Arterial street as a place

An urban code for livability in Saudi Arabia

Nawaf Saeed Al Mushayt

Orientador: Doutor Sérgio dos Santos Barreiros Proença

Tese elaborada para a obtenção do grau de doutor em Urbanismo

2024

U LISBOA UNIVERSIDADE

FACULDADE DE ARQUITETURA
LISBON SCHOOL OF ARCHITECTURE
UNIVERSIDADE DE LISBOA

Arterial street as a place

An urban code for livability in Saudi Arabia

Nawaf Saeed Al Mushayt

Orientador: Doutor Sérgio dos Santos Barreiros Proença

Presidente:

Doutor João Pedro Teixeira de Abreu Costa,
Professor Catedrático
Faculdade de Arquitetura da Universidade de Lisboa;

Vogais:

Doutora Filipa Maria Salema Roseta Vaz Monteiro
Professora Associada com Agregação
Faculdade de Arquitetura da Universidade de Lisboa;

Doctor Eulalia Maria Gomez Escoda,
Profesora Agregada
Universitat Politècnica de Catalunya UPC-Barcelona TECH;

Doutor João Rodrigo Parreira Coelho,
Professor Associado
Faculdade de Arquitetura da Universidade do Porto;

Doutor João Miguel de Sousa Carvalho Ribeiro da Silva Leite,
Professor Auxiliar
Faculdade de Arquitetura da Universidade de Lisboa;

Doutor Sérgio dos Santos Barreiros Proença,
Professor Auxiliar
Faculdade de Arquitetura da Universidade de Lisboa, orientador.

Tese elaborada para a obtenção
do grau de doutor em Urbanismo

2024

LISBOA
UNIVERSIDADE

FACULDADE DE ARQUITETURA
LISBON SCHOOL OF ARCHITECTURE
UNIVERSIDADE DE LISBOA

Abstract

The arterial street is considered the backbone and structuring element of an urban area. As a linear structure, this typology of street is understood both as the main mobility axis and as a place that stimulates urban vitality and provides the desired setting for everyday urban life. This research addresses how arterial streets, often exclusively seen as vehicle movement routes, can enhance public life and improve livability.

Saudi Arabia's 2030 Vision prioritizes people, their quality of life, and the social impact of the built environment. Rapid urban, social, and economic changes have shaped Saudi cities, especially since the 1970's oil boom, impacting both the physical structure of cities and public life, leading to a decline in the significance of streets as interactive spaces.

Amidst these transformative changes, redesigning arterial streets is seen as an opportunity to improve the quality of life. In addition to supporting the urban structure and connecting its parts, it can foster a more cohesive and integrated social interaction. In this regard, this study's main objective is to build an urban code for arterial streets that enables the support of livability.

The urban code is formulated by a process of reading, interpreting, and decoding the formal characteristics of eight international reference cases of livable arterial streets, and two local arterial streets. The decoding process was based on an interdisciplinary, multiscale approach that instrumentally combines morphological interpretation and public life studies to read, decode, and code their physical qualities. Based on the extracted morphological qualities that support livability, the urban code systematizes typological variants, expressed through abstract representations, reducing the street composition to its essential formal characteristics in three scales.

Keywords:
street, urban morphology, public life, urban code, livability

Resumo

Ao longo da história, a rua tem sido fundamental para a vida social dos seres humanos. Espaço essencial para a vida pública, desde a antiguidade foi uma componente fundamental na formação das cidades. A rua, enquanto elemento urbano do espaço público, suporta várias necessidades humanas, como a comunicação, o entretenimento e o cumprimento de funções políticas, religiosas, comerciais, cívicas e sociais. A rua, para além de um canal de circulação, é suporte de lugares sociais, económicos e de lazer para as pessoas.

A rua evoluiu e assumiu diferentes papéis e formas, desde a cidade industrial até aos contextos urbanos contemporâneos. O movimento moderno influenciou a rua e a sua vida social, favorecendo o automóvel. Além disso, a transformação de numerosas ruas em estradas, em grande parte devido ao crescente domínio do automóvel nos espaços urbanos, afectou a noção de rua (Jacobs et *al.,* 1996).

Como resultado, a rua adquiriu uma maior diversidade de tipos e classificações. As ruas que evoluíram para ruas arteriais urbanas representam o núcleo da vida económica e social das cidades (Svensson *et al.,* 2004). No entanto, o incremento dos automóveis particulares, seguido da conjugação entre as profissões de engenharia de tráfego e de planeamento no início do século XX, afectou a forma e o uso das actuais ruas arteriais, levando à perda da sua atração como locais de reunião, de vida e de trabalho. Como resultado, as ruas arteriais foram reduzidas a meros canais de circulação em vez de potenciais pontos focais e centros de trocas das cidades (Jacobs *et al.,* 1996).

