URBAN FURNITURE AND HUMAN INCLUSION IN PUBLIC SPACES

A DISSERTATION

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ABSTRACT

The urban landscape is composed of tangible and intangible elements that co-exist to form the public realm. An integral part of this landscape, 'urban furniture' consists of all the static things that make urban spaces useful and functional (Akinci & Konakoglu, 2013). A growing focus on inclusive public spaces has necessitated the need to pay special attention to the tangible component of the space i.e. urban furniture. Extending on the works of E.T. Hall (Hall, 1969), William H. Whyte (Whyte, 1980), Jan Gehl (Gehl & Svarre, 2013), Matthew Carmona (Carmona, 2014) and the likewise, this dissertation aims to investigate urban furniture as one of the many elements that help enhance inclusivity of public spaces.

An intensive review of literature was conducted in order to develop a comprehensive understanding of urban furniture and human inclusion in public spaces. Case studies of inclusive urban furniture around the world complemented the literature through real life examples. Typologies of public spaces for field studies, in the contexts of India and Germany, were identified. Luisenplatz and Street Zeil in Germany and Sector 17C and Blocks E & F (Connaught Place) were selected for the research. A crucial step in the dissertation was to evolve, from the literature review, a list of criteria for assessing inclusivity of urban furniture in public spaces, the criteria being accessibility, usability, comfort, safety and maintainability. These were later applied to the furniture elements in the field studies under investigation. A list of furniture elements, that inform human inclusion, was generated for each site and the elements were classified under four categories i.e. seating furniture, surfaces, information systems and other services. This was followed by developing frameworks to collect and analyze field data. Observation-based and evidence-based tools (activity mapping, tracing movement patterns, documenting furniture and photographing) were identified as the tools to carry out the research. Field interviews were carried out as a participation-based research tool for understanding issues related to inclusion and urban furniture on each site. The method of random stratified sampling was used to select the respondents on site. The collected data was then analyzed for assessing human inclusion in the field studies. The four categories of furniture were assessed alongside the criteria evolved earlier.

The analysis led to the conclusion that inclusive urban furniture is a vital component of inclusive public spaces. The four cases (four distinct typologies), with variations in the degree of inclusivity, bring forth useful insights into the usage of urban furniture, including or excluding certain user groups. By reviewing all the field studies under the criteria to assess inclusion, recommendations were drawn for four categories of inclusive urban furniture. The research was instrumental in bringing new insights into the field of human inclusion in two distinct cultural and climatic contexts.

ACRONYMS

PPS	Project for Public Spaces
SDG	Sustainable Development Goals
UN-HABITAT	United Nations Human Settlements Programme
WISE	Well-being in Sustainable Environment

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Chapter 1

Research Proposal

1.1 INTRODUCTION

The Project for Public Spaces and UN-HABITAT collaborated in 2011 for working towards sustainable growth and urbanization. Special attention was paid to place-making, public spaces, and urban quality of life. This resolution signifies a growing global recognition of inclusive public spaces as a significant aspect of quality of urban life (Maciver, 2011). It also represents the first consolidated approach to inclusive urban public space policy within the UN-HABITAT. In addition to this, Goal 11 of SDG 'Sustainable Cities and Communities' emphasizes the need for safe and inclusive public spaces (Sustainable Cities and Communities, n.d.). As a key aspect of social sustainability, inclusion contributes to development of sustainable communities (Burton & Mitchell, 2006). Inclusive design, here, caters to the needs and aspirations of as many end users as possible, regardless of their gender, age or ability, positively influencing product design and the built environment, and thus society as a whole (Richards, 2017). Ensuring inclusivity in urban design often involves breaking down stereotypes, realigning value systems and thinking 'outside the box' from project inception through to completion (Makore, Ormerod, & Newton, 2014).

Although successfully functioning public spaces are one of the most visible forms of public good, local authorities' and urban planners' appreciation of its social dimension beyond its physical dimension is lacking (Maciver, 2011). The potential benefits of public space are not shared equally by everyone, and the right to the city is rarely enjoyed by all. While enough attention has been paid to form and space, the people-oriented premise remains neglected and relatively unexplored (Gehl & Svarre, 2013). This aspect of inclusivity of urban space and the fact that it is often overlooked, especially in developing countries, also finds mention in a recent conference on sustainability (Cobos, Uribe, Toledo, & Ortega, 2014).

The urban landscape is composed of elements, both tangible and intangible, that together make up the public realm. An integral part of this landscape, urban furniture is a wide term with a vast range of concerns (Hong, 2007) and is beginning to gain importance in the developing parts of the world. The phrase 'urban furniture' consists of all the static things that make urban spaces useful and functional (Akinci & Konakoglu, 2013). It comprises of objects and infrastructural facilities, located in urban public spaces that provide various services and functions to the public (Hong, 2007). Furniture for the public realm emerged alongside the birth of early cities, although sufficient evidences and documents for the works of that age are unavailable (Riki, Riki, Rouzbeh, & Sarabandi, 2015).

In this dissertation, urban furniture has been investigated as one of the many elements that help enhance inclusivity of public spaces. Taking cues from the seven principles of inclusive design and extending on the works of E.T. Hall (Hall, 1969), William H. Whyte (Whyte, 1980), Jan Gehl (Gehl & Svarre, 2013), Matthew Carmona (Carmona, 2014) and the likewise, this dissertation aims to assess inclusivity of urban furniture in public spaces by examining human behavior of diverse users around furniture elements. Human behavior is the function of the interaction between environmental and personality dimensions, making it obligatory to value the environment and the elements within it (Dadghostar & Zandmoghadam, 2016). The study addresses the question – 'How does urban furniture play an inclusive role in public spaces?' The study begins with a review of the state of the art literature on urban furniture from public space perspectives, as outlined in Chapter 2. This includes definitions and classification (Makore, Ormerod, & Newton, 2014), the role of urban furniture in public spaces and guiding principles. This chapter also includes literature on inclusive design and urban public spaces, supplemented by case studies of inclusive urban furniture around the world. A list of criteria to assess inclusion of urban furniture emerges as one of the key learnings from the literature review. Chapter 3 details out the methodology for research, elaborating on the development of frameworks for data collection and the corresponding analysis of collected data. The collection and analysis of data (field studies) has been described in Chapter 4. Chapter 5 deals with the conclusions and recommendations for inclusive urban furniture in public spaces. This is followed by outlining the scope for further research.

1.2 RESEARCH BACKGROUND

A concept called *'Streets for Life'* emerged out of the ongoing research in the Well-being in Sustainable Environment (WISE) research unit at the Oxford Brookes University, aimed at offering design guidance for creating inclusive environments that maximize people's quality of life (Burton & Mitchell, 2006). *'How is a bench used?'* a series of photographs on the nuances of bench use, in the book *'How to Study Public Life?'* by Jan Gehl, analyzes urban furniture and its relationship to culture, context and people. According to Jan Gehl, an alliance can be forged between life and space in cities by the development and analytical application of contemporary tools (Gehl & Svarre, 2013).

In a research paper titled *'Explaining the Criteria of Designing Urban Furniture and Landscape, with a Cultural-Social Design Approach*', the author explores the relationship between socio-cultural design of urban furniture and the disturbances regarding uneven distribution of elements (Allahdadi, 2017). Yücel focuses on the significance of urban furniture in the contemporary

landscape with emphasis on five criteria for furniture location and design (material and color). The principles have been summarized under the book chapter *'Street Furniture and Amenities: Designing the User-Oriented Urban Landscape'* (Yücel, 2013). The approach adopted by Mourthe considers a comparative analysis of historical, socio-cultural, environmental and functional aspects (Mourthe & Menezes, 2000). The analysis helps in understanding the impact of urban furniture on the interaction between public spaces and its users (Mourthe & Menezes, 2000). The case study on *'Park Seating Furniture Design in Hong Kong'* digs deep into inclusive design and its relation to user interaction at Cornwall Street Park in Hong Kong. The sources mentioned here, and many others, formed the basis on which further research was carried out for the purpose of this dissertation.

1.3 NEED FOR STUDY: RESEARCH GAPS

Urban public spaces are considered as the lungs of urban areas (Kim, 2015) that go beyond the physical world and delve into the realms of the virtual, social, cultural, and emotional. A city is therefore considered successful and livable when it comprises of a network of well-designed and inclusive public spaces (Public Space Design, n.d.).

In India, where the traditional and the modern co-exist in complex layers, these spaces include streets and pavements parks, railway and metro stations, maidans and bagaans, shopping malls and bazaars, exhibitions, museums and gallery spaces. Indian cities face the constant struggle to include diverse user groups through design of public spaces and their qualities.

1. **Indian public spaces struggle for inclusion (Vanka, 2014).**

   In a newspaper article titled *'Making Public Spaces Inclusive for All'*, the author talks about field interviews conducted with a wide variety of users in public spaces from different cities of the country. During the interviews, people of all ages, classes and communities revealed their deep desire to be in urban public spaces and to be there more often (Khan, 2017). It was also mentioned that access to such spaces was routinely denied or curtailed (Khan, 2017). Public spaces in India also become exclusive by the lack of safe and clean public amenities, sturdy footpaths, benches and other amenities that encourage people to come out of their homes and use these spaces (D'Silva, 2018). In the interviews conducted in Sector 17C, one of the respondents said, "The furniture is not well-maintained and the areas near the fountains and eating booths are often unclean." In addition to this, the elderly are often excluded by design. In the words of Ms. Krishna Priya (66 years old), "I don't particularly like

the seating. It gives me a backache and isn't very comfortable." Also, public spaces that do not function round the clock become vulnerable to crime, making them exclusive from the point of view of safety (D'Silva, 2018).

Over the past few years, several attempts have been made to measure inclusivity of urban public spaces in Indian cities. *'Safetipin'* is one such app that has managed to collect data from around 30 cities on the issue of inclusion in public spaces. The method of data collection involves community involvement and engagement of key stakeholders. The data is fed into a program that helps suggest changes in policies for enhancing inclusion and safety in urban public spaces in the selected cities (Future, 2018). The available data base, however, lacks focused studies on urban furniture from a human perspective.

2. **The design of urban furniture has been neglected, either through ignorance, lack of adequate knowledge on the subject or because it is not considered a priority (Cobos, Uribe, Toledo, & Ortega, 2014).**

The human dimension is an inseparable component of public space. In his lectures on *'Person Place Thing'*, Jan Gehl talks about the need to make public life the driver for urban design as one of the five principles that inform *'Great City Design'* (Budds, 2016). To provide meaning and purpose to an urban space, one needs to develop a truly inclusive urban design that considers the community's diverse needs (such as physical, ergonomic and of interaction) within its social, cultural and historical context (Cobos, Uribe, Toledo, & Ortega, 2014). Although numerous studies claim to consider the needs of various stakeholders, not much research has actually been done with regard to users' diverse and changing needs (Siu, 2015). Even though urban furniture tends to be designed in a utilitarian and functional way, it does not take into consideration the physical and mental attributes of the citizens that attend to the place. Related literature shows that few studies have been done in this regard and the existing researches lack a comprehensive view of urban design (Allahdadi, 2017).

3. **There is a tangible lack of a comprehensive source on urban furniture that can provide new ideas to designers and urban planners (Allahdadi, 2017).**

The study brings forth useful insight into the relationship between urban furniture and human behavior, with a special focus on the needs of diverse user groups (for all genders, ages and abilities) in the Indian and German contexts. It acts as an urban furniture design reference tool by providing a comprehensive understanding of concepts and principles in the said field.

1.4 RESEARCH QUESTION(S)

How does urban furniture play an inclusive role in public spaces?

1.5 AIMS AND OBJECTIVES

To assess inclusivity of urban furniture in the selected field studies and provide recommendations for inclusive urban furniture in public spaces.

1. To develop a comprehensive understanding of urban furniture and human inclusion in public spaces.
2. To evolve a list of criteria for assessing inclusivity of urban furniture in public spaces.
3. To develop frameworks for data collection on field and the corresponding analysis of collected data.
4. To document and analyze (without comparing) the collected data for assessing inclusivity of urban furniture in the selected field studies.
5. To provide recommendations for inclusive urban furniture in open/ semi-open public spaces.

1.6 SCOPE AND LIMITATIONS

Within urban infrastructure, the study is focused on urban furniture and does not delve into other infrastructural services. Alongside covering both the macro and micro aspects of urban public spaces, the study explores four categories of urban furniture elements (seating furniture, surfaces, information systems and other services) that are crucial for determining inclusivity of public spaces. Time-based activity mapping, tracing movement patterns and field interviews, supported by personal observations and photographs, have been used as the tools to achieve the said aim.

The scope of work is limited to open/ semi-open public spaces in the urban contexts of India and Germany. Elements of urban furniture that do not directly inform human inclusion (for instance: flower beds, fire hydrants, post boxes etc.) have not been incorporated within the scope of work. The study assesses inclusivity of urban furniture for different genders (males, females and others), ages (children, young adults, adults and the elderly) and abilities (able-bodied, people with mobility-related impairment and the visually impaired) but does not cater to economic inclusion.

1.7 METHODOLOGY FOR RESEARCH

(Refer Section 3.1)

1.8 EXPECTED OUTCOMES

1. An enhanced understanding of urban furniture as a fundamental aspect of inclusive public spaces.
2. A list of criteria and sub-criteria for assessing inclusivity of urban furniture in public spaces.
3. Development of a detailed framework for data collection and another for analysis of collected data.
4. Assessment of inclusivity of urban furniture in the selected field studies of India and Germany.
5. Recommendations for inclusive urban furniture in open/ semi-open public spaces.

1.9 RESEARCH NOVELTY

1. Provides a comprehensive list of criteria and sub-criteria, crucial for assessing inclusivity of urban furniture in public spaces.
2. Provides frameworks for data collection and analysis of collected data on urban furniture and public life, applicable to contexts other than the selected field studies as well.
3. Provides recommendations for inclusive urban furniture (seating furniture, surfaces, information systems and other services) in two distinct cultural and climatic contexts.

1.10 CHAPTERISATION

1. Chapter 1: Research Proposal

   The first chapter gives an introduction to the study and summarizes the research background. This is followed by establishing the need for study in the Indian as well as the international context. The study aims to find answers to the research question, “How does urban furniture play an inclusive role in public spaces?” Next, the aims and objectives are formulated and the scope of work is decided. The methodology for research in the form of a flowchart briefly outlines the process to be followed in order to reach the aim. The expected outcomes and research novelty highlight the contributions of the study to the existing research database.

2. Chapter 2: Literature Review Learnings

A comprehensive understanding of the subject is developed by reviewing a large domain of literature on urban furniture, public spaces and human inclusion. The review begins with an understanding of urban furniture, with a special focus on characteristics, guiding principles and anthropometrics for furniture design. This is followed by an overview of urban public spaces. A classification of public spaces (based on ten sources) plays a crucial role in selecting public space typologies for field study. Global and local perspectives on public space bring forth interesting insights into humans in the public space and the need to include them. This is followed by case studies on inclusive urban furniture around the world, highlighting the use of urban furniture to enhance inclusivity of public spaces.

3. Chapter 3: Research Design

The chapter begins with the methodology for research, as previously mentioned in Chapter 1. The public space typologies listed in Chapter 2 are tabulated alongside feasibility criteria for selecting the typologies of public spaces suitable for the research study. This is followed by evolving a criteria, from the literature review, to assess inclusivity of urban furniture in public spaces in general and the selected field studies in particular. Next, the chapter gives an introduction to the selected field studies, user profiles and the furniture elements chosen for assessment on field. A framework for data collection is developed, followed by a review of research tools. This is followed by development of the analytical framework and selecting the sample for field interviews.

4. Chapter 4: Field Observations (Cases of Germany and India)

A brief analysis of literature on anthropometrics in the two contexts is carried out. The collection and analysis of spatial data consists of documenting the four cases, understanding patterns in distribution and clustering through activity mapping, tracing people's movement patterns to develop the shadow maps and cataloguing furniture elements on each site. The collection and analysis of visual data deals with the existing furniture on each site and its compliance with furniture design standards of the context in question. The analysis is supported by imagery from the field visits. Generating user feedback through field interviews is considered as an important step for understanding issues related to each site. The criteria for assessing inclusivity of urban furniture, evolved in Chapter 3, is put to use here for assessing elements of furniture on site. The charts, thus prepared, give useful insights into trends and variations across the field studies.

5. Chapter 5: Conclusions and Recommendations

The last chapter outlines the conclusions made on the basis of literature review and the analysis of field data. The study concludes by providing recommendations (for designers and architects) for four categories of urban furniture elements i.e. seating furniture, surfaces, information systems and other services in two different contexts.

Chapter 2

Literature Review Learnings

2.1 INTRODUCTION TO URBAN FURNITURE

2.1.1 Definitions and Classification

In an urban environment or landscape, elements that are placed to provide user comfort, entertainment and to control access are referred to as urban furniture. Urban furniture consists of all the static things that make urban public spaces useful and functional (Akinci & Konakoglu, 2013).

In both urban and landscape design, it is necessary to consider structural units that provide information, comfort, safety and satisfaction of physical needs and environmental hygiene (Akinci & Konakoglu, 2013). These units, known as urban furniture, when used properly, improve the visual value of the landscape (Akinci & Konakoglu, 2013).

Urban furniture differs according to the size and location of urban public spaces, whether surrounding spaces, semi-urban spaces and urban spaces (Seçil ŞATIR, 2005). Elements of urban furniture are greatly influenced by user and activity diversity in public spaces. From the point of view of transportability, urban furniture can be classified as permanent, temporary and either permanent or temporary, each with its associated functions, activities and user groups. Another classification can be made on the basis of activities that humans perform in urban public spaces (Seçil ŞATIR, 2005).

Figure 1 - Bicycle racks as permanent elements of urban furniture.

Figure 2 – Seating furniture combined with a bicycle rack.

Source: https://www.archiproducts.com/en/products/bicycle-racks

- On the Basis of Transportability
    1. Permanent (cannot be disassembled and transported)

This includes banners, bicycle racks (refer figures 1 and 2), billboards, bollards, drain covers, fences, fire hydrants, indoor and outdoor flooring, flower beds, gazebos and pavilions that are fixed to the ground, modular ground coverings cast on site, information boards, information kiosks, kerb ramps, manhole covers, memorials, parklets associated with rest and recreation, fountains, public lavatories, ramps, signage and sign boards, stepped approach, street lights, fixtures associated with transit-related activities such as traffic lights and signs, trees and tree lawns.

2. Temporary (can be disassembled and transported)

   This includes extended seating spaces, news racks, phone boxes and traffic barriers.

Figure 3 - Seating furniture design for public spaces.

Source: https://www.archiproducts.com/en/products/benches

Figure 4 - Seating furniture design for public spaces.

Source: https://www.archiproducts.com/en/products/benches

3. Either Permanent or Temporary

   This includes artificial rocks, benches and other sitting spaces (refer figures 3 and 4), children's play spaces, community kiosks, post boxes, poster poles, public art and sculptures, transit shelters (refer figure 5), trash cans (refer figure 6), vending machines, waste recycling machines and watering troughs.

- On the Basis of Human Activities

  Table 1 on 'Elements of Urban Furniture' highlights the primary and secondary functions associated with each furniture element. Presence of urban furniture lets people perform certain activities in an urban public space. Some activities are independent of each other, for example cycling or exercising. Others are interdependent, either static or dynamic in nature. The same, along with user diversity, has also been tabulated. The table gives a holistic view

of the vast variety of elements that exist as part of furniture in an urban public space. According to human activities that take place in an urban public space (Seçil ŞATIR, 2005), furniture can be classified as follows:

1. Dynamic areas of communication that make human circulation possible.
2. Areas that provide a place for shopping, sitting, relaxing and meeting.
3. Recreational areas concerning culture, art, recreation, entertainment, outing and fitness.

Figure 5 - Transit shelter with relevant information systems.

Source: https://www.jcdecaux.com/press-releases/jcdecaux-accelerates-roll-out-small-cells-its-street-furniture-france

Figure 6 - Trash cans as part of urban furniture.

Source: https://www.archiproducts.com/en/products/litter-bins

2.1.2 Historical Development

Furniture for the public realm emerged alongside the birth of early cities, although sufficient evidences and documents for the works of that age are unavailable (Riki, Riki, Rouzbeh, & Sarabandi, 2015). Even though ancient cities have been perfectly documented, there is absence of a comprehensive study with regard to urban furniture.

Since the beginning of the 20th century, prominent squares with architectural value, parks and open spaces with many functions, urban spaces that can be easily accessed by city dwellers and where urban furniture was densely employed have been formed. With post-modernism, increased importance was attached to comprehensive preservation and innovation, bringing into agenda the traditional understanding of the city, integrated with urban life. In the quest to adapt to the ever-changing social demands, the urbanscape has become increasingly varied and multifunctional (Bain, Rodgers, & Gray, 2012). Besides, in order to cater to the increasing variety of social activities, the design of furniture in such urbanscapes has become more diverse.

2.1.3 Role and Characteristics

Urban furniture is a structural element that has a key role in giving meaning to urban identity and facilitating social life (Riki, Riki, Rouzbeh, & Sarabandi, 2015). Identity, on the other hand, can help decode design of urban furniture and make it acceptable for better perception (Seçil ŞATIR, 2005).

Urban furniture elements make up the tangible and accessible components of public spaces (Allahdadi, 2017). Urban fixtures and furniture are important components of identity (Seçil ŞATIR, 2005) and help distinguish one city from another (Allahdadi, 2017). They play an auxiliary role in strengthening the identity of urban spaces and make it possible for people to use these spaces. Urban furniture which conforms to its environment from technical, aesthetical, and social points of view is a vital tool to increase the quality of the space (Seçil ŞATIR, 2005). The main function of city furniture is to make urban public space visitable (Seçil ŞATIR, 2005). Urban furniture is important for balancing human-environment relationships, providing urban comfort and consequently fulfilling the diverse needs of its users. It acts as a bridge between people and their city and is in constant development (Akinci & Konakoglu, 2013).

Figure 7 - A multipurpose light pole at Luisenplatz, Darmstadt.

Figure 8 - Art installation as an element of urban furniture at Heidelberg.

Source: Author

In the past, urban furniture was designed according to public needs. Today, the aim is to satisfy user needs, prevent problems during use, to perform tasks (functional or recreational) and to include social and cultural activities (Akinci & Konakoglu, 2013). An important function is behavior-creation and facilitation of people's communication (Allahdadi, 2017) that can motivate people to walk and spend time in public places, resulting in enhancement of safety in these places (Stevens & Salmon, 2014). Furthermore, urban furniture not only provides physical comfort and satisfaction, but also

fulfils the social, cultural, psychological and ideological needs of the city dwellers (Lee & Chan, 2008). In its design, it is assisted by all groups and specialties, which itself implies the interdisciplinary nature of urban furniture (Allahdadi, 2017).

Urban furniture is designed according to the size of the space, the features of the environment and the socio-cultural status of the inhabitants (Seçil ŞATIR, 2005). The design arises from the thoughts and identity of the community (Allahdadi, 2017). It varies according to the cultural features of countries or cities (Bulut & Atabeyoglu, 2006). Designs that are not harmonious with urban identity and not based on integration may leave positive impressions for a transitory look of the space, but in the long run, they turn out to be short-lived designs which do not reflect the historical character of the city and cannot firmly establish a futuristic urban image (Seçil ŞATIR, 2005). Poorly planned and visually unattractive furniture leads to a chaotic city with lack of order and harmony (Yücel, 2013). The desirable characteristics of urban furniture for enhancing inclusivity of urban public spaces are summarized below:

1. Urban furniture should meet the social, cultural and physiological needs of the city dwellers including both men and women, the young and the old, the healthy, the ill, the disabled and of all professions. The location must be scientifically decided.
2. The users of the urban space must be dealt with in a multi-sided manner; for instance, the needs of both pedestrians and drivers must be taken into careful consideration for a transit-oriented public space.
3. Urban furniture should ergonomically support as many users as possible. All safety measures must be ensured along with a focus on the technical standards of the context under investigation.
4. It must be easily perceivable and recognizable, located at a position such that it is of maximum use to the users of the space.
5. To avoid vandalism, urban furniture should be produced with durable materials. It can either be mounted on durable structures or can rise above the ground as an extension.

2.1.4 Guiding Principles for Selecting and Placing Elements

As people-public facilities interaction is inev21qxitable in an urban public space on a daily basis, the design, installation and maintenance of urban furniture is integral at the user level. The principles associated with urban furniture in a public space can be summarized as under (Siu, 2015):

Principles for Selection

1. Identity and Unity

   Materials, colors and finishes of the furniture should complement one another and the surrounding urbanscape. The most common way to create unity is to select a family of elements. Particularly for higher order transit systems, the family of elements should be branded. Some urban public spaces may require a uniquely identifiable family that enhances its character.

2. Size and Scale

   The furniture elements should be of a size that fits proportionately in the public space, with respect to floor area as well as height. It will be useful to use the same type of furniture in varied sizes according to space usage requirements.

3. Flexibility

   The design and location must be flexible to meet the changing demands of various urban conditions (Siu, 2015). Modular products or product families should be selected to provide a range of elements that can be used in a variety of different styles and configurations. The design should broaden the range of functions supported by various elements of furniture. This can be achieved by combining closely related functions into one, using simple operations to carry out different functions and using modularity in design and location. Urban furniture should be designed to accommodate changing circumstances.

4. Accessibility and Comfort

   The design must be inclusive enough to fulfil, with a degree of use fitness, the actual needs and preferences of site users. To do so, one must provide the users with a choice of operating methods (Siu, 2015), designed for people with a wide range of abilities.

5. Maintenance and Sustainability

   Urban furniture should be weather-resistant and durable. The fixtures should also be resistant to graffiti and vandalism. Selection of elements should be such that they are easy to repair and replace individually. Outdated, broken and other furniture elements that are now redundant should be able to be recycled and used to make new products (Siu, 2015).

Principles for Placement

1. Grouping and Spacing of Elements

   The furniture should be grouped and laid out in such a way so as to avoid clutter in the public space (Coordinated Street Furniture Guidelines, 2015). Spacing, layout and orientation should

balance both function and aesthetics. Elements from the same family should be grouped together.

2. Accessibility, Use and Maintenance

   The furnishing elements should be placed with sufficient setbacks and clearances so that they can be accessed, used and maintained by people with different abilities. If required, pathways should lead to furniture elements. Layout should not create interferences with pedestrian or vehicular movement. It should be effective and useful to the staff when undertaking their management and maintenance activities (Siu, 2015).

3. Safety

   The location should be such that it is adequately lighted and well-used by pedestrians. It is also important to maintain sightlines.

4. Site Specific Conditions

   The placement, layout and orientation should respond to the architecture of the open space around. The furniture should be oriented towards places of interest. In certain cases, it may be appropriate to take a site-specific approach to furniture selection and placement.

5. Use Patterns

   Locations, quantities and types of urban furniture elements should reflect usage patterns and placement opportunities.

Failure to observe necessary principles can result in inoperative, confusing and visually polluted urban furniture (Allahdadi, 2017).

2.1.5 The Socio-Cultural Design Approach

Place constitutes an important part of human identity. Previous researches show that place plays a fundamental role in cultural changes, prevalence of human lifestyles and formation of human values (Allahdadi, 2017). Culture, in a general sense, is a method of living and thinking (Allahdadi, 2017). It is a manifestation of style and method of life of a social group and includes all social relations and information that is passed on from one generation to the next. Words such as ‘synomorphy’ and ‘congruence’ have been used to express the relationship between patterns of physical environment and patterns of behavior.

All activities of urban life are set in public spaces, also acting as the physical manifestation of modern socio-cultural structure in their historical backgrounds. Urban public spaces are like mirrors that reflect the urban identity (Seçil ŞATIR, 2005). Urban temporary template is the cornerstone of

citizens' interactions with the environment. Such events result in the emergence of a sense of belonging and creation of memories. Urban furniture becomes a part of the city and reflects the characteristics of its environment. It must be lively, dynamic and informative, fulfilling the needs of its users when required. Elements that facilitate recreation and entertainment must be inviting. The result is the creation of a dependable, healthy and protective environment. Beyond comfort, the aim of furniture choice is to offer a place with identity and personality in order to encourage people to enjoy urban public spaces (Allahdadi, 2017).

Several articles talk about the importance of furniture in the urban view. *'Importance of Street Furniture in Urban Landscape'* discusses the design and integration of urban furniture elements in order to create a sense of place for the users (Gupta & Bhatti, 2015). It is important to design urban furniture with an architectural quality that can enrich the identity of the place in the city and provide services for creating peace and comfort (Amini, 2006). The design of urban environment and furniture, all around the world, can be linked to identity of the society. The red phone booths in London present a stark example of the same (Gupta & Bhatti, 2015).

The strategies for urban furniture design and placement from the socio-cultural point of view include attention to user behavior in designing the appearance, avoiding creation of obstacles in an urban space and providing a platform for social communications (Allahdadi, 2017).

2.1.6 Understanding Anthropometrics for Furniture Design

Anthropometrics is a research area within physical ergonomics that deals with body measurements, particularly with measurements of body size, shape, strength and working capacity (Pheasant, 2003). The definition of ergonomics, as given by the International Ergonomics Association (IEA), reads as follows:

"Ergonomics (or human factors) is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimize human well-being and overall system performance."

Historically, the theory of human proportions began to gain great significance during the classical times. According to the knowledge gained during the classical times, certain whole number ratios between the dimensions of the body and its component parts are essentially harmonious (Pheasant,

2003). The most detailed system of human proportions is visible in the celebrated drawing of the 'Vitruvian Man' by Leonardo da Vinci (refer figure 9). It deals with the idealized version of human beings as they ought to be according to some pre-existing aesthetic or metaphysical principle, rather than real human beings as they actually are (Pheasant, 2003).

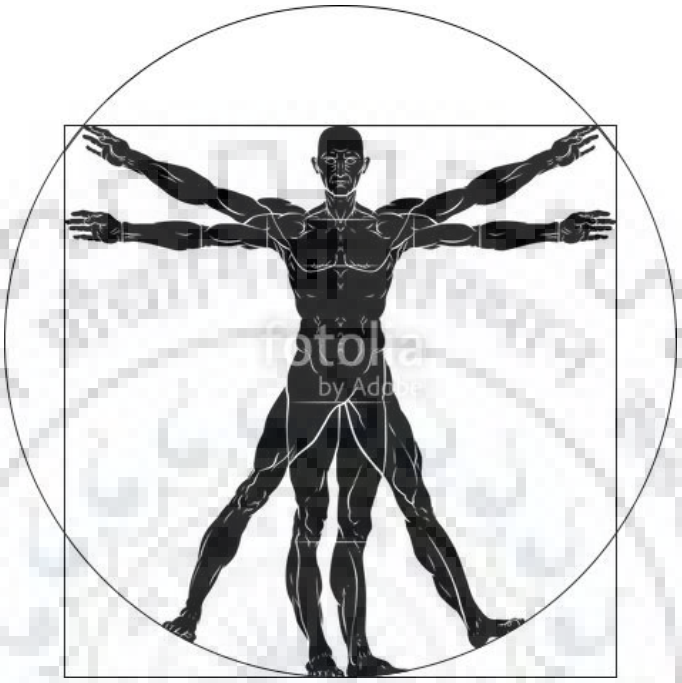


Figure 9 - An illustration based on the Vitruvian Man by Leonardo da Vinci.
Source: https://www.fotolia.com/id/193093948

The dimensions of the individual human being vary with time and from one person to another (Handbook on Barrier Free and Accessibility, 2014). In addition to this, the average dimensions vary from one country to another (Handbook on Barrier Free and Accessibility, 2014). When adopting a user-centric design approach, size variations between males and females as well as between different ages must be considered.

When considering ergonomics, the design of urban furniture must focus on man by taking into account the physical and psychological capabilities of humans. Factors such as body posture and movement (sitting, standing, lifting, pulling and pushing), environmental factors (noise, vibration, illumination, climate and chemical substances), information and operation (information gained visually or through other senses, controls, relation between displays and controls), as well as work organization, all play a crucial role in ergonomics (Dul & Weerdmeester, 1993). As a result of its application, the ergonomic approach to furniture design plays an important role in prevention of inconveniences (Dul & Weerdmeester, 1993). The result is an environment that fits people, rather

than the other way round (Dul & Weerdmeester, 1993). Most designs, in the first instance, are mostly suited to only 95% of the population (Dul & Weerdmeester, 1993). This means that the design excludes 5% of the users who require special, individual measures (Dul & Weerdmeester, 1993). Examples of such users are people who are too short or too tall, overweight people, the handicapped, the young, the elderly and pregnant women (Dul & Weerdmeester, 1993).

According to the principle of user-centered design, *"If an object, a system or an environment is intended for human use, then its design should be based upon the physical and mental characteristics of its human users (Pheasant, 2003)."* Inclusive design is an example of a user-centered design approach in practice that aims to consider ergonomics for a wide range of users (Waller, Bradley, Hosking, & Clarkson, 2013).

