatest visibility (Ali & Aksamija 2008).

Fig. 2.11: Street Orientation and Visibility in an Urban Context

Source: Koltsova, Tunçer & Schmitt 2013

2.5 Urban Design Theories

2.5.1 Oscar Newman's Defensible Space Theory (1972)

In the context of safety in the housing system, Oscar Newman (1972) mentioned 'defensible space' which supports community design for crime prevention. According to this concept, the public spaces themselves should defend or supervise the public by their unique way of designing (Mayhew 1979). The theory emphasizes the role of the surrounding built environment to improve the sense of safety of people in a community. As discussed earlier in the CPTED report, defensible space theory also follows the same principles such as natural surveillance, access control, territorial reinforcement, etc. It encourages human interaction in public spaces so that 'interdependency' and 'self-help' cultures arise among the people of a community. The buildings, streets, green areas, trees, etc. are the physical components that are prime design concerns as the theory argues.

2.5.2 Kelling and Wilson's Broken Window Theory (1982)

In the context of neighbourhood safety, it is supposed that an "untended" behaviour towards a house may invite unwanted intruders. This is as if one of the windows of a house is broken and remains unattended and unrepaired, the other windows sometimes will also break and soon the house will become an abandoned property. These physical structures in between city fabric create feelings of doubt and reduce public interference in such a disorganized physical setting. The broken window theory tries to discourage criminal mindsets through social cohesion engaging the community. Abandoned buildings, broken graffiti, unused open spaces, damaged and unrepaired roads and sidewalks, etc. are the physical elements of an urban environment which if not maintained to a standard level, then it may lead to a breakdown of community control that may give rise to criminal activities (Weisburd & Braga 2019, p.121).

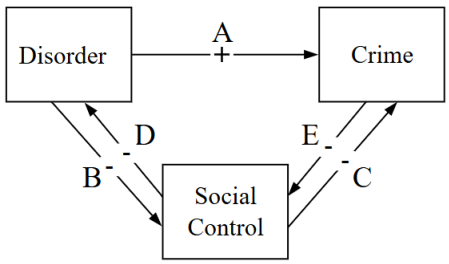


Fig. 2.12: Inter-relationship Among Crime, Disorder and Social Control

Source: Lanfear 2021

Disorders add up or invite crime, whereas social control can restrain or prevent both disorder as well as crime, ensuring safety in the localities.

2.5.3 Appleton's Prospect and Refuge Theory (1984)

The theory is based on the idea that people often prefer places that allow them clearly to observe the surroundings or prospects and, at the same time give opportunity and protection to withdraw if needed. As per the normal human tendency, people feel safe where they can observe their surroundings and get familiar with the environment; at the same time in case of need, there are places to hide or seek help. It shows concern for the following aspects of the built environment: *different surfaces, light intensity, scale, balance, and locomotion*. (Kawshalya & Dharmasena 2019).

2.5.4 Cornish's Rational Choice Theory

According to the rational choice theory, people make criminal judgments based on logical cost-benefit calculations. This hypothesis implies that prospective criminals consider the benefits and hazards of committing a crime before acting on it. A criminal is more inclined to commit a crime if they believe the rewards (like financial gain) will exceed the costs (like getting caught and facing legal repercussions) (Clarke & Felson 1993).

2.5.5 Cohen and Felson's Routine Activity Theory (1979)

The theory concerns the identification of the threats of the built environment that open opportunities for crime. According to this concept, crimes are likely to occur in the presence of three elements: a motivated offender, a suitable target, and the absence of a capable guardian. It believes that the urban design of any place has the power to manipulate the built environment through its planning to discourage the offender from committing a crime. This phenomenon has been termed a *'systematic accident'* by Felson, as cited by Cote (2002).

2.5.6 Tactical Urbanism

Tactical urbanism is one such approach that tries for immediate actions towards safe and secure streets and plazas through short, and low-cost initiatives. Temporal changes in the built environment for place-making in collaboration with local public participation to bring out more people on the streets are one of the main principles of tactical or pop-up urbanism. Such DIY (Do It Yourself) Urban Design initiative helps the social, cultural, religious, spatial, economic, and political development of an urban area allowing it to become a safe and vibrant activity place (Elrahman 2019, p.224).

2.6 Identification of Components of Built Environment Affecting Sense of Safety

A detailed literature study is conducted using different sources such as national and international journal papers, books, global reports, master and doctoral dissertations, websites of different govt. authorities, government reports and guidelines. The literature study has identified different physical components affecting people's sense of safety.

The research that focuses on components of the built environment, found in the literature review, is represented in a systematic and condensed form in Table 2.2. The components are arranged according to the authors who had introduced them and citations as per Google Scholar (as of April 2021), and consensus level based on frequency of appearance across reviewed literature and expert opinions are provided.

Table 2.2: Summary of the literature sources highlighting the Built Components

Sl. No.	Authors & Sources	Year	Physical Components Affecting Built Environment Safety	Citations as per Google Scholar Citations & Consensus level
Research Articles & Books				
1	Brian E. Saelens and Susan L. Handy	2008	Land use pattern & accessibility, proximity, aesthetics, street connectivity, built forms, transportation system, sidewalks	Highly Cited
2	Nicola Dempsey	2008	Attractiveness, Architectural characters, mixed land uses, accessibility, connectivity, permeability, legibility	Not found
3.	Jie Li	2012	Architecture styles	Not found
4.	B. Setiawan	2017	Green space	Not found
5.	O.A Rastyapina	2016	Architecture style	Not found
6.	Solanki, H.K., Ahamed, F., Gupta, S.K. and Nongkynrih,	2016	Road efficiency and safety	Not found
7.	Iain Butterworth	2000	Architectural style and characters, legibility, built forms, built form, transportation	Not found
8.	Oc, T., & Tiesdell, S.	1999	Built form, barriers	46
9.	Jansson, M., Fors, H., Lindgren, T. and Wiström, B.,	2013	Vegetation, landscape design, lighting on street.	Highly Cited 156

10.	Mouratidis, K.,	2019	Tree cover, built form	36
11.	Kuo, F., Bacaicoa, M., & Sullivan, W.,	1998	Tree density, grass maintenance	Highly Cited 440
12.	Harvey, C., Aultman-Hall, L., Hurley, S., & Troy, A.	2015	Tree canopy, Built form	71
13.	Dumbaugh, E., & Gattis, J.	2005	Liveable streetscape, architecture style	Highly Cited 308
14.	Garnett, N.	2012	Mixed land use	5
15.	Raman, R., & Roy, U.	2019	Mixed land use	26
16.	BE Saelens, SL Handy	2008	Transportation, distance to different destinations and land use mix	Highly Cited 2404
17.	SL Handy, MG Boarnet, R Ewing	2002	Urban design, land use patterns, and transportation systems	Highly Cited 2578
18.	Barton, H., Thompson, S., Burgess, S. and Grant, M. eds.	2015	Land use types	154
19.	Elbeltagi, E., Hegazy, T. and Eldosouky, A.,	2004	Layout, placement of amenities	209
20.	Cozens, P. and Hillier, D.,	2008	Layout, walkability	116
21	Stoker, P., Garfinkel-Castro, A., Khayesi, M., Odero, W., Mwangi, M., Peden, M., & Ewing, R.	2015	Layout, land use	118
22.	Hong, J. and Chen, C.	2014	Accessibility, pedestrian facilities, layout	75
23.	Tugnoli, A., Khan, F., Amyotte, P. and Cozzani, V	2008	Layout, Plant layout	116
24.	Law, S., Stonor, T. and Lingawi, S.	2013	Layout design	9
25.	Evans, G.	2009	Layout of buildings and road infrastructure	115
26.	Marcus, C.C. and Francis, C. eds.	1997	Layout of public open spaces	Highly Cited 1179
27.	Ma, Q., Zhang, J. and Li, Y.	2024	Street layout, architectural style, façade design, built form, access points, planting and lighting layout	40
28.	Sharifi, A.	2019	Built form	175
29.	Mouratidis, K.	2018	Built form, mixed land uses	223
30.	Shach-Pinsly, D.	2019	Built form, building façade and entrances	58
31.	Novakovic, N. and Djukic, A.	2015	Built form, public open space	6

32.	Taraszkiewicz, A. and Gerigk, M.	2015	Multifunctional building design	4
33.	Schepers, P., Lovegrove, G. and Helbich, M.,	2019	Built form, accessibility	26
34.	Tonkiss, F.	2014	Built form	453
	Authority Reports & Websites			
1.	Urban Safety Project 'Urban Safety and Security in Myanmar	2018	Transport, green public spaces, lighting system, sidewalks	NA
2.	Indicators for a Healthy Built Environment in BC	2008	Mix land-use, connectivity, public transit system, recreational facilities, infrastructure	NA
3.	Report by Public Health Dept. of Ireland	2006	Well-lighted streets, well connected public open space, streets facilities for cycling and walking, low-rise apartments	NA
4.	New Urban Agenda	2016	Quality public spaces, road design	NA
5.	Goal 11: Sustainable Development Goals		Open space, land use	NA
6.	Safer City Program by UN		Street design, connectivity, public spaces, mixed land use	NA
7.	Safe Cities and Safe Public Spaces: Flagship Programme		Layout, open spaces, inclusivity	NA
8.	UN's Global Report on Human Settlements Enhancing Urban Safety and Security	2007	Layout, visibility, lighting, land use mix, public open spaces	NA
9.	Center for Urban safety		Accessible parks, recreational facilities, and pedestrian-friendly streets	NA
10.	Un Habitat		Accessibility, inclusivity	NA
11.	Cycling-inclusive policy development: A handbook	2009	Built form, cycling tracks	NA
	Urban Design Theories			
1.	Oscar Newman's defensible space	1997	Fences, high walls, building placement, building height and size, barriers, public open spaces etc.	1520
2.	Urban village Theory	Late 1980	Human scales, pedestrian paths, built form	3
3.	Urban fortress Theory	-	Entry and exit points, layout	104
4.	Cohen and Felson's Routine Activity Theory	1979	Layout, access points, visibility	159

5.	James Q Wilson & George Kelling's Broken Windows Theory	1982	Architecture style, signage, landscape, lighting, and ground floor design	78, 54
6.	Brantingham & Brantingham's Environmental Criminology Theory	1981	Land use, traffic patterns, and street layout	12
7.	Cornish & Clarke's Rational Choice Theory	1987	Fences, visibility, and lighting	12
8.	Felson and Clarke's Crime Pattern Theory (CPT)	1998	Nodes, paths, edges.	12
9.	Crime Prevention Through Environmental Design	2000	Landscape, lighting system, Architectural style, accessibility, public places, Materials, etc.	NA

Compiled by researcher

This variety of literature sources, as mentioned in the above-table helps in understanding the diverse perspectives and foundational knowledge related to the components of built environment that ensures safety and security. The research papers provide empirical evidences, reports present practical insights from authoritative sources, and theories offer conceptual frameworks.

The identified components need refinements to be used in this research. The following sections of this chapter will provide an explanation of the selection procedure of the components identified for the purpose of using the components in upcoming stages.

2.7 Selection of components from the literature survey

To arrive at a manageable and concise set of components, a frequency-based selection method is adopted that is showcased in literature used by Heymans et. al (2024, p.20), He & Chen (2024), Zhang and team (2020), and Fu et. al. (2021) in their research. Therefore, from the above-mentioned research conducted by various authors, it can be observed that "frequency of appearance" is an appropriate method to choose and emphasise influential aspects or dimensions/components among multiple aspects.

Therefore, firstly, the built components are listed, which are likely 1) built forms, 2) layout, 3) land use, 4) open spaces, 5) trees, 6) lighting, 7) landscape, 8) architectural style, 9) visual symbols, and 10) materials. Based on the mentions and appearance of these ten components in the available literature, a frequency table has been prepared. To highlight the ten number components and their recorded instances, the following frequency table (Table 2.3) has been formed which is considered crucial for further investigation.

Table 2.3: Literature Mentions of Built Components

Sl. No	Components	Frequency of Appearance
1	Built Form	59
2	Layout	52
3	Land use	47
4	Open spaces	45
5	Location of Trees	43
6	Lighting	42
7	Landscape	36
8	Architectural Style	32
9	Visual Symbol	31
10	Materials	27

From the above table, it can be considered that the researchers of the relevant subject matter prefer the mentioned components to be most effective for research related to safety and the built environment. Here, out of all the ten, 1) built form, 2) layout, 3) land use, 4) open space, and 5) tree are the five built components that top the list and are found to appear more frequently in the available literature. To validate this process of component selection, the researcher has conducted an Expert Opinion survey, which has been discussed in the next section of this chapter.

2.8 Prioritising the components by experts

Prioritising the components is necessary for further study to narrow the focus of the research. The expert opinion survey method is essential at this stage to validate the most previously built components that are found from the 'frequency of appearance' method. For this purpose, nine numbers of experts were selected by the researcher from the relevant fields out of which three are Architect Planners (B.Arch, M.Plan), one is Engineer Planner (B.Tech, M.Plan), one is Landscape Architect (B.Arch, M.Arch in Landscape Architecture), three are Urban Designers (B.Arch, M.Arch in Urban Design), and another one is Environmental Planner (B.Arch, M.Plan).

Consultation with the selected experts developed the weights of the selected components with the help of the expert opinion survey method. For this purpose, the experts were asked to rank the 10 numbers of components. To rank the components as per their importance the experts

are requested to use a 5-point Likert scale where 5 means 'most important' and 1 means 'minimal importance'. The average rating value for each of the selected components has been listed in Table 2.4.

Table 2.4: Average Ratings of Components as per Expert Consultation

Sl. No.	Components	Expert 1	2	3	4	5	6	7	8	9	Average Rating
1	Built Form	5	4	4	5	5	4	5	5	5	4.66
2	Layout	4	5	5	4	4	5	4	4	4	4.33
3	Land use	4	3	5	4	4	3	3	4	5	3.88
4	Open Space	4	3	4	4	4	3	4	4	4	3.77
5	Tree location	3	4	3	3	3	4	5	3	5	3.66
6	Lighting	3	3	2	3	3	3	3	3	3	2.89
7	Landscape	2	3	1	2	2	3	1	2	1	1.99
8	Architectural Style	1	2	3	1	1	2	2	1	2	1.67
9	Visual Symbol	2	1	1	2	2	1	2	2	2	1.67
10	Materials	1	2	1	1	1	2	2	1	2	1.44

Based on Table 2.4, built form (4.66) is found to be the most important component among all the others. It, also, appeared to carry the highest value in the frequency table (59 times as per Table 2.3). Built form is followed by layout (4.33), land use (3.88), open space (3.77), trees (3.66) and others.

Table 2.3 and Table 2.4 prove a strong alignment and substantial correlation between literature findings and expert consultation, and results in the same set of built components which comprises 1) built form, 2) layout, 3) land use, 4) open space, and 5) trees. Considering these five as the key components of the research, the further sections of this chapter will explore the indicators and evaluation criteria for further stages.

2.9 Identification & Selection of Indicators of the Selected Components

This part of the literature review has been done to identify the indicators of the key components of the study. Another set of research papers from reputed journals, and articles from official websites are studied and indicators are noted down and tabulated in the table below. The indicators against each component are identified based on their relevance to the objectives of the research.

Table 2.5: Compilation of Indicators of Selected Components

Sl. No.	Components	Indicators	Literature Sources
1	Built Form	Human Scale, Architectural details, Urban elements, Building density	Shach-Pinsly 2019 Lukina, Selivanova & Temirsultanova 2020 Shen et al. 2017, p.1004 Wadley & Gore 2016
2	Layout	Road Network Design, Connectivity, Pedestrian Flows, Edge treatment, Access points	Elhamy 2012 Pavone, Polimeni & Vitetta 2013 Stangl & Guinn 2011 Ozbil, Peponis & Stone 2011 Igakura et al. 2013, p.345 Silavi et al. 2017, p.101
3	Land use	Diversity, Access, Compatibility, Change, Function, Proximity	Chiang & Lei 2016 Rachman & Marsuq 2020 Perez-Soba et al. 2008, p. 375 Effati & Saheli 2022
4	Public Open Space	Spatial Characteristics, Accessibility to green spaces, Legibility	Gao, Wu, & Wang 2021 Chen, Liu & Liu 2016 Rosa 2014 Koseoglua & Camas 2016
5	Trees	Tree cover, Height, Size, Density, Tree form	Troy et al. 2012, p.262 Harvey et al. 2015, p.18 Mouratidis 2019 Sterck & Bongers 1998 Klein et. al., 2021, p. 127307 Kuo, Bacaicoa & Sullivan 1998 Lin, Wang & Huang 2021

Compiled by researcher

A comprehensive set of indicators is, initially, identified through a literature review as discussed in Table 2.5, later for focused research, a researcher should select indicators that are crucial for research. Hence, an expert survey with the same group of experts (as chosen earlier for component selection) guided the selection of three key indicators per component based on their expertise and considering the relevance of each indicator. During this consultation, the experts are asked to use a 5-point Likert scale (as in the component selection process) to mark the identified indicators as per their priority and relevance. After the survey as the weights are achieved, the values are averaged to get the top three indicators with the highest weights. The top three indicators with the highest average ratings are chosen as the final indicators for each component (refer Table 2.6). The reason behind limiting to selection

of three indicators is to ensure uniformity among the components of the study so that the research does not get biased to a specific set of indicators. The following indicators are identified and weights are calculated based on expert consultation.

Table 2.6: List of Identified Indicators and their Weights

Components	Parameters/Indicators	Av. Weights
1. Built Form	**Human Scale**	**1.04**
	Architectural Details	**0.94**
	Urban elements	**0.89**
	Building density	0.86
2. Layout	**Road Design**	**1.10**
	Connectivity	**1.02**
	Pedestrian Flow	**0.86**
	Edge Treatment	0.79
	Access points	0.86
3. Land use	**Diversity**	**1.11**
	Access	**1.07**
	Compatibility	**1.06**
	Change	0.91
	Function	0.84
	Proximity	0.81
4. Open Space	**Spatial Characteristics**	**1.53**
	Accessibility	**1.45**
	Legibility	**1.04**
5. Trees	**Tree Cover**	**1.34**
	Height	**1.00**
	Size	**0.65**
	Density	0.44
	Tree Form	0.42

The top three indicators of each of the components achieve the highest weights and are considered key indicators for the components selected. These selected indicators will not only be helpful in present research but also can be instrumental for future research in this field.

2.10 Identification of Evaluation Criteria for each of the indicator

This chapter, till now, has discussed different components and indicators available in the literature. The process of selection of 10 numbers of components and 3 components for each of the components has also been discussed.

Although using the selected indicators researcher can collect relevant data in the field, to measure the data collected, it has to be appraised through a few evaluation criteria, so that measurable and achievable outcomes or inferences can be drawn. These evaluation criteria will help the researcher effectively collect the exact required data and avoid getting confused among a lot of irrelevant data, as well as help generate effective inferences from the collected dataset (Abdel-Rasoul et al. 2017). The researcher has generated a few evaluation criteria for each of the indicators, drawn from the literature review, which have been listed in Table 2.7. As suggested by (Abdel-Rasoul et al. 2017), in their work on how to collect evaluation criteria, a few evaluation criteria, along with instruments and tools to investigate those criteria concerning the study areas, have been listed. For future reference and to systematically organise the hierarchical structure of components, indicators and evaluation criteria, a nomenclature system has been adopted. The format used for the nomenclature is CxIyEz, wherein,

'C' denotes the key component

'I' denotes the indicator under that component

'E' denotes the evaluation criterion under the specific indicator, and

'x, y, z' are the sequential numbers of each element

Table 2.7: The List of Evaluation Criteria of Each Indicator

Sl. No.	**Components**	**Indicators**	**Evaluation criteria**	**Citation of Sources**
1	**C**1: Built Form	**C1I**1: Human Scale	**C1I1E**1: Human-proportioned doors and windows	Salingaros, N.A., 2021
			C1I1E2: Quality of Ground Floor Façade Design	Hassan, D.M., Moustafa, Y.M. and El-Fiki, S.M., 2019
		C1I2: Architectural Details	**C1I2E**1: Design Quality	Eilouti, B., 2020.
		C1I3: Urban Element	**C1I3E**2: Quality of Visual Aesthetic	Gjerde, M., 2010
2	**C**2: Layout	**C2I**1: Road Network Design	**C2I1E**1: Traffic Efficiency	Cui, Y., Yu, Y., Cai, Z. and Wang, D., 2022.

			C2I1E2: Condition of Road Surfaces	Rosolino et al. 2014, pp.624
		C2I2: Connectivity	**C2I2E1**: Route Directness	Stangl, P. and Guinn, J.M., 2011.
		C2I3: Pedestrian Flow	**C2I3E1**: Walking Quality	Paul, S., 2024, June.
3	**C3**: Land use	**C3I1**: Diversity	**C3I1E1**: Functional Mix	Zhuo et al. 2022, pp.2198
		C3I2: Access	**C3I2E1**: Access to Amenities	(https://x.com/complexurbanism/status/1296780101842087936/photo/1)
			C3I2E2: Proximity	Torre et al. 2014, pp.3
		C3I3: Compatibility	**C3I3E1**: Functional Synergy	Kangas et al. 2022, pp.115174
4	**C4**: Open Space	**C4I1**: Spatial Characteristics	**C4I1E1**: Functionality	Düzenli, T., Alpak, E.M. and Eren, T.E., 2018.
			C4I1E2: Social Interaction	Tabassum, S. and Sharmin, F., 2013.
		C4I2: Accessibility	**C4I2E1**: Quality of Access points	Paul, S., 2024,
		C4I3: Legibility	**C4I3E1**: Visual Landmarks	Massawe, E.M., 2011.
			C4I3E2: Enclosure Definition	Mackesy-Buckley, A.H., 2012.
5	**C5**: Trees	**C5I1**: Cover	**C5I1E1**: Density	Sheil, D., Ducey, M.J., Sidiyasa, K. and Samsoedin, I., 2003.
			C5I1E2: Canopy Coverage	Mincey, S.K., Schmitt-Harsh, M. and Thurau, R., 2013.
		C5I2: Height	**C5I2E1**: Ability to provide shade	Parisi, A.V. and Turnbull, D.J., 2014.
		C5I3: Size	**C5I3E1**: Diameter at breast height	Williams, V.L., Witkowski, E.T.F. and Balkwill, K., 2007.

2.11 The final selected Components, Indicators and Evaluation Criteria

The chosen key components, their associated indicators and evaluation criteria against each of the indicators are graphically arranged in the branch chart to get a clear idea about the components, their associated indicators and measuring criteria for this research.

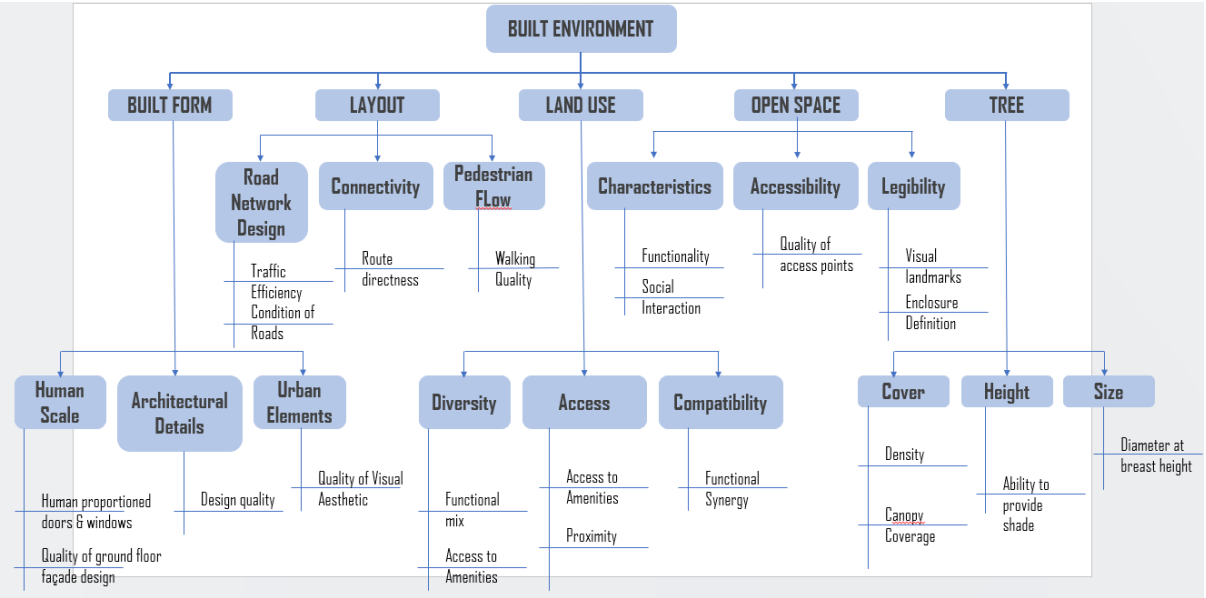


Fig. 2.13: Key Components, Indicators and Evaluation Criteria of Built Environment

2.12 Inferences

Approximately, 60% of the urban population in developing countries has been victims of urban crime and violence, globally which is 20% approx. The recent literature included in this chapter has justified the relevance of the topic in today's urban context. This chapter effectively shows a compact inquiry into the status, and dependent factors of the built environment and delivers the concept of a sense of safety. This chapter addresses the first and second research questions those are – "How does the built environment connect to peoples' sense of safety?" and "What are the physical components of the built environment that affect the sense of safety?".

This chapter has, also, fulfilled the first, and second objectives of the research which are to identify the physical components of the built environment affecting the sense of safety and the impact of the components on peoples' perceived safety. This chapter has listed relevant research for the selection of five components, fifteen indicators and twenty-one evaluation criteria.

The aforementioned reviews of research papers, books and theories included in Chapter 2 made a substantial contribution to the development of the framework required for further study.

Chapter 3: Materials and Methods

3.1 Chapter Overview

According to Kothari (2004), the research design or method means *"the conceptual structure within which research perceived is conducted; it constitutes the blueprint for the collection, measurement and analysis of data"*. So, research design gives the scientific way of expressing – *"What is the study about?", "(ii) Why is the study being made?", "What techniques of data collection will be used?", "(ix) How will the data be analysed?"* etc., concerning problem statement, aim, objectives, limitations, etc. So, there is always a need to decide the methodological approach of any research project at a very early stage. It does provide the researcher with a clear idea about the different steps to be followed to finish the research, as well as help the researcher to be on the right track till the completion stage. A research plan without a proper research design can mislead the researcher at any point in time, and thus, the work can be overlong and disoriented.

Therefore, the present chapter discusses, in detail, the research methodology adopted to conduct the various stages of this research. Here, a structured outline of the chapter has been created.

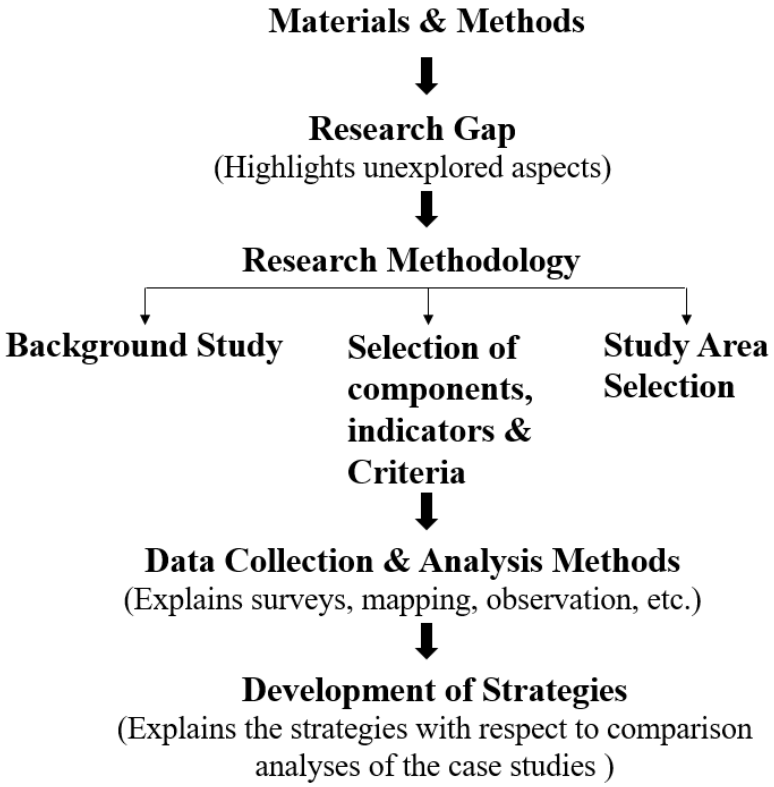


Fig. 3.1: Outline of the Chapter

This chapter explains the technicality and scientific approach behind the entire research project. Initially, the researcher's area of interest and the thriving discourses in today's urban context help to decide the broad subject matters of this research such as 'built environment', 'sense of safety', and 'urban areas of Guwahati'. The researcher, then, conducts a quick online search to learn more about the subjects. The feasibility considerations provide the researcher with background information. The initial search could establish the demand of the research to evaluate the surrounding environment and understand human perspectives about the elements of built spaces they use daily. Also, to examine the opportunities and deficiencies of the built environment better, the case example is intended to be considered by the researcher. Guwahati, as a rapidly changing city and having diverse localities present, is a perfect example to conduct research on the subject matters that this thesis deals with. To fully comprehend the problem within the context of Guwahati's urban areas, two steps are taken by the researcher – (i) a conversation with colleagues and friends of architecture and urban design and planning backgrounds and (ii) the conduction of a preliminary study on available literature to get more familiarize with the research problem. The formulation of the research problem offers the first scientific viewpoint on the project's topic. Moreover, further literature exploration helped the researcher to finally address the safety concerns of people due to the surrounding environment which furnishes the title of the research project as "Analysing Built Environment Affecting Sense of Safety: Case of Urban Areas in Guwahati, Assam".

3.2 Research Gap

Although there are many studies available on built environment parameters in the research repositories, a large number of studies are restricted when it comes to considering the urban people's sense of safety into account in the context of evaluating the physical environmental components. Most of the accessible investigations concentrate on health safety, road safety, crime, land safety, safety from disaster, environmental safety, etc. and are oriented towards medical, economic, and environmental studies Architecture and urban design studies are scarce to find from an open source which becomes the challenge for the researcher to construct the detailed methodology.

Furthermore, it is quite difficult to locate data on the research topics in relation to Guwahati or any other city in the northeast. Most available studies of this region are concentrated to crime statistics, political issues, etc. with limited emphasis on urban design and peoples' sense of safety. Encountering literature about the subject matter and various related facts, the

following in-depth methodology has been adopted for the thesis.

3.3 Research Questions and Objectives

After establishing the topic relevance and identifying the problem statement, the researcher now had to articulate the research questions and objectives to get a proper direction throughout the process of research. Narrowing down the broad topics into specific aspects and using clear and concise words, four research questions are formulated. It is done in a way so that answering these questions eventually leads the researcher to the research outcome, and the research remains focused and targeted throughout the entire phase of the research. The research questions introduced the terms 'built environment connects to people', 'indicators related to the physical components', etc, which can ultimately result in measurable outcomes. Subsequently, the five specific objectives are framed to provide clarity of the process to achieve the research aim and solve the research problem. The research objectives are framed keeping in mind the several points that should allow for achieving some measurable assessment results and be realistic, making the research possible to complete within the research timeline. These objectives provide the direction towards what should be studied and included, as well as what should not be covered, which finally helped to decide the scope and set the limitations of the research.

3.4 Research Methodology

3.4.1 Background Study

The initial phase of the background study explores the information about the key terms of the research title. It has been carried out to refine the preliminary idea of research, establish the research problem as well as formulate the research questions. As the research is decided to be focused on Guwahati's context, it becomes a necessity to display a precise understanding of Assam, Guwahati, and safety concerns in overall Indian settings. News articles published in various newspapers, news videos etc. are referred to understand the subject matters in the context of Guwahati. Many discussions with experts from related fields like urban design, architecture, urban planning, psychology, and civil engineering are called for to determine the need and feasibility of the proposed study.

Then, a thorough literature review was conducted from various journal papers, research reports, books, various organization reports, authoritative reports and summaries, etc. to understand the complexities of built environments, their impact on safety and people's sense of safety, etc. To get such information and clarity of the concepts through internet surfing,

web search key phrases such as 'indicators of the built environment', 'built environment and community building', 'sense of safety and built environment', 'physical built components affecting peoples' safety', 'people safety and quality of life', 'safety in neighbourhoods and life satisfaction', components that affect the safety of people, etc. are used. It, also, helps to observe and find the research gaps by highlighting the need for further research on such subject matters. The background study, also, allowed me to understand related theories, concepts, and guidelines in the related fields. Such theories are the Broken Window theory by James Q. Wilson and George L. Kelling (1982), the Defensible Space concept by Oscar Newman (1972), Brantingham & Brantingham's Environmental Criminology Theory, guidelines by CPTED (2007) and so on. The study listed several highly cited sources in the form of a table that discusses numerous physical components that directly or indirectly impact people's sense of safety. With the help of the literature review, the researcher, successfully, identified the ten numbers of components of the built environment, fifteen numbers of indicators (three for each selected component) as well and twenty-one numbers of evaluation criteria against each of the indicators proceeding with the further stages of the thesis.

3.4.2 Selection of Components, Indicators, and Evaluation Criteria

From the literature study, ten no. of built components have been identified. All these 10 physical components are listed down after studying the research papers, various national and international standards and guidelines, frameworks, theoretical concepts related to urban design fields etc. Later on, this list of 10 components is arranged as per the 'frequency of appearance' method based on several mentions in the available sources. Built form, layout, land use, open space and tree are the five components that top the list when all the ten were arranged in tabular manner along with their mentions counts. To cross-verify and validate the built components during the selection process, the researcher decided to consult the experts in the field and conduct an expert opinion survey through a set of questions (refer to Section 2.8 for a detailed selection of components). Nine experts of relevant fields out of which three are Architect Planners, one is Engineer Planner, one is Landscape Architect, three are Urban Designers, and one is Environmental Architect are requested to take part in the expert opinion survey. They are asked to mark the identified components on the questionnaire out of 5 (where 5 depicts most important and 1 means least important) based on their opinion, which they consider as most pertinent and significant about people's sense of safety. The average values of experts' comments against each of the built components help to derive a consensus-

based evaluation and arrange such components in descending order of importance. The overall results of the mixed methods such as literature analysis and expert opinion, reveal the five most important built components likely built form, layout, land use, open space, and trees.

Another thorough study is conducted from available literature sources to find the indicators of the selected components as well as the evaluation criteria of each of the selected indicators. Consequently, three numbers of indicators for each component are selected based on an expert opinion survey consulting the same group of experts as consulted during the component selection. Thus, a large number of components are sorted out and brought down to a manageable number of indicators for the ease of the study. To extract the built environment data needed to determine safety perception, these indicators must first be expressed in terms of evaluation criteria before being evaluated in Guwahati's situation. So, the further stage of the literature study explores the evaluation criteria against each indicator which are considered as measurable parameters during the assessment of built environment quality in the case study sites. These qualified components, indicators, and evaluation criteria are, now, equipped to be observed and studied in the selected sites for the upcoming stages of the research. The above-mentioned set of components, indicators and evaluation criteria are listed below.

Table 3.1: The selected Components, Indicators and Evaluation Criteria

Sl. No.	Components	Indicators	Evaluation Criteria
1	Built Form	Human Scale	Human-proportioned doors and windows
			Quality of the Ground floor façade design
		Architectural Details	Quality of visual aesthetic
		Urban Elements	Visual aesthetic
2	Layout	Road Network Design	Traffic efficiency
			Condition of road surfaces
		Connectivity	Route directness
		Pedestrian Flow	Walking Quality
3	Land use	Diversity	Functional mix
		Access	Access to Amenities
			Proximity
		Compatibility	Functional Synergy

4	Open Space	Spatial Characteristics	Functionality
			Social interaction
		Accessibility	Quality of public access points
		Legibility	Visual Landmarks
			Enclosure Definition
5	Trees	Cover	Density
			Canopy coverage
		Height	Ability to provide shade
		Size	Diameter of the trunk at breast height (DBH)

After the selection of the evaluation criteria, now, it was the task of the researcher to find out a few urban localities of Guwahati through which a comparative analysis can be done understanding the built components and sense of safety.

3.4.3 Case Study Selection

To decide the case study sites, the crime data from the police station (PS) jurisdictions of urban Guwahati has been decided to discussed (refer to Chapter 4 for details). Accordingly, the crime data from the PS jurisdiction of the Guwahati Municipal Corporation (GMC) area of 2018, 2019, and 2020 have been collected, compared, and analysed. From these data, Dispur is constant in the highest crime-rated jurisdiction for all three years whereas Latasil is in the lowest crime-rated jurisdiction GMC area. Theft, rape, robbery, etc. are the most common crimes recorded during these years in the police jurisdiction of Dispur whereas Latasil PS records a significantly lesser number of crimes as per the data (Masters Dissertation by Bhargav 2021).

After achieving the PS jurisdictions, now, it was now a task for the researcher to identify the safest and unsafe localities of these jurisdictions to conduct the criteria assessment for making the research more focused and specific. Therefore, by conducting a perception survey with the experts of the respective areas, the researcher attempts to find the most unsafe and the safest localities. For each location, two groups of twenty experts are chosen from the pertinent fields, each of whom represents a diverse variety of backgrounds with a wealth of subject knowledge, experience, and skill in issues related to crime, safety, and urban design. They belong to professionals of various domains like local police officer, local government official, technical experts, and community representative, etc. These experts are asked which localities in Dispur and Latasil, they consider to be the most unsafe and safest respectively.

As per this perception survey with locals, Hengrabari is found to be the most unsafe locality in Dispur and Uzan Bazar to be the safest locality in Latasil. Therefore, Dispur and Uzan Bazar are selected to measure, compare, and analyse the evaluation criteria to assess the built environment peoples' perceived safety. This method of choosing case studies provides the researcher variety of users to be dealt with so that safety perception can be understood from a broader perspective.

The rationale for selection of one safest and one unsafe locality is made considering that it will be useful to compare the set of built components to one safest and another unsafe locality giving such components a comparative status in both situations. In such situations, this method of evaluating the built environment's physical components is believed to make sense to comprehend how people perceive safety.

3.4.4 Process of Data Collection and Analysis

3.4.4.1 Base Map Preparation

Systematic mapping can help a researcher to document and verify the existing data accurately. To realize the safety status of the selected localities, the researcher analyses the physical built components extracted from the literature using the expert opinion survey method, spatial mapping method, etc. For such analysis, the most convenient approach is the base map generation. It can provide support to the researcher, to begin with the basic information collection. In this research, with the help of GIS (Geographical Information System) and GPS (Global Positioning System) along with the ideas from the GMDA master plan, a base map has been prepared. The base map guides the geographic settings, built structures, road networks, land cover etc. Also, the use of the OSM (Open Street Map) technique helped in generating a base map to get more accuracy at building-level mapping (Misra & Kumar 2018).

3.4.4.2 Reconnaissance Survey

After the generation of the base map using GIS, GPS, and OSM, with the help of its printed copy, the site survey was initiated. To verify the base maps of Uzan Bazar as well as Hengrabari, a team of seven people who are architecture students of a local institution along with the researcher herself visited the study areas and cross-referenced the base maps and noted down the points about respective areas wherever little changes are required. The interaction with the local people was beneficial to understanding the perceptive factors concerning the spatial settings. The reconnaissance survey helped to achieve more accurate

and correct base maps of both the study areas. The verified points are marked which need to be incorporated in the base map and later, considering the visual observations in the site, the changes and editions are made and thus, base maps have been updated.

3.4.4.3 Sample Design: Focus groups and Population Sampling

Based on the literature study and the major focus of the research as well as keeping the characteristics of the study areas in mind, the target population are decided to be the residents of the selected localities. Residents aged above 18 years have been considered, disregarding any specific age group, as it is assumed they can respond with maturity. The focus group is believed to be familiar with different spaces of their locality and frequent visitors of public spaces because of many purposes such as job, children's school or tuition, shopping, and many other professional and personal purposes. Moreover, to calculate the population of the site i.e Hengrabari and Uzanbazar I have used "Areal interpolation" and "Proportional Allocation method" as the locality chosen for the case study does not coincide/align perfectly with the administrative ward boundary. The population of Uzan bazar is 15,467 as per census 2011 and Hengrabari is 18,362 as per census 2011. So, the research findings will be considered to be representative of the intended population.

$$\text{Estimated Locality Population in Ward} = \left(\frac{\text{Locality Area in Ward}}{\text{Total Ward Area}}\right) \times \text{Ward Population}$$

Out of the total population, to decide the sample size, Slovin's formula is used for calculation.

Slovin's Formula, $n=N/(1+Ne^{2)}$ where,

n=Sample size,

N=Total population,

e= Margin of error (generally 5% is chosen)

So, through Slovin's formula, the sample size obtained is 390 (for Uzan Bazar) and 391 (for Hengrabari). Simple random sampling is the simplest style of choosing a sample, as this sampling method is easier for the sole researcher. About 390 and 391 randomly selected people are considered to ask the questions for the perception survey to gather information, know opinions, and collect data from Uzan Bazar and Hengrabari, respectively, in a structured way.

3.4.4.4 Sample Plot Selection

As it is not feasible to study both localities entirely due to their huge areas and extents, a sampling technique is used for choosing the sample plots. The localities, individually, are divided into small plots of 100m x 100m (1 hectare). Out of the total plots count, every 15^{th} number of plots are selected as sample plots for assessment through systematic sampling method. The results, obtained by this method are extrapolated for all the other remaining plots.

While doing so, the entire site area of Uzan Bazar (2.18 sq.km area) is divided into 218 plots of 100m x 100m (1hectare), and a total of 14 number of plots are selected as sample plots for survey. The same for site area of Hengrabari (1.87 sq.km area), is divided into 187 plots of 1hectare out of which 14 number of plots of are surveyed to conduct the necessary assessments.

3.4.4.5 Sample Street Selection

Sample streets were chosen to assess the built-forms of the localities in detail. For this reason, two sample streets (one for each study area) having similar characteristics such as being predominantly residential with a mix of few institutional, commercial and mixed land uses are selected strategically for the ease of data collection and analysis.

In Uzan Bazar, Lamb Road is such a sample street length of which is 900 m and the average width is 12 m with a total of 74 built forms present whereas, in Hengrabari, the Namghar Path which gets converted as Puberun Path towards the western part of the locality is of 1000m length, 7 m average width and a total of 109 built forms present is the sample street. To conduct the survey on human-proportioned doors and windows of the built forms of the above-mentioned streets, the number of built forms is scoped out to 30% using random sampling from each of the streets.

The data collection from these streets involved visual observations and mapping techniques and the findings are analysed to deduce inferences for the overall trends of the locality.

3.4.4.6 Scoring of Safety Criteria

To judge the relative importance and safety quality of different evaluation criteria, a scoring framework is developed. The gathered responses are combined and averaged into weighted ratings to allow for an organized comparison of several evaluation criteria. In order to ensure that all criteria could be compared on a comparable scale, these ratings have given each

criterion a relative measure of importance. The study is able to go beyond descriptive answers because to this computation-based methodology, which provided a more methodical way to examine the ways in which different components of the built environment contribute to the overall feeling of safety.

3.4.4.7 Questionnaire Design

As mentioned in the literature survey, questionnaires are the most convenient way of data collection for such qualitative research which is used by various researchers in perception studies (Bennetts et al. 2017, p.401). Depending on the components selected by the experts, a questionnaire has been designed before conducting the site survey to decide the indicators. The expert opinions on the importance of the components were analyzed using MS Excel. The weights assigned by the experts were first normalized to ensure comparability across responses. The normalized weights from all experts were then averaged to obtain the overall weight of each indicator considered in the study. The questionnaire prepared by the researcher has two different categories. The first category of questionnaires is designed aiming the experts which has closed-ended questions to rate the desired attributes. This portion has requested the selected groups of experts for rating out of 5 using Likert scale. Four questionnaires are designed in this category which are – one is to rate components out of the ten total, the second one is to rate indicators to decide three most rated, the third and forth questionnaires are meant for choosing the safe and unsafe localities in Latasil and Dispur jurisdictions respectively. The other category of the questionnaire is designed for the resident of the respective localities to assess the evaluation criteria at the site. Likert scale method has been used for rating the responses out of 5 in which 5 denotes 'Extremely Strong', 4 'Strong', 3 'Neutral', 2 'Not so strong', 1 means 'Weak'. The use of the Likert scale in this study strengthens the comparability of attributes while also allowing for a neutral option, thereby preserving data validity in expert evaluations.

Two aspects are kept in mind at the time of questionnaire preparation. The first one is that the questionnaire should carry questions about all the evaluation criteria of all five important components whereas the second concern is all the questions should be easily understood by the interviewee who is expected to be a layman in the mentioned field. After the data were collected using this method, the researcher tried to generate inferences against each indicator and their evaluation criteria which will not only help to understand the status of physical components in terms of sense of safety but also, to achieve the research outcome.

3.4.4.8 Team Building for the Perception Survey

For the ease of the field survey, a research team has been prepared out of seven people, along with the researcher, who are well aware of the questions in the questionnaire as well as the expected outcome of the overall research. The members, other than the researcher, are architecture students in a local private institute and are chosen based on their ability to communicate effectively, proficiency in the Assamese language, as well as cultural understanding of Guwahati. The members are trained to clarify the questions in a way that the interviewee can comprehend to reply in an unbiased and accurate manner.

3.4.4.9 Documentation of Spatial Features and Map Generation

During the data collection, the spatial arrangements of the built components are visually observed and then marked on a tablet version of Google Maps of the selected localities, which is found to be a practical and effective way of spatial data collection. The research team, created by the researcher along with architecture students, conducted the documentation of such spatial information related to land use, open space structure, tree count, etc. The 'Share Location' and 'Street Level Imagery' features of Google Maps, in this mapping technique, greatly aided in collaborating with team members. Once the spatial data are collected, those inputs are transferred to base maps generated in a GIS system earlier. Adobe Photoshop software is used to make the drawing presentable, which finally generates detailed urban design assessment maps for both localities.

3.4.4.10 Physical Features Observations and Mapping

For the physical features mapping during the perception survey, the researcher along with the team members took the help of the satellite images of both the localities. The documented data about all the components with respect to their indicators and evaluation criteria through visual observations are marked on the satellite image one after another using the 'add layer' tool. The information collected in this manner is saved layer-wise, with similar types of data grouped on a single map. Initially, the study was conducted for Uzan Bazar, and then for Hengrabari. To save time on-site, photo and video documentation methods are used by the team. Snapshots at different elevations were taken to capture the characteristics of the skyline, like fenestrations, human scale, architectural details, etc., whereas the dynamic features of the sites, such as the road scenarios, people's behaviour on the street, and overall ambience, were recorded through videography during the site survey.

3.4.4.11 Expert Evaluation and Perception Survey

An expert evaluation method is used in the data collection of built forms, land uses, etc. Using this method, the researcher rated (out of 5) various attributes of the study areas in order to collect the related data. Whereas, during the perception survey, the respondents are asked to rate attributes using a five-point scale in which 5 means 'strong', 4 means 'not so strong', 3 means 'somewhat strong', 2 means 'not at all strong', and 1 means 'weak'. The average of the responses provides the value of people's perception.

3.4.4.12 Data collection through social media

Data collection through social media has now become a mainstream practice to understand public opinion, trends, frequency of visits, etc. Direct search on Instagram using the hashtag (#) followed by the location name, and then, recording these hashtag counts for the desired location provides the prominent viewpoints, frequency and purpose of visit with respect to each of the study areas. Such data from social media reflects the tastes and perceptions of urban space users, offering more authentic and direct evidences. However, it must be noted that not all age groups of people belong to the users on social media which may introduce a biasness in the dataset.

3.4.4.13 Data Analysis and Interpretation

After the data collection is done and inconsistencies are corrected, the collected data are organized and compiled systematically in Excel sheets by the researcher to prepare them for thematic analysis. From such data charts, trends of variables, interrelationships between variables, etc. are interpreted as well as the average values of the attributes of each component are achieved. The spatial data collected from study areas are presented in the form of maps which provide a visual tool for understanding the patterns and the distributions.

The equal interval method is used for the data classification which divides the range of data into equal parts and helps in establishing relationships between various attributes. This approach has provided a qualitative understanding of the sense of safety of people of each study areas and helped making a comparative analysis between them.

3.4.4.14 Development of Strategies and Discussion with respect to Case Studies

After doing the analyses of the case studies in terms of the evaluation criteria, the formulation of urban design strategies will provide the thesis with more meaning and a holistic plan to

enhance the sense of safety through the built environment. Eight strategies are developed taking into account the strengths and flaws noted in the case studies. These strategies are framed to respond to the indicators, making sure that the greatest number of indicators are taken into account and they handle the spatial and design-related elements that were found to be important during analyses. The proposed strategies are, then, explained in context to the safe and unsafe localities through photographic analysis and a comparative discussion is carried out which validates their relevance and feasibility.

3.5 Inferences

This chapter is a detailed discussion of the stages to practically execute the research work by the researcher. Each method and tool discussed here are chosen from the significant literature sources of the research field. The chapter addresses the procedure of selection of components, and indicators, about evaluation criteria, data collection, sampling technique, mapping methods, methods of reconnaissance survey, about software use, etc. The findings derived from these methods will be presented and discussed in the subsequent chapters.

Chapter 4: Selection of Case Study Sites

4.1 Chapter Overview

A case study, in general, needs to be an appropriate representation of the real-world context and is suitable to be considered when it can reflect different aspects related to the observed components of the research. A case study helps the researcher explore issues or opportunities present in the real-life context within a framework curated by the researcher (Baxter & Jack 2008). Here, is a structured outline of the current chapter presented in the figure below.