Considera-se que a rua arterial é a coluna vertebral e o elemento estruturante de uma área urbana. Enquanto estrutura linear, esta tipologia de rua é entendida simultaneamente como um eixo de mobilidade principal e como um local que estimula a vitalidade urbana e suporta a vida pública urbana quotidiana. A rua arterial é um elemento urbano complexo e multifuncional, que combina o papel de via e de lugar. Caracteriza-se pela sobreposição de funções e actividades variadas, constituindo uma forma de espaço público hierarquizante do tecido urbano em que se encontra. A dissertação aborda como a rua arterial, muitas vezes vista exclusivamente como via de circulação de veículos, pode suportar e melhorar a vida pública de quem a habita e visita.

No contexto da Arábia Saudita, o país sofreu uma rápida urbanização após o boom petrolífero da década de 1970, que se manteve até ao final da década de 1980 e muito depois. Ao longo dos anos, a procura de habitação e emprego alargou as fronteiras das cidades e as redes rodoviárias mais rapidamente do que o planeamento conseguia acompanhar, produzindo bairros suburbanos monótonos (Misk Art Institute, 2018).

Este crescimento disperso trouxe uma nova escala às cidades sauditas, que foi sustentada e aumentada pela mobilidade automóvel. O boom do petróleo que impulsionou a urbanização moderna na Arábia Saudita também introduziu uma devoção ao "Motordom" e o planeamento das cidades foi orientado pela ideia de que o automóvel deveria ser o meio de transporte predominante.

As ruas preexistentes que suportavam a vida social e pública transformaram-se em estradas para a circulação de veículos e tornaram-se as linhas direcionais que ligam os quarteirões residenciais às zonas comerciais descentralizadas da cidade. Na segunda metade do século XX, a maioria das cidades e bairros perdeu o seu espaço público para o automóvel privado. Assim, foram reduzidas a quarteirões de edifícios isolados cercados por vias asfaltadas com laterais não transitáveis e os espaços abertos transformaram-se em parques de estacionamento.

No entanto, em 2016, a Arábia Saudita introduziu a Visão 2030, incluindo o programa de Qualidade de Vida, que visa melhorar as infraestruturas e os transportes, o desenho urbano e os factores ambientais. A este respeito, na sequência da Visão 2030 do país e do programa de Qualidade de Vida, surgiu gradualmente uma série de mudanças socioeconómicas e económicas nas cidades sauditas. Estas incluem uma série de projectos e iniciativas, que desempenham um papel crucial não só na modelação da forma urbana da cidade num futuro previsível, mas também na modelação das transformações sociais, incluindo o estilo de vida, que atualmente depende dos automóveis como principal meio não só de transporte, mas também de entretenimento, para um estilo de vida de maior qualidade.

Neste contexto, a Arábia Saudita está atualmente a passar por enormes mudanças, e acredita-se que o redesenho das ruas arteriais representa uma oportunidade para melhorar a qualidade de vida nas cidades. Para além de apoiar a estrutura urbana e ligar as suas partes, pode promover uma interação social mais coesa e integrada. Nesse sentido, o objetivo principal deste estudo é construir um código urbano para as vias arteriais que favoreça o suporte da vida pública social.

No seu estudo sobre a forma da cidade, Colin Rowe e Fred Koetter sublinham que a cidade existente pode ser utilizada como uma referência, um instrumento didático (Rowe e Koetter, 1978). A cidade e os seus componentes, incluindo as ruas, podem ser uma fonte rica de conhecimento e um instrumento valioso com o qual podemos aprender. Por conseguinte, estes componentes estão disponíveis como um quadro de referência aberto de ingredientes urbanos com os quais se pode aprender para se construir ou desenvolver uma cidade.

Esta compreensão permite formular a hipótese de que existem princípios para a composição de ruas arteriais que suportam a vida pública e que estes princípios estão presentes e podem ser deduzidos das próprias ruas arteriais vividas existentes. Por outras palavras, o estudo das ruas arteriais que suportam vida existentes em diferentes contextos pode ser uma fonte de conhecimento. Propõe-se então descodificar os princípios de composição que favorecem a vida pública através da interpretação e descodificação das características formais das ruas arteriais internacionais que suportam vida em comparação com as ruas arteriais Sauditas - incluindo a forma como estas ruas se relacionam com as actividades e os comportamentos das pessoas. Consequentemente, a sintetização das características formais contribui para a formulação de um código urbano que se suporta na abstração tipológica para expressar regras essenciais para a composição de ruas arteriais, e que possa ser adaptado a necessidades e vontades específicas de cada lugar.