2.2 URBAN PUBLIC SPACES: AN OVERVIEW

2.2.1 Definitions and Classification

The Charter of Public Space defines urban public spaces as all places that are publicly owned or of public use, accessible and enjoyable by all for free and without a profit motive. Each urban public space has its own spatial, historic, environmental, social and economic features (Lancerin, Sepe, & Garau, 2013). Urban public spaces are areas of use which, when defined from the periphery to the center, can be grouped as surrounding spaces, semi-urban spaces and urban spaces. These spaces consist of developed and undeveloped land, forming the backdrop for all urban events (Seçil ŞATIR, 2005). Public spaces are generally functional gaps which are open to public, and organized for constant use.

In the formation of open space systems in the urban space, modeling the urban infrastructure and land use are important subjects of urban design (Seçil ŞATIR, 2005). It consists of all the complementary elements that help organize urban life (Riki, Riki, Rouzbeh, & Sarabandi, 2015).

In the larger context of urban infrastructure, public spaces may seem to be insignificant at first. The relationship is a two-way dependency with public spaces depending on urban infrastructure for provision of services, regulation and maintenance. Urban infrastructure in turn depends on urban public spaces to merge the services and to create a platform to bring societies together.

Urban public spaces are fundamental to the physical environment in the primary definition of urban identity and are spaces that are furnished with urban furniture. Urban furniture aims to bring

certain services to the dwellers (Seçil ŞATIR, 2005), creating harmony between the city and its residents. A review of more than a thousand public spaces around the world has led to the conclusion that the presence of the following qualities make an urban public space successful; accessibility, vitality and presence of activities, comfort and sociability (Allahdadi, 2017). The quality of urban spaces is the result of the mutual interactions between human culture and characteristics of natural environment, with urban furniture creating a space for rest, sitting, eating, and social encounters with others (Allahdadi, 2017).

Public spaces can be classified into a wide range of categories, each classification made by either a leading figure in the field of urban design or a reputed organization/ institution. Matthew Carmona, a Professor of Planning and Urban Design at The Bartlett School of Planning, UCL, in her research article *'Re-Theorizing Contemporary Public Space: A New Narrative and a New Normative'*, talks about classification of urban public spaces on the basis of form, function and rights of responsibility (Carmona, 2014). Another major contribution to the same has been made by the UN Habitat by introducing the 'Global Public Space Toolkit' with categories such as streets, public open spaces and public urban facilities, under the broad heading of typology. The Charter of Public Space and the University of Calgary classify urban public spaces on the basis of typology only, with several sub-categories within in.

Table 2 - Typologies of urban public spaces.

TYPOLOGIES OF URBAN PUBLIC SPACES			
AUTHOR	**YEAR**	**CLASSIFICATION BY**	**TYPE OF PUBLIC SPACE**
B.V. Doshi	-	-	Street Bazaars
			Local Activity Streets and Squares
			Activity Nodes
			Public Greens
			Hawkers' Public Spaces
Matthew Carmona	2014	Form	Plazas
			Courtyards
			Incidental Spaces
			Garden Squares
			Forecourts

			Other Spaces
		Function	Community
			Corporate
			Undefined
			Domestic
			Civic
			Consumption
			Service
			Transit
		Rights & Responsibility	Purely Public
			Public Private
			Private
UN Habitat - Global Public Space Toolkit	2014	Streets as Public Spaces	Streets, Avenues and Boulevards
			Squares and Plazas
			Pavements
			Passages and Galleries
			Bicycle Paths
		Public Open Spaces	Parks
			Gardens
			Playgrounds
			Public Beaches
			Riverbanks and Waterfronts
		Public Urban Facilities	Public Libraries
			Civic/ Community Centers
			Municipal Markets
			Public Sports Facilities
Charter of Public Space	2013	Typology	Spaces that have an exclusive or prevalent functional character.
			Spaces that presuppose or favor individual uses.

			Spaces that, by mix of form, function, meanings and by connecting the built with the non-built, have the prevalent role of aggregation and social condensation.
Department of Local Government, Sport & Cultural Industries (Australia)	2012	Catchment Hierarchy	Local Open Space
			Neighborhood Open Space
			District Open Space
			Regional Open Space
		Function	Recreation
			Sport
			Nature
University of Calgary	2010	Typology	Street
			Square
			Park, Garden, Cemetery
			Linear System, Green Corridor
			Outdoor Sport/ Recreational Facility
			Campground and Picnic Areas
			Natural/ Semi-Natural Green Spaces
Peter Bosselmann	2008		Streets
			Public Squares
			Public Plazas
			Intersections and Junctions
Henri Lefebre	1991	Production of Public Space	Perceived Space
			Conceived Space
			Lived Space
			Rural Public Space
			In-Between Space

William H. Whyte	1980	-	Public Plazas
			Streets
			Plazas at Street Corners
			Urban Greens
			Concourses
			Walkways
Jan Gehl	1971	-	Parklands
			Riverbanks
			Public Squares
			Streets and Laneways
Jane Jacobs	1961	-	Streets and Sidewalks
			Neighborhood Parks
			Mixed-Use Spaces

The classifications made according to activity diversity and the associated physical environment may be defined as temporary, permanent, and functional. The service areas or areas of auxiliary uses are related to arrangement, maintenance, infrastructure, security, etc. and are given by means of permanent or temporary tools and equipment (Seçil ŞATIR, 2005).

2.2.2 Global Perspectives

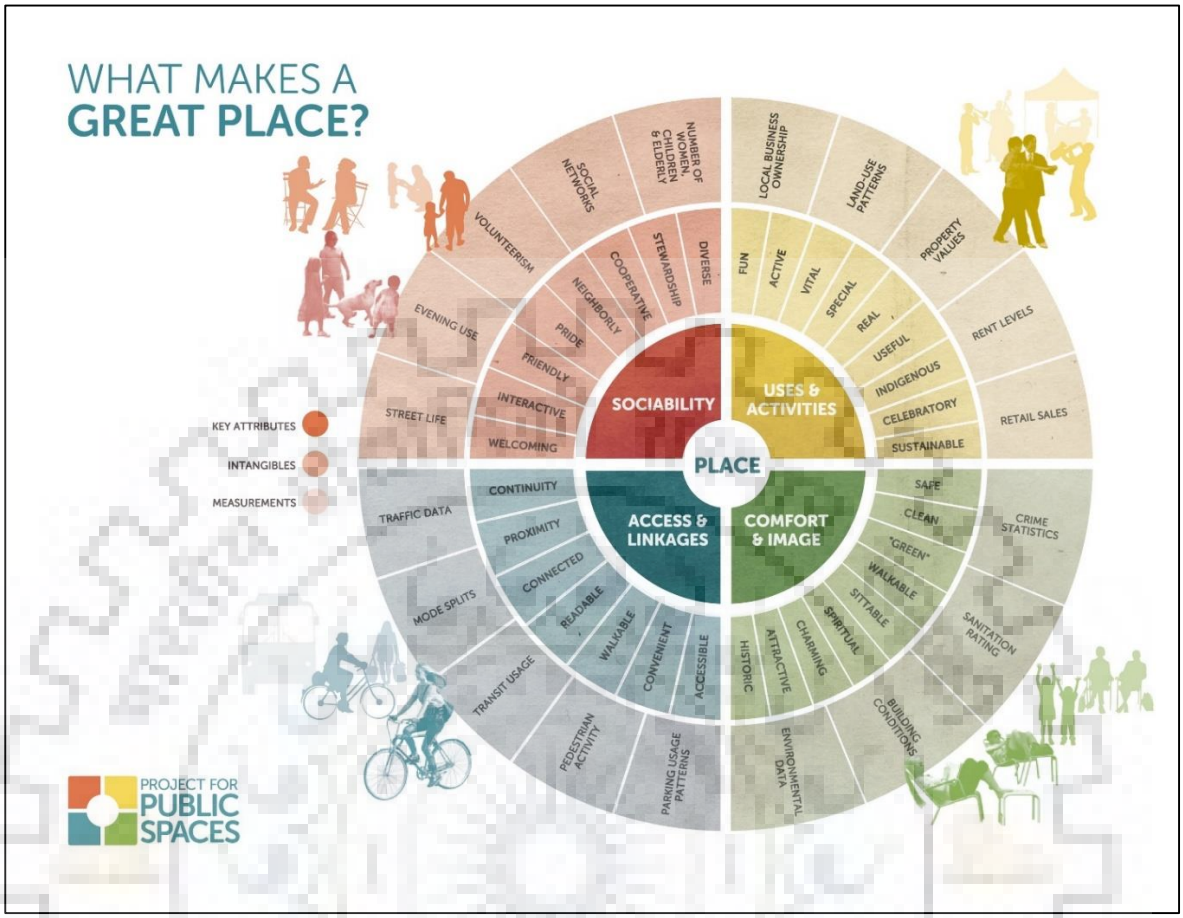


Figure 10 - 'What Makes a Great Place' by Project for Public Spaces.
Source: https://www.pps.org/article/grplacefeat

According to the 'Project for Public Spaces', public spaces enhance the civic realm by adding a sense of character and providing a forum for public activities. Such places offer opportunities for people to relax, making the community more livable (refer figure 10). Public places offer open forums for people to encounter art, to enjoy performances, and to participate in other cultural activities. From *'Shakespeare in the Park'* festivals to string quartets at a downtown plaza, good places foster and enhance a city's cultural life (Great Public Spaces: What Makes a Place Great?, 2008).

In the words of Jan Gehl, *"In a society becoming steadily more privatized with private homes, cars, computers, offices and shopping centers, the public component of our lives is disappearing. It is more and more important to make the cities inviting, so we can meet our fellow citizens face to face and experience directly through our senses. Public life in good quality public spaces is an important part of a democratic life and a full life."* Public spaces contribute to community health, whether socially, economically, culturally or environmentally.

In order to correlate public space and public life, Jan Gehl categorized activities as either optional or necessary. This illustration (refer figure 11) dates back to the 20th century. If the same diagram were to be produced in the today's world, it would include new activities, using a gadget for example. The nature of activity would also vary from one place to another.

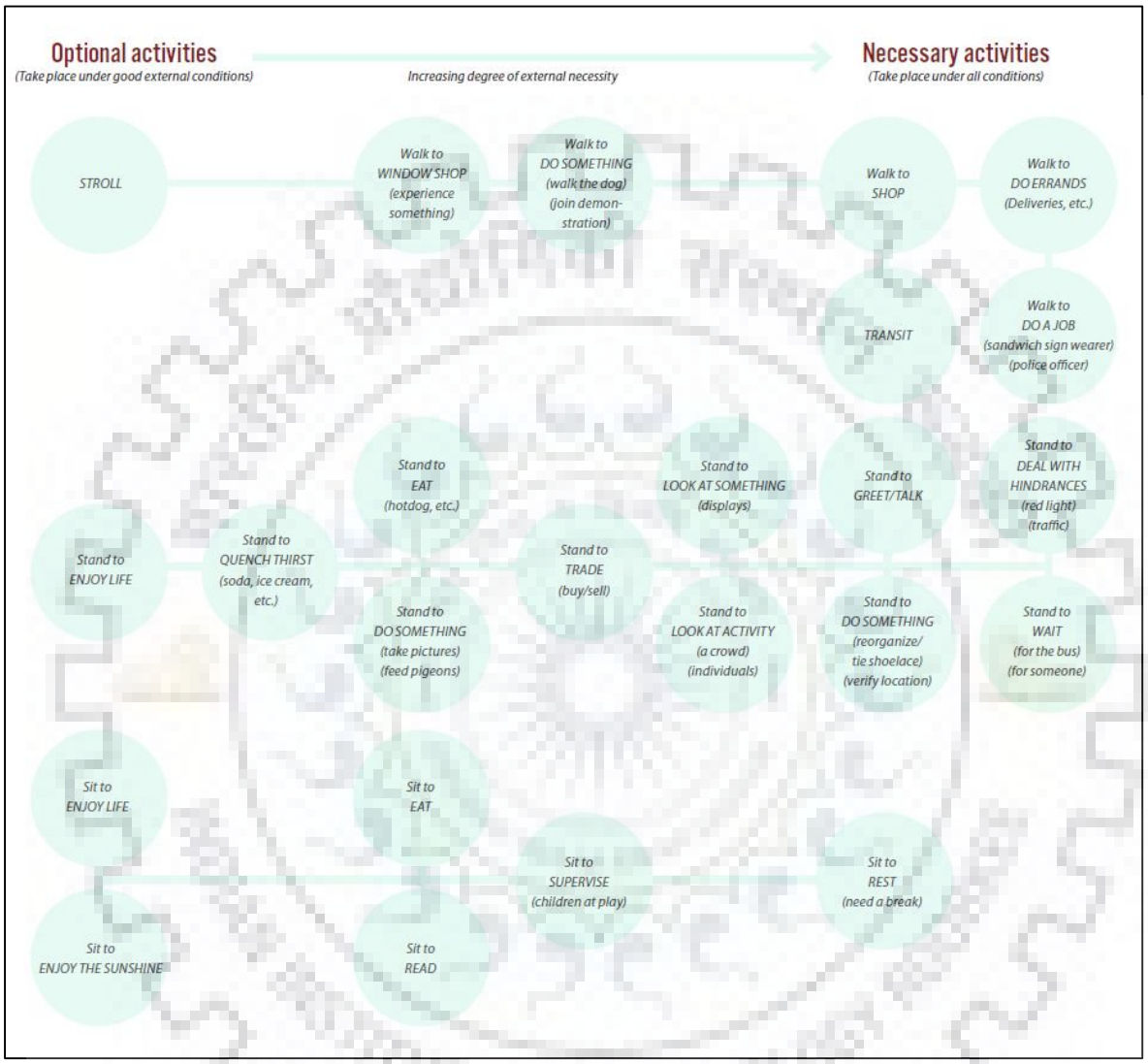


Figure 11 - Jan Gehl, "People on Foot", Arkitekten No. 20/ 1968

Source: (Gehl & Svarre, 2013)

Jan Gehl, in the year 1974, developed a list of quality criteria for evaluating and comparing various public spaces. Over the years, the 43 criteria were reduced to 12 and are now being used as a checklist for public space assessment. The 12 criteria are broadly divided into four categories: protection, comfort and enjoyment (refer figure 12).

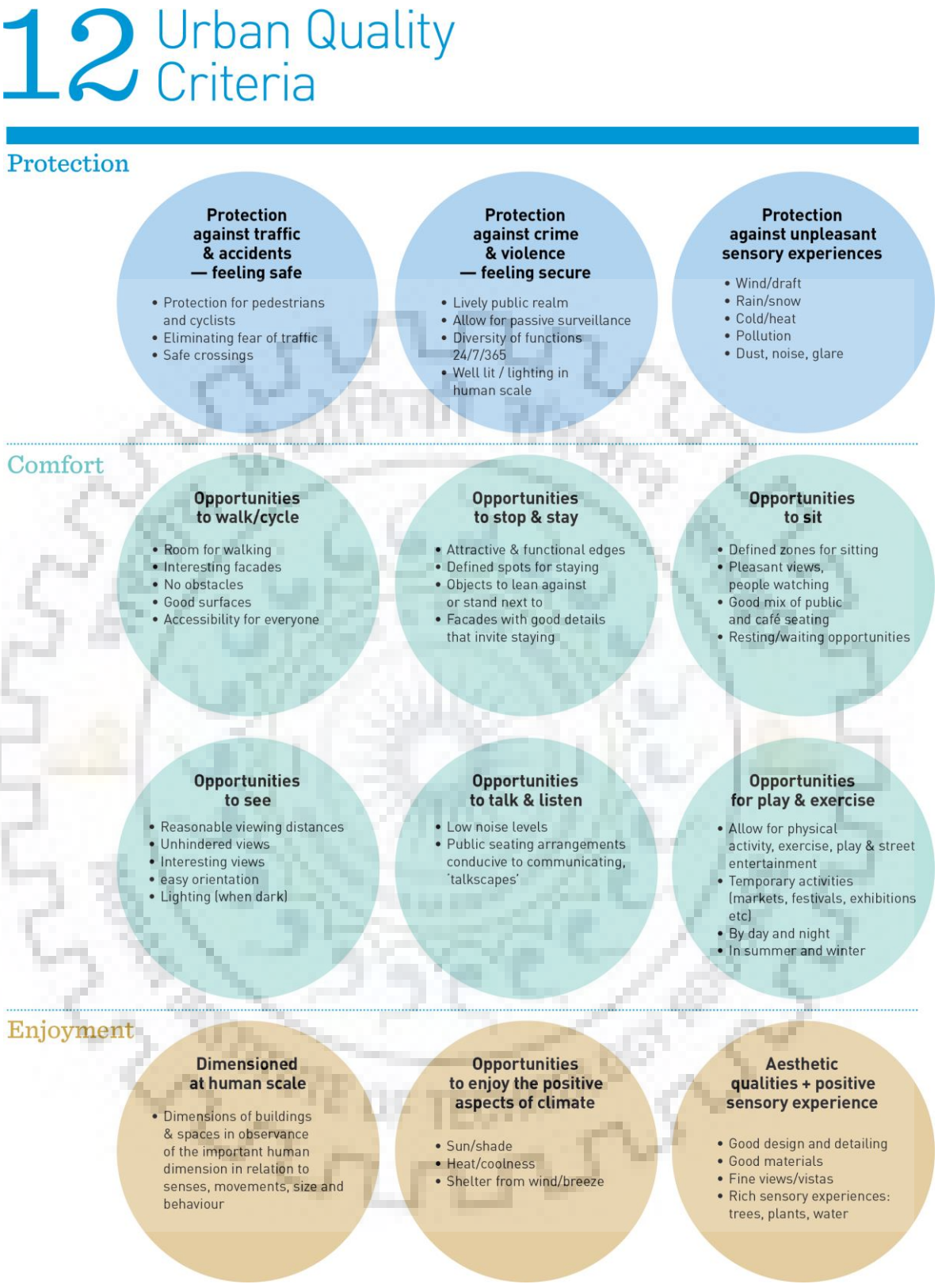


Figure 12 - 12 Quality Criteria by Jan Gehl.

Source: (Gehl & Svarre, 2013)

2.2.3 Human Inclusion in Public Spaces

The ’12 Quality Criteria’ for urban public spaces by Jan Gehl summarizes the qualities that make a public space useful and inclusive. Further, it can be seen that majority of these qualities emerge from a focus on elements of urban/ city furniture.

Urban public space is a four dimensional entity (Akkar), the fourth dimension being that of time. In order to study human inclusion in a public space, it is necessary to understand how the space and its elements work in a twenty four hour cycle. The following features of public spaces can be extended to urban furniture, making the space more inclusive for human activity (Nadimpalli, Babiona, & Das, 2018):

1. The layout and design of elements in the public space should not favor specific groups.
2. Inclusive design encourages a diverse mix of people to use public spaces. The features of deign make them feel safe and comfortable. The furnishings of the public space should cater to both inter-generational and inter-cultural diversity.
3. Human inclusion, by its very definition, requires one to respect and acknowledge the presence of people of all age groups, genders and abilities who constitute the users of furniture.
4. Inclusive spaces can prosper only when they are open, free and accessible, meaning that the arrangement of elements must not hinder human activity flow patterns in any way. Urban furniture and consequently the urban public space should allow flexibility in its use to suit the changing needs. The public space should be activated at all times, even if used differently at different times of the day.
5. Inclusion depends on real participation, building place-based relationships and fostering a sense of belonging.

2.3 INCLUSIVE DESIGN FOR FURNITURE IN PUBLIC SPACES

2.3.1 Definitions and Dimensions

An inclusive design approach can be used in order to achieve a design that can successfully be used by the whole target group (The EIDD Stockholm Declaration, 2004). Inclusive design aims to create designs for human diversity (refer figure 13), social inclusion and equality, enabling all people to have equal opportunities to participate in every aspect of the society (Waller, Bradley, Hosking, &

Clarkson, 2013). The Inclusive Design Research Center at OCAD University defines Inclusive Design as:

"Design that considers the full range of human diversity with respect to ability, language, culture, gender, age and other forms of human difference (What is Inclusive Design?, n.d.)."

The subject of 'Inclusive Design' is vast with multiple definitions. For this dissertation, the following operational definition shall be used:

"Inclusive design caters to the needs and aspirations of as many end users as possible, regardless of their age or ability, positively influencing product design and the built environment, and thus society as a whole (Richards, 2017)."

Inclusive design aims to make the space or product accessible to as many end users as possible. Meeting all accessibility standards, however, is not the aim of inclusive design. Accessibility can be defined as the ability of the space or product to match the requirements of individual users by provision of specific features for persons with disabilities. Ideally, accessibility and inclusive design work together to make spaces that are not only compliant with the standards but also truly usable and open to all (Holmes, 2018).

Figure 13 - Depicting diverse users groups.
Source: https://app.emaze.com/@AOFOFIZZL

Inclusive design must hold and support both diversification and cohesion (or inclusion). While inclusively designing urban furniture, the following three dimensions of inclusive design (refer figure 14) must be kept in mind:

1. Recognize Diversity and Uniqueness

   Inclusive design considers the diversity in users of the site. As individuals move away from the hypothetical average, the needs become more and more diverse. A mass solution, therefore,

does not work when designing macro or micro elements of urban furniture. Optimal inclusive design maintains interoperability and is best achieved through one-size-fits-one configurations (What is Inclusive Design?, n.d.). This, however, does not call for a specialized solution for individual user types.

2. Inclusive Process and Tools

   The process of designing inclusively should be able to generate feedback, through field interviews, from diverse user groups. All users ranging from the average to the extreme should be made part of the design process.

3. Broader Beneficial Impact

   Urban designers are required to be aware of the context in which the design is being implemented in order to create a broader design impact. The curb-cut effect is an example of inclusive design, recognizing the interconnectedness of users and systems.

Figure 14 - Dimensions of inclusive design as given by IDRC.

Source: https://idrc.ocadu.ca/about-the-idrc/49-resources/online-resources/articles-and-papers/443-whatisinclusivedesign

2.3.2 Taking Cues from Universal Design

"Universal Design assumes that the range of human ability is ordinary, not special."

- Elaine Ostroff, 2001

The Disability Act 2005 defines Universal Design as:

"The design and composition of an environment so that it may be accessed, understood and used to the greatest possible extent, in the most independent and natural manner possible, in the widest possible range of situations and without the need for adaptation, modification, assistive devices or specialized solutions, by any persons of any age or size or having any particular physical, sensory, mental health or intellectual ability or disability."

Universal Design creates design solutions that are inclusive and promote accessibility, allowing people with different levels of ability to remain as independent as possible (Benefits and Drivers, n.d.). It is, however, not a synonym for compliance with accessible design standards Developed in 1997, the '7 Principles of Universal Design' (refer figure 15) are meant to guide the design of products and environments. This is not a special requirement, for the benefit of only a minority of the population. It is a fundamental condition of good design. If an environment is accessible, usable, convenient and a pleasure to use, everyone benefits. From micro to macro, Universal Design has implications for the design of any single feature of a product, service or environment, as well as the design of that product, service or environment as a whole.

Figure 15 - 7 Principles of Universal Design given by North Carolina State University.

Source: http://universaldesign.ie/What-is-Universal-Design/The-7-Principles/

In addition to this, the Center for Inclusive Design and Environmental Access (IDeA Center) at the University of Buffalo, New York, is dedicated to making environments and products more usable,

safer and healthier in order to respond to the needs of an increasingly diverse population. In the words of Steinfeld and Maisel, *"Universal Design is a design process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation."* (Steinfeld & Maisel, 2012).

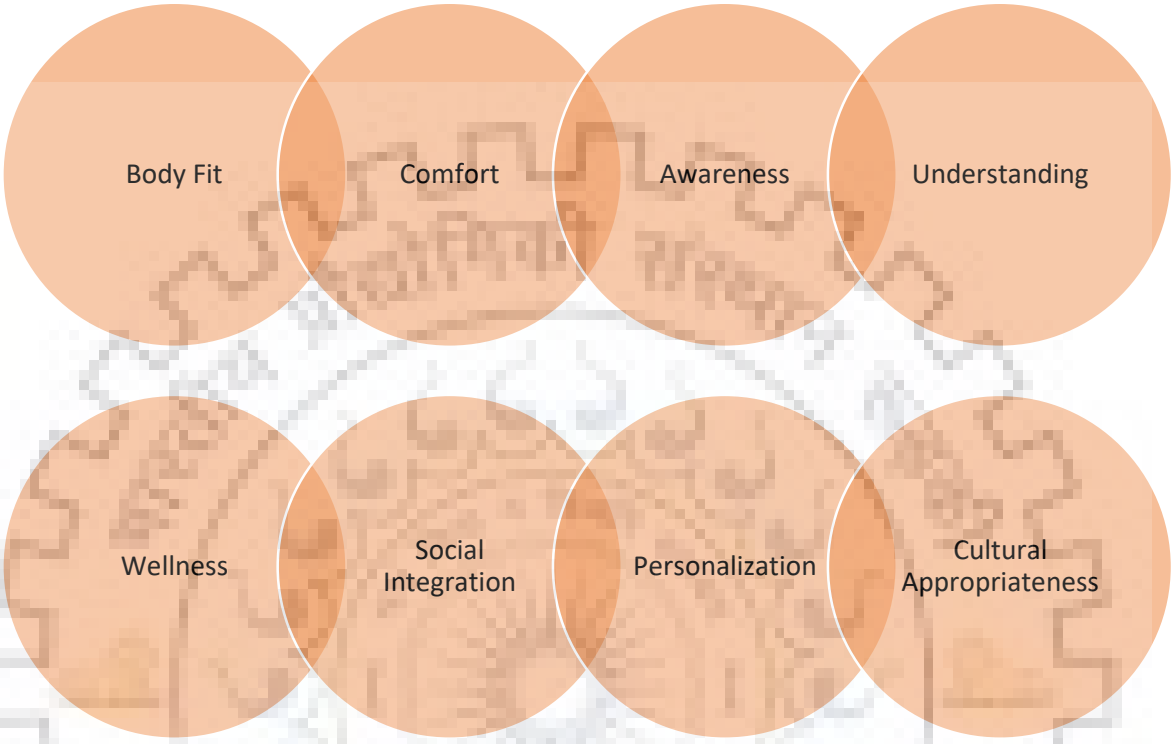


Figure 16 - 8 Goals of Universal Design

Source: http://www.buffalo.edu/access/help-and-support/topic3/GoalsofUniversalDesign.html

Figure 17 - 5 Universal Design India Principles

Source: (Khare, Mullick, & Raheja, 2011)

The '8 Goals of Universal Design', as given by the IDeA Center (refer figure 16), define the outcomes of the practice in ways that can be measured and applied to all design domains (Steinfeld & Maisel,

2012). The Universal Design India Principles (refer figure 17) were developed by an interdisciplinary team of Indian experts, aimed at addressing the needs of the diverse population in the Indian context. The idea was to regionalize and localize the global idea of Universal Design in order to suit the social and cultural needs of the Indian people. The '7 Principles of UD' mentioned earlier remain as overarching principles, complemented by UDIP for addressing the issues of local importance and the needs of diverse Indian users across various ages, abilities and socio-economic strata.

2.3.3 Whom to Include?

Public spaces, by nature, are socially inclusive and pluralist (Tiesdell & Taner, 1998). The inclusive public space can be said to possess the following mutually supportive qualities; physical access, social access, access to activities and discussions and access to information (Akkar). Physical access refers to access to the physical environment. Social access, also referred to as symbolic access, involves the presence of people and space defining/ confining elements. It is therefore important to improve the image and ambience of a public space to make it more welcoming to a wider range of social groups. This can be done by focusing one's attention on the physical elements that make a public space, namely urban furniture.

Urban public spaces provide a shared service to various groups of a society; namely where individuals and groups of different social, cultural, and economic structure, from different genders, ages and levels of education, traditions, customs, and backgrounds are together. Meeting the needs and demands of this large user group is the common task of urban planners, urban central designers, and urban furniture designers (Seçil ŞATIR, 2005). Within the diversity mentioned above, this dissertation focuses on:

1. People of all genders: males, females and others
2. Ages: children, young adults, adults and the elderly
3. People with mobility-related impairment: wheelchairs and crutches
4. Visually impaired: partial and complete visual impairment
5. Others: people walking with strollers

For this research project, all activity maps follow a legend wherein males are represented in blue, females in pink, children in red and the elderly in green. People with mobility-related and visual impairment (partial or complete) have been represented in yellow and those walking with strollers in orange.

2.4 CASE STUDIES OF INCLUSIVE URBAN FURNITURE

2.4.1 Selection Criteria

Table 4 below summarizes the criteria that were kept in mind while selecting case studies for internet based research. The selected studies showcase noteworthy examples of inclusive urban furniture from around the world.

Table 4 - Criteria for selecting case studies.

CRITERIA FOR SELECTING CASE STUDIES			
Criteria	**Harvard Plaza, USA**	**Red Ribbon Park, China**	**Dilli Haat, New Delhi**
Presence of Inclusive Furniture Elements	Public Seating Flooring Bicycle Racks	Seating Furniture Pavilions Wooden Deck Flooring	Flooring Ramps Shop Counters
Size/ Scale of the Public Space	1.2 Acres	50 Acres	6 Acres
Similarity to Climatic Context	Similar to German Climate	Similar to Indian Climate	Located in the Indian Context

2.4.2 The Humble Public Bench at Harvard Plaza, Cambridge, USA

Location: Cambridge, USA (2013)

Area: 1.2 Acres

Typology: Institutional Public Space

Figure 18 - Use of the 'Humble' Seating.

Source: http://www.stoss.net/projects/16/the-plaza-at-harvard/

Figure 19 - 3D View of the plaza at Harvard University.
Source: http://www.stoss.net/projects/16/the-plaza-at-harvard/

Elements of Inclusive Urban Furniture Identified:

1. Public Seating
2. Innovative Flooring Material
3. Bicycle Racks

The Plaza at the Harvard University (refer figure 18) is a gathering space that serves students, faculty, staff, visitors and the local community. It is a hub of campus life that draws students to large and small events of all kinds. This includes a farmers' market, food trucks, impromptu performances, and alumni gatherings. The public seating provides a casual gathering spot for students and the local community (refer figure 19).

There are 17 benches, made up of 7 types, each with similar ergonomically-sound geometries (refer figure 20). Some have high backs, some have low. Some are upright, while others are low-to-the ground. With the human body in mind, each bench type has been created as a 1 to 1 prototype to incredible precision using advanced fabrication technologies. The seating furniture, thus produced from sustainably-sourced and reused yellow cedar, accommodates people's bodies in various ways.

It provides moments for individuals to sit alone or in groups, in sun or full shade, lounging or seated next to one another. All genders and ages have been taken care of.

Figure 20 - Ergonomically designed benches in the plaza.

Source: http://www.stoss.net/projects/16/the-plaza-at-harvard/

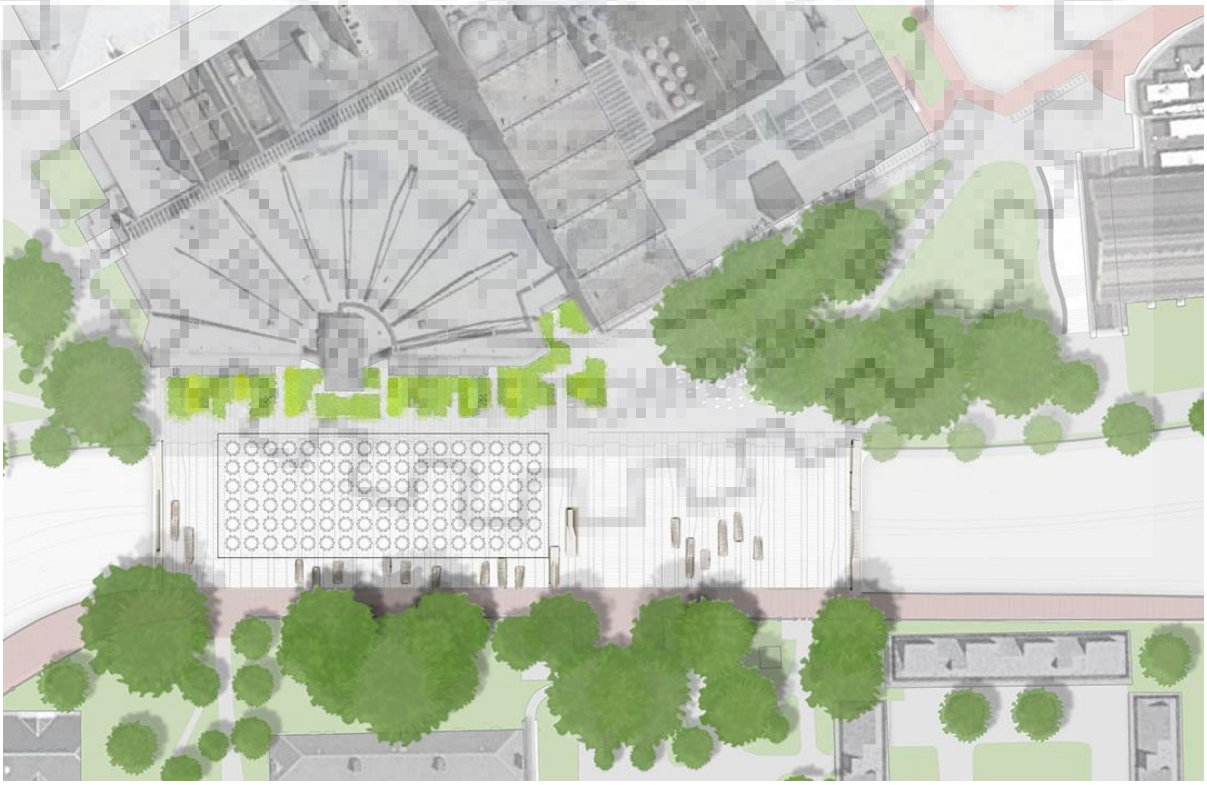


Figure 21 - Plan of the plaza showing layout of the benches.