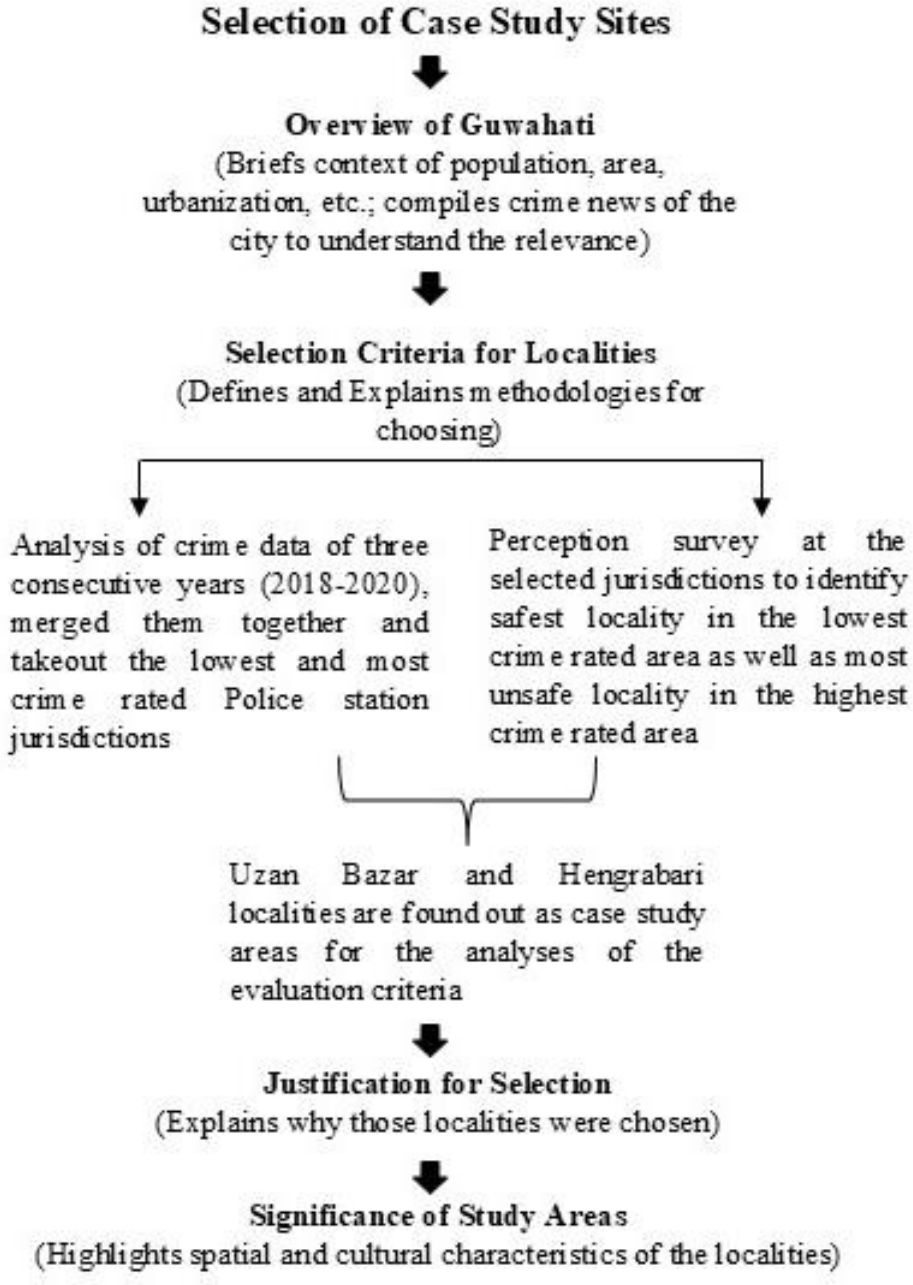


Fig. 4.1: Outline of the Chapter

This chapter has been crafted to select the required case study sites for the research as investigation in a specific case study site can help the research to achieve a successful completion. In the initial portion of it, a broad introduction to Guwahati city is provided followed by the methodology of selecting two localities as case study sites. A variety of data sources has been used to provide the introduction of the city such as demographic profile, socio-economic data and public safety status of Guwahati etc.

The later portion of the chapter compiles the police station-wise crime data for three consecutive years 2018, 2019 and 2020. Year-wise spatial maps are created highlighting the police stations as per the crime occurrences. All these maps with the crime data when merged, a hotspot map is created and analysed. According to the hotspot map, Latasil and Dispur have been found as the lowest and highest crime-rated police jurisdiction areas, respectively. A perception survey considering expert consultation (20 experts are surveyed at each area), individually, at both the police station areas discovered that Uzan Bazar is the safest locality within Latasil, and Hengrabari is the most unsafe locality within Dispur area respectively.

4.2 About Guwahati city

Guwahati, the largest metropolitan city of North-East India, serves as the gateway to its entire region. Guwahati has remained an important cultural, religious, economic, political, and administrative centre of Assam. The city started emerging in 1826 with 8 total number of municipal wards covering 6.4 sq. km, which has now become an area of 328 sq. km with 60 total number of municipal wards (Hemani & Das 2016). Being a significant metropolitan city, Guwahati is experiencing tremendous growth and development in recent years. The population of the city is growing very fast, which was 0.81 million in 2001, and 0.96 million in 2011 and is estimated to be 2.1 million by 2025 (Desai, Mahadevia & Mishra 2014) (Master Plan 2025). The overall urban development in the city is being noticed by two main authorities, namely, GMDA (Guwahati Metropolitan Development Authority) and GMC (Guwahati Municipal Corporation). The GMC area covers 216 sq.km. Whereas the GMDA jurisdiction is estimated to extend up to 328 sq.km. comprising areas such as the Guwahati Municipal Corporation Area (GMCA), North-Guwahati Town Committee Area, Amingaon, and 21 other revenue villages. (Draft Master Plan Report for Guwahati Planning Area – 2045).

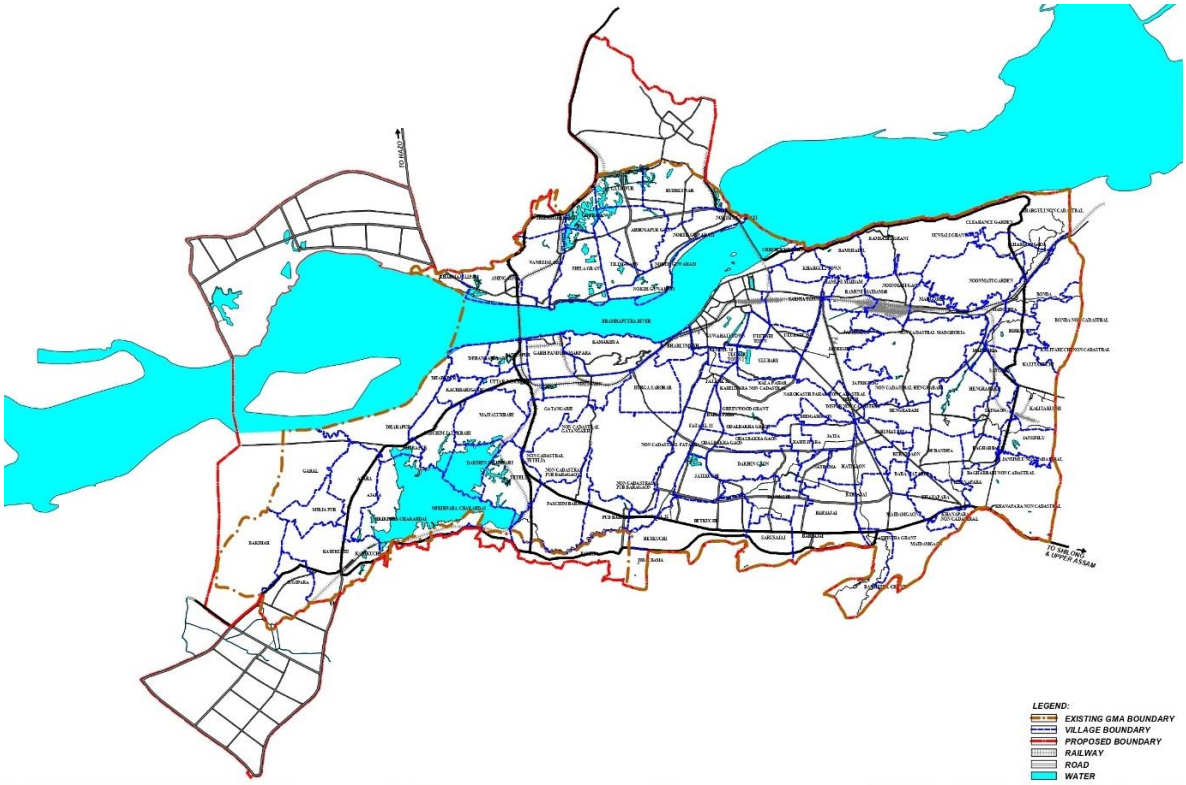


Fig. 4.2: Administrative Map of Guwahati with existing GMA Boundary

Source: GMDA 2024

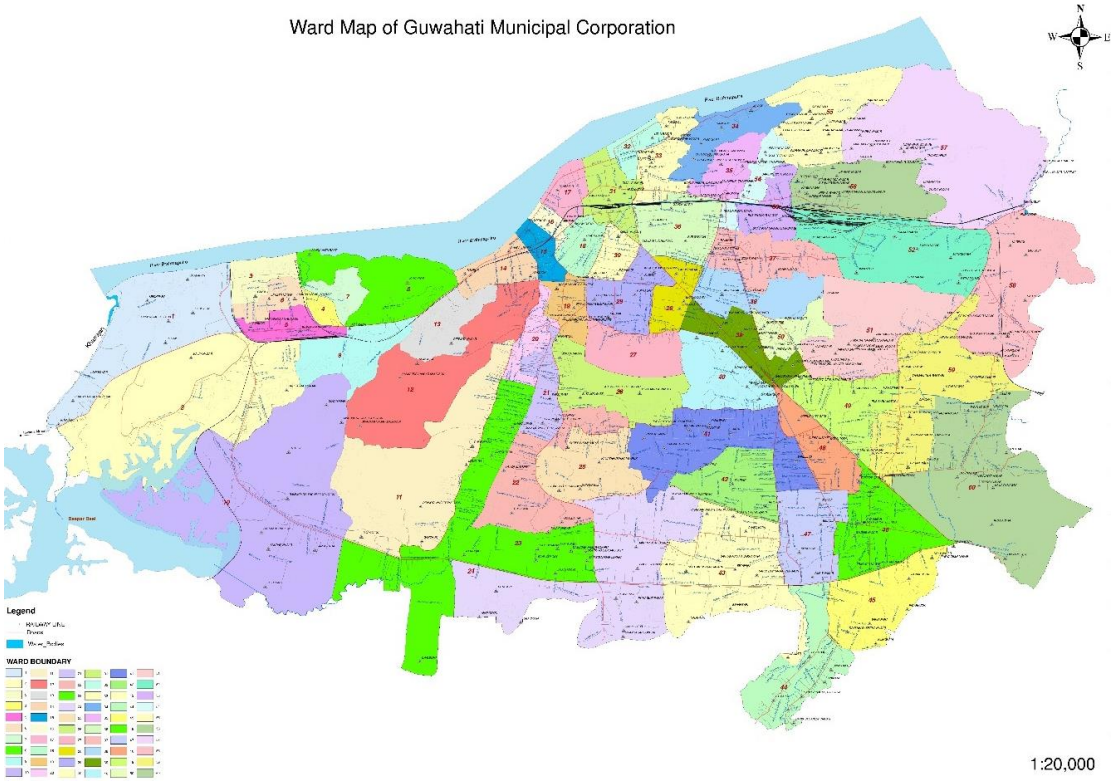


Fig. 4.3: Ward Map of Guwahati with Existing GMC Boundary

Source: GMDA 2024

The mention of ancient Guwahati as "Pragjyotishpura" can be traced back to Mahabharata and Ramayana (Boruah 2003) and other Indian literature. The modern city has grown around the mighty Brahmaputra River approximately since the year 1826 (Hemani 2015). When the capital of Assam shifted to Guwahati in 1972 from Shillong, since then the migration from different parts of Assam and other states of the northeast took place in a rapid manner. Over the years, the city has extended its spatial confines from its initial core areas such as Uzan Bazar, Fancy Bazar, and Paltan Bazar towards areas in the north-eastern side such as Sonapur, Tepesia, Khetri etc. and south-western side such as Borjhar, Azara, Kahikuchi, Mirza etc.

The growth of the population is a boom due to the rapid increase of urbanization rate which was increased from 7.65% in 1951 to 32.76% in 1991 and 36% in 2001 (Hazarika 2016). The literacy rate of Guwahati Agglomeration is 91.50% (Census 2011). Out of the total population, the percentage of literate men and women was 94.27% and 88.52%, respectively. There are 797,613 literate people in the Guwahati urban area, of which 425,837 are men and the remaining 371,776 are women (Census 2011). The population is primarily Hindu 84.74% as per census 2011. The other religions are as follows - Muslim 12.45%, Christian 0.93%, Sikh (0.36%) etc. The floating population of about 10% comes to the city for daytime activities. It is estimated that the floating population, the city has housed for various daytime activities is going to be 22.94 lakhs by 2025 ('The Sentinel' 2024).

As far as the occupation is concerned, out of the total working population of the city which is 4.4 lakhs, more than 78.88% is engaged in the tertiary sector i.e on trade, tourism, hotels, informal sector etc.; 18.34% is engaged in primary sector i.e on agriculture, horticulture, oil & gas etc.; whereas 2.78% are dependent in secondary sector i.e Manufacturing, household industries, construction etc. (Draft Master Plan Report for Guwahati Planning Area – 2045). Guwahati Municipal Corporation Area (GMCA) and Guwahati Metropolitan Area (GMA) have workforce rates of 35.1% and 34.8%, respectively. The wholesale and retail trade sectors are the main drivers of the trade and commerce sector (Master Plan 2025).

4.2.1 Safety Status of Guwahati

The secondary sources like newspapers, websites, and online published reports are investigated to understand the safety scenario of the city. Special emphasis has been given to newspaper articles as the news published in newspapers speaks briefly of not only the reported crime incidences but also unreported crime events that occurred in a place.

Furthermost, newspapers provide a more analytical view of crime news along with mere reporting than other media houses such as television or radio (Feist 1999).

A few of the newspaper articles are discussed below which reflect the safety scenario.

Table 4.1: Compilation of Crime News of Guwahati City

News Headlines	Summary of the News	Citation
"Guwahati: Thieves loot cash and valuables as Namghar is burgled in Narengi."	Thieves gained access to Namghor complex and looted valuable items from Juba Nagar under Noonmati Police station	Sentinel Digital Desk (March 30, 2024) Available at: https://www.sentinelassam.com/cities/guwahati-city/guwahati-thieves-steal-cash-and-valuables-as-namghar-burgled-in-narengi
"Businessman shot dead In Daylight Robbery in Guwahati"	A 58-year-old businessman got shot at his neck in Panjabari while inside his car and was taken away with Rs. 2.5 lakhs.	G Plus News (November 21, 2022) Available at: https://guwahatiplus.com/guwahati/businessman-shot-dead-in-daylight-robbery-in-guwahati
"Guwahati: Accused Apprehended in Pandu Mobile Snatching Incident, Accomplice Flees"	Thief was caught and arrested for the attempted theft of a mobile at Pandu-Adabari Road.	G Plus News (May 11, 2024) Available at: https://www.guwahatiplus.com/guwahati/guwahati-accused-apprehended-in-pandu-mobile-snatching-incident-accomplice-flees
"Juvenile accused in G.S. Road molestation case pronounced guilty"	Gang of criminals molested a young girl in public in July 2012 when she was on her way to return home.	The Hindu (updated- October 18, 2016, Published – December 27, 2013) Available at: https://www.thehindu.com/news/national/other-states/Juvenile-accused-in-G.S.-Road-molestation-case-pronounced-guilty/article11615636.ece
"Man found dead in Hatigaon in mysterious circumstances"	22-year-old boy who awas working in a restaurant in Guwahati was found dead on his bed, his roommate reported the police.	G Plus News (March 23, 2024) Available at: https://guwahatiplus.com/guwahati/man-found-dead-in-hatigaon-under-mysterious-circumstances
"Guwahati: 5 Including Woman Arrested As Bag Snatching Racket Busted"	A total of five individuals involved in a incident of bag snatching from a woman in Survey, Beltola were arrested by the Dispur Police.	Sentinel Digital Desk (May 04, 2024) Available at: https://www.sentinelassam.com/cities/guwahati-city/guwahati-5-including-woman-arrested-as-bag-snatching-racket-busted
"Chain snatched at gunpoint in Six Mile	Two miscreants on bikes threatened a	Sentinel Digital Desk (May 02, 2024) Available at:

locality of Guwahati city"	woman with a weapon and robbed of her gold chain at around 6 in the morning.	https://www.sentinelassam.com/cities/guwahati-city/chain-snatched-at-gunpoint-in-six-mile-locality-of-guwahati-city
"Assam: 10 spine chilling incidents of crime against women since June 29"	Robbers fled the scene leaving a woman seriously injured with sharp weapons after robbing her jewellery and cash in Bamunimaidam area of Guwahati.	Northeast Live Digital Desk (August 08, 2023) Available at: https://northeastlivetv.com/around-ne/assam/assam-10-spine-chilling-incidents-of-crime-againsssst-women-since-june-29/
"Former SP sacked for hushing up rape, murder of minor in Assam"	A former SP was taken into custody in relation to the 13-year-old girl's murder and sexual assault.	The Times of India (April 7, 2024); Available at: https://timesofindia.indiatimes.com/city/guwahati/former-sp-sacked-for-hushing-up-rape-murder-of-minor-in-assam/articleshow/109098348.cms
"Two Minors Held For Allegedly Raping 15-year-old Girl In Guwahati"	Two minors aged 16 and 17 respectively raped another minor girl in the Barsapara Area of Guwahati.	G Plus News (May 08, 2023) Available at: https://guwahatiplus.com/guwahati/two-minors-held-for-allegedly-raping-15-year-old-girl-in-guwahati

The news found from recognized newspapers of Assam highlights the recurring pattern of incidents such as theft, robbery, molestation, rape of women etc. that took place mostly on public places like roads during the daylight. Such incidents show concern about walking alone on the roads even during day times and indicate the measures that support natural surveillance, community engagement, environmental design approach, etc. to enhance safety.

Investigation of other literary sources reflects that the number of women and child crimes related to public transportation, walkability, road accidents, etc. can be observed increasing very rapidly in Guwahati. Women's safety in Guwahati is an arguable debate as according to CID reports, the number of crimes against women in Guwahati has skyrocketed, rising from 43 incidents in 1980 to 484 in 2011. Most of such occurrences happened on the streets resulting poor walkability index of 0.39 as well as a safety index of 0.03. Poor condition roads, flash floods, women abuse, overcrowded public busses, inefficient street lights, property, land disputes, etc., and many behavioural issues of the public due to drug-alcohol consumption are the reasons behind the crimes of Guwahati as per research (NEN 2014).

Almost 73% of women in Guwahati have faced sexual harassment majorly in outdoor public spaces and public transport systems. Another database of NUMBEO (numbeo.com: a database on quality of living); updated in January 2024 has shown theft, mugging, drug dealing, vandalism, robbery, and assault are the moderately common crimes that occurred in Guwahati. The data, here, are based on perceptions of visitors to this website in the past 3 years. If the value is 0, it means it is perceived as very low, and if the value is 100, it means it is perceived as very high.

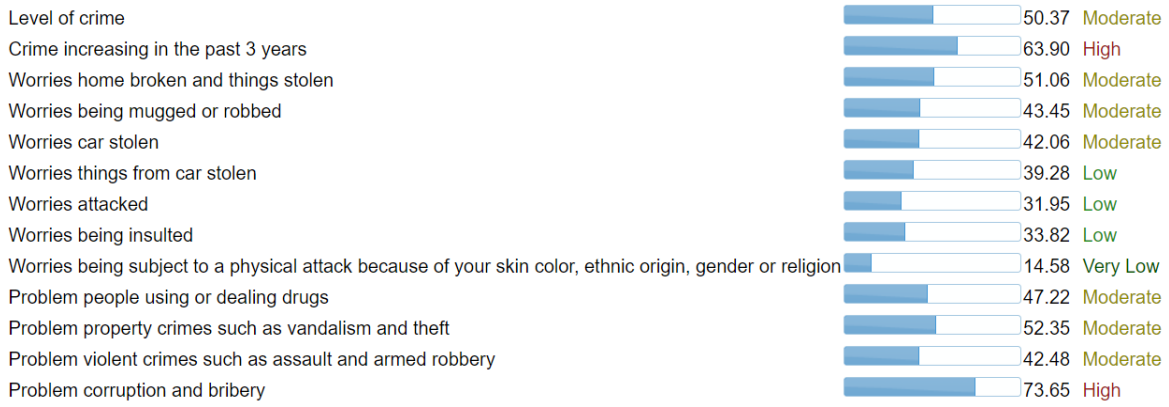


Fig. 4.4: Crime Rates of Guwahati

Source: NUMBEO 2024

4.3 Selection of the Case Study Sites in Guwahati

4.3.1 Methodology

Selection of case study site is a crucial task for any research because the case study acts as an experiment lab for validating the methods and tools selected for a study.

This research has selected a few components, indicators and evaluation criteria of the built environment through a rigorous literature study (Refer to Chapter 2). These need to be assessed, and analysed in real-life cases, the results of which can be considered as outcomes of the research. However, in the line of aim and objectives that are already formulated in Chapter 1 of this doctoral thesis report, the selection of case study sites within Guwahati is a mandatory task to investigate the selected components of the built environment which will help to fulfil the fourth objective of the research.

The research has selected the case study sites following the scientific-methodical approach, incorporating the crime data (gathered from secondary sources for the years 2018, 2019, and 2020 as per different police jurisdictions) as well as the data gathered from a primary

perception survey. The crime maps are generated for three consecutive years (2018-20) using the crime data received from police stations. The jurisdictions with the highest and lowest crime ratings for 2018–20 have been finally determined by overlapping these maps (refer to fig: 4.11). Since this type of urban design research requires in-depth analysis for better validation of indicators and evaluation criteria about case studies, it is problematic to consider the entire land area of police jurisdiction due to its broad spatial extent. Therefore, to make the research simple, pinpointed, and focused, it is decided to select two localities for study and analysis from the highest and lowest crime-rated police jurisdictions. In this context, as the data related to crime occurrences at the locality level is not available in the secondary sources, therefore, a perception survey consulting experts is mandatory to select the safest and the most unsafe localities as case study sites for the further stages of research.

The primary survey was conducted in those jurisdictions that have come up as a highest and lowest in case of crime occurrences for the year 2018, 2019, 2020. The expert consultation survey was conducted to investigate the perceptions of 20 number of experts from each of the jurisdictions through a short questionnaire run through simple random survey procedure.

The inferences and findings from secondary as well as primary data are discussed below:

4.3.2 Secondary Data Inferences understanding Safety Status of Guwahati

There are a total of three police station districts in Guwahati which are namely – Central, East, and West. The Central district covers the core areas of Guwahati such as key commercial and residential areas; the East district covers the eastern parts of Guwahati; as well as the West district covers the western parts. These three police station districts have in total fifteen different police stations (PS) jurisdictions present in urban Guwahati (Fig. 4.5).

The crime records and data of three consecutive years (2018, 2019 and 2020) received from the police stations are analysed through percentage distribution and frequency distribution. The collected data of crime incidents are mapped in GIS to understand the pattern of crime in Guwahati city. The results indicate that theft, robbery, murder, rape and dacoity are the most common crimes on the list for these mentioned years.

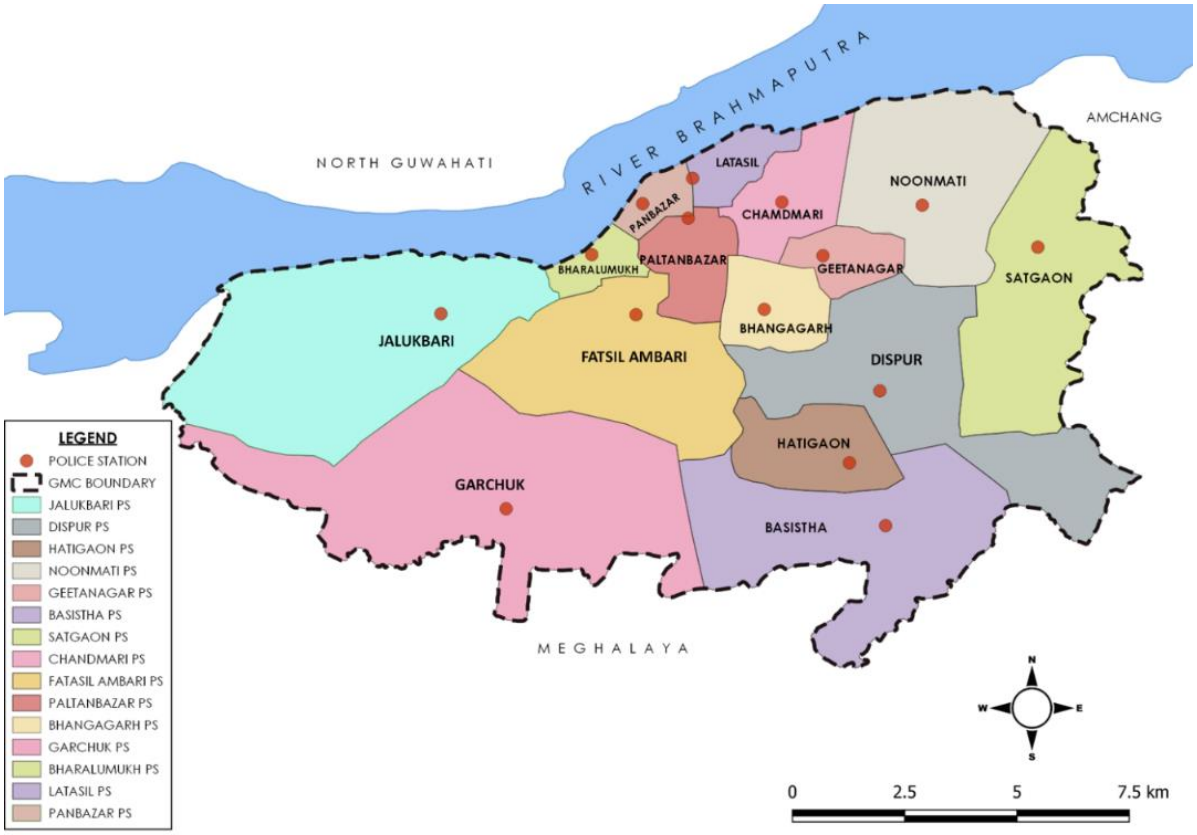


Fig. 4.5: Jurisdiction of different police stations within the GMC area
Source: Talukdar, Bharadwaj & Ghosh 2024

Analysis of crime data of the years 2018, 2019 and 2020

According to the crime occurrences data recorded at each of the PS, maps have been generated in ArcGIS. The size of the circle at each police station highlights the number of crime occurrences. The largest circle indicates the highest crime recorded police station whereas the smallest circle indicates the lowest crime recorded police station. As per data of 2018, Fig. 4.6 shows the crime occurrences in that year. Similarly, the maps (Fig. 4.7 & Fig. 4.8) for the years 2019 and 2020 are, also, generated for a comparative analysis among all the three years.

From the maps, it is evident from the data that in 2018, in terms of overall crime rate, Dispur recorded the highest number of crimes followed by Jalukbari, Paltanbazar and others (Fig. 4.6) whereas Latasil recorded the lowest crime. In 2019, also, Dispur also recorded the highest number of crimes followed by Basistha, Chandmari, and others. Latasil becomes the lowest crime recorded jurisdiction followed by Satgaon and Geetanagar (Fig. 4.7). 2020's crime data, also, displays Dispur as having the highest number of recorded crimes (as like

that in 2018 and 2019) followed by Basistha and Jalukbari as well as Latasil as the lowest crime-rated PS jurisdiction (Fig. 4.8).

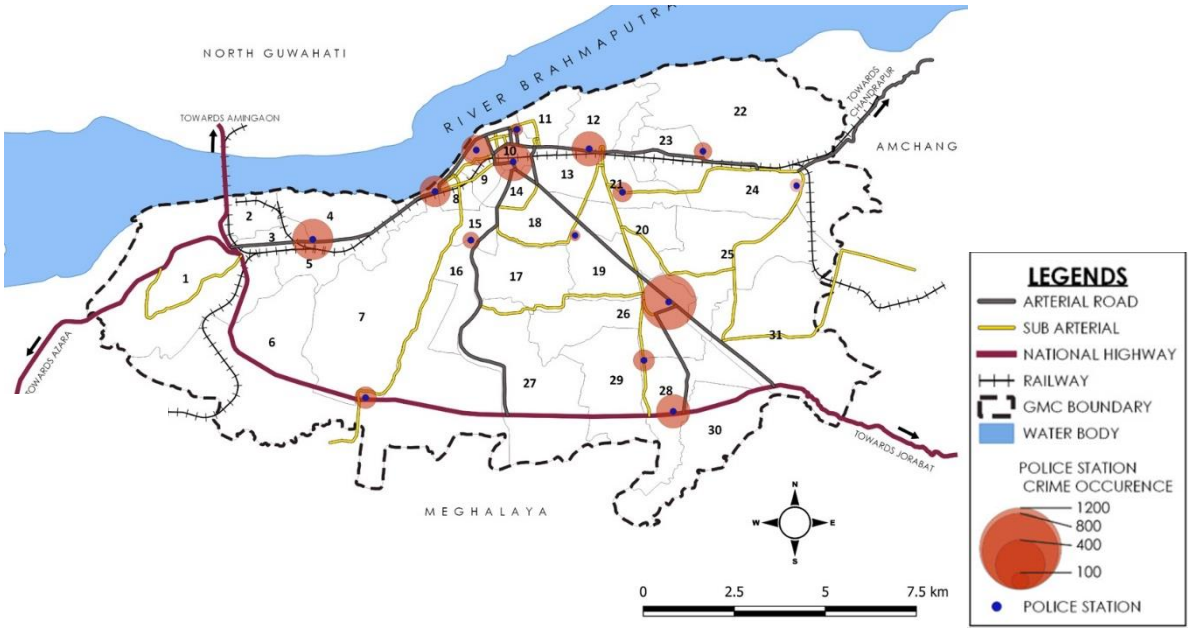


Fig. 4.6: Crime Distribution Analysis Police station-wise (year 2018)

(Bharadwaj 2021)

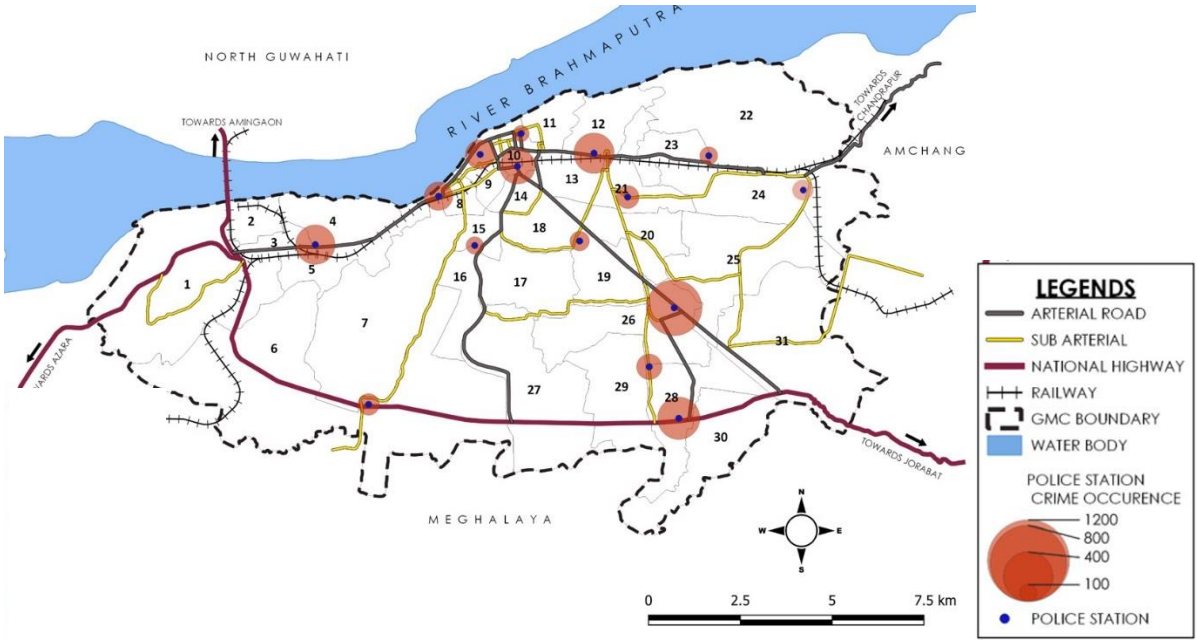


Fig. 4.7: Crime Distribution Analysis Police station-wise (year 2019)

(Bharadwaj 2021)

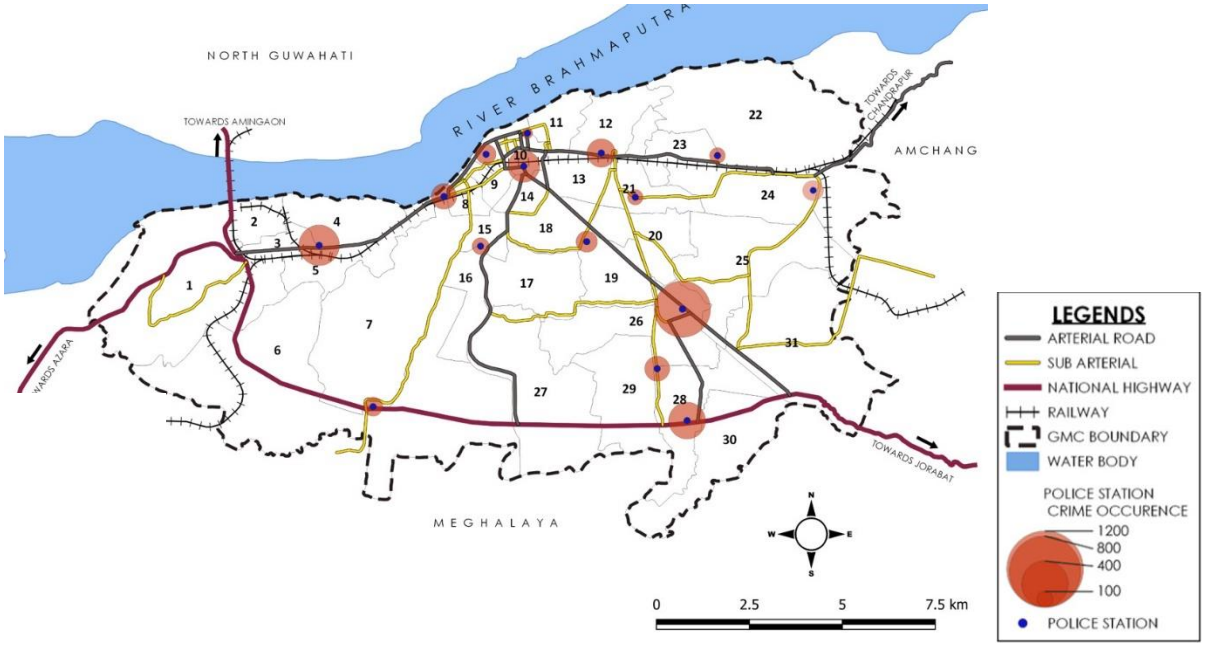


Fig. 4.8: Crime Distribution Analysis Police station-wise (year 2020)
(Bharadwaj 2021)

The yearly occurrence of crime in Guwahati City has increased from 2018 to 2019 by 2.88% (Bharadwaj 2021). The possible reason behind this variation is probably due to the general elections that took place in 2019, greater police surveillance during elections may result in more crimes being recorded. On the other hand, the Covid-19 pandemic situation, in 2020, may result in the reduction of reported crimes (as compared to 2018-2019) due to lockdowns, restricted movement of people, and increased police surveillance in the city. With less people on roads decreases the possibilities of crime occurrences as well as social distancing, also, reduced disagreements between people.

When the above-discussed crime data from all three years are merged and prepared to use for hotspot analysis, visible crime occurrence zones have been identified (Fig. 4.9).

On the heat map, it is observed that Dispur reported the highest crime during all three years. Jalukbari and Basistha also have high crime rates. A significant shift can be observed in terms of crime rate, between 2018-19, when Paltanbazar and Chandmari followed after Dispur in 2019. So, from this analysis, it can be concluded that Dispur, Basistha, Chandmari, Jalukbari and Paltan Bazar reported higher cases, whereas Latasil, Geetanagar, and Satgaon experienced low cases during the entire study period of three years (2018–2020).

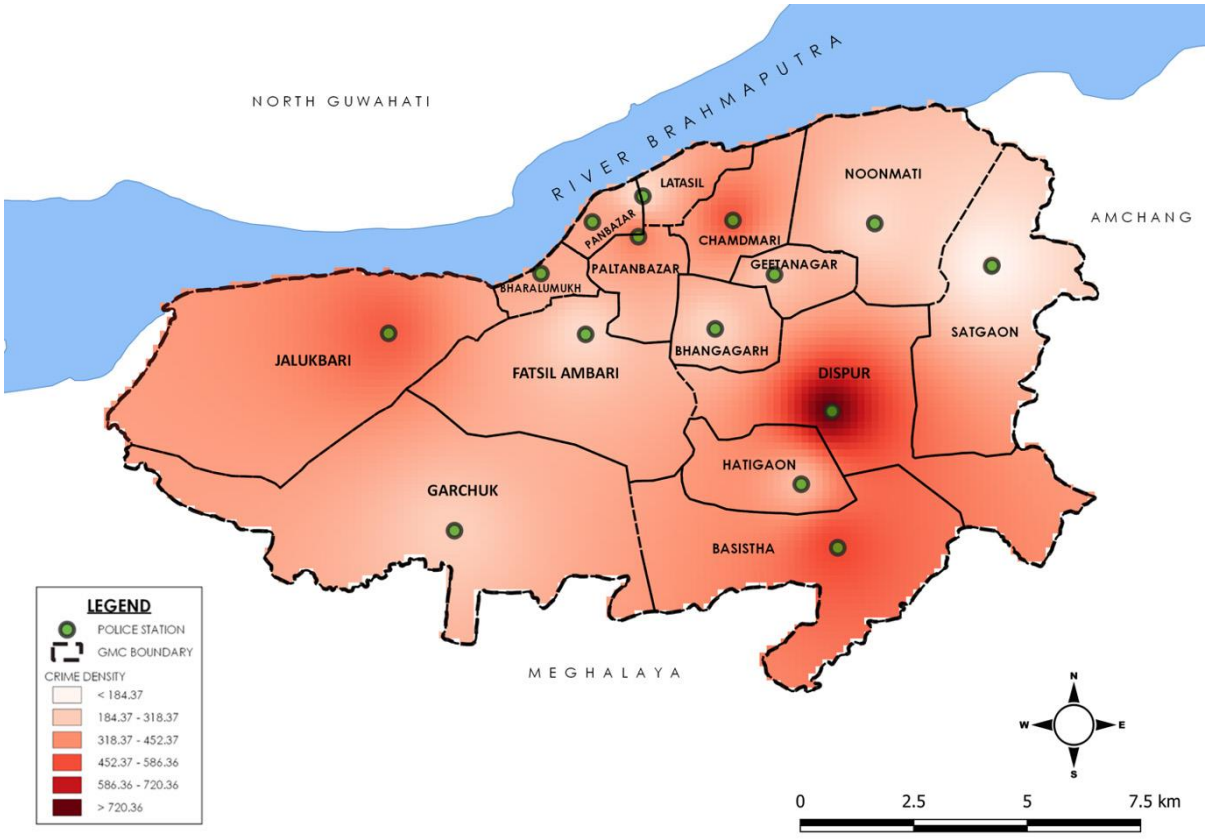


Fig. 4.9: Heat Map Showing Police Station-Wise Crime Occurrences
(Source: Bharadwaj 2021)

To be more focused on the study, Dispur PS jurisdiction and Latasil PS jurisdiction are found as the highest and lowest crime-rated jurisdictions, respectively, in the GMC area of Guwahati. Now, after getting the PS station names, selecting study areas within those PS jurisdictions for an accurate assessment of the components is the task at hand for the upcoming steps of the research. Since each jurisdiction covers a large geographical area, it would be feasible for the researcher to identify specific urban localities within each jurisdiction which can later be compared about safety and danger. For the same, the researcher decided to conduct a perception survey at the identified PS jurisdiction areas taking into account that the perception of the individual is the key aspect to defining a locality and identifying what overall outcome people expect (Jenks & Dempsey 2007).

This perception survey is an attempt to understand the people's minds and confirm the specific localities of Dispur and Latasil jurisdictions for the built component's assessment. The results of the survey are discussed in the upcoming sections.

4.3.3 Primary Survey Inferences to Select the Safest and Most Unsafe Localities

As the hotspot map (Fig. 4.9), shows, the Dispur PS jurisdiction is the most unsafe, and the Latasil police station (PS) jurisdiction is the safest out of all others in terms of crime occurrences. Therefore, the primary study is conducted in these two jurisdiction areas, choosing a group of twenty experts in Dispur jurisdiction and another group of twenty experts in Latasil, all of them representing a wide range of related fields with extensive subject knowledge, experience, and expertise in safety, crime, and urban design concerns. They belong to professionals of various domains like local police officer, local government official, technical experts, and community representative, etc. The selected experts in Dispur are asked to choose the most unsafe localities as per their perception amongst Ganeshguri, Rukminigaon, Bhagaduttapur, Hengrabari, and Jonaknagar which are part of their PS jurisdiction. Similarly, in Latasil PS area, the experts are asked to choose the safest amongst Ambari, Uzan Bazar, Chenikuthi, Kharghuli and Barowary. The questionnaire also included a question regarding the underlying reason behind their choice, which was made optional.

This perception survey will be helpful for the researcher to understand about:

- The occurrences of small-scale non-reported petty crimes (that are not present in the recorded crime data collected from PSs).
- The perception of locals about the places and their concerns for safety and security in their neighbourhoods. The findings of the perception survey are discussed below.

The results of the survey have been shown below.

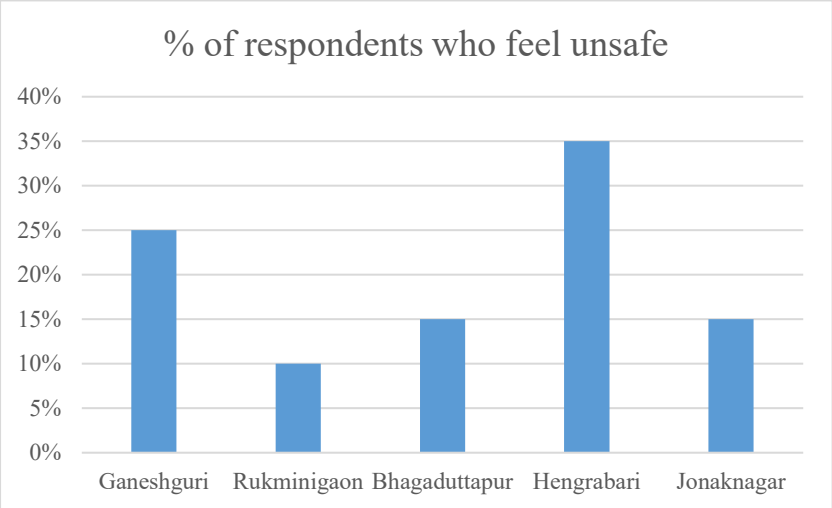


Figure 4.10 Results of Perception Survey in Dispur PS jurisdiction (as per Primary Survey)

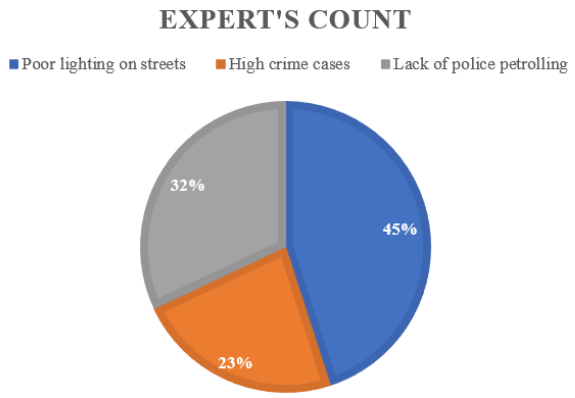


Fig. 4.11: Reasons Cited by Experts for Perceiving Hengrabari as Unsafe (as per Primary Survey)

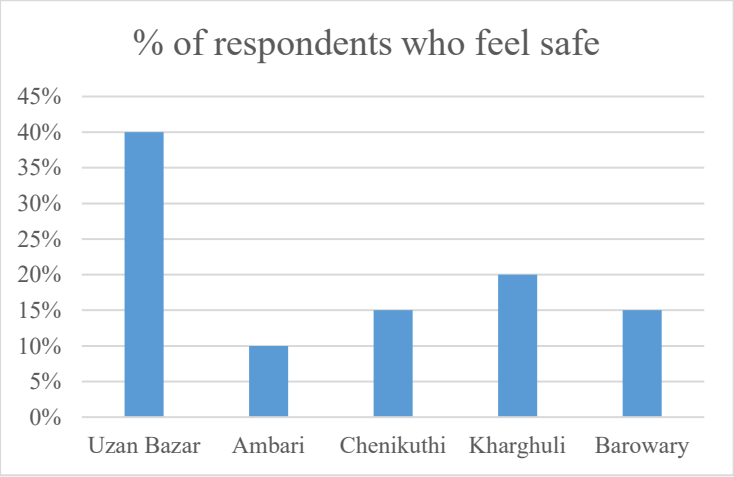


Fig. 4.12 Results of Perception Survey in Latasil PS jurisdiction (as per Primary Survey)

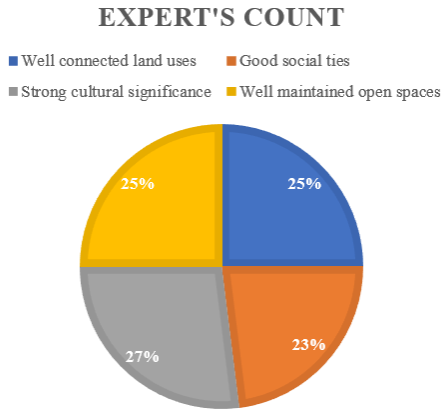


Fig. 4.13: Reasons Cited by Experts for Perceiving Uzan Bazar as Safe (as per Primary Survey)

The above-pie and bar charts, deduced from the primary survey, show that almost 35% of the surveyed people of Dispur perceive Hengrabari as the most unsafe among all other localities

(Fig.:4.10). It is also seen that more than 25% of experts feel Ganeshguri is unsafe, followed by Bhagaduttapur and others. Whereas, in Latasil, Uzan Bazar is found to be the safest locality (more than 40% of people say it is safe) as compared to other localities (Fig.4.12). Poor lighting, high crime cases, are some of the prevalent issues as per perception of experts in Hengrabari whereas in Uzan Bazar, they appreciated the well-connected public spaces, and strong cultural significance. During the survey, the locals are also, interviewed about petty crimes that take place in their respective localities. Verbal altercation and harassment, noise disturbances, public urination, cycling on sidewalks, trespassing, etc., are the most common petty crimes found in these areas that are not often reported by people. However, the Uzan Bazar locality is marked as the lowest in all types of petty crimes, whereas the Hengrabari locality is marked as highest by the locals in the occurrence of almost all petty crimes. This shows that although petty non-reported crimes go unnoticed and don't get attention in the official crime statistics, community-level interviews and interactions can provide valuable insights into ground-level issues. According to the interview, 78% of the people believe that petty crimes might seem insignificant individually, but collectively they can impact the safety perception of people in a locality.

The above-explained primary survey demonstrated that people find Hengrabari as the most unsafe area within Dispur PS and Uzan Bazar as the safest area within Latasil PS out of all other localities of Guwahati city. Therefore, Hengrabari and Uzan Bazar localities are selected as case study sites for the components' evaluation in the further stages of the thesis. As per the survey, the crime occurrences, poor lighting and road conditions are the common reasons cited by the respondents for perceiving Hengrabari as the most unsafe locality. Whereas, in Uzan Bazar, the social and emotional bonding between people, well connected spaces as well as public areas, etc. are the aspects for which people perceive it as safe area.

4.3.4 Justification of Selection

As discussed, and mentioned above, the two localities (Hengrabari and Uzan Bazar) have been selected as the case study sites for the research based on secondary data from three consecutive years (PS jurisdiction-wise) and a primary survey of field study with the experts. These two sites are assumed to be perfect examples of unsafe and safe localities respectively in an urban context which is enough to represent a holistic scenario for the whole of Guwahati. Therefore, the assessment of the evaluation criteria of each indicator investigated

earlier in the context of these two sites will give a representation of how or why the physical components can affect potential crime incidents and sense of safety in a city like Guwahati.

The methods adopted here for the selection of case studies (which is present in Chapter 4) and the inferences that are to be drawn after the in-detail assessment of components (which is envisioned to be discussed in the following Chapter 6) will be instrumental for similar studies in the context of other Indian cities.

4.4 About The Selected Case Studies

Uzan Bazar and Hengrabari are two major residential localities of urban Guwahati. The following map of Guwahati shows the location of both the localities within the city. The justification and significance of the selected localities are discussed in sections 4.4.1 and 4.4.2.

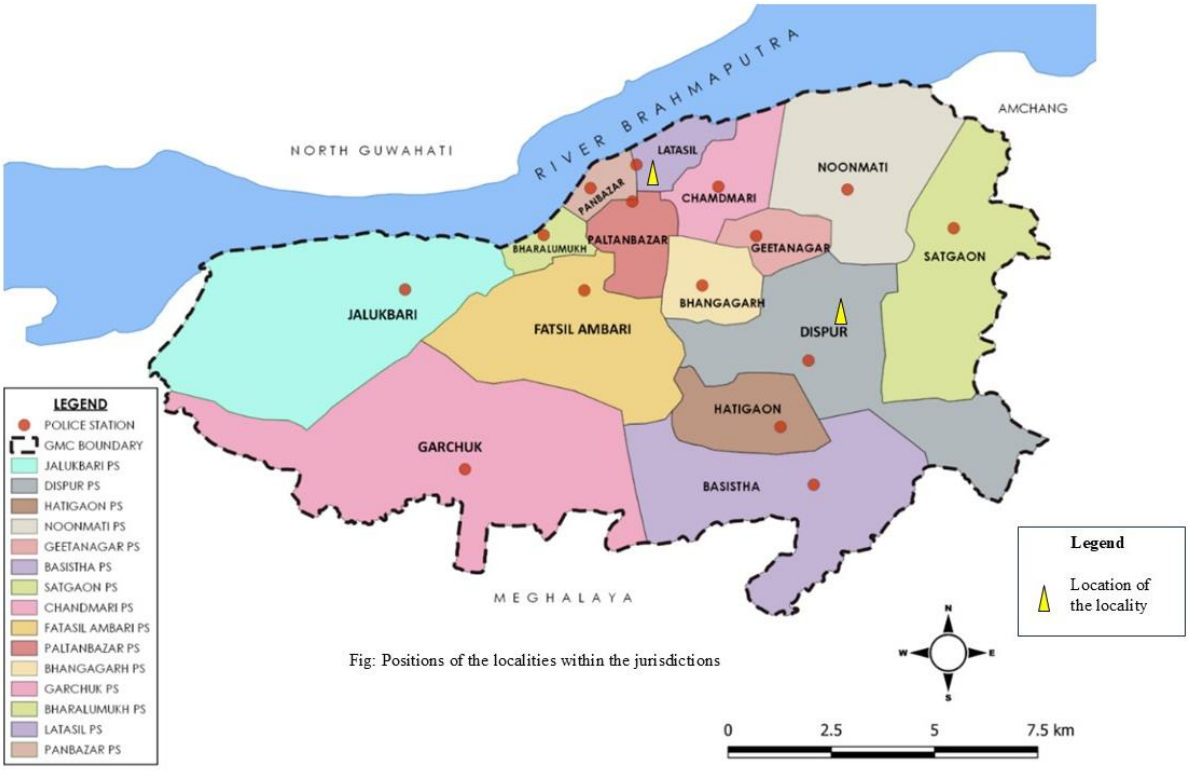


Fig: Positions of the localities within the jurisdictions

Fig. 4.14: Location of Selected Localities within the PS area and the City of Guwahati

4.4.1 Case Study 1: Uzan Bazar and Its Significance

Uzan Bazar is one of the oldest localities of Guwahati with a land area of 2.18 sq.km (approx.) located towards the southern bank of the Brahmaputra River. Being alongside the mighty river, Uzan bazar has been a hub for trading and commercial activities along with the residential settlements. The river gives a vibrant and calm character to this part of the city at

the same time, as well as provides a strong historical significance along with the existence of the wholesale fish market, which highlights its role as a trade hub since historical times. From generation to generation, this market has provided a living for many locals, and it has been, now, an emotional source of connection for them. Moreover, the presence of age-old structures such as Sri Sri Ugratara temple, Uzan Bazar Gurudwara, Jorpukhuri water ponds, and Kachari vegetable market, provide evidence of the past glory of the area. As the traditional and ethnic communities of old Guwahati reside in this locality, Uzan bazar is socio-culturally very active and celebrates Bihu, and Durga puja on the Latasil Bihu toli playground and Barowari Durga Puja Mandap respectively. The Vivekananda Kendra is a spiritual centre that serves yoga and meditation training to the city people (Trashigang 2020).