O código urbano é formulado por um processo de leitura, interpretação e descodificação das características formais da rua arterial. O processo de descodificação baseou-se numa abordagem interdisciplinar e multiescalar que combina instrumentalmente a interpretação morfológica e os estudos da vida pública para ler, descodificar e codificar as suas qualidades formais.

As três escalas seleccionadas para esta investigação são a microescala (o interface da rua), a mesoescala (a partição da rua) e a macroescala (a estrutura urbana). A microescala aborda as propriedades configuracionais da interface da rua e a potencial perceção visual que os peões têm dela ao nível do rés do chão. A mesoescala refere-se à escala intermédia, que trata os componentes das partições e subpartições da rua em relação às actividades dos peões, permitindo a descodificação das qualidades da rua que promovem a sua habitabilidade e vivência. Finalmente, a macro-escala aborda o estudo da rua ao nível da estrutura urbana, onde o interesse principal é a influência dos padrões das ruas e quarteirões, e a sua permeabilidade, no fluxo pedonal.

A abordagem interdisciplinar multinível desenvolvida para esta investigação é um método misto que integra dados quantitativos e qualitativos para abordar as questões de investigação de modo abrangente. Por conseguinte, a investigação recorreu a um conjunto de procedimentos e métodos para recolher e analisar dados. Foram utilizados determinados métodos em função da escala, da forma e da vida urbana da rua selecionada. Consequentemente, a criação de um código urbano foi formulada através de três fases fundamentais.

A primeira fase baseia-se na leitura interpretativa de oito casos internacionais de referência de ruas arteriais habitáveis, e de duas ruas arteriais locais, proporcionando uma oportunidade para uma investigação aprofundada da complexidade das ruas arteriais. Os estudos de caso internacionais centram-se em dois casos principais, a Avenida da República em Lisboa e a Avinguda Diagonal em Barcelona, e seis casos ancilares de ruas arteriais habitáveis que consistem em centralidades lineares com qualidades morfológicas que permitem estabelecer paralelos comparativos com os casos principais. Para além destes, duas ruas arteriais de Riade foram escolhidas como estudos de caso locais. A escolha de Riade justifica-se por ser um caso representativo da concepção e formação de ruas arteriais na Arábia Saudita.

A segunda fase introduziu uma análise comparativa das experiências internacionais em paralelo com os estudos de caso locais. A leitura comparativa das três escalas permitiu compreender as diferenças nos elementos morfológicos descodificados que melhoram a vida pública nos estudos de caso internacionais em comparação com os locais.

A última fase consistiu na extracção de características morfológicas partilhadas que melhoram a vida pública e na construção da sua tipificação por abstracção racional. Os tipos gerados referem-se, antes de mais, ao princípio de organização espacial que define o suporte de vida urbana das ruas arteriais. Nesta perspetiva, a abordagem da pesquisa medeia duas relações interdependentes: primeiro, a de descodificação e codificação; segundo, a de influência internacional e adaptação local.

Com base nas qualidades morfológicas extraídas que suportam a vida pública, o código urbano sistematiza variantes tipológicas, expressas através de representações abstractas, reduzindo a composição da rua às suas características formais essenciais nas três escalas seleccionadas.

Embora estes tipos tenham emergido de um conjunto específico de factores culturais, climáticos e económicos, os princípios tipológicos que lhes estão subjacentes têm o potencial de serem transferidos e adaptados a diferentes contextos para constituírem um ponto de referência explícito e implícito. Como referem Christ et al., (2015), o conceito de tipologia caracteriza-se pela sua natureza abstrata e geral, permitindo-lhe transcender localizações geográficas específicas. Assim, espera-se contribuir para fundamentar o futuro projeto de ruas arteriais habitáveis com flexibilidade e capacidade de adaptação a diferentes contextos.

Palavras-chave:
rua, morfologia urbana, vida pública, código urbano, habitabilidade

To the soul of my Father, the first to teach me.
To my mother, the origin of my success.

Acknowledgements

I stand at the culmination of an arduous journey, on the threshold of achieving my Doctoral degree, and it is with profound gratitude that I express my heartfelt appreciation to those who have played a significant role in shaping this endeavor. Their unwavering support, invaluable guidance, and enduring belief in my abilities have propelled me forward, enabling me to surmount numerous challenges and emerge triumphant.