Source: http://www.stoss.net/projects/16/the-plaza-at-harvard/

As shown in figure 21, the plaza is bordered by lush groves of sumac, gingko and ferns on the northern edge, offering shade for students and visitors to gather. The floor is covered with a high-performance surface of sustainable concrete pavers (refer figure 22), manufactured from recycled porcelain. It provides flexibility for an array of university events and directs storm water to the groves where it can infiltrate into the ground.

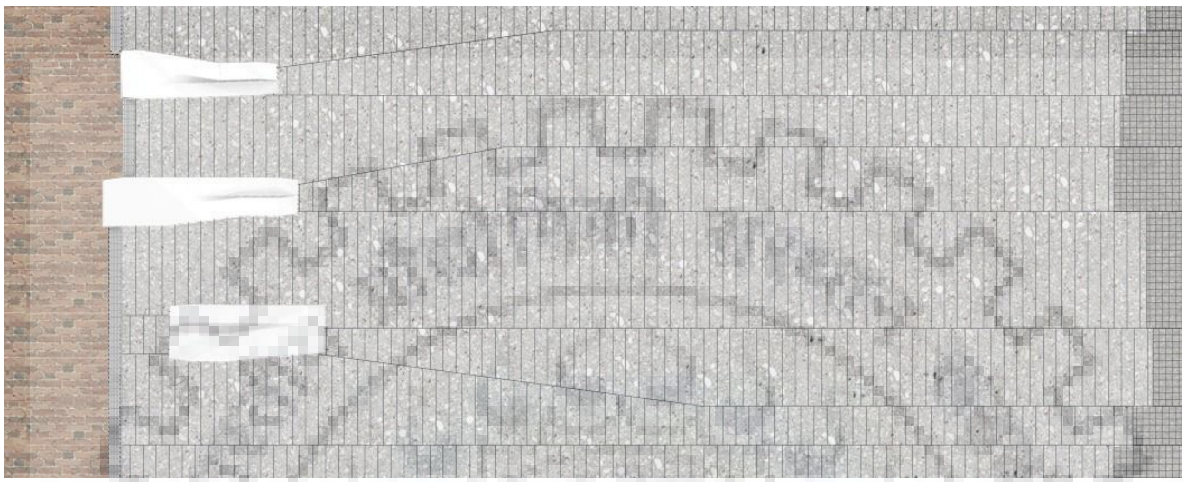


Figure 22 - Sustainable concrete pavers designed to direct storm water towards the edges.
Source: http://www.stoss.net/projects/16/the-plaza-at-harvard/

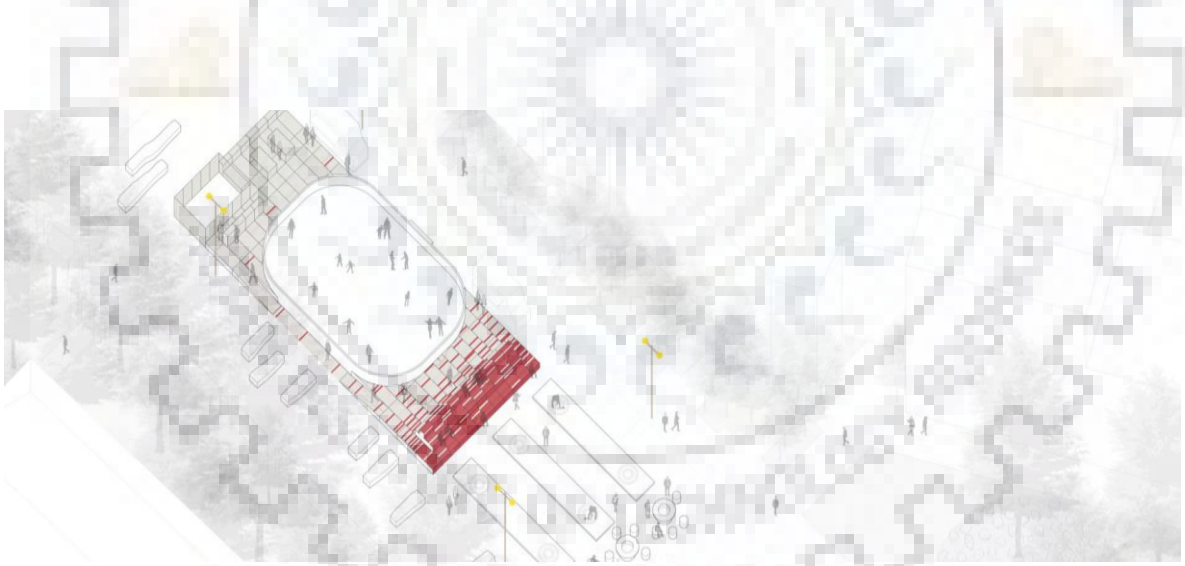


Figure 23 - Temporary skating rink installed during the winters.
Source: http://www.interboropartners.com/projects/winter-wonderplan

It is interesting to note that the plaza aims to provide scope for flexibility in use with variations in climatic conditions. Though just a proposal at the moment, figure 23 shows how the plaza incorporates an ice skating rink for the winter months. This is in addition to the originally existing humble public benches.

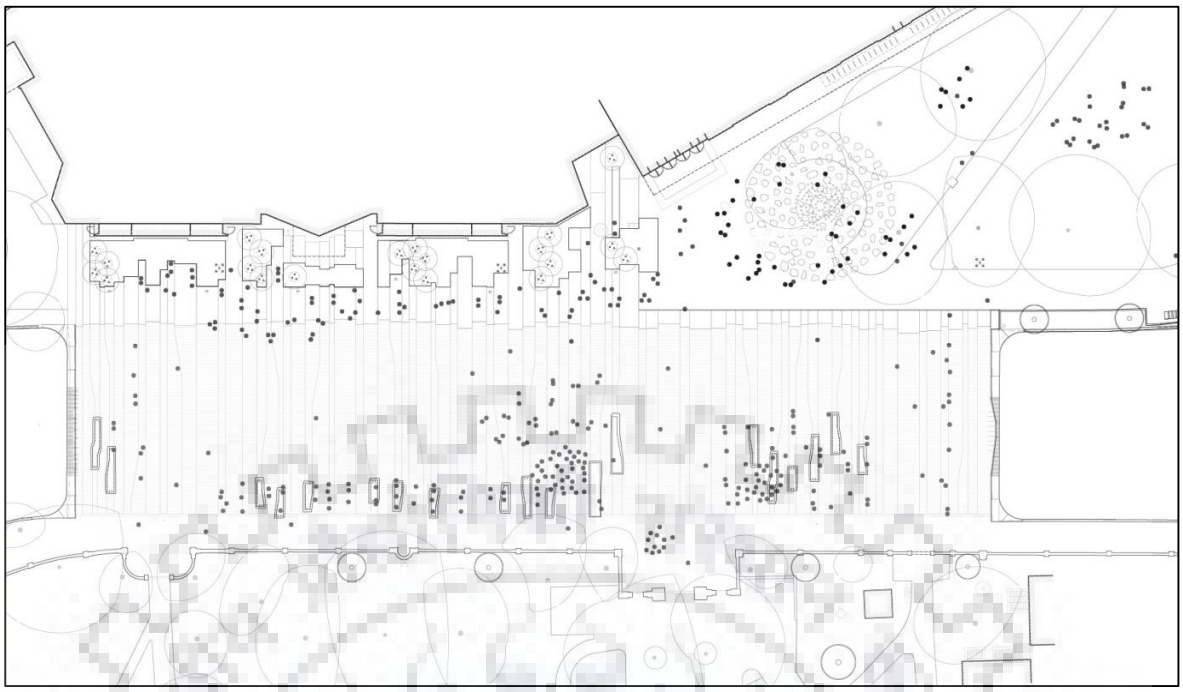


Figure 24 – Activity map developed at the plaza for a weekday evening.
Source: http://www.stoss.net/projects/16/the-plaza-at-harvard/

Low-energy LED panels beneath the benches provide a soft reflective glow at night, inviting everyone to lounge during cool summer evenings. The new benches fit right into the historic landscape of the University. Each unique piece of the bench is logged in the computer system. In this way, if any part of the bench is damaged, the entire system need not be replaced.

Inferences:

1. The redesign of the plaza led to a dramatic transformation of an underutilized field, converting it into a hub of campus life. This was made possible by providing the humble seating that serves users of all categories. Furniture elements lend a unique and distinct character to the space.
2. The flexibility, grouping and spacing of the furniture elements leads to comfort and safety. Light below the benches suggests that the focus of the project was towards a 24 X 7 usage of the space, making it safe and accessible for one and all, at all times of the day. Considering the people with ambulatory disabilities, the flooring has been made without any level differences.
3. With numerable inter-changeable positions, the seating furniture has been designed to suit the needs of the children, young adults, adults and the elderly. In addition to the students, faculty and staff of the campus, the plaza also includes visitors and the local community.

2.4.3 Qinhuangdao Red Ribbon Park, Hebei, China

Location: Qinhuangdao, Hebei, China (2007)

Area: 2,00,000.0 sq.m.

Typology: Riverfront

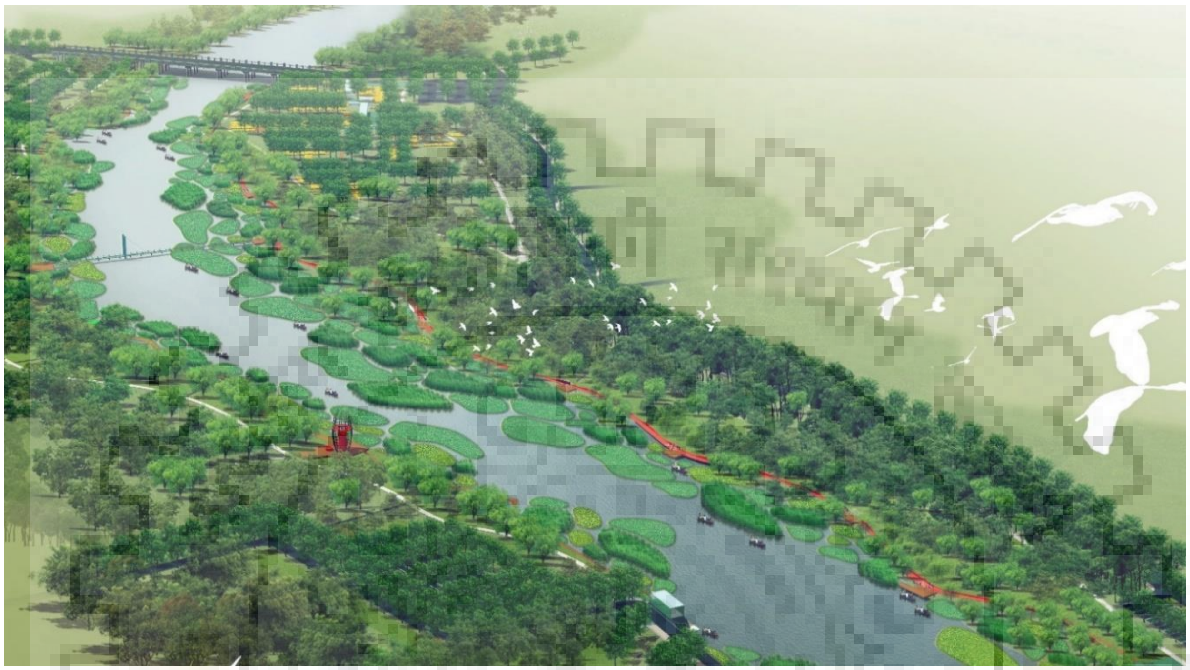


Figure 25 - Bird's eye view of the park.

Source: https://www.archdaily.com/445661/red-ribbon-park-turenscape

Elements of Urban Furniture Identified:

1. Red Ribbon as Seating
2. Pavilions for Rest
3. Wooden Deck Flooring

The park is located on the Tanghe River at the eastern urban fringe (refer figure 25) of Qinhuangdao (Red Ribbon Park/ Turenscape, 2013). Originally a garbage dump, the site was covered with diverse native vegetation, virtually inaccessible and unsafe for people to use. The major challenge was to preserve the natural habitat alongside creating opportunities for recreation.

The 500m long red ribbon was designed as a vivid element, curving with the terrain (refer figure 26). It integrates the functions of lighting, seating, environmental interpretation, and orientation (Red Ribbon Park/ Turenscape, 2013). The ribbon acts as a structural device that reorganizes the formerly unkempt and inaccessible site. Made of fiber steel, the ribbon is lit from inside during the

night. The project demonstrates positively reinforced perceptions of urban public spaces through interventions in urban furniture.

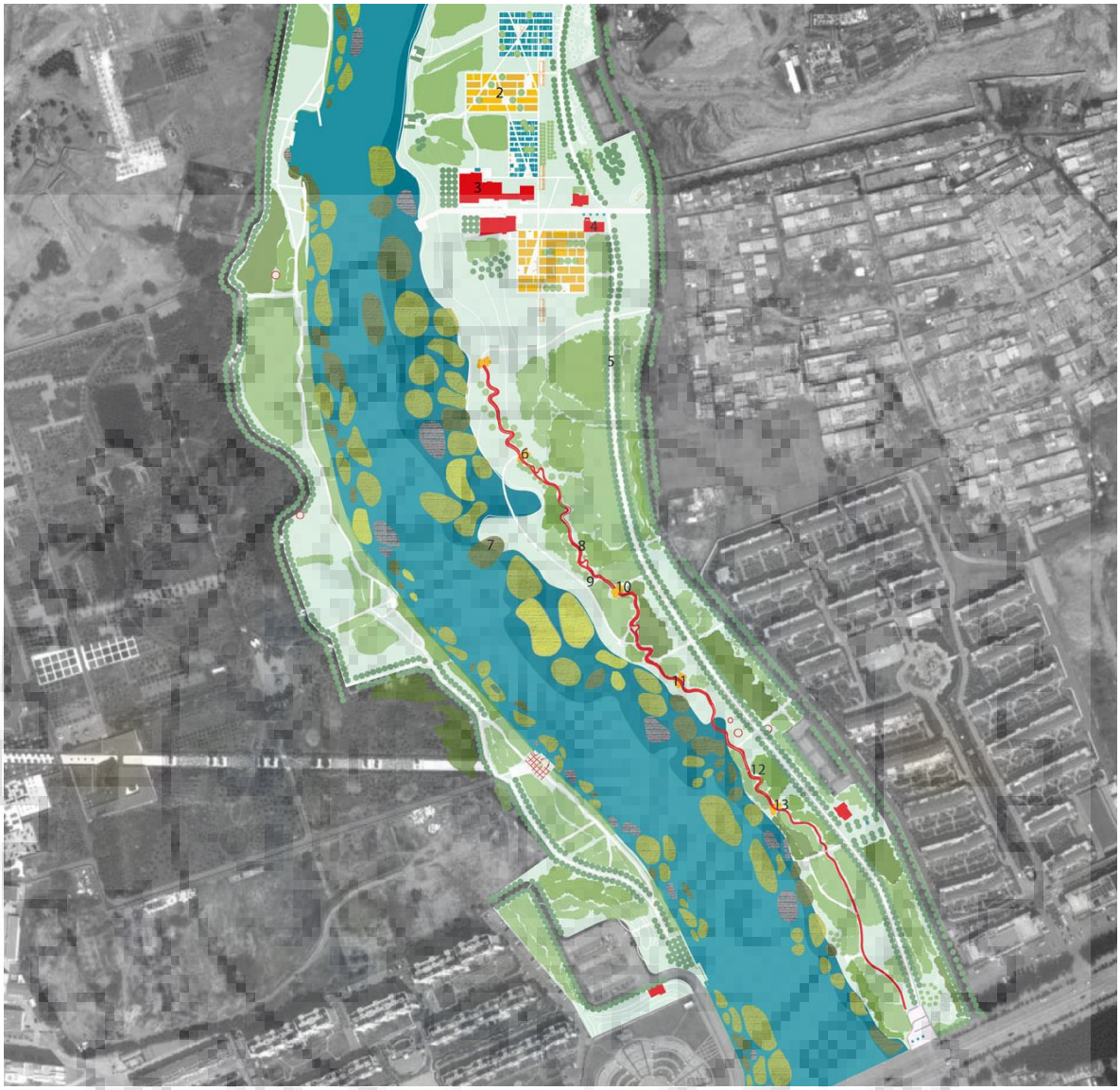


Figure 26 - Rendered image showing the plan of Qinhuangdao Red Ribbon Park.
Source: https://www.archdaily.com/445661/red-ribbon-park-turenscape

Inferences:

1. The red ribbon integrates with the natural environment, running along the edge of the river. The seating furniture responds well to the local context by attracting people from different communities to participate in leisure-related activities at the river.
2. With the design of the red ribbon, the ill-utilized edge of the river has become increasingly inclusive in terms of user diversity, activity diversity, user welfare and comfort. The stark red

color, material and features of the ribbon add distinctiveness and familiarity to the riverfront. Since the ribbon is lit from inside, it makes the place accessible at night as well.

3. The park and riverfront are safe and easy to access for all. The seating furniture, though well-integrated with the site and responsive to the context, has not been designed to suit the ergonomic needs of all age groups, especially the children and the elderly. The wooden deck flooring is well-built without any level differences.

2.4.4 Dilli Haat, New Delhi, India

Location: Aurobindo Marg, New Delhi, India (1993)

Area: 6 Acres

Typology: Food and Crafts Bazaar

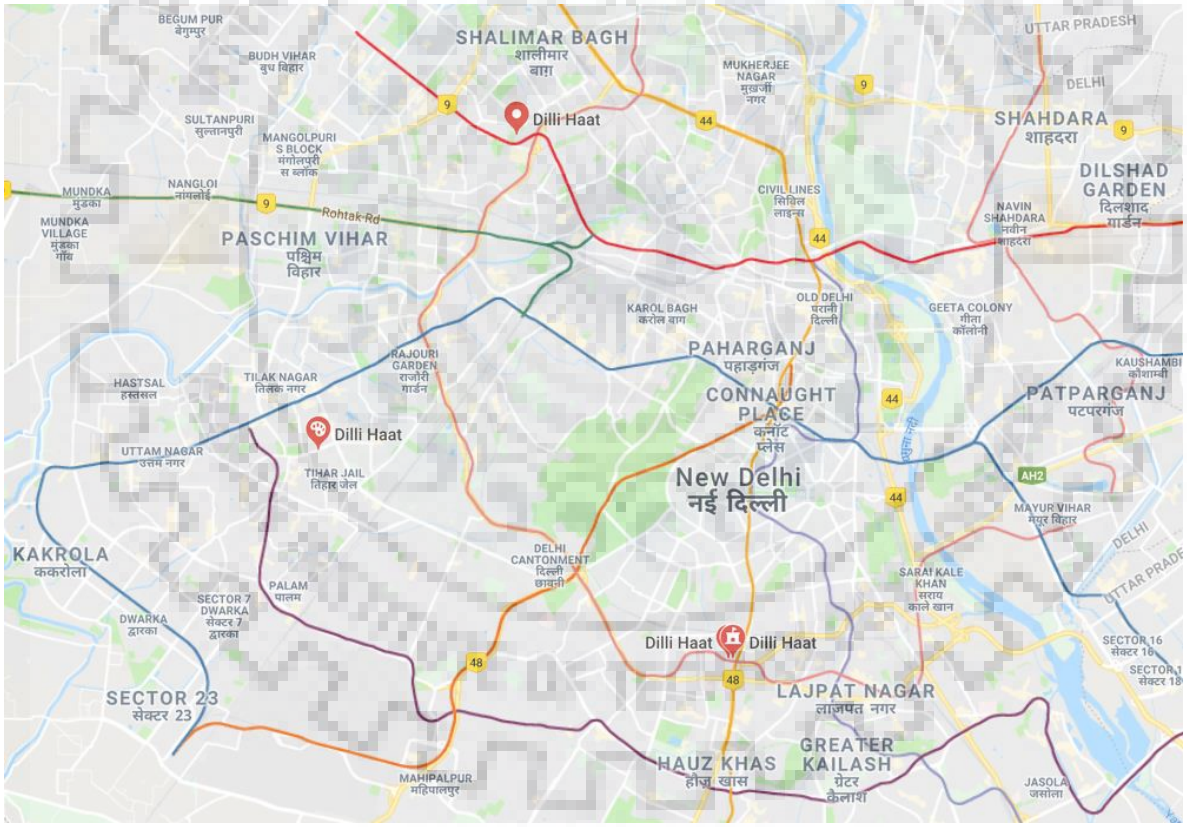


Figure 27 - Location of Dilli Haats in INA, Janakpuri and Pitampura.

Source:
https://www.google.com/maps/place/Dilli+Haat+INA/@28.573618,77.206385,17z/data=!3m1!4b1!4m5!3m4!1s0x390ce3a05beb30d3:0x664ef6c14c65a89!8m2!3d28.573618!4d77.2085737

<u>Elements of Urban Furniture Identified</u>:

1. Flooring
2. Ramps
3. Shop Counters

Originally a storm water drain and garbage dump, Dilli Haat has emerged as an active and engaging public space where local artisans display and sell their crafts (Raheja, Borgmann, & Pillai, 2015). It is not just a market but a public space where rural life and folk art are brought closer to an urban business. Dilli Haat proved to be a boost for tourism alongside integrating the local culture and the marketplace. Its success led to the development of two more Haats in the city, one at Pitampura and another at Janakpuri.

An initiative led by the NGO Dastakari Haat Samiti, Dilli Haat is a food and crafts bazaar that has emerged as one of Delhi's most loved urban leisure spaces (Public Realm: Dilli Haat, Aurobindo Marg, New Delhi, n.d.). Having won the 'National Award for Promotion of Barrier-Free Environment' in 2005, Dilli Haat became one of the first public spaces in the country to be made completely barrier-free.

The flooring is mostly made of Kota Stone and marble. Brick has also been used as flooring material in order to give the look of a village. Delhi quartz and red sandstone have been used as pavers to define the movement corridors. The flooring is inclusive with no level differences and small joint gaps. Counters in the stalls are fixed at a height of 750mm, making it possible for children and for people on wheelchairs to look at products on display. With variations in height, sitting spaces cater to the needs of diverse user groups. Absence of back and arm rests, however, makes them unsuitable for use by the elderly.

Inferences:

1. The project was envisioned to respond to the city's culture, consciously designed as a public space for an average urban Delhi resident, who otherwise did not have enough choices for urban recreation.
2. The flooring and shop counters are truly inclusive while the seating furniture is not.
3. The Haat was conceived as a barrier-free public space, making it suitable for use by people with ambulatory disabilities (wheelchairs and crutches) and visual impairment. Though conceptualized for 1000-2000 people per day, Dilli Haat witnesses up to 3000 people on weekdays and 7000 on weekends (Raheja, Borgmann, & Pillai, 2015). This vitality in itself is an indicator of the public space being inclusive for diverse user groups. Special importance

was given to the needs of the craftsmen and artisans, one of the key stakeholders of the project.

2.5 SUMMARY

After a thorough review of the available literature on urban furniture, public spaces and inclusive design, the following conclusions can be drawn:

1. Urban furniture is fundamental to the concept of human inclusion in an urban public space. Further, the degree of human inclusion is directly proportional to the quality of a public space. Interpretation of data from multiple sources suggests that a strong relationship exists between the three. Urban furniture lies at the core of any public space.
2. Available literature helped understand the necessity of a threefold whole to part analysis of existing urban furniture in the given context i.e. planning and location, design and detail and use and behavior.
3. Case studies of urban furniture around the world highlight the significance of response to context and local identity, the use of inclusive and innovative techniques in furniture design and a focus on needs of key stakeholders.

OBJECTIVE ACHIEVED:

TO DEVELOP A COMPREHENSIVE UNDERSTANDING OF URBAN FURNITURE AND HUMAN INCLUSION IN PUBLIC SPACES.

Chapter 3

Research Design

3.1 METHODOLOGY FOR RESEARCH

(Refer Section 1.7)

3.2 CRITERIA FOR SELECTING PUBLIC SPACE TYPOLOGY

For the purpose of this dissertation, a detailed desk-based literature review was conducted on urban public spaces and their classification. Urban designers and planners have written extensively on public spaces and their works were referred to for generating a list of public space typologies. Other sources of information were reputed organizations/ institutions that have dealt with urban public spaces in the past or continue to do so now. Table 5 summarizes the same from ten such sources.

The spaces were compared on a set of criteria, the criteria having been derived from theoretical sources and field observations. Since the study is majorly field-oriented, it was important, first, to consider the practical aspects of conducting the research on field. To begin with, the location (urban, semi-urban, or rural) and scale (small, medium or large) helped identify typology of spaces, whether manageable or not for an individual research study. Ease of physical access to the public space for the researcher (self) and permission to collect the necessary data during field work played a very important role in selection of the cases. In some public spaces, privacy can be a huge concern, making it difficult for one to collect photographic and videographic data. Since a lot can be inferred by going back and forth on such visual data, public spaces with little or no privacy concerns were chosen. The dissertation aims to focus on areas that are more vibrant, with a diverse group of users performing a wide range of activities around urban furniture for a long duration of time. Since the idea is to study human behavior around urban furniture, more attention was paid to pedestrian-oriented urban public spaces. From the point of view of collecting data on field, availability of base data and ease of data collection supplemented the process of case selection. Purely public, semi-public and private typologies were listed and tabulated. Public spaces of high significance with respect to elements of urban furniture were identified. Eventually, typologies of urban public spaces (for field study) with the following qualities were chosen:

1. Located in an urban setting, purely belonging to the public.
2. Medium in scale (ranging between 5-15 acres).
3. Easily accessible to the researcher (self).
4. Permission to collect necessary data on and off site.

5. Little or no privacy concerns, making it easy to collect photographic and videographic data.
6. High user and activity diversity.
7. Long duration of use.
8. Pedestrian and not vehicular-oriented.
9. Availability of base data and ease of further data collection.
10. Presence of significant urban furniture elements.

Table 3 on 'Criteria for Selecting Public Space Typology' gives an overview of all the criteria that were considered while selecting the typology of cases for field studies in order to conduct a research on urban furniture and human inclusion in public spaces.

3.3 CRITERIA TO ASSESS INCLUSION: EVOLUTION AND VALIDATION

The literature review establishes the fact that a vast amount of data exists on inclusion and public spaces. However, as mentioned in 'Need for Study: Research Gaps' (refer Section 1.3), little data is available on urban furniture as an element of inclusive public spaces. This is either because of lack of adequate knowledge on the subject or because it is not considered a priority (Cobos, Uribe, Toledo, & Ortega, 2014). Hence, a crucial objective of the study was to evolve a list of criteria for assessing inclusivity of urban furniture in public spaces (refer Section 1.5). The contents of Chapter 2 'Literature Review Learnings' were taken as the theoretical basis for evolving the criteria.

1. Characteristics of Urban Furniture
   Principles for Selection
   Principles for Placement
2. Dimensions of Inclusive Design
   7 Principles and 8 Goals of Universal Design
   5 Universal Design India Principles
3. What Makes a Great Place? (What is Placemaking?, n.d.)
   12 Quality Criteria by Jan Gehl

In addition to this, an intensive approach was adopted wherein several research papers were reviewed (refer sources below Table 5) and a comprehensive list of criteria was evolved. The first draft of criteria and sub-criteria was forwarded to 5 experts who validated the list and gave recommendations for improvements. Here, the final list (second draft) of 5 criteria and associated

sub-criteria has been tabulated, aimed at assessing inclusivity of urban furniture in existing public spaces.

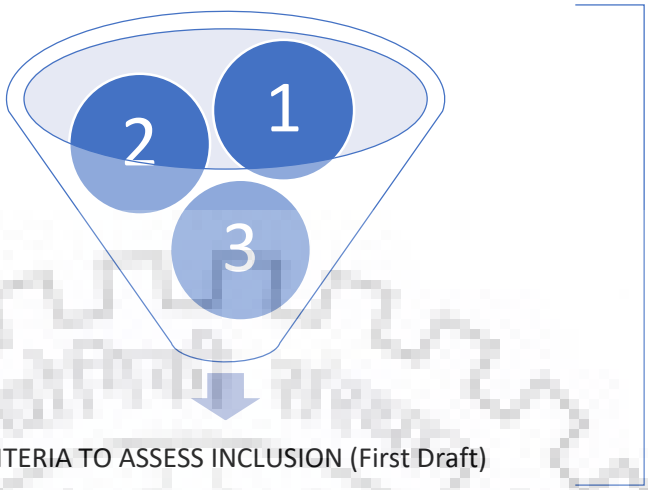


Figure 28 - Filtering principles from the literature review for evolving criteria to assess inclusivity of urban furniture in public spaces.

Table 5 - Criteria to Assess Inclusion

CRITERIA	**SUB-CRITERIA**
Accessibility	Ease of Access or Approach
	Location: Distribution, Spacing and Arrangement
	Proximity to Relevant Services
Usability	Considers User Diversity
	Adequacy w.r.t. Demand of the Site
Comfort	Ergonomically Designed
	Variability in Use
	Comfort w.r.t. Climate
	Comfort w.r.t. Surroundings
Safety	Safe Materials (Non-Toxic, Non-Staining)
	Designed to Prevent Injury
	Arrangement: Visibility and Sightlines
Maintainability	Material Durability against Weather and Use
	Designed for Anti-Vandalism
	Response to Standards

Abdi, F., & Fatholla Nejad, S. (2014). Urban Furniture Element Design. *Conference on Quality Improvement of Urban Landscape.* Tehran, Iran.

Allahdadi, M. (2017). Explaining the Criteria of Designing Urban Furniture and Landscape. Tehran, Iran.

Amini, A. (2006). Design of Fitting Urban Furniture. *National Conference on Urban Environment Fitting.* Tehran.

Asl Fallah, M. (2010). Basics of Designing Urban Furniture Elements: Improvement instead of Beautification. *Proceedings of the First Conference on Environmental Graphics and Urban Furniture.* Isfahan: Mobarakeh Applied Scientific University.

Burton, E., & Mitchell, L. (2006). *Inclusive Urban Design: Streets For Life.* UK: Architectural Press.

Dadghostar, S. S., & Zandmoghadam, M. R. (2016). Organizing Urban Furniture and its Effect on the Urban Landscape. *Specialty Journal of Biological Sciences*, Volume 2: 1-5.

Gupta, N., & Bhatti, V. (2015). Importance of Street Furniture in Urban Landscape. *International Journal of Latest Trends in Engineering and Technology (IJLTET)*, 174-179.

Lang, J. (2005). *Urban Design: A Typology of Procedures and Products.* Sydney: Architectural Press.

Lee, Y. B., Chan, L. D., & Tang, M. (2013). Park Seating Furniture Design in Hong Kong. Hong Kong.

Mourthe, C. R., & Menezes, J. B. (2000). Ergonomics Methodology for Comparative Study of Street Furniture in Different Cities. *IEA 2000/ HFES 2000 Congress*, (pp. 28-31). Rio De Janeiro.

Real, P. d., Tomico, O., Pons, L., & Lloveras, J. (2006). Designing Urban Furniture through User's Appropriation Experience. *Engineering and Product Design Education Conference.* Salzburg.

Riki, A., Riki, J., Rouzbeh, F., & Sarabandi, M. (2015). Analysis of Urban Furniture Space and Limitations of Urban Space. *International Journal of Biology, Pharmacy and Allied Sciences*, 460-474.

Yücel, G. F. (2013). Street Furniture and Amenities. In G. F. Yücel, *Advances in Landscape Architecture.* Istanbul: INTECH.

Zafarabadi, F., Rezaei, M., & Panahi, L. (2015). Examination and Measurement of the Extent of Citizens' Satisfaction with Urban Furniture (Case Study: Ghasroldash - City of Shiraz). *International Journal of Review in Life Sciences, Vol. 5 (1)*, 208-218.

Zeinali, S., & Beik Babaei, B. (2015). Organizing the Urban Furniture. *International Research Journal of Management Sciences, Vol. 3 (1)*, 9-13.