Ahmed (2024) Incredible India ETV Bharat (2022) Alamy (2019)

Fig. 4.15: City Level Public Centres Present at Study Area
(From left to right) Assam State Museum, Rabindra Bhavan Cultural Center, Burra Masjid
Source: Google Images

Regarding public safety, derogatory comments on passing, cycling on sidewalks, public urination, trespassing etc. are a few of the non-reported crimes that take place in public areas here. On the other hand, theft and robbery are the most common crimes reported by people in the police stations. As Uzan Bazar has a mix varieties of building typologies such as high-rise apartments, individual plot housing, mixed buildings having institutional (college, training centre etc.), commercial (coaching centre, offices etc.), and residential accommodations together, it attracts different age group of people ranges from youths to adults. Many governmental land parcels are covered by slum dwellers (Fig. 4.17) which have a different eco-system from the other parts of the neighbourhood. The street activities of the youths and children's residents (Fig. 4.18), roadside tea stalls (Fig. 4.18), different looking perforations present on the boundary walls (Fig. 4.19) improve legibility as well as allow face-to-face interaction among people, many the street arts by local artists contribute to break the monotony of boundary walls, let public realize the presence of the community and adds vibrancy to the edges of the locality. On the contrary, neglected enclosures and dead-ends at

many places, encroached footpaths, poor quality street lights and sidewalks are the common problems faced by the locals in public areas.

Fig. 4.16: Residential typologies

Fig. 4.17: Slum activities roadside

Fig. 4.18: Street-side activities

Fig. 4.19: Built environment of Uzan Bazar

4.4.2 Case Study 2: Hengrabari and Its Significance

Hengerabari is a densely populated locality with a land area of 1.87 sq. km (approx.) located in the state capital of Assam 'Dispur'. Due to its location at the heart of the city, Hengerabari experiences the hustle of the city traffic and environmental strain every day. Because of the concentrated population and high land values in this particular portion of the city, the predominant housing design observed is mostly of vertical growth character. The surrounding

of the locality is covered by the Assam Secretariat towards the southwestern part, and Borbari and Bormotoriya lie adjacent towards its east and south respectively. With the presence of DC and ADC offices, several hospitals, doctor's clinics, nursing homes and other healthcare facilities, schools and colleges, community spaces such as Shiva, Kali and Shani temples, Karbi namghar, city-level open park, as well as numerous plot and apartment housing societies demonstrate the place to stand out as a typical neighbourhood of the city. The tribal indigenous communities such as Boro, Rabha, Karbi etc. live here in large numbers. Hengrabari holds a community open park 'Amrit Udyan' initiated and maintained by GMDA and GMC which is also a place for cultural events and community gatherings during the festivals.

Amrit Udyan, Photo by researcher Basumatary(2024)

DC Office, Photo by Bodosa Swmkhwr

Nabajyoti Club Image from Google

Fig. 4.20: Photos of city-level public centres

4.5 Inferences

The chapter meticulously laid the foundation of the research by investigating the intricate process of selecting case study sites. The researcher has opted for a unique approach for selecting the most unsafe locality (Hengrabari) within the highest crime-rated PS area and the safest locality (Uzan Bazar) within the lowest crime-rated PS area as case studies. The

assessment of their spatial, visual, and perceptual qualities through the built component evaluation will provide a more meaningful basis for the current research. The following chapter delves into the in-detail assessment of the evaluation criteria in the context of both the selected localities.

Chapter 5: Site Survey, Data Collection, and Analysis

5.1 Chapter Overview

The research, till now, has developed five physical components of the built environment, fifteen indicators of those components, and twenty-one evaluation criteria, which are the qualitative benchmarks to assess the indicators (refer to Chapter 2). Moreover, chapter 4 has contributed to the case studies located in Guwahati City, such as Uzan Bazar and Hengrabari. The analysis of the evaluation criteria in terms of these case studies, collectively, will reveal the physical state of the built environment and human perception. The key results derived from the analysis will finally contribute to the research findings, urban design strategies, and broad recommendations in the upcoming chapters (chapters 6 and 7), which are the key segments of the research outcome of this thesis.

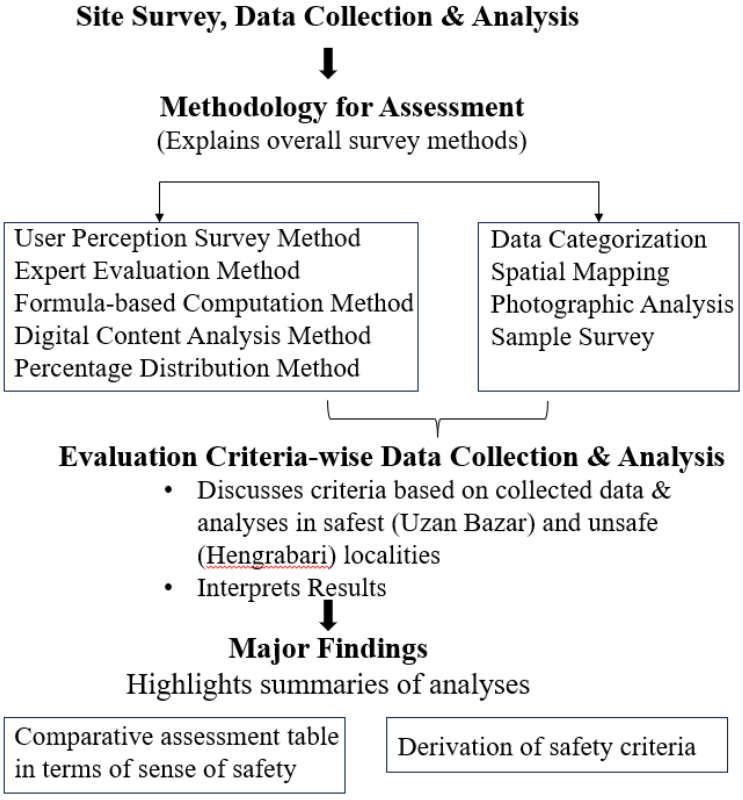


Fig. 5.1: Outline of the Chapter

Also, the data collection process focuses only on the kind of data which are specific to the evaluation criteria which is 21 in number and which depicts the five key components, namely built-form, layout, land use, open space and trees. To assess the evaluation criteria, this chapter deduces a set of measurable attributes, with the help of which scoring systems are

developed and comparative analyses are done according to the data collected in terms of a sense of safety. Other than this method, expert evaluation, digital content analysis, formula-based computation, user's perception survey, etc. are used and supported by spatial mapping and photographic analysis to assess the built environment of the case studies. The adopted methods are reinforced by a combination of literature review and expert consultation.

Thus, chapter 5 is a weighty step towards the overall findings of this research which will be discussed in the upcoming chapter.

5.2 Methodology

Human-proportioned doors and windows, ground floor façade design, visual aesthetics, traffic efficiency, condition of road surfaces, route directness, functional mix, access to amenities, etc. are the evaluation criteria extracted from the literature study for each of the indicators. The criteria are qualitative and appropriate to assess the performance and quality of the built environment. A scientific methodology is used to assess the qualitative aspects of each of the criteria. After doing a thorough literature review on these criteria, the researcher first determines a few measurable attributes of the criterion to obtain the actual data points and quantifiable values. A simple random survey is conducted through a structured questionnaire and individual responses are recorded for the attributes individually through a 5-point Likert scale. The points are thought to be able to provide a reading of the value with 5 denoting 'Extremely Strong', 4 'Strong', 3 'Neutral', 2 'Not so strong', 1 means 'Weak' and expected the highest and the lowest values are to be 20 and 5 respectively.

Interviews and visual observations are conducted through such perception surveys to the residents of the localities and the data are recorded for each criterion. The arithmetic additive method is used to add the responses of each individual against each criterion and criteria scores are achieved. The scores are, then, calculated to get the average value for all the respondents. The average value of all the respondents showcases the perception score of the respondents between the highest to the lowest possible value i.e. between 20 and 5. Amenity access score, land use proximity score, human scale score, walking quality score, land use diversity score, etc. are calculated using this method.

For analysis, later, categorisation is applied to classify the responses into 3 categories: Low (5-10), Moderate (10-15) and High (15-20) using the equal interval technique of categorization as suggested in research by Yu, Tung & Chung (2015). 'The expert evaluation method' has been employed in such instances to evaluate the indicators which are believed to

be more complex to understand by the general public, in the perception survey. In this method, the researcher, herself, rated the evaluation criteria based on the measurable attributes to ensure data reliability and consistency. Assessment of the criteria, such as walking quality, land use synergy, etc., is done using the researcher's ratings.

'Digital Content Analysis Method' has been adopted to check the aesthetics of viewpoints present in the study areas. Moreover, Nolli's map, building use map, tree density map, road network and traffic maps, etc. – many spatial maps are generated for visually representing complex relationship and patterns during the analysis.

Among all, the assessment of trees involves a 'simple random survey method' which divides the entire study area into equal plots of 100m x 100m in size with the help of a Google Earth satellite image. Every 15th number of plots are considered strategically and systematically for such data collection and analysis. Photographic analysis is adopted to analyse the overall perceptual qualities of built features. The collected data are tabulated in a data format, and graphs are used to infer the findings.

The following table is a compilation of the methods adopted for the above-mentioned assessment.

Table 5.1 The Methods Adopted for Assessment of Evaluation Criteria

Sl. No.	Components	Indicators	Evaluation criteria	Methods adopted for analysis										Sub chapter number to refer
				Spatial Mapping	Expert Evaluation	Photographic Analysis	Digital Content Analysis	Perception Survey	Data Categorization	Percentage Distribution	Formula Based Computation	Sample Streets	Sample Plots	
1	Built Form	Human Scale	Human proportioned doors and windows	✓	✓	✓						✓		5.3.1.1
			Quality of Ground Floor Façade Design	✓	✓							✓		5.3.1.2
		Architectural Details	Design Quality		✓	✓						✓		5.3.2.1
		Urban Element	Quality of Visual Aesthetic				✓							5.3.3.1
2	Layout	Road Network Design	Traffic Efficiency	✓				✓						5.3.4.1
			Condition of Road Surfaces	✓						✓				5.3.4.2
		Connectivity	Route Directness	✓				✓						5.3.5.1
		Pedestrian Flow	Walking Quality	✓	✓	✓		✓						5.3.6.1
3	Land use	Diversity	Functional Mix	✓					✓	✓				5.3.7.1
		Access	Access to Amenities	✓				✓	✓					5.3.8.1
			Proximity					✓	✓					5.3.8.2
		Compatibility	Functional Synergy		✓									5.3.9.1
4	Open Space	Spatial Characteristics	Functionality					✓	✓					5.3.10.1
			Social Interaction	✓				✓	✓					5.3.10.2
		Accessibility	Quality of Access points					✓	✓					5.3.11.1
		Legibility	Visual Landmarks					✓	✓					5.3.12.1
			Enclosure Definition					✓	✓					5.3.12.2
5	Trees	Cover	Density	✓							✓		✓	5.3.13.1
			Canopy Coverage							✓			✓	5.3.13.2
		Height	Ability to provide shade								✓		✓	5.3.14.1
		Size	Diameter at breast height										✓	5.3.15.1

5.3 Data Collection & Analysis of Physical Components in the Study Areas as per the Evaluation Criteria

5.3.1 Built Form (C1) - Human Scale (C1I1))

5.3.1.1 Human Proportioned Doors and Windows (C1I1E1)

Human proportioned doors and windows indicate human-centric design approach. People feel safe and comfort in an environment where human scale is taken into account; it strengthens the sense of attachment. Human proportioned doors and windows provide visibility and maintains aesthetic and visual harmony.

Dillenburger et al. (2019) discussed built forms concerning human proportioned fenestrations in an urban design context. According to the research, human-proportioned doors and windows help in the psychological well-being of people in public areas as well as inside. These fenestrations of the built forms act as the mediator for the occupants to communicate with the outside world. Besides, these are the aids to the urban public to establish a visual connection with the spaces within the boundary walls providing reassurance that the area is inhabited and safe to walk through. Ching (2023), in this context, suggested that a figure-ground analysis can help to evaluate the visual connectivity between outdoor and indoor spaces and the feeling of safety due to the proportion of spaces to comprehend human-proportioned doors and windows in a built environment. Moreover, Nosheen & Ajmal (2021) addressed human-scaled doors and windows in neighbourhood design highlighting the two types of housing communities – gated apartments and non-gated housing communities. The design features like doors, windows, balconies, etc. in gated apartments are designed using standardized methods. The dimensions of these are less bothered by individual preferences as they are meant commonly for a large group of people. Whereas the individual plotted houses can be more personalised and standards can be modified as per occupant's individual requirements.

Taking inputs from literature, to assess human proportioned doors and windows in built-forms, the figure-ground maps and the housing typology maps of both the localities – Uzan Bazar and Hengrabari have been analysed. The figure-ground map of Uzan Bazar (Fig. 5.2) shows that 43% of Uzan Bazar's spatial area is covered by built spaces whereas 57% is open spaces that include the parks, playgrounds, water bodies, road network, and building margins. The central portion of the Uzan Bazar locality exhibits a high density of built forms whereas the eastern portion has a scattered development pattern due to the sloppy geographical setting towards the Kharghuli area. The large built forms of educational institutions, parks and fields,

and wider built forms along GNB road like the State Museum, District library, BSNL building, High court building etc. show the coarse grain and maintain the proportion of built forms and open spaces preventing over-congestion. Moreover, the residential pockets and small commercial setups show fine-grain support for more human-oriented spaces such as alleys, courtyards, temples etc. More open spaces and large built forms indicate the possibility of clear visibility as well as an increased number of doors and windows present in the area. The educational institutions of historic importance Cotton University, and Handique Girls' College are observed to have significantly higher no. of doors and windows as these built forms reflect a blend of Assamese traditional and modern construction styles.

Also, from the housing typology map of Uzan Bazar, it is found that approximately 97% of houses are individual plotted houses and only 3% of the total residences are apartment housing. In the majority of individual plotted houses, the spaces are observed to be appropriately sized and have more flexible building fronts, gardens, porches, and front yards. It is, also, observed that the maximum height of such buildings is not exceeding 12 meters (equals height of four floors max.). This is considered to be rather pleasant and gives passersby a sense of openness and visibility. The presence of road-facing windows and other fenestrations enables a constant watch of the residents on road-side.

Fig. 5.2: Built-form analysis: Built and Unbuilt spaces in Uzan Bazar

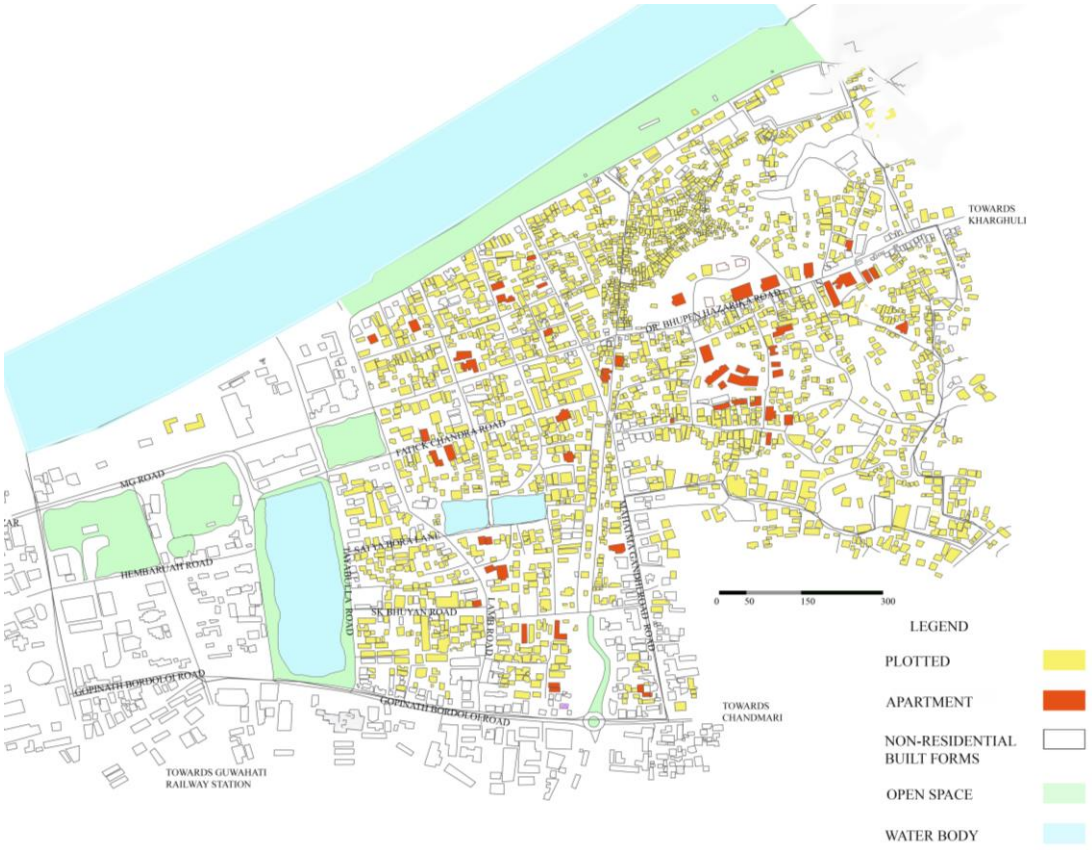


Fig. 5.3: Built-form analysis: Housing Typology in Uzan Bazar

Maps prepared by the researcher

A similar study on built and unbuilt spaces and housing typology is conducted for Hengrabari, also. The analysis from the figure-ground map (Fig. 5.4) explores that in Hengrabari, approximately 74% of the total area is built forms. No prominent consolidated open spaces are found other than one major which is a 1,368 sqm open park. Approximately, 26% area holds unbuilt spaces which includes the road network, a few open fields of temple spaces, and the only Amrit Udyan. The locality shows mostly fine grain from the top, except being few of the portions as coarse grain for example the built forms of the public govt. offices. The densely built forms indicate narrow and smaller windows in Hengrabari as compared to that of Uzan Bazar. The close positioning of doors and windows in compact residential spaces cut the efficiency of those and used only for daylighting. On the other hand, from the map of housing typology (Fig. 5.5), it is found that in Hengrabari, out of the total residential land uses 16% of them are observed to hold gated apartments, heights of which go up to 30m. The apartment houses tend to disconnect visibility due to their high-rise walls, gates, and building heights. Though many fenestrations face road-side, their distances and heights cut the view and thus, tend to deviate from the principles of human-scaled spaces.

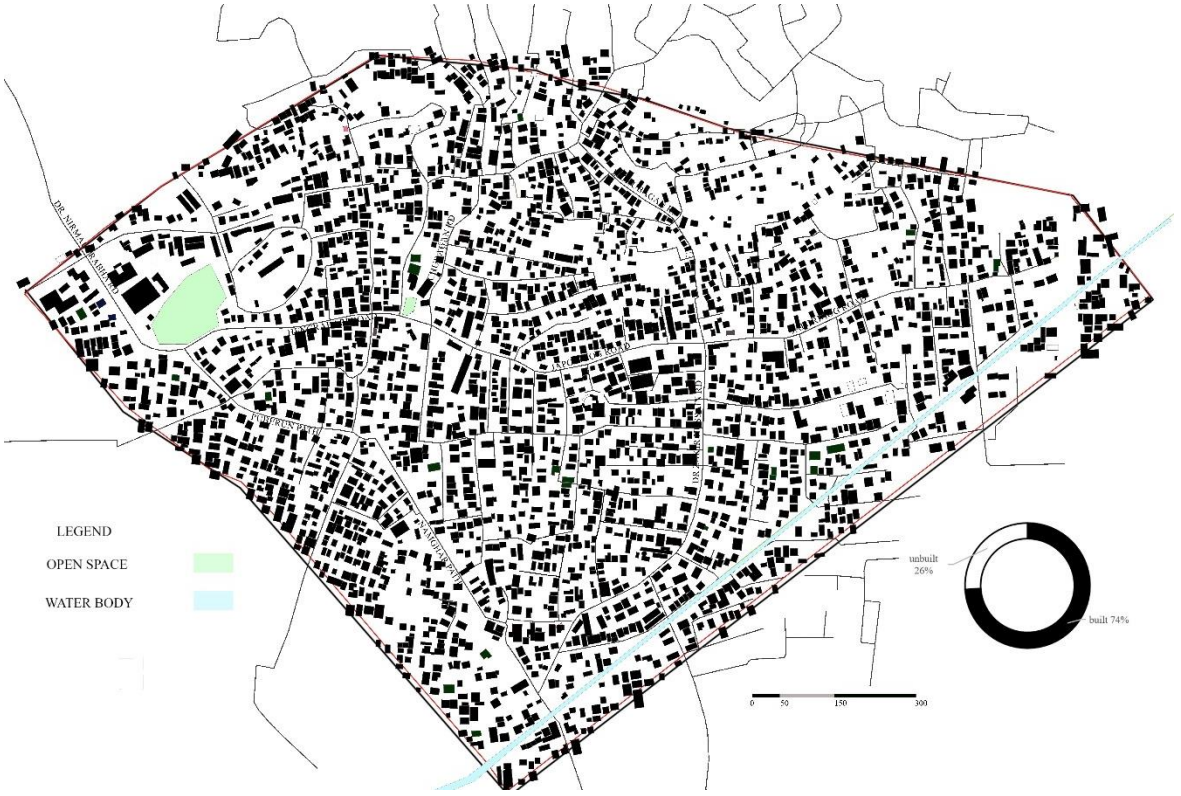


Fig. 5.4: Built-form analysis: Built and Unbuilt spaces in Hengrabari

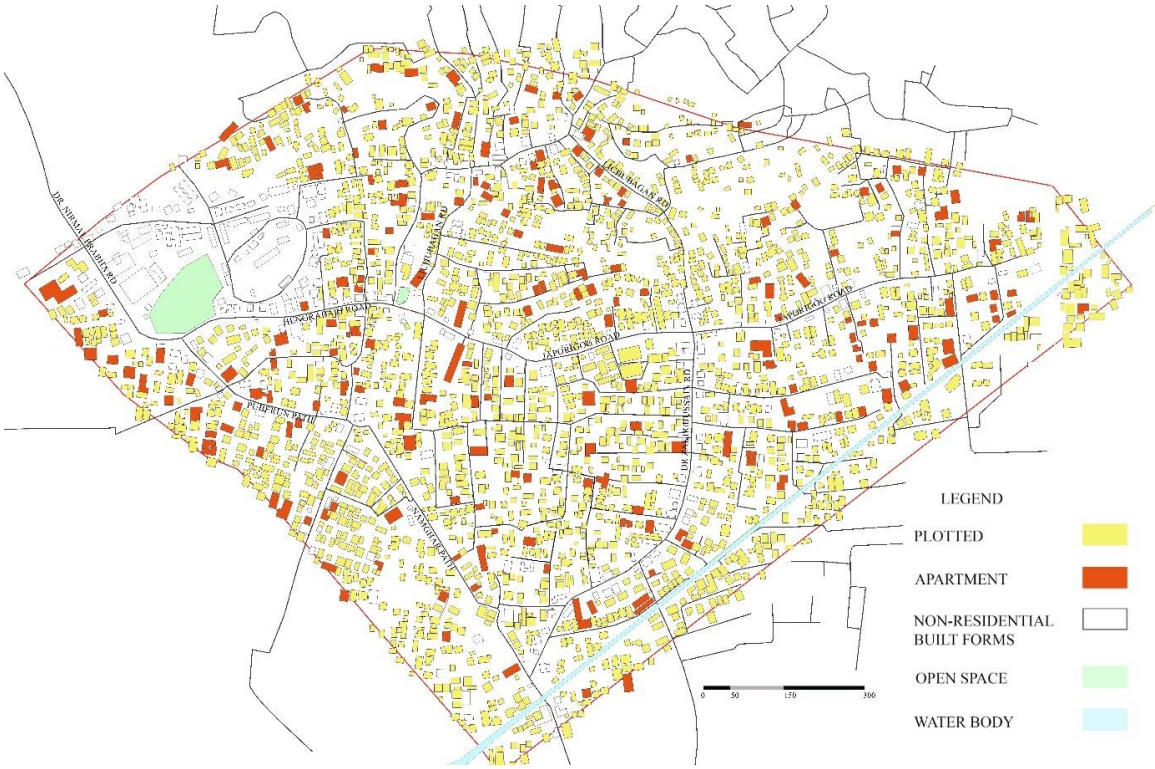


Fig. 5.5: Built-form analysis: Housing Typology in Hengrabari

Maps prepared by researcher

To understand the physical status of the doors and windows in the localities, two sample streets (one for each study area) having similar characteristics (being predominantly residential with a mix of few institutional, and commercial as well as being accessible to community-level open spaces) are selected strategically for the ease of the study and analysis. In Uzan Bazar, Lamb Road has a sample street length of which is 900 m and average width is 12 m with a total of 74 built forms present. Whereas in Hengrabari, the Namghar Path which gets converted as Puberun Path towards the western part of the locality is of 1000m length, 7 m average width and a total of 109 built forms present is the sample street. To conduct the survey on human-proportioned doors and windows of the built forms of the above-mentioned streets, the number of built forms is scoped out to 30% using random sampling from each of the streets. The built forms of the streets from Uzan Bazar and Hengrabari represent the two localities and will help to do a comparison in the larger metropolitan context. Narrowing the study areas to sample streets can enhance the focus of the research and in-depth understanding to fulfil the purpose of the research.

Fig. 5.6 Building Use of Sample street - Lamb Road (Uzan Bazar)

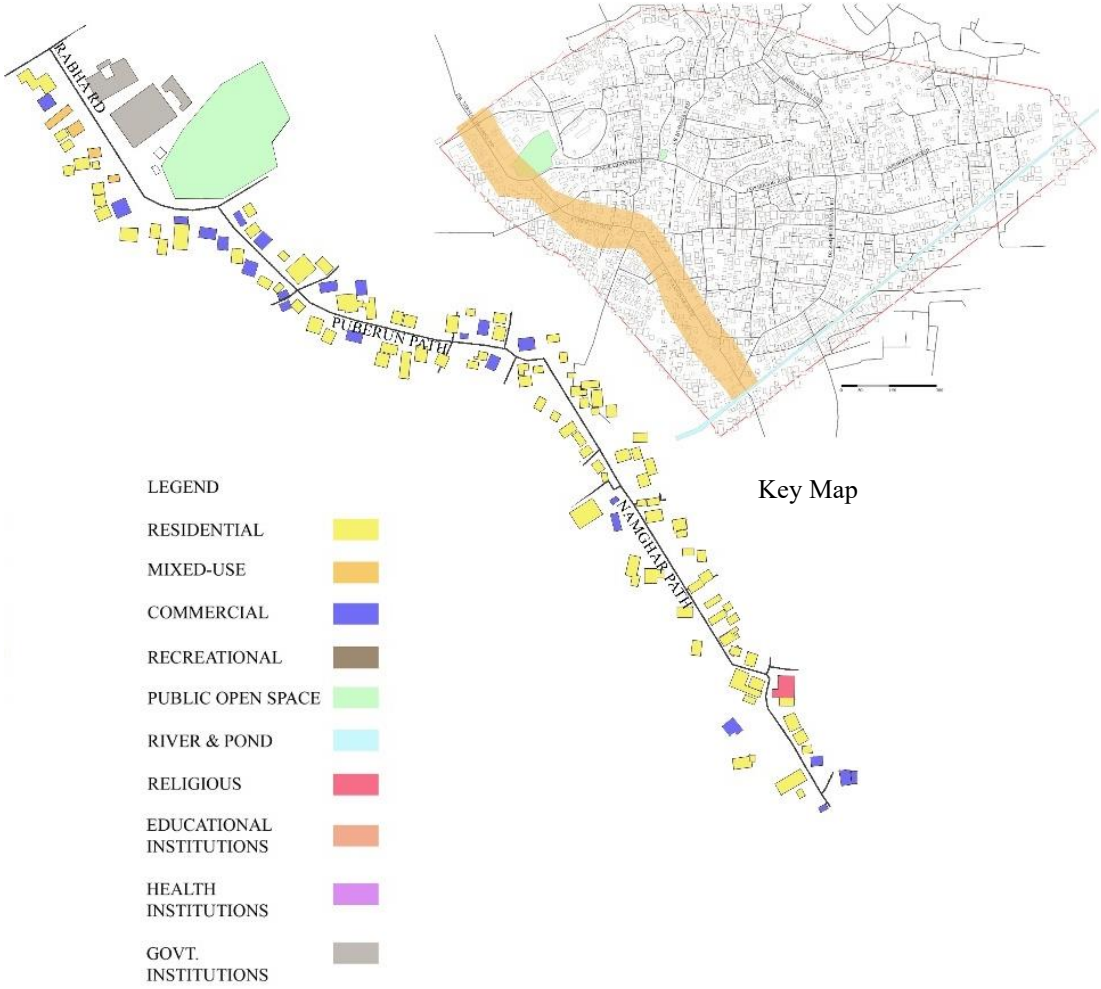


Fig. 5.7 Building Use of Sample street - Namghar Path (Hengrabari)

To assess the sample streets based on the research, the researcher has found 'usability', 'visibility', 'aesthetic value', and 'proportion', to be the measurable attributes of human-proportioned doors and windows in the built-form evaluation as suggested by Bertlin (2014). Considering these, the sample streets are analyzed after the researcher rated them for each of the sample built-forms (30% built forms of each sample street) out of 5. Such ratings for each of the sampled built forms are, then, tabulated in an Excel file, and averaged and the values against each attribute helped to achieve the evaluation score of human proportioned doors and windows for both the localities. The results found are shown in Table 5.2.

Table 5.2: Scoring Analysis of Human Proportioned Doors and Windows across Localities

Measurable Attributes (from literature study)	**Attributes are rated based on**	**Average value of scores of each building (Uzan Bazar)**	**Average value of scores of each building (Hengrabari)**
Usability	If the fenestrations are functional and facilitate a safe experience	3.1	4
Visibility	If doors and windows allow visual connection without hampering privacy	4.4	3.9
Aesthetic value	If the design balances visual harmony	3.4	2.5
Proportion	If the height-to-width ratio respects human scale	4	3.7
Evaluation Score of human proportioned doors and windows		**17.7**	**15.7**

The table shows that Uzan Bazar has secured a higher score (17.7) than Hengrabari (15.7), so it indicates that the built forms of Uzan Bazar follow the human scale. But when noticed carefully it is evident that out of all the attributes, it has got a comparatively lower score in usability (3.1). The reasons behind this might be the assam-style houses present in the sample street which are more than 60 years old, and the strength of the doors and windows has become weaker. Whereas, the rich Assam-type design elements of these buildings in Uzan Bazar make them stand as aesthetically valuable as those of Hengrabari. Such elements include the traditional Ikara construction techniques, hipped roofs at different levels, the jalis in the windows and balconies, the wooden framed doors and windows, wood-battered house walls, transparent wooden boundary walls, etc. On the other hand, in Hengrabari, the uninteresting designs of buildings with minimum ornamentation and more practicality make it get lower score in aesthetic value (2.5). The following images of the site buildings discuss the human-scaled doors and windows, their appearance, and usability.

Fig. 5.8: Photographs of doors and windows of built forms of Uzan Bazar

Fig. 5.9: Photographs of doors and windows of built forms of Hengrabari

The above-scoring system (Table 5.2), photographic discussion (Fig. 5.8 and Fig. 5.9), and overall analysis of human-proportioned doors and windows in the built forms infer that the Uzan Bazar performed better than Hengrabari in human-scaled doors and windows evaluation.

5.3.1.2 Ground Floor Façade Design (C1I1E2)

Ground floors are visually more connected to the public. The quality and use of ground floors can decide the activeness of any place by creating opportunities for face-to-face interaction enhancing social life and social capital (Gehl 2013). So, the ground floors are considered as

fundamental element for a good and safe urban space.

Hassan, Moustafa & El-Fiki (2019) have discussed ground floor building uses in connection with ground floor façade design. The building used to provide a purpose to the buildings and the diversity of uses on the ground floors of buildings involves diverse people and thus, diverse activities. This study identifies certain attributes associated with the quality of ground-floor façade design. These are namely – 'porosity' (visual and physical), 'architecture' (balance in design and style clarity), and 'customization' (uniqueness and cultural originality). Accordingly, to assess the ground floor facades' designs, in context to Uzan Bazar and Hengrabari, the ground floor uses are mapped by the researcher's team through visual observations. Such maps are discussed through Fig. 5.10 and Fig. 5.11, respectively. In addition to understand the perceptual implication of the façade design of ground floor uses, the researcher does a field observation and rates the measurable attributes extracted from literature, which is discussed in context to the sample streets.

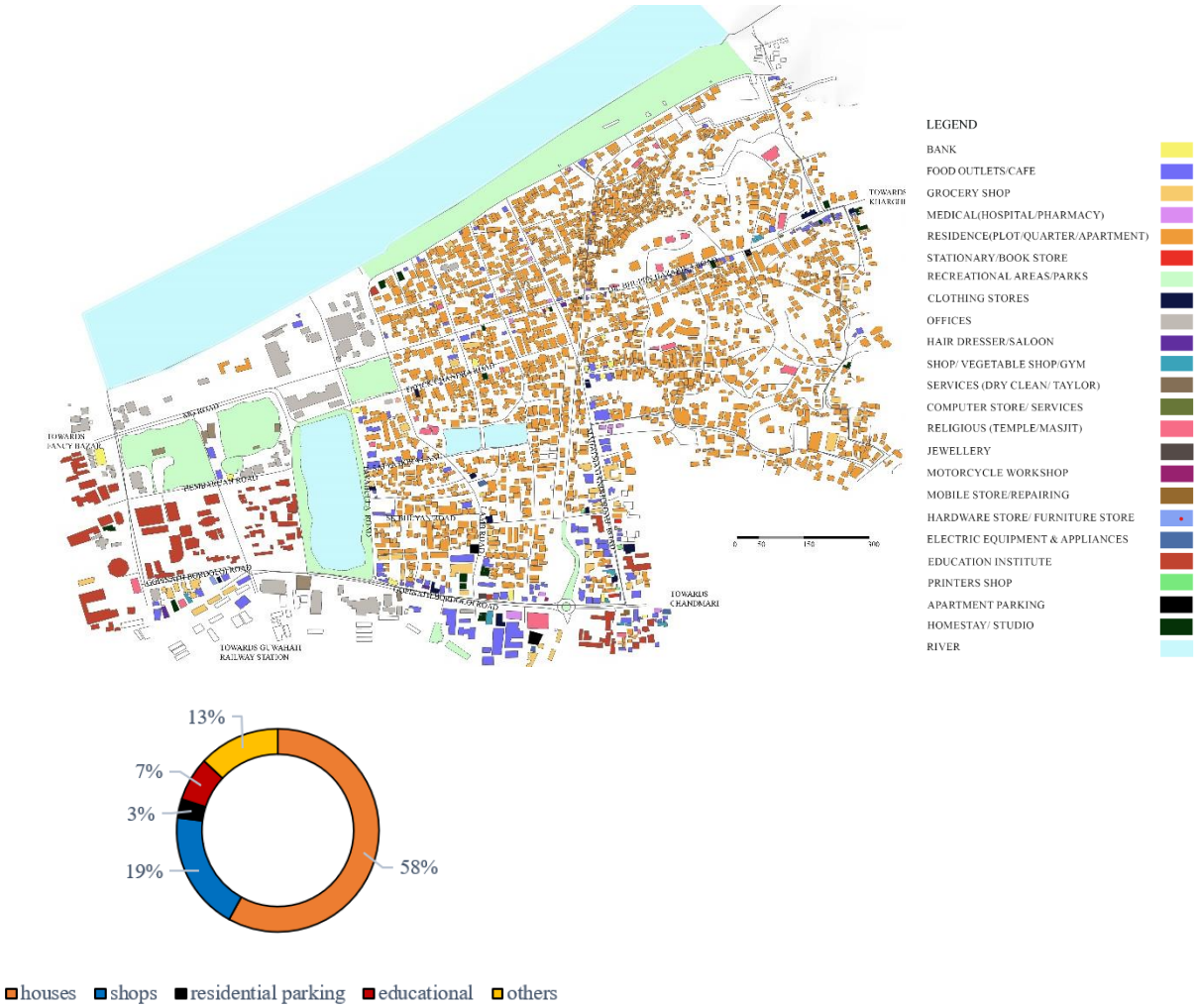


Fig. 5.10: Built-form Analysis: Ground Floor uses in Uzan Bazar

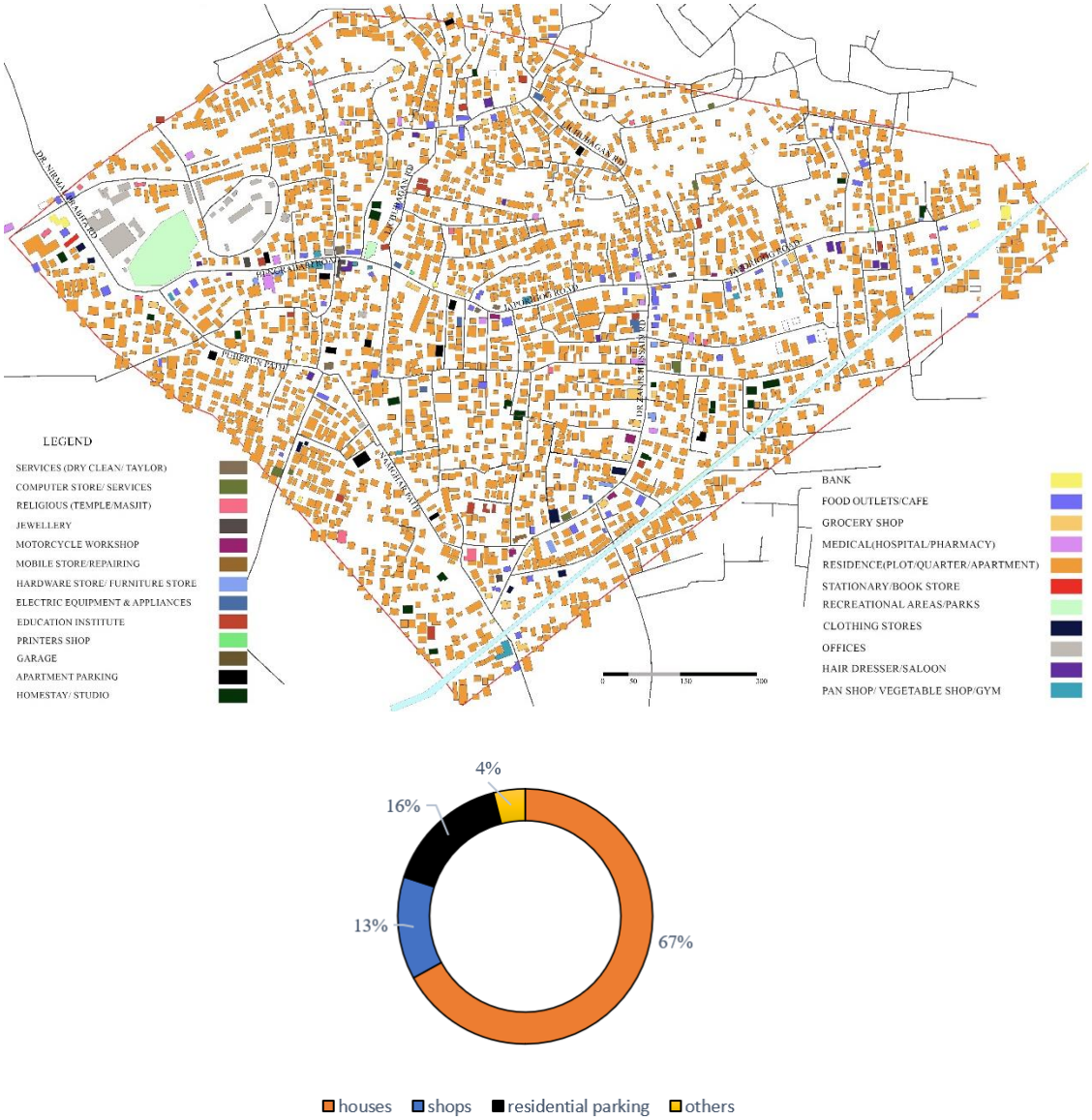


Fig. 5.11: Built-form Analysis: Ground Floor Uses in Hengrabari

From the maps, it can be determined that in Uzan Bazar (Fig. 5.10), 58% of ground floors are of residential use whereas 19% are commercial followed by residential parking (3%), educational institutions (7%) and others. The ground floor residences belong to are either purely plots or partially share commercial activities on the upper floors such as tuition centres, hostel facilities, lodges, etc. Among these, the independent residences with enclosed premises have front yards, private garden areas, and parking for private vehicles, which make the premises busy with human activities and enhance the overall design quality. The residential parking areas (3%) on the ground floors are part of the apartments available in the area which are dull and dead most of the time. The commercial floors include food outlets, grocery shops, garments shops, local service outlets like tailors, electronics shops, furniture shops, printers shops, etc. and maintain the flow of young people during the daytime till

evening. Moreover, residential facilities (girls' and boys' hostels) inside the institutional land use keep the area busy even till late at night.

On the other hand, in Hengrabari (Fig. 5.11), it can be observed that approximately 67% of the ground floors are for residential use followed by commercial buildings (13%), parking (16%), and others (4%) which includes temples, buildings not in use, etc. Here, the land use has residential dominance; the commercial land uses are distributed along the main roads. The commercial ground floors share comparatively lesser varieties of activities. As a result, though the arterial roads show dynamic activities, the internal roads with residential ground floors are likely uniform to look at due to their similar usability. Also, the narrow plot width of the residences leaves no spaces for the front yards, planted setbacks inactive street edges, especially during evening time Hengrabari.

Now, based on the attributes of façade design, the researcher conducted the expert evaluation survey prepared a survey sheet and rated the buildings of the sample streets of both the localities out of 5. The average value of ratings against each selected building based on the attributes provides the score for ground floor façade design in Uzan Bazar and Hengrabari. The results are tabulated and displayed for Uzan Bazar and Hengrabari in Table no 5.3.

Table 5.3: Evaluation of Scores for Ground Floor Façade Design across Sample Streets

Street & Locality	**Façade porosity**		**Architectural Style**		**Customization**		**Quality Score for Ground Floor Façade Design**
	Visual porosity	**Physical porosity**	**Balance**	**Clarity**	**Uniqueness**	**Originality**	
Lamb Road in Uzan Bazar	3.0	3.6	3.4	4.0	3.7	3.4	20.7
Namghar Path in Hengrabari	2.5	2.6	2.4	2.1	1.7	1.8	13.2

The above table shows a significant difference in scores of both localities (20.7 and 13.2 for Uzan Bazar and Hengrabari, respectively). It results that Uzan Bazar scored highest in clarity and uniqueness, whereas it scored lower in visual porosity. Uzan Bazar's residential houses are of one floor height, and the Assamese architectural style is strongly visible in their facade design. The wooden and bamboo frame screening on the wide verandah, sloped roof, corrugated iron simple roofing, minimalist ornamentation, and simple wooden framed doors and windows provide its residential buildings with cultural identity and originality of

tradition. On the contrary, in the modern type of buildings of the locality, the use of solid boundary walls may reduce the visual porosity. In some cases, the vegetation used inside the campus of the residences cuts the views from and to the roadside at a few places, which may be a reason behind the low score in visual porosity.

On the other hand, Hengrabari has secured the 2.6 highest score in physical porosity and the lowest 1.7 in uniqueness in built forms. The buildings of Hengrabari carry solid boundary walls and narrow clear yards, don't follow any specific architectural style, and are of more practical use than aesthetics. Moreover, many developers and landlords have developed their plots by building several units in standard measurements, which results lack of individuality and cultural significance in such plots.

From the above analysis of the Ground floor façade design through spatial mapping and scoring system, it can be inferred that the Uzan Bazar performed better than Hengrabari.

5.3.2 Built Form(C1) – Architectural Details (C1I2)

5.3.2.1 Design Quality (C1I2E1)

The quality of architectural design of a particular urban space controls a visitor's mood and insights he perceives from the space's safety, and comfort. The architectural design can provide local identity and improve overall cultural vitality of an urban space.

For the design quality assessment in the localities, the researcher has undergone a literature study to extract some measurable attributes of design quality which depict architectural details of the urban locality. Among the available literature, Ching's book (2011) has mentioned material fineness, and plants as the most influential elements of architectural design in an urban context to establish its design quality. Whereas Berleant (1997), Kansas.Shafaghat & Keyvanfar (2022) mentioned colour aesthetics and shade structures that play significant roles in maintaining the design quality of urban streetscapes. Therefore, for the ease of this research for the analysis in a qualitative manner, 'material fineness', 'colour aesthetics', 'plantation', and 'shade structures' are considered as measurable attributes and the sample streets are analyzed. The built forms of those streets are rated out of 5 using the Delphi method (Ghomeshi, Nikpour & Jusan 2012). Such ratings for each of the sampled houses are, then, calculated, and averaged. The averaged values against each attribute helped to achieve the evaluation score of design quality for both localities. The results found are shown in Table 5.4.

Table 5.4: Scoring Analysis of Design Quality across localities

Street & Locality	Colour Aesthetics	Material Fineness	Plantation	Shade Structures	Design Quality score
Lamb Road in Uzan Bazar	3.2	4.5	3.3	3.2	14.2
Namghar Path in Hengrabari	3.2	2.5	3.9	2.3	11.9

The above-table results that the architectural design quality of the built forms secured by the built forms of the sample streets of both the localities has a significant difference which is 14.2 in Uzan Bazar and 11.9 in Hengrabari. The architecture of Uzan Bazar is routed to its cultural identity in many places. The colours of the building are subdued which balances the visual harmony. The fineness of the materials shows rough texture with unpolished stones at a few places, whereas unfinished concrete or exposed bricks at others making the streets easily readable. The shading devices include awnings, chajjas, jalis, overhangs or plantation screens that provide protection from sun lights. On the other hand, in the case of Hengrabari, it scores less in material fineness (2.5) and shade structure (2.3). The regular modern modular materials like glass, concrete, and steel are the popular materials used in the construction of built-forms which provide no peculiarity as a whole. Poor representation of traditional Assamese elements in the architecture of the locality hinders the overall quality of the design.

Fig. 5.12: Photographs of Architectural Style of Built Forms of Uzan Bazar

Fig. 5.13: Photographs of the architectural style of the built forms of Hengrabari

From the overall study and assessment of design quality, it can be inferred that the Uzan Bazar performed better than Hengrabari in the evaluation of the quality of architectural design.

5.3.3 Built Form (C1) – Urban Elements (C1I3)

5.3.3.1 Visual Aesthetic (C1I3E2)

A well-designed visual aesthetic aids in the visitors' ability to develop a clear mental image of any urban place and to identify the place on subsequent visits. The quality and the variety of visual aesthetics are a crucial tool for designing urban elements, and it has a direct impact on how safe and comfortable individuals feel on which the visiting frequency depends (Kawshalya, Weerasinghe & Chandrasekara 2022).

In regard to the assessment of the visual aesthetic of a locality, social media is one of the best platforms to find out about public interest and engagement through the digital content analysis method (Molinillo et al. 2019, pp.247). On searching counts of hashtags from Instagram against the prominent landmarks as well as landscape points, it is noticed that there are several natural features and pleasing views available in Uzan Bazar which are enhanced through man-made design aspects. For example, the views of the Brahmaputra riverfront from the roadside have been tried to enhance and utilized through the ongoing riverfront development project. Also, the presence of ponds Dighalipukhuri, Jorpukhuri, etc. is utilized through the beautiful parks in the surroundings, and so on. However, architecturally significant temples like Umananda (the smallest river island) and Ugratara as well as several years old trees have provided pleasant viewpoints, landmarks, and vistas to the locality. Almost every major internal street, in the locality has either one park or a pond or large trees that help to improve the visual orientation of Uzan Bazar.

On the other hand, Hengrabari holds only a few viewpoints including a few from the Amrit Udyan, its well-maintained garden areas, and elevated serene views. Aside from these, there are a few views from some of the local rooftop restaurants, a few makeshift viewpoints set up during festival festivities, and some natural views made possible by the few big, ancient trees at the intersections, which are not particularly noticeable but occasionally appear on Instagram.

In order to detect the visually aesthetic viewpoints and understand their richness as well as popularity in terms of urban elements, the researcher has surveyed social media i.e. Instagram platform posts from Android devices. The viewpoints are identified as those with more than 100 hashtag counts, collated and analysed.

The following table (Table 5.5) shows the Instagram Hashtag Data for viewpoints in Uzan Bazar and Hengrabari.

Table 5.5: Visual Aesthetic Analysis through Instagram Hashtag Data Analysis Method

Locality	**Type**	**Prominent Viewpoints**	**Direct search (Instagram)**	**Hashtag Counts (updated as on 29.22.2024)**	**Purpose of visit**
Uzan Bazar	Park	Digholipukhuri Pond	#dighalipukhuri, #dighalipukhuripark, #dighalipukhuri_guwahati	1000+, 100+, 100+	Boating, and seating facilities, youth recreational activities
		Jor Pukhuri Park	#jurpukhuri, #jorpukhuri, #jorpukhuripark	463+, 100+, 100+	Pictures of festivals,
		Nehru Park	#nehruparkguwahati	100+	Public figures taking selfies
		Sati Radhika Prashanti Udyan	#satiradhikashantiudyan	fewer than 100 posts	Recreational
	Infrastructure Facility	Ropeway Terminal	#ropewayguwahati	100+	Transport
	Temple	Ugratara Temple	#ugrataratemple	500+	Religious
		Umananda Temple	#umanandatemple, #umananda, #umananda_island, #umanandaisland, #umanandatemple_worlds_smallest_river_island, #umananda_temple	1000+, 1000+, 1000+, 500+, 100+, 100+	Religious
Hengrabari	Park	Amrit Udyan	#amritudyanguwahati, #hengrabaripark	fewer than 100 posts, fewer than 100 posts,	seating, playing facilities,

Compiled by the researcher

The two localities' visual aesthetics of urban elements are analysed, and the results show a sharp disparity in their importance and attraction. With numerous unique perspectives and hashtags that have received 100, 500, or more than 1,000 mentions on Instagram, Uzan Bazar is full of visual points of interest. This suggests a varied and visually appealing setting that appeals to both tourists and residents, making it a popular spot for documenting and disseminating experiences. Hengrabari, on the other hand, just has one website linked to Instagram hashtags, underscoring its lack of visual appeal and lower level of significance online. The notable difference in the quantity and popularity of viewpoints indicates that the Uzan Bazar locality has a more lively and well-known aesthetic value, whereas Hengrabari finds it difficult to forge a comparable identity, as a result of the presence of fewer landmarks or less striking features.