First and foremost, I extend my deepest gratitude to my supervisor, Professor Sérgio Barreiros Proença. Your unwavering commitment to excellence, tireless dedication, and unwavering belief in my potential have been the driving force behind my doctoral journey.

I am also grateful to formaurbis LAB, the faculty, and staff, who have provided the necessary resources and facilities to undertake this research.

To my fellow colleagues and researchers, thank you for the stimulating discussions, the exchange of ideas, and the camaraderie we shared.

I owe a debt of gratitude to my beloved country, Saudi Arabia, for the opportunities and resources provided, allowing me to contribute to its vision of progress and innovation. I am especially grateful to the Ministry of Education in the Kingdom of Saudi Arabia for its generous support, which has enabled me to pursue my academic goals and aspirations.

To the enchanting Lisbon, a place I hold dear to my heart, thank you for embracing me with your vibrant culture, history, and intellectual ambiance. Your beauty and allure have provided the perfect backdrop for moments of reflection, inspiration, and scholarly pursuits.

To my friends, both near and far, thank you for your unwavering support, understanding, and encouragement. Your belief in me, even during moments of doubt, has been a constant source of strength.

Lastly, but most importantly, I express my deepest gratitude to my family. Your unwavering love, sacrifice, and unyielding belief in my abilities have been the bedrock of my success.

Nawaf Al Mushayt, 2023

Table of Contents

Part IV | The Urban Code

List of Figures

"The Street is a Room by agreement / A community Room the walls of which belong to the donors (dedicated to the city for common use) / Its ceiling is the sky / From the street must have come to the Meeting House also a place by agreement."

Kahn, 1971

01. Introduction

This first chapter explains the reasoning behind the research presented in this thesis. Subchapter 1.1 introduces the fundamental concept of the street, with a specific focus on the arterial street as the primary object of investigation. Subchapter 1.2 introduces the research problem in the context of Saudi Arabia. Subchapters 1.3 and 1.4 outline the precise research objectives, articulate the pivotal research questions, and present the underlying hypotheses. Subchapter 1.5 presents the significance of the study and the main theoretical and methodological contributions of the thesis. Lastly, subchapters 1.6 and 1.7 explain the research methodology employed and present a succinct overview of the thesis structure, guiding the reader through the forthcoming chapters.

1.1. The Street and the Road

"The only legitimacy of the street is as public space. Without it there is no city."
(Kostof, 1992, p. 194)

Cities are accumulations of different urban patterns influenced by the inhabitants' different economic, social, political, and technological activity systems, as well as by the previous form of the city and its location. Within all these patterns, travel has prevailed as a constant condition of daily life (Kostof, 1992). In this regard, the street, as a fundamental element and building block of cities, embodies the physical foundation for these activities. The city can be considered a component of several physical, social, economic, and political dimensions that grow out of shared civic ideas (Rykwert, 1982). However, if cities are the most significant manifestation of this civil concept, the street is the physical manifestation of this idea (Kostof, 1992).

The street stands as the essence of a city, with neither existing independently of the other. It is a fundamental element of cities and the most legible form of urban structure. It is between architecture and urban design where public and collective life occurs (Lasala, 2018). The process of street determination has taken different perspectives throughout history. All these perspectives have agreed that without the street, cities could not exist, because streets are the center of all urban discussions (Kostof, 1992).

Over time, several terms have been used interchangeably to describe the street, such as boulevard, street, road, highway, and avenue, and others (Moughtin, 1991). The street can also be informally used as a synonym for "road." In this regard, for the purpose of this research and because of the vastness of the concept of the street, it is essential to state the differences between the terms "street" and "road."

The word "street" came from the Latin word "*sternere*," which means "to pave" (Kostof, 1992). According to Rykwert (1991), the very word street is related to all Latin-derived words with the "*str*" root, which is connected with building and construction—for example, "*strada*" in Italian or "*strasse*" in German. On the other hand, "road" refers to a movement channel from one place to another and the transportation of people and goods to a destination (Rykwert, 1991).

The term "street" incorporates the role of serving as an itinerary and a place. The street occupies a tremendous amount of city space and a considerable amount of people's daily lives (Gehl, 1987). The street is a place where the public realm mediates the conflict between private interests. People use the street for different purposes and needs, where they meet, talk, trade, and learn (Moughtin, 2003). This description sheds light on the significance of the street as a route and a place of social, economic, and cultural exchange.