3.4 INTRODUCTION TO FIELD STUDIES AND USER PROFILES

For the purpose of this dissertation, four typologies of urban public spaces were selected (refer Table 3) in the contexts of India and Germany (two each) in order to study urban furniture and human inclusion paradigms. The criteria developed in Section 3.3 was applied to assess inclusivity of urban furniture in the selected field studies.

3.4.1 Field Study 1: Luisenplatz, Darmstadt, Germany

Site Area: 5 Acres

Luisenplatz is a major transit (bus and tram) interchange junction. The location of Luisenplatz within the city of Darmstadt has been shown in figure 29 below. Surrounded by the Darmstadt Regional Council in the north, Luisencenter in the south and other government and private buildings on the east and the west, the square is cross-shaped in plan. It holds the 'Ludwigsmonument' in the center, with steps and benches around it. The tram tracks divide the square into three parts, two of which contain strategically placed fountains, each surrounded by benches. The bus/ tram stops are equipped with transit shelters and information systems. Information systems in Luisenplatz consist of digital display boards for bus/ tram schedule and printed information boards. Ticket vending machines next to the information systems are elements of importance on the site. Trash cans are present all over the square, mostly located adjacent to seating furniture. The cobblestone flooring is rich in design and divides Luisenplatz into multiple zones.

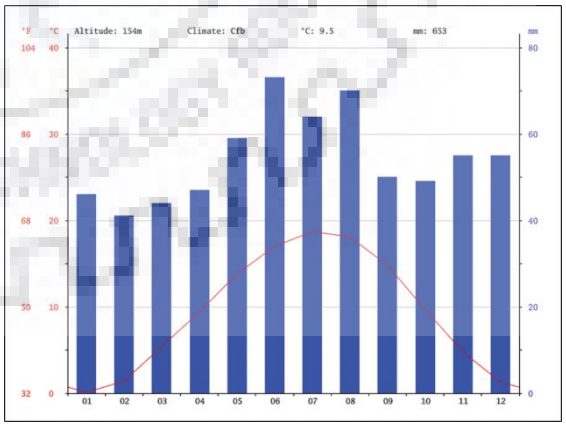


Figure 29 - The location of Luisenplatz within the city of Darmstadt.

Figure 30 - Climate chart for Darmstadt.

Source: https://en.climate-data.org/asia/india/chandigarh/chandigarh-4075/

Total Population - 1,57,437

Males - 80,183

Females - 77,254

3.4.2 Field Study 2: Street Zeil, Frankfurt, Germany

Site Area: 7.5 Acres

Located in the city center of Frankfurt, Street Zeil is one of the busiest shopping streets in Germany. The focus here is on the western part of the street, extending between two plazas, Hauptwache and Konstablerwache. The plazas serve as major intersections for underground trains and trams. Seating furniture is available in abundance throughout the stretch between both the plazas. The fountain in the center of the stretch acts as a landmark. Here, one can see children playing and people sitting on the edge of the fountain. The flooring is geometrically designed, with trees, trash cans and bicycle racks are arranged on it. A clear distinction between the movement and relaxing zones is visible, made possible by the variation in flooring patterns.

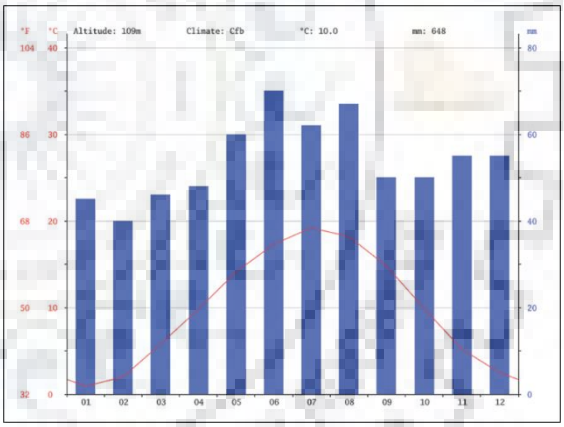


Figure 31 - The location of Street Zeil within the city of Frankfurt.

Figure 32 - Climate chart for Frankfurt.

Source: https://en.climate-data.org/asia/india/chandigarh/chandigarh-4075/

Total Population - 7,36,414

Males - 3,63,754

Females - 3,72,660

3.4.3 Field Study 3: Sector 17C, Chandigarh, India

Site Area: 15 Acres

Designed as the heart of the city of Chandigarh, Sector 17 is the main commercial and business hub of the city. The plaza in Sector 17C, also called the Neelam Plaza, is a vibrant hub of the city center. It is T-shaped in plan and surrounded by four storied concrete buildings on all sides. The lower floors of the shops are accessed via a colonnaded gallery. The fountains are a prominent feature of the site, serving as zones for leisure-related activities. The plaza is flanked by benches towards the edges and next to the fountains. Flat surfaces around tree lawns serve as additional seating arrangements. Raised at 750mm behind the larger fountain, the plaza is accessed through steps (riser 150mm) and ramps. There is no signage on the site. People orient themselves with help from landmarks such as the fountains, theatre and shops that are well-known. Information systems in Sector 17C consist of one information board, located in the plaza of Neelam Theatre, and a tourist information center. Trash cans are present everywhere, mostly located adjacent to seating furniture. The flooring is mostly made of concrete and is uniform throughout the plaza.

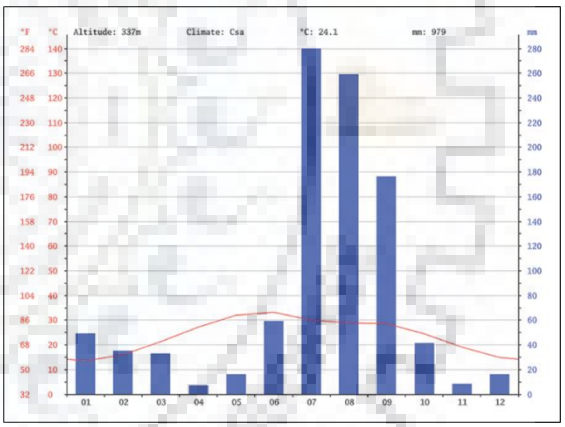


Figure 33 - The location of Sector 17C within the city of Chandigarh.

Figure 34 - Climate chart for Chandigarh.

Source: https://en.climate-data.org/asia/india/chandigarh/chandigarh-4075/

Total Population - 9,70,602

Males - 5,31,051

Females - 4,39,551

3.4.4 Field Study 4: Blocks E & F, Connaught Place, New Delhi

Site Area: 5 Acres

The main commercial area of New Delhi, Connaught Place is counted among the top heritage sites of the city. In plan, the area looks like a big circle with a central park, roads radiating out in 8 directions. The area selected for the study is the pedestrian walkway of Blocks E & F, running along the inner circle and raised at 100mm from the road level. Seating furniture is present in clusters at the corners of each block and as individual benches along the corridors. Horizontal surfaces around tree lawns provide additional spaces for sitting. There is no signage on the site. Bollards provide access control and trash cans are present all along the walkway. The flooring is made of unpolished granite and stone. Waste recycling machines are a new addition to the site, installed as part of the 'Smart City Project'.

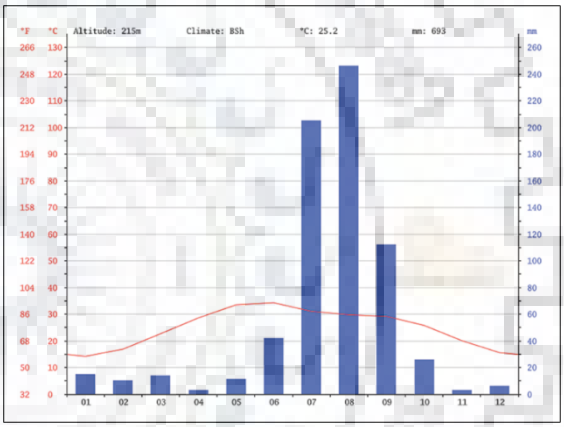


Figure 35 - The location of Connaught Place within the city of New Delhi.

Figure 36 - Climate chart for New Delhi.

Source: https://en.climate-data.org/asia/india/chandigarh/chandigarh-4075/

Total Population - 1,42,004

Males - 77,942

Females - 64,062

The users of the four sites were identified through personal observations during the pilot surveys. The following users were considered in the study in order to assess human inclusion with respect to urban furniture:

- Gender: Male, female and others.

- Age: Children (< 15 Years), young adults (15-24 Years), adults (25-64 Years) and the elderly (> 64 Years).
- Ability: People with mobility-related impairment (wheelchairs and crutches) and the visually impaired (partial and complete impairment).
- Others: People walking with strollers.

The classification for age category has been derived from the 'UN Provisional Guidelines on Standard International Age Classifications (1982)'. As mentioned in Section 1.6, the scope of work does not cater to economic inclusion. The term 'mobility-related impairment' always refers to wheelchair and crutch users, unless specified otherwise.

3.5 SELECTING FURNITURE ELEMENTS FOR ASSESSMENT

Table 6 below enlists all the elements of furniture (45) that can found in urban public spaces, classified on the basis on transportability. Elements that are present are marked with grey under the respective site. The table also clusters furniture elements under 4 categories:

1. Seating Furniture (Yellow)
2. Surfaces (Blue)
3. Information Systems (Green)
4. Other Services (Orange)

Table 6 - Inventory of elements present on each site.

INVENTORY OF ELEMENTS PRESENT ON EACH SITE				
Urban Furniture Elements	**Luisenplatz, Darmstadt**	**Street Zeil, Frankfurt**	**Sector 17C, Chandigarh**	**Blocks E & F, Connaught P.**
Permanent				
Banners				
Bicycle Racks				
Billboards				
Bollards				
Drain Covers				
Fences				

Fire Hydrants				
Flooring (Indoor)				
Flooring (Outdoor)				
Flower Beds				
Gazebos and Pavilions				
Ground (Used for Sitting)				
Information Boards				
Information Kiosks				
Kerb Ramps				
Manhole Covers				
Memorials				
Parklets				
Public Fountains				
Public Lavatories				
Ramps				
Signage and Sign Boards				
Stepped Approach				
Street Lights				
Traffic Lights				
Traffic Signs				
Trees				
Tree Lawns				
Temporary				
Extended Seating				
News Racks				
Phone Boxes				
Traffic Barriers				
Either Permanent or Temporary				
Artificial Rocks				
Benches and Seating Spaces				
Children's Play Spaces				
Community Kiosks				
Post Boxes				

Poster Poles				
Public Art				
Public Sculptures				
Transit Shelters				
Trash Cans				
Vending Machines				
Waste Recycling Machines				
Watering Troughs				
LEGEND				
Seating Furniture		Surfaces		
Others		Information Systems		

Not all furniture elements present on the sites were assessed for inclusivity. Fire hydrants, for example, though present on all sites were not considered when assessing inclusivity of urban furniture. Only those elements were chosen that directly relate to human inclusion.

3.6 DEVELOPING A DATA COLLECTION FRAMEWORK

A data collection framework was developed to guide the process of collecting data. Within the framework, data collection falls within two categories i.e. literature-based and field-based data.

3.7 HOW HE DID IT: RESEARCH NOTES

In an attempt to study preferred places to stand at a public square, Jan Gehl used the method of behavioral mapping first in 1965 to record transitory and stationary activities. By platting in the position of all the people at the square who are not walking, the observer made one registration to get an overview of all the good places to stand. The study at the square in Ascoli Piceno shows that pedestrians typically crisscross the space while people who stand choose spots near the edges (Gehl & Svarre, 2013). People prefer to stand by the columns of the archways, under the archways and along the facades.

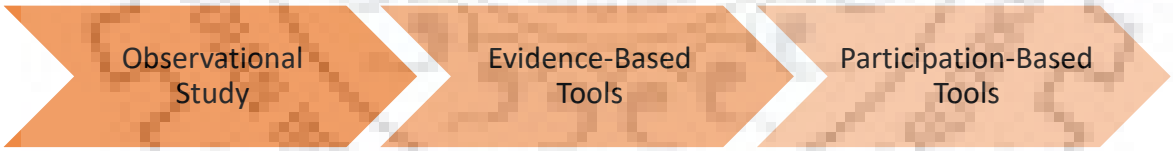
In Piazza del Popolo, behavioral mapping was used to register stationary activity, and patterns formed where there were few and many stays relative to the design of space, other people etc.

Jan Gehl also conducted a study called *'Who Walks, How Fast, When?'* in order to study walking speeds of various categories of people in different seasons by using the method of tracking. The observer first measured out a distance of 100 and 200 meters: a discreet chalk mark on the pavement at the start and finish of the 'test course' is useful. Once the observer has calculated the average walking tempo, interesting variations can be noted over the day, week and year.

In 1965, Jan Gehl received a grant for a six-month study tour to Italy to gather basic material about the interaction between public space and public life. Situations that supported the data gathered were photographed underway. The study was called *'Studying Activities and Excuses for being in Public Space'*. The observations underline the importance of making sure that public space has something to offer, and that this 'something' need not be a huge display of flora and fountains. A bench to sit on or a couple of pigeons for entertainment can be enough to create life in public space – but the most important element is other people.

3.8 DEVELOPING TOOLS FOR RESEARCH

The public life studies conducted by Jan Gehl and his colleagues usually consist of three parts – a quality evaluation of the public spaces, a recording of public life in these spaces and, based on this, providing recommendations for improvements. A similar scheme is being followed in this dissertation, where observational study, evidence-based and participation-based tools have been employed to collect data on public life around urban furniture in the selected cases.



3.8.1 Observational Study

Taking cues from the field works conducted by Jan Gehl, observational study was identified as the first and the most important tool for the purpose of this research project. The tool is necessary to make basic observations on site. It supplements other research tools by providing qualitative insights into the real situations on site. The observer is required to be patient while on field and must locate himself as a point that does not hinder the normal functioning of the site. While observing, one can make notes in a diary (keeping a diary) and take photographs alongside. Observations at different times of a day are considered useful.

3.8.2 Evidence-Based Tools

How is this tool helpful?

- Understanding the site at the macro level.
- Identification of user density and diversity w.r.t. urban furniture for different days and times.
- Information on designed v/s desired paths.
- Cataloguing furniture elements of importance on the site.
- Evidences of users, activities and issues on site.

i. Public Space Documentation

Since this dissertation focuses on field-based research of furniture and human interactions in urban public spaces, it is vital to document the physical elements of urban furniture before plotting the humans on it. This can be done by measuring distances and plotting, onto a physical map. It is required to document both permanent and temporary structures for different times of the day and on different days. By considering a variety in time and days, location and number of temporary furniture elements can be identified with accuracy.

ii. Activity Mapping

The second part of documentation focuses on humans in the urban public spaces. Users can be documented in space through activity mapping at different times of the day, for both weekdays and weekends, and at different times of the year (since climate is crucial to open urban public spaces).

iii. Tracing Movement Patterns (Shadowing)

People's movements inside a limited space can be drawn as lines of movement on a plan of the area being studied (Gehl & Svarre, 2013). The observer is required to discreetly follow people, without their knowledge, while they move in the urban public space.

iv. Documenting Furniture Elements

In order to study urban furniture and associated human behavior at a micro level, the researcher must first measure the furniture on site and analyze the dimensional drawings alongside the specifications given in the standards. Urban furniture is considered well-designed if the specifications match with what is given in the standards.

v. Photographing

Photo and video documentation is a method frequently used in the field of public life studies to illustrate situations (Gehl & Svarre, 2013). Photographs and videos provide initial insights

and act as evidences of activities that happen on site. While the human eye can observe and register, photographs and films are good aids for communication (Gehl & Svarre, 2013). For situations that change rapidly or are complex, photographs are useful for the researcher to understand situations that are otherwise not easily comprehensible to the naked eye. The data collected enables one to go back and forth on a wide variety of visual data. It is important to position oneself at an appropriate location on the site for the purpose of photo and video documentation in order to avoid suspicion or to hinder with the activities on site.

3.8.3 Participation-Based Tool(s): Field Interviews

How is this tool helpful?

- Structured questionnaires help to discover data (quantitative and qualitative) of importance.
- Interviews and questionnaires can provide multiple perspectives on furniture, degree of inclusion and urban public spaces.
- Help to identify the real issues on site.

Since humans lie at the center of any inclusive design approach, on-site surveys become integral to assess inclusivity of any site. To begin with, the users of each site are identified through observational study. Here the word 'user' has been used in place of 'stakeholder' as the focus is only on the people present on the site and not the authorities who might have a stake in the site. Pilot surveys (semi-structured interviews) are carried out on beginning the study. This is followed by self-administered detailed structured interviews. The results highlight issues on importance on site and also generate feedback from the respondent in the form of suggestions for improvements.

3.9 DEVELOPING AN ANALYTICAL FRAMEWORK

In order to conduct an analysis, researchers and analysts are encouraged to use an analytical framework (Fray, 2018). Analytical frameworks are models that are designed to help the researcher think logically in a systematic manner and facilitate understanding (Fray, 2018). Often presented visually, analytical frameworks are used to:

- Identify useful information.
- Identify desirable analysis outputs from the data collected.

- Provide a method to summarize key inferences.

Here, the analytical framework for field-based analysis, under the broad domain of environment behavior studies, is dived into three parts i.e. spatial, visual and content analysis. The field of environment behavior studies has been formed by the integration of the fields of architecture, town planning and urban design with socio-cultural and behavioral sciences (Kar & Sarkar, 2017). EBS is a multi-disciplinary field that advocates involvement of users and a detailed consideration of user aspects in the design process (Kar & Sarkar, 2017). In the field of urban design, EBS includes the systematic inspection of relationships between the built environment and human behavior (Kar & Sarkar, 2017).

By applying the framework to each of the selected field studies i.e. Luisenplatz (Darmstadt), Street Zeil (Frankfurt), Sector 17C (Chandigarh) and Blocks E & F (Connaught Place, New Delhi), qualitative and quantitative inferences were drawn with regard to urban furniture and human inclusion. Consequently, the 4 categories of urban furniture, identified earlier (refer Section 3.5), were analyzed under the inclusivity criteria i.e. accessibility, usability, comfort, safety and maintainability.

3.9.1 Spatial Analysis

Within spatial analysis, the activity maps were analyzed for each site to develop an understanding of patterns in distribution and clustering of diverse user groups (categorized on the basis of gender, age and ability) at different times of a day (morning, afternoon and evening), on different days (weekday and weekend) and for different climatic conditions i.e. summers and winters. The intent was to answer the following question:

- Where is the site and what is its function?
- How is urban furniture arranged on site?
- What trends can be observed in distribution and clustering of diverse user groups vis-à-vis urban furniture?

A study of people's movement patterns across each site was conducted in order to analyze flooring (both design and material) as a crucial element of urban furniture that contributes to human inclusion. Through round the year personal observations, it was inferred that movement patterns, with regard to flooring, remain the same across weekdays, weekends, and different times of the day as well as across different weather conditions, irrespective of gender, age and ability. A detailed

analysis of movement patterns on a typical weekend afternoon has been presented for each field study in Chapter 4. The results, however, are applicable to all other conditions as well.

The method of shadowing was applied to trace movement patterns of fifty users on each site. The shadow maps, thus developed, were analyzed to answer the following questions:

- How is the flooring designed?
- What flooring materials have been used on site?
- What trends can be observed in movement patterns of diverse user groups vis-à-vis flooring in the urban public space?

The elements of furniture were documented on site for preparing drawings. The dimensional drawings were then analyzed alongside technical standards of furniture design for each context.

3.9.2 Visual Analysis

For assessing inclusivity of furniture elements, the selected elements were tabulated alongside five crucial parameters (as given in the standards of both the contexts) for each field study. Based on personal observations, the furniture was identified to be compliant or non-compliant with the listed parameters. This method of analysis helped answer the following questions:

- Which elements of urban furniture respond to the technical standards?
- If an element conforms to the standards, is it necessarily inclusive as well?
- What is the relationship between the results obtained from spatial and visual analysis?

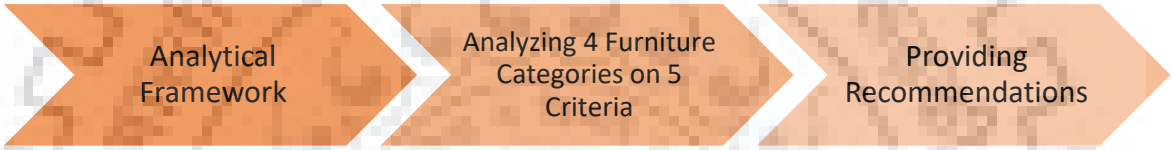
This was accompanied by personal observations in order to analyze public use of urban furniture.

3.9.3 Content and Thematic Analysis

Content analysis is a partially quantitative method of investigating texts for making replicable and valid inferences from data (Krippendorff, 2004). Most content analysis results in a numerical description of features of a given text or series of images (Joffe & Yardley, 2004). While early proponents conceptualized content analysis solely in terms of counting the attributes in data, more recent writings contain a broader vision (Joffe & Yardley, 2004). Thematic analysis, on the other hand, pays greater attention to the qualitative aspects of the material analyzed (Joffe & Yardley,

2004). It permits the researcher to combine analysis of the frequency of codes with analysis of their meaning in context, adding the advantages of subtlety and complexity of a qualitative analysis (Joffe & Yardley, 2004).

Field interviews, in the form of a questionnaire, were conducted for the selected field studies. The questionnaire comprised of ten questions, dealing with both the macro and micro issues in the urban public space in general and urban furniture and human inclusion in particular. The method of random stratified sampling was used to identify the ideal sample size for the survey. Primarily qualitative in nature, the interviews were conducted till a saturation point was reached in the responses. The responses, collected on different times of a day, on different days, and for different climatic conditions i.e. summers and winters, were analyzed to draw inferences specific to contextual response, comfort and safety, maintenance and issues related to urban furniture.



3.10 SAMPLING FOR FIELD INTERVIEWS

Sampling for field interviews can be divided into probability and non-probability sampling. Further, probability sampling is of 5 types: random, systematic, convenience, cluster and stratified. Non-probability sampling is of the following types: quota sampling, convenience sampling, purposive sampling, self-selection sampling and snowball sampling.

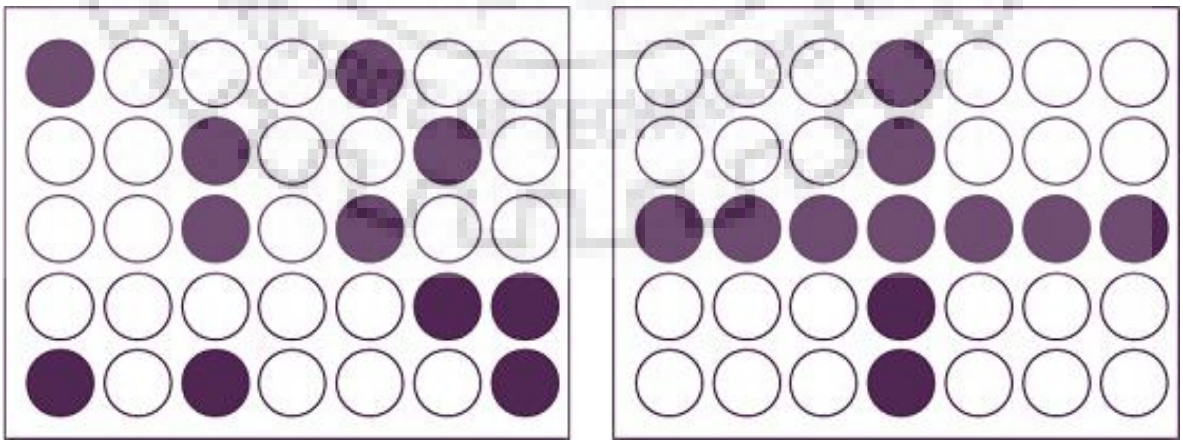


Figure 37 - Probability v/s non-probability sampling.

Source: https://keydifferences.com/difference-between-probability-and-non-probability-sampling.html

Random stratified sampling (probability sampling) has been used for this research study.

In addition to the population size, the following criteria are considered for determining the sample size of a study:

- Level of Precision: Sometimes also called the sampling error, the level of precision is the range in which the true value of the population is estimated to be. The range is often expressed in percentages.
- Level of Confidence: The confidence or risk level is based on ideas encompassed under the Central Limit Theorem. The key idea is that when a population is repeatedly sampled, the average value of the attribute (in case of quantitative interviews) obtained by those samples is equal to the true population value. In other words, if a 95% confidence level is selected, 95 out of 100 samples will have the true population value within the range of precision specified earlier.
- Degree of Variability: This criterion refers to the distribution of attributes in the population. The more heterogeneous a population, the larger the sample size required to obtain a given level of precision.

With these criteria in mind, Yamane (1967:886) provided a simplified formula to calculate sample sizes.

$$n = N/ [1 + N(e)^2]$$

Where n is the sample size, N is the population size and e is the level of precision. By applying this formula to the selected field studies (for population sizes refer Section 3.4), the required sample size comes out to be 100 and 25 for a precision level of 10% and 20% respectively.

Chapter 4

Field Observations (Cases of Germany and India)

4.1 ANALYZING ANTHROPOMETRICS FOR DIVERSE CONTEXTS

Personal observations in India and Germany led to the understanding that people in the two contexts differ in proportions. For instance, majority of the people in Germany were observed to be taller than those in India. The understanding was further solidified through a literature review on body dimensions (anthropometrics) of people in the two contexts. Table 7 below summarizes the values of a few critical body dimensions.

Table 7 - Anthropometric data for Indian and German populations.

DESCRIPTION OF MEASUREMENT	**PERCENTILE**							
	INDIA					**GERMANY**		
	Min.	**5**	**50**	**95**	**Max.**	**5**	**50**	**95**
While Standing (in mm)								
Stature (Body Height)	1288	1465	1619	1771	1950	1530	1719	1880
Eye Height	1215	1355	1507	1633	1821	1420	1603	1750
Shoulder Height	1011	1184	1327	1448	1598	1260	1424	1570
Elbow Height	791	908	1022	1115	1405	960	1078	1190
Knee Height	245	289	333	386	530	397	472	530
While Sitting (in mm)								
Popliteal (Lower Leg Length)	305	374	419	466	540	380	444	495
Eye Height	515	623	723	796	867	680	790	860
Shoulder Height	426	475	541	603	657	510	623	695
Elbow Rest	102	150	210	268	335	190	243	280
Knee Height	412	456	509	563	612	460	530	602

Among both the countries, the values for all percentiles i.e. 5^{th}, 50^{th} and 95^{th} were found to be higher for Germany. Consider body height for instance. In India, the height ranges from 1465-1771mm while in Germany, the height ranges from 1530-1880mm (for 90% of the population). This variation leads to changes in the required dimensions of urban furniture. The values indicate that design of urban furniture is highly context-dependent and what is applicable to one context (India) may not necessarily be applicable to another context (Germany). Consequently, the standards for furniture design vary. For example, the popliteal (lower leg length) ranges from 374-466mm for the Indian

context. Correspondingly, the ideal seat height, as given in the standards, falls within the range of 350-425mm.

Table 8 - Anthropometric data in comparison to design standards for lower leg length range (India and Germany).

Country	Popliteal - Lower Leg Length (in mm)	Seat Heights as Given in the Standards (in mm)
India	374 – 466	350 – 425
Germany	380 – 495	450 – 470

When considering anthropometrics for designing inclusively, the design must cater to as many end users as possible i.e. a range of body measurements for a given context, and not just the average population (roughly 50%). Generalizing the average to all probable users of the site will leave 50% of the population dissatisfied. The data given in Table 3 above caters to 90% of the young adult and adult (male and female) population. Other provisions must be made to incorporate the needs of the children, the elderly, people with mobility-related impairment and the visually impaired.

4.2 COLLECTING AND ANALYZING SPATIAL DATA

4.2.1 Public Spaces at the Macro Level

An introduction to the selected field studies is given in Section 3.4. As illustrated in the framework for data collection (refer Section 3.6), the research began by documenting the following urban public spaces (field studies) in India and Germany.

- Field Study 1: Luisenplatz, Darmstadt, Germany
- Field Study 2: Street Zeil, Frankfurt, Germany
- Field Study 3: Sector 17C, Chandigarh, India
- Field Study 4: Blocks E & F, Connaught Place, New Delhi

The sites in Germany were documented to produce the plans as given alongside. Local authorities in New Delhi and Chandigarh were contacted for obtaining the plans of Connaught Place and Sector 17C respectively. The site plans shown here highlight the open spaces and their built surroundings, significant elements of furniture and locations of trees.

4.2.2 Patterns in Distribution and Clustering

Figures 38 and 39 show a variation in the number of people (diverse users) who occupy Luisenplatz at different times of the day on weekdays and weekends. Due to its transit-oriented character, the distribution of people is majorly dependent on the points of bus/ tram departure and arrival. This is quite evident on weekdays (Monday to Friday) as people wait for, get on to and get off from various modes of transport to go to schools and colleges or to go to work. The furniture elements of transit shelters and seating are strongly associated to the activity of 'waiting'. Though appropriately located, the transit shelters were found to be insufficient in number, as is clear from the dense clusters of people (standing) around bus/ tram stops.

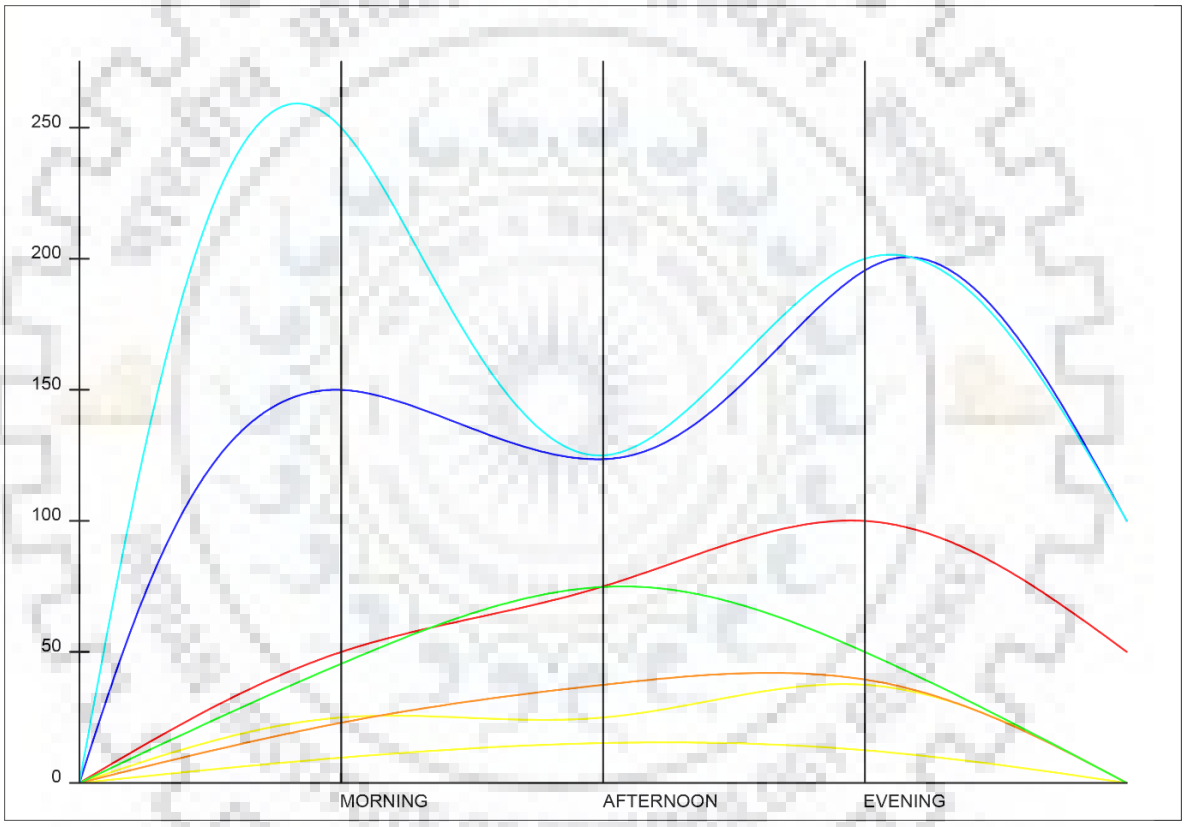
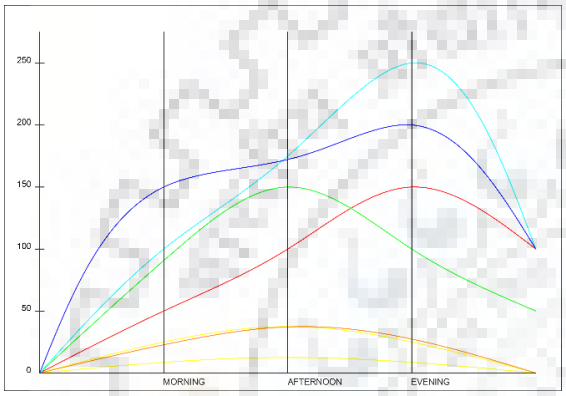


Figure 38 - Summary of weekday activity mapping (summer) in Luisenplatz.