From the above analysis based on social media hashtags, it can be inferred that Uzan Bazar performed better than Hengrabari in the evaluation of visual aesthetics.

5.3.4 Layout (C2)– Road Network Design (C2I1)

5.3.4.1 Traffic Efficiency (C2I1E1)

Traffic efficiency indicates the degree of effectiveness of a traffic system of an urban area holds. The crucial part of traffic efficiency is traffic management. The count of traffic volume, speed and time, congestion points etc. decide the traffic efficiency which may vary time to time depending on the new developments in the spatial context.

To assess the traffic efficiency of both localities, the spatial conditions of the road network are mapped through a primary survey and analysed (Refer to Fig. 5.14, 5.15, 5.16, 5.17, & 5.18). The results of this analysis are discussed in the upcoming paragraphs. After the spatial conditions are assessed, to understand the impact of the distinguished facts on commuters as well as to check the reliability of such facts, a perception survey (as mentioned in section 5.2 of this chapter) is conducted through a questionnaire and asked the surveyed people to rate the measurable attributes of traffic efficiency like ‘dependability’, ‘mobility’, ‘system performance’, and ‘safety’ as suggested by Kaparias, Bell, & Tomassini (2011). The addition of the average values of these ratings for each attribute provides the traffic efficiency scores of both localities (Table 5.6).

The following maps are prepared after the spatial study is done in Uzan Bazar through the primary survey.

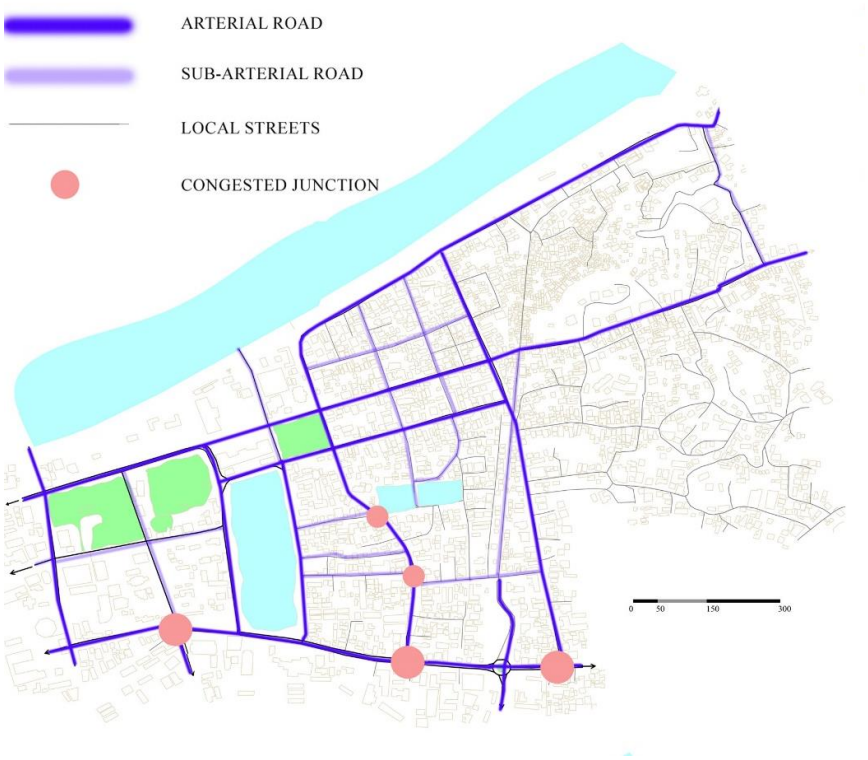


Fig. 5.14: Road Hierarchy Map of Uzan Bazar

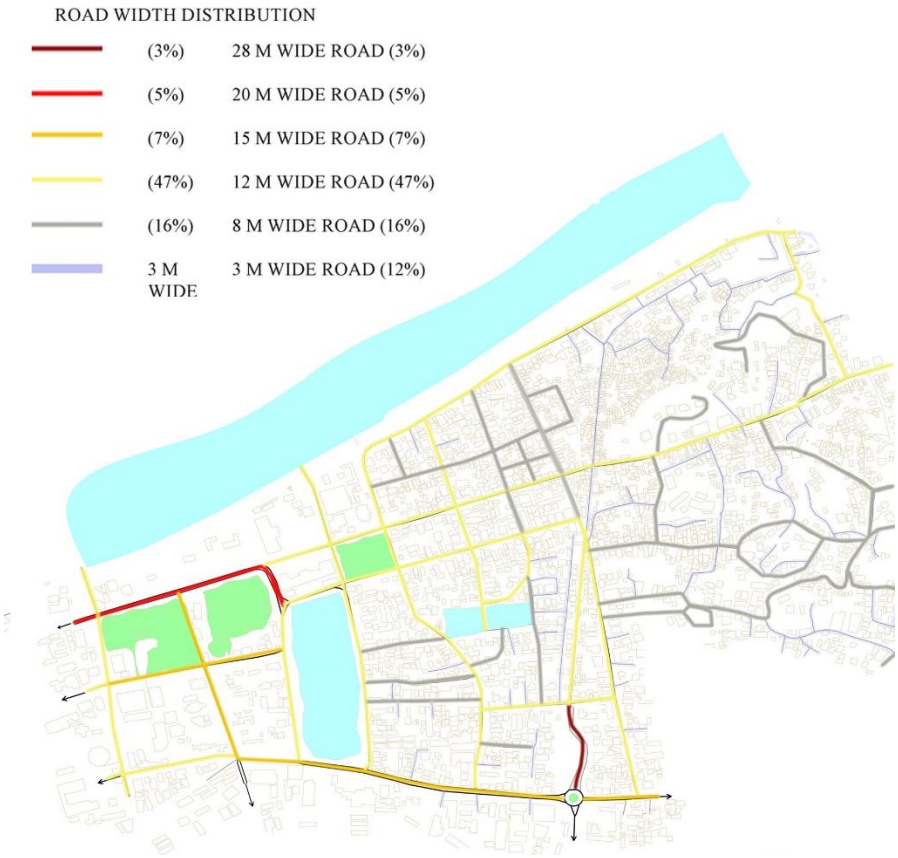


Fig. 5.15: Road Width Distribution

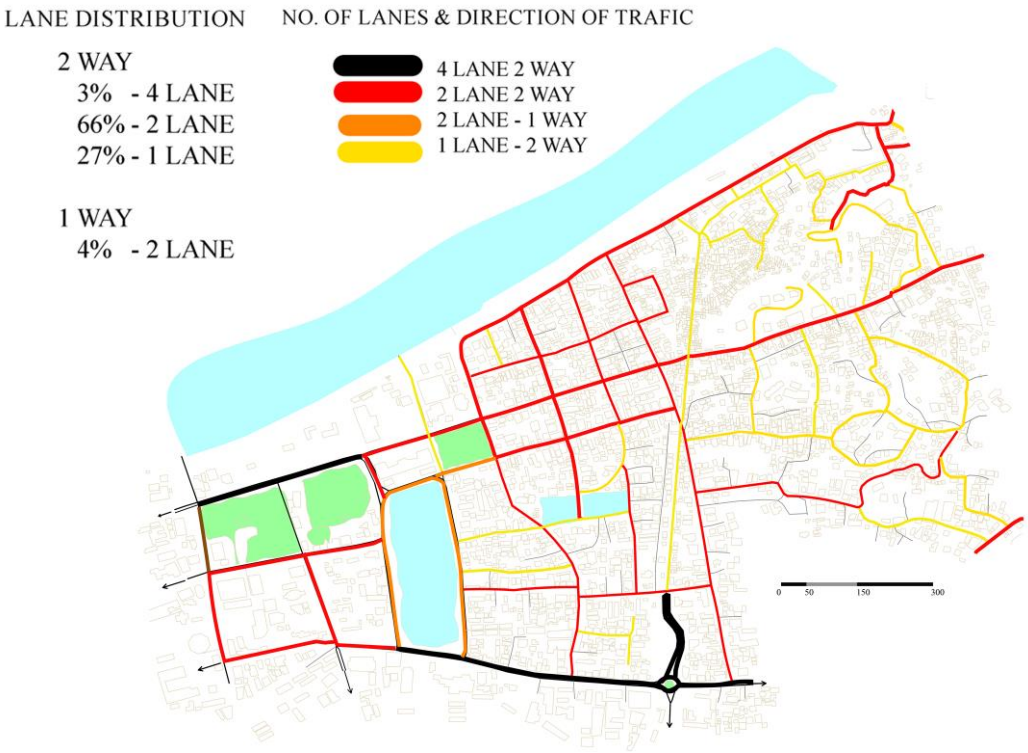


Fig. 5.16: Lane Distribution of Road Network system

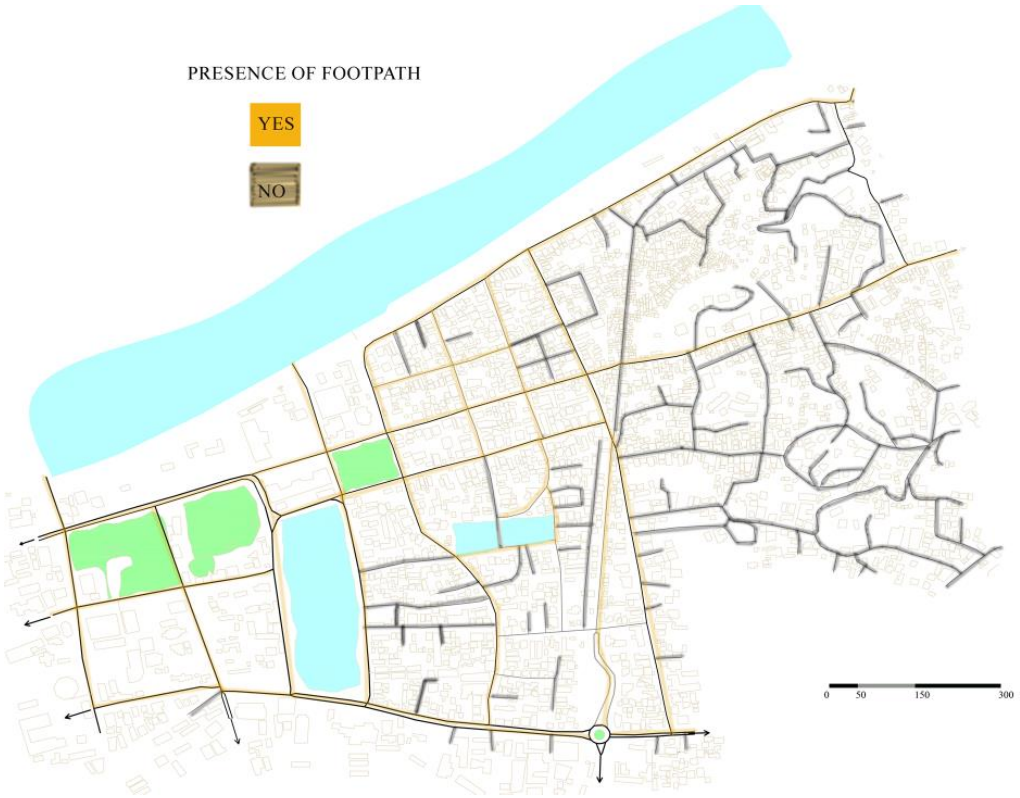


Fig. 5.17: Footpath Mapping of Uzan Bazar

Maps prepared by researcher

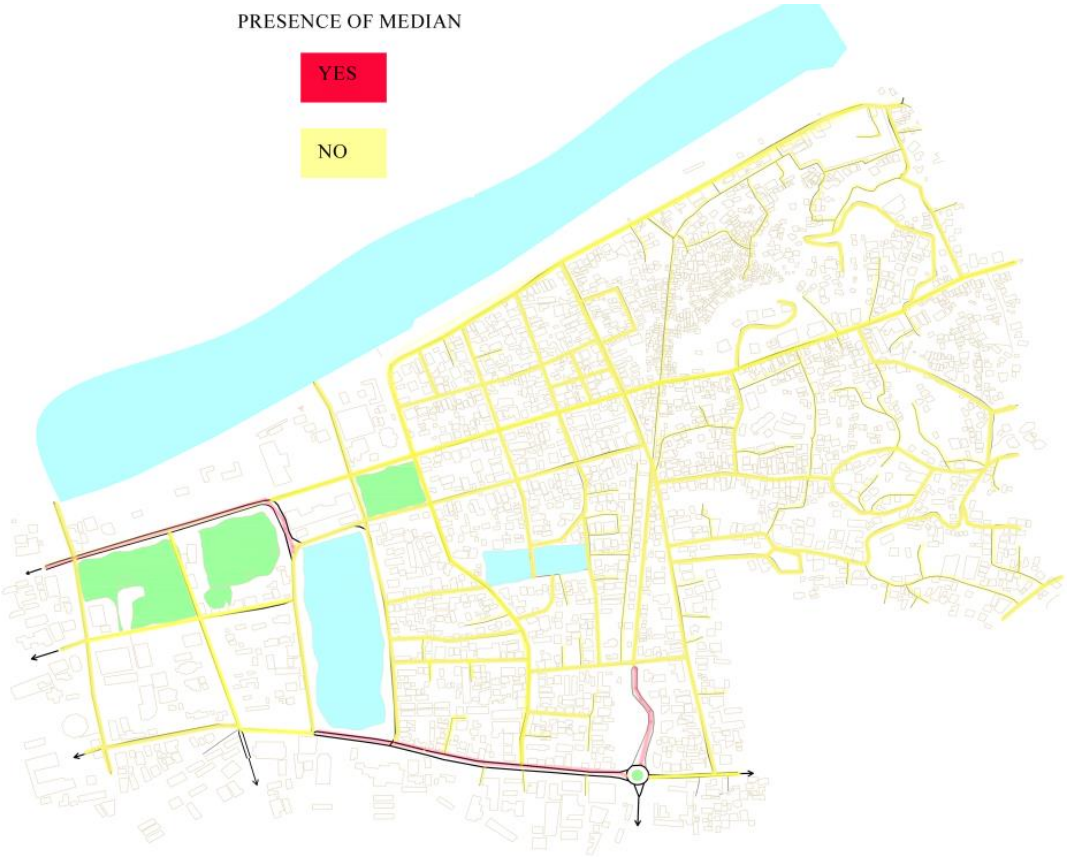


Fig. 5.18: Median Mapping of Uzan Bazar

Maps prepared by researcher

The analysis of the maps reveals that the 22.9 km length of the road network of Uzan Bazar laid in a partially grid and partially organic pattern. Almost 63% of these roads (15 km length approx.) are the arterial and sub arterial roads of 12 m average width. Other 37% roads are the local streets of 8 m and 3 m widths leading to the residential zones (Refer Fig. 5.14 & 5.15). The lane distribution map (Fig. 5.16) shows that 96% road's length (approx.) has having 2-way lane distribution which indicates easy connectivity within the locality, but 27% of these are single lane that carries two-way traffic movement. Such single-lane two-way roads include majorly the local streets which are very narrow (3m wide approx.) to pass two vehicles at a time. From a pedestrianization perspective, when the presence of footpaths and road medians are mapped (Refer Fig. 5.17 & Fig. 5.18), it is seen that only 9% of roads have medians which create chaotic traffic conditions during rush hours due to unrestricted turning movements. It creates hurdles for pedestrians, and also, to walk comfortably. The footpath mapping shows that approximately 84% of the road network, which includes the entire

arterial and sub-arterial road lengths as well as a few local street lengths, are designed with footpaths.

A similar analysis for Hengrabari displays the status of its 19 km road length (in total), 59% of which are local streets of a width not more than 4 m. The other 41% length includes the arterial and sub-arterial roads of 6-10 m width (Fig. 5.19 & Fig. 5.20). Shorter arterial roads make Hengrabari more chaotic and increase more vehicles on sub-arterial and local streets. Almost 34% of the arterial and sub-arterial roads exist with two-lane and two-way traffic movement as mapped in the lane distribution map of Hengrabari (Fig. 5.20 & Fig. 5.21). The local streets are single-lane (4 m) with two-way traffic direction. It has been observed that due to the narrower width of local streets, the through traffic movement is reduced in Hengrabari. It becomes difficult to distribute the vehicular traffic effectively that originates from the residences, which leads to congestion. From a walkability point of view, Hengrabari possesses minimum pedestrian infrastructure which can be said by observing the absence of footpaths in almost 82% of the roads (Fig. 5.22). No medians are present to ensure traffic channelisation.

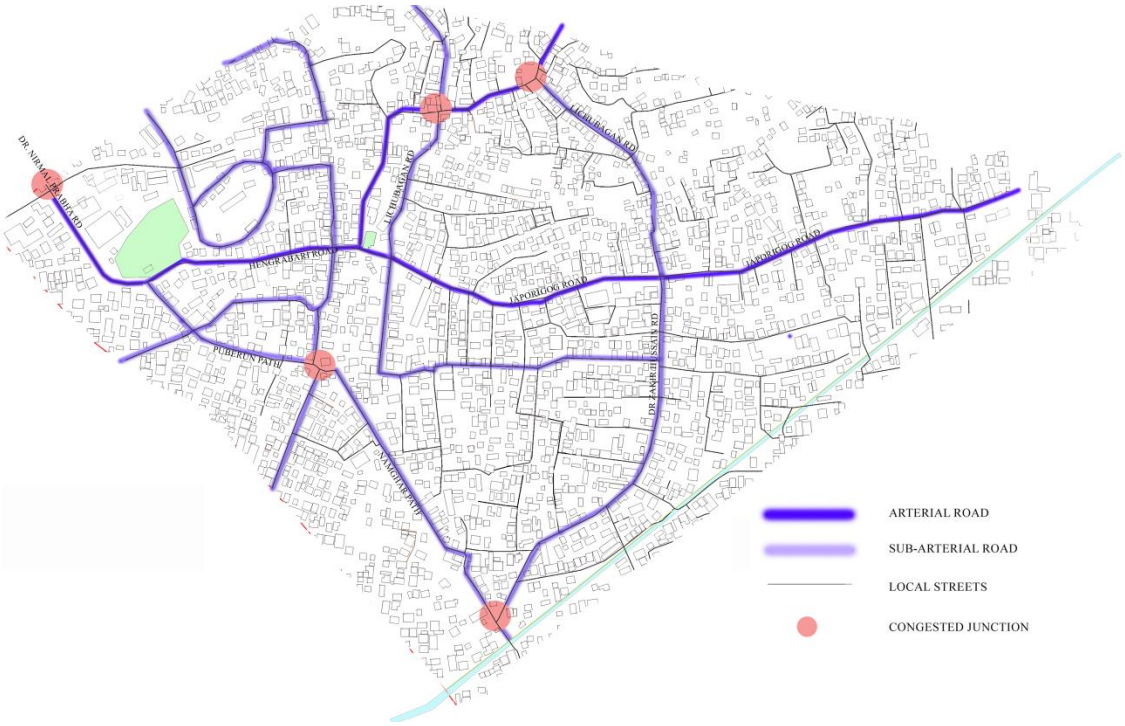


Fig. 5.19: Road Hierarchy Map of Hengrabari

Fig. 5.20: Road Width Distribution

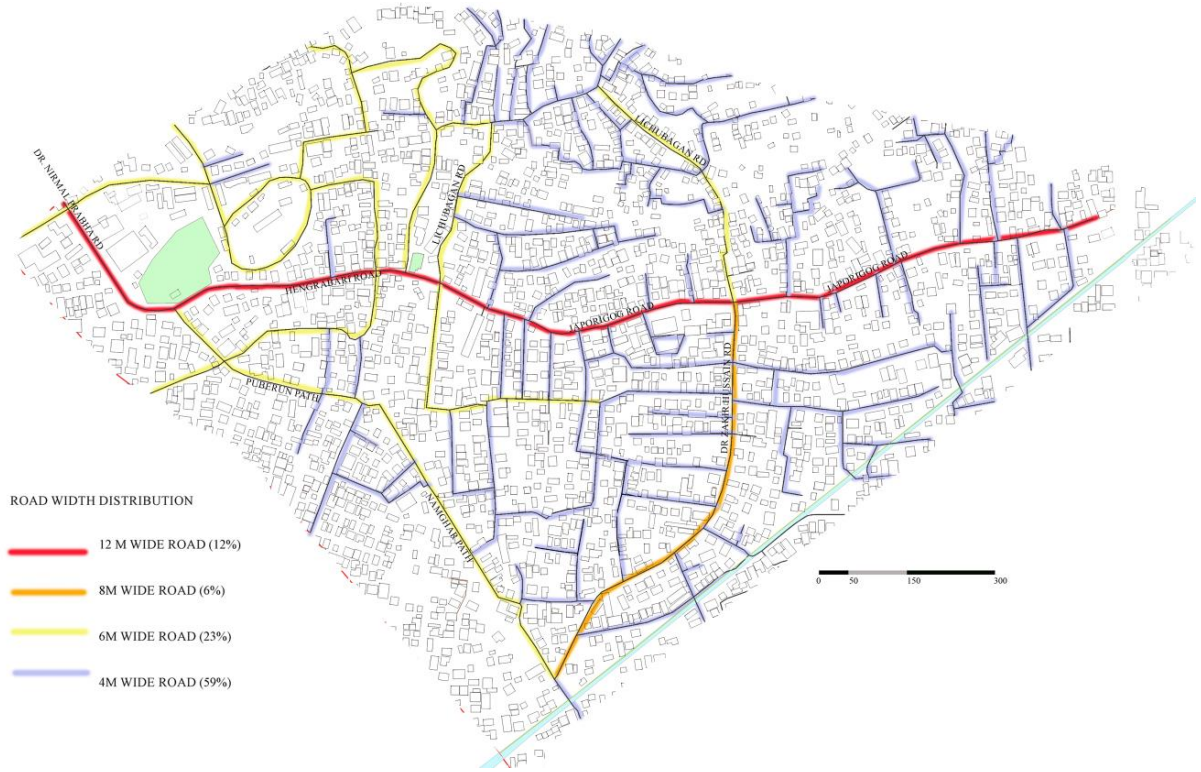


Fig. 5.21: Lane Distribution of Road Network System

Map prepared by researcher

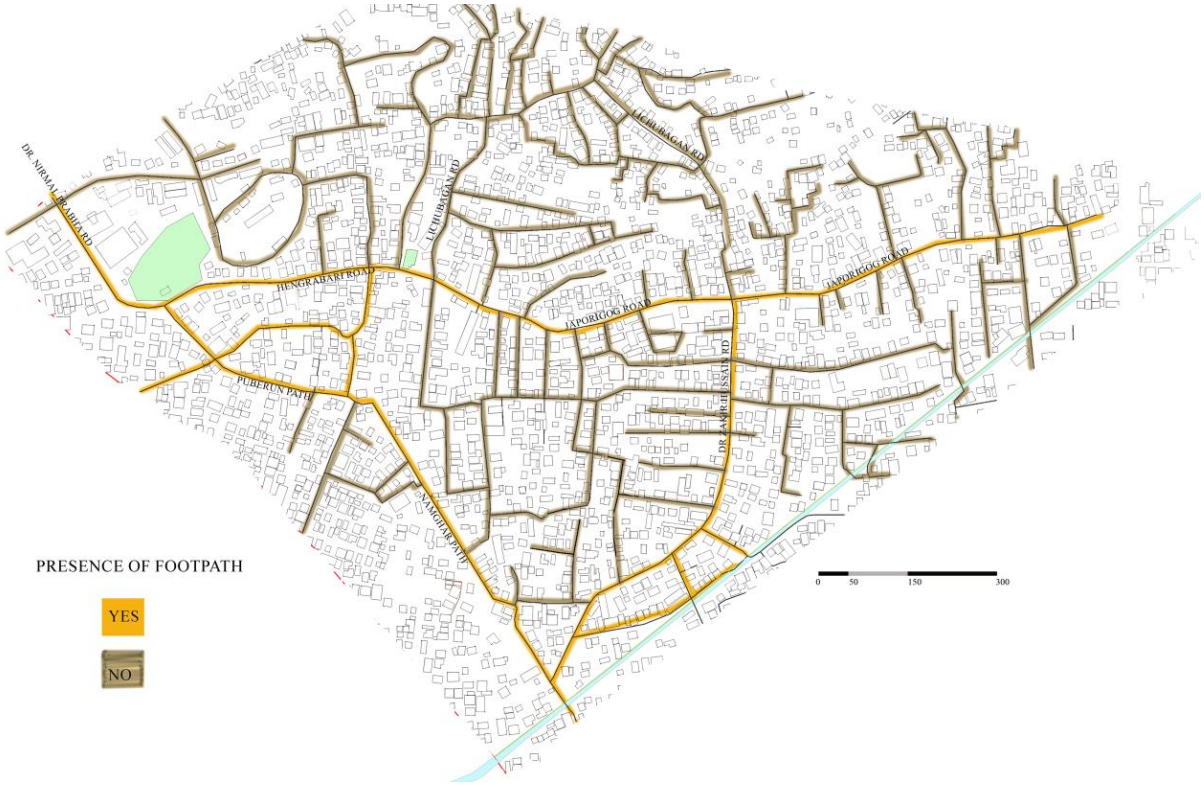


Fig. 5.22: Footpath Mapping of Hengrabari

After the spatial analysis of the road network of Uzan Bazar and Hengrabari, the results of the perception survey are tabulated in the table (Table 5.6). These scores of each of the attributes are achieved by adding the calculated average value of the respondents.

Table 5.6: Scoring Analysis of Traffic Efficiency across Localities

Measurable Attributes	**Av. Score of respondents at Uzan Bazar**	**Av. Score of respondents at Hengrabari**
Dependability	2.9	2.6
Mobility	3.4	2.8
System performance	3.3	2.7
Safety	2.7	1.9
Traffic efficiency Score	**12.3**	**9.9**

The above table shows that Uzan Bazar has a greater value of traffic efficiency which is 12.3 than Hengrabari (9.9) (refer to Table 5.6). It can be observed that the respondents gave a lower rating to safety and dependability in traffic efficacy of Hengrabari which become 1.9

and 2.6 respectively after averaged. The absence of public transportation routes on the major and internal roads of Hengrabari is one of the major reasons why people of the locality find it unreliable to move through. The Ganeshguri bus stand is the nearest public bus service route which is another locality almost 1km away from Hengrabari. Due to insufficient footpath provision in most of the streets and the absence of medians make the commuters insecure while walking on roads. Besides that, single lane two-directional traffic movement on the local streets is another major traffic issue that prohibits Hengrabari from getting good scores in traffic efficiency.

Based on the analysis above, the studied and mapped parameters of traffic efficiency can be compared with respect to both the study areas and inferences can be drawn. The inferences from the comparison against these parameters are tabulated for analysis (see Table 5.7).

Table 5.7: Comparison of Localities Based on Studied Parameters

Attributes to check	Uzan Bazar	Hengrabari	Remarks
Traffic Efficiency Score as per perception survey	12.3	9.9	Uzan Bazar has higher value.
Road Hierarchy	Total road length 22.9 km	Total road length 19 km	Uzan Bazar has more road length; more amount of arterial and sub arterial.
	Arterial and sub-arterial roads (63%) are more than local streets (37%)	Total of arterial and sub arterial is 41% and Local streets are 59%	
Width Distribution	More than half of the road length are arterial and sub-arterial due to which local streets see less traffic pressure	More than half of the total road length is of single lane but carries both way traffic generating congestion time to time	Uzan Bazar has wider ROW
	63% roads are 8-12m wide	82% roads are 4-6m wide	
Lane Distribution	96% are either 4 lane or 2-lane carrying 2-way traffic	47% are 2-lane carrying 2-way traffic. No 4 lane roads are present.	Hengrabari possess more than half roads with single lane and two-way traffic flow.
	Almost 27% are 1-lane 2-way	Almost 45% are 1-lane 2-way	
Presence of Footpath	82% availability	Only 12% availability	Hengrabari has footpaths on minimum roads
Presence of Median	Only 9% availability	No availability	Hengrabari possess no medians on roads

The table indicates that Uzan Bazar demonstrates superior performance across all the examined aspects of traffic efficiency when compared to Hengrabari. That's why it can be inferred that the traffic efficiency is better in Uzan Bazar than that of Hengrabari.

5.3.4.2 Condition of Road Surfaces (C2I1E2)

The quality of road surfaces influences the overall speed of traffic, congestion conditions, and the capacity of the road. Surface irregularities and severe potholes on vehicular roads and pedestrian pathways impact public comfort in public spaces and affect the overall well-being of the area (Ali et al. 2023, p.8677) (Batrakova & Gredasova 2016).

To assess the surface conditions of roads, primary surveys are conducted in both localities, and the conditions are mapped. To do the assessment systematically, the conditions are categorised into three criteria Good, Moderate and Bad. The assessment criteria are considered based on observable attributes. For example, 'Good' signifies paved, no signage of damage; 'Moderate' indicates fair and minor surface issues, yet doesn't possess major risk; and 'Bad' signifies roads with extensive damage, surface irregularities, and severe potholes.

Observing the above-mentioned criteria on the streets of Uzan Bazar, the road conditions are mapped in Fig. 5.23. This map reveals that in Uzan Bazar, 21% of roads are 'Good' facilitating smooth vehicular and pedestrian movement. Other 68% of roads are categorized as 'Moderate' which are mostly the approach roads to the residences, and 11% are the 'Bad' condition roads. In conducting a similar study in Hengrabari, it is shocking to find that no 'Good' condition roads are observed (Fig. 5.24). The 'Moderate' and 'Bad' condition roads are distributed as 58% and 42% in amount respectively.

Fig. 5.23: Surface Condition of Roads in Uzan Bazar

Fig. 5.24: Surface Condition of Roads in Hengrabari

The analysis of the maps reveals that the overall road surface condition of Uzan Bazar is better than that of Hengrabari.

5.3.5 Layout (C2) – Connectivity (C2I2)

5.3.5.1 Route Directness (C2I2E1)

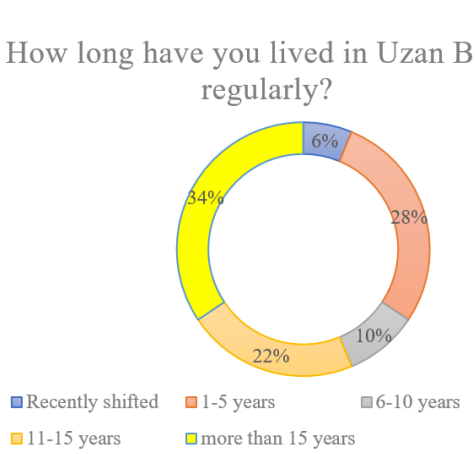
The term 'route directness' describes how direct and uninterrupted the connectivity between the origin and the destination. The role of the shortest and longest routes connecting origin and destination for vehicles as well as pedestrians is significant, as it is associated with travel time, speed of traffic, congestion, etc. Research has shown 'route transparency' (Silavi et al. 2017, p.101), 'route friendliness' (Payyanadan, Sanchez & Lee 2018), 'route connectedness' (Daghash et al. 2023, p.2612), and 'alternate route availability' (Meeder & Weidmann 2018) are the attributes which must be taken into account while addressing route directness.

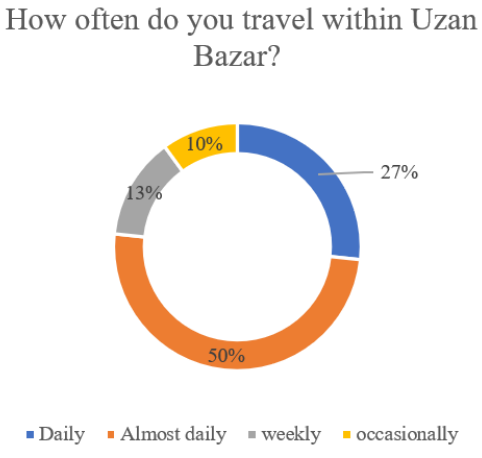
Therefore, to understand people's perception of the route directness of both localities, perception surveys are conducted separately for both localities. The people who are surveyed from each study area belong to the residents of the locality. They are asked to mark the attributes on a five-point scale as well, and a questionnaire is prepared, which carries 4 questions and the hard copies with the residents. The results found from this perception survey in Uzan Bazar as well as Hengrabari are recorded in Table 5.8.

Table 5.8: Scoring System of Route Directness across Localities

Measurable attributes	Av. Score of respondents at Uzan Bazar	Av. Score of respondents at Hengrabari
Route transparency	3.1	2.8
Route friendliness	3.5	2.9
Route connectedness	3.2	2.9
Alternate route availability	3.8	3.3
Route Directness Score	**13.6**	**11.9**

From Table 5.8, it is evident that though the values show not much difference, Uzan Bazar scored higher than Hengrabari in the study of the perception of people about route directness. Also, it has scored higher recorded value against each of the physical attributes. The road network of Uzan Bazar follows a partial grid and partially organic pattern whereas, in the case of Hengrabari, it follows an entirely organic and irregular spatial character. Because of this organic layout, Hengrabari results in indirect travel paths. The interconnectedness of the internal streets is poorer than that of Uzan Bazar. Therefore, the road system of Hengrabari constrains route flexibility for its visitors largely (score of Alternate route availability 3.3) as shown in Table 5.8. Additionally, the absence of footpaths and medians on the local streets are the major reasons why people do not feel comfortable walking as well as riding or driving through the roads of Hengrabari; which has made it score significantly less in 'Route friendliness' (2.9). Furthermore, the results of a questionnaire survey, the following perception could be understood about the residents of the people.





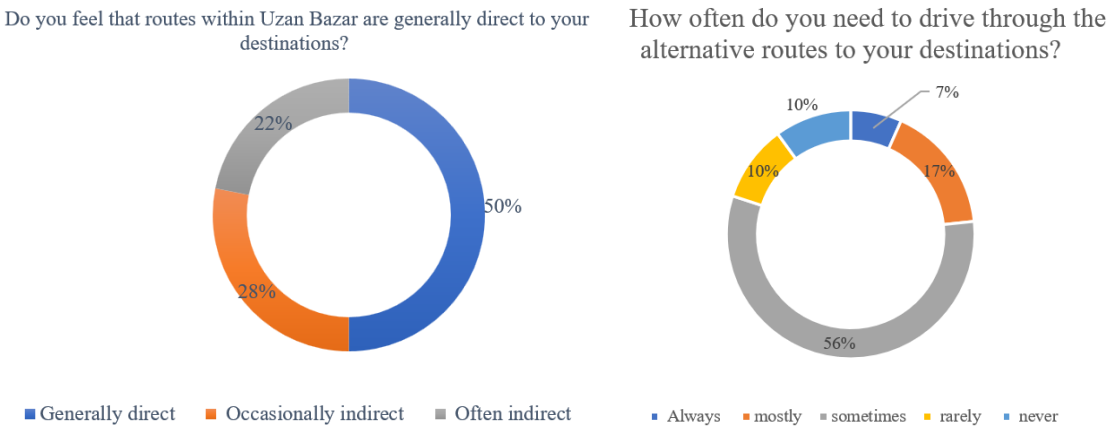


Fig. 5.25: Responses of Respondents during Perception Survey in Uzan Bazar

According to the survey, 34% of the respondents have been residents of Uzan Bazar for 11-15 years, and 28% for 1-5 years which indicates the participants are a mix of old and new residents, can provide varieties of perspectives of which the old residents have a deep understanding about the place and strong perception as well as the new residents provides their perception rating based on the fresh impression and challenges. Most of these respondents are either daily (27%) or almost daily (50%) travellers within the locality. During the survey, almost 50% of respondents feel that their routes to their destinations are generally direct, and 28% feel as 'occasionally indirect' in festive seasons when the festivals take place in Latasil field or Dighalipukhuri Park. At this time of the year, sometimes they see the local streets full of cars of strangers parked. Moreover, 56% of respondents reacted as 'sometimes' when they were asked if they needed to take alternate routes to their destinations.

On the other hand, in Hengrabari, among the respondents, 28% have been there for 6-10 years, and 22% have been there for more than 15 years. 53%% respondents said that they occasionally need to follow indirect routes due to the poor road conditions, as well as chaos in the commercial streets. More than 28% and 25% of respondents either mostly or sometimes respectively opt for alternate routes. The respondents also said that in case of any event in the Amrit Udyan, the visitors from other parts of the city create extra pressure on the main arterial road of the area and generate traffic congestion points at junctions.

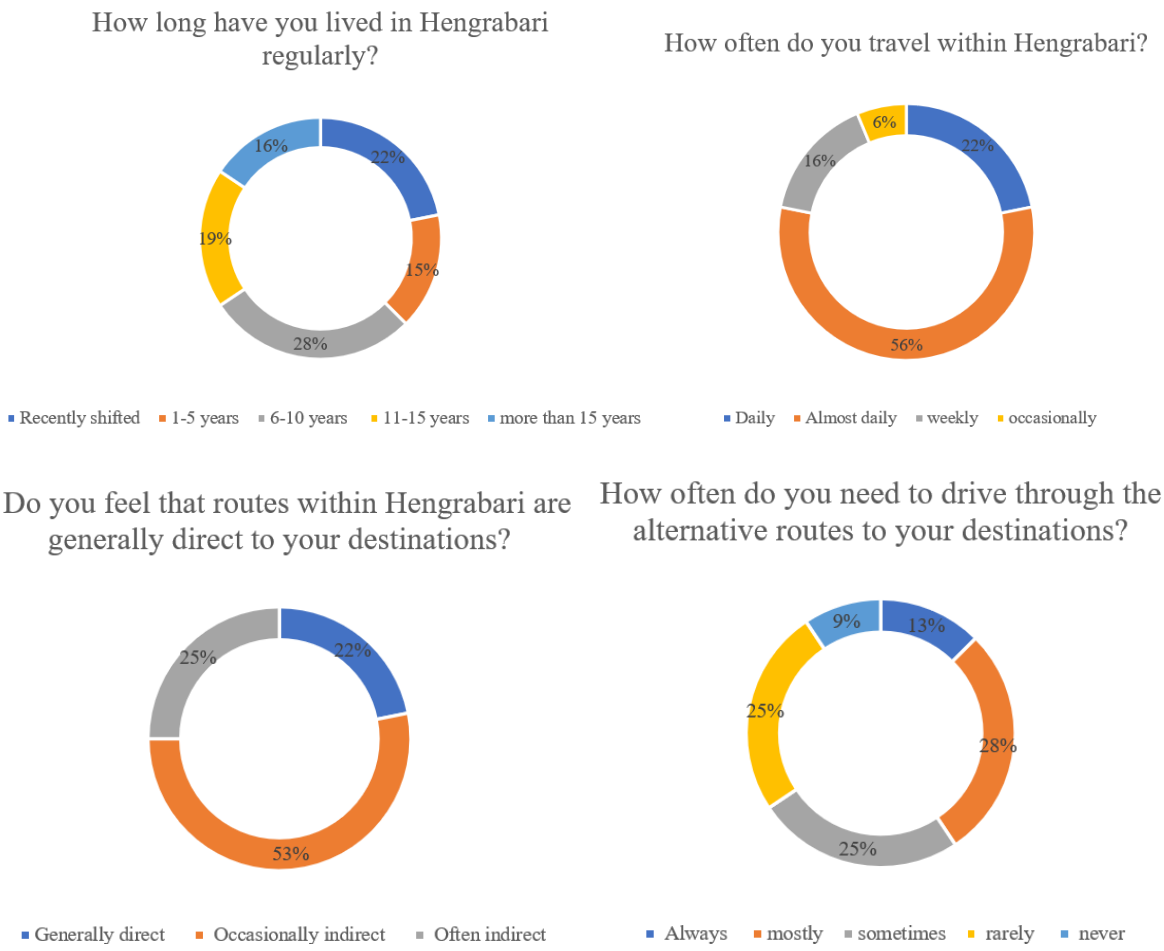


Fig. 5.26: Responses of Respondents during Perception Survey in Hengrabari

The perspectives obtained from the perception survey are verified through spatial assessment of the localities by the researcher. As a result, the parking facilities, transportation stations etc. are mapped in Fig. 5.27. It is seen that in Uzan Bazar, there are no dedicated parking facilities available in the entire locality. The private cars and bikes are parked by the side of the roads which creates chaos on the major roads. The streets adjacent to Dighalipukhuri Park, Latasil field and Nehru Park get congested by on-street parking during weekend evenings. Moreover, on mapping of dead ends in the locality (Fig. 5.28), it is evident that approximately 1.5 km length is dead ends which are the local streets, create blind spots, and reduce shorter travel route options.

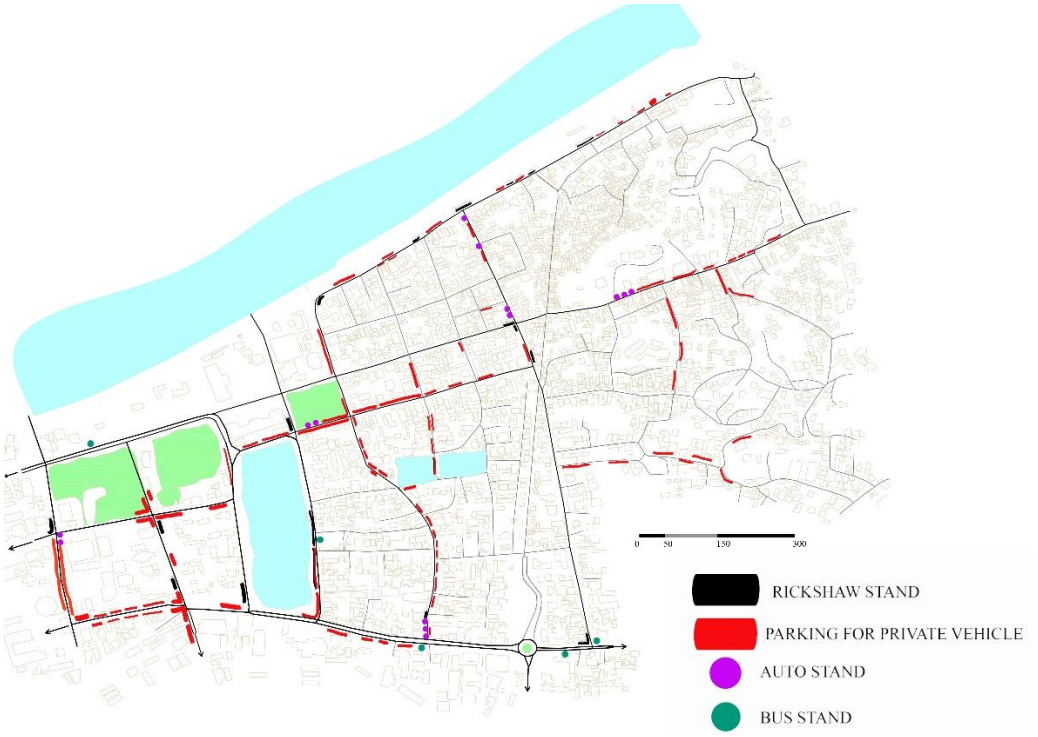


Fig. 5.27: Street Parking Map in Uzan Bazar

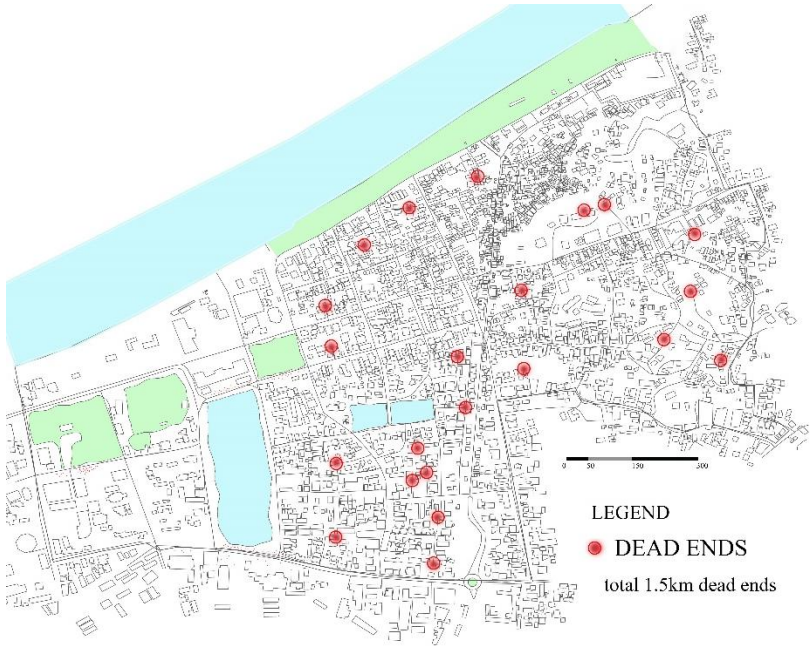


Fig. 5.28: Dead ends in Uzan Bazar

Maps prepared by researcher

In Hengrabari, the mapping of the public transport stops, such as bus stands, rickshaw stands, auto stands, and private vehicle parking spaces, discloses the pitiful situation due to the absence of public bus stands and private auto stands in the locality. People need to travel to the main road of either Ganeshguri or Rukmini gaon to reach the nearest bus stop, which is

about 1.5-1.8 km distance from Hengrabari locality. The dead-end length goes up to 2.6 km, which is almost 14% of the total road length. It denotes the reduced route directness.

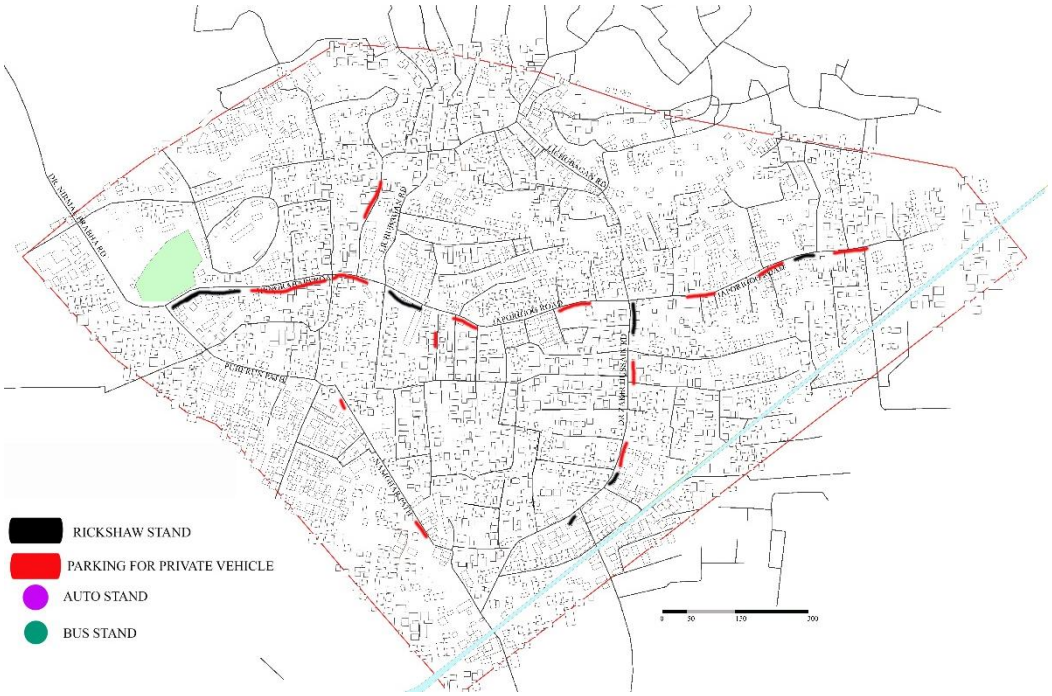


Fig. 5.29: Street Parking Map in Hengrabari

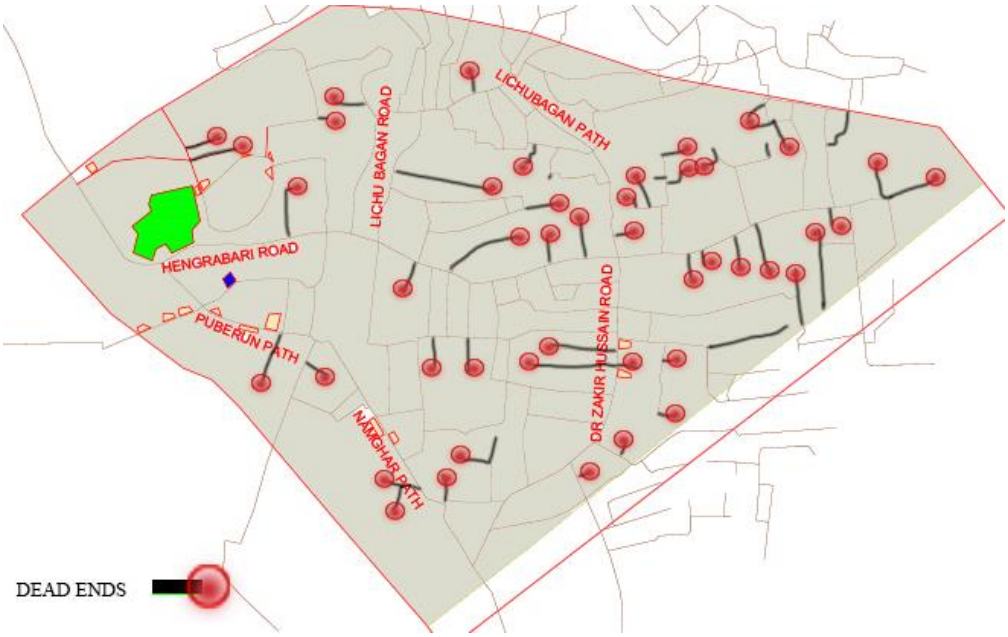


Fig. 5.30: Dead ends in Hengrabari

Maps prepared by researcher

The above-discussed route directness analysis infers that the route directness is better in the road network of Uzan Bazar than that of Hengrabari.

5.3.6 Layout (C2) – Pedestrian Flow (C3I3)

5.3.6.1 Walking Quality (C2I3E1)

Pedestrian flow depends on the walking quality of the roads and the quality of roads indicate presence of walking friendly elements to enhance walkability. Increased foot traffic, "eyes on the street" awareness, and organic surveillance are all benefits of walking streets to ensure safety and security. This, also, encourages different activities on, and financial exchanges between the walking population and city's street service providers.

To examine walking quality in Uzan Bazar and Hengrabari, ten attributes are taken into consideration to be evaluated as suggested by DUAC Street Design Guidelines. Such attributes are landmarks, footpaths, pedestrian crossing, street furniture, street lights, public toilets, waste bins, trees, public art, and signages which contribute to a high-quality walking environment. After examining the spatial condition of the study areas, these attributes are rated out of 5 by the researcher through the Expert evaluation method. To support the results of these ratings, some spatial maps and photographic representations are, also, discussed which will help finally to infer about walking qualities of both the urban localities.