The street is one of the most vital parts of a city's form, as it provides movement and facilitates social life. Thus, urban designers' interest in the street is not recent. It has been nearly a half-century since Jane Jacobs's treatise on the importance of streets and sidewalks, saying, "Think of a city, and what comes to mind? Its streets. If a city's streets look interesting, the city looks interesting; if they look dull, the city looks dull" (Jacobs, 1961, p. 29).

Many authors have defined the term "street." Jacobs (1961) described the street as the lifeblood of a city, while Alexander, Ishikawa and Silverstein, 1977 saw streets as multi-functional urban patterns. Moreover, Whyte (1980) described the street as "the river of life of the city" and as a place where people gather. Francis (1987) defined good streets as "democratic streets—streets that have meaning for people, invite access for all, encourage use and participation, are loved, and are well cared for by their users" (p. 23). Last, Jukes (1991) defined the street as a central thoroughfare and a gathering space where strangers encounter one another.

These perspectives emphasize the notion of the street as a hub for exchanging goods, culture, knowledge, and ideas. The street is also a route and provides access to many places within and outside a city. Therefore, this research defines the street as a linear urban element combining public and private realms, built and open spaces, individuals and society, and movement and place.

1.1.1. Arterial streets

The street has always been an essential subject in urban studies and theories seeking to develop a more comprehensive understanding of the city. Since the progressive establishment of urban planning as an autonomous discipline in the second half of the nineteenth century (Pinson, 2004), the nature of the relationship between the street and society has been extensively emphasized, including the street as a public arena for everyday activity. A variety of theoretical perspectives have sought to highlight the importance of populated and active streets (Jacobs, 1961; Appleyard, 1981; Gehl, 1987; Rykwert, 1991) because "new forces – like motor vehicles – have entered the game, and their impact on the city has not been understood" (Doxiadis, 1970, p. 11).

The increasing dominance of the automobile over urban public space and the conversion of numerous streets into roads have generated a desire and need to recover streets as places. Since the early 1960s, authors such as Kevin Lynch (1960), Jane Jacobs (1961), and Gordon Cullen (1961), among others, have pointed to the essentiality of the street as a place by linking it with the human scale as a response to the modern movement that swept away the traditional pattern of urban structure constituted by streets.

However, as a result of continuing urban transformation over the last century, the street has acquired a greater diversity of typologies and classifications. The notion of "street" as a generic term has become diverse. It can often be used to refer to different types of streets as urban elements, ranging from the smallest alley to the widest boulevard or avenue. These different street typologies refer to various forms, functions, moments of design and construction, or even symbolism.

The streets that have evolved into urban arterial streets represent the core of cities' economic and social life (Svensson *et al.*, 2004). In the United States and Europe during the late nineteenth and early twentieth centuries, arterial streets tended to form commercial strips and accommodate streetcar lanes as important city corridors. Nevertheless, with the boom of private automobiles, these corridors lost their appeal as places to gather, live, and work. As a result, arterial streets were reduced to being only movement channels rather than potential focal points and business centers of cities (Jacobs *et al.*, 1996).

The increasing use of the automobile changed the notion, function, and form of arterial streets. Safety concerns superseded urban design concerns in the streetscape, where the increasing rates of accidents led to streets designed to allow fast and safe vehicle movement. The change included separating the various users of the street and the designation of different street types for different purposes (Jacobs *et al.*, 1996).

However, the current classification of arterial streets dates back to the introduction of conventional functional classification, which came into practice in the 1920s and 1923s (Marshall and McAndrews, 2017). The conventional functional street classification was applied to provide an order system that categorizes streets based on mobility and access functions, including their ability to move traffic and access adjacent properties (Forbes, 1999).

Mobility in the system refers to travel speed. In contrast, land access refers to the frequency of intersections and driveways on a stretch of a thoroughfare. As the core of the functional system, the degree of a street's mobility and land access result in three types: local, collector, and arterial. Local streets aim to provide high levels of access and low levels of mobility, while arterial streets support high levels of mobility and low levels of access (Forbes, 1999; Marshall and McAndrews, 2017).

Thus, the current models are inherited from a long tradition of organizing and developing the street network by focusing on automobile use. One of the most emblematic of these new approaches was the Radburn plan by Clarence Stein and Henry Wright in 1929. Their work was inspired by the Garden Cities movement and the work of Clarence Perry around the concept of the neighborhood unit, which is, in fact, based on the implementation of a hierarchical road network associated with an internal pedestrian network from which automobile traffic is excluded (Marshall and McAndrews, 2017).

The urban design principles of Stein and Wright included limiting traffic movement on residential streets and separating vehicles and pedestrians (Gehl and Svarre, 2013). Stein and Wright also went beyond physically separating vehicles and pedestrians and established a street hierarchy that was regulated for the first time—the layout permitted residential streets to be used only for local traffic (Southworth and Ben-Joseph, 2013).