As the day progresses, the distribution of people in the plaza becomes more random. Owing to the pleasant weather (18°C - 24°C) and long daylight hours in summers, plenty of people cluster around the fountains, sitting on the fountain edges or on the benches around them. Here, majority of the people were found to be standing and a few were even found to be sitting on the boulders around the tunnel emergency exit (originally not meant for sitting), implying an insufficiency in seating furniture.

With reductions in temperature (0°C - 12°C) and daylight hours towards the winter months, the use of the square becomes majorly transit-oriented, with very few people participating in leisure-related activities. Thus, Luisenplatz witnesses a decrease in the number of people, especially during the evening hours (refer figure 40). The users prefer to sit inside the transit shelters rather than around fountains, non-functional from December to February. Again, as can be seen from the winter activity mapping, the number of people present inside and outside the transit shelters suggests insufficiency in the number of transit shelters. The abandoned seating around the fountains indicates a need for covered seating spaces (equipped with supporting elements like trash cans) for the winter months.



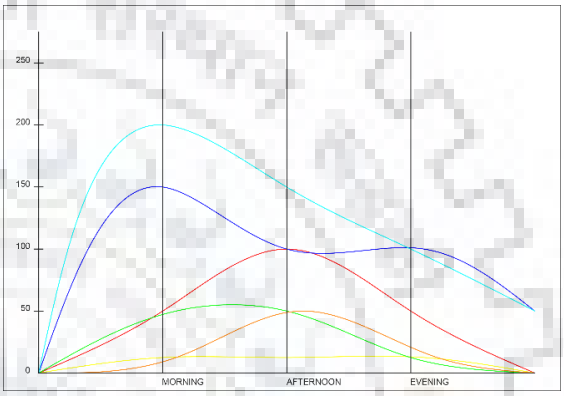


Figure 39 - Summary of weekend activity mapping (summer) in Luisenplatz.

Figure 40 - Summary of weekday activity mapping (winter) in Luisenplatz.

Figures 41 and 42 show a variation in the number of people (diverse users) who occupy Street Zeil at different times of the day on weekdays and weekends. Since Street Zeil is commercial in character from Hauptwache to Konstablerwache, visitors are evenly distributed throughout the stretch. Few people visit the street in the morning hours. The number of people increase as the day progresses, with temperature ranging from 18°C - 24°C in the summer months. This is starkly visible in the activity maps of the afternoon and evening hours. Visitors flock to Street Zeil for recreational purposes towards the second half of the day, on both weekdays and weekends. The resting zone, running in the center of the street, strongly supports this activity of 'recreation' with people sitting, eating, resting and enjoying street performances. The walking majority can be seen on either side of this zone. The seating furniture was found to be sufficient to cater to the site demand with dense clusters of users occupying the benches in the central zone.

Reductions in temperature (0°C - 12°C) and daylight hours towards the winter months have little impact on the number of visitors (refer figure 43). People enjoy sitting and soaking the sun in the

afternoon hours. In the evening hours, fewer people sit but prefer to stand or walk around. A decrease can be seen only in the number of aged people visiting the site.

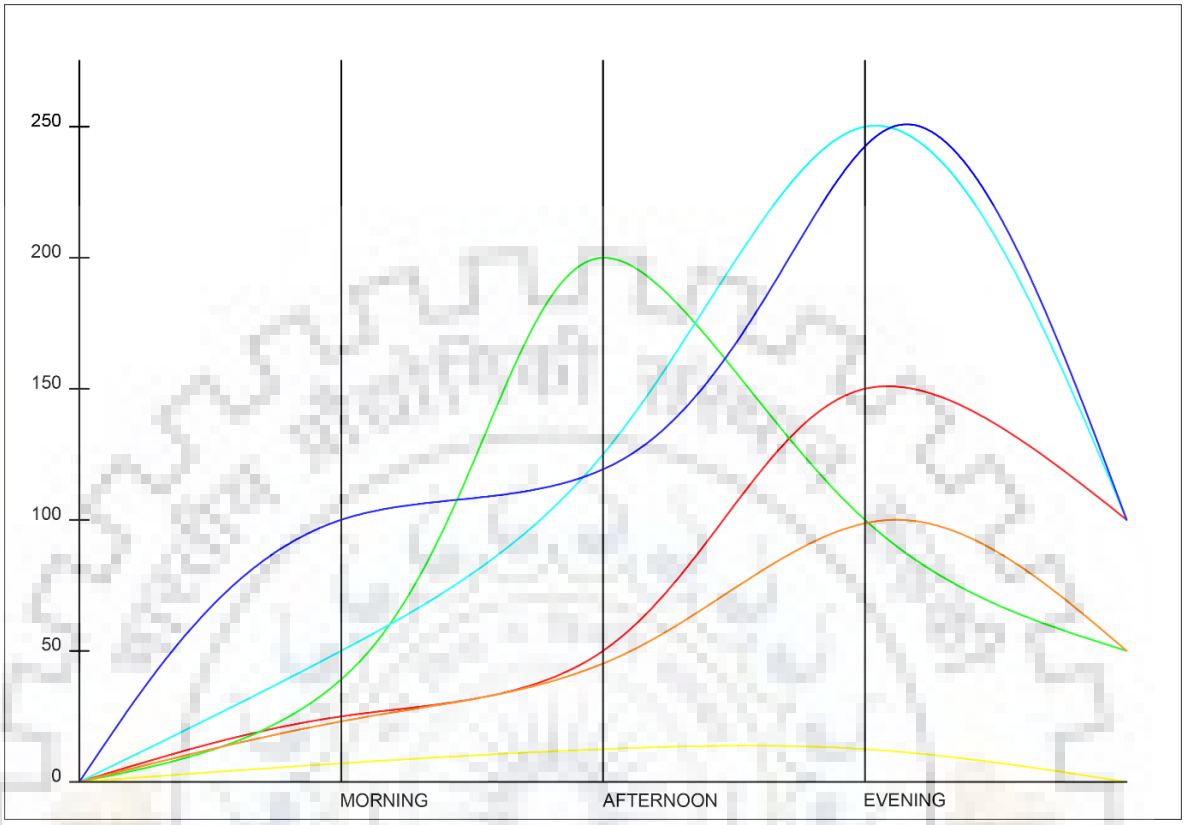
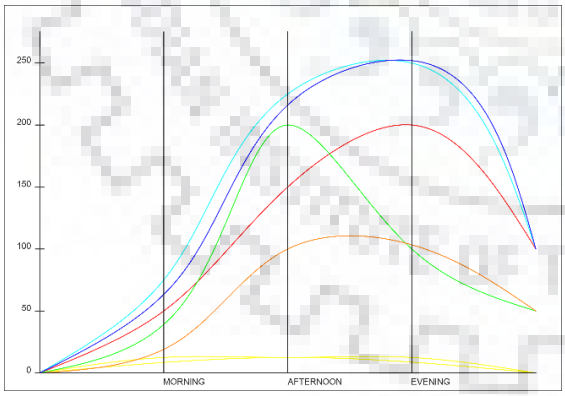


Figure 41 - Summary of weekday activity mapping (summer) in Street Zeil.



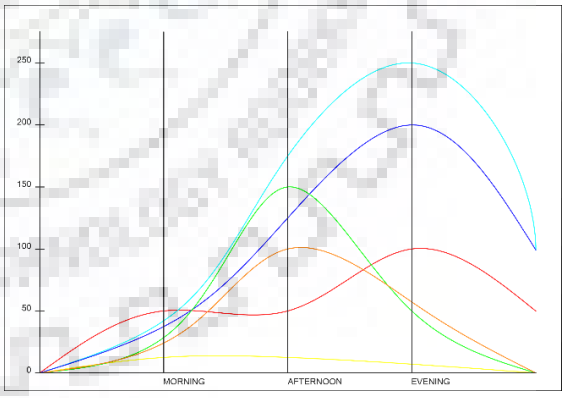


Figure 42 - Summary of weekend activity mapping (summer) in Street Zeil.

Figure 43 - Summary of weekday activity mapping (winter) in Street Zeil.

Because of being open to sky, the benches in the resting zone become unusable during rainfall and snowfall, indicating a need for covered spaces for sitting. Due to its commercial character, the

distribution of people in Sector 17C is majorly dependent on the locations of famous shops, banks and locations that enable one to spend leisure time here (fountains, theatre etc.). Banks and post offices are hot spots for weekday mornings. Though relatively vibrant, the summer afternoons remain passive (refer figures 44 and 45). Owing to the high temperatures (36°C - 42°C) and harsh sunlight, people tend to sit in shaded areas, either under trees or in areas shaded by buildings. Furthermore, street vending starts in the early evening hours. People gather around vendors to shop and around fountains to watch the laser fountain show. As the day progresses, the activities start to become more leisure-oriented. This is quite evident on weekday evenings and weekend afternoons and evenings as people come here to spend the day, shop and eat. The furniture elements of seating and fountains are strongly associated to this activity of 'spending time'. Though appropriately located, the seating furniture in the central plaza was found to be insufficient in number, as is clear from the dense clusters of people (standing) here. People were also found sitting on the edges of the fountain.

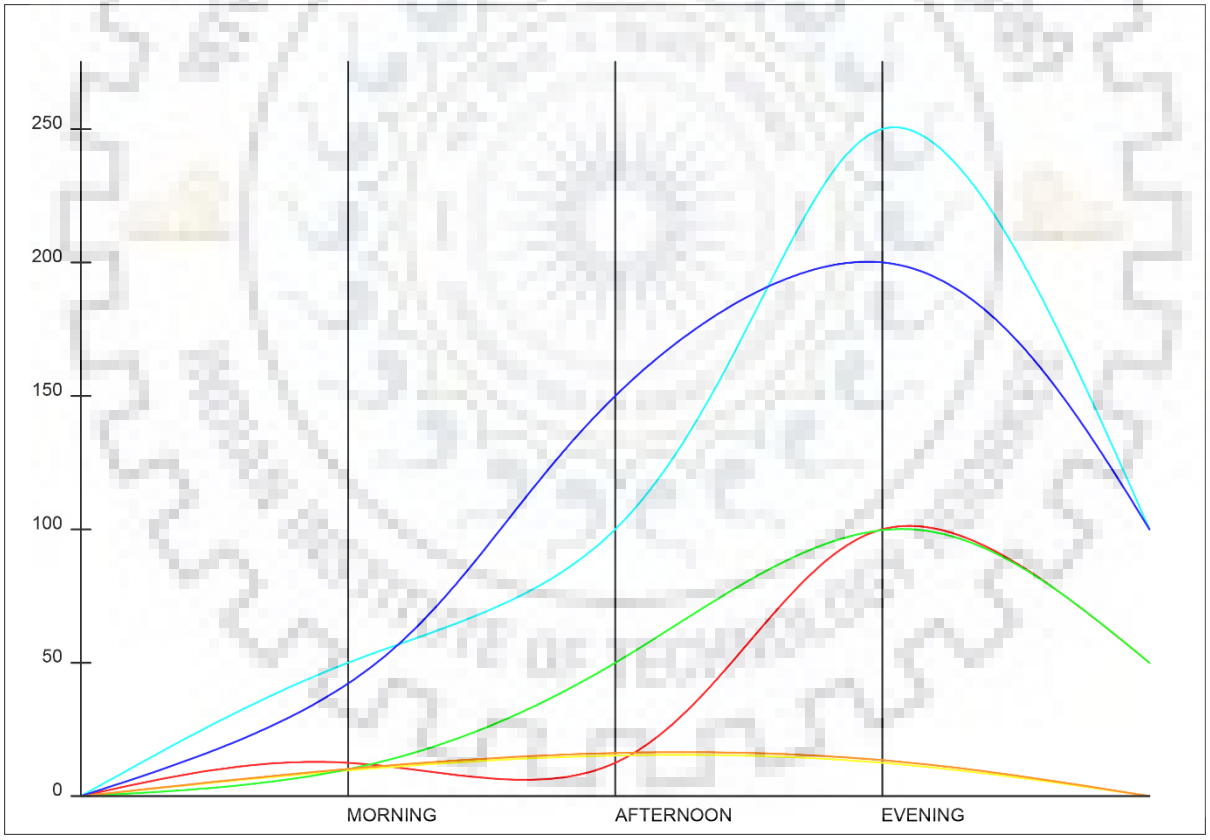


Figure 44 - Summary of weekday activity mapping (summer) in Sector 17C.

With reductions in temperature (4°C - 16°C) towards the winter months, the plaza witnesses an increase in the number of visitors during the afternoon hours (refer figure 46), with more people

participating in leisure-related activities. The users of the plaza like to idly walk around, shop and sit in the sun during these months. Fewer people are seen gathering around the fountain, non-functional from December to February. The insufficiency in seating furniture is visible in the maps for winter activities as well. The activity maps show that the females tend to avoid the corners of the plaza at night. This can be attributed to insufficient illumination in these zones that leads to safety concerns, making the plaza only partially inclusive for females.

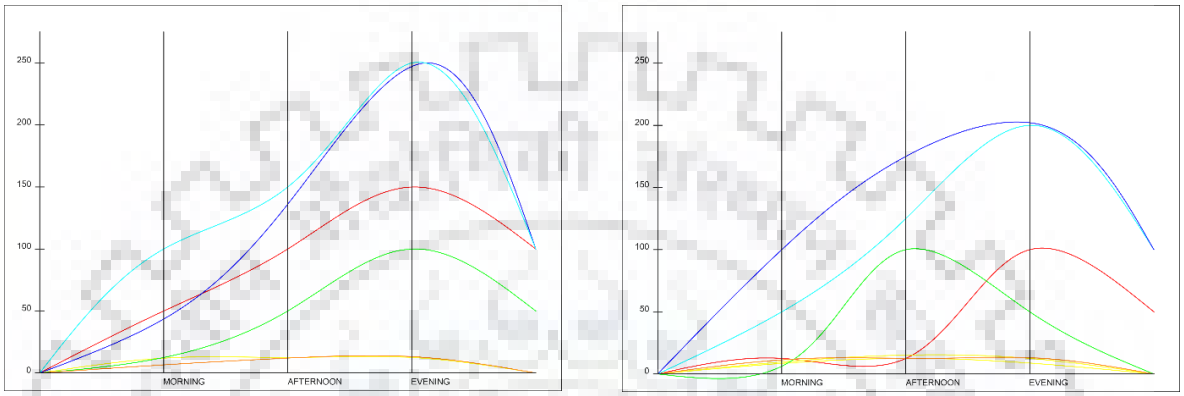


Figure 45 - Summary of weekend activity mapping (summer) in Sector 17C.

Figure 46 - Summary of weekday activity mapping (winter) in Sector 17C.

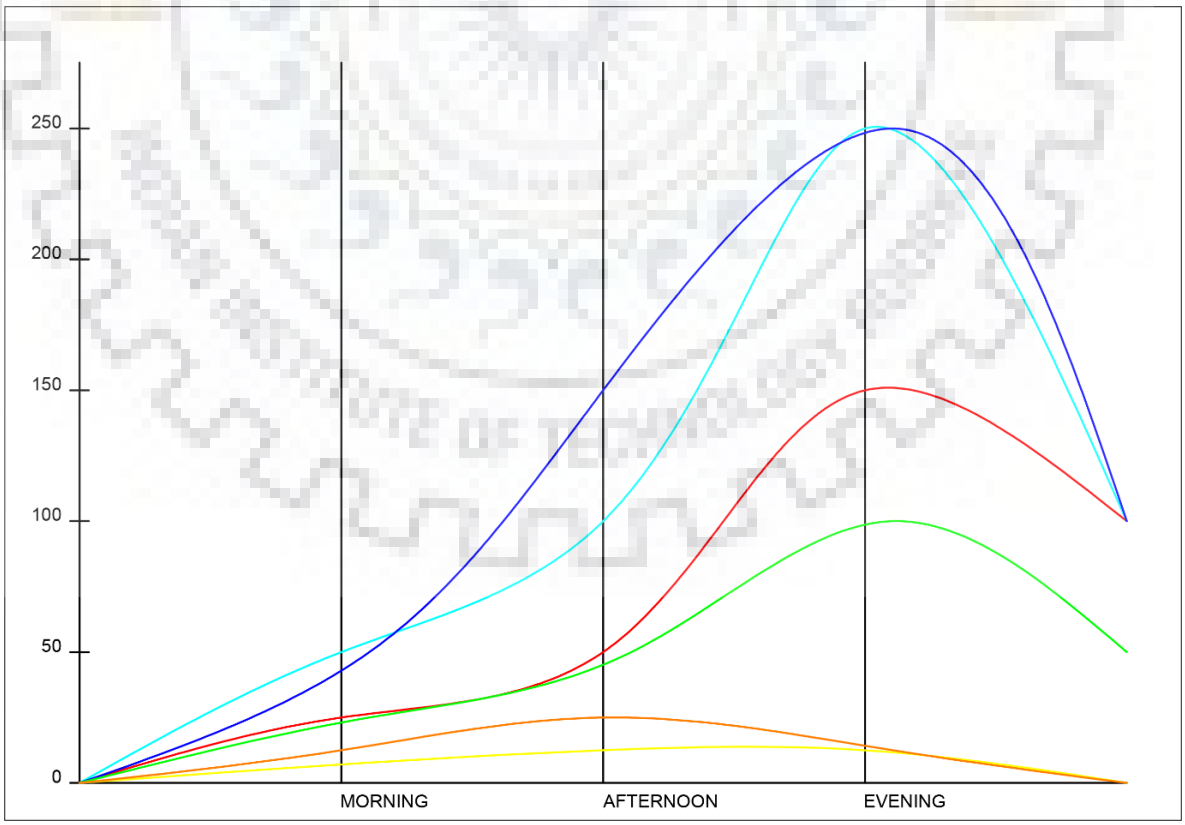


Figure 47 - Summary of weekday activity mapping (summer) in Connaught Place.

C.P. is similar to Street Zeil in character, with people visiting the site for the purpose of recreation. The blocks are primarily composed of shops and restaurants on the ground floor. The number of visitors on weekends is always more than that on weekends. The activity maps suggest uneven distribution of people in the pedestrian walkway alongside Blocks E & F. This distribution is dependent on the location of famous shops and restaurants. Though relatively vibrant, the summer afternoons remain passive (refer figures 47 and 48).

Owing to the high temperatures (36°C - 44°C) and harsh sunlight, people tend to sit in shaded areas, either under trees or in areas shaded by buildings. Diversities in users and activities increases towards the evening hours (refer figure 48) with people clustering around street vendors and grouped configurations of seating furniture. Majority of the visitors are constantly in motion. Spaces for sitting, therefore, are not required in abundance and the seating furniture present on site at the moment is adequate with respect to demand.

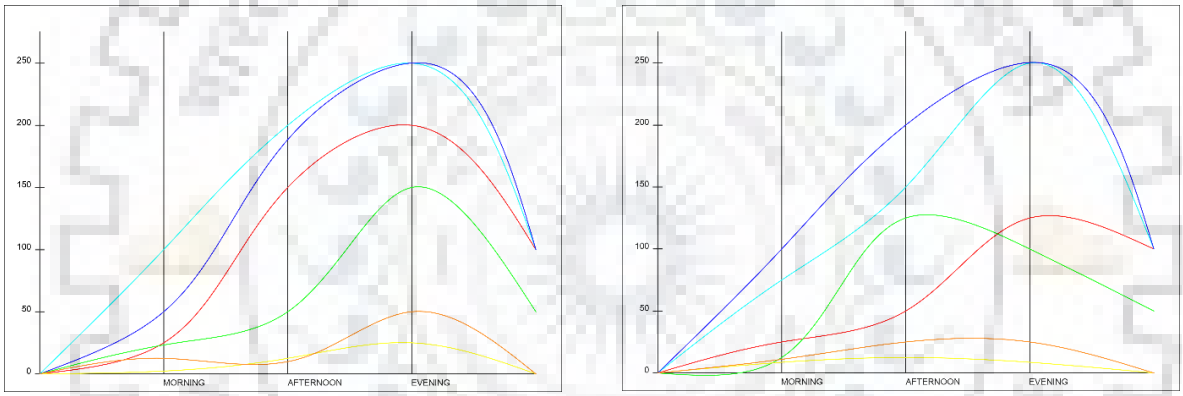


Figure 48 - Summary of weekend activity mapping (summer) in Connaught Place.

Figure 49 - Summary of weekday activity mapping (winter) in Connaught Place.

Owing to reductions in temperature (4°C - 12°C) towards the winter months, more people visit C.P. during the afternoon hours (refer figure 49). The users of the plaza like to idly walk around, shop and sit in the sun during these months.

4.2.3 Flooring and Movement Patterns

The flooring in Luisenplatz is rich in terms of material variety and color contrast, designed symmetrically around the Lugwigsmonument. Bands of red bricks, white and grey stone radiate from the center in eight directions, two towards the fountains, two along the tram tracks running east-west (later split into two each) and four towards the buildings in the north-east, north-west,

south-east and south-west. Thick bands (1500mm) of grey natural stone (200 X 150mm) run on either sides of each of the tram tracks. The remaining surface is entirely covered with a fish-scale pattern of quarried granite setts (also known as Belgian blocks), often referred to as cobblestone. Aesthetically appealing, the flooring supports orientation by highlighting the fountains through the band of red bricks that lead directly to them. Though meant to direct the user's eyes towards particular elements, the design does not seem to create any significant impacts on majority of the users. Users carefully avoid elements of urban furniture to walk from origin to destination points, often selecting the shortest possible route. This is true for people of all genders, children and those belonging to the age categories of young adults and adults. Observations suggest that the elders (assisted by walkers and walking sticks) prefer to use the brick paved surface, instead of the cobblestone surface (unless necessary), owing to lesser joint gap between the bricks. This also applies to people with mobility-related impairment and people walking with strollers. The map, shows overlaps in movement patterns of diverse user groups. Since origin and destination points are mostly similar, many are forced to leave desired pathways to reach their destinations. For instance, in the shadow map, quite a lot of old and mobility impaired users can be seen moving on the cobblestone surface, around or across the fountain, to reach Luisencenter. The variety of materials used for flooring in Luisenplatz are considered inclusive for people of all genders and ages but the design only partially includes the elders (assisted by walkers and walking sticks) and those with mobility-related impairment. The visually impaired are completely excluded, both by material and design, indicated by an absence of flooring bands for tactile orientation.

Having used red, white and grey stone alongside cobblestone, the flooring in Street Zeil is similar to that in Luisenplatz. However, unlike Luisenplatz, the cobblestone flooring is laid out in straight lines. The design of flooring divides the width of the street into three parts: a resting zone in the center, flanked by pedestrian thoroughfares on either sides. Bands of red, polished white and grey stone provide structure to the central stretch. Tree grids are located at band intersections. The large squares are covered with quarried granite setts (also known as Belgian blocks), often referred to as cobblestone. Large blocks of natural grey stone (600 X 900mm) in herringbone pattern form the pedestrian walkways on both sides of the resting zone. Continuous drain covers run along the edges of the resting zone. As can be seen in the shadow map for Street Zeil, visitors usually walk in straight lines from origin to destination points, on the pedestrian walkway, hardly ever cutting across the resting zones in the center. This is true for all user groups. Observations suggest that the flooring is suitable for all users except the visually impaired. This is due to the absence of floor guiding tiles for tactile contrasts.

The flooring in the open space in Sector 17C, extending from east to west, is primarily composed of concrete blocks (2m X 2m). The central plaza around the fountains is composed of concrete pavers. On the south of the car parking i.e. the linear stretch in front of the theatre, the flooring is finished with red and grey concrete pavers. Red pavers form arrows in the flooring to give it an aesthetic appeal. The edges of the plaza are bordered by stone tiles (10cm X 10cm). Polished granite tiles (60cm X 60cm) make up the flooring in the colonnaded galleries. The floor gradually slopes down towards drain covers. Manhole covers, embossed with the plan of the city are crucial to the city's cultural identity. Since the flooring is uniform for most of the open space, it is not possible to determine flooring material preferences for different user groups. From the shadow map, it can only be inferred that users carefully avoid elements of urban furniture to walk from origin to destination points, often selecting the shortest possible route. This is true for people of all genders, ages and abilities.

Primarily composed of red and yellow unpolished granite (60cm X 60cm), the open space flooring in Connaught Place was found to be random in design. Kota Stone (60cm X 60cm) makes up the flooring in the colonnaded galleries. An open drainage channel runs along the outer edge of the walkway, adjacent to the fences. The shadow map suggests that the design of the flooring does not impact patterns of movement for diverse user groups. The design and layout Is suitable for all users except the visually impaired. Though present all along the stretch, floor guiding tiles start and end abruptly and do not lead anywhere. A visually impaired person will not know which direction to walk in once the tiles end.

4.2.4 Cataloguing Elements of Urban Furniture

The selected elements for field study were documented on site. The dimensional drawings of the same have been attached alongside.

4.3 COLLECTING AND ANALYZING VISUAL DATA

4.3.1 Urban Furniture and Design Standards

The catalogue of site furniture (refer Section 4.1.4), supported by personal observations, was instrumental in comparing the urban furniture elements on site with the technical standards for each context.

A detailed study of design standards for furniture in an urban public space was carried out for India and Germany using the following sources:

For Germany:

- DIN Standards (Deutsches Institut für Normung), 1993, 1998, 2007, 2009, 2011
- Berlin - Design for All Standards, 2011

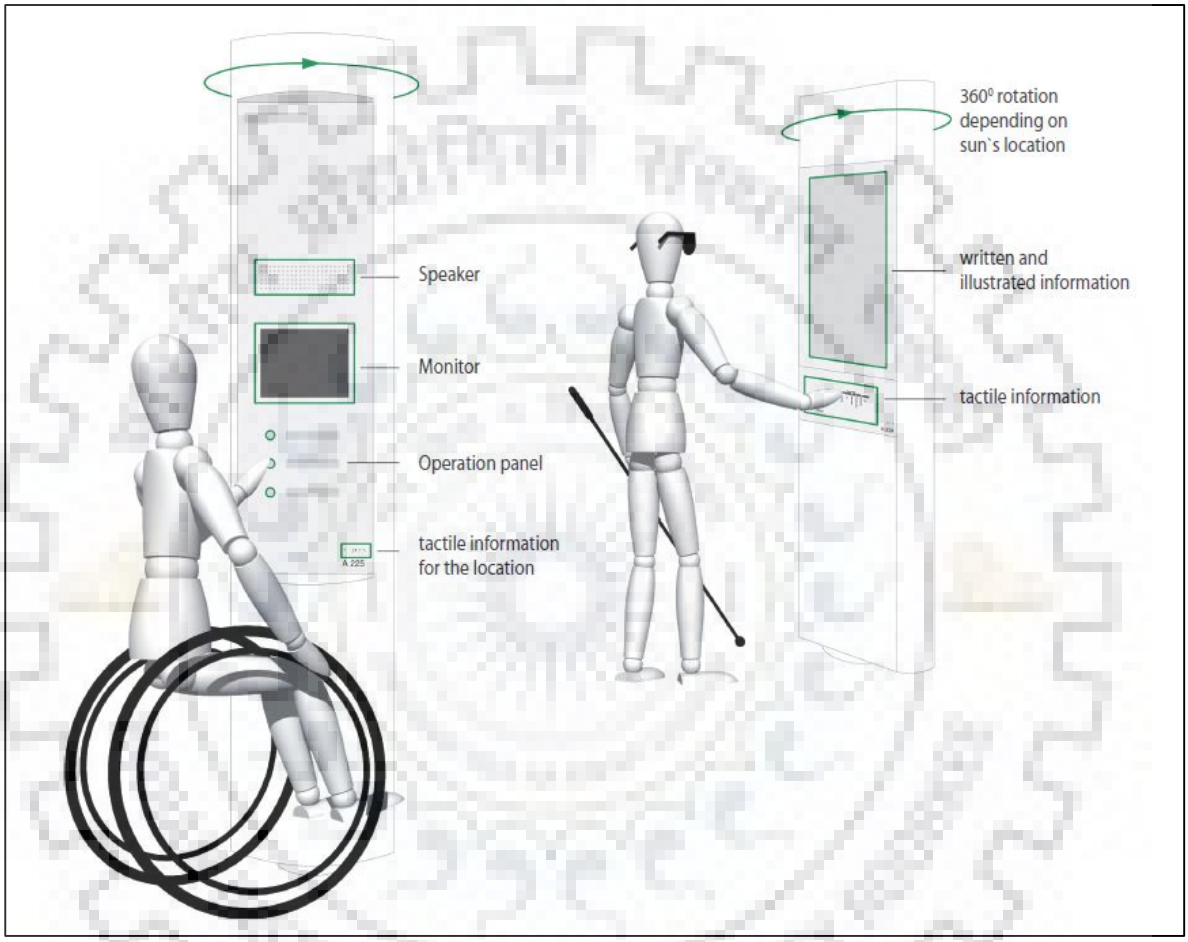


Figure 50 - Information pillars as illustrated in the manual of 'Berlin - Design for All'.

For India:

- Handbook on Barrier Free Built Environment and Accessibility, CPWD, 2014
- Harmonized Guidelines and Space Standards for Barrier Free Built Environment for Persons with Disability and Elderly Persons, Ministry of Urban Development, Government of India, 2016
- National Building Code of India (NBC), 2016

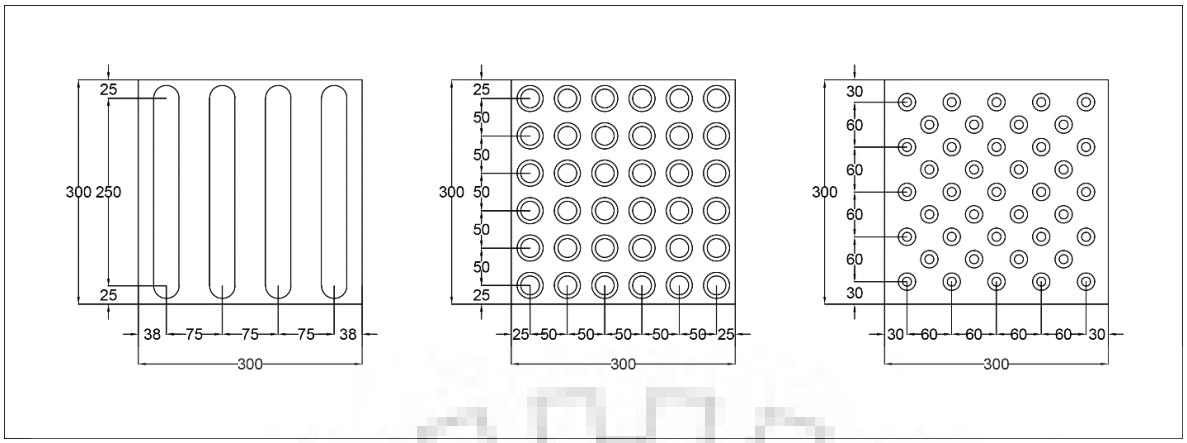


Figure 51 - Dimensional drawings for directional tile, hazard warning tile and positional tile.

Source: Handbook on Barrier Free Built Environment and Accessibility, CPWD

In Luisenplatz, seating furniture, flooring, street lights, signage, ticket vending machines, information systems, transit shelters and trash cans were investigated as elements of urban furniture that impact human inclusion of diverse users. Out of these, seating furniture and flooring were found to be non-compliant with the standards. Ticket vending machines and trash cans were found to be partially compliant.

Though the seating furniture integrates well with the visual and tactile contrasts in the flooring, a visually impaired person is unable to detect the location of seating arrangements due to absence of floor guiding tiles. The design of seating furniture is ergonomically suitable for the young adults and adults but is uncomfortable for children to use (finished surface of benches is at a height of 450mm). Without back and arm rests, the benches are unsuitable for use by the elderly as well (refer figures 52 and 53).

Figure 52 - The seating furniture is unsuitable for the elderly. Back and arm rests are absent.

Figure 53 - The old man, resting his hand on his bag.

The stone surface of the flooring is prone to skidding under wet conditions. The joint gaps in the cobblestone flooring are greater than 8mm, making it difficult to walk on for the elderly (assisted by walkers and walking sticks), people with mobility related impairment and those walking with strollers (refer figure 54). With insufficient letter and symbol height, the signage only partially includes the users. The service counter heights of the ticket vending machines are installed at a height > 800mm, making it insensitive to the needs of people on wheelchairs. There is an absence of floor indicators to lead the visually impaired to transit shelters. Trash cans are placed directly adjacent to benches throughout the square, making it uncomfortable for people to sit.