Table 5.9: Ratings against the Measurable Attributes by the Researcher

Sl no.	Attributes	Based on	Uzan Bazar	Hengrabari
1	**Restaurant, shopping mall or any other landmark which invite crowd**	No. s of such buildings, frequency of people's visit, spatial appearance etc.	5	2
2	**Footpath**	presence, surface quality, efficiency of width, overall comfort	3	1.5
3	**Pedestrian Crossing**	presence of a zebra crossing and pedestrian signal, etc.	2	1
4	**Street Furniture**	presence, options availability, location comfort, safety, etc.	3	2
5	**Street Lights**	workability and presence	3	1
6	**Public Toilet**	presence, convenient distance between each other, hygiene maintenance, etc.	2	2
7	**Waste Bins**	No.s, distance from residences, quality, hygiene maintenance, etc.	3	2
8	**Trees on the Footpath**	shading ability, tree	3.5	2

		maintenance, etc.		
9	**Public Art**	visibility, harmony with the surroundings, aesthetic integration, etc.	2	3
10	**Signages**	Visibility of signboards, aesthetic value, content relevance etc.	5	1
Total walking quality score			**33.5**	**17.5**

The Table 5.9 calculates the walking quality score of Uzan Bazar and Hengrabari based on the validated attributes and the scores have come up as 33.5 for Uzan Bazar and 17.5 for Hengrabari. From this study, it can be clarified that Uzan Bazar has a quality walking environment than in Hengrabari. The pictorial representation below can display the condition of urban elements available in the locality to improve people's walking experience.

Fig. 5.31 The trees providing shade to the sidewalks in Uzan Bazar

Fig. 5.32 Presence of Roadside Activities Improves Legibility

Fig. 5.33 Street Art Activates

Fig. 5.34 non-interesting street edges reduces walking encouragement in Hengrabari

Fig. 5.35: Unnoticed Street art, Unappealing Building Geometry in Hengrabari

To examine the walking quality in terms of safety and security, the analysis of street light availability in Uzan Bazar and Hengrabari is done. Such analysis in Fig. 5.36 and Fig. 5.37 shows that 82% of the streets in Uzan Bazar have street lights, whereas, in Hengrabari, only 18% of streets, including the main arterial road, have street lights available. Though Uzan Bazar is showing the presence of street lights, 9% of streets, including MG Road, HC Road, etc., the lights present are not efficient and are not working readily. On the other hand, more than 80% of Hengrabari streets lack street lights. The absence of illumination creates insecurity in people's minds about walking during the evenings.

The following maps discuss the street light condition in the localities.

Fig. 5.36: Availability of Street Lights in Uzan Bazar

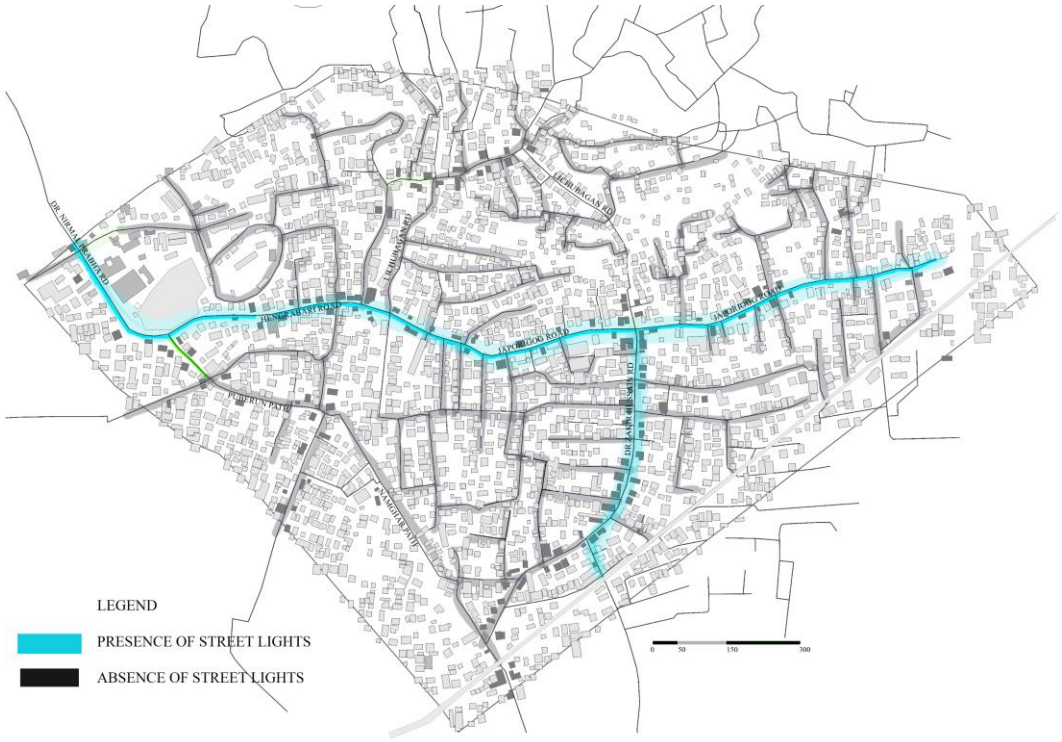


Fig. 5.37: Availability of Street Lights in Hengrabari

Maps prepared by the researcher

For the perception survey, questions to verify the perception of people of both localities about the walking quality of the streets are included in the questionnaire. The survey is conducted separately in Uzan Bazar and Hengrabari with different groups of residents. The results are discussed in the upcoming paragraphs.

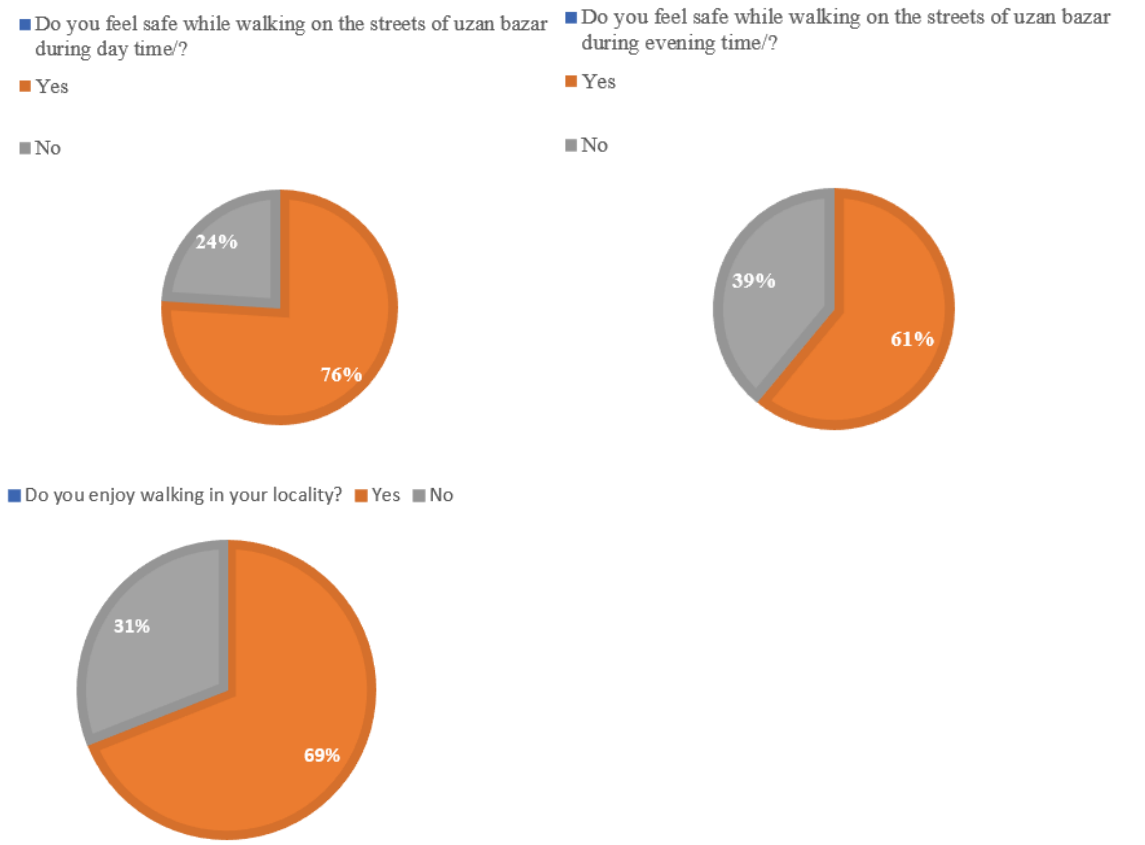


Fig. 5.38: Responses of Respondents during Perception Survey in Uzan Bazar

In Uzan Bazar, 76% of respondents feel safe walking on the streets in the daytime, on the other hand, 39% of respondents do not feel safe walking on the streets during the evening. Though the street lights are present, at many places they are not working due to poor maintenance. Also, the dead end leads to nowhere creating insecurity of getting trapped in the evening might be another reason behind such safety problems. Among the respondents, 69% enjoy walking in Uzan Bazar, whereas 31% don't enjoy walking.

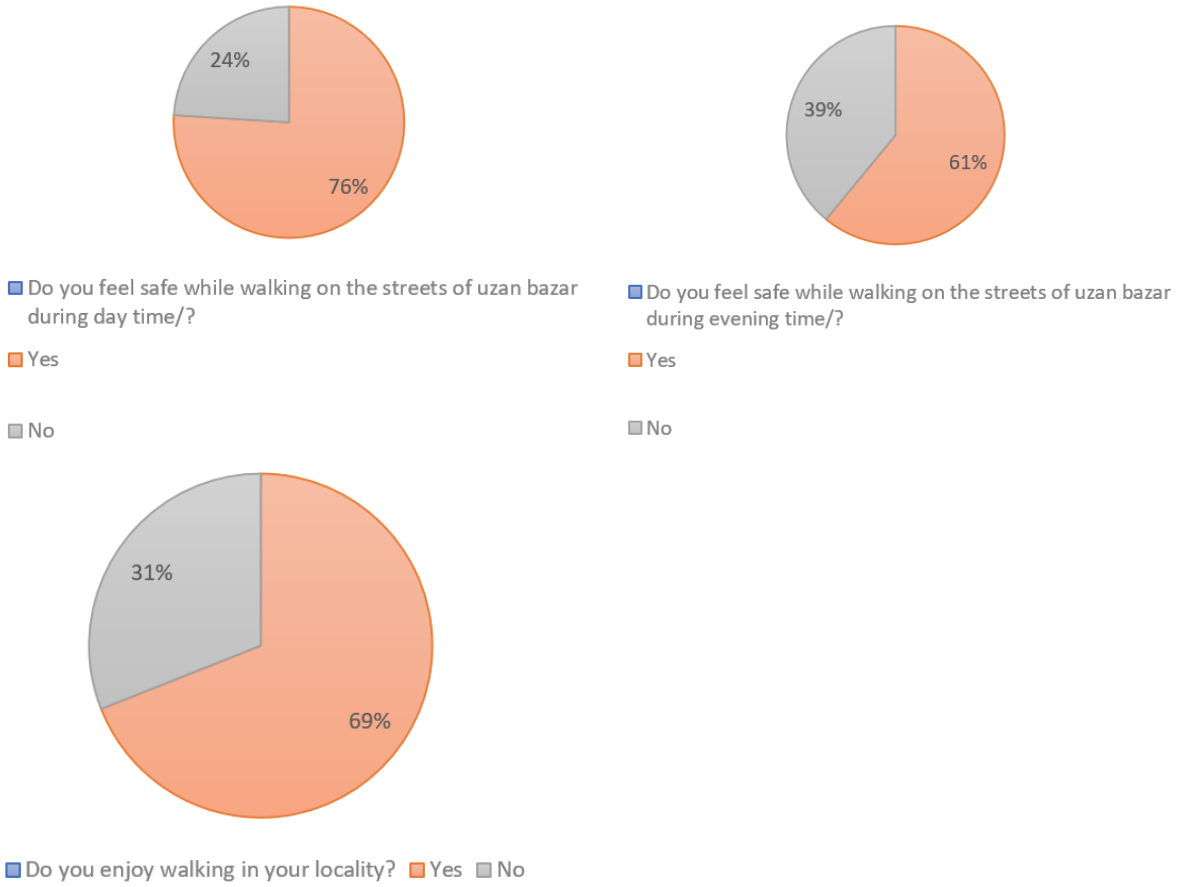


Fig. 5.39: Responses of Respondents during Perception Survey in Hengrabari

In Hengrabari, 68% of respondents feel safe walking during daytime, whereas 32% don't feel safe. However, 57% of the respondents reacted as 'no' when asked if they feel safe walking on the streets during evening time. This shows a significant safety concern for the people of Hengrabari. The street activities are limited on the streets of the locality due to the fewer no. of cafes, restaurants, etc. The absence of street furniture and, the presence of non-interesting elements on the street edges might be the reasons behind the fact that people (52%) don't enjoy walking on the streets.

The above-discussed walking quality analysis infers that the quality of the walking environment is better in the road network of Uzan Bazar than that of Hengrabari.

5.3.7 Land use (C3) – Diversity (C3I1)

5.3.7.1 Functional Mix (C3I1E1)

Functional dependency between different land uses as well as functional variation within same type of land use indicate diverse uses of lands. Such functional mix may refer to activities related to residential, commercial, religious, industrial and many more and can lead

to active and liveable urban environment.

To assess the diversity of Uzan Bazar, understanding different land uses and their distribution is crucial. Fig. 5.40 shows the land use map of Uzan Bazar locality which has land uses such as residential (65%), commercial (9%), mixed-use (6%), religious (4%), govt. Institutions (5%), and open spaces (11%).

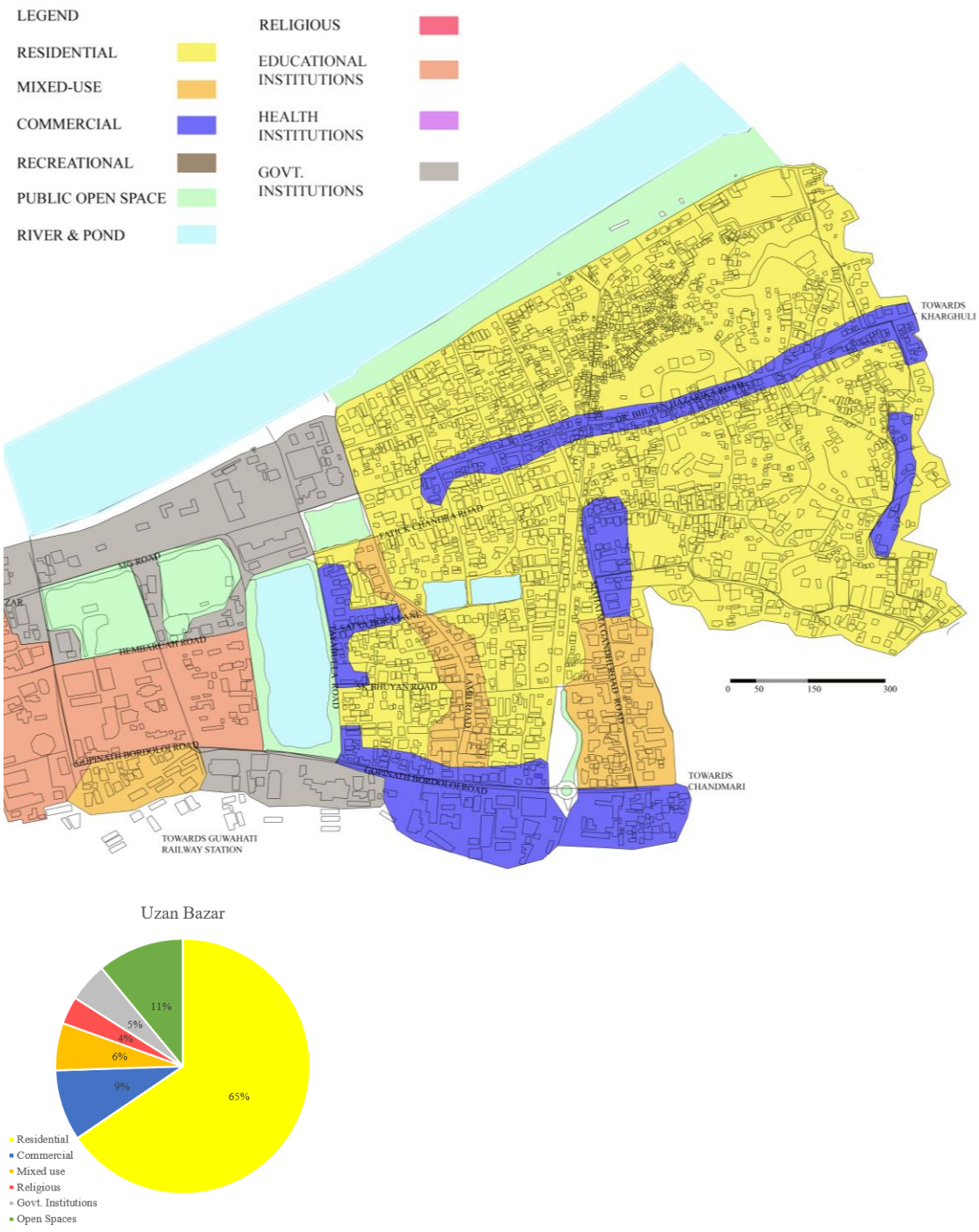


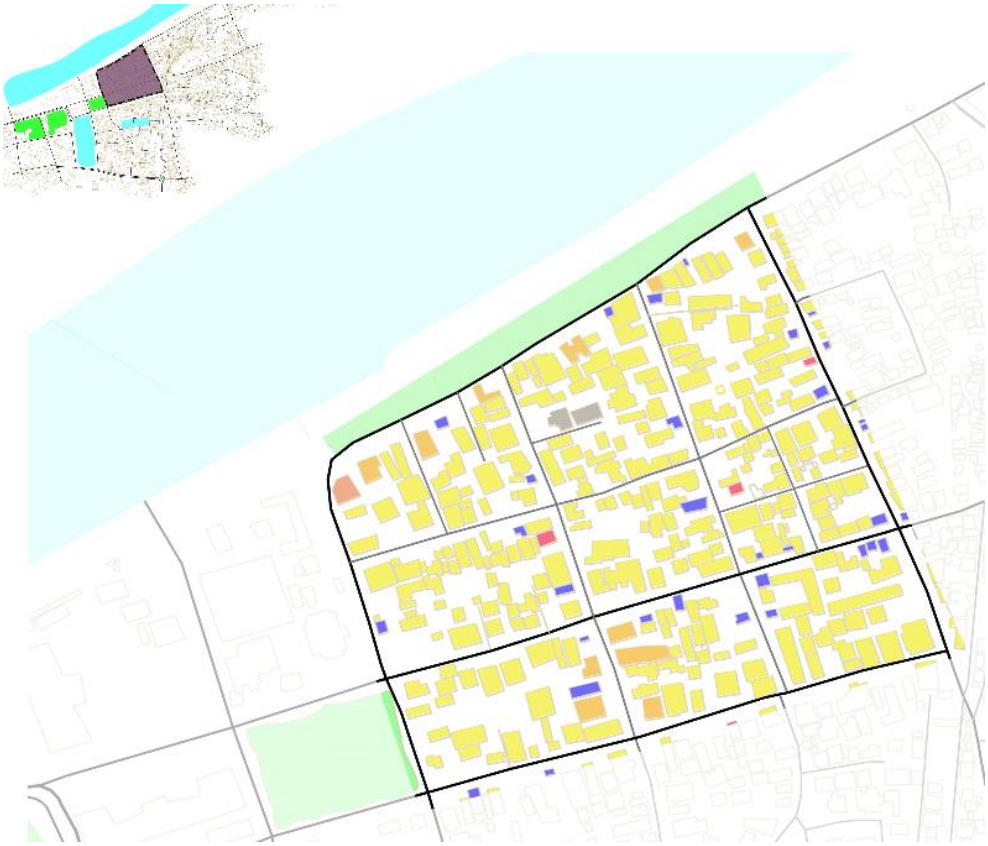
Fig. 5.40: Land Use Distribution Map of Uzan Bazar

An expert opinion survey is conducted to explore and validate qualitative method to assess functional mix within urban blocks. The idea is to gather insights from the urban experts that can contribute to the research.

Suggested methodology: The survey is initiated through an informal conversation about functional mix within the land use types of residential localities with peers practicing architecture and urban design. Three such experts participated in the survey, two of them are architects and urban designers, and one is an architect and urban planner. The experts are asked to share their views regarding the qualitative assessment of functional diversity. Regarding this, the experts are asked mainly two descriptive types of questions, such as "What do you understand by saying the functional mix of land uses of an urban locality?", "What qualitative method do you think can be used assess the functional mix of a locality?". The responses are recorded.

Expert Recommendation: The experts recommended employing mapping techniques to identify various building uses within a sample of urban blocks of the locality as according to them, understanding the variety of building uses within the block is important for functional mix. The experts suggested, finally, to use of a simple scoring system based on ranges decided for proportional representation to attain a functional mix score against the sample block.

As per the recommendation of experts, a sample block (refer Fig. 5.41) is chosen in Uzan Bazar keeping in mind the presence of a variety of land uses within the block. An accessible open space is, also strategically included within the selected block so that one more functional variety can be added. Mapping of the functional variety, it is seen that the selected block shows predominantly residential land use as well as the land uses that support the residents, such as shops, markets, schools, offices, parks, etc. The land use categories found are as follows: 76% residential, 8% commercial, 6% mixed-use, 2% religious, 1% govt. Institutions and 7% open spaces. Within the chosen block, mixed-use buildings mostly have residential and commercial mix functions.



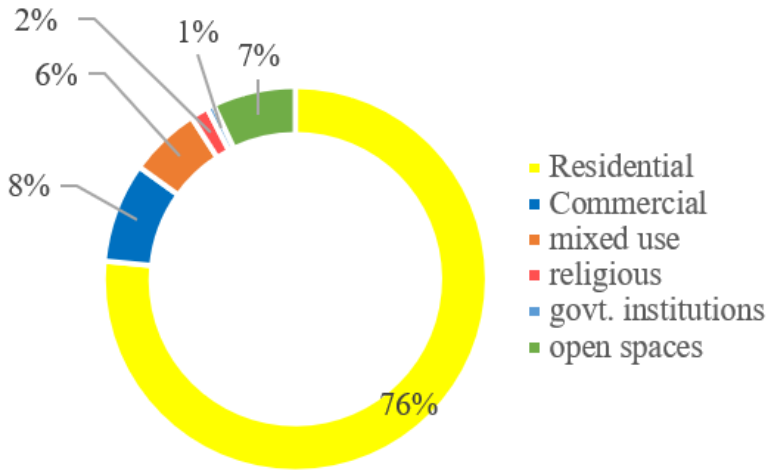
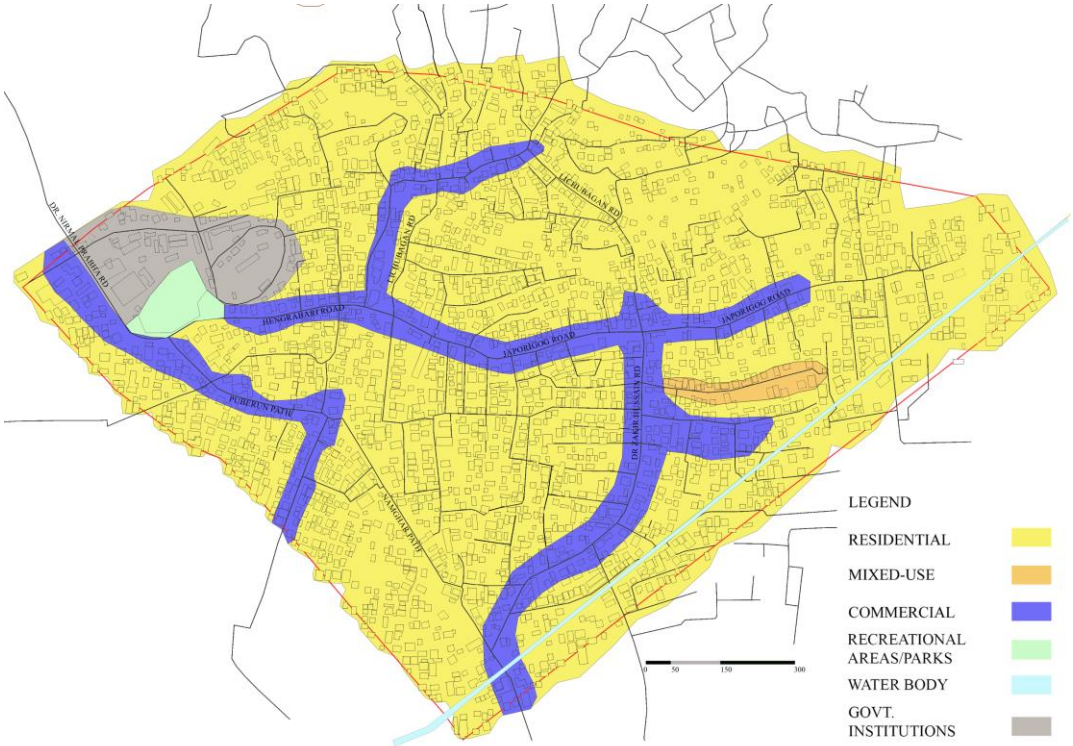


Fig. 5.41: Functional Mix within Sample Block in Uzan Bazar

After Uzan Bazar, the similar study is conducted for Hengrabari also. The overall land use pattern of Hengrabari can be analysed from Fig. 5.42. The sample urban block (Fig. 5.43) is having the similar land use characteristics as that of Uzan Bazar case. The categorization of scores as per the availability of land uses (%) has been tabulated in the Table 5.10.



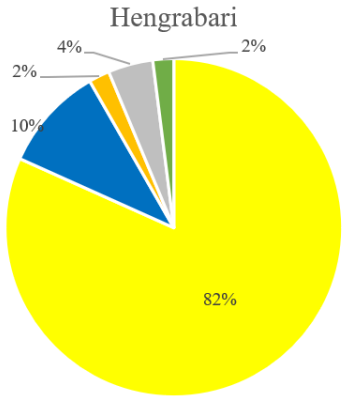


Fig. 5.42: Land use Distribution Map of Hengrabari

It is observed that though the overall land use distribution in Hengrabari shows residential (82%), commercial (10%), mixed-use (2%), govt. institutions (4%) and open spaces (2%) (refer Fig. 5.42). The functional mix study in the sample block results some additional varieties of building uses such as healthcare institutions, religious buildings etc. the functional distribution of building uses in this block is as follows – residential (83.74), commercial (5.06) followed by other as shown in Table 5.10.

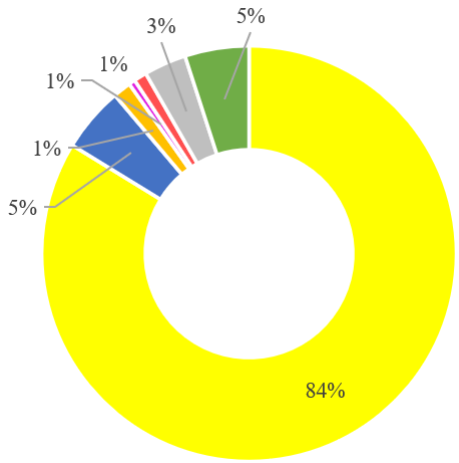


Fig. 5.43: Functional Mix within Sample Block in Hengrabari

For the categorization of the data, a simple scoring system has been developed based on proportional representation. According to this system, considering score 1 for a land use category that ranges from 0-25% (minimal proportional representation), score 2 for 26-50% (moderate proportional representation), score 3 for 51-75% (high proportional representation), and score 4 for 76-100% (dominant proportional representation). According to the mentioned categorization (Mahalakshmi & Duraiswamy 2012), the diversity scores concerning the land use availability within the selected blocks of Uzan Bazar and Hengrabari both are tabulated in Table 5.10.

Table 5.10: Functional Diversity Score of Sample Blocks

Sl. No.	Building Uses Types	Availability in Uzan Bazar (in %)	Functional Diversity Score in Uzan Bazar	Availability in Hengrabari (in %)	Functional Diversity Score in Hengrabari
1	Residential	76.5	4	83.74	4
2	Commercial	8.4	1	5.06	1
3	Mixed use	6	1	1.4	1
4	Religious	1.5	1	0.5	1
5	Govt. Institutions	0.6	1	1	1
6	Open Spaces	7	1	3.3	1
Total diversity score			**9**		**10**

The table 5.10 results the value of Functional Diversity of the sample urban block situated in Uzan Bazar is found to be 9 and Hengrabari is 10.

From the above analysis, inference can be drawn about the localities that the functional diversity in the land use of Hengrabari is higher (Functional Diversity Score 10) than that of Uzan Bazar (Functional Diversity Score 9).

5.3.8 Land use (C3) – Access (C3I2)

5.3.8.1 Access to Amenities (C3I2E1)

Proper connections and comfortable distances between transit stations and residential areas; each landmark buildings; daily needed services such as shopping stores; occasional services such as parks, restaurants, public restrooms as well as social infrastructure such as schools, colleges, hospitals etc. contribute to the accessibility to the amenities of a locality.

To understand the spatial distribution of the amenities in the Uzan Bazar locality, the access amenities map (Fig. 5.44) has been prepared. From this map, it can be observed that Uzan Bazar has amenities such as public parks, public toilets, educational institutions, etc. Though the map shows no. of restaurants and healthcare facilities, there are a few constraints observed during the spatial survey of the area. The numerous cafes and restaurants attract mostly the youth population from the nearby educational institutes and their hostels rather than the families of the locality which is because of the presence of less no. of family dining restaurants. Also, among the healthcare facilities, there are medical clinics such as Eye Care Centre; and hospitals like Wintrobe Hospital and Redcross Hospital etc. which offer general

medical services. However, the locality lacks multi-speciality hospitals for advanced treatments of the general public. The presence of govt. post office and Latasil Police Station are able to provide people with physical and financial security.

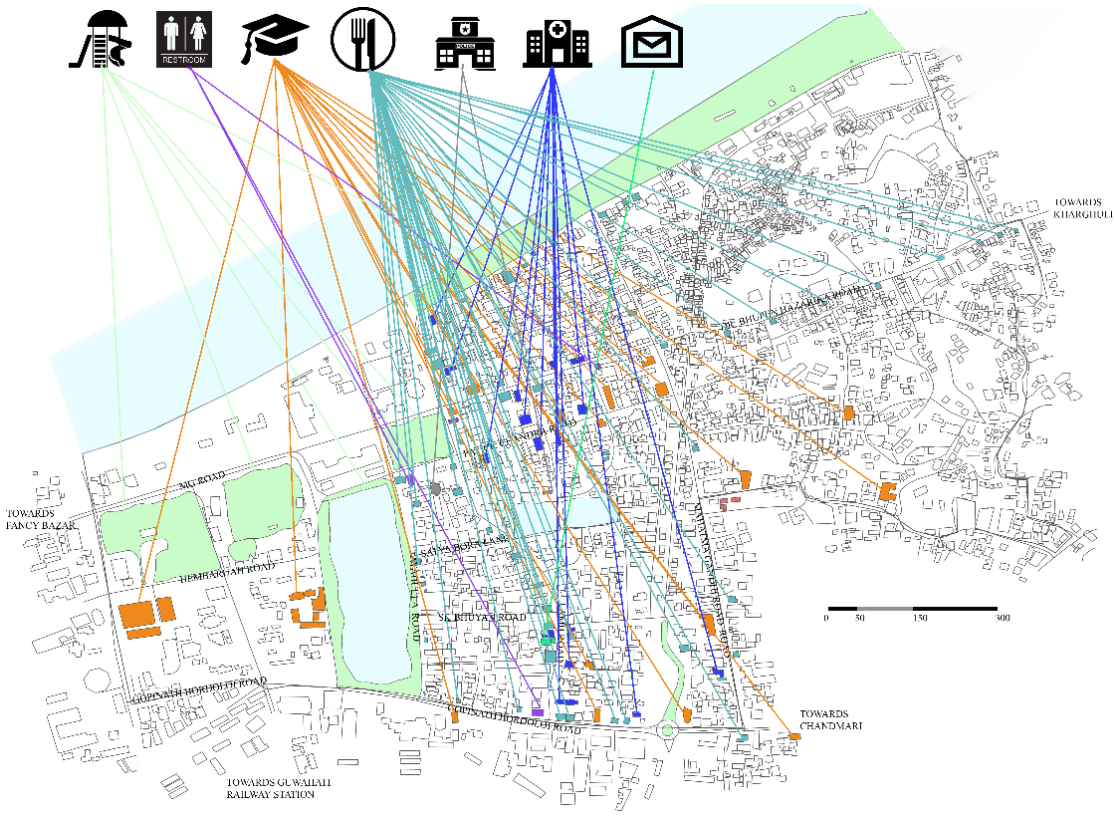


Fig. 5.44: Spatial Distribution of Public Amenities in Uzan Bazar

Map prepared by researcher

Now, according to the spatial distribution of the amenities, the covered service area mapping has been shown in Fig. 5.45. Here, a 250 m buffer radius has been considered to show the coverage of the amenities. Different colours are used to show different amenities such as children's play areas, public toilets, educational institutions, cafes and restaurants, police stations, hospitals, post offices, etc. It is evident from the map that all the public open spaces are concentrated in the central portion as well as in the western part of the locality. Residents and visitors say that the riverfront stretch is underutilised because it has served no purpose up to this point. Currently, a park is being constructed along this stretch of the river which may enhance its usability and accessibility to park infrastructure as well. The three numbers of

public toilets present in the locality which is insufficient as well as serve only the central portion of the locality leaving more than 50% of the area unserved.

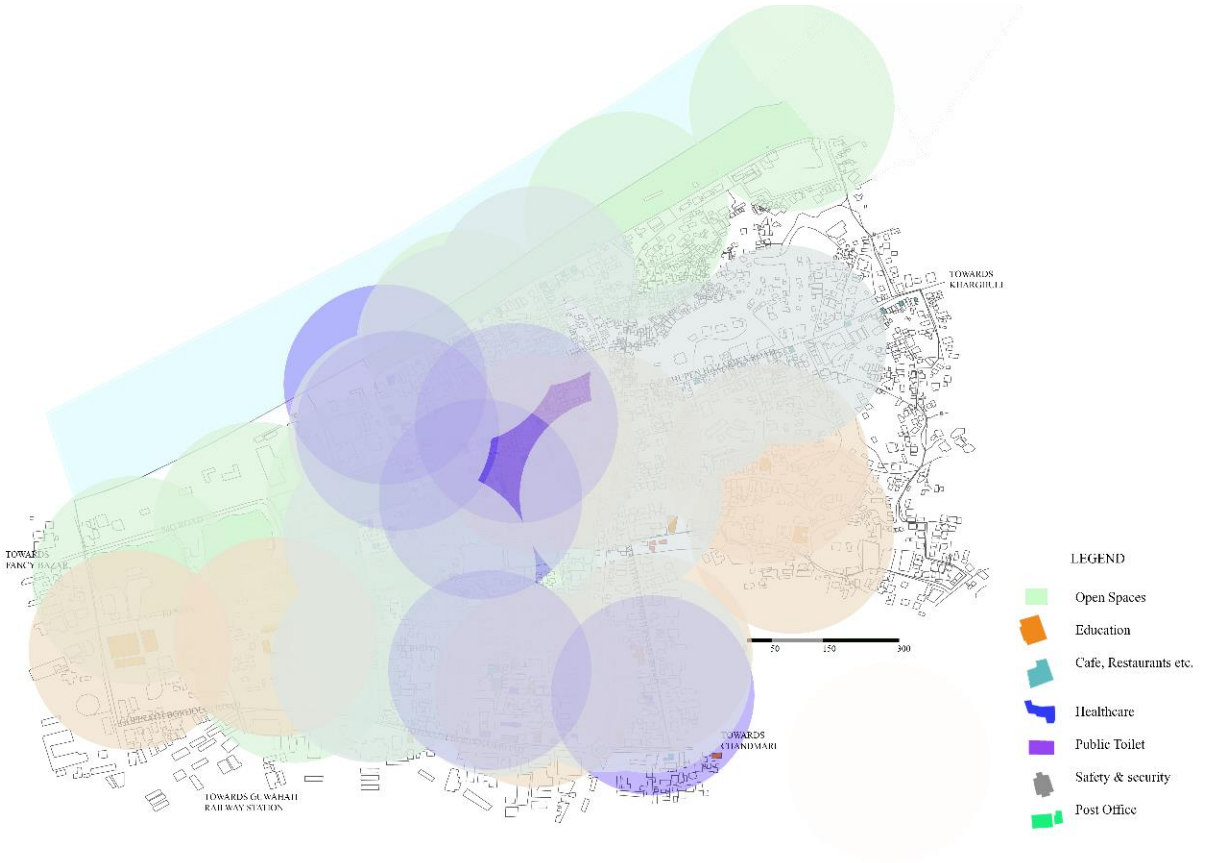


Fig. 5.45: Mapping of Amenities coverage in Uzan Bazar

Map prepared by researcher

On the other hand, in Hengrabari, apart from educational institutions, other amenities such as public open spaces, hospitals and food joints like cafes and restaurants are observed to be significantly limited (refer to Fig. 5.46). There are no public toilets encountered. The available healthcare services are also limited to a few clinics and health centres. There is no police station in the locality as the area falls under the Dispur Jurisdiction. From the amenity coverage map of Hengrabari, it is evident that educational institutes are uniformly distributed all over the locality on the other hand, the open spaces serve not more than 10% of the entire area (refer to Fig. 5.47). The food joints include only a few of the local eateries and roadside stalls.

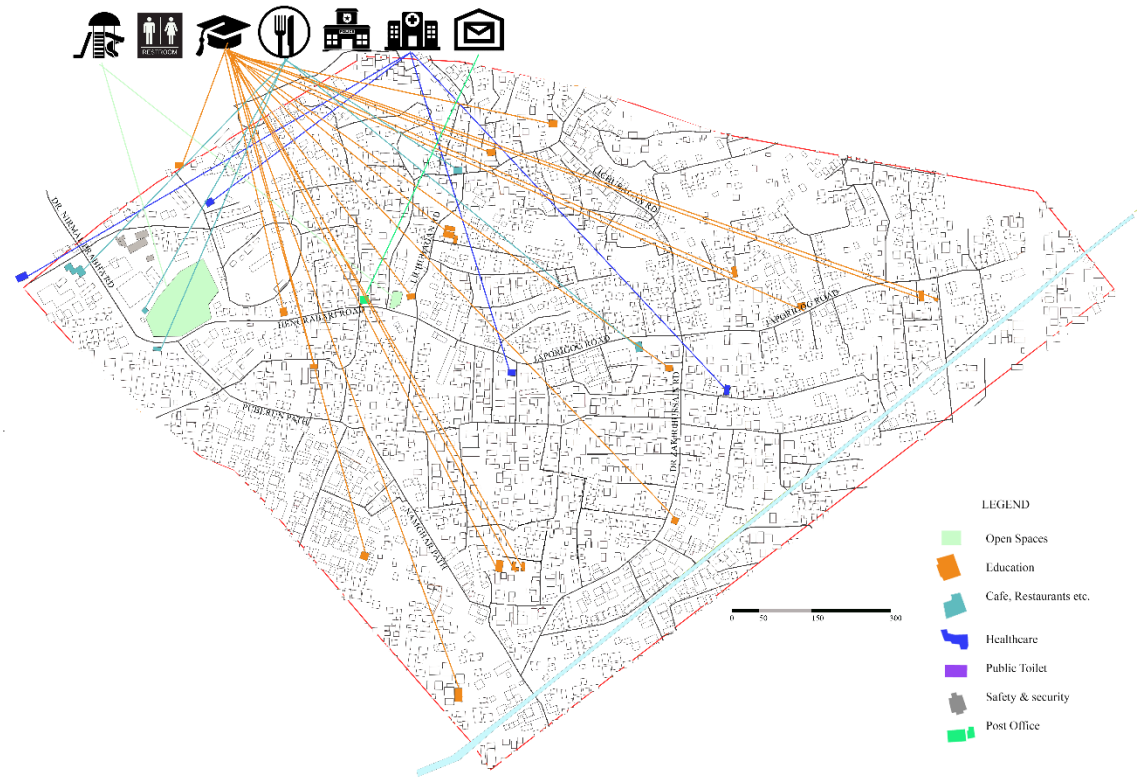


Fig. 5.46: Spatial Distribution of Public Amenities in Hengrabari

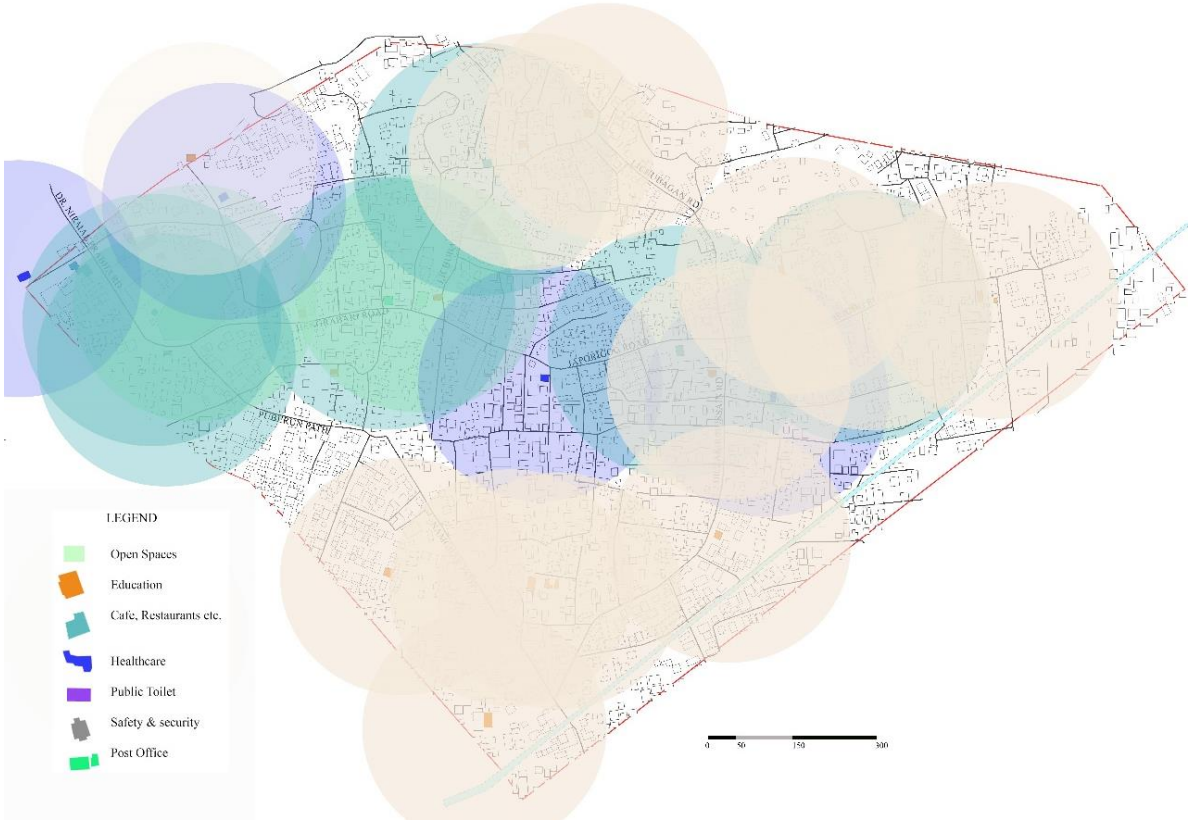


Fig. 5.47: Mapping of Amenities Coverage in Hengrabari

Maps prepared by researcher

The mapping of the availability of public amenities and their access in the context of both localities can be assessed based on Table 5.11.

Table 5.11: Comparison of Amenities across Localities

Sl. No.	Amenities	Availability in no.s		Remarks
		Uzan Bazar	Hengrabari	
1	Cafes, Restaurants etc.	23	5	Uzan Bazar: 80% of the area is served. Hengrabari: No interesting food joints available, families and youth crowd as well.
2	Public Parks	7	2	Uzan Bazar: 60% of the area is catered. Hengrabari: The availability caters to not more than 10% of the residences.
3	Educational services	15	18	Uzan Bazar: Not uniformly distributed. Only 45% is served.
4	Healthcare services	6	4	Both the localities lack multi-speciality hospitals for advanced treatments for the general public.
5	Safety and Security services, including a police station	2	0	Uzan Bazar: Falls under Latasil jurisdiction. Hengrabari: No police outpost is available as it falls under Dispur jurisdiction.
6	Public Toilets	4	0	Limited in numbers. Doesn't serve even one-third of the area in either case.
7	Post Office	1	1	Availability of only one post office may create challenges in accessing postal services conveniently by the public in both cases.

From the spatial survey and above-table, it has been found that Uzan Bazar has more food joints (23), parks (7), healthcare facilities, safety and security services (2) and public restroom services (4) than that available in Hengrabari. To compare this data to people's perceptions, data from perception survey is analysed to understand how individuals perceive the accessibility of amenities in their community.

In the perception survey, the respondents are asked to rate out of 5, the scattering of amenities, travel time efficiency, and network connectivity, which are considered as the measurable attributes of amenity accessibility as suggested in research by Geurs (2006). After calculating the average responses and categorising the responded data, the state of amenities access is analysed in context to both the cases - Uzan Bazar and Hengrabari. Table 5.12 shows that the scores are found to be 11.1 and 9.7 for Uzan Bazar and Hengrabari, respectively. The pattern of responses from the surveyed people after considering the categorisation is discussed in the next paragraph.

Table 5.12: Scoring Analysis of Access to Amenity across Localities

Measurable attributes	**Amenity access score in Uzan Bazar**	**Amenity access score in Hengrabari**
Travel time efficiency	3.6	3.5
Network connectivity	3.3	3.1
Scattering of amenities	4.1	3
Amenity access score	**11.1**	**9.7**

Table 5.13: Categorization of Responses for Amenities Access in Uzan Bazar

Category	**Responses**
Low (2-5)	11.0%
Moderate (6-9)	37.0%
High (10-13)	52.0%

Table 5.14: Categorization of Responses for Amenities Access in Hengrabari

Category	**Responses**
Low (2-5)	13.0%
Moderate (6-9)	73.0%
High (10-13)	14.0%

The amenities access score of Uzan Bazar is 11.1 (Refer Table 5.12), whereas the responses show more than half of the respondents (52%) have rated as 'High' access to amenities, 37% rated as 'Moderate' and only 11% has rated as 'Low' (Table 5.13). On the other hand, the amenities score of Hengrabari has been evaluated as 9.7 which is a lower value than that of Uzan Bazar and here, most of the respondents (73%) have rated as 'Moderate' access to amenities (refer Table 5.14). The reasons behind this reaction of people could be the uneven distribution of the amenities in the locality as well as the lack of public transportation routes.

From the above analysis in Uzan Bazar and Hengrabari and Fig., 5.48 justifies the fact that Uzan Bazar has a better status of access to amenities as compared to that of Hengrabari. The spatial distribution as well as the perception survey prove the statement.

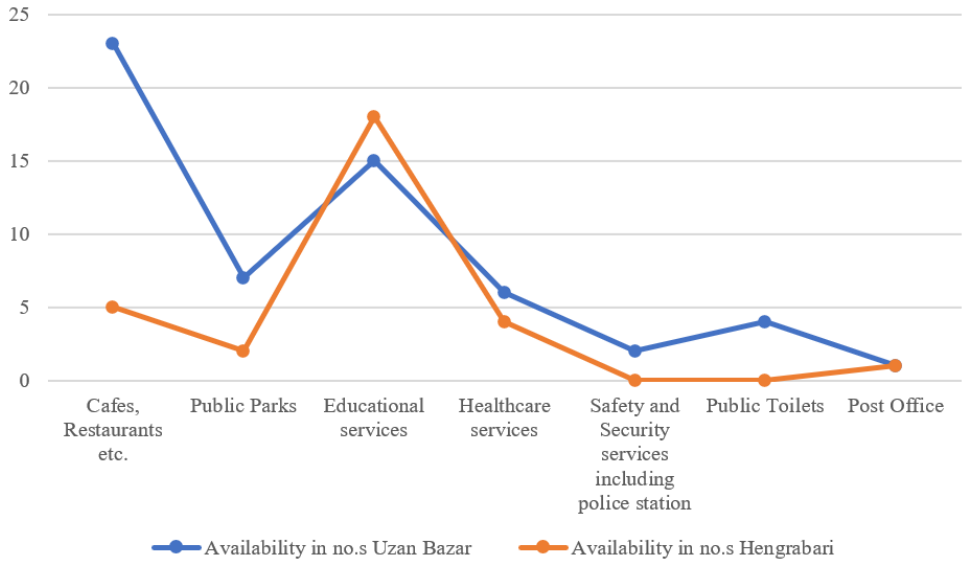


Fig. 5.48: Categorisation of Responses for Access to Amenities for Both Study Areas

5.3.8.2 Proximity (C3I2E2)

Proximity refers to the closeness of regularly frequented areas. In other words, the closeness of land uses refers to how easy and enjoyable it is to access the various land uses in the area. The questionnaire of five specific questions, which are descriptive, is prepared by the researcher. This type of question will help the researcher to initiate a conversation about the proximity of the place and provide the researcher with an opportunity to understand the attributes as per people's perception of the proximity of the land use pattern of the locality. The questions included in the questionnaire are as follows: 'Describe your experience of your everyday journey to transit nodes.'; 'Are you satisfied with the accessibility from home to essential services such as school, markets, groceries, etc?'; 'Which facility would you wish to locate nearer to you? Why?'; 'Describe your experience of reaching the park from your home?' The same set of questions is asked of the surveyed people of each locality separately.

The above-mentioned questions helped the researcher to initiate and continue an appropriate conversation, during which the responses were recorded and analysed later. The same conversation gets to come up with five attributes of proximity, such as 'ease of access', 'parking facilities', 'distance perception', 'comfort of travel', and 'time perception'. Now, these attributes are asked to be weighed by the respondents in the second part of the perception survey. This time, also, the same group of people's perceptions are recorded on the second form of the revised questionnaire that had been prepared based on the first perception survey.

In Uzan Bazar, the respondent's ratings on a five-point scale and the average of these ratings that provide the scores of proximities in the different localities are displayed in Tables 5.15, 5.16, and 5.17.

Table 5.15: Average Ratings of Proximity Attributes Based on Perception Survey

Attributes	Average rating for Uzan Bazar
Ease of access	2.7
Parking facilities	2.6
Distance perception	3.2
Comfort of travel	2.9
Time perception	3.7
Proximity perception score	**15.3**

Table 5.16: Percentage Distribution of Responses for Proximity Attributes in Uzan Bazar

Category	ease of access	parking facilities	distance perception	comfort of travel	time perception
Weak	37%	23%	12%	9%	11%
Not so strong	28%	33%	22%	4%	4%
Neutral	14%	27%	7%	22%	20%
Strong	12%	10%	21%	36%	36%
Extremely strong	9%	7%	38%	29%	29%

Table 5.17: Categorisation of responses for Proximity of land uses in Uzan Bazar

Category	Responses
Low (5-11)	12.0%
Moderate (12-18)	51.0%
High (19-25)	37.0%

After calculating the average score of all the measurable attributes, the land use proximity score achieved is 15.3 in Uzan Bazar in which 37% of the respondents have rated as 'High' proximity, 51% rated as 'Moderate' proximity and only 12% has rated as 'Low' proximity. To understand the reason behind this, when the detailed breakdown of responses is observed it is revealed that in Uzan Bazar people are concerned about the dedicated parking facilities as well as inefficient street lighting in some of the areas and that resulted in only 12% and

10% respondents rated 'Strong' in "ease of access" and "parking facilities" respectively (Refer Table 5.16).