In most Western countries, after World War II and its restrictions on street use, many cities prepared plans for the expected increase in automobiles. This expected increase did occur, creating the need for more drastic measures, such as one-way streets and limiting local access. Moreover, street widening was an option to reduce the sudden increase in automobiles. The concentration of heavy traffic on arterial streets impacted the livability of adjacent neighborhoods and created urban fragmentation that interrupted the continuity of the urban fabric. The massive transformation of urban arterials in some cities led to removing transit from the street level by putting it above or below grade, or obliterating it to create a space for traffic movement (Jacobs *et al.,* 1996).

In the 1950s, engineers started making new plans to improve streets and traffic. For example, the new planners' system in the United States was to create a comprehensive network of arterial streets that would serve the significant flow lines of urban areas. The new system also aimed to keep through-traffic off local streets and redirect it around the new highways. However, many arterial streets were designated as highways for automobile use (Jacobs *et al.,* 1996).

Therefore, the functional classification system of streets and its hierarchy, which focuses on traffic volume, share an intellectual and institutional heritage based on early twentieth-century urban theories (Hess, 2009). Those theories were criticized by several authors such as Kevin Lynch (1960), Jane Jacobs (1961), Aldo Rossi (1966), Gordon Cullen (1961), Jan Gehl (1971), and Alexander, Ishikawa and Silverstein (1977), among others. This model defined various typologies of streets, and the classification system led to the definition and design of arterial streets to carry the majority of vehicle traffic movement within the urban area, ignoring the concept of the street as a social place. Thus, traffic engineers' understanding of how streets should function based on vehicle distribution and circulation introduced the concept of arterial streets that are only movement corridors.

Nevertheless, though there have been some changes in the notion of arterial streets, this research considered arteries as a fundamental and significant urban element that existed in urban areas before the street classification system's various names and typologies. They are more than a channel of movement in an urban area; they are also an urban element with identity and functionality. A street has a physical form that affects users' behavior (Jacobs *et al.,* 1996). Consequently, streets not only are a social space and the dynamic center of a city; they also play commercial and economic roles in the surrounding area.

Therefore, the definition of arterial streets appears to be absent and has received less attention in the field of planning and urbanism. In most cases, the definitions that do exist have been offered by professional engineering associations that follow the functional classification system based on mobility, speed, and accessibility. In this context, arterial streets are defined as enabling large traffic volume within and through urban areas as well as access to the major activity centers of a city. In light of this fact, this research redefines, reinterprets, and gives another dimension to the arterial street as a linear center that improves the livability of an urban area.

Despite the official lack of recognition of arterial streets as an urban element, this research considers the definition of the European research program "Arterial Street Towards Sustainability" (2004):

"Throughout history, towns and cities have been organized to a significant extent around their streets: and none more so than arterial streets. [...] They assumed a variety of urban functions in addition to their original role for movement. An arterial street is, therefore, much more than simply a road in an urban area. An arterial street is also an urban place with a definite identity and character; a physical environment or behavior setting; a social space. Arterial streets may perform a variety of civic, ceremonial, political, cultural and social roles, as well as commercial and economic roles, in addition to their movement roles" (Svensson *et al.*, 2004).

In this regard, the urban arterial street is defined as a linear center and as a significant multi-functional urban element, combining a strategic network role that provides mobility and accessibility to major destinations with dynamics that reflect the new dynamics of social life. Morphologically, the arterial street presents a wide cross-section in its urban area, corresponding to its various cultural, social, commercial, and economic roles. The width of an arterial street often allows it to be divided into multiple partitions with different functions. The arterial street is also usually lined by significant buildings and commercial services, with different commercial activities along the ground floor. In this manner, this research seeks the opportunity to explore a new facet of the "livable arterial street" through the notion of the arterial street as a route and place.

1.2. The lost art of street as a place in Saudi Arabia

Over the past few decades, Saudi Arabia has experienced various developmental changes, including rapid urbanization following the oil boom of the 1970s. During the last three decades, rapid urbanization, infrastructure development, and the economic boom have brought remarkable changes to Saudi cities. Thus, Saudi Arabia has become one of the most urbanized countries in the world, with approximately eight out of every 10 people living in urban areas. Besides, urbanization is expected to increase to 97.6% by 2030 (UN-Habitat, 2018).