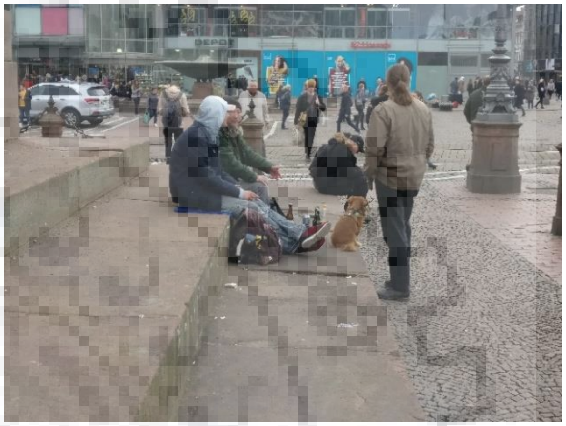


Figure 54 - An elderly person with a walker.

Figure 55 - The steps around the central monument being used as seating furniture.

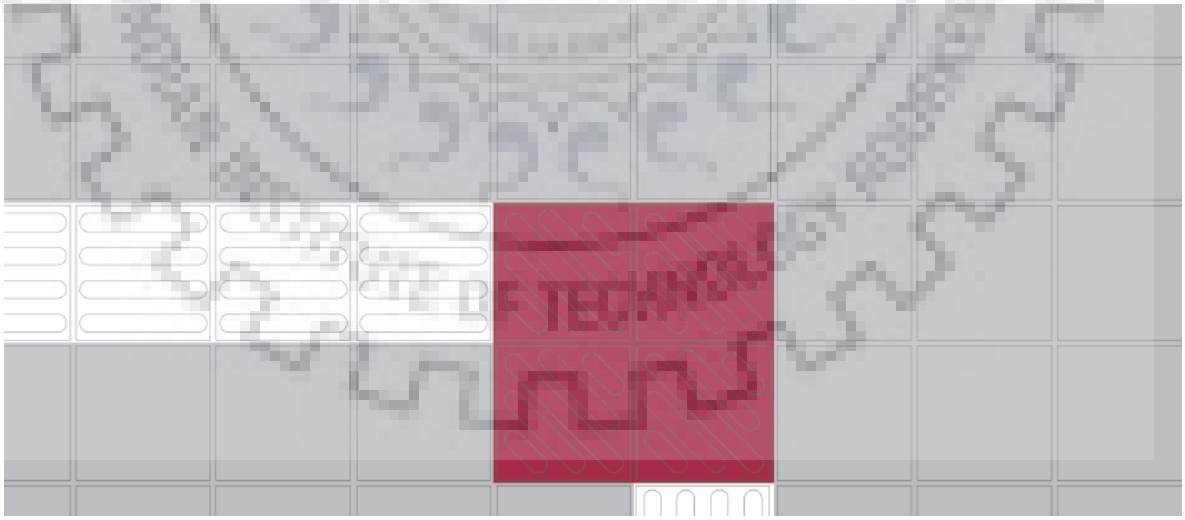


Figure 56 - Continuous tactile bands for visually impaired users as illustrated in the manual of 'Berlin - Design for All'.

In Street Zeil, seating furniture, flooring, street lights, signage, information systems, stepped approach and trash cans were investigated as elements of urban furniture that impact human

inclusion of diverse users. Out of these, seating furniture, signage and stepped approach were found to be non-compliant with the standards. Flooring was found to be partially compliant.

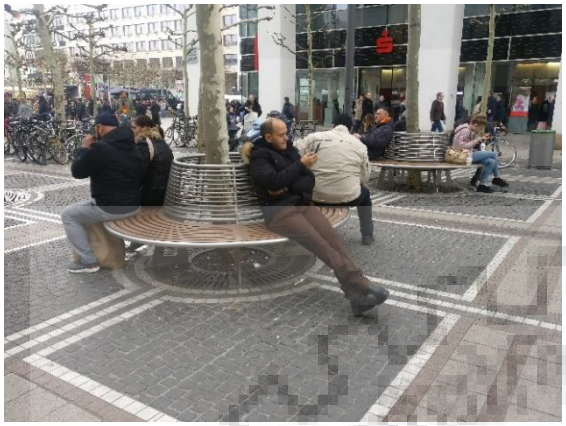


Figure 57 - Seating furniture in Street Zeil.

Figure 58 - The stone flooring for walking and resting zones in Street Zeil.

Similar to the case of Luisenplatz, seating furniture in Street Zeil integrates well with the visual and tactile contrasts in the flooring. A visually impaired person, however, is unable to detect the location of seating arrangements due to absence of floor guiding tiles. The seat height fall in the given range but do not vary (refer figure 57). The stone surface of the flooring (refer figure 58) is prone to skidding under wet conditions.

With insufficient letter and symbol height, the signage only partially includes the users. Information-related infrastructure for bus and tram schedules is completely absent. The stepped approach at both Hauptwache and Konstablerwache lacks detectable warning surfaces and steps markings, completely excluding the visually impaired users.

Figure 59 - A street performer on the floor in Street Zeil.

Figure 60 - Diverse users of the site.

No ramps were found to support the stepped approach on the site.

In Sector 17C, seating furniture, flooring, street lights, information systems, stepped approach, ramps, fountains and trash cans were investigated as elements of urban furniture that impact human inclusion of diverse users. Out of these, ramps were found to be partially compliant with the standards. All other elements were either non-compliant or absent.

Seating furniture with benches is inappropriately spaced, with some very close together and others far apart. Continuous tactile bands for visually impaired users are absent and, hence, not available to guide them to seating furniture either. In some arrangements, such as the granite surfaces around tree lawns, back and arm rests are absent, making it unsuitable for use by the elderly. The three materials i.e. concrete blocks, concrete pavers and stone tiles provide some degree of tactile contrast. Visual contrast in material and color of flooring, however, is insufficient for orientation. Street lights do not provide sufficient levels of illumination to the plaza. As mentioned in Section 4.2.2, the corners of the plaza are poorly illuminated, making it unsuitable for use by females due to safety concerns. Information systems and signage are absent. There are no warning blocks at the beginning and end of stairs and ramps throughout the plaza. Metal bands mark the edges of the steps in the open space, but the color contrast between the metal and concrete (material of steps) is not enough to be instantaneously recognized. Handrails are absent on the stepped approach to both, the upper level of the plaza and the colonnaded galleries. The gradient of ramps that lead to the colonnaded galleries is very steep (approximately 1:3) and unsuitable for use by people with mobility-related impairment and people walking with strollers. Trash cans are insufficient in number, ill-maintained and not located appropriately.

In Connaught Place, seating furniture, flooring, street lights, information systems, kerb ramps, bollards and trash cans were investigated as elements of urban furniture that impact human inclusion of diverse users. On site, information systems are absent and all other elements are non-compliant with the standards.

Continuous tactile bands, though present, have discontinuities in layout and do not guide the visually impaired users to seating furniture. Seat heights fall in the given range but do not vary. Not all seating arrangements are equipped with back and arm rests. The flooring design is random and the visual and tactile contrasts do not orient the users. Information systems and signage are absent. Though compliant with the given gradient of ≤ 1:12, none of the ramps have flared sides. There are no warning blocks at the beginning and end of kerb ramps. The red color of the bollards make them

difficult to be spotted in the background of red granite flooring. Also, the clear distance between two bollards is 700mm, insufficient for a wheelchair to pass through. Trash cans are insufficient in number, ill-maintained and not located appropriately.

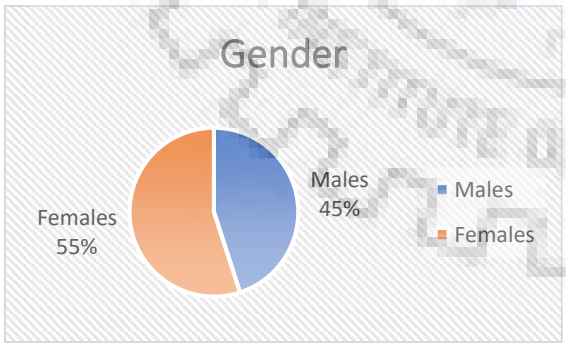
Figure 61 - Seating furniture in Connaught Place, Block E.

Figure 62 - Benches along the pedestrian corridor, Connaught Place.

4.4 COLLECTING AND ANALYZING CONTENT AND THEMATIC DATA

4.4.1 Field Interviews: Issues and Suggestions

In Luisenplatz, responses were collected from 9 males and 11 females. Out of the 20 respondents, 1 was a child, 9 were young adults, 8 were adults and 3 were aged more than 64 years. A diverse population was interviewed comprising of people who do not live in Darmstadt and those who have lived in the city for a period of 6 months to more than 60 years.



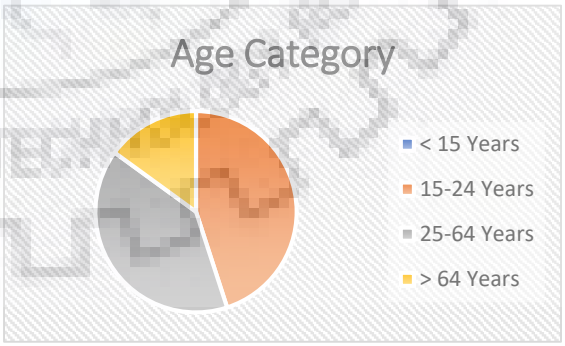


Figure 63 - Pie chart showing the percentage of male and female respondents for field interviews conducted in Luisenplatz.

Figure 64 - Pie chart showing the percentage of respondents belonging to various age categories for field interviews conducted in Luisenplatz.

The square remains active at all times of the day, owing to its transit-oriented nature. Majority of the crowd is invested in transit-related activities in the morning. As the day progresses, the focus shifts towards leisure-related activities i.e. shopping, talking, eating and relaxing. People like the vast open space and the liveliness in the plaza, especially in the area around the fountains and the central landmark i.e. Ludwigsmonument. In addition to transit-related activities, the square is ideal for people to relax and hang out with their peers.

- *"I like how lively the place is around the fountains."*
- *"I like everything here. The first time I came here I thought it looked very pretty. I can see kids playing and other people having fun."*
- *"… I like sitting in the sun and talking to my group mates."*
- *"Spaces to sit, talk and pass the time while waiting for the tram/ bus."*
- *"I like the area around the Ludwigsmonument. The presence of the landmark makes it homely and gives a unique identity to the square."*

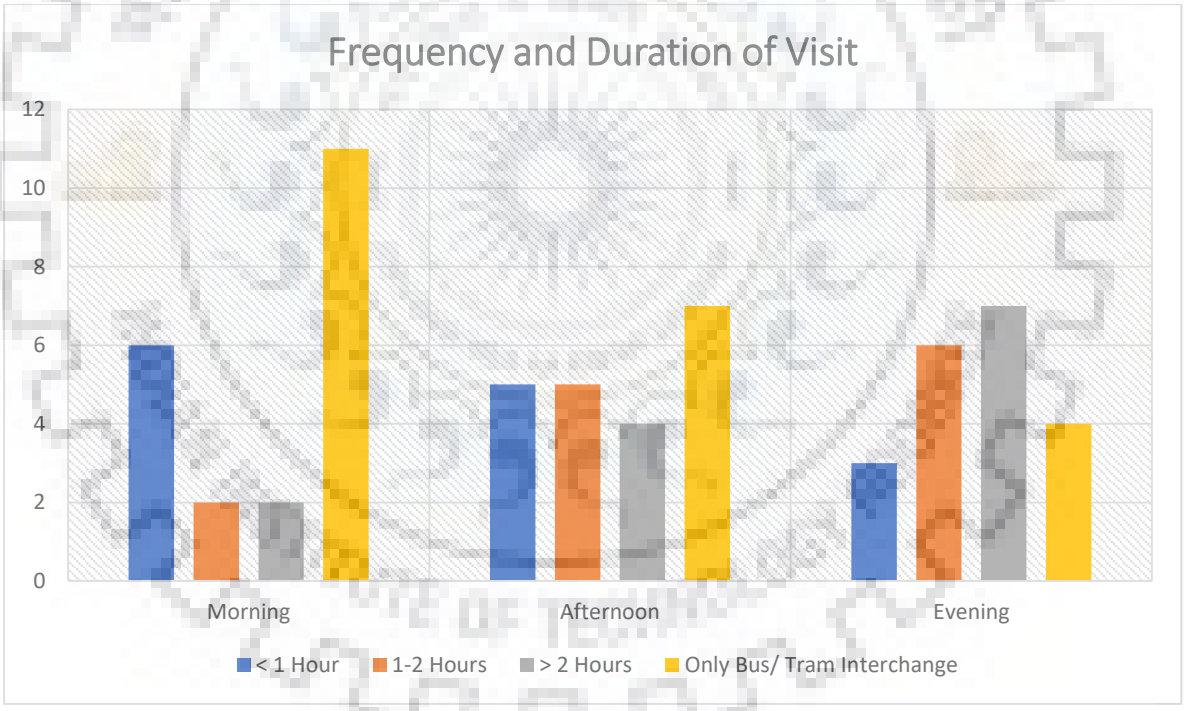


Figure 65 - Bar graph showing the frequency and distribution of site users for different times of the day in Luisenplatz.

A summary of the responses suggests that urban furniture in Luisenplatz responds well to the local context.

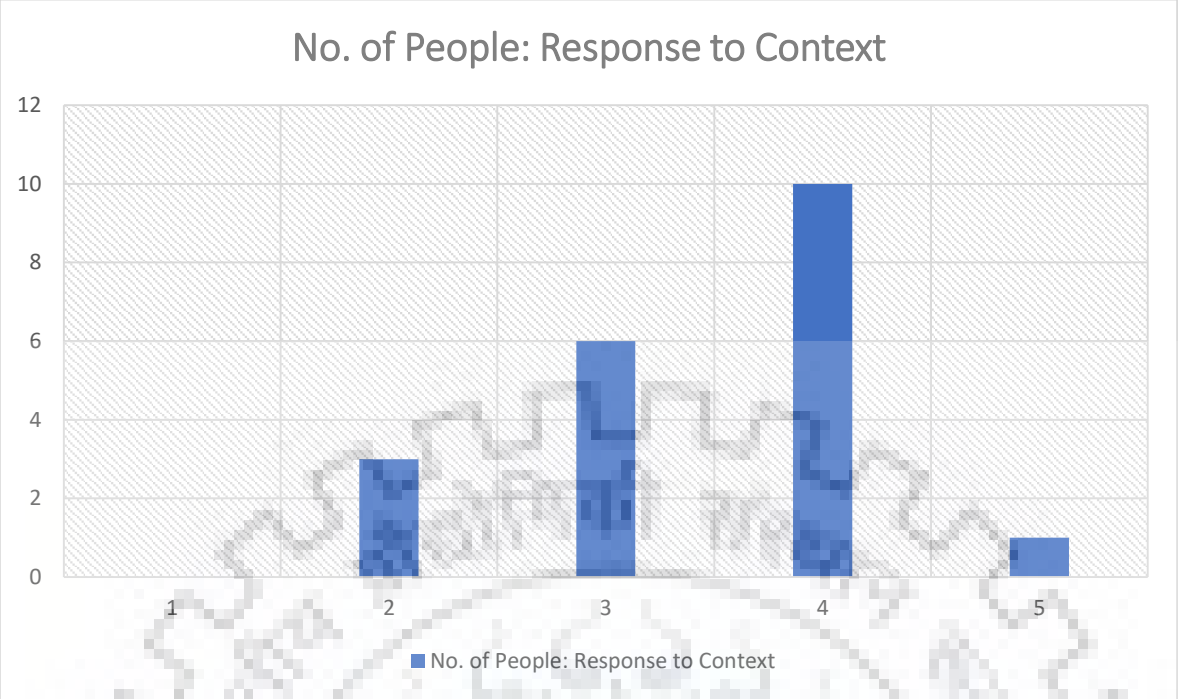


Figure 66 - Bar graph showing the rating of urban furniture vis-à-vis response to context in Luisenplatz.

The following issues related to urban furniture were highlighted during the interviews:

1. Lack of cleanliness and maintenance.

   "Lack of maintenance, for instance the area around the fountain in front of Luisencenter."

   "It's just very dirty. There is no maintenance."

   "Lack of maintenance. I don't prefer to use the transit shelters anymore because they stink."

2. Absence of green spaces.

   "… There is no greenery in the plaza."

3. Insufficient and uncomfortable (for the elderly) spaces for sitting.

   "Seating is insufficient and could be made more comfortable."

4. Inappropriate flooring for the elders (assisted by walkers and walking sticks) and for people with mobility-related impairment.

"The floor is horrible and a lot of old people have problems while walking."

5. Conflicts in movement of pedestrians and cyclists.

   "I don't like the bikes as they interfere with the pedestrian movement."

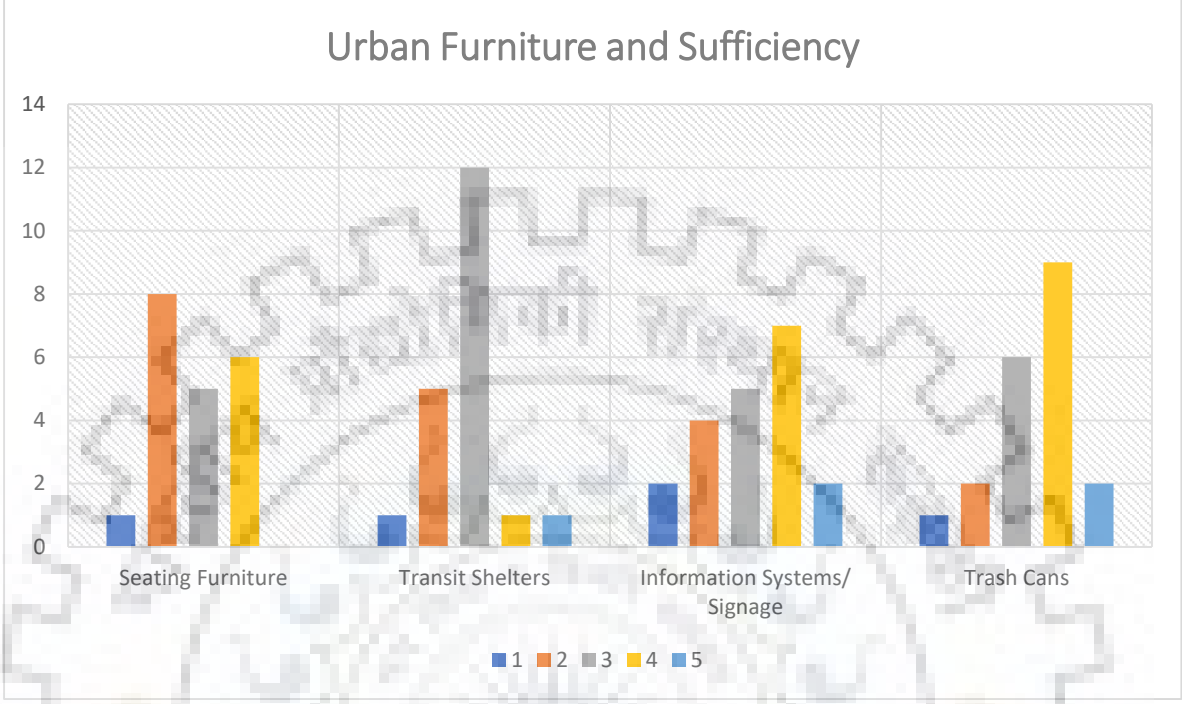


Figure 67 - Bar graph showing the different elements of urban furniture as rated on a scale of 1-5 in terms of sufficiency.

The following suggestions were made by the interviewees to improve the current scenario of inclusivity in Luisenplatz:

1. Increase number of appropriately located and comfortable sitting spaces and transit shelters for diverse user groups.

   "More comfortable places to sit."

   "There could be more transit shelters."

   "Seating can be improved by installing them at varying heights."

   "More seating furniture and more covered areas."

   "… Spaces for sitting should have back rests for comfort."

2. Improve the condition of flooring through maintenance of existing flooring (filling in joint gaps) or through installation of maintenance-free material.

   "The flooring needs to be maintained. I have seen old people face problems because the flooring is broken at a lot of places."

"… I have also observed the elders and the physically challenged struggle with flooring sometimes."

"I think flooring needs an improvement. I have seen the old people's walking sticks getting stuck in the joint gaps. The design is okay but there are portions where the flooring is broken."

3. Improve information systems and signage.

"It needs a transport information desk/ kiosk. More visible information display boards are required. Voice assistance for the visually impaired would be great."

"Sometimes it's difficult to find a particular shop. Something that can help one in orienting himself better is required."

"I think better signage of where the routes are would improve the experience. Initially, when I didn't know what route to take, I would have to walk to each of those sign boards with the schedule and traverse through all that foot and bus/tram traffic. That was especially stressful the first time."

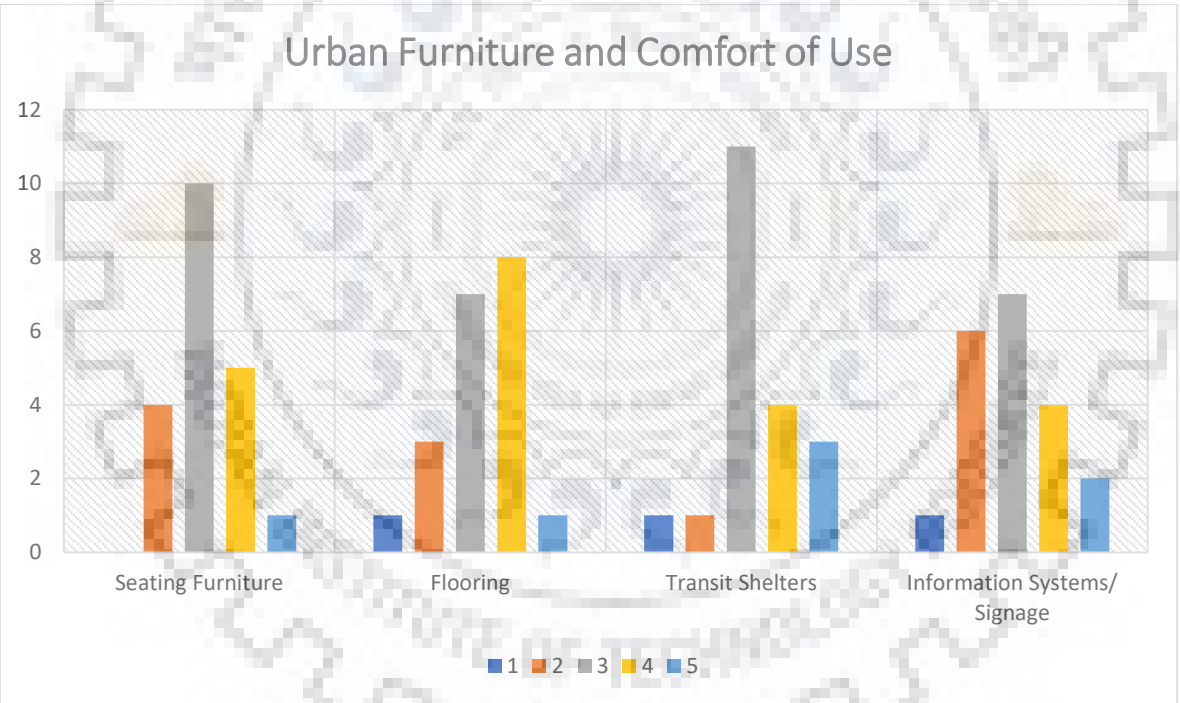
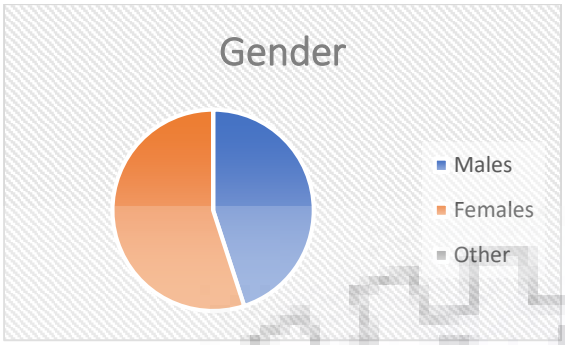


Figure 68 - Bar graph showing the different elements of urban furniture as rated on a scale of 1-5 in terms of comfort of use.

In Street Zeil, responses were collected from 9 males and 11 females. Out of the 20 respondents, 1 was a child, 7 were young adults, 9 were adults and 3 were aged more than 64 years. A diverse

population was interviewed comprising of people who do not live in Frankfurt and those who have lived here for a period of 6 months to more than 30 years.



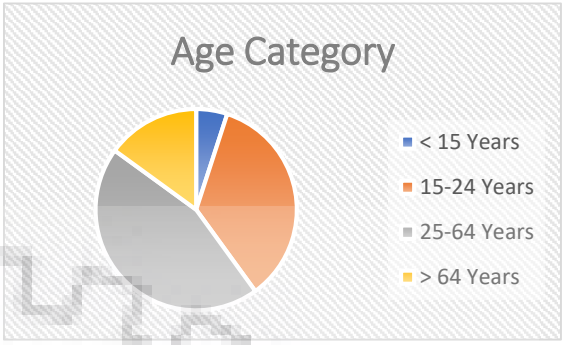


Figure 69 - Pie chart showing the percentage of male and female respondents for field interviews conducted in Street Zeil.

Figure 70 - Pie chart showing the percentage of respondents belonging to various age categories for field interviews conducted in Street Zeil.

From the graph on frequency and duration of visit, it can be inferred that very few people visit Street Zeil during the morning hours. The street is usually active in the afternoons and evenings, with people visiting for the purpose of shopping and entertainment. Majority of the crowd is invested in leisure-related activities i.e. shopping, eating and meeting friends. When tired, the plenty of seating arrangements, running linearly from Hauptwache to Konstablerwache (the major entry and exit points of the site), come to use. The visitors appreciate the liveliness in the plaza. The presence of street performers, artists and musicians contributes to this 'liveliness'.

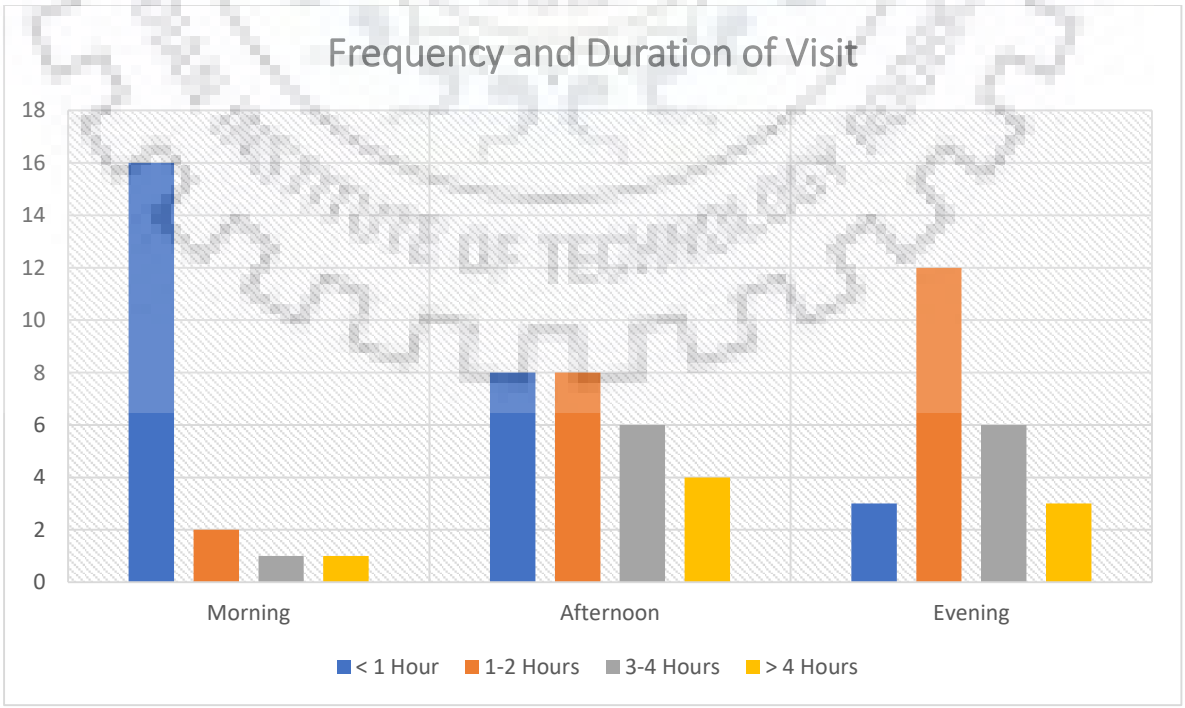


Figure 71 - Bar graph showing the frequency and distribution of site users for different times of the day in Street Zeil.

- *"The street is lively throughout the week, except for Sundays when the shops are closed."*
- *"…The best part is the street performers. They make it so lively and happy."*
- *"This is one of the liveliest places in the city… I like coming here especially on Saturdays because the street is full of music and art performers."*
- *"It's a lively place. I like to see the kids play."*
- *"Liveliness of the street and artists. The musicians make the place pleasant."*

A summary of the responses suggests that urban furniture in Street Zeil responds well to the local context.

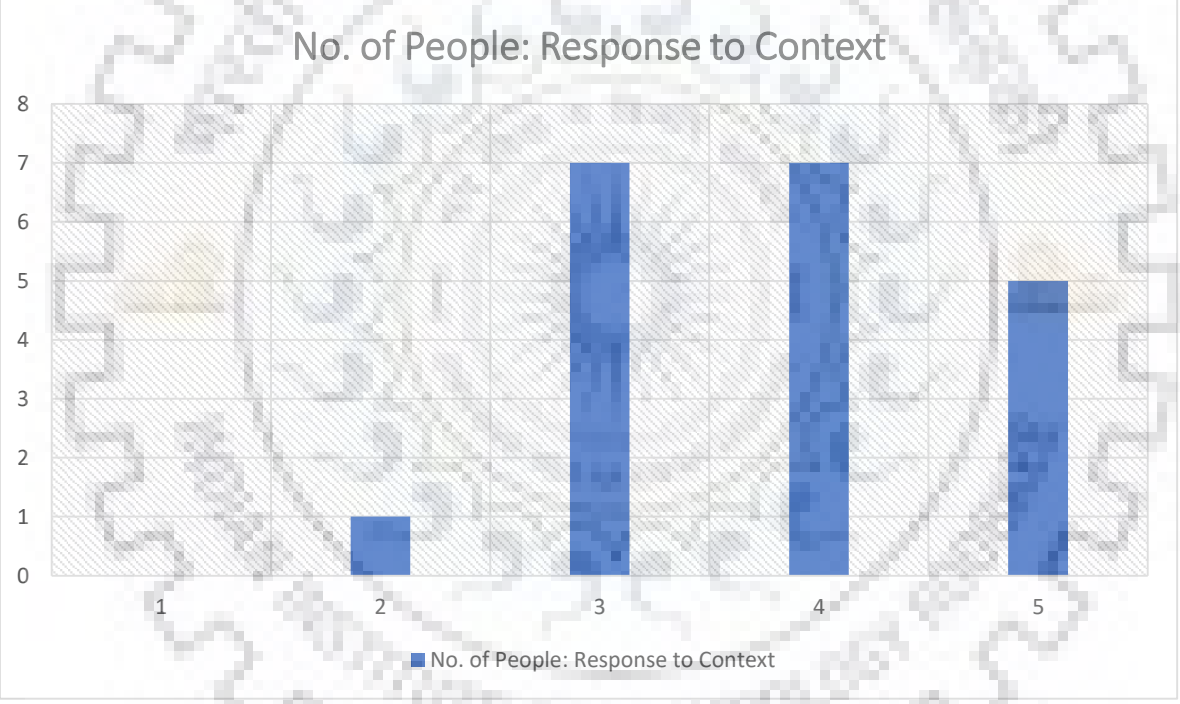


Figure 72 - Bar graph showing the rating of urban furniture vis-à-vis response to context in Street Zeil.

The following issues related to urban furniture were highlighted during the interviews:

1. Lack of information systems and signage.

   "There are no information systems for S and U-Bahn anywhere. I always have to check my phone for that."

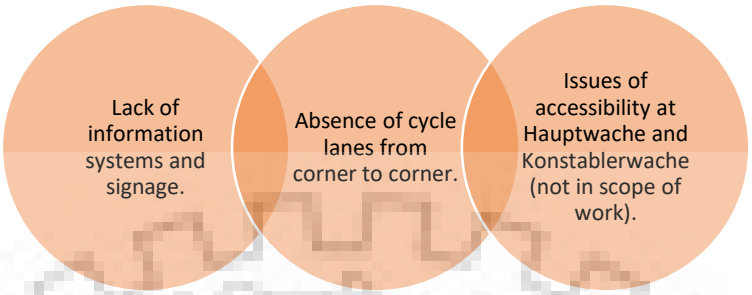
2. Absence of cycle lanes from corner to corner.

   "… A dedicated lane for cyclists can be added."

"… the cyclists are a problem sometimes as they interfere with the pedestrian traffic."

"Separate lane for cyclists would be great. I have encountered conflicts while walking."