Using a similar process the proximity study is, then, conducted for Hengrabari as well. The results are discussed below in the Table 5.18, Table 5.19 and Table 5.20.

Table 5.18: Average Ratings of Proximity Attributes Based on Perception Survey

Attributes	**Average rating for Hengrabari**
Ease of access	1.9
Parking facilities	1.1
Distance perception	1.4
Comfort of travel	0.6
Time perception	1
Proximity perception score	**6**

Table 5.19: Percentage Distribution of Responses for Proximity Attributes in Hengrabari

Category	**Ease of access**	**Parking facilities**	**Distance perception**	**Comfort of travel**	**Time perception**
Weak	38%	36%	28%	42%	38%
Not so strong	21%	21%	7%	14%	21%
Neutral	18%	11%	18%	5%	18%
Strong	14%	22%	37%	21%	14%
Extremely strong	9%	10%	10%	18%	9%

Table 5.20: Categorization of Responses for Proximity of Land Uses in Hengrabari

Category	**Responses**
Low (5-11)	67.0%
Moderate (12-18)	27.0%
High (19-25)	6.0%

After getting the average value of ratings for all attributes, the proximity score for Hengrabari has been achieved as 6. Almost 67% of the surveyed people have rated Hengrabari as 'High' in proximity and only 6% have rated it as 'Low' (Table 5.20). Though the broad land uses don't show many types, land use variations can be seen at block level and it becomes easier for people to reach. This might be the reason behind people's positive perception of

proximity. Table 5.19 displays the positive perception of people about proximity in Hengrabari in which almost all the attributes (ease of access, parking facilities, distance perception, comfort travel, and time perception), more than 50% of people rated as either 'Strong' or 'Extremely Strong'.

To conclude the analysis, the overall perception of people about land use proximity in both localities can be observed in Fig. 5.49. The perception data shows a huge difference between both localities in terms of land use proximity. From here, it can be inferred that the status of Uzan Bazar is far better than that of Uzan Bazar.

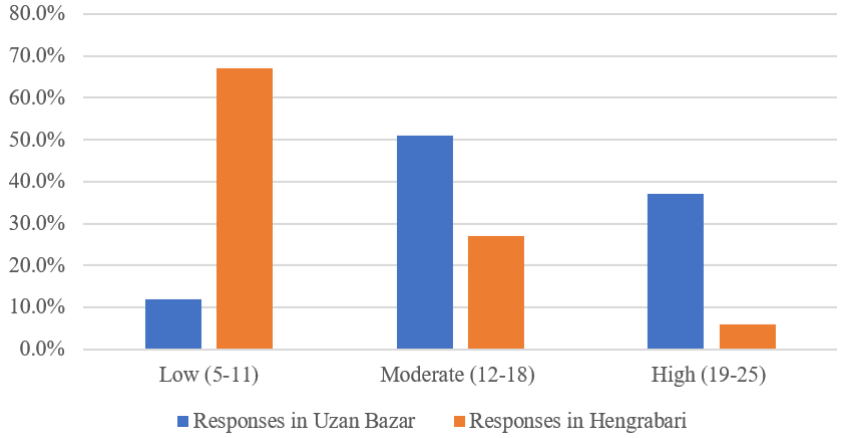


Fig. 5.49: Categorization of Responses for Proximity of Land Uses for Study Areas

5.3.9 Land use (C3) – Compatibility (C3I3)

5.3.9.1 Functional Synergy (C3I3E1)

Synergy is the ability of one land use to improve or have a positive impact on the performance and value of neighbouring land uses. This refers to how well the adjacent land uses function with each other enhancing the overall activeness of the area.

To understand how well different land uses complement each other in Uzan Bazar, the researcher rates different land uses based on her perception and study of both localities. These attributes of land use compatibility are rated using the 5-point Likert scale where 1 is 'Not Compatible' land uses which has conflicting synergy; 2 is 'Marginal Compatibility' which depicts adjacent land uses with weak relationship in between; 3 as 'Moderate Compatibility' showing non-essential synergy in between land uses; 4 as 'Significant Compatibility' that shows strong and non-critical synergy and 5 as 'Highly Compatible' referring land uses having essential and highly beneficial relationship.

The results of this rating (Table 5.21) show that in Uzan Bazar, residential and open spaces (5), and religious spaces (5) indicate high compatibility whereas residential and transportation (3) indicate 'moderate compatibility'. This is because, during rush hours, the roads get soaked due to the traffic flow. Healthcare and transportation indicate 'Moderate Compatibility' because of the traffic congestion on roads due to the on-street parking of Winthrop Hospital and other general healthcare clinics. Transportation and Institutional indicate 'Marginal Compatibility' considering the traffic conflict points due to soaked vehicles at the nearest junction leading to Handique College. The summation of such ratings, when divided by the total type of adjacent land uses, a synergy score can be achieved for Uzan Bazar as 4.1.

Table 5.21: Ratings for Land Use Synergy Based on Researcher's Understanding

Land use	Residential	Commercial	Institutional	Open Space	Religious	Recreational	Healthcare	Transportation
Residential	5	4	4	5	5	4	3	3
Commercial	4	5	3	3	3	4	3	4
Institutional	4	3	5	5	4	4	3	2
open Space	5	3	5	5	5	5	3	2
Religious	5	3	4	5	5	4	4	4
Recreational	4	4	4	5	4	5	4	4
Healthcare	3	3	3	3	4	4	5	3
Transportation	3	4	2	2	4	4	3	5

From the above-table, the average synergy for the land use of Uzan bazar can be calculate as,

Average Synergy (for Uzan Bazar) =

∑Compatibility scores of each type of adjacent land use/Total no. of adjacent uses

= 5+4+4+5+5+4+3+3/8

= 4.1

On the other hand, from similar ratings (Table 5.22) done for Hengrabari, the synergy score is found to be 3.6 which is a lower score than that of Hengrabari's case. The results of the ratings show that commercial and residential (4) have 'significant compatibility' as the crowd

of strangers on streets during the evening can be spotted due to commercial activities. On the other hand, open space and transportation (2) and transportation and institution (2) have 'Marginal Compatibility' which is probably due to the poor road conditions and traffic congestion.

Table 5.22: Ratings for Land Use Synergy Based on Researcher's Understanding

Land use	Residential	Commercial	Institutional	Open Space	Religious	Recreational	Healthcare	Transportation
Residential	5	4	4	4	5	3	2	2
Commercial	4	5	2	3	2	3	3	4
Institutional	4	2	5	3	4	3	2	3
open Space	4	3	3	5	3	4	3	2
Religious	5	2	4	3	5	4	3	4
Recreational	3	3	3	4	4	5	4	4
Healthcare	2	3	2	3	3	4	5	3
Transportation	2	4	3	2	4	4	3	5

As per these ratings, the average synergy of Hengrabari can be calculated using the same formula used earlier. So,

Average Synergy (for Hengrabari) = 5+4+4+4+5+3+2+2/8

= 3.6

Then, to understand the perception of people about the synergy of different land uses, a questionnaire is prepared and hard copies are distributed to each of the respondents to know how they perceive synergy. Their ratings out of 5 for the adjacent land use types are recorded and arranged in an Excel file. The average value of these data gives the overall value of the perception of people about the functional synergy in land uses (Refer to Table 5.23).

Table 5.23: Average Rating of Respondents for Different Land Uses across Localities

Land use Assessment	Assessment between		Relationship details	Rating for Uzan Bazar	Rating for Hengrabari
	Land use type 1	Land use type 2			
Residential - Residential	Residences	Residences	Similar uses, shared amenities and restful co-existence	5	5
Residential - Commercial	Residences	Small grocery shops	Proves ease of essential services	4.2	3.9
Residential - Institutional	Residences	Schools	Convenient for the parents and their wards	4.7	3.9
Residential - Transportation	Residences	Nearby Public transport Stands and stops	Public transport system helps to connect residents to other parts of the city	2.7	1.7
Residential - Open Space	Residences	Park	Park provides open spaces and enhances liveability	4.3	4.1
Residential - Religious	Residences	Temples, mosques etc.	Enhances community relationships and cultural cohesion	4.7	4.4
Commercial - Recreational	cafes & restaurants	open seating	Enhances community relationships and liveability	2.1	4.1
Commercial - Commercial	Offices	Retail shops	noticeable but not essential uses	5	5
Healthcare - Transport	Hospital	Nearby Public transport Stands and stops	Health facilities connected to public transport system encourages accessibility	1.6	1.9
Institutional - Transportation	School, colleges etc.	Heavy traffic streets	not suitable for children	3.3	1.9

From the above table, it can be revealed that the compatibility score of most of the land uses is higher in case of Uzan Bazar except Commercial – Recreational (2.1) and healthcare – Transport (1.6) than that in case of Hengrabari.

Therefore, from the synergy scores by the researcher and the results of the perception survey, it can be inferred that Uzan Bazar has a better synergy status than Hengrabari.

5.3.10 Open Space (C4) – Spatial Characteristics (C4I1)

5.3.10.1 Functionality (C4I1E1)

Different typologies of open spaces such as parks, gardens, playgrounds, community grounds etc., exhibit different functionalities related to different groups of people based on their interests, age, sex etc., The functionality of an open space varies with time for example an open space may be used for exercising in the morning and recreational walks in the evening hours. The diverse functionality of an open space makes the space vibrant, as well as keeps the urban localities busy and active throughout the year.

A vibrant and active functional space has wider effects in the safety of the users along with people nearby. Ahirrao & Khan (2021) suggested that functionality of open space is linked with inclusive nature, belongingness, public participation and satisfaction, which in turn affects the overall perception of quality of the space.

This study considers the above-mentioned four aspects related to 'functionality', to assess the state of open spaces (in both the study areas), and to understand the perception of people. The research has used a 5-point Likert Scale to assess the perception of people (refer to Chapter 3 for detailed methodology). The perception-based functionality scores for all the parks (which is 6 in number) in Uzan Bazar are tabulated in Table 5.24.

Table 5.24: Scoring Analysis of Functionality for All the Parks in Uzan Bazar

Sl. No.	Open Spaces	Typology	Area (approx.)	Functionality Score
1	Dighalipukhuri Park	Leisure-park for children	70,500 sqm. (including pond)	14.6
2	Sati-Radhika Brahmaputra riverine park	Leisure-park for youth	30,000 sqm.	9.2
3	Jor Pukhuri Park	Leisure-park for youth	16,000 sqm. (including ponds)	11
4	Nehru Park	Leisure-park for youth and kids	38000 sqm.	18.1
5	Judges' Field	Active Play area	36,100 sqm.	19.1
6	Latasil Playground	Active Play area	11,760 sqm.	19.7

The data tabulated above showcases that Latasil Playground (Functionality score 19.7) is perceived to be a highly functional open space followed by Judges' Field (19.1) Nehru Park (18.1) and other parks. The analysis shows that Dighalipukhuri Park, being the largest in the area exhibits a lower score than the Latasil Playground, Judges' Field and Nehru Park. The lowest score achieved by Sati-Radhika Brahmaputra Riverine Park (9.2) is probably because of low visibility from the roadside, inadequate lighting facilities, etc. However, the park is undergoing construction work as a part of a riverfront development project.

To understand the distribution of scores among the parks, the following table (Table 5.25) shows the classification of data related to open space functionality, in the three categories mentioned.

Table 5.25: Categorization of Responses for Functionality of Open Spaces in Uzan Bazar.

Category	Dighalipukhuri Park	Sati-Radhika Brahmaputra riverine park	Jor Pukhuri Park	Nehru Park	Judges' Field	Latasil Playground
Low (5-10)	18%	43.4%	41%	17.7%	25.6%	9%
Moderate (10-15)	19%	31.5%	27%	34.7	13.8%	19%
High (15-20)	63%	25.1%	32%	47.6%	60.9%	72%

The table reflects, 72% of the respondents have rated Latasil Playground as ‘high’ in functionality, 19% rated ‘moderate’ and 9% has rated as ‘low’ in functionality. Almost 63% of respondents rated Dighalipukhuri Park having high functionality, followed by Judge’s field (60.9%), Nehru Park (47.6%) and others. The lowest score is observed in Sati-Radhika Park with 43.4% responses as low, 31.5% as moderate and 25.1% as high in functionality.

Using a similar process, the perception scores for the parks present in Hengrabari have been calculated and tabulated in Table 5.26, and the categorisation of scores has been tabulated in Table 5.27.

Table 5.26: Scoring Analysis of Functionality for the Park Available in Hengrabari

Sl. No.	Open Spaces	Typology	Area (approx.)	Functionality Score
1	Amrit Udyan	Leisure-park for youth & kids	13,68 sqm.	13.1

Table 5.27: Categorization of Responses for Functionality of Open Spaces in Hengrabari

Category	Amrit Udyan
Low (5-10)	13.4%
Moderate (10-15)	41.2%
High (15-20)	45.4%

The only public park in Hengrabari, the Amrit Udyan covers only 2% of the area of the entire locality, which shows a functionality score of 13.1. During the survey, more than 86% of the surveyed people rated this park as 'high' and 'moderate' functional open space, which is quantified as 45.5% and 41.2% respectively. Only 13.4% of people have rated it as a 'low' functionality open space. However, the inadequacy in the number of parks in Hengrabari may have affected the high perception score (which is 86% approx., combining high and moderate scores) offered by locals.

For getting overall ideas of all the parks in Uzan Bazar and Hengrabari, based on human perception level a comparative figure has been generated (Fig. 5.50) that shows low level of perception in functionality of open space in Hengrabari (maximum is 45.4% responses in high category) compared to parks in Uzan bazar (72% in Latasil playground, 63% in Dighalipukhuri park, and 60.9% in Judge's field).

The contrasting number of available parks in both the localities may have an impact on such functionality scores. From the analysis, inference can be drawn about the localities that Uzan Bazar is perceived to be higher in functionality of open spaces than Hengrabari which ultimately contributes positively to the overall safety perception of people of Uzan Bazar.

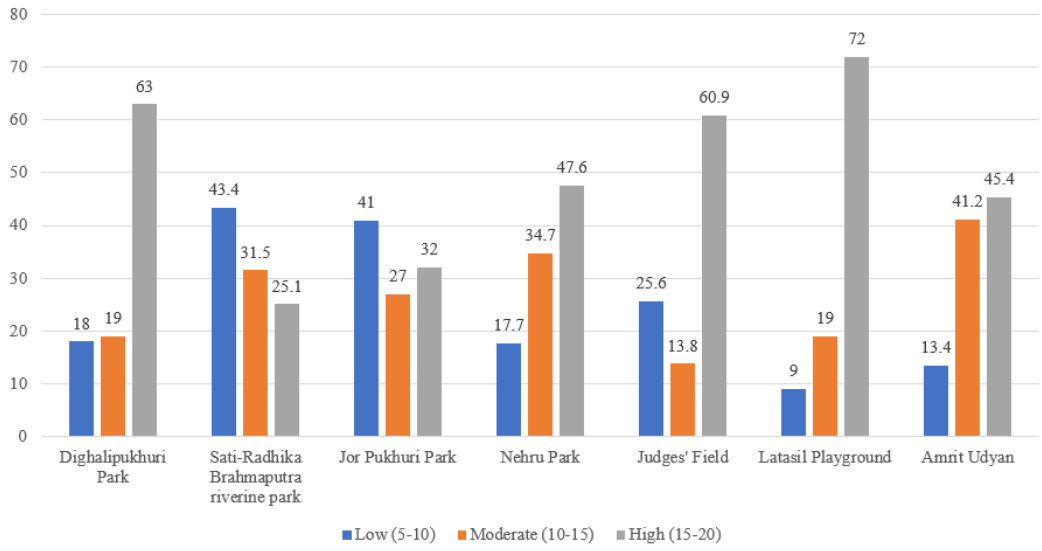


Fig. 5.50: Categorization of Responses for Functionality of Open Spaces-Study Areas

5.3.10.2 Social Interaction (C4I1E2)

Social interaction in public spaces enhances social cohesion among people. It allows cultural and emotional exchanges among them and thus, strengthens their physical and mental health. Strong social networks of the residents encourage them to take community initiatives, celebrate social lives and participate actively in public events for the betterment of the locality.

Rad & Ngah (2013) have discussed four aspects of public open spaces which are mandatory for effective social interaction among people. Those aspects are 'friendliness of the space', 'activities take place', 'spatial convenience', and 'access of the open space' and can be used as measurable parameters to assess social interaction in public open spaces.

Considering these four aspects as measurable attributes of social interaction the perception survey is done with a total number of 390 residents for each of the parks available in Uzan Bazar using a similar 5-point Likert scale. The ratings of the respondents about the parks result in the average score to get the total social interaction score against each of the available parks. The following table (Table 5.28) shows the social interaction scores of the parks in Uzan Bazar.

Table 5.28: Scoring Analysis of Social Interaction for All the Parks in Uzan Bazar

Sl. No.	Open Spaces	Social Interaction Score
1	Dighalipukhuri Park	15.3
2	Sati-Radhika Brahmaputra riverine park	9.1
3	Jor Pukhuri Park	10.9
4	Nehru Park	12.9
5	Judges' Field	11
6	Latasil Playground	12.7

The above table illustrates that Dighalipukhuri Park recorded the highest score (Social Interaction score of 15.3) among all the other parks likely due to its well-connected location at the heart of the city. It becomes easy for the public to reach the park and visit it again and again. The Dighalipukhuri Park is followed by Nehru Park (12.9), Latasil Playground, Judges' Field (11) and other parks in social interaction scoring. The Sati Radhika Brahmaputra riverine park has the lowest score (9.1) as it scored in functionality analysis. There is a roadside wholesale fish market near the entrance of this park in which the fishermen sell their fish during the day and evening time those are caught from Brahmaputra River. The odor comes from the market, the stranger visitors of the market and vendors etc. might be the reasons for the youth of the city don't feel comfortable visiting the Sati Radhika riverine park.

Now, the classification of the social interaction data of the parks is displayed in Table 5.29. After classifying them such as Low (5-10), Moderate (10-15) and High (15-20).

Table 5.29: Response Categorization For Social Interaction in Open Spaces (Uzan Bazar)

Category	Dighalipukhuri Park	Sati-Radhika Brahmaputra riverine park	Jor Pukhuri Park	Nehru Park	Judges' Field	Latasil Playground
Low (5-10)	3.0%	50.4%	37.0%	7.0%	24.3%	11.0%
Moderate (10-15)	33.3%	35.6%	44.0%	40.5%	37.7%	40.0%
High (15-20)	63.6%	14.0%	19.0%	52.5%	38.0%	49.0%

The above table indicates that 63.6% of respondents of the Dighalipukhuri Park (which scored highest in the perception study of social interaction) have rated the park as 'high' whereas only 3% have rated it as 'low'. Whereas in the Sati Radhika riverine Udyan, more than 50% of the respondents (50.4%) have rated it as 'low'. Including the 35.6% of respondents of this park who have rated as 'moderate' more than 85% of respondents have a negative perception of social interaction in this riverfront park despite holding a beautiful riverine view. Apart from these two, 52.5% and 49% of respondents from Nehru Park and Latasil Playground respectively have rated them as 'high' socially interactive parks.

To understand the age group of people who are visiting these parks in Uzan Bazar according to the spatial arrangement of the parks, the map (Fig. 5.51) has been created. This shows that the Dighalipukhuri Park, Nehru Park, Latasil Playground, and Judges' Field are mostly accessed by the youths as well as children whereas in the Sati Radhika River Udyan and Jorpukhuri Park, only the youth population is recorded as visitors. A minimum number of senior citizens are spotted in Dighalipukhuri Park and the Judges' field. The avoidance of universal design considerations is probably the reason behind no utility of such parks by the senior citizens of society.

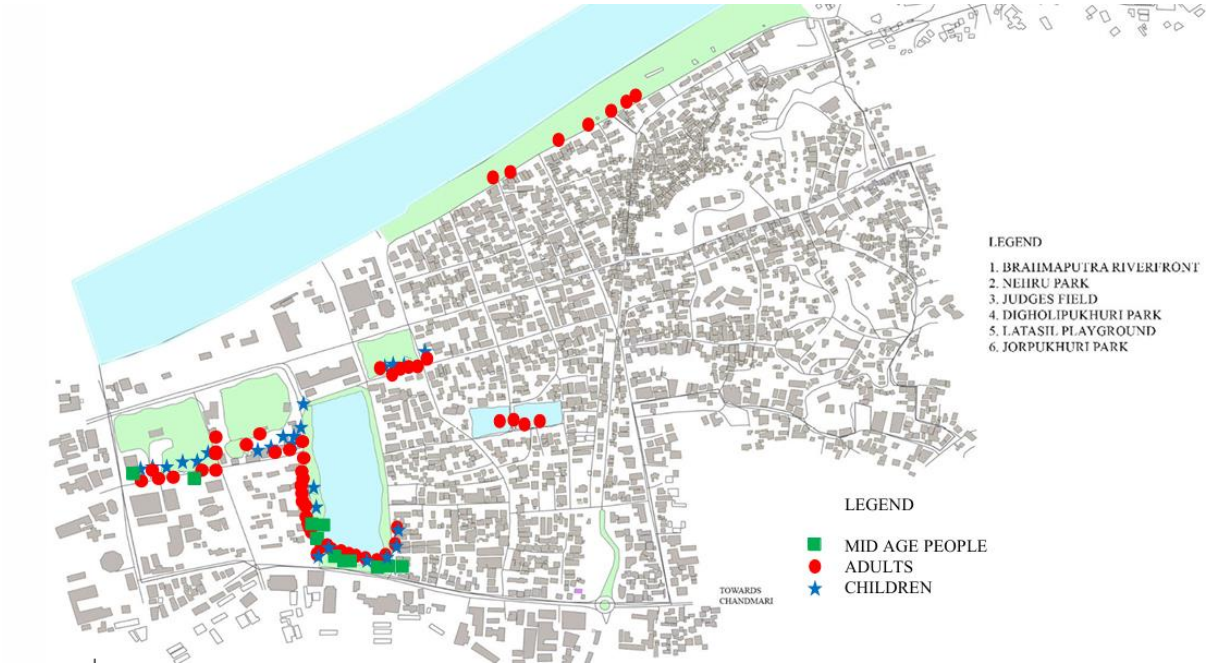


Fig. 5.51: Spatial Arrangements of Parks and Distribution of People

After the perception survey in Uzan Bazar is done, using a similar process, the perception scores for the parks present in Hengrabari, also, has been calculated. The data relating to

social interaction scores are tabulated in Table 5.30, and the categorisation of respondents' scores has been tabulated in Table 5.31.

Table 5.30: Scoring Analysis of Functionality for All the Parks in Hengrabari

Sl. No.	Open Spaces	Social Interaction Score
1	Amrit Udyan	12.6

Table 5.31: Response Categorization For Social Interaction in Open Spaces (Hengrabari)

Category	Amrit Udyan
Low (5-10)	25.0%
Moderate (10-15)	43.4%
High (15-20)	31.6%

Hengrabari's only park the Amrit Udyan has scored 12.6 in social interaction (refer to Table 5.30). The facilities of this park encourage the youths as well as the children to participate in the park activities. During the survey, it was found that the respondents rated as 'moderate' in social interaction is maximum (43.4%). The moderate score in social interaction in Amrit Udyan suggests that the park provides a reasonable level of opportunities to interact with people but the lack of a public transport route may be a cause for many people from another part of the city to reach the park. This may be a reason for the respondents (25%), also, who have rated it as 'low' in social interaction' (refer to Table 5.31).

From the perception study about the social interaction of all the public open spaces of both localities, it can be inferred that Uzan Bazar has overall better status of parks in terms of public interaction as it has Dighalipukhuri Park (15.3), Nehru Park (12.9), and Latasil Playground (12.7) securing satisfying scores than Hengrabari which has only a park securing 12.6 out of 20 which is a moderate value (refer Fig. 5.52). From the analysis, inference can be drawn about the localities that Uzan Bazar is perceived to be higher in social interaction than Hengrabari.

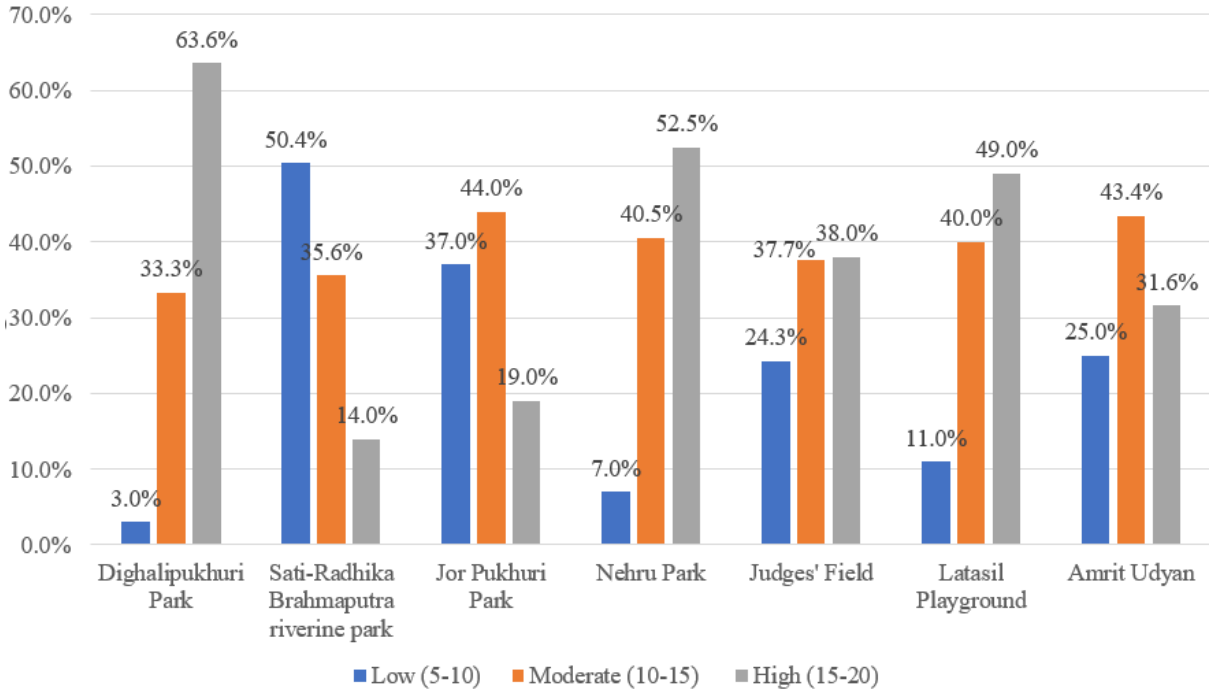


Fig. 5.52: Response Categorization For Study Areas-Open Space Social Interaction

5.3.11 Open Space (C4) – Accessibility (C4I2)

5.3.11.1 Quality of Access Points (C4I2E1)

Good quality access points of the open spaces are crucial to easily access those by the public of all ages, and physical ability. They help in reaching the open space in less time, navigating the area without any trouble, ensuring visibility from the roadside and improving physical connectivity of the open space with the rest of the locality (Thibaud 2001). So, in public spaces research, Alonso, Berghauser and Amorim (2018) have discussed ease of movement concerning open spaces like public parks, gardens, grounds, etc., which can be determined by the number of access points, connectivity between different entrances, presence of universal design elements, etc. Another research claims that an attractive and eye-catching entrance designed properly inspires people to use a park more often for physical activities (Hillsdon et al. 2006, pp.1128).

As suggested in the above discussion, ‘ease of movement’, ‘appeal’, ‘size’, and ‘visibility’ are considered measurable attributes for perception surveys using 5 5-point scale to achieve the quality of access points analysis. The overall quality score acquired by each of the parks of both the localities, as well as average values (in percentage) of responses against each measurable parameter concerning all open spaces available in Uzan Bazar, was then

calculated, tabulated and presented in Table 5.32 and Table 5.33. After that, the categorisation of these access points' data of the parks is displayed in Table 5.34.

Table 5.32: Scoring Analysis of Quality of Access Points for the Parks in Uzan Bazar

Sl. No.	Open Spaces	Quality of access points Score
1	Dighalipukhuri Park	11.6
2	Sati-Radhika Brahmaputra riverine park	12.1
3	Jor Pukhuri Park	14
4	Judges' Field	11
5	Nehru Park	11.3
6	Latasil Playground	14.1

Table 5.33: Percentage Distribution of Responses for Measurable Attributes in Each Park

Dighalipukhuri Park				
Category	**Ease of movement**	**Appealing design**	**Size**	**Visibility**
Weak	3%	27%	3%	36%
Not so strong	3%	17%	23%	40%
Neutral	27%	30%	37%	10%
Strong	40%	17%	20%	4%
Extremely strong	27%	10%	17%	10%
Sati-Radhika Brahmaputra riverine park				
Weak	11%	22.00%	12%	39%
Not so strong	11%	18%	25%	29%
Neutral	5%	10.00%	13.00%	21%
Strong	35%	13%	27.00%	7%
Extremely strong	38%	37%	23.00%	4%
Jorpukhuri Park				
Weak	13%	7%	3%	20%
Not so strong	20%	10%	23%	24%
Neutral	27%	10%	17%	10%
Strong	33%	23%	20%	24%
Extremely strong	7%	50%	37%	22%
Nehru Park				
Weak	18%	14.00%	12%	13%
Not so strong	17%	11%	21%	17%
Neutral	9%	20.00%	23.00%	18%
Strong	35%	18%	23.00%	27%
Extremely strong	21%	37%	21.00%	25%
Judges' Field				
Weak	7%	24.00%	37%	5%

Not so strong	13%	33%	23%	18%
Neutral	3%	7%	10%	11%
Strong	47%	20%	10%	35%
Extremely strong	30%	17%	20%	31%
Latasil Playground				
Weak	7%	7%	3%	10%
Not so strong	10%	10%	10%	24%
Neutral	20%	10%	20%	10%
Strong	33%	23%	30%	34%
Extremely strong	30%	50%	37%	22%

Table 5.32, reveals that Latasil Playground (14.1) has got highest score in terms of quality of access points followed by Jor Pukhuri Park (14), Sati-Radhika Brahmaputra Riverine Park (12.1), and others. Latasil Playground has been able to achieve positive responses in all the attributes individually by the respondents. For example, it has achieved 63%, 73%, 67% and 56% responses as 'Strong' and 'Extremely Strong' against 'ease of movement', 'appealing design', 'size', and 'visibility' respectively (refer Table 5.33). On the other hand, the Judges' field (11) has secured the lowest score. Though judges' Field's quality of access points score is significantly low, the responses it gets against each attribute shows that more than 77% and 66% of respondents respectively have rated 'ease of movement' and 'visibility' as 'Strong' and 'Extremely Strong'. Whereas, 57% and 60% respectively commented on 'appealing design' and 'size' as 'Weak' and 'Not so strong'. 73% of respondents in Sati-Radhika Brahmaputra River Park have rated 'ease of movement' as 'strong' and 'extremely strong' whereas 68% have rated 'visibility' as 'Weak' and 'Not so Strong'. 73% of responses of Jorpukhuri found the 'appealing design' of access points as 'strong' and 'extremely strong'. The painting articulated the significance of the park, displayed on the walls of the entrance points are reason why people like the design, as well as it provides visibility to the park from the roadside.

Table 5.34: Categorization of Responses for Quality of access Points

Category	Dighalipukhuri Park	Sati-Radhika Brahmaputra riverine park	Jor Pukhuri Park	Nehru Park	Judges' Field	Latasil Playground
Low (5-10)	20%	30%	6%	9%	26%	3%
Moderate (10-15)	70%	38%	24%	37%	50%	23%
High (15-20)	10%	32%	71%	54%	24%	73%

The categorization table (Table 5.34) indicates that in Latasil Playground, 73% respondents rated as 'High' quality access points whereas only 3% rated as 'Low' quality access points whereas in Judges' Field only 24% has rated as 'High' quality access points.

The data received from the perception survey in Hengrabari has been tabulated in the following tables (Table 5.35, Table 5.36 and Table 5.37).

Table 5.35: Quality of Access Points Scores for the Park in Hengrabari

Sl. No.	Open Spaces	Quality of access points Score
1	Amrit Udyan	14.9

Table 5.36: Percentage Distribution of Responses Against Each Measurable Attributes

Category	Ease of movement	Appealing design	Size	Visibility
Weak	7%	10%	3%	36%
Not so strong	13%	7%	23%	40%
Neutral	27%	13%	37%	10%
Strong	43%	40%	50%	60%
Extremely strong	10%	30%	7%	3%

Table 5.37 Categorization of Responses for Quality of Access Points

Category	Amrit Udyan
Low (5-10)	3%
Moderate (10-15)	4%
High (15-20)	93%

The overall quality of access points data of Hengrabari shows a score of 14.9 which is a higher score than that of any park available in Uzan Bazar (Table 5.35). Moreover, each individual's measurable attributes in Amrit Udyan have been appreciated by more than half of the respondents. For example, 53%, 70%, 57%, and 63% of responses are received as 'Strong' and 'Extremely Strong' against 'Ease of movement', 'Appealing design', 'Size' and 'Visibility' respectively (Table 5.36). The design of the Entrance point of Amrit Udyan is highly admired by the respondents.

Then, the categorization data (Table 5.37) reveals that 93% respondents have rated Amrit Udyan as a park holding 'High' quality access points. Its location and connectivity are

probably the prime reasons due to its popularity by most of the visitors.

From the above discussion, it is found that in the context of the quality of access points of the parks of both the study areas, Amrit Udyan (14.9) in Hengrabari, Latasil Playground (14.1) and Jorpukhuri Park (14) in Uzan Bazar fall on the higher range of quality of access points scores. The responses of people about social interaction in open spaces can be visually presented in bar charts as shown in Fig. 5.53.

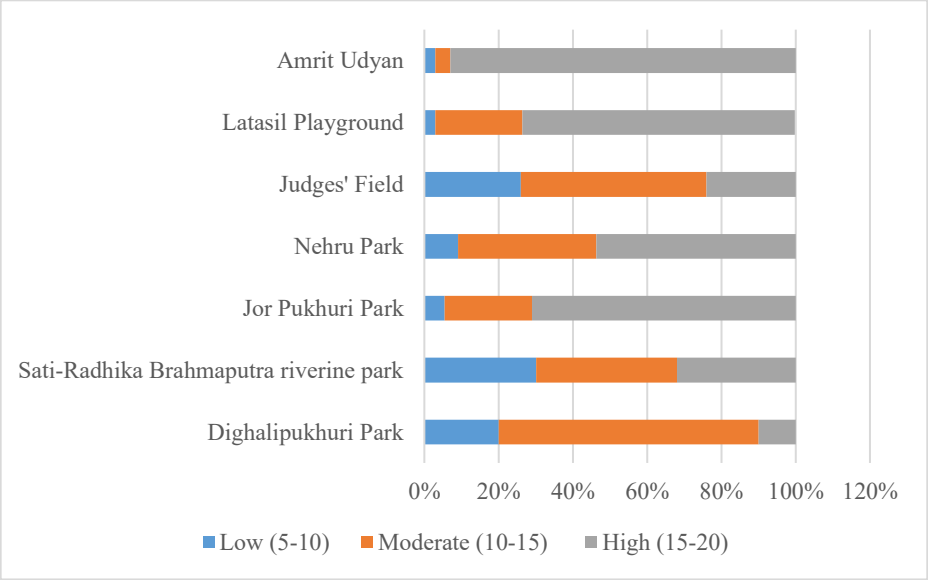


Fig. 5.53: Response Categorization for Study Areas-Open Space Access Points

From the access points analysis, inference can be drawn about the localities that Uzan Bazar is perceived to be high in quality of access points than that of Hengrabari.

5.3.12 Open Space (C4) – Legibility (C4I3)

5.3.12.1 Visual Landmarks (C4I3E1)

Every space people visit leaves some image in their minds which helps them to remember that place for the next visit in future. This happens due to the clear and legible characteristics of the visual landmarks of that place, which plays a big role in identifying spatial relationships between different zones (Massawe 2011). Therefore, aesthetically significant urban elements that get noticed in common places by the public can include sculptures, trees, fountains, any natural features, etc. (Zhanget al. 2024, pp.1079) (Lamit 2004)

The ‘utility’, ‘attractiveness’, ‘visibility’, and ‘clarity’ – these four aspects have been considered as measurable attributes for the visual landmarks analysis for the perception survey. The researcher has identified and listed the visual landmarks around the open spaces of Uzan Bazar and tabulated in Table 5.38.

Table 5.38: Visual Landmarks Present in Uzan Bazar and Their Characters

Sl. No.	Landmarks	Characters	Open Space Sites
1	The Dighalipukhuri	pond at the centre of the park	Dighalipukhuri Park
2	Group of massive trees	distinct trees at the boundary of the site	
3	A main battle tank	a real MBT at war memorial ground near the pond	
4	The twin ponds	twin ponds at the centre	Jor Pukhuri Park
5	A statue of the great activist	sculpture at the central axis of the twin ponds	
6	Brahmaputra river stretch	natural river-flow along main road	Sati Radhika Park

As listed in Table 5.38, among all the visual landmarks most of them are water sources either natural river portions or man-made ponds with numerous historical significances, few of them are large matured trees which are more than 100 years old and attached to the Assamese culture of the place. The Dighalipukhuri is a man-made pond dug by the King of old Pragjyotishpur King Bhagadutta during the marriage of his daughter Bhanumati as a dossier (The Times of India, Sept. 10, 2023). Besides this, the pond holds the legacy of standing as a fragment of history since the British period. The Jor pukhuri (twin ponds) is another historical pond built by Swargadeo Siva Singha as a water reservoir which was connected to the Brahmaputra River and acts as a strong landmark for the Uzan Bazar locality with the tortoise tank inside it (Directorate of Tourism 2024). Moreover, the main battle tank of the Dighalipukhuri War Memorial is displayed at the heart of the city which symbolises the sacrifice of the soldiers at various times for the state. Besides all these, the statue of Karmabir Nabinchandra Bordoloi, a great politician and activist of independence movement.

Upon rating of these landmarks by the respondents during the perception survey, the visual landmarks scores are achieved by each park present in Uzan Bazar.

Table 5.39: Scoring Analysis of Visual Landmarks Scores of the Parks in Uzan Bazar

Sl. No.	Visual Landmarks	Utility	Attractiveness	Visibility	Clarity	Visual Landmark Score
1	The Dighalipukhuri Pond	3.6	3.6	3.6	3.6	14.4
2	Group of massive trees	4.1	4.2	4.6	3.8	16.7
3	A main battle tank	3.5	3.1	3.5	2.8	12.9
4	The twin ponds	3.4	3.5	3.4	3.1	13.4
5	A statue of the great activist	2.1	2	3.8	2.3	10.2
6	Brahmaputra river stretch	2.4	4.1	3.5	2.5	12.5

Table 5.39 tabulates the visual landmarks score against each of the visual landmarks that are present in the designated open spaces of the locality based on the four attributes. The table displays that out of all the six different visual landmarks, the group of old large trees at the periphery of the Dighalipukhuri has been rated the highest (visual landmark score 16), whereas the statue at the central axis of the Jorpukhuri Park is one that got the lowest score (10.2). The average values of the attributes concerning the trees of Dighalipukhuri park have achieved a score of more than 4, except in clarity (3.8). This is because the presence of the large trees has become a part of the culture of this place for a long time and holds the emotions of the people who reside here in the locality frequently. On the other hand, all the attributes of the sculpture at Jorpukhuri have achieved an average score below 3, eg, Utility 2.1, Attractiveness 2, Clarity 2.3, except visibility 3.8. The Brahmaputra River stretch of Sati-Radhika Park also has scored below 3 in utility (2.4) and clarity (2.5).

The data are, then, the classified into categories such as Low (5-10), Moderate (10-15) and High (15-20) and are tabulated in Table 5.40.

Table 5.40: Categorization of Responses for Visual landmark Score

Category	The Dighalipukhuri	Group of massive trees	A main battle tank	The twin ponds	A sculpture	Brahmaputra river stretch
Low (5-10)	9%	2%	37%	27%	70%	30%
Moderate (10-15)	22%	20%	36%	29%	19%	43%
High (15-20)	69%	78%	27%	42%	11%	27%

It is found from Table 5.39 that 78% of respondents rated the large trees of Dighalipukhuri Park as 'High' and only 2% rated them as 'Low', whereas the sculpture at Jorpukhuri Park was recorded as 'Low' by 70% of the respondents. The statue at Jorpukhuri received a "low" rating for the following probable reasons: first, although being in a prominent spot with good visibility, the design of the base on which the statue is placed fails to attract the attention of the general public. The second reason is that the statue's scale and material, which are small and dark brown, fail to draw the viewer's attention. The Dighalipukhuri pond, also, has achieved 69% of people's responses as 'High' and 22 % as 'Moderate'.

Now, on conducting the similar survey, in Hengrabari, to get the visual landmark score, the following data are found (refer Table 5.41).

Table 5.41: Visual Landmarks Score of the Parks in Hengrabari

Sl. No.	Visual Landmarks	Utility	Attractiveness	Visibility	Clarity	Visual Landmarks Score
1	A massive tree	2.7	3.7	3.3	3.3	13
2	The entrance	3	4	3.3	3.2	13.5

Table 5.42: Categorization of Responses for Visual Landmark Score in Hengrabari

Category	A massive tree	The Entrance
Low (5-10)	19%	16%
Moderate (10-15)	35%	20%
High (15-20)	46%	64%

The two visual landmarks of Amrit Udyan in Hengrabari such as the old large Banyan tree and the entry point are 13 and 13.5 respectively (Refer Table 5.41). The categorized data as tabulated in Table 5.42, also, shows that 64% of respondents rated the entrance of the park as 'High' and only 16% rated it 'Low' whereas in the case of the tree at the entrance, 46% and 35% respondents rated as 'High' and 'Moderate' as people gets shade from this tree as well as it provides a natural appeal to the area.

For getting an overall idea of all the parks in Uzan Bazar and Hengrabari, based on human perception level a comparative figure has been generated (Fig. 5.54). It shows that though

Uzan Bazar has more no. of landmarks present in the locality than that of Hengrabari their utility, attractiveness, clarity, etc. are similar across all the landmarks of both the localities.

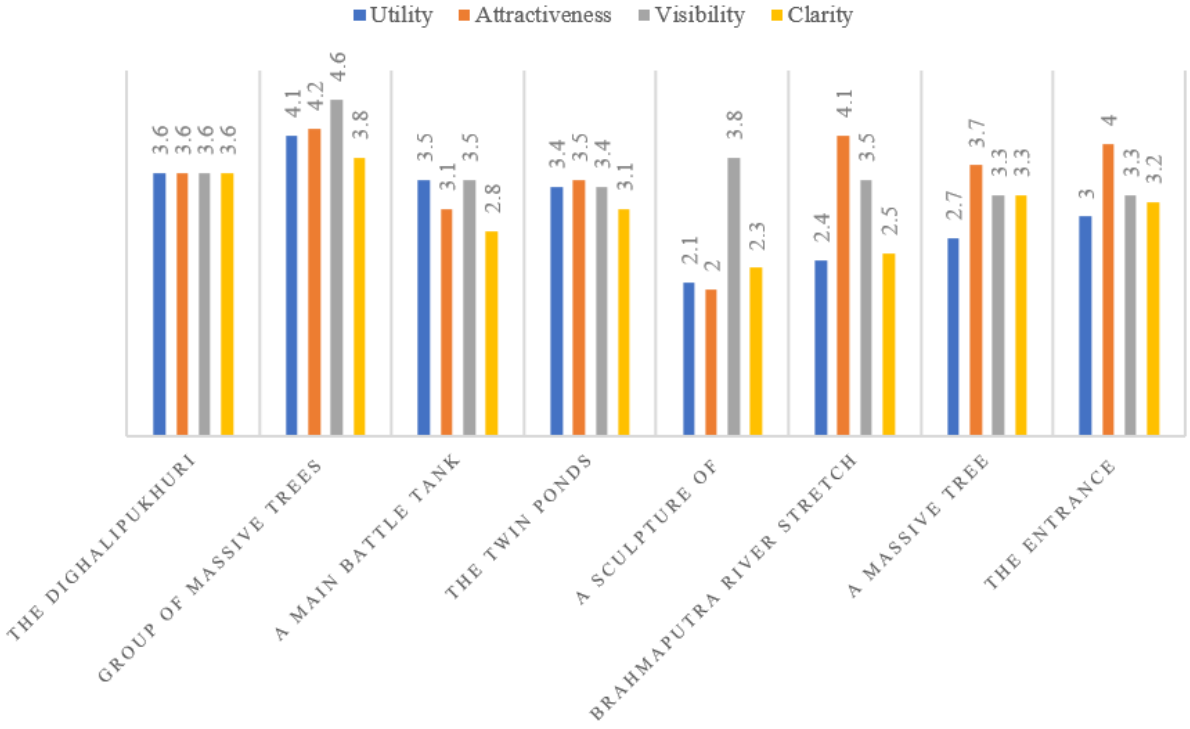


Fig. 5.54: Response Categorization for Study Areas-Visual Landmarks of Open Spaces

From the visual landmarks analysis, inference can be drawn about the localities that Uzan Bazar is performed better than Hengrabari.

5.3.12.2 Enclosure Definition (C4I3E2)

Enclosures provide a frame to any structure or space. It clarifies the use and functionality of spaces by providing proper boundary. The human mind perceives safety and comfort in relation to the type of enclosure defining a space (Mackesy-Buckley 2012). Therefore, the design elements are of utmost need to think about when it tends to create a balance between safety, comfort and legibility.

'Transparency' (Ewing & Handy 2009), 'Human scale', 'Texture' (Paydar & Kamani 2021) and 'Materials' (Medjkoune, Bada & Bougdah 2023) are considered basic measurable attributes to assess the enclosure of open spaces. To assess the enclosure definition of the open spaces of both localities, the researcher has listed the enclosure scores based on these attributes by conducting the perception survey at Uzan Bazar and the data are tabulated in the Table 5.43.

Table 5.43: Scoring Analysis of Enclosure of the Parks of Uzan Bazar

Sl. No.	Open Spaces	Enclosure Score
1	Dighalipukhuri Park	14.9
2	Sati-Radhika Brahmaputra riverine park	11.2
3	Jor Pukhuri Park	15.3
4	Nehru Park	11.6
5	Judges' Field	13.1
6	Latasil Playground	15

From the table, it is evident that in the enclosure definition, Jorpukhuri Park (15.3) scored the highest, followed by Latasil Playground (15), Dighalipukhuri Park (14.9), and others. During the site survey, it was found that almost all the boundary walls of the open parks available here (except the walls of Nehru Park) are made up of iron grill barriers, which allow transparency and visibility through them. Nehru Park has brick walls as boundary demarcation at the front, which doesn't allow the public to view from the roadside what is going on inside. This may be one of the probable reasons behind the low enclosure score of this park.

Table 5.44: Categorization of Responses for Enclosure Score of the Parks in Uzan Bazar

Category	Dighalipukhuri Park	Sati-Radhika Brahmaputra riverine park	Jor Pukhuri Park	Nehru Park	Judges' Field	Latasil Playground
Low (5-10)	0.0%	45.0%	4.0%	26.0%	24.0%	5.0%
Moderate (10-15)	73.0%	36.0%	14.0%	57.0%	55.0%	8.0%
High (15-20)	27.0%	19.0%	82.0%	17.0%	21.0%	87.0%

On categorization of the data acquired from survey, it is found that 87% and 82% of the surveyed people of Latasil Playground and Jorpukhuri park respectively has been rated the park as 'High' in enclosure definition. Whereas, in Nehru Park and Sati-Radhika Brahmaputra riverine Park's case, only 17% and 19% has rated as 'High'.

Now, a similar perception study for Hengrabari shows that Amrit Udyan has achieved a 12.6 enclosure score (refer to Table 5.45). Here, 67% of people have rated as 'Moderate' and 27% have rated as 'High' (refer to Table 5.46). Though the transparent iron grill barriers allow

transparency the level differences in the landform of the park do not allow the roadside viewers to have ideas about the activities going on inside the site.

Table 5.45: Scoring Analysis of Enclosure of the Park of Hengrabari

Sl. No.	Open Spaces	Enclosure Score
1	Amrit Udyan	12.6

Table 5.46: Categorization of Responses for Enclosure Score of the Parks in Hengrabari

Category	Amrit Udyan
Low (5-10)	6.0%
Moderate (10-15)	67.0%
High (15-20)	27.0%

For getting an overall idea of the enclosure definition of all the parks in Uzan Bazar and Hengrabari, based on human perception level a comparative figure has been generated (Fig. 5.55). It can be understood from the figure that despite the difference in no. of open spaces' presence between the two localities, the enclosure of the only park of Hengrabari people's perception is positive and most of them have highly and moderately appreciate its presence.

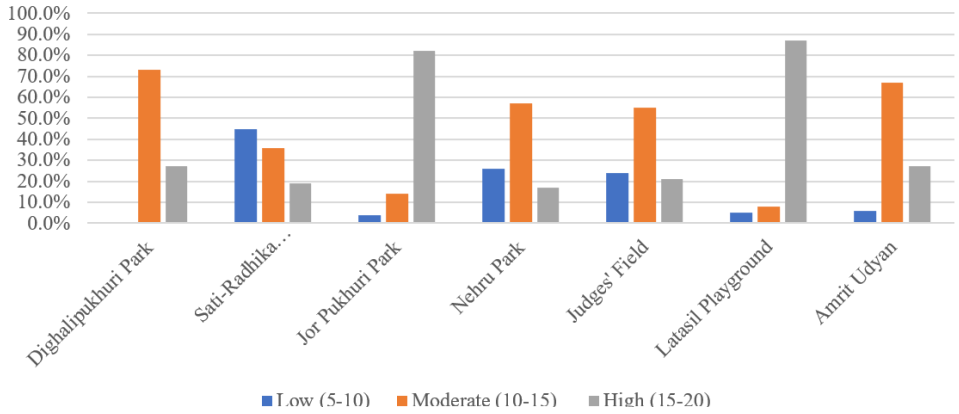


Fig. 5.55: Response Categorization for Study Areas- Enclosures of Open Spaces

5.3.13 Tree (C5) – Cover (C5I1)

5.3.13.1 Density (C5I1E1)

Tree density has a direct connection to mental well-being as trees can calm people's psychology by relieving stress (Tsai et al. 2018, p.340). Dense vegetation, also, provides shade, maintains the built and unbuilt ratio and improves the visual aesthetic of urban spaces. The balance between the placement of trees and the organization of activity spaces finally

contributes to keeping the visibility of spaces and sufficient lighting on streets (Camacho et al. 2014, pp.762).