This rapid urban expansion had a significant impact on the urban form and was accompanied by a tremendous change in open spaces, both in terms of form and function. As a result, most of the cities in the country went through a significant spatial transformation that affected lifestyle and society (Al-Hemaidi, 2001). In the second half of the twentieth century, most cities and neighborhoods lost their public spaces to the private automobile. They were reduced to blocks of isolated buildings surrounded by asphalt roads with non-walkable sides. Streets and open spaces turned into parking lots, and the promise of the car became a curse for people in urban areas. Besides congestion and pollution, this change isolated friends and strangers alike in their private cubicles (Misk Art Institute, 2018).

In the case of Riyadh, the capital city, after establishing the modern Kingdom of Saudi Arabia in 1932, the city faced a fast-paced and dramatic transformation. For centuries, Riyadh's residents lived in multi-family traditional houses characterized by their central courtyard and narrow streets, which were the center of public and social life. In the 1950s, as construction boomed and the population soared, Riyadh lost its mud walls and opened several thoroughfares to connect the old city center to new neighborhoods, such as Al-Malaz (Al-Hemaidi, 2001; Al-Said, 2003). What was once a friendly pedestrian city was transformed into an open-ended, car-centered one. Riyadh had to adapt to modern exigencies, such as wide streets and walled single-family dwellings (Middleton, 2009; Al-Hathloul, 2017; Alotaibi and Potoglou, 2018).

By the early 1970s, because of booming oil prices, increased demand for housing, and state-guaranteed loans, the city suddenly leaped far beyond its boundaries, expanding northward at an ever-increasing pace (Mubarak, 2004). Wide, straight highways to facilitate easy and quick movement were designed around a central spine (Middleton, 2009). Soon, the standard of living a "modern" life was based on individual villas and private cars. Consequently, Saudis' daily social life has progressively moved away from the street and public spaces as they no longer meet their lifestyle (Misk Art Institute, 2018; Tesoriere and Errigo, 2018).

In contrast with the vernacular city that adapted to the harsh climate with its narrow-shaded alleys, the new Riyadh quickly became a sprawling city dependent on automobiles, where the human dimension was overlooked. The traditional houses built in mud-brick and organized around a central open courtyard were replaced by single-family villas with low population densities that triggered cultural unease. Although the decision-makers and the municipality were trying to manage the city's expansion, the dominance of machines over space encouraged the city's sprawl (Al-Hemaidi, 2001).

In light of these profound changes, Saudi Arabia's reliance on automobiles has grown at an alarming rate. Between 1970 and 1984, asphalt road construction multiplied threefold, increasing from 5,000 miles to 15,000 miles. Registered vehicles also rapidly increased from 22,805 in 1971 to more than 2 million by 1996, reaching over 12 million in 2016 (Al-Fouzan, 2012; Tesoriere and Errigo, 2018)the USA, and the Kingdom of Saudi Arabia (KSA. The oil industry facilitated this rapid growth of automobile use, and cars became the largest import category in the country between 1969 and 1992 (Tüncalp, 1993). This automobile dependency could not have advanced without the massive urban expansion and low operating costs of cars, all driven by oil revenues (Al-Hemaidi, 2001).

Furthermore, the sprawling urban form of major Saudi cities and the growing dependency on private cars have shaped people's lifestyles. As reported, more than 92% of daily trips in Riyadh in 2001 were made by private cars (ADA, 2001). Therefore, Riyadh, as is the case in other major Saudi cities, has adapted its decentralized and urban form to the needs of automobiles. The predominance of the private automobile has built an automobile culture that has consumed the city's public spaces and transformed lively streets into high-speed roads that lack separate pedestrian spaces. Moreover, the dominance of individual cars over public spaces shaped the scene of public life in Riyadh, where cars were no longer only a mode of transportation but a way of life.

Private automobile dependency had a tangible impact on the conception of streets and public spaces in Saudi Arabia (Aldalbahi and Walker, 2016; Tesoriere and Errigo, 2018). The second half of the twentieth century witnessed a transformation of public space, from streets to asphalt roads with non-walkable sides dominated by private automobiles. In addition to the urban sprawl, several other factors relating to society, culture, comfort, family privacy, and more contributed to the use of the private automobile for daily commuting (Al-Rashid et al., 2020; Youssef, Alshuwaikhat and Reza, 2021). These factors created the perfect recipe for automobile culture, which significantly influenced public life and how, where, and when people interacted with each other. The high-speed streets became the city's lifelines, and driving around the city, often with no particular destination, became a way for people to experience the city.