3. Issues of accessibility at Hauptwache and Konstablerwache (not in scope of work).



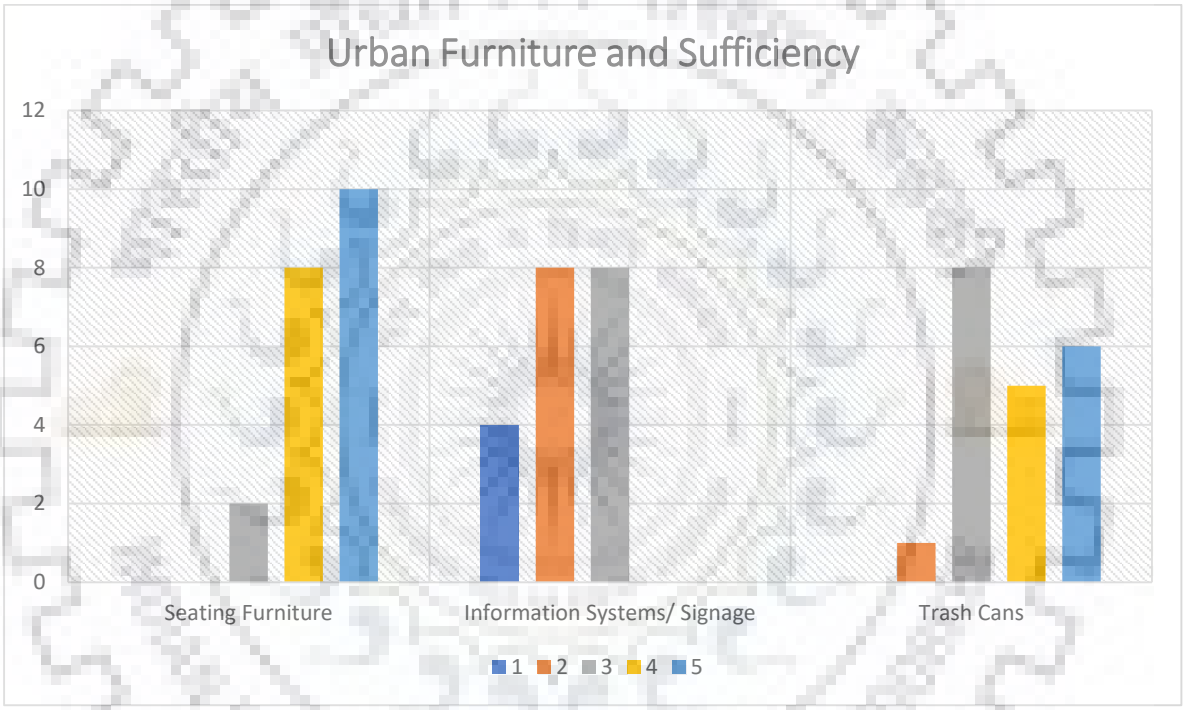


Figure 73 - Bar graph showing the different elements of urban furniture as rated on a scale of 1-5 in terms of sufficiency.

The following suggestions were made by the interviewees to improve the current scenario of inclusivity in Street Zeil:

1. Install information systems and signage.

"… Information systems for S and U-Bahn should be added between the two points."

"Add information systems for S and U-Bahn. Maps with location of major shops would be great. Me and my friends get confused sometimes."

"Add information boards and signage with bigger letters and symbols. I tend to get lost sometimes with respect to orientation."

2. Add children's play spaces.

   "I have seen kids playing around the sculptures and fountains. Children's play spaces can be an interesting intervention."

3. Improve facilities for the people with mobility-related impairment (at Hauptwache and Konstablerwache) and the visually impaired.

   "… I have seen old people struggle with the steps at Hauptwache and Konstablerwache."

   "There are no ramps at Hauptwache or Konstablerwache for the physically disabled."

   "Ramps with handrails at Hauptwache and Konstablerwache."

   "There should be different types of furniture meant for sitting for the aged, something that is more comfortable."

   "… Add tactile guide markings for visually impaired users."

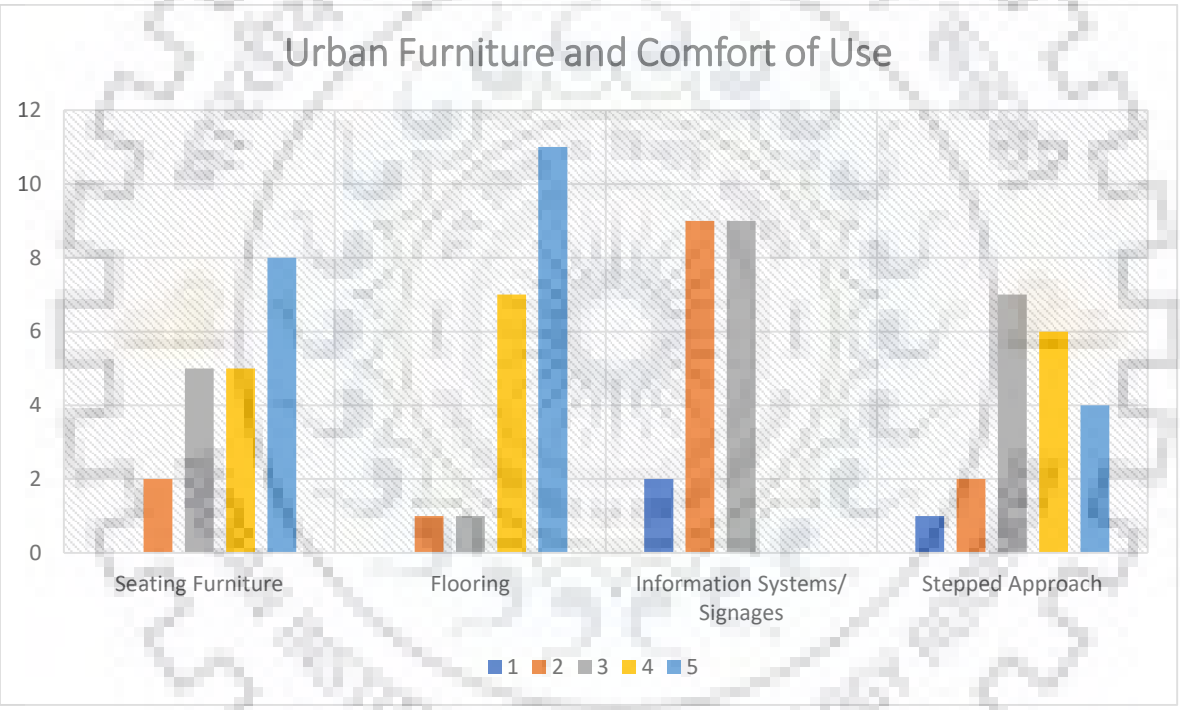
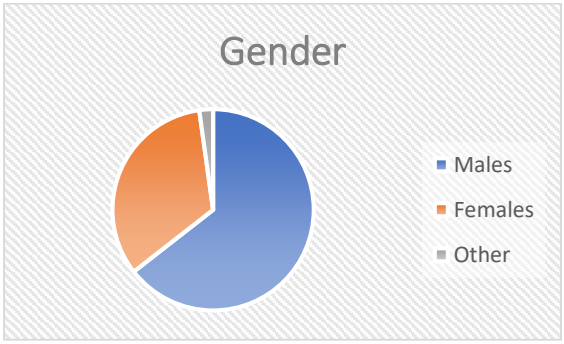


Figure 74 - Bar graph showing the different elements of urban furniture as rated on a scale of 1-5 in terms of comfort of use.

In Sector 17C, responses were collected from 29 males, 15 females and 1 belonging to the 'other' gender category. Out of the 45 respondents, 1 was a child, 20 were young adults, 18 were adults and 6 were aged more than 64 years. A diverse population was interviewed comprising of people who do not live in Chandigarh (tourists) and those who have lived here for a period of 6 months to more than 60 years.



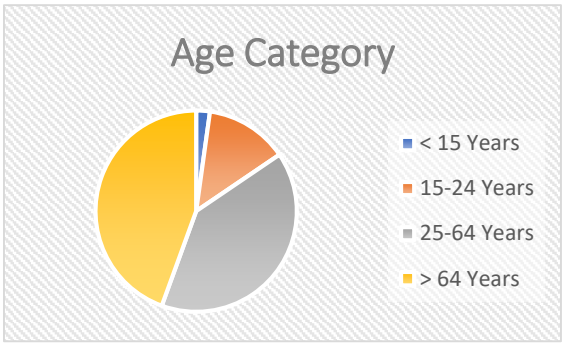


Figure 75 - Pie chart showing the percentage of male and female respondents for field interviews conducted in Sector 17C.

Figure 76 - Pie chart showing the percentage of respondents belonging to various age categories for field interviews conducted in Sector 17C.

In terms of number of visitors on a particular day, mornings are lean, afternoons and relatively busy and evenings are peak, owing to the commercial nature of the sector. Majority of the crowd is invested in leisure-related activities i.e. shopping, talking, eating and relaxing. People like the vast open space and the liveliness in the plaza, especially in the area around the fountains. The presence of street vendors and fountains contributes to this 'liveliness'.

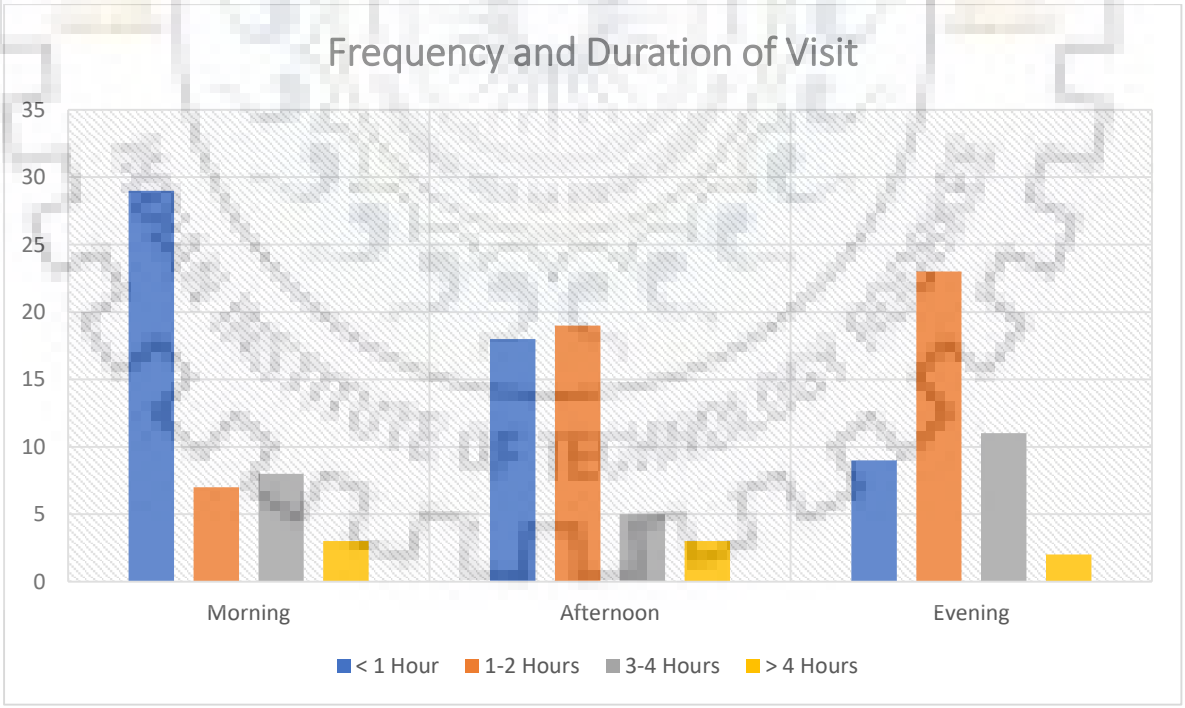


Figure 77 - Bar graph showing the frequency and distribution of site users for different times of the day in Sector 17C.

- *"Open and semi-open spaces as they connect the plaza."*

- *"I particularly like the fountain. It keeps the environment cool."*
- *"The area near the fountain, especially when the laser fountain show happens."*
- *"Yes, I like the central space in the plaza very much. It becomes lively during the evening when street vending begins."*
- *"The street vendors because they grab your attention and make the space lively."*

A summary of the responses suggests that urban furniture in Street Zeil responds well to the local context.

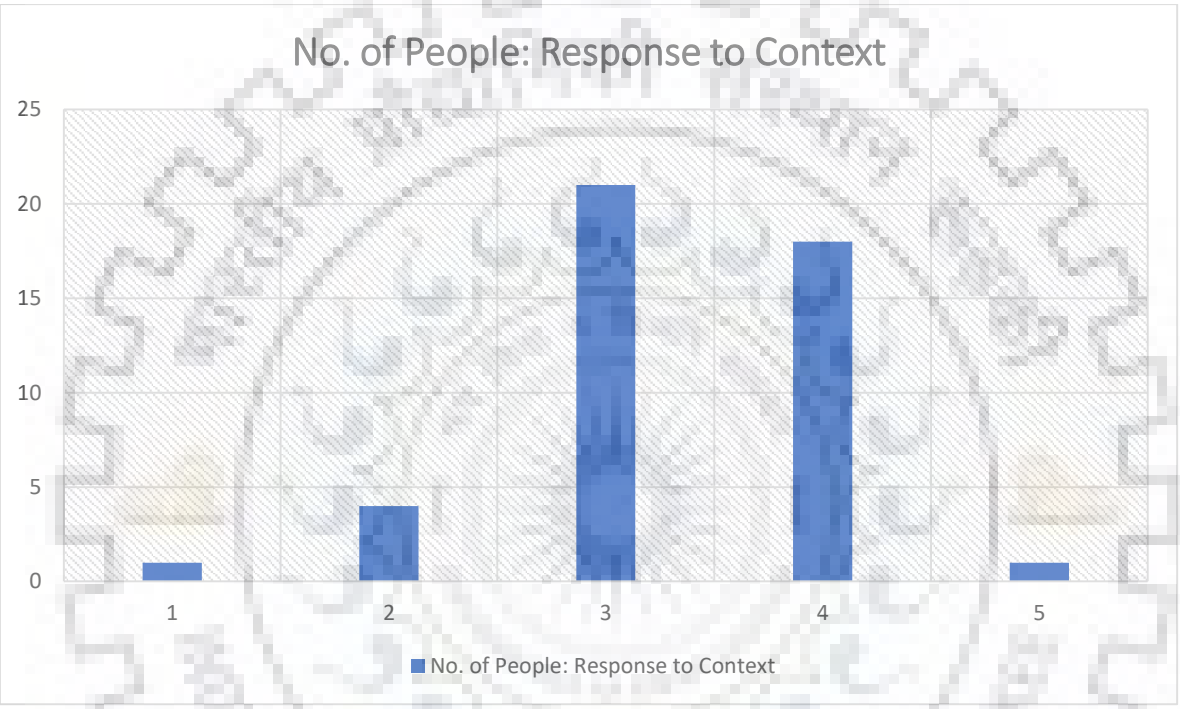
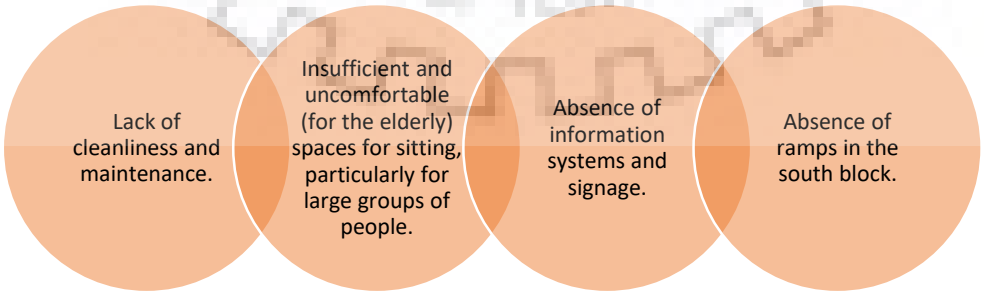


Figure 78 - Bar graph showing the rating of urban furniture vis-à-vis response to context in Sector 17C.

The following issues related to urban furniture were highlighted during the interviews:



1. Lack of cleanliness and maintenance.

"The furniture is not well-maintained and the areas near the fountains and eating booths are often unclean."

"The space is not maintained, trash cans for instance."

"Yes, furniture is sometimes unusable due to lack of maintenance."

2. Insufficient and uncomfortable (for the elderly) spaces for sitting, particularly for large groups of people.

"There is a lack of furniture here and placement has not been taken care of properly. Additionally, there are no interactive spaces for large groups of people."

"Yes, lack of seating spaces for aged people."

"I don't particularly like the seating. It gives me a backache and isn't very comfortable."

3. Absence of information systems and signage.

"No information boards. I often get confused."

"Absence of drinking water fountains."

"No drinking water fountains are available."

4. Absence of ramps in the south block.

"... When I go to the south block, I'm never able to find the ramp there. I believe it doesn't exist, so that's a problem."

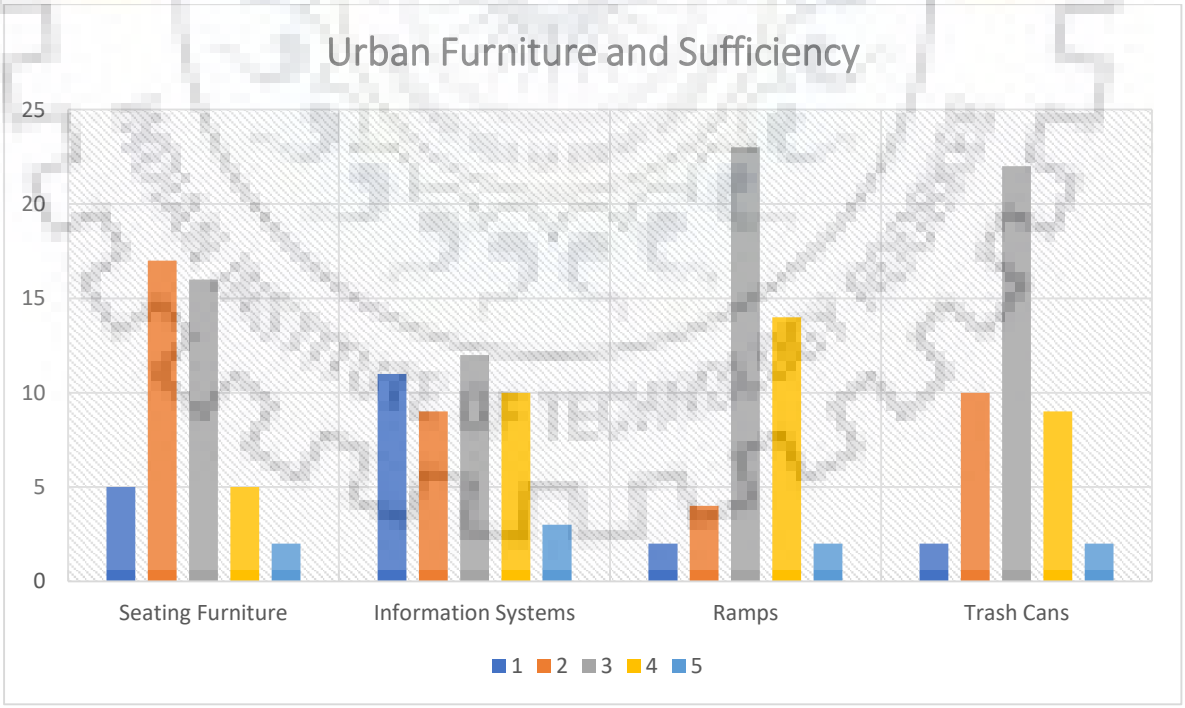


Figure 79 - Bar graph showing the different elements of urban furniture as rated on a scale of 1-5 in terms of sufficiency.

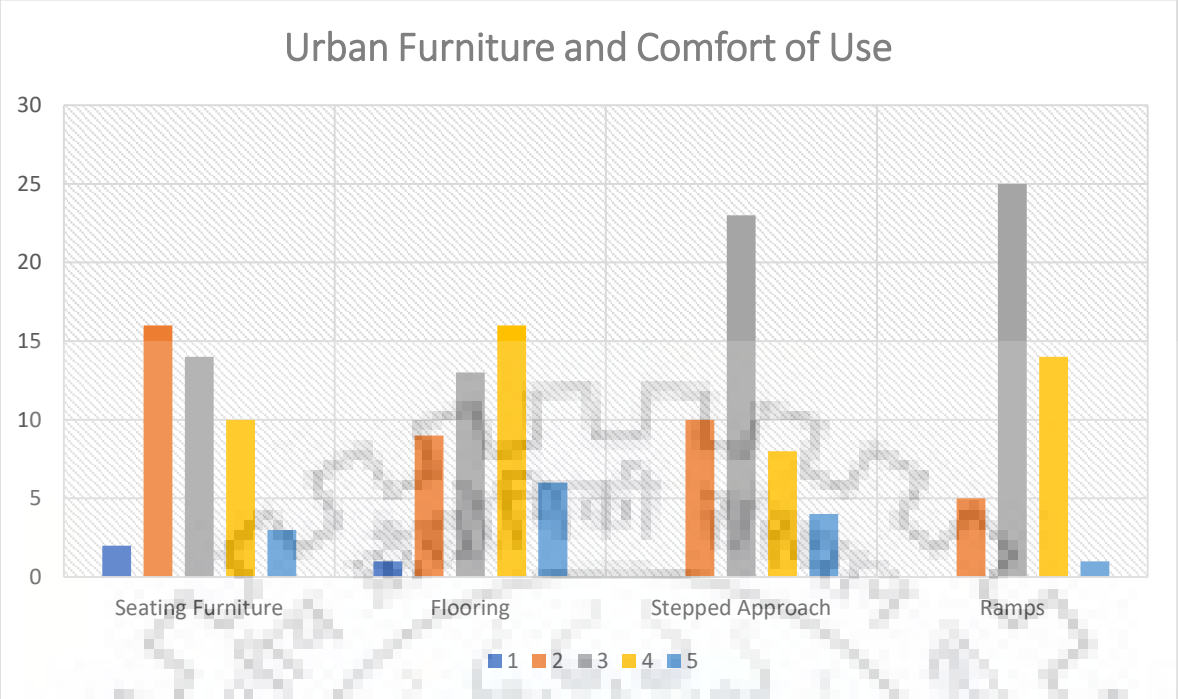


Figure 80 - Bar graph showing the different elements of urban furniture as rated on a scale of 1-5 in terms of comfort of use.

The following suggestions were made by the interviewees to improve the current scenario of inclusivity in Sector 17C:

1. Increase number of appropriately located and comfortable sitting spaces.

   "... the furniture should be redesigned in terms of location and placement."

   "More seating and covered spaces."

   "The number of seating areas should be increased."

2. Install information systems and signage.

   "Installing modern information systems (for instance: bus schedules, navigation)."

   "Sign boards must be installed since people often get confused and have a hard time in finding places."

   "... information systems or sign boards must be added for orientation. It's difficult for new people to navigate in the plaza."

3. Improve facilities for the people with mobility-related impairment and the visually impaired.

   "Small services for taking senior citizens from one place to another would be nice."

   "... the seating arrangement needs to be made more accessible."

   "Better accessibility for wheelchair users."

"Provide facilities for the visually impaired (for example: guide markings on the floor and information systems in braille)."

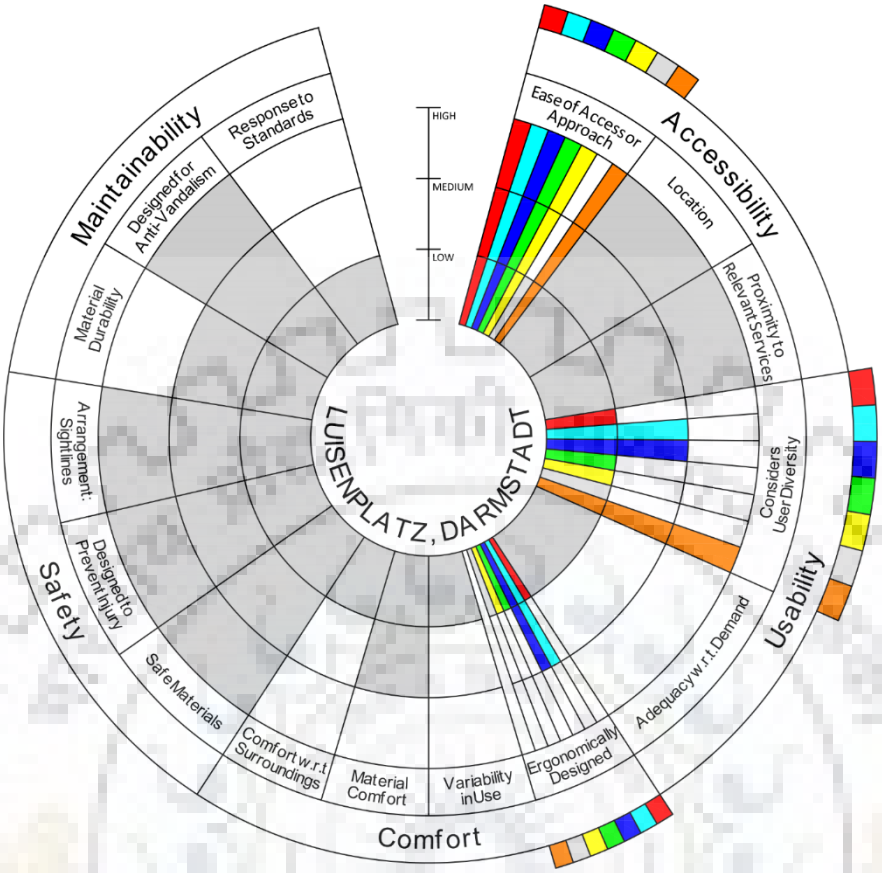
"Dedicated spaces to enter the plaza from the parking should be provided with proper ramps. Handrails for steps are missing."

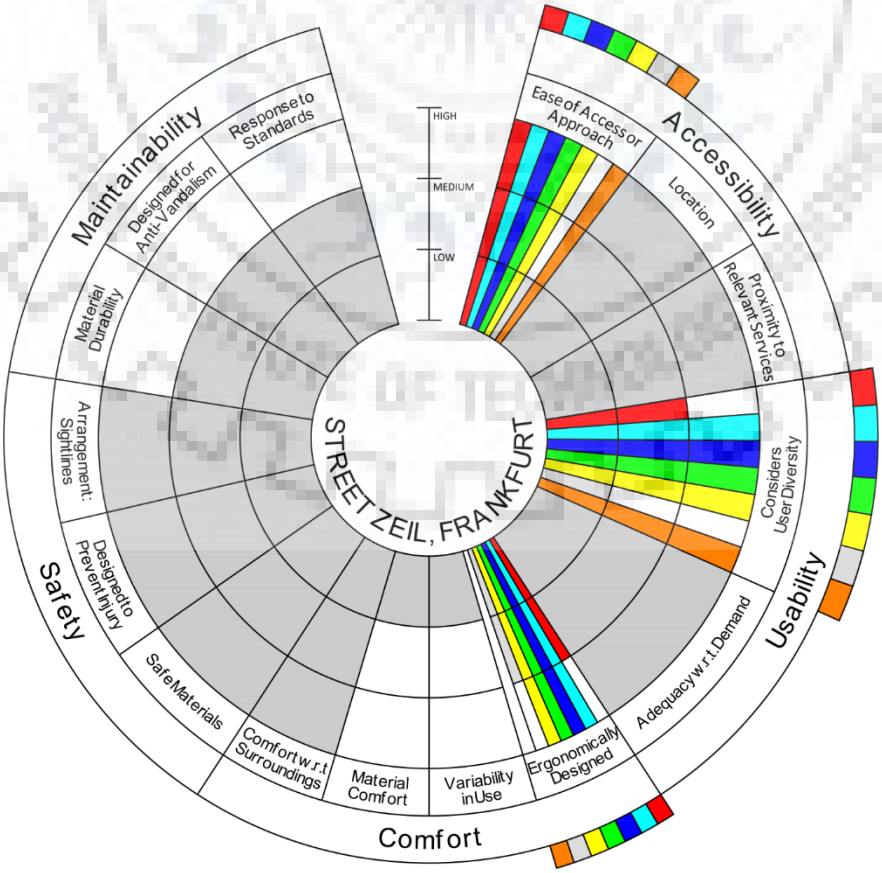
4.5 ANALYZING KEY FURNITURE ELEMENTS FOR ASSESSING INCLUSIVITY

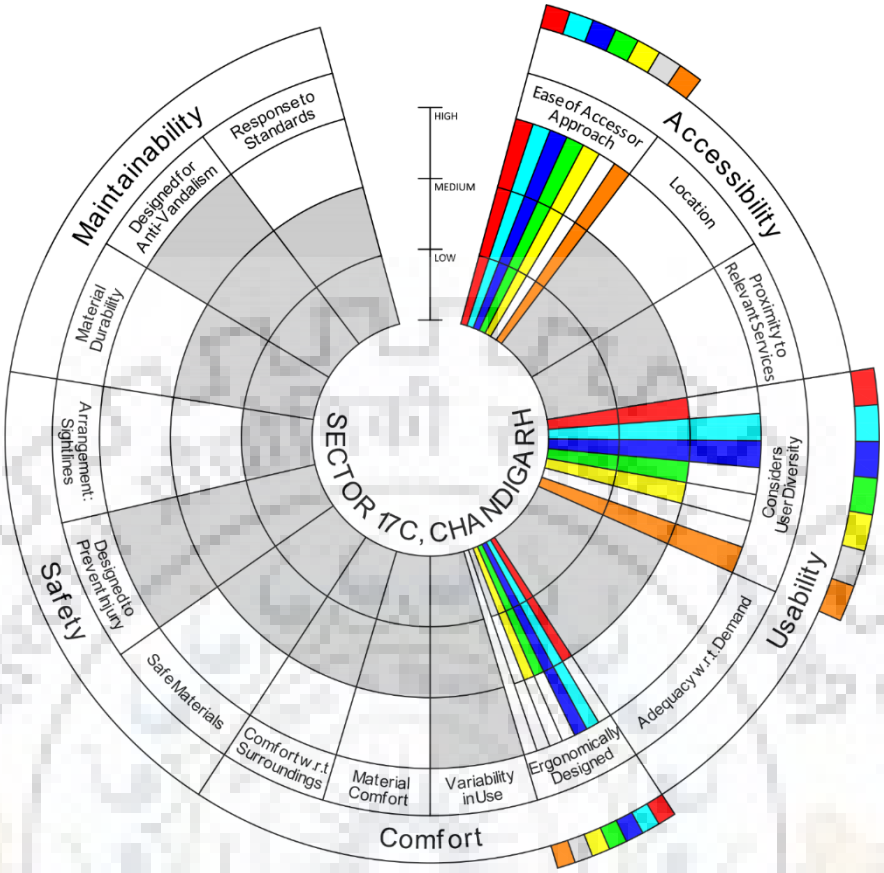
Section 3.3 discusses the evolution and validation of 'Criteria to Assess Inclusion'. This list of 5 criteria and 15 sub-criteria was used for assessment of inclusivity of 4 categories of urban furniture in the selected field studies. The 4 categories have been tabulated in Table 6 under Section 3.5.

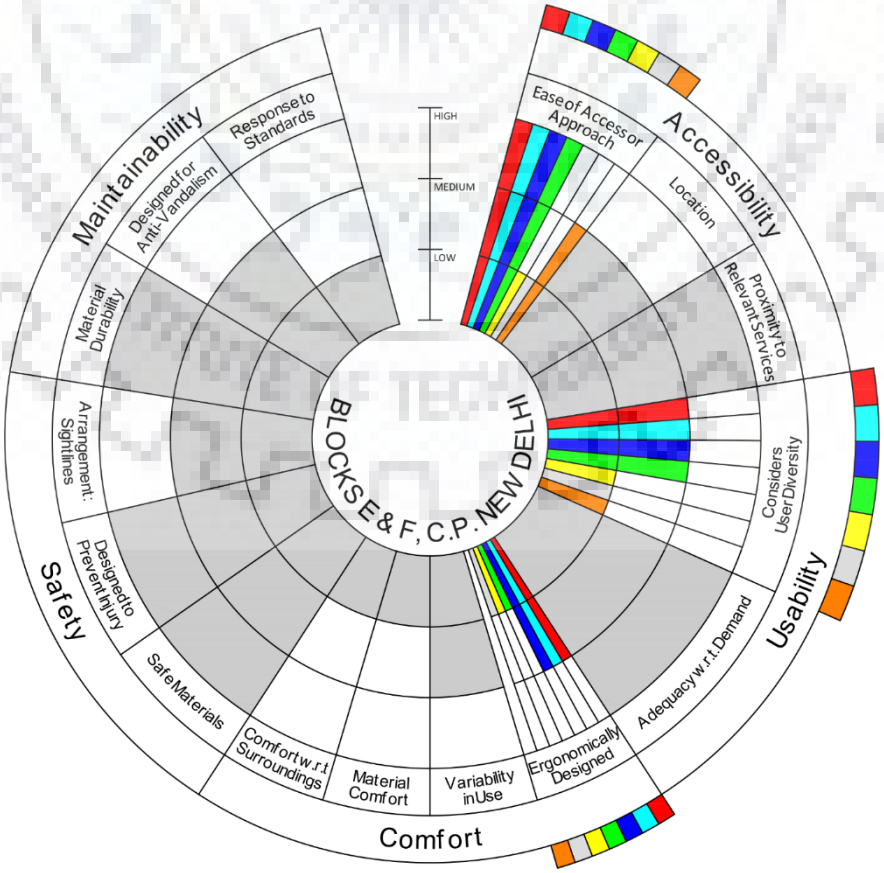
The elements were analyzed on the basis of personal observations and learnings from all the methods of analysis discussed in Sections 4.2 to 4.4. The results of the analysis have been tabulated in the sheets attached alongside. The analysis has also been summarized in the form of 'Criteria Charts' for representing the results graphically. Variations between field studies can be seen by placing and viewing the charts alongside.