To assess the condition of trees in the localities, the study areas are divided individually into plots of 100m x 100m (1 hectare) area. This is how, the entire area of Uzan Bazar (2.18 sq.km area) is divided into 218 plots (1 hectare each) for the ease of the survey conduction and out of these, every 15th number of plots are considered as the sample plots (as already discussed in Chapter no. 3) for the tree study. This way, a total number of 14 plots are selected as sample plots in Uzan Bazar for tree density assessment through a systematic sampling method. Then, the tree counts obtained using this method are extrapolated for all the other remaining plots. A similar process is followed to choose the sample plots for Hengrabari which results in a no. of 187 plots (1 hectare each) and a total of 14 plots are achieved as sample plots for the survey. Such division of the study areas for the convenience of conducting the survey has been shown in the following figures (Fig. 5.56 and Fig.5.57).

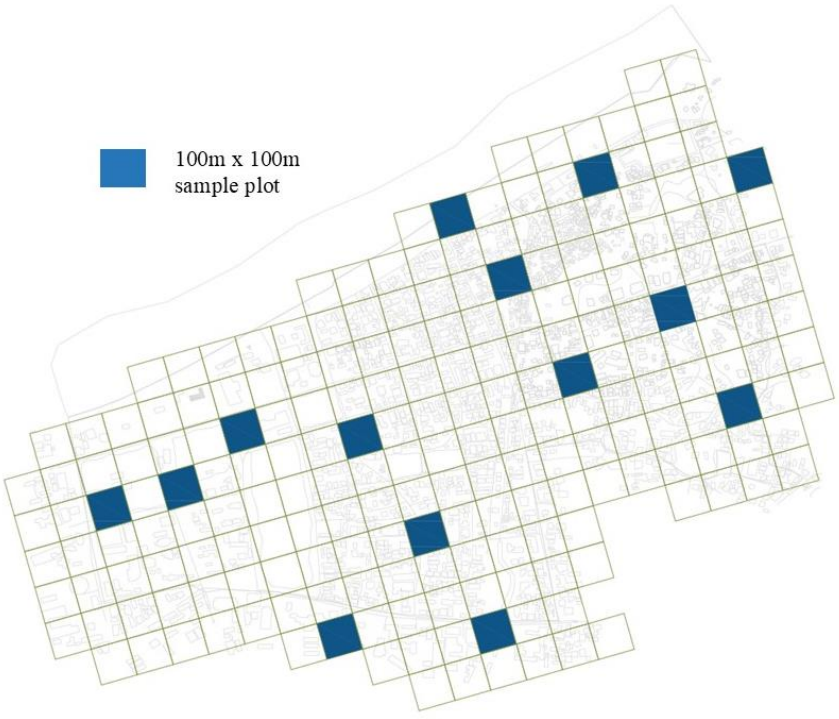


Fig. 5.56: Plot Division for Sample Selection in Uzan Bazar

Fig. 5.57: Plot Division for Sample Selection in Hengrabari

Now, to assess the density of trees in Uzan Bazar, a simple random sample survey is conducted, firstly, for the sample plots. To calculate the tree density in the locality, the formula provided below can be used.

Tree density = total no. of trees in the plot/total area of plot.

Hence, the total number of trees counted in for all the 14 sample plots, when calculated, in Uzan Bazar, it is found to be 884 no. s in total

So, the average tree counts = 884/14

= 63 no. s

Then, the total tree counts in entire Uzan bazar = (63x218) no. s

= 13,734 no. s

Hence, **tree density in Uzan Bazar = 13,734 /2.18 = 6300 no. of trees per sq. km.**

For a better understanding of the distribution of these trees in the study area, the spatial mapping of trees in the study area is done (refer to Fig. 5.58). From the map, it can be seen that in Uzan Bazar, the trees are concentrated primarily linearly along the river, in the open parks, inside the institutional campuses of Cotton University and Handique Girls' College, as well as in part of the roadside. The compact housing areas of the locality lack trees, though

the available trees in the study area balance the ratio of trees and built spaces to a great extent.

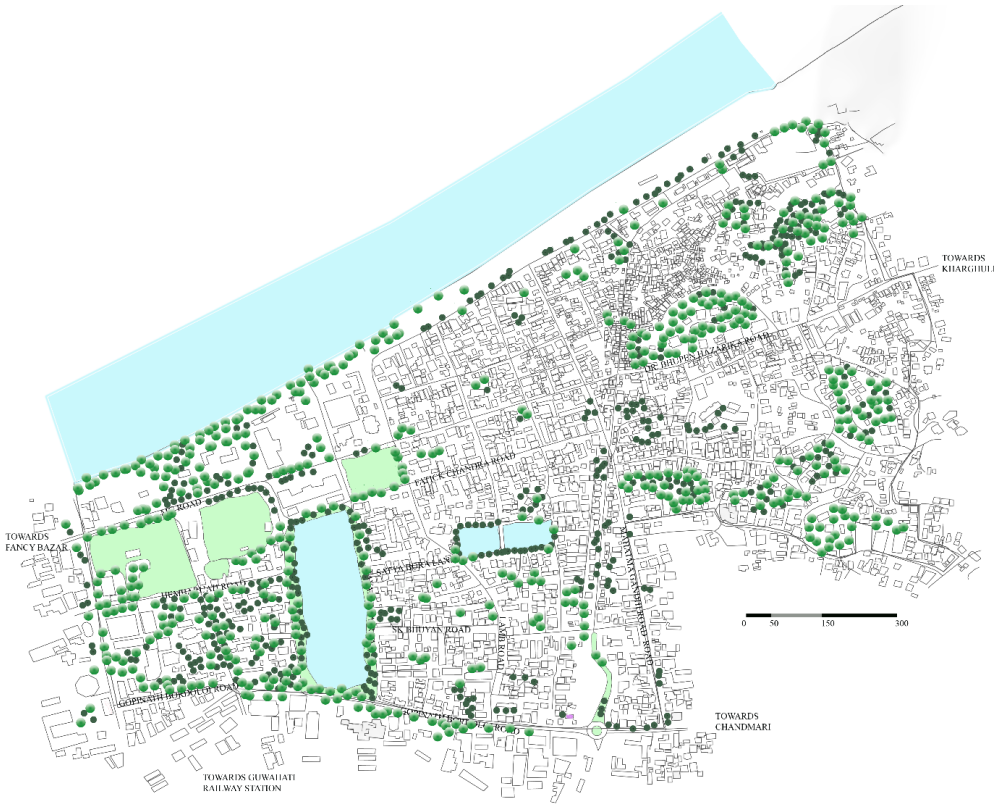


Fig. 5.58: Spatial Distribution of Trees in Uzan Bazar

When the similar calculation is done for the study area of Hengrabari with a total of 187 plots (1 hectare each), and 14 no.s of sample plots, it is found that -

Tree density in Hengrabari is found to be 3415 no. of trees per sq. km.

The spatial distribution of the trees of Hengrabari can be observed in Fig. 5.59. Here, the trees are distributed majorly along the roads. The government plots such as the Amrit Udyan, Office of Directorate of Health Services, as well as Office of District Commissioner hold a significant number of trees on the site.

Fig. 5.59: Spatial Distribution of Trees in Hengrabari

From the tree density analysis in both the study areas, it can be inferred that Uzan Bazar has a greater number of trees present than that of Hengrabari (Refer Table 5.47).

Table 5.47: Availability and Density of Trees across Localities

Uzan Bazar		**Hengrabari**	
No. of Trees available	**Tree Density (no. s per sq.km)**	**No. of Trees available**	**Tree Density (no. s per sq.km)**
13,734	6300	6,385	3,415

5.3.13.2 Canopy Coverage (C5I1E2)

Canopy coverage refers to an area on ground which is covered by tree canopies at above ground level. Canopy coverage has a direct effect on psychology of people (Zhang et al. 2022, p.111795). For example, large canopy trees stimulate pedestrian traffic to become frequent on streets. Sometimes, especially in places with fewer people, a lot of canopy cover might provide feeling of confinement or isolation.

To assess the canopy coverage of the chosen localities, Google Earth images and Autodesk AutoCAD software are used. The Google Earth Raster Imagery of respective study areas are saved and imported into AutoCAD. Then, using the polyline command, the area on the ground covered with tree canopies in the sample plots (14 no. s of plots for each of Uzan

Bazar and Hengrabari) are calculated and recorded. These data are converted into percentages of canopy coverage with respect to the total area of one plot. Such percentage measurements are recorded separately for each of the sample plots (both Uzan Bazar and Hengrabari) and then, the average measurements are calculated which is shown in Table 5.48.

Table 5.48: Percentage Distribution of Canopy Coverage across localities

Plots of 100mx100m	**Canopy Coverage**	
	Uzan Bazar	**Hengrabari**
Plot 1	38%	8%
Plot 2	59%	12%
Plot 3	17%	16%
Plot 4	18%	13%
Plot 5	66%	16%
Plot 6	42%	8%
Plot 7	52%	22%
Plot 8	62%	27%
Plot 9	50%	12%
Plot 10	25%	15%
Plot 11	52%	17%
Plot 12	50%	12%
Plot 13	27%	11%
Plot 14	52%	9%
Av. count	**43.6%**	**15.2%**

From the above table, it is revealed that,

In Uzan Bazar, the average canopy coverage is found to be 43.6%

In Hengrabari, the average canopy coverage is found to be 15.2%

From the canopy coverage analysis in both the study areas, it can be inferred that Uzan Bazar has a greater percentage of canopy coverage than Hengrabari (Refer Table 5.48).

5.3.14 Tree (C5) – Height (C5I2)

5.3.14.1 Ability to Provide Shade (C5I2E1)

The height of a tree determines the size of the shadow it casts. Tree height affects their ability to provide shade, but the width and density of the canopy frequently have a greater impact on the amount and quality of shadow (Morakinyo et al. 2017, pp.3).

Tree's ability to provide shade calculation requires the average radii of tree canopies. The formula to get ability of trees to provide shade is as follows,

$$\text{Shade Area } (\text{m}^2) = \pi \times \left(\frac{\text{Canopy Radius (m)}}{2} \right)^2$$

After calculating the average canopy area of each plot using data from tree counts and canopy coverage, the average canopy diameters and radii are achieved as shown in Table 5.49 & Table 5.50.

Table 5.49: Shaded Area in Uzan Bazar

Plots of 100mx100m	**Av. tree canopy area (in sq.m)**	**Av. Diameter of canopy**	**Av. Radius**	**Shaded area (in sq.m)**
Plot 1	190	15.6	7.8	47.5
Plot 2	71.9	9.6	4.8	17.9
Plot 3	58.6	8.6	4.3	14.7
Plot 4	50	7.9	4	12.5
Plot 5	58.9	8.7	4.3	14.7
Plot 6	100	11.3	5.6	25
Plot 7	74.3	9.7	4.9	18.6
Plot 8	67.4	9.3	4.6	16.9
Plot 9	51.0	8.1	4	12.8
Plot 10	35.7	6.7	3.4	8.9
Plot 11	83.9	10.3	5.2	20.9
Plot 12	100	11.3	5.6	25
Plot 13	122.7	12.5	6.3	30.7
Plot 14	52.5	8.2	4.1	13.1
Shaded area in one plot (Av. Value)				**20.5 sq.m**

Table 5.50: Shaded Area in Hengrabari

Plots of 100mx100m	**Av. tree canopy area (in sq.m)**	**Av. Diameter of canopy**	**Av. Radius**	**Shaded area (in sq.m)**
Plot 1	38.1	7.0	3.5	9.5
Plot 2	36.4	6.8	3.4	9.1
Plot 3	40.0	7.1	3.6	10.0
Plot 4	37.1	6.9	3.4	9.3
Plot 5	40.0	7.1	3.6	10.0
Plot 6	40.0	7.1	3.6	10.0
Plot 7	46.8	7.7	3.9	11.7
Plot 8	51.9	8.1	4.1	13.0
Plot 9	40.0	7.1	3.6	10.0
Plot 10	40.5	7.2	3.6	10.1

Plot 11	92.5	10.9	5.4	23.1
Plot 12	48.0	7.8	3.9	12.0
Plot 13	25	5.643326	2.821663	6.25
Plot 14	22	5.293909	2.646955	5.5
Shaded area in one plot (Av. Value)				**11.1 sq.m**

By applying these average values of shaded area (20.5 for Uzan Bazar and 11.1 for Hengrabari) in the formula, the shaded area that trees can provide in each locality can be determined.

Thus, the tree ability to provide shade are found to be

In Uzan Bazar, 20.5x218= 4462.8 sqm

In Hengrabari, 11.1x187= 2072.7 sqm.

From the analysis in both the study areas, it can be inferred that Uzan Bazar has a greater value of shade area than that of Hengrabari.

5.3.15 Tree (C5) – Size (C5I3)

5.3.15.1 Diameter of the Trunk at Breast Height (DBH) (C5I3E1)

The maturity and stability of a tree are indicated by its higher diameter at breast height (DBH), which has a more aesthetically pleasant and psychologically beneficial effect (Zhao, Xu & Li 2017). People feel more secure and perceive a sense of security by the presence of mature trees around, that's why there is a metaphorical saying *"Old Trees Are Our Parents"* (Woodward 2022).

The Portland gov. advised measuring the tree trunk at a height of 4.5 feet or 1.37 meters to get the DBH using a measuring tape. Now, to attain the value of the DBH of the trees of both localities, the average dimensions of the diameters of the trees of each sample plot have to be calculated first. The average values of DBH found this way, then, can give the multiplied value of all the plots (14 no. s for each locality) to achieve the overall DBH values of the localities individually.

Table 5.51: Average Values of DBH of Trees in Each Sample Plot

Plots of 100mx100m	**DBH**	
	Uzan Bazar (in mm)	**Hengrabari (in mm)**
Plot 1	213	100
Plot 2	187	150
Plot 3	190	86
Plot 4	250	250
Plot 5	255	167
Plot 6	60	200
Plot 7	150	235
Plot 8	400	79
Plot 9	165	290
Plot 10	230	193
Plot 11	77	75
Plot 12	157	97
Plot 13	150	75
Plot 14	177	25
Av. count	**204.7**	**160.2**

The av. count of DBH gives the average value of the diameters of trees of one plot. This value can be multiplied by the total number of plots of each of the localities to achieve the DBH value individually for both.

From the above table, it is revealed that,

In Uzan Bazar, the average size of Trees in terms of DBH is found to be 204.7 mm

In Hengrabari, the average size of Trees in terms of DBH is found to be 160.2 mm

From the DBH analysis in both the study areas, it can be inferred that Uzan Bazar has a greater average value of the diameter of the tree trunk than that of Hengrabari (Refer Table 5.51).

5.4 Major Findings

Both case study locations have been thoroughly assessed using a predetermined set of criteria pertinent to the research objectives as a consequence of the analyses that are carried out. The findings from this comparative assessment offer insights into the strengths and weaknesses of each locality. As a result, the following table is a summary of the major findings and inferences. The table reveals the status of evaluation criteria at each of the localities and

infers which performed well in terms of public safety.

Table 5.52: Summary of Findings Inferred from Analyses

Sl. No.	**Compo-nents**	**Indicators**	**Evaluation Criteria**	**Uzan Bazar**		**Hengrabari**	**Inference** (the locality that scores high)
1	Built Form	Human Scale	Human proportioned doors and windows	Human scale evaluation Score	17.7	15.7	Uzan Bazar
			Quality of Ground Floor Façade Design	Quality Score for Ground Floor Façade Design	20.7	13.2	Uzan Bazar
		Architectural Details	Design Quality	Design Quality score	14.2	11.9	Uzan Bazar
		Urban Element	Visual Aesthetic	Digital Content Analysis	1000+ hashtags	Fewer than 100 posts	Uzan Bazar
2	Layout	Road Network Design	Traffic Efficiency	Traffic efficiency score	12.3	9.9	Uzan Bazar
			Condition of Road Surfaces	Good	21%	0%	Uzan Bazar
				Modearte	68%	58%	
				Bad	11%	42%	
		Connectivity	Route Directness	Route Directness Score	13.6	11.9	Uzan Bazar
		Pedestrian Flow	Walking Quality	Walking quality score	33.5	17.5	Uzan Bazar
3	Land use	Diversity	Functional Mix	Functional Diversity score	9	10	Hengrabari
		Access	Access to Amenities	Amenities access score	11.1	9.7	Uzan Bazar
			Proximity	Proximity score	15.3	6	Uzan Bazar
		Compatibility	Functional Synergy	Synergy score	4.1	3.6	Uzan Bazar
4	Open Space	Spatial Characteristics	Functionality	Functionality score			Uzan Bazar
				Dighalipukhuri Park	14.6	13.1 (Amrit Udyan)	
				Sati-Radhika Brahmaputra riverine park	9.2		
				Jor Pukhuri Park	11		
				Nehru Park	18.1		
				Judges' Field	19.1		
				Latasil Playground	19.7		

			Social Interaction	Dighalipukhuri Park	15.3	12.6	Uzan Bazar
				Sati-Radhika Brahmaputra riverine park	9.1		
				Jor Pukhuri Park	10.9		
				Nehru Park	12.9		
				Judges' Field	11		
				Latasil Playground	12.7		
		Accessibility	Quality of Access points	Dighalipukhuri Park	11.6	14.9	Uzan Bazar
				Sati-Radhika Brahmaputra riverine park	12.1		
				Jor Pukhuri Park	14		
				Judges' Field	11		
				Nehru Park	11.3		
				Latasil Playground	14.1		
		Legibility	Visual Landmarks	The Dighalipukhuri Pond	14.4	13 (The Gate)	Uzan Bazar
				Group of massive trees	16.7	13.5 (The Old tree)	
				A main battle tank	12.9		
				The twin ponds	13.4		
				A sculpture of	10.2		
				Brahmaputra river stretch	12.5		
			Enclosure Definition	Dighalipukhuri Park	14.9	12.6	Uzan Bazar
				Sati-Radhika Brahmaputra riverine park	11.2		
				Jor Pukhuri Park	15.3		
				Nehru Park	11.6		
				Judges' Field	13.1		
				Latasil Playground	15		
5	Trees	Cover	Density	No. of trees available	13,734	6,385	Uzan Bazar
				No. of trees per sq. km	6,300	3,415	

			Canopy Coverage	Average canopy coverage	43.60 %	15.20%	Uzan Bazar
		Height	Ability to provide shade	Shaded area	4462.8 sqm	2072.7 sqm	Uzan Bazar
		Size	Diameter at breast height	Average size of Trees in terms of DBH	204.7 mm	160.2 mm	Uzan Bazar

The above-table presents a valid comparison between the safest and most unsafe localities of Guwahati city which are Uzan Bazar and Hengrabari respectively. The colours 'red', 'yellow' and 'green' highlighting the evaluation criteria in the table are used to depict the criteria showing 'huge difference', 'significant difference' and 'almost similar range' of the scores and performance concerning both localities. This representation with colours will be able to provide a clear idea about the evaluation criteria related to physical components which affect more in peoples' perception about safety and security. Here, the components such as open space and trees show a huge difference in scores of their criteria and Uzan Bazar exhibits significantly improved performance whereas in diversity and compatibility in land uses, both the localities show scores of almost similar ranges and are found to have not much impact on the safety perception. The indicators of the layout component have significant and huge differences in their criteria scores. On the other hand, most of the indicators of built form component show significant differences in scores which implies their significant impact on people's safety perception.

5.5 Derivation of Safety Criteria from Analyses

Based on the major findings of the analyses, a synthesised table has been created to highlight only those evaluation criteria that were red-coded in Table 5.53 and exhibited 'huge differences' in affecting the sense of safety. That is why it can be said that the safety criteria are shown in the table below, which only includes highly relevant evaluation criteria.

Table 5.53: Synthesised Safety Evaluation Criteria from Comparative Study

Components	**Indicators**	**Evaluation Criteria**	**Code**	**Relevance** (in terms of sense of safety)
C1-Built Form	C1I3-Urban Element	Visual Aesthetic	C1I3E2	High
C2-Layout	C2I1-Road Network Design	Condition of Road Surfaces	C2I1E2	High

	C2I3-Pedestrian Flow	Walking Quality	C2I3E1	High
C3-Land use	C3I2-Access	Proximity	C3I2E2	High
C4-Open Space	C4I1-Spatial Characteristics	Functionality	C4I1E1	High
		Social Interaction	C4I1E2	High
	C4I2-Accessibility	Quality of Access points	C4I2E1	High
	C4I3-Legibility	Visual Landmarks	C4I3E1	High
		Enclosure Definition	C4I3E2	High
C5-Trees	C5I1-Cover	Density	C5I1E1	High
		Canopy Coverage	C5I1E2	High
	C5I2-Height	Ability to provide shade	C5I2E1	High
	C5I3-Size	Diameter at breast height	C5I3E1	High

The evaluation criteria presented in the above table are the most critical and highlighting these, it provides a more targeted and context-specific understanding of how the built environment is to be designed to improve people's sense of safety.

5.6 Inferences

This chapter analysed the components of the built environment in terms of the evaluation criteria and discussed the physical states and the implications of those on people's sense of safety. The perceptions are collected through a five-point Likert scale and discussed through a scoring system and percentage distribution. According to the survey findings, in almost all the evaluation criteria that had been chosen for analysis, Uzan Bazar is found to perform better than Hengrabari; moreover, evaluation of a few of the criteria shows significantly lower values in the case of Hengrabari. In the functional mix, Hengrabari performed slightly higher than Uzan Bazar. Apart from that, human proportioned door windows, design quality, traffic efficiency, and route directness – these criteria of the built environment show either 'significant' or 'low' differences between their respective values in context to Uzan Bazar and Hengrabari.

With all such analytical findings, it can be inferred that the important physical components

this study has chosen in chapter no. 2 through a detailed literature survey are as appropriate for such research as the physical conditions of these have been found better in the safest locality and the worst in the unsafe locality in alignment with the chosen components. This result confirms the efficacy of the chosen components and offers empirical support for the inter-relationship between established safety components and actual site circumstances.

Chapter 6: Discussion and Development of Strategies

6.1 Chapter Overview

This chapter, in its initial part, summarises the research contribution. Moreover, in the later and major part, the development of strategies and case study the comparative analyses discussed in the previous chapter (Chapter no.5) have brought to light particular strengths and flaws in each case study; so, this chapter is to synthesize the inferences drawn from the analyses and translate the insights into an organized foundation to provide a standardized set of eight strategies. This process of developing strategies from the insights that emerged from the analyses ensures that the strategies are not abstract or generalised, but are a real use of observable conditions of case studies to enhance safety perception and improve the built environment. Additionally, strategies are examined in both case study areas, highlighting existing deficiencies and strengths through the use of visual references and on-ground data to emphasise the existing gaps.

These strategies will offer practical suggestions to policymakers, architects, urban designers and urban planners enabling them to systematically evaluate and enhance safety perceptions in urban built environments. The following flowchart has provided the structured outline of the chapter.

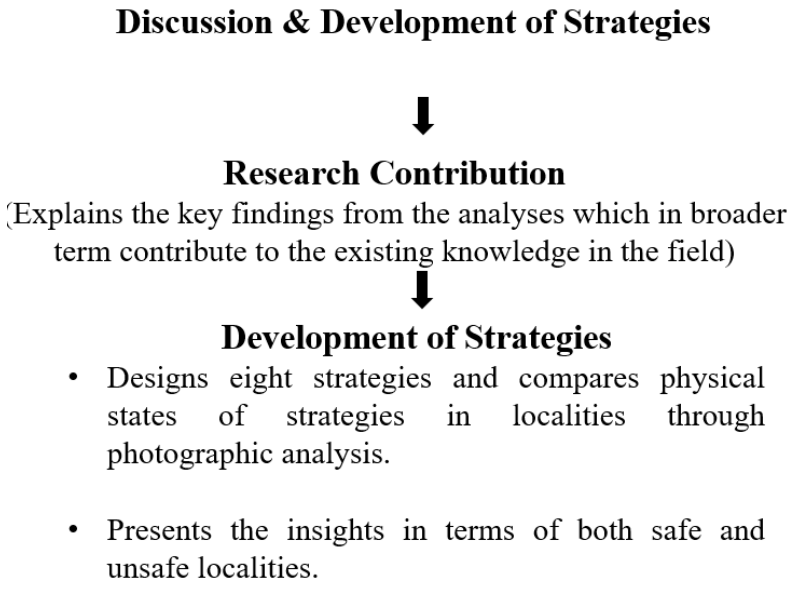


Fig. 6.1: Outline of the Chapter

This chapter will try to fill the research gap by providing strategies related to the top three built components (such as built form, layout, and land use) and their indicators that the

research has already explored. These three components show the strongest correlation with safety perception and relevance to practical implementation, which has already been proven from expert consultation and discussed in Chapter No. 2. Additionally, it establishes the objectives of the framework, ensuring a systematic approach to evaluating and improving urban safety.

6.2 Research Contribution

Some key points are observed, which are mentioned below as part of the major findings of the research.

- In relation to safety studies of urban built spaces, the mentions of Northeastern cities are very scarce, as addressed by the research, whereas studies from other parts of the country are widely found. This thesis directly fills that gap by representing the only metropolitan city of Northeast India.
- Another key finding of the research is the set of ten important physical components which constitute the built environment and have a strong effect on people's sense of safety. Such components are built form, layout, land use, open spaces, trees, lighting, landscape, architectural style, visual symbol, and materials. Proper design and maintenance of these components have been proven to reduce crimes in urban neighbourhoods.
- Guwahati's police jurisdictions' reported crime rates are revealed by the research's investigation. It implies that, according to crime occurrences, Dispur and Latasil have the highest and lowest crime PS ratings, respectively. The perception survey discloses the localities from these PS jurisdictions - Uzan Bazar, which is a safer locality, and Hengrabari, which is an unsafe locality.
- According to the study, Amrit Udyan Park is the only centralized open area in Hengrabari that is used for community events. Aside from that, it has an inadequate playground and a few little temple grounds. Therefore, one of the main causes of the residents' decreased sense of safety in this area is the absence of open space at the community level.
- The research results that in land use analysis, Hengrabari has performed better in functional mix (10) but less in functional synergy (3.6) than that of Uzan Bazar (4.1). This indicates though Hengrabari has coexistence of diverse land

uses but the incompatible land uses in the locality results mismatched activity pattern, create confusion, and decrease the safety perception of its residents.

- People have the general tendency that they don't enjoy being present in a built environment with unappealing streetscape. As shown in data, Hengrabari's architectural design quality (Design Quality score 11.9) is low as well as the 'human scale' factor is less considered in the built forms. This is due to the dull and ordinary geometric shape of doors and windows which are not welcoming and attractive enough to connect to the people on streets.
- People opt more for the open spaces which have easy accessibility, connectivity to public transit stations, transparent enclosure and proper visibility at human height. Such open spaces are more active and people feel psychologically safe being present there. For example, people perform their significant life activities in Nehru Park, Judges' Field, Dighalipukhuri Park etc. and enjoy the presence of these open spaces in their locality. These create emotional bindings with the place and people visit those again and again. The frequent visits to those open spaces can be easily observed from the Instagram hashtag assessment of viewpoints.
- It is found from the analysis that the integration of modern text style, colour, creative graphics, and human scale in the signage boards attracts the attention of visitors to the streets. Such boards displayed at the frontages attract the youth crowd and help create crowds, making these their favourite spots to take photos and share on social media. These actions of the public enhance the popularity of the place and help in engaging more people to the place.
- Inactive ground floors show no role in public safety. Hence, more gated communities depict numerous human-less parking spaces on the ground floors. Instead, the activities of commercial ground floors can maintain crowded spaces most of the time of the day.
- Uzan Bazar holds seven no. of public open spaces which are accessible, functional and visually more appealing to the public than those of the only available park of Hengrabari and has an average condition in terms of the parameters mentioned. This means that contrasting the number of open spaces is a key factor in determining the score in addition to their scoring. The larger number of parks creates a cumulative effect and gives locality Uzan Bazar an

advantage in the scoring.

- Data results that high tree density and shaded area improve the pedestrian infrastructure. They encourage the pedestrian activities and ensure 'eyes on street' promoting overall road safety.
- The presence of the trees provides aesthetic value to the built form of Uzan Bazar. The matured trees provide stability and people feel more psychologically secure being present in the built environment surrounded by such trees.
- The study shows how conventional urban design evaluation techniques can be modified to offer a reproducible framework for urban safety that other practitioners and scholars can use in environments with limited resources.

The spatial criteria that performed well in the "safe" neighbourhood—such as more trees, human-scaled facades, and lively street layouts—became prominent design references, highlighting their capacity to affect the sense of safety. However, the strategy suggestions to close the spatial and psychological gaps directly addressed the unsafe locality's persistent absence of criteria such as road conditions, amenity access, human scale design, etc.

6.3 Development of Strategies

In this section, a set of urban design strategies based on the case study analyses and safety indicators are presented. By converting evaluation findings into meaningful spatial actions, the aim is to fill in the gaps that have been identified and improve safety perception.

6.3.1 Objectives

The suggested strategies seek to create a comprehensive and holistic approach towards a sense of safety by incorporating key indicators related to components such as built form, layout and land use of the built environment. This approach stresses striking a balance between functional safety, psychological comfort, and spatial quality. It will concentrate on strategies associated with human-oriented built forms, visual references, walkability, proximity of land uses, pause points, buildings of attractive design, signages with interesting fonts, etc. encouraging connectivity and visibility, activating streets, improving smart safety measures, and enhancing safety perception of people. By incorporating psychological comfort and aesthetic appeal into urban design, this approach fills gaps in current safety models beyond physical interventions, resulting in a people-centric strategy that improves urban well-being. By filling in these gaps, the approach gives policymakers, urban designers,

and planners a systematic, flexible, and context-sensitive instrument to enhance how secure cities are perceived.

6.3.2 Methodology

To comprehensively address urban safety through the indicators of built components, the following strategies have been developed based on the inferences drawn from the analysis. The strategies are developed employing a revere-mapping process that involves first tracing back the important evaluation criteria used during analysis and their indicators. The indicators are, then, tried to be carefully included and covered in the suggested strategies to address the observed gaps between the safe and unsafe localities.

After formulating the strategies, a comparative discussion is carried out concerning the case studies. This will strengthen the strategies' context-based relevance and application by demonstrating how each one fits with the current circumstances and what needs to be improved in the less safe area. The relative advantages and disadvantages of each localities are made clearer by comparing the situations, which enables strategies to be prioritized and adapted effectively. By demonstrating that lessons acquired in one context can direct actions in similar urban settings, such a comparative lens also improves the transferability of insights.

The following table lists the suggested strategies that relate perceptions of safety to evaluation criteria and indicators of the built environment.

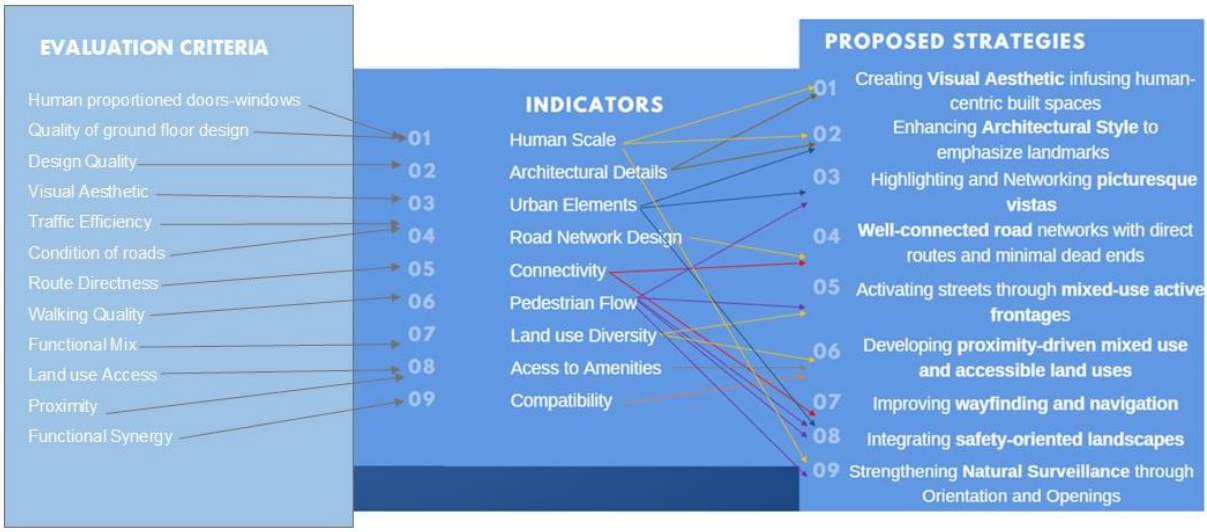


Fig. 6.2: Proposed Strategic Framework to Attain Safer Built Environments

The suggested strategies shown in the above-figure are reviewed in the following sections in relation to both case studies in order to comprehend their development as a framework.

6.3.3 Suggested Strategies

Eight strategies designed to enhance the sense of safety in the built environment are discussed with the help of the case studies context below in the following sections, using photographic representations and observations to support their relevance and applicability.

"Strategy 1: Creating Visual Aesthetic Infusing Human-Centric Built Spaces"

This strategy aims to enhance and emphasize visual quality of built environment reflecting human-scale built forms, spaces, rhythm, and openness, visibility that supports human's physical and psychological comfort. This strategy has been developed addressing the indicators human scale, and architectural details by focusing on elements that directly influence how people perceive and interact with the built environment. Attention is given to aspects such as façade articulation, window placement, entrance orientation, signage, and material finishes, all of which contribute to the overall legibility and comfort of the streetscape. By strengthening these details, the built environment becomes more engaging, walkable, and responsive to human needs, thereby enhancing both functionality and aesthetic quality.

Contextualising the strategy within real urban situations is made easier by the following comparative visuals from the two localities.

Physical scenario in Uzan Bazar

Fig. 6.3: Photographic Analysis of Visual Appeal in Built Forms of Uzan Bazar

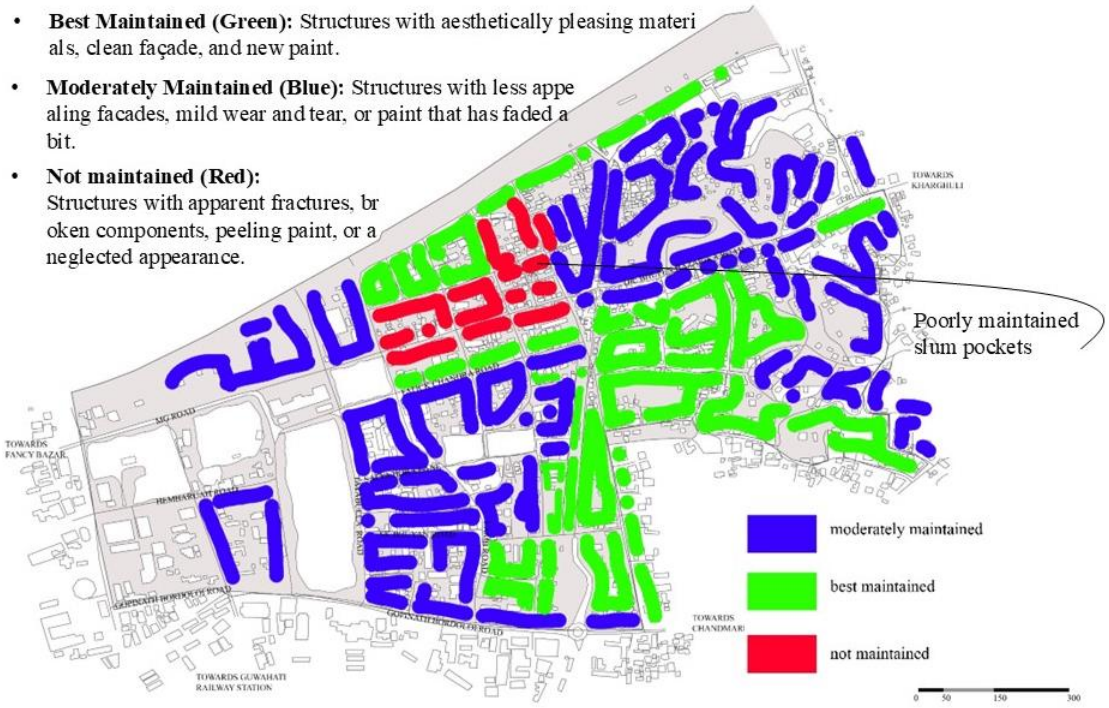


Fig. 6.4: Façade Quality Mapping of Uzan Bazar

Map prepared by researcher

Physical scenario in Hengrabari

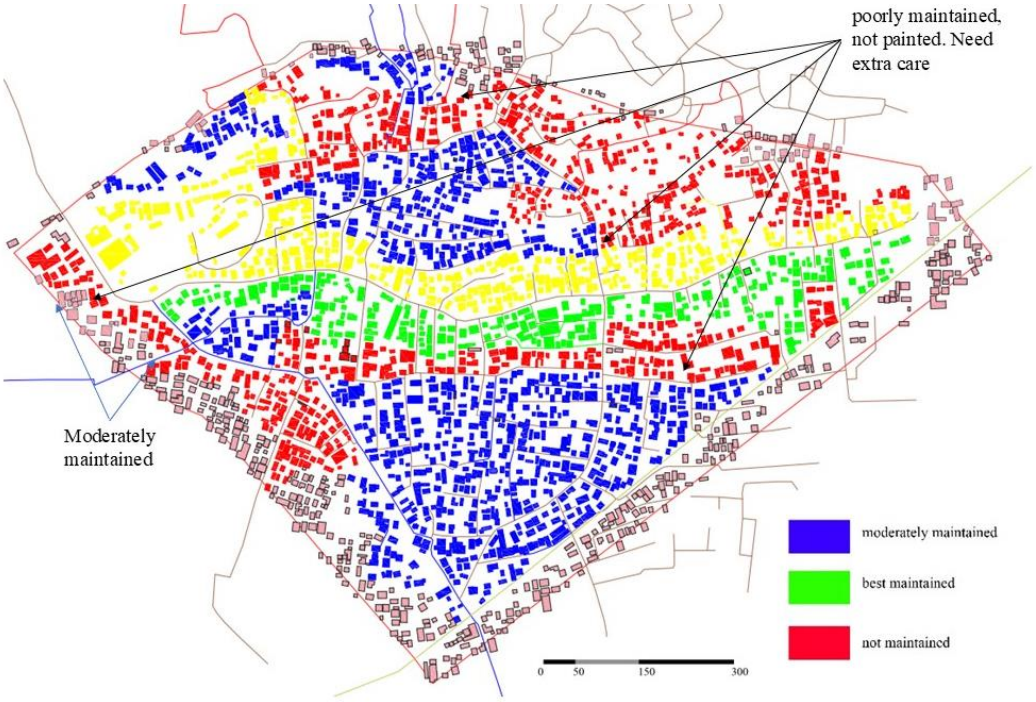


Fig. 6.5: Façade Quality Mapping of Hengrabari

Map prepared by researcher

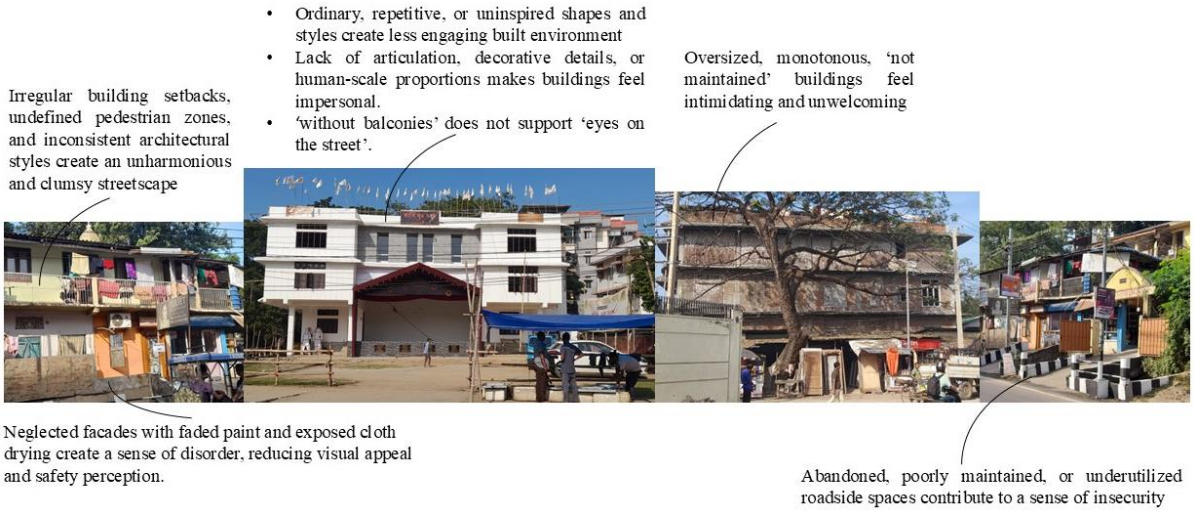


Fig. 6.6: Photographic Analysis of Visual Appeal in Built Forms of Uzan Bazar

Key Insights from the Comparison

The safe locality 'Uzan Bazar' demonstrates aesthetics coherence and human-scale design contributing towards a sense of safety. Key insights include,

- Well-Maintained Facades: Clean exteriors, mostly painted, and architectural details add visual comfort and order. Almost 85% structures are either 'best maintained' or 'moderately maintained' as found in the map (Fig. 6.4).
- Low height Street-Friendly Boundary Walls: Textured walls break monotony; transparency allows surveillance and creates a sensory connection between built environment and people passing through.
- Articulated Design Elements: Use of arches, pergolas, ornamental railing designs provides visual appeal and a welcoming environment.
- Human-Scale Building Features: Windows, doors, pathways, and balconies are all sized to be both aesthetically pleasing and physically welcoming and interesting building design.

The unsafe locality 'Hengrabari' lacks a few of the physical conditions in its urban environment, which leads to the unsafe perception of people. These are likely –

- Ignored and Unmaintained Built-forms: Faded paint, cracks, and crumbling exteriors are signs of neglect and lack of maintenance. Almost 27% structures are not
- maintained as found in the mapping (Fig. 6.5) of Hengrabari.

- Minimum Balconies Facing Road-Side: A lesser no. of balconies creates insecurity in the minds of people who are passing by the roadside as well as decreases natural surveillance.
- Irregular Building Setbacks: Multiple building lines create disorder in streetscapes, confuse people, and generate unpredictable corner spaces on the roadside.

"Strategy 2: Enhancing Architectural Style to Emphasise Landmarks"

The second strategy aims to encourage safety perception through enhancing familiarity with spaces, highlighting and creating prominent landmarks of rich architectural style at different spots of the urban setting. This approach addresses the built features like design quality, visual aesthetic, etc., as well as the indicators of architectural details, human scale, etc. It also promotes establishing focal points with the urban fabric to help people orient themselves and navigate the spaces. It also promotes establishing focal points with the urban fabric to help people orient themselves and navigate the spaces. Landmarks such as heritage buildings, distinctive architectural forms, or prominent civic structures play a critical role in strengthening the sense of place.

Discussion on the visuals from the safe and unsafe localities are shown below to help ground this strategy in real-world observation –

Physical scenario in Uzan Bazar

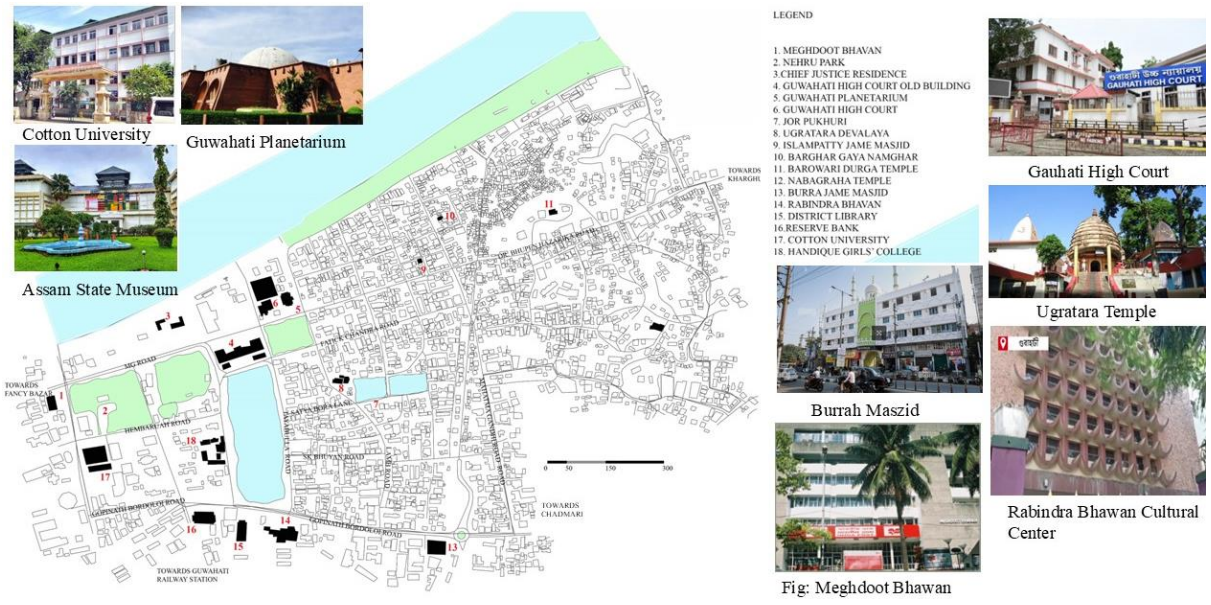


Fig. 6.7: Mapping of Landmarks with Architectural significance of Uzan Bazar

Physical scenario in Hengrabari

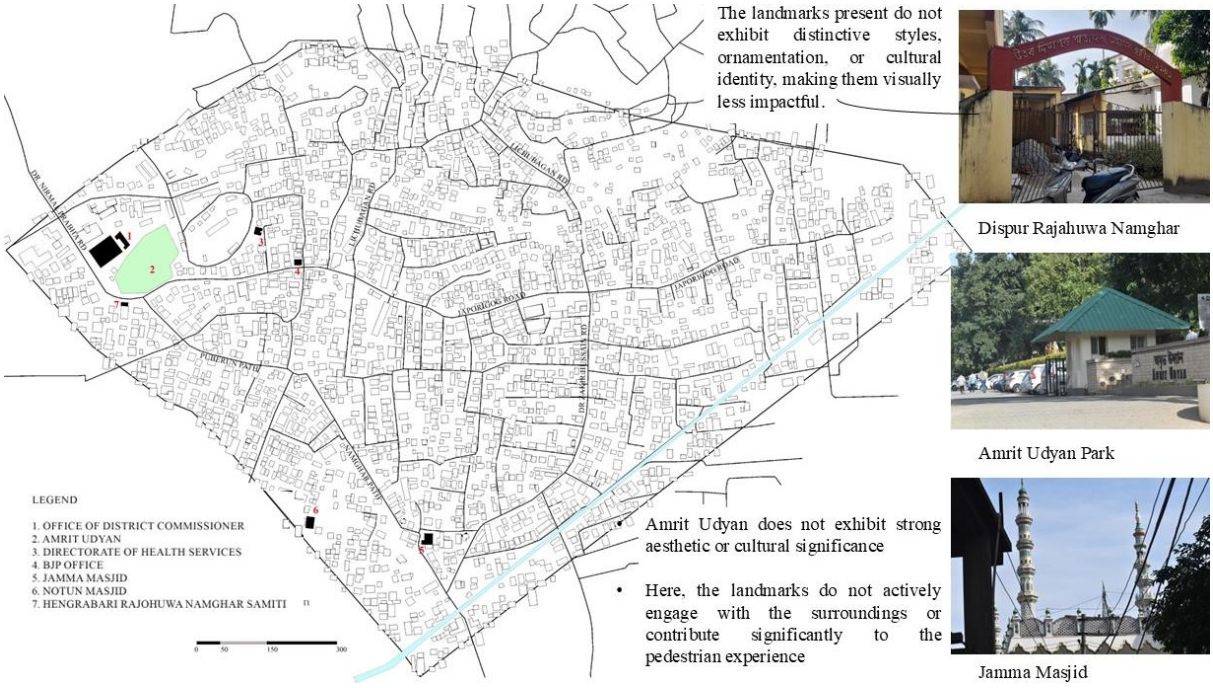


Fig. 6.8: Mapping of Landmarks with Architectural Significance of Hengrabari

The analysis below in Fig.6.7 shows that Uzan Bazar holds several significant buildings with significant architectural styles with historical importance. Here, it can be observed that temples like Ugratara, Barowari, and Namghar have a stronger architectural sense, contributing to visual aesthetics. The Sikhara style roof, arches, curves, etc., enhance visual richness, create identity, and help people to remember a place. The water bodies, Meghdoot Bhavan, The State Museum and public institutions like Cotton University and Handique Girls' College are examples of landmarks where the public actively gets engaged. These places encourage more people to walk and passively monitor the region, which increases the peoples' sense of safety.

Key Insights from the Comparison

The safe locality 'Uzan Bazar' is found to hold several landmarks with strong architectural characteristics, which help to create an independent identity of the locality. The key insights include,

- Cultural Richness: The distinct and prominent architectural features create a sense of place and encourage the public to visit the locality again and again.
- Well-integrated streetscape: The historical essence of landmarks enhances the orderliness and vibrancy of the place.

The unsafe locality 'Hengrabari' has weak architectural characteristics in its landmarks. The noted points are likely –

- Lacks identity: The absence of notable landmarks with cultural or historical significance diminishes the area's aesthetic and distinctive value. The ordinary shapes and forms of design elements such as doors, windows, balconies, articulation etc. fail to contribute a sense of place and identity.

Uneven Distribution of Landmarks: The landmarks are not uniformly distributed throughout the entire locality which results in their reduced impact as reference points for movement and navigation.

"Strategy 3: Highlighting and Networking Picturesque Vistas"

The third strategy tries to establish the importance of interesting viewpoints within the urban locality and linking them together for easy accessibility and visibility. The presence of the picturesque vistas satisfies the human mental needs for beauty, aesthetic, openness, clarity, and comfort.

To demonstrate this strategy's relevance, a comparative visual study of both safe and unsafe localities has been presented below in the table.

Physical scenarios are displayed in Uzan Bazar as well as in Hengrabari

Key findings are illustrated with images in the table below, which shows differences in the built environment's features, utilization trends, and public space quality. in the context of appealing views.

Table 6.1: Comparison between the localities in terms of Picturesque Views

Parameters	Comparison between the study areas
Architectural Harmony Uzan Bazar	Local/traditional materials and features like timber screens in balcony, sloped roofs, wooden chajjas aligns with the vernacular style of the region. A well-proportioned G+1 building with a visible entrance and defined openings enhances human scale and welcomes interaction Clear front setback, well-defined entrance pathway, and green buffer with plants, trees enhance spatial harmony  Seamlessly blended with landscape elements, enhances harmony and visual appeal

Hengrabari

Facade lacks symmetry, randomly placed openings, awkwardly extended structures, non-interesting elements disrupt the overall streetscape rhythm.