The urban, social, and economic changes in Saudi cities have directly affected the meaning of public spaces. Saudi public life is now shaped around low-density neighborhoods, along with a tendency to prioritize vehicles as the predominant mode of transport, which has resulted in deep social divisions and empty public spaces. Thus, modern public spaces have been centered chiefly inside shopping centers, where people need to drive through the city to reach these shopping centers instead of having their own spaces between buildings.

1.2.1. Saudi Arabia's Vision 2030 and the Quality of Life Program

In 2016, Saudi Arabia's Crown Prince Mohammed Bin Salman introduced an ambitious national vision for 2030. Saudi Arabia unveiled its 2030 vision as an economic and national transformation plan for all sectors to overcome current and future challenges. The vision is based on three fundamental themes: an ambitious nation, a thriving economy, and a vibrant society, and it seeks to overcome oil dependency and to build a new era of opportunity and prosperity. The vision is divided into 12 vision-realization programs (VRPs) and 96 strategic objectives (Vision2030, 2016).

Among these 12 programs is the Quality of Life (QoL) Program, which was established to improve the lifestyles of individuals and society and to enhance livability. The program aims to include at least three Saudi Arabian cities in the Top 100 Most Livable Cities by 2030. Therefore, based on an exhaustive approach that includes a range of benchmarks for the most livable cities, the program focuses on both livability and lifestyle as the central underlying concepts (Figure 1.2-1). Livability is comprised of several concepts, including infrastructure and transportation, security and political environment, healthcare, economic and educational opportunity, housing, and urban design and environment. On the other hand, lifestyle comprises sports, culture and the arts, entertainment, recreation, and social engagement (*Quality of Life Program,* 2020).

Based on the interest of this research, four main pillars and three supporting pillars compose the scope of the urban design sector as follows:

- Developing cities: Since the program's main goal is to make Saudi cities more competitive, urban design is seen as the main way to reach this goal.
- Providing services: This pillar comes up with seven ideas to deal with issues like visual pollution, the need for the right infrastructure, and the use of smart technology in municipal processes to improve users' lives.
- Changing behavior: This pillar focuses on enhancing social engagement in different areas, including municipal councils, private charities and associations, and corporate social responsibility

(CSR), among others.

- Developing amenities: Because of the lack of public amenities in cities, this section aims to humanize public amenities and to make Saudi cities more livable by building open spaces, parks, and pedestrian pathways.
- Developing laws and regulations: This pillar aims to enhance decision-making and to ensure effective city development by establishing urban codes to develop the necessary laws and regulations.
- Financial sustainability: This pillar aims to facilitate private sector investment.
- Effective communication: As a critical aspect of improving cities, this section seeks inhabitants' participation in the urban development process by enhancing social engagement (*Quality of Life Program*, 2020).

The objectives and implications of the QoL program show the relationship between the program's goals and cities in the categories of housing, urban design, and the environment; infrastructure and transport; and security and the socio-environment. In addition, the program aspires to develop Saudi cities as the main driver of development in order to enhance livability by creating human-centric cities with safe pedestrian pathways and streets, efficient public transportation, and walkable, distinguished neighborhoods.

In this regard, the program aims to improve lifestyles by focusing on people as the main center of the 2030 Vision. In the vision of the Kingdom and its programs, including the QoL program, there is a clear ambition and goal to improve Saudi cities and to make them leading global destinations in several areas. Thus, the program, in cooperation with the Ministry of Municipal Rural Affairs and Housing, aims to develop and organize laws and regulations as well as establish urban codes to improve cities and enhance the quality of life (Vision2030, 2016). In this context, streets, particularly arteries, present opportunities that contribute to improving the quality of life and moving forward to achieve the country's vision.

Quality of Life VRP 2020 aspiration overview

Have 3 cities in the top 100 most recognized cities in the world

Lifestyle					Livability				
Social Engagement	Recreation	Entertainment	Heritage, Culture &Arts	Sports	Security & socio-environment	Economic & Education Opportunity	Healthcare	Housing, Urban Design & Environment	Infrastructure & Transportation
Mobilize volunteers to reach a thirtyfold increase KSA volunteer base	Maintain expenditure levels on Food and Beverage once additional lifestyle options are introduced	Reach levels of population engagement in entertainment of most livable countries	Match international engagement levels for culture and arts	Increase participation in sports by mobilizing KSA population to exercise on a wekly basis	Increase offering of e-government to reach top 3 of most livable countries	Reduce Saudi unemployment to reach top 5 most livable countries	Accomplish equivalent life expectancy to the top among top 5 most livable countries	Achieve home ownership equal to top 3 of most livable countries	Drive public transport use to reach the top 5 most livable countries
Increase # of NGO median of countries in subsequent livable bracket3	Become global Food and Beverage