4.5.1 Seating Furniture

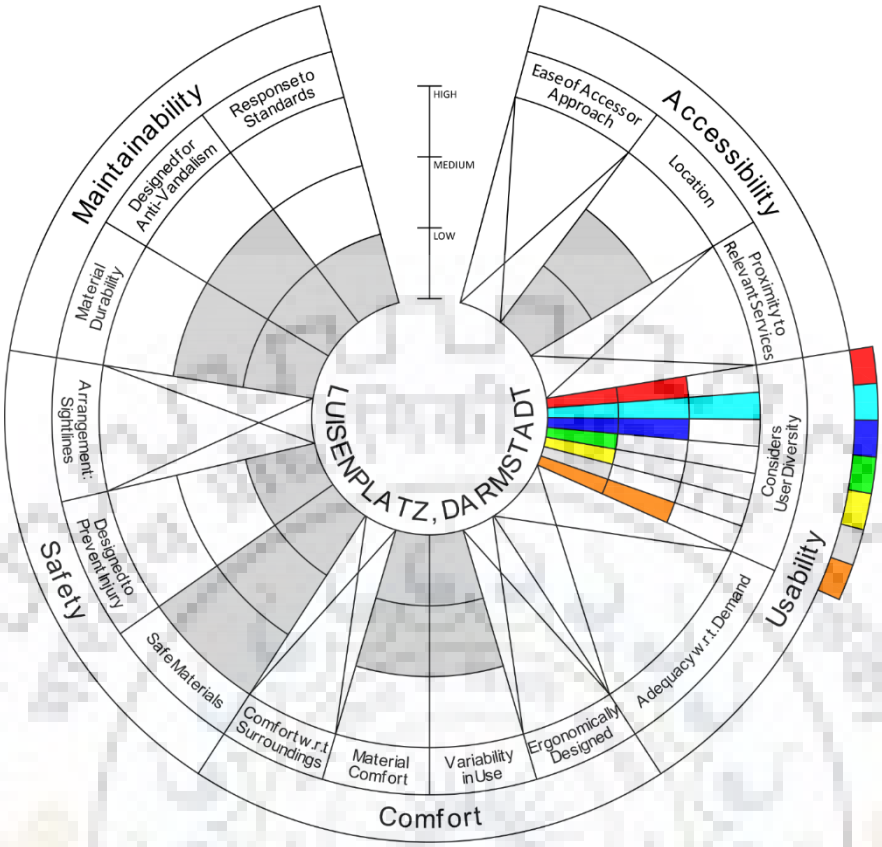


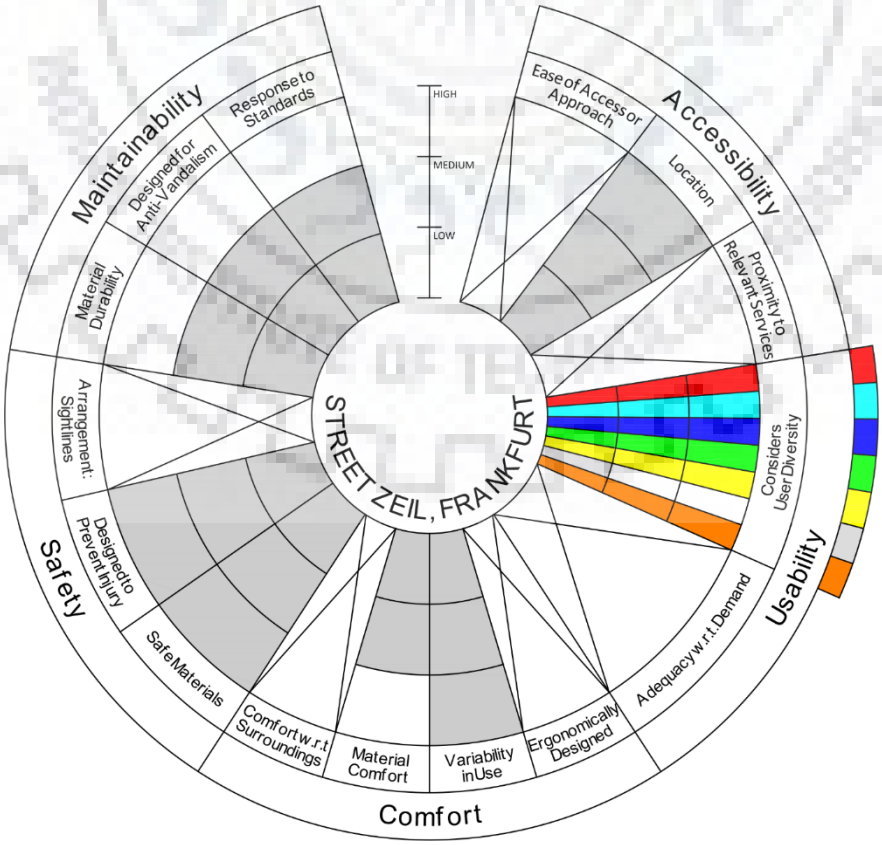



SECTOR 17C, CHANDIGARH
HIGH
MEDIUM
LOW
Accessibility
Ease of Access or Approach
Location
Proximity to Relevant Services
Usability
Considers User Diversity
Adequacy w.r.t. Demand
Ergonomically Designed
Variability in Use
Comfort
Material Comfort
Comfort w.r.t. Surroundings
Safe Materials
Safety
Designed to Prevent Injury
Arrangement: Sightlines
Maintainability
Material Durability
Designed for Anti-Vandalism
Response to Standards

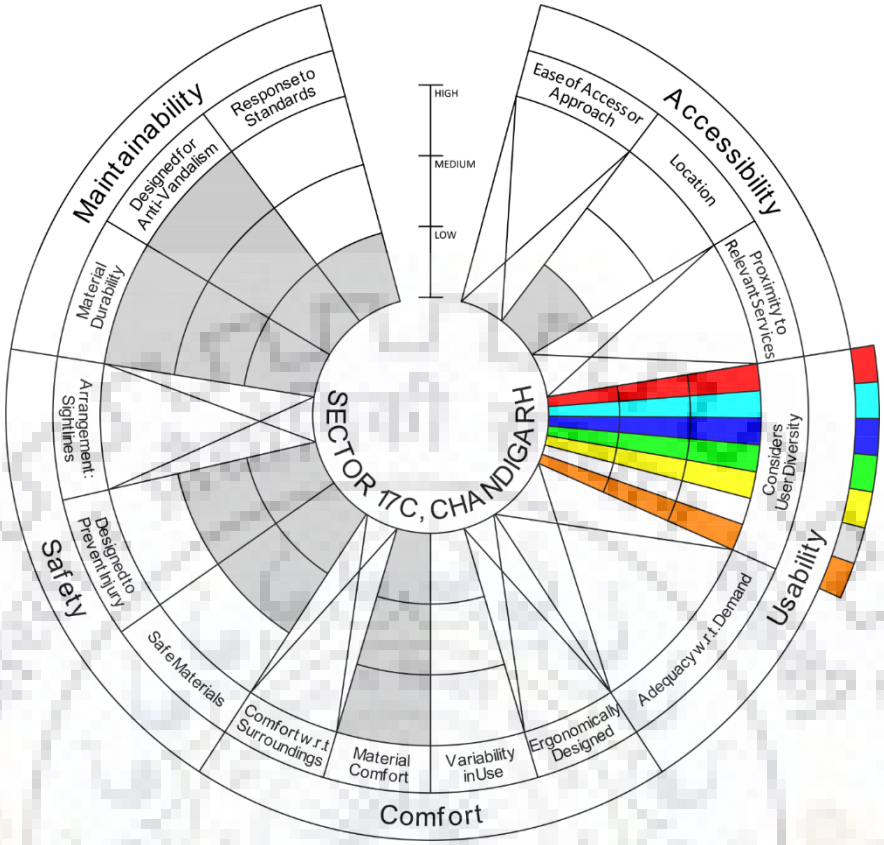

BLOCKS E & F, C.P. NEW DELHI
HIGH
MEDIUM
LOW
Accessibility
Ease of Access or Approach
Location
Proximity to Relevant Services
Usability
Considers User Diversity
Adequacy w.r.t. Demand
Ergonomically Designed
Variability in Use
Comfort
Material Comfort
Comfort w.r.t. Surroundings
Safe Materials
Safety
Designed to Prevent Injury
Arrangement: Sightlines
Maintainability
Material Durability
Designed for Anti-Vandalism
Response to Standards

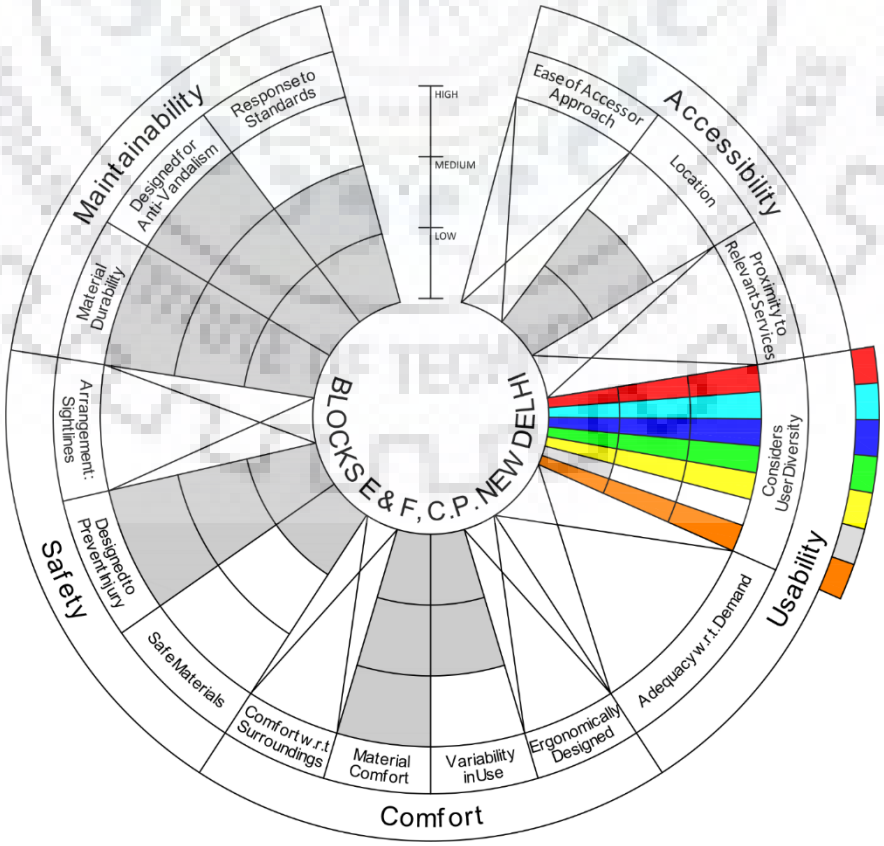
4.5.2 Surfaces



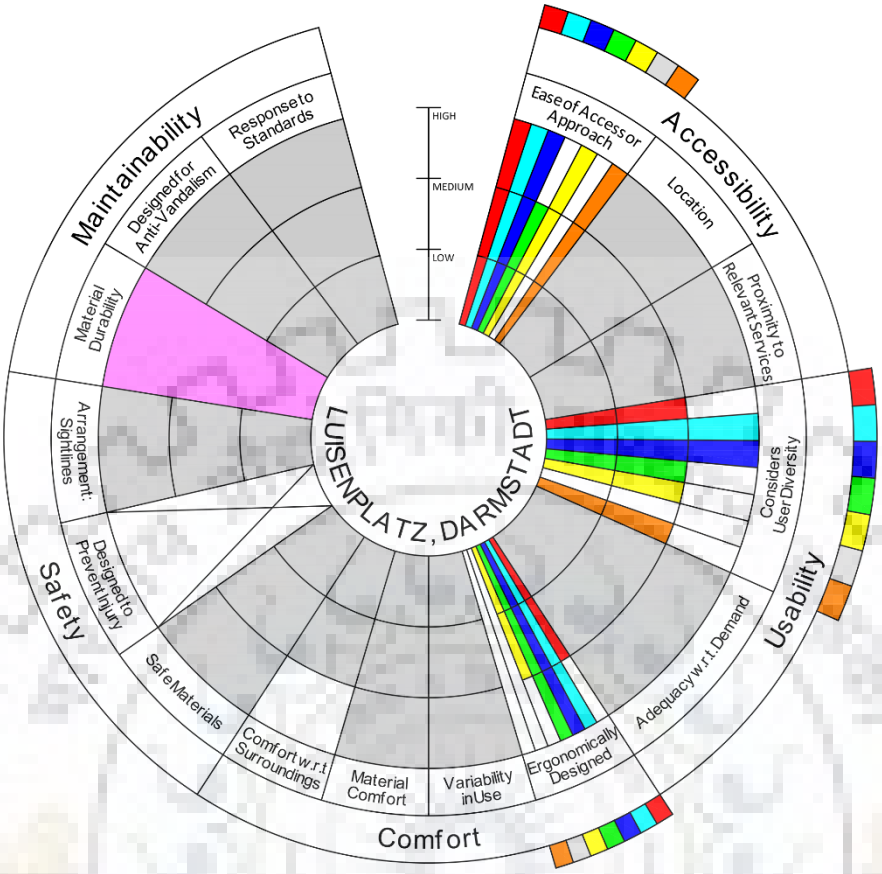


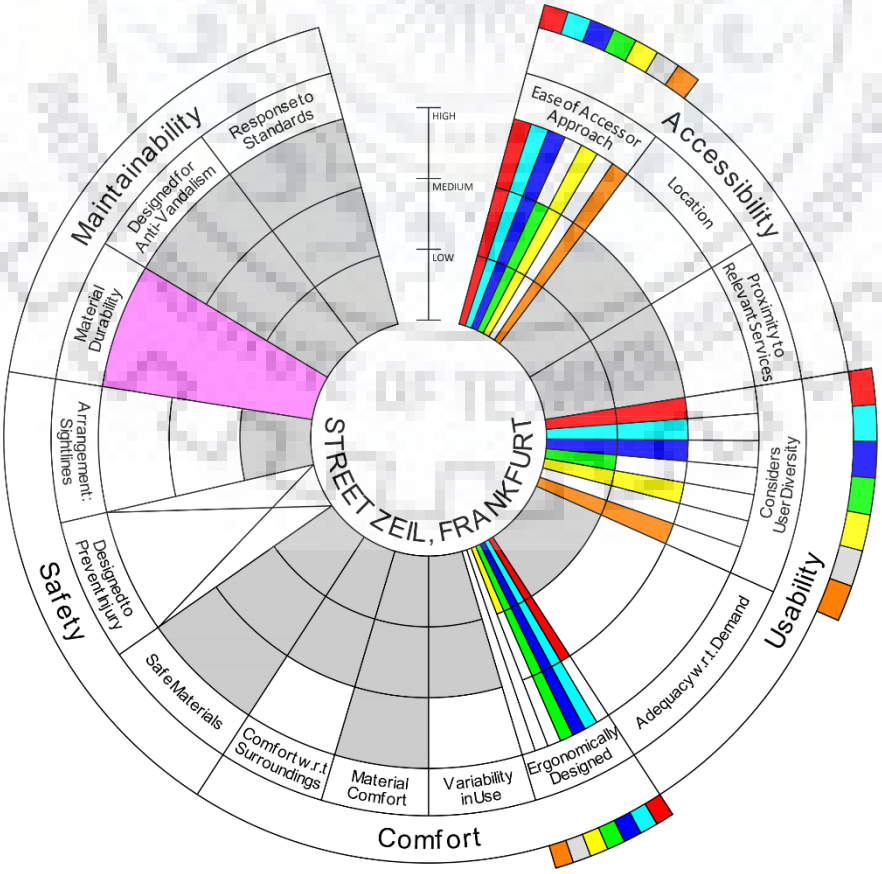
4.5.3 Information Surfaces





4.5.4 Others


LUISENPLATZ, DARMSTADT
HIGH
MEDIUM
LOW
Maintainability
Response to Standards
Designed for Anti-Vandalism
Material Durability
Accessibility
Ease of Access or Approach
Location
Proximity to Relevant Services
Usability
Considers User Diversity
Adequacy w.r.t. Demand
Safety
Arrangement: Sightlines
Designed to Prevent Injury
Safe Materials
Comfort
Comfort w.r.t. Surroundings
Material Comfort
Variability in Use
Ergonomically Designed


STREETZEIL, FRANKFURT
HIGH
MEDIUM
LOW
Maintainability
Response to Standards
Designed for Anti-Vandalism
Material Durability
Accessibility
Ease of Access or Approach
Location
Proximity to Relevant Services
Usability
Considers User Diversity
Adequacy w.r.t. Demand
Safety
Arrangement: Sightlines
Designed to Prevent Injury
Safe Materials
Comfort
Comfort w.r.t. Surroundings
Material Comfort
Variability in Use
Ergonomically Designed

Chapter 5

Conclusions and Recommendations

5.1 CONCLUSIONS

With a focus on urban furniture and inclusive design in the public realm, this dissertation was instrumental in establishing the relationship between furniture and humans in the context of urban public spaces. The literature-based research was accompanied by on-site data collection and analysis to reveal issues of human inclusion with respect to urban furniture. The following conclusions can be drawn:

1. A strong relationship exists between furniture and its users in urban public spaces. Furniture elements make up the tangible components of a public space that humans directly interact with. This necessitates the need to follow a user-centered approach while designing and planning for urban furniture. The design must be able to satisfy the needs of diverse user groups. As per the operational definition of inclusion adopted for the purpose of this study, the user groups include people of all genders (males, females and others), ages (children, young adults, adults and the elderly), people with mobility-related impairment (wheelchairs and crutches), the visually impaired (partial or complete) and others (people walking with strollers).
2. Field studies led to the conclusion that even though variations in context exist between different cities, the basic requirements of diverse user groups with respect to urban furniture remain the same. Slight differences in specifications may arise depending on the climate and proportions of the human body in the given contexts.
3. Generating user feedback lies at the very core of any inclusive design approach, be it at the macro or the micro level. Real inclusion is achieved only when the opinion of site users is taken into careful consideration. Here, a field interview approach was followed to gather opinion on issues of inclusion with respect to urban furniture on all four sites. Users not just highlight the issues but can also provide useful suggestions for improving the furniture and consequently, the public space under investigation.

5.2 RECOMMENDATIONS

5.2.1 Seating Furniture

1. For seating furniture to be inclusive, it must be easily accessible or approachable by people of all genders, ages and abilities, including those with mobility-related impairment (crutches) and the visually impaired. The layouts must provide enough space for crutch users and for

people with strollers to manoeuvre around sitting spaces. Floor guiding tiles for visually impaired users must lead directly to spaces meant for sitting, laid out without any discontinuities. Located at an appropriate distance from the entrances and exits of the site, seating furniture should be evenly distributed in order to provide rest areas throughout the site. An optimum spacing of ≤ 30m is desirable for avoiding fatigue while people walk from one corner to another on the site. Multiple configurations are desirable to cater to small and large groups as well diverse users. The arrangement of elements should ideally be consistent with the flooring grid, comprising of layouts that promote social interaction. Elements must support the primary function of the site (transit, commercial etc.) and hence, be located in close proximity to the function.

2. Seating furniture design must acknowledge the fact that any site is used by diverse groups of people and hence, the design must cater to the needs and aspirations of as many end users as possible. This diversity includes people of all genders (males, females and others), ages (children, young adults, adults and the elderly) and abilities (able-bodied, mobility impaired users on wheelchairs or crutches and the visually impaired). In some cases, such as for sites in India, the needs of street vendors may also be considered. Adequacy with respect to demand of the site is of utmost importance for optimal functioning of the site.
3. Inclusive urban seating furniture must be ergonomically comfortable for diverse users. A change in dimensions of the human body from one context to another causes a change in the required dimensions of seating furniture and hence, the ideal range of seat heights may vary. For example, the desirable horizontal surface height for seating furniture in India ranges from 350 – 425mm and must never exceed 450mm. On the other hand, for Germany, the height varies from 450 – 470mm. Each layout must also be equipped with seating furniture that is desirable for children. Table 17 below shows the recommended seat heights for Indian children as given by the Central Building Research Institute (CBRI), India.

Table 17 - Recommended seat heights for Indian children.

Age (in Years)	Ideal Seat Height (in mm)
5-7	270
8-10	300
11-13	340
14-15	375
16-17	400

Therefore, the seat heights must vary so as to incorporate as many users as possible, with special attention to the needs of the children. Seating furniture must be equipped with back and arm rests (arm rests at 700mm) in order to include the elderly, people with mobility-related impairment (crutches) and the visually impaired. Variation in configurations is also desirable as users can make a choice depending on their needs. A study of materials used for seating furniture in the four field studies has led to the understanding that climate plays a major role in determining the choice of materials. A comparison of the materials used in the field studies is given in Table 18 below.

Table 18 - Comparison of materials used for seating in the four field studies.

Material	Comfort w.r.t. Climate	Safety	Durability	Vandalism
Wood	It feels warmer in cold weather and cooler in warm weather. Absorbs moisture and begins to develop cracks when the moisture evaporates. If moisture persists, algae begins to grow on the surface. Good for places that experience low levels of rain or snow.	Non-toxic and non-staining.	Moderate durability against weather and use.	Moderate tolerance to vandalism.
Stone	For cold climates, the rate of evaporation of moisture is slow. For moderate humid conditions, stone is a suitable choice for outdoor seating furniture. Does not drain or ventilate well after rain or snow.	Non-toxic and non-staining.	High durability against weather and use.	High tolerance to vandalism.
Aluminium	Ideal for all climates.	Slightly prone to corrosion.	Moderate durability against	Moderate tolerance to vandalism.

			weather and use.	
Concrete	The surface tends to get hot in summers and cold in winters, but not as much as other metals. Does not drain or ventilate well after rain or snow.	Non-toxic and non-staining.	High durability against weather and use.	High tolerance to vandalism.
Wrought Iron	Unsuitable as the surface tends to get hot in summers and cold in winters. Can be used under shade.	Prone to corrosion.	High durability against use but low against weather.	Moderate tolerance to vandalism.
Granite Slabs	Unsuitable as the surface tends to get hot in summers and cold in winters. Can be used under shade.	Non-toxic and non-staining.	High durability against weather and use.	High tolerance to vandalism.
Stainless Steel	Unsuitable as the surface tends to get hot in summers and cold in winters. Can be used under shade.	Non-toxic and non-staining.	High durability against weather and use.	Moderate tolerance to vandalism.

For cold countries with low humidity levels like Germany, the ideal material choice for seating furniture is aluminium. Wood or stone can be used as second options if aluminium is found aesthetically unappealing to the site. For countries with a sub-tropical climate like India, the ideal choice for seating furniture is stone and aluminium. Wood and concrete can be used as second options. Materials that become hot in the presence of direct sunlight, such as wrought iron, granite slabs and stainless steel, can be considered for shaded areas. For seating furniture to be truly comfortable, the arrangements meant for sitting must be integrated well with the site as well as with other elements of urban furniture. Trash cans must be located no

closer than 900mm from seating furniture. In order to avoid discomfort caused by traffic noise, sitting spaces must not be located directly adjacent to vehicular traffic zones.

4. Non-toxic and non-staining materials, such as wood, stone and concrete, are considered safe for urban seating furniture. Materials such as aluminium and wrought iron, when used in humid places, are prone to corrosion. Granite and stainless steel are considered safe in terms of toxicity and corrosion. Seating furniture must have a horizontal hard-packed surface and the design must not cause injury to any of the users during use. An arrangement will feel safe if it encourages one to view the site and is also visible from multiple directions, equipped with sufficient lighting levels for night time.
5. The material for seating furniture must be easy to maintain and durable against weather and use. Stone, concrete, granite slabs and stainless steel are examples of materials that are highly durable against weather and use. Elements of seating furniture should be tolerant to vandalism, both in design and material. Lastly, it is desirable to maintain consistency with the technical standards for urban furniture, as given by competent authorities. This is in view of the fact that standards are developed after thorough research for the context in question and provide a starting point for choosing elements with the right specifications.

5.2.2 Surfaces

1. The design of flooring must be able to create zoning on the site, as can be seen in the example of Street Zeil where the stretch of the street is divided into walkways and resting zones. By playing with visual (color) and tactile contrasts, the flooring can lead the users to various directions. For flooring to be suitable for human use, the drain and manhole covers must be flushed with the level of the flooring. Difference in levels can people to stumble and fall.
2. Considering user diversity is a must for flooring design of an urban public space. In order to be suitable for people of all genders, ages and abilities, flooring should be evenly surfaced with small joint gaps (< 8mm). Small joint gaps are specifically desirable for the elderly (assisted by walkers and walking sticks), people with mobility-related impairment (wheelchairs and crutches), the visually impaired (assisted by white canes) and people walking with strollers. The flooring must be equipped with floor guiding tiles, without any discontinuities in layout, for assisting the visually impaired. Visual and tactile contrasts in flooring may be helpful for the ones with partial visual impairment. For the Indian context, it is important to consider that street vendors might use the floor for sitting and hence, the

material should be such that it does not become too hot or too cold in the summer and winter months respectively.

3. A comparison of the flooring materials used in the field studies is given in Table 19 below.

Table 19 - Comparison of materials used for flooring in the four field studies.

Material	Comfort w.r.t. Climate	Safety	Durability	Vandalism
Red Bricks	Unaffected by temperature changes and hence, can be used for both hot and cold climates. Do not skid under wet conditions.	Non-toxic and non-staining.	Moderate durability against weather and use.	Moderate tolerance to vandalism.
Polished Red, White and Grey Stone	Unaffected by temperature changes and hence, can be used for both hot and cold climates. Unsuitable for sites that receive ample rain or snow (prone to skidding under wet conditions).	Non-toxic and non-staining.	Moderate durability against weather and use.	Moderate tolerance to vandalism.
Natural Grey Stone	Suitable for both indoor and outdoor flooring as it is only minutely affected by changes in temperature. Does not skid under wet conditions.	Non-toxic but prone to staining.	High durability against weather and use.	High tolerance to vandalism.
Cobblestone	Unaffected by temperature changes and hence, can be used for both hot and cold climates. Unsuitable for sites that receive ample rain or snow (prone to skidding under wet conditions).	Non-toxic and non-staining.	Moderate durability against weather and use.	Moderate tolerance to vandalism.
Concrete	Tends to get hot in summers and hence, not comfortable for street vendors to sit in the morning and afternoon hours.	Non-toxic but prone to staining.	High durability against weather and use.	High tolerance to vandalism.

	Does not skid under wet conditions.			
Polished Granite Tiles	Tend to get hot and cold in the summer and winter months respectively. Ideal to use in shaded areas.	Non-toxic and non-staining.	High durability against weather and use.	High tolerance to vandalism.
Unpolished Granite Tiles	Tend to get hot and cold in the summer and winter months respectively. Ideal to use in shaded areas.	Non-toxic but prone to staining.	High durability against weather but low against use.	High tolerance to vandalism.
Kota Stone	Suitable for both indoor and outdoor flooring as it is only minutely affected by changes in temperature. Does not skid under wet conditions.	Non-toxic but prone to staining.	High durability against weather and use.	High tolerance to vandalism.

With respect to climate, red bricks, natural grey stone, concrete and Kota Stone are the ideal choices for cold regions as they are mostly unaffected or only minutely affected by temperature changes and do not skid even under wet conditions (when it rains or snows). Cobblestone can be used in cold regions with low levels of rainfall or snowfall. For regions with a hot or sub-tropical climate like India (Chandigarh and New Delhi in particular), red bricks, polished stone, natural grey stone, cobblestone, and Kota Stone are appropriate choices for outdoor flooring, depending on their availability and ease of procurement. Concrete can be used otherwise. Polished and unpolished granite tiles are highly unsuitable for outdoor flooring as they tend to heat up in the summer months, making it uncomfortable for street vendors to sit on the floor. For semi-open galleries, it is recommended to use granite, either polished or unpolished and Kota Stone.

4. Non-toxic and non-staining materials are considered appropriate for indoor and outdoor flooring. The ideal choice for drain and manhole covers is cast iron, concrete, or a combination of both. For regions that experience high amounts of rainfall or snowfall, skid-resistant

flooring materials should be used. The floor should be even with small joint gaps (< 8mm), making it suitable for the elderly (assisted by walkers and walking sticks), mobility impaired users (wheelchairs and crutches) and the visually impaired (assisted by white canes). Drain and manhole covers must be flushed with the flooring. Ideally, drain covers must slope inwards by around 10° to facilitate flow of water. As per the standards for Indian urban public spaces, the holes in channel covers must be ≤ 20mm (not parallel to travel path) with a grating slot width ≤ 13mm.

5. Materials that are durable and require little maintenance (such as natural grey stone, concrete and Kota Stone) should be used for outdoor flooring. The selected materials must be able to perform well in all temperatures and precipitation conditions. For contexts that are prone to vandalism, only those materials should be used for flooring that have a high tolerance to vandalism. For sites in India for example, natural grey stone, concrete and Kota Stone are ideal for outdoor flooring. Lastly, it is desirable to maintain consistency with the technical standards for flooring in urban public spaces, as given by competent authorities. This is in view of the fact that standards are developed after thorough research for the context in question and provide a starting point for choosing elements with the right specifications.

5.2.3 Information Systems

1. All systems used for information should be physically accessible by diverse user groups. Floor guiding tiles must be installed to lead the visually impaired to information systems. The users must be able to approach the information boards or signage in order to read what it says. In terms of access to information, the letter and symbol height should be legible not just to the average user but also to those with poor vision. For people with partial or complete visual impairment, the information systems must be equipped with tactile (braille) and acoustic systems. The location must be such that they support the function of the public space they are installed in, being located in close proximity to relevant services. For a transit-oriented square, for example, it is important to place the information systems close to waiting areas, as can be seen in the case of Luisenplatz. The spacing between the components in one arrangement should allow wheelchair users to easily manoeuvre around the systems.
2. Diverse users across all genders, ages and abilities should be considered while designing inclusively for information systems. As mentioned above, appropriate letter and symbol height accompanied by tactile and acoustic information are the starting specifications for

designing information systems. All boards and signage must be sufficient as per the demand of the site. This demand can be identified during pilot surveys for designers.

3. The non-digital information boards, that are required to be read by the users, must be installed at the eye level 1200 – 1600mm. For signage and street signs, the acceptable heights range between 2300 – 3000mm. As a result, the children and people on wheelchairs are also included. Information must be available to the users in multiple forms. It is desirable to install non-digital systems in addition to digital systems. This is helpful in case of a failure or system error in the digital information systems. For other signage and street signs, standards for icons must be followed. The signage should be uniform throughout the public space in order to avoid confusion. Since information boards and signs are likely to be installed in the open space, the systems must employ the use of anti-reflex glass and matte surfaces.
4. The materials used for information systems must not corrode under changing weather conditions. The location must facilitate easy visibility for users from various locations on the site. For street signs, the simplest and the most direct way of giving directions is to point directly towards the destination by using a finger sign. Such signs can be attached to existing lighting columns and structures

Figure 81 – Finger signs attached to existing column in Luisenplatz.

Figure 82 - Finger signs as present on Street Zeil.

Source: Author

5. The material, since used outdoors, must be durable against weather. It should be easy to maintain with high tolerance to vandalism. Non-digital display boards must be contained within an illuminated weather and vandal resistant case. All specifications must be compliant with the technical standards of the context study.

5.3 SCOPE FOR FURTHER RESEARCH

The research study has been able to add to the existing research database by developing criteria for assessing inclusion of urban furniture in public spaces and by developing frameworks for collection and analysis of data. 3 categories of furniture elements were investigated to assess inclusion i.e. seating furniture, surfaces and information systems. This study can further to expanded to include other services such as kerb ramps, steps, bollards, street lights etc. in detail. The frameworks and criteria developed here can be used for assessment of other sites as well.

The research framework can be used as a tool by architects and designers to study other public space settings as well. The study is not site specific and can be expanded to other sites as well. In terms of recommendations, crude recommendations have been given as of now. However, more detailed research on each element can be done. Recommendations can also be given in order to improve standards and make them more sensitive to inclusion.

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