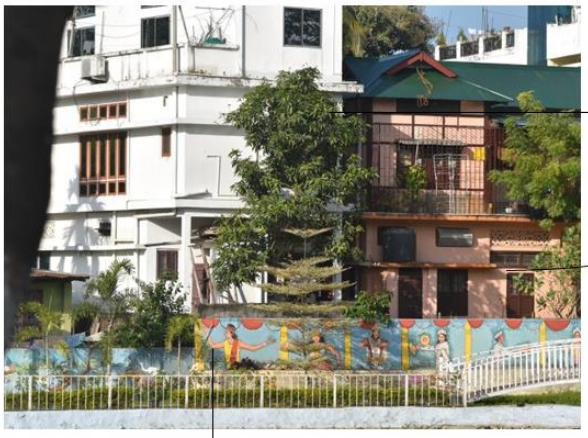
A well-proportioned G+1 building with a visible entrance and defined openings enhances human scale and welcomes interaction

Solid walls interrupt visual rhythm, making the area unappealing and lifeless

Excessive use of colors in a building's elevation can create a cluttered and uncoordinated appearance, reducing architectural harmony.

Imageability

Uzan Bazar



Well-maintained plants and trees indicate care for the public realm

The mix of low-rise and mid-rise buildings creates a balanced skyline

Subtle, well-coordinated color palette on buildings, street elements enhances imageability

The presence of street art adds vibrancy, breaks the monotony and adds a character

Hengrabari

- Undefined spaces, lack of organization makes the area feel disorderly and unplanned
- Streetscape appears cluttered or empty, lacking well-defined edges or visual focal points

Faded, dull, or mismatched colors in facades fail to provide a recognizable identity

Lack of distinctive elements, or culturally significant designs

Missing imageability, street view not capable of evoking any memorable experience

Picturesque Vistas

Riverfront provides natural focal points, creating picturesque views at multiple locations

Walking, sitting, and social interactions, lead to higher foot traffic and natural surveillance

Hengrabari

Blocked Sightlines, obstructed architectural views reduce overall visibility

High boundary walls, tightly packed buildings create blind spots and obstruct views

Limited sightlines and hidden corners can create a sense of vulnerability for pedestrians.

Public Realm

Uzan Bazar

- **Active Streets:** Food Vending zones at different local streets
- **Khao Gali** has been developed along 'Dighali pukhuri
- Residential streets are utilized by the younger students and kids for **playing purpose**.
- The road sides are used by the adults for 'adda'.

<table>
<tr>
<td>Hengrabari</td>
<td>
• The limited presence of street vendors and pedestrians with less social interaction
• Few vendors fail to activate t streetscape.

• A few vendors operating during specific hours, it may feel completely deserted at other times
</td>
</tr>
<tr>
<td>Integrity with Landscape

Uzan Bazar</td>
<td>

Seamless Integration of Built & Natural Elements
• Shaded streets and tree-lined pathways lower temperatures, making spaces more comfortable and usable.
• Buildings are harmoniously integrated with trees, shrubs, and landscaped areas, softening the urban fabric.
</td>
</tr>
<tr>
<td>Hengrabari</td>
<td>

Lack of Trees & Landscaping
• Lack of greenery reduces visual comfort, making the area appear more rigid and less inviting.
• Lack of shaded resting spots discourages pedestrian activity.
• Lack of greenery reduces visual comfort.
</td>
</tr>
</table>

<u>Key Insights from the Comparison</u>

After the side-by-side comparative representation, the safe ‘Uzan Bazar’ provides the key insights include,

- Enjoyable Views: More appealing and picturesque vistas can be spotted by its visitors due to the presence of natural features, man-made water bodies, rich cultural and architectural significance in its built forms, and maintained landscape elements such as trees and plantations, parks, sculptures, etc.
- Engaging Street Activities: Visitors enjoy spending time on active streets that can engage them in having street foods, vegetable marketing, enjoying riverfront views, and spending time for casual conversation, relaxation, and social interaction.

The unsafe locality 'Hengrabari' provides the key points likely –

- Lack of Visual Beauty: Absence of sidewalks, street activities, sufficient landscape elements, etc.
- No Human on Streets: Low levels of public participation create a drab and unwelcoming environment.

No Shaded Area: Less vegetation leaves no spaces for pedestrians to rest and enjoy views.

"Strategy 4: Well-Connected Road Networks with Direct Routes and Minimal Dead Ends"

This forth strategy focuses on the easy mobility of people i.e the pedestrians as well as riders and drivers without getting any harm during movement. It addresses the criteria like traffic efficiency, route directness, etc. as well as indicators like road network design and connectivity. Such networks provide accessibility, natural surveillance, and an overall pleasing spatial experience.

The discussion through the case studies and their photographic analyses are presented below.

Physical scenario in Uzan Bazar

Fig. 6.9: Photographic Analysis of Road Network of Uzan Bazar

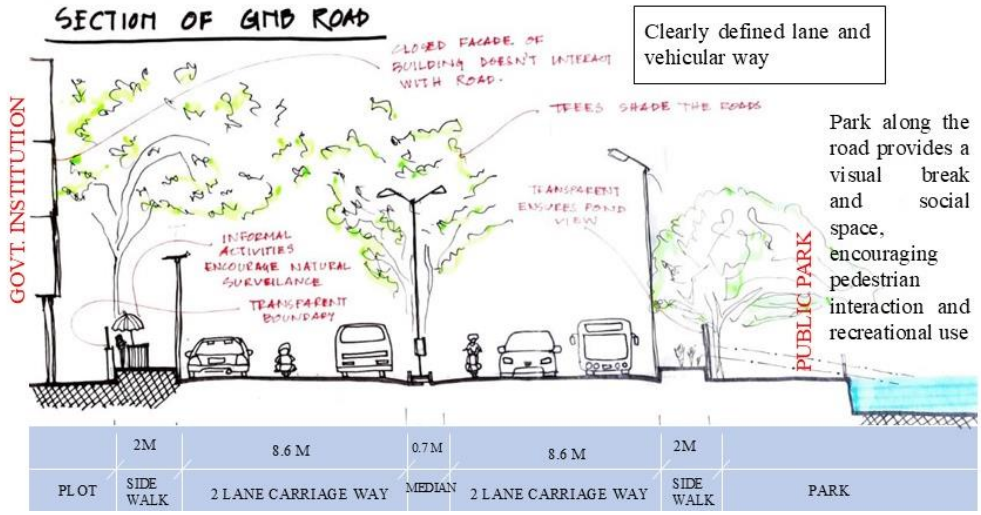


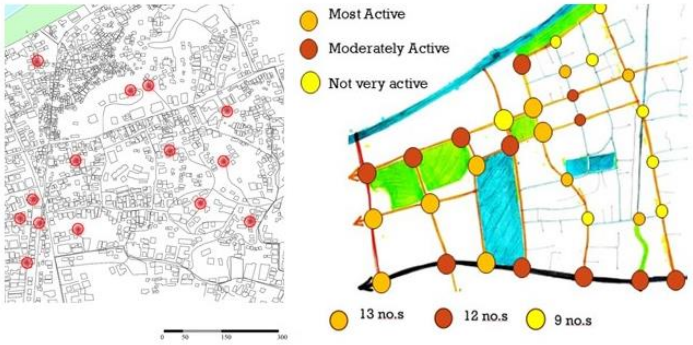
Fig. 6.10: Road Section through GNB road (Uzan Bazar)

Length of Dead ends

Approximately 1.5 km (6%) length of total length is dead ends.

No. of Nodes

90% of the nodes are connected 3ways



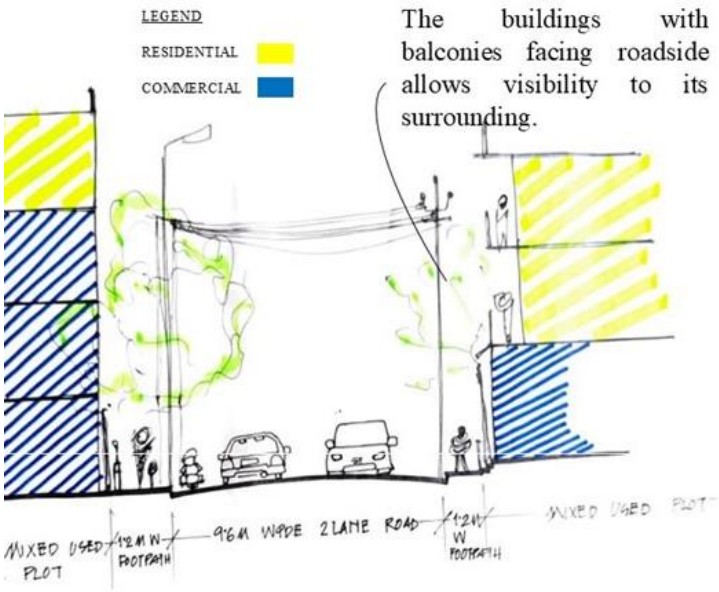


Fig. 6.11: Dead Ends
Fig. 6.12: Node Analysis
Fig. 6.13: Section of Collector Road

Physical scenario in Hengrabari

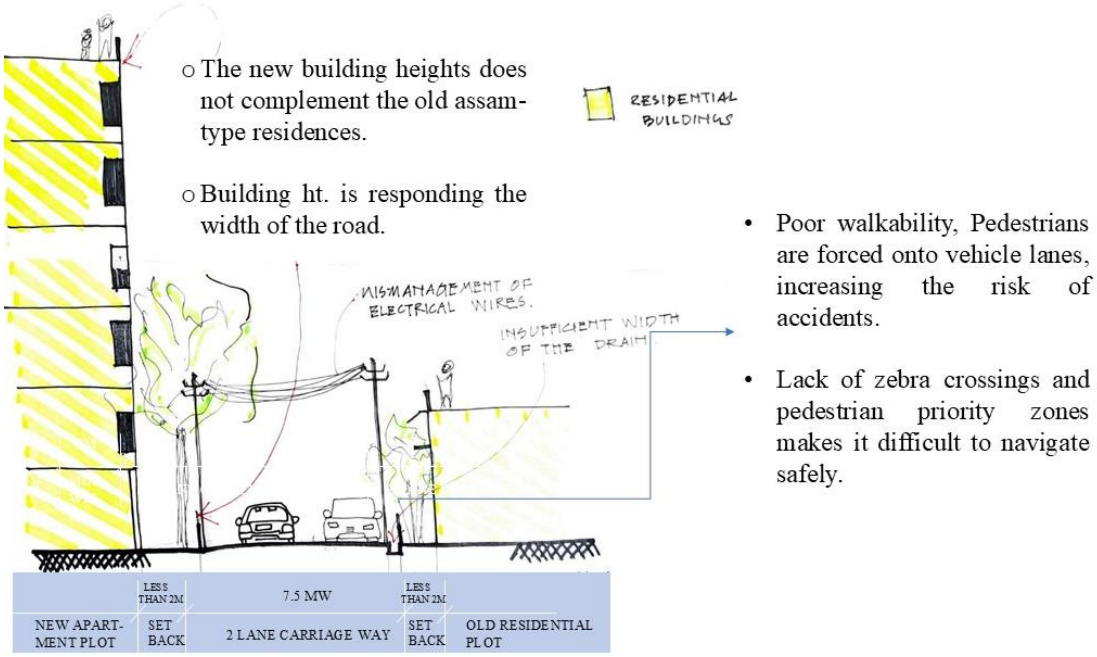


Fig. 6.14: Section through Collector Road (Hengrabari)

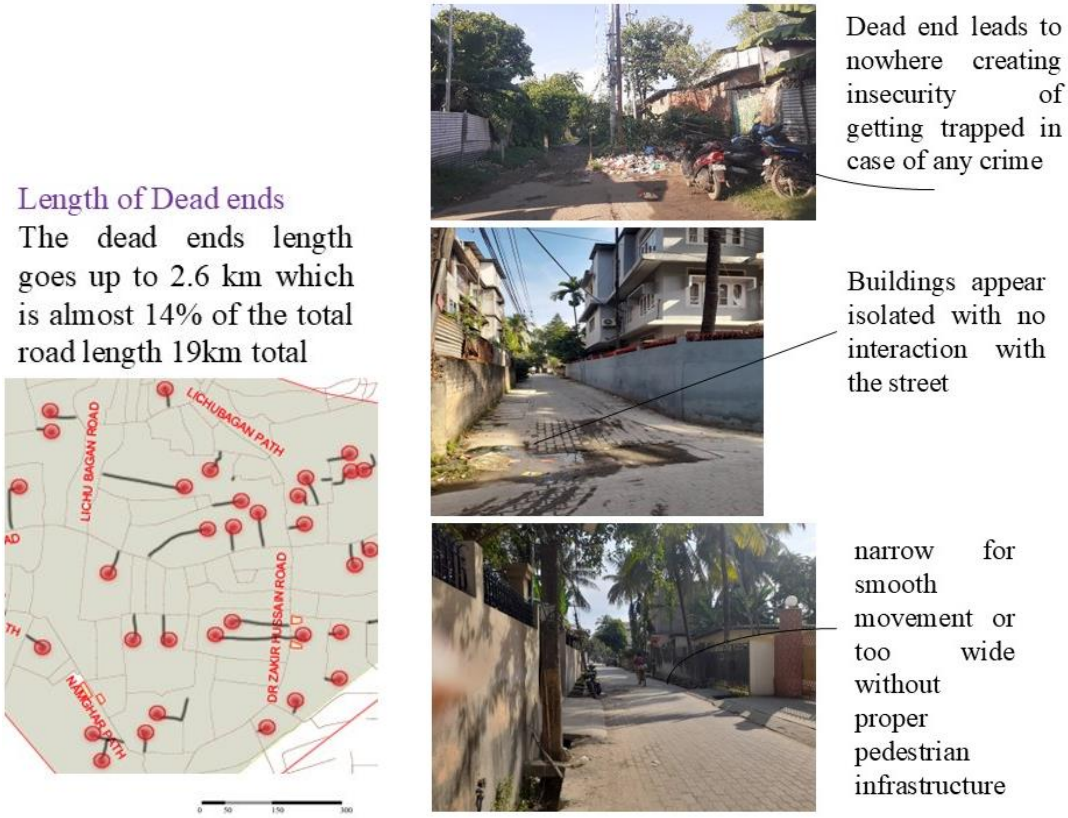


Fig. 6.15: Photographic Analysis of Road Network of Hengrabari

Key Insights from the Comparison

The safe locality 'Uzan Bazar' demonstrates better road connectivity with most of the road facilitated with pedestrian infrastructure, route directness, as well as no. dead ends. The key insights include,

- Connectedness: Well-connected vehicular roads and pedestrian pathways provide easy and comfortable movement for people.
- Permeability: Accessibility and walkability are enhanced by well-distributed streets and frequent intersections which make commuters connected and comfortable with the surrounding environment.
- Well-defined Nodes: Identifiable intersections, and chowks. Enhance wayfinding and urban legibility. Facilitating easy navigation and self-orientation.

The unsafe locality 'Hengrabari' provides the key points likely –

- Discontinuous Streets: Fragmented streets with numerous dead ends act as barriers in easy movement which provide discomfort for commuters and make one feel trapped, increasing vulnerability and terror.
- Low Walkability: Lack of through connections on streets results in isolated areas with less foot traffic and no natural surveillance.

"Strategy 5: Activating Streets through Mixed-Use Active Frontages"

This strategy aims to enhance the sense of safety by creating provisions for keeping the streets full of human activities most of the time of the day. A busy and interesting street edge can be achieved by integrating a variety of uses along building frontages, including commercial and recreational ones. Thus, by enhancing street vitality, encouraging natural monitoring, and maintaining a constant human presence, this strategy raises the locality's perceived level of safety and vibrancy.

The following photographic discussion on both localities presents the applicability of the strategy in an urban area to enhance the psychological safety of its people.

Physical scenario in Uzan Bazar

Evenly distributed active frontages, ensuring pedestrian engagement

Even after dark, well-lit, bustling areas guarantee pedestrian safety and visibility.

Residents actively use their front yards for drying clothes, sitting, gardening, this creates a watchful neighborhood, making pedestrians feel safer.

Mixed-use buildings with people visible in upper floors, different activities taking place on the street.

Fig. 6.16: Photographic Analysis of Frontages of Uzan Bazar

Physical scenario in Hengrabari

The activity of visitors to purpose-driven; people visit only to purchase something and leave immediately.

Visitors do not socialize, observe their surroundings, or stay longer, reducing passive surveillance.

Dead internal streets with no commercial edges

Vacant plots promoting unlawful dumping, encroachment, and antisocial activity

Fig. 6.17: Photographic Analysis of Frontages of Hengrabari

Key Insights from the Comparison

The key insights about 'Uzan Bazar' with respect to active frontages include,

- Sense of Community: Commercial set ups such as shops, cafes, restaurants, girls' hostel, residential uses in ground floors attract people to interact and socialize.
- Slow Traffic: Active frontages ensure human presence on street which results in slower vehicular movement making these streets safer for movement of pedestrian, kids, and elderly.

The key insights about 'Hengrabari' include,

- Single Use Commercial Activity: Inactive and unattracted frontages of commercial settings create no diversity in the kind of persons attending casual get-togethers or

leisure activities on the streets.

- Lack of Friendly Environment: The absence of benches, dedicated interactive porches, and shaded spaces reduces walkability, casual lingering, and cannot provide a sense of belongingness.

"Strategy 6: Developing Proximity-Driven Mixed Use and Accessible Land Uses"

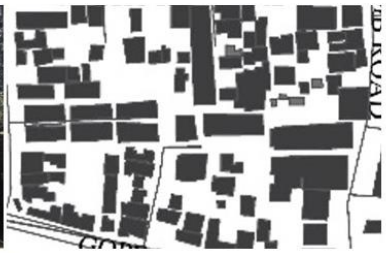
The sixth strategy encourages to promotion variety of uses within close proximity, ensuring diversity, accessibility, natural monitoring, and safer movement day and night. This approach promotes a lively street life that boosts both economic activity and a greater sense of safety by promoting shops, cafes, and small enterprises next to residences as well as open parks and recreational areas alongside the institutional areas and so on. This kind of functional diversity enables social engagement and interaction. It addresses indicators such as land use diversity, access to amenities and compatibility related to the urban built environment.

The discussion on this strategy in the context to the case studies are presented below.

Physical scenario in Uzan Bazar

The course gain has been observed on the contour lines due to which the bunglows are scattered over the area.
widely spaced bungalows, reducing land use proximity and pedestrian connectivity.

The institutional buildings show scattered development with large footprint buildings and open spaces.
large footprint structures are complemented by open spaces, enhancing ventilation, accessibility, and a campus-like environment



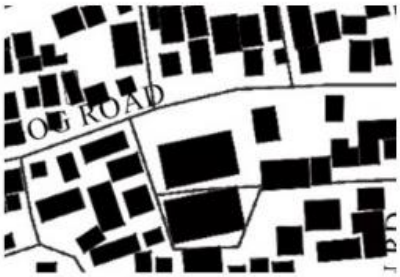
- The residential neighbourhood shows old bunglows with shorter building edges. On the other hand, the newly constructed apartments don't match the granis with the earlier ones.

- The land of railways are taken over by the slums of the area and shows fine grains with small and compact footprints.

Fig. 6.18: Analysis of Landuse Proximity through Nolli's Map (Uzan Bazar)

Physical scenario in Hengrabari

Old residential small footprints create a fine-grained urban fabric, enhancing walkability, land use proximity, and accessibility



Contrast older, low-rise structures with newer high-rises, assessing their impact on spatial continuity.

Larger built forms of govt. offices create coarse grain. The surrounding institutional buildings with inactive edges reduce land use proximity, the park nearby balances attracting footfall.

Fig. 6.19: Analysis of Landuse proximity through Nolli's Map (Hengrabari)

Key Insights from the Comparison

The key insights about 'Uzan Bazar' with respect to active frontages include,

- Mixed-Grained Texture: The older bungalows maintain close-knit spatial relationships, while the newer apartments create larger gaps, reducing land use proximity and neighbourhood cohesion.

The key insights about 'Hengrabari' include,

- Scattered large-footprint buildings reduce land use proximity and pedestrian connectivity, creating fragmented urban spaces. The lack of small-scale structures results in inactive edges, limited natural surveillance, and a weaker sense of safety.

"Strategy 7: Improving Wayfinding and Navigation"

This strategy focuses on wayfinding through the use of identifiable famous buildings, distinctive signage, well-placed billboards, etc. This method aims to improve the mental anchors so that the above-mentioned visual features aid in the comprehension and retention of spatial spaces. Furthermore, distinct physical boundaries - whether created by architectural form, landscape, or functional transitions - help identify zones, making urban navigation simple and minimizing confusion, particularly for tourists or vulnerable populations. The seventh strategy addresses indicators such as connectivity and pedestrian flow. The following paragraphs display the case studies' comparison analyses.

Physical scenarios display in Uzan Bazar as well as in Hengrabari

Table 6.2: Comparison of the Localities in terms of Wayfinding and Navigation

Uzan Bazar		
Signages		
Iconic Elements		

Edge Definition	 
Remarks	**Better wayfinding is available due to its distinct landmarks, well-defined boundaries, preserved urban character, and simple navigation, which facilitate comfortable mobility.**
Hengrabari	
Signages	 
Iconic Elements	 
Edge Definition	 
Remarks	**Navigation feels less organized because there aren't any obvious landmarks and the route connectedness isn't as clear as the other locality.**

Key Insights from the Comparison

The key insights about 'Uzan Bazar' with respect to wayfinding and navigation include,

- Eye-catching Signages: Prominent location, use of modern stylish fonts and vibrant colors of signages catching attention of visitors. It promotes the place identity and ease them to navigate their exact locations.
- Distinctive Urban Elements: Iconic elements such as specific building elements, prominent mature trees, or well-designed gates are the best way to provide remarkable character to the streets of the localities.

The key insights about 'Hengrabari' include,

- Dead Walls: Solid and unwelcoming dead walls do not give any idea of what is happening inside, creating insecurity in people's minds who are passing through.

Ordinary Street Art: Art on a wall with no significant character, when not thoughtfully designed, can make people feel intrusive and neglected.

"Strategy 8: Integrating Safety-Oriented Landscapes"

This strategy promotes the use of safety-conscious landscape elements in the urban built environment to ensure public safety. Such a landscape supports uninterrupted visibility and promotes steady pedestrian movement by preserving clear sightlines, reducing visual obstructions, and carefully positioning vegetation and lights. The open, accessible, and well-lit layout of landscaped zones minimises hiding places and improves natural surveillance. Through these improvements, pedestrian walkways throughout the urban fabric are made safer, more accessible, and more welcoming. A pleasant setting with a picturesque landscape keeps individuals mentally free and encourages them to think positively. In an urban setting, no negativity takes place to frighten them in such situations.

The discussion on this strategy through the case studies and their photographic analyses are presented below.

Physical scenario in Uzan Bazar

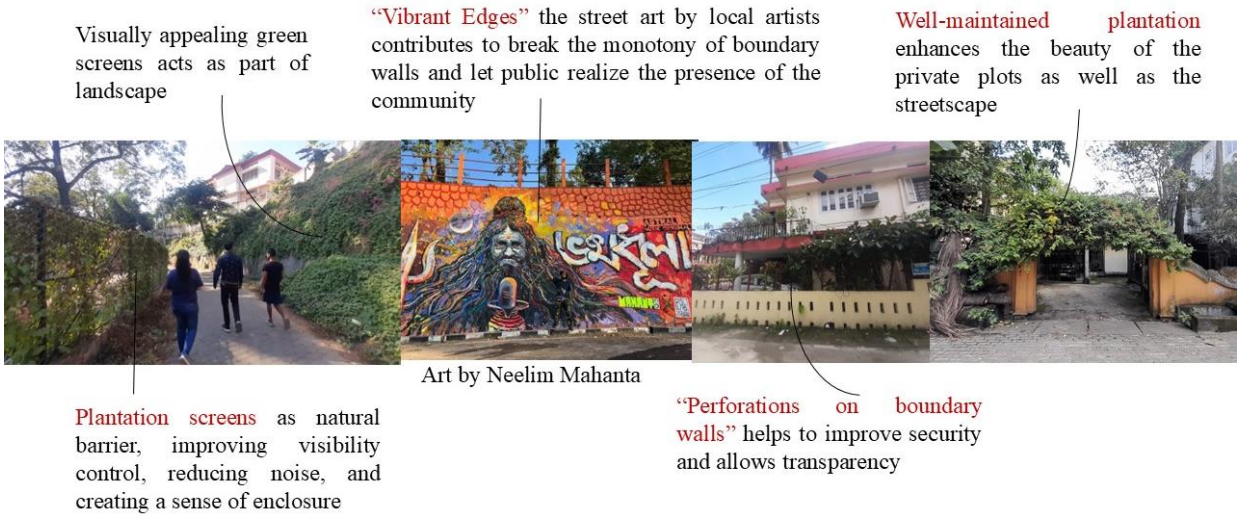


Fig. 6.20: Photographic Analysis of Safety oriented landscape of Uzan Bazar

Physical scenario in Hengrabari

Fig. 6.21: Photographic Analysis of Safety oriented landscape of Hengrabari

Key Insights from the Comparison

The key insights about 'Uzan Bazar' with respect to the safety-oriented landscape include,

- Nature Integration: Well-balanced built environment that promotes safety, comfort, and social interaction through a variety of greenery, well-maintained and designed open areas, and well-defined edges.
- Landscape Harmony: Landscaping integrates well with built form, creating an inviting atmosphere, while the unsafe area has neglected facades, poorly designed edges, and a lack of visual cohesion.

- Man-made landscapes: Pergolas combined with private gardens, public art, and sculpture forms improve visual appeal, comfort in the surroundings, and a sense of safety.

The key insights about 'Hengrabari' include,

- Dead Space: The abandoned structures deteriorate the urban landscape, which also reduce public interaction, create visual blight, and create an atmosphere that is unwelcoming and hazardous.
- Green Deficit: Limited variety of landscape elements, with little flora and fewer open areas, creating a bleak, unwelcoming atmosphere that is less safe and favorable to social contact.

"Strategy 9: Strengthening Natural Surveillance Through Orientation, and Openings"

This strategy demonstrates the significance of appropriately orienting constructed shapes in relation to human movement in order ensure people's natural observation. However, arrangement, orientation, and visual appeal of the fenestrations, also, contribute to drawing in onlookers and keeping 'eyes on the street'. Designing buildings with doors, windows, balconies, and frontages facing streets, parks, markets, etc. encourage creating sense of vigilance around. Additionally, natural surveillance promotes psychological comfort since making people feel less isolated and more secure.

The discussion on this strategy through the case studies and their photographic analyses are presented below.

Physical scenario in Uzan Bazar

Fig. 6.22: Photographic Analysis of Building Orientation and Openings in Uzan Bazar

Physical scenario in Hengrabari

- Streets with deep setbacks, houses built far from the street
- Empty spaces with no overlooking activity
- Creates visual disconnection

- Park surrounded by vacant land, boundary walls, or no active frontage.
- No "eyes" from nearby buildings.

Fig. 6.23: Photographic Analysis of Building Orientation and Openings in Hengrabari

Key Insights from the Comparison

The key insights about 'Uzan Bazar' with respect to natural surveillance are,

- Natural Surveillance Elements: The food kiosks and small eateries on the sidewalks as well as on the roadside invite the younger crowd in the evening keeping the streets lively. Moreover, the doors, windows, and balconies facing roadside give residents a view of the street. The potential for being noticed keeps pedestrians safer.

The key insights about 'Hengrabari' include,

- Solid Facades: Streets with high blank compound walls, shuttered facades that prevent surveillance.
- Disturbed Sightlines: Covered balconies and high opaque boundary wall prevent street view between the private property and the public common spaces.

6.4 Inferences

The framework offers some strategies and summarizes the key urban indicators that affect people's perceptions of safety, emphasizing built form, layout, and land use. The study illustrates how well-integrated urban components improve the built environment, walkability, surveillance, and public engagement while fragmented spaces generate insecurity and dissatisfaction by comparing safe and unsafe localities. Also, these strategies seek to increase safety perception through observable physical improvements by translating the evaluation criteria as well as the indicators into focused urban design initiatives. To make sure that the built environment successfully responds to the daily life of urban users, the above strategies work together to create an integrated framework that will direct future planning and design decisions.

Chapter 7: Conclusion

7.1 Chapter Overview

In the contemporary world, sustainability, inclusivity, resistivity etc. are getting so much attention in urban design and planning studies that the built environment has become one of the key subjects to be experimented with to enhance human comfort. Even rural areas are, now, continuously keeping in converting into urban spaces every single day. Consequently, to work to make safety sure to fulfil aforementioned urban concepts with respect to its built environment is a wise decision. Therefore, the main interest of the thesis had been to explore urban built environments in relation to people's sense of safety.

The Conclusion chapter highlights how the objectives of the research are achieved through the study's analysis and contribution presents broad recommendations, as well as offers a concise discussion of the future research possibilities in the field.

Fig. 7.1: Outline of the Chapter

7.2 How are the objectives achieved?

The first objective of the research "To identify the physical components of the built environment affecting the sense of safety" is achieved in the second chapter of the report. There is literature available online and offline which have discussed the social factors integrated with the physical elements of the built environment which relate to people's sense of safety. Various topics are discussed in the literature review chapter to understand the relationship between built environment and safety and security such as built environment and

community relations, public health, quality of life, safety satisfaction of people etc. Then, the aims and the concerns of urban initiatives like the New Urban Agenda, the Safe City Program, and CPTED are, also, considered for the study. Besides all these, the urban design theories and approaches such as the Broken window theory, Rational activity theory, the Defensible space approach, the Tactical urbanism approach, and Prospect and refuge theory are found relevant and necessary to detect the physical components responsible for human safety comfort. An accumulation of all investigations identifies layout, land use, open space, lighting, architectural style, trees, built form, landscape, visual symbol, and materials as the most relevant built components. These are listed and later, built form, land use, layout, open space and trees are chosen all for further study through literature prioritization and expert opinion survey methods.

The second objective, "To understand the effect of the components on people's sense of safety", is accomplished in three stages. First, when the components were attempted to be identified, and second, when a further study was conducted in an effort to identify the indicators for each component. Then, the investigation of the evaluation criteria for all the indicators finally provides the researcher with a clear idea about how the physical aspects of the built environment behave with the users in the actual ground scenarios. This study reveals how the physical components are attached to the social, cultural and personal experiences of people and affect their moods, actions, interactions and perceptions engaging the built spaces. The inquiry about interdependency, and interconnectedness of various aspects related to the physical elements deepens the understanding of how these contribute to people's safety and sense of safety.

Then, the later part comprises the in-depth analysis of the chosen components and discloses fifteen indicators (three for each of the five components) which are the measurable factors to examine the performance of the component in perception development. Additionally, the research done during the extraction of evaluation criteria, which has also provide insights into the components and their impact on people's safety feeling.

The third objective, "To prioritise the most relevant components" is established in chapter no. 2 of the thesis report. The investigation of the physical components from the existing literature results in ten such components which are discussed in section 2.7 of the Literature Review Chapter. The 'frequency of appearance' method has been adopted to prioritise the components based on their mentions in the literature reviewed which are tabulated in Table 2.3 - 1) built forms, 2) layout, 3) land use, 4) open spaces, 5) trees, topped the table and these

five components are selected as most appeared components. To validate this selection method, nine experts participated in an Expert Opinion survey that finally validated the five selected components. Later, indicators and evaluation criteria are considered based on these selected components as key findings of the research.

The fourth objective, "To analyse the components concerning the case studies of Guwahati city" has been fulfilled in the chapter no. 4 and 5 of this report. To choose the case studies to assess the components, the researcher took the help of the crime data collected from police station jurisdictions of urban Guwahati Municipal Area which is well explained in Chapter no. 4. These data reveal that Dispur PS has the highest recorded crime jurisdiction whereas Latasil PS jurisdiction is the lowest recorded crime out of all other jurisdictions in 2018, 2019 and 2020 in three consecutive years. So, at the initial stage of the case study selection, the researcher considered Latasil and Dispur as the safest and most unsafe PS jurisdiction in Guwahati. Using a perception survey with the residents of the localities of these jurisdictions, the researcher has chosen Uzan Bazar as the safest locality in the Latasil Jurisdiction whereas Hengrabari is the most unsafe locality in Dispur Jurisdiction. After selecting Uzan Bazar and Hengrabari as the case study sites, their built environments are, then, assessed and analysed in terms of the five built components such as built form, land use, layout, open spaces and trees as discussed in the Chapter No. 5. The analysis and the inferences about each of the components concerning both the localities are, also, discussed to achieve the fourth objective of the research.

The fifth objective, "To infer the outcomes which may be relevant to other cities" has been achieved in the discussion under the heading "Major Findings" of Chapter No. 5 as well as the entire "Chapter No. 6". The key findings of the fifth chapter provide light on the key components of the topic being studied by highlighting the significant patterns and connections found in the data. Moreover, the sixth chapter developed eight urban design strategies, as well as each of the strategies, is discussed concerning the case studies of the research to assess the applicability of those which can be, in future, used in model cities to improve safety and security.

7.3 Broad Recommendations for Improving Sense of Safety

Based on research findings and inferences, the potential recommendations for improving safety and security in Indian cities are as follows -

- This is to recommend that further study be conducted on the identified components beyond the five key components selected for the research.

- This research finds that the absence of planned physical components decreases the feeling of safety. Well-connected and accessible urban fabric as well as human-proportioned built spaces decrease crime rates as in the case of Uzan Bazar. This research recommends considering the built components while planning for a new city or neighbourhood.
- In country like India with such crowded cities, efficient safety management by local government and law enforcement agencies through a group of concerned people or an agency may not be possible every time. Therefore, this research recommends 'natural surveillance' being the effective and easiest way for achieving safety and security.
- It recommends to establish citywide safety benchmarking to make awareness among people about safe and unsafe areas. It will also help them in choosing right time and place for their individual tasks.
- It suggests creating an urban design handbook that covers building safety issues in India. This should contain instructions on how to improve safety in urban spaces by utilizing physical components including well-defined entrances, mixed-use areas, lively frontages, good sightlines, and enough lighting.
- It is recommended that when creating public places, authorities should assign the task of integrating safety-enhancing components in built forms to technical professionals such as architects, landscape architects, urban designers, etc.
- This research recommends prioritising community involvement in ensuring safety in the neighbourhood.

It recommends that NGOs develop safety-related apps (like – Safety Pin) to contribute to real-time information on safe and unsafe areas, and to help people make informed decisions about their movements.

7.4 Future Scope of Research

Future research should focus on identifying additional indicators and evaluation criteria related to the built components this research has obtained. This will result in a more detailed analysis of the built environment in neighbourhood design. To make the research stronger for the Indian city context, the study of comparative case studies can be conducted across multiple cities to validate the current patterns of data and to understand more interdependencies between indicators. During the process, the qualitative aspects of the built components and indicators as discussed in the research should be collated parallelly with the quantitative ones to get into a more specific argument about the topic.

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Annexure I:

"Rating Questionnaire: Selection of Built Environment Components Influencing Sense of Safety"

– as a part of research work for the Ph.D degree of Namrata Talukdar

Expert 1
Profession/Designation:
Years of Experience:
Date of Response: 27/01/2023

Dear Expert,

Please rate each component on a scale of 1 to 5 based on its perceived strength in influencing people's sense of safety in the built environment. Your insights will help in identifying and prioritizing the most influential built components out of all the ten mentioned components that effect safety perceptions.

Note: Please use the rating scale below to indicate your response for each component. Rate each component independently, not in comparison with the others.

Rating scale description

Rating	**Interpretation**
5	Extremely Strong
4	Strong
3	Neutral
2	Not so strong
1	Weak

Components >>>	Architectural Style	Lighting	Built Form	Land Use	Tree	Material	Landscape	Open Space	Layout	Visual symbol

Thank you for your response.

Annexure II:

"Rating Questionnaire: Selection of Indicators of the Key Components of Built Environment Effecting Perception of Safety"

– as a part of research work for the Ph.D degree of Namrata Talukdar

Expert 1
Profession/Designation:
Years of Experience:
Date of Response: 6/07/2023

Dear Expert,

Please rate each indicator with respect to the component on a scale of 1 to 5 based on its perceived strength in influencing people's sense of safety in the built environment. Your insights will help in identifying and prioritizing the most influential indicators of built components that effect safety perceptions, as per your knowledge and experience.

Rating scale description

Rating	Interpretation
5	Extremely Strong
4	Strong
3	Neutral
2	Not so strong
1	Weak

Sl. No.	Components	Indicators	Ratings				
			5	4	3	2	1
1	Built Form	Building density					
		Human Scale					
		Urban elements					
		Architectural details					
2	Layout	Pedestrian Flows					
		Edge treatment					
		Access points					
		Connectivity					
		Road Network Design					
3	Land use	Diversity					
		Compatibility					
		Change					
		Function					
		Proximity					
		Access					
4	Public Open Space	Spatial Characteristics					
		Legibility					

		Accessibility to green spaces					
5	Trees	Tree Form					
		Tree height					
		Cover					
		Size					
		Density					

Thank you for your response.

Annexure III:

"Expert Rating Questionnaire: Identification of the Safest Locality under Latasil Police Station"

– as a part of research work for the Ph.D degree of Namrata Talukdar

Expert 1
Profession/Designation:
Years of Experience:
Date of Response: 6/07/2023

Purpose of the questionnaire: This short questionnaire is designed to gather expert input on which locality within the Latasil Police Station jurisdiction is perceived to be the safest based on your experience. Your opinion is valuable for understanding spatial patterns of safety in Guwahati's urban fabric.

Kindly answer the following based on your judgment of:

- Safety concerns expressed by residents, especially women, children, and elderly
- Based on urban design concerns relating built form, land use, tree, open space and layout.

Q1. Which locality under Latasil Police Station do you consider to be the safest? (Please tick one).

- ☐ Uzan Bazar
- ☐ Kharghuli
- ☐ Chenikuthi
- ☐ Barowary
- ☐ Ambari
- ☐ Others (please specify): ……..

Q2. Please briefly explain the reason for your choice (optional):

……

……

Thank you for your response.

Annexure IV:

"Expert Rating Questionnaire: Identification of the Most Unsafe Locality under Dispur Police Station"

– as a part of research work for the Ph.D degree of Namrata Talukdar

Expert 1
Profession/Designation:
Years of Experience:
Date of Response: 7/02/2024

Purpose of the questionnaire: This short questionnaire is designed to gather expert input on which locality within the Dispur Police Station jurisdiction is perceived to be the least safe or most unsafe based on your experience. Your opinion is valuable for understanding spatial patterns of safety in Guwahati's urban fabric.

Kindly select one locality from the list below that you consider the most unsafe, based on your judgment of:

- Frequency of criminal activity
- Physical infrastructure
- Vulnerable public spaces
- Safety concerns expressed by residents, especially women, children, and elderly
- Based on urban design issues relating built form, land use, tree, open space and layout.

(Please tick one).

- ☐ Ganeshguri
- ☐ Bhagaduttapur
- ☐ Hengrabari
- ☐ Rukminigaon
- ☐ Jonaknagar

Please briefly explain the reason for your choice (optional):

……

……

Thank you for your response.

Annexure V:

"Perception Survey at Case Study Areas"

– as a part of research work for the Ph.D degree of Namrata Talukdar

Location: ☐ Uzan Bazar ☐ Hengrabari (Tick one)
Date: _____
Interviewer Name: _____ Household No.: _____

Section A: General Information

1. Name (optional): _____
2. Gender:
   ☐ Male ☐ Female ☐ Other
3. Age: _____ years
4. Occupation: _____
5. How long have you been living in this locality?
   ☐ Recently shifted ☐ 1–5 years ☐ 6–10 years ☐ 11–15 years ☐ More than 15 years
6. How often do you visit within Uzan Bazar/Hengrabari?
   ☐ Daily ☐ Almost daily ☐ Weekly ☐ Occasionally
7. Do you feel the routes within Uzan Bazar are generally direct to your destinations?
   ☐ Generally direct ☐ Occasionally direct ☐ Often indirect
8. How often do you need to drive through the alternative routes to your destinations?
   ☐ Always ☐ Mostly ☐ Sometimes ☐ Rarely ☐ Never
9. Do you feel safe while walking on the streets of your locality during the day time?
   ☐ Yes ☐ No
10. Do you feel safe while walking on the streets of your locality during the evening time?
    ☐ Yes ☐ No
11. Do you enjoy walking in your locality?
    ☐ Yes ☐ No

Section B: Perception Ratings

Please rate each attribute with respect to the evaluation criteria on a scale of 1 to 5 in which 5 denoting 'Extremely Strong', 4 'Strong', 3 'Neutral', 2 'Not so strong', 1 means 'Weak based on how influential do you think are the attributes with respect to Uzan Bazar/Hengrabari.

12. *Rate '**traffic efficiency**' through the attributes at your locality*

Attributes	***Ratings***
Dependability	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Mobility	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*

System performance	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Safety	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*

*13. Rate '**walking quality'** through the attributes at your locality*

Attributes	***Ratings***
Route transparency	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Route friendliness	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Route connectedness	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Alternate route availability	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*

*14. Rate '**access to amenities**' through the attributes at your locality*

Attributes	***Ratings***
Travel time efficiency	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Network connectivity	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Scattering of amenities	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*

*15. Rate '**proximity**' through the attributes at your locality*

Attributes	***Ratings***
Ease of access	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Parking facilities	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Distance perception	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Comfort of travel	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Time perception	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*

Section C: Perception Ratings about Open spaces

Location: ☐ Uzan Bazar ☐ Hengrabari (Tick one)
Date: _____
Interviewer Name: _____ Household No.: _____

Open Space Name: _____ (Mark with Sl. No.)

Sl. No.	Open Spaces
1	Dighalipukhuri Park
2	Sati-Radhika Brahmaputra riverine park
3	Jor Pukhuri Park
4	Nehru Park
5	Judges' Field
6	Latasil Playground

Sl. No.	Open Spaces
1	Amrit Udyan

1. *Rate '**Open Space-Functionality**' through the attributes at your locality*

Attributes	***Ratings***
Individual's well-being	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Inclusiveness	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Engagement with space	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Engagement with community	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*

2. *Rate '**Open Space-Social Interaction**' through the attributes at your locality*

Attributes	***Ratings***
Friendliness	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Activities	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Convenience	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Access	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*

3. *Rate '**Open Space-quality of access points**' through the attributes at your locality*

Attributes	***Ratings***
Ease of movement	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Appealing design	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Size	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Visibility	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*

4. *Rate '**Open Space-visual landmarks**' through the attributes at your locality*

Attributes	***Ratings***
Utility	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Attractiveness	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Visibility	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Clarity	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*

5. *Rate '**Open Space-enclosure'** through the attributes at your locality*

Attributes	***Ratings***
Transperancy	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Human Scale	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Texture	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*
Material	☐ *5* ☐ *4* ☐ *3* ☐ *2* ☐ *1*

Annexure VI:

Sample Questionnaire: Façade Design Quality (Uzan Bazar Study)

Instructions: Please answer the following questions by ticking (✓) either **Yes** or **No**.

Q. No.	Questions	YES	NO
1	Can you clearly see through the ground floor façade from the street?		
2	Does the ground floor provide enough entry/exit points?		
3	Do the doors, windows, and walls appear proportionate?		
4	Is the ground floor façade free from clutter and confusion?		
5	Does this façade look different from most others nearby?		
6	Does the design reflect creativity or originality?		
7	Does the façade create a positive impression at first glance?		

Annexure VII:

Sample of Expert Evaluation – Normalized Scores and Average Weights

Components	Parameters/ Indicators	Experts									Av. Weights
		1	2	3	4	5	6	7	8	9	
1. Built Form	Human Scale	0.38	1.19	1.87	1.16	0.94	0.46	1.16	0.94	1.26	1.04
	Architectural Details	1.07	0.81	0.41	0.5	0.99	1.86	1.16	1.22	0.46	0.94
	Urban elements	1.55	0.99	0.71	1.32	1.05	0.67	0.61	0.86	0.29	0.89
	Building density	0.66	0.21	1.25	0.99	0.71	1.36	1.37	1.08	0.07	0.86
2. Layout	Road Design	0.32	1.21	1.73	0.93	0.85	1.59	1.53	1.15	0.59	1.1
	Connectivity	0.89	0.88	0.55	0.68	1.72	0.75	1.41	1.15	1.13	1.02
	Pedestrian Flow	0.74	0.61	0.7	0.38	0.41	1	1.33	1.3	1.3	0.86
	Edge Treatment	0.89	0.88	0.55	0.68	0.72	0.42	1.77	0.36	0.9	0.79
	Access points	1.78	0.89	0.7	0.38	0.41	1.1	0.85	1.41	0.29	0.86
3. Land use	Diversity	0.42	1	0.38	0.8	0.74	1.5	2.01	1.12	2.08	1.11
	Access	1.71	1	1.18	1.61	0.32	0.38	1.09	1.08	1.28	1.07
	Compatibility	0.87	1	0.93	0.58	1	1.08	0.57	1.67	1.87	1.06
	Change	0.47	0.96	0.35	0.32	0.32	0.63	2.25	1.69	1.27	0.91
	Function	1.54	0.44	0.6	0.8	0.88	1.21	0.33	0.94	0.86	0.84
	Proximity	0.87	1	0.83	0.58	1	0.28	0.71	1	1.06	0.81
4. Open Space	Spatial Characteristics	1	0.96	1.35	2.32	1.32	1.23	1.57	1.91	2.12	1.53
	Accessibility	0.99	1.59	1.14	1.87	0.78	0.4	2.65	1.99	1.64	1.45
	Legibility	0.54	1.11	1.69	0.8	0.88	0.96	0.73	1.02	1.64	1.04
5. Trees	Tree Cover	1	1.57	1.21	1.61	0.98	0.36	2.79	1.13	1.43	1.34
	Height	0.21	0.65	0.72	0.8	1.23	0.93	1.97	1.28	1.22	1
	Size	0.95	0.42	0.35	0.58	0.27	0.06	1.05	1.02	1.22	0.65
	Density	0.3	0.17	0.25	1.1	0.18	0.4	0.25	0.32	1.02	0.44
	Tree Form	0.3	0.19	0.04	1.1	0.18	0.4	0.21	0.35	1.01	0.42

Annexure VIII:

Sample: Ratings and Average Scores of 'Ground Floor Façade Design' Attributes (Uzan Bazar)

Buildings In Uzan Bazar	Façade porosity		Architectural Style		Customization	
	Visual porosity	Physical porosity	Balance	Clarity	Uniqueness	Originality
Building 1	4	3	5	3	4	4
Building 2	4	3	4	4	3	5
Building 3	2	1	3	4	2	2
Building 4	3	3	2	5	5	3
Building 5	2	5	3	3	2	4
Building 6	4	5	3	3	4	4
Building 7	3	3	2	5	5	3
Building 8	3	3	2	5	5	3
Building 9	2	5	3	3	2	4
Building 10	4	5	3	3	4	4
Building 11	2	3	5	4	4	4
Building 12	3	4	4	4	2	4
Building 13	3	3	2	5	5	3
Building 14	2	5	3	3	2	4
Building 15	4	5	3	3	4	2
Building 16	2	3	5	4	4	2
Building 17	3	4	4	4	2	3
Building 18	3	3	5	5	5	3
Building 19	3	3	5	5	5	3
Building 20	3	3	2	5	5	3
Building 21	4	3	5	3	4	2
Building 22	4	3	4	4	3	5
Building 23	3	4	2	4	4	4
Average Value	3	3.6	3.4	4	3.7	3.4

Annexure IX:

Sample: Ratings and Average Scores of 'Ground Floor Façade Design' Attributes (Hengrabari)

Buildings In Hengrabari	Façade porosity		Architectural Style		Customization	
	Visual porosity	Physical porosity	Balance	Clarity	Uniqueness	Originality
Building 1	2	2	2	1	1	1
Building 2	3	3	2	3	2	1
Building 3	1	3	2	3	1	2
Building 4	2	3	2	3	1	2
Building 5	3	3	3	2	2	3
Building 6	2	3	3	1	2	3
Building 7	3	2	3	1	2	3
Building 8	3	2	3	3	2	1
Building 9	1	3	3	1	3	1
Building 10	3	3	2	2	2	3
Building 11	3	1	2	1	1	1
Building 12	3	3	2	1	1	2
Building 13	2	3	2	2	3	3
Building 14	3	2	3	4	2	2
Building 15	1	3	3	3	2	2
Building 16	5	3	4	3	1	1
Building 17	2	1	3	4	2	2
Building 18	3	2	3	3	2	2
Building 19	3	3	1	3	2	2
Building 20	3	3	2	2	3	2
Building 21	3	3	2	2	1	2
Building 22	3	4	3	2	3	2
Building 23	3	3	3	3	1	2
Building 24	3	2	3	1	1	2
Building 25	2	2	3	2	1	2
Building 26	3	3	2	2	1	1
Building 27	3	3	2	2	3	3
Building 28	2	3	2	2	3	3
Building 29	2	2	1	1	1	1
Building 30	3	3	2	2	1	1
Building 31	1	2	2	1	1	1
Building 32	2	2	2	1	2	1
Building 33	2	3	1	3	1	1
Average Value	2.5	2.6	2.4	2.1	1.7	1.8

Annexure X:

Expert Panel Details: List of Experts for Selection of Components and Indicators of Built Environment

Sl. No.	Experts	Designation	Total Years of Experience	Field of Expertise
1	Expert 1	Assistant Professor, GCAP	10	Urban Design
2	Expert 2	Specialist Expert, AUKH, Assam	8	Urban Planning
3	Expert 3	Senior Architect, PWD, Assam	18	Urban Design
4	Expert 4	Assistant Professor, DDC	4	Environmental Planning
5	Expert 5	HOD, Dept. of Architecture. GCAP	17	Urban Design
6	Expert 6	Rtd. Consultant, Administrative Staff College, Guwahati	25	Urban Planning
7	Expert 7	Mid-level Planner, AUKH, Assam	7	Urban Planning
8	Expert 8	Assitant Professor, JEC, Jorhat	7	Engineering
9	Expert 9	Ph D Scholar, SPA Delhi	5	Landscape Architecture

Annexure XI:

"Expert Panel Details: Fields of Experts for Selection of safest locality in Latasil jurisdiction"

Sl. No.	Expert's Field	No. of Experts
Law Enforcement		
1	Officer-in-Charge of police station	2
2	Constables	3
3	Traffic Police	2
4	Retired Police Officers	1
Local Government		
5	Urban Planner	5
6	Ward Commissioner	1
Technical Experts		
7	Architects	3
8	GIS Expert	1
Local Community Representatives		
9	NGO Representative	1
10	Journalist	1
TOTAL EXPERTS:		20

Annexure XII:

"Expert Panel Details: Fields of Experts for Selection of most unsafe locality in Dispur jurisdiction"

Sl. No.	Expert's Field	No. Of Experts
	Law Enforcement	
1	Sub-Inspector of police station	1
2	Constables	3
3	Traffic Police	1
4	Crime Branch Officer	3
	LOCAL GOVERNMENT	
5	Ward Commissioner	1
6	Urban Designer	3
	TECHNICAL EXPERTS	
7	Architects	4
8	Research Scholar	1
	MOBILITY PROFESSIONALS	
9	Auto Union Head	1
10	Urban Mobility Consultant	2
	Total experts:	20

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18.9.2025

18.9.25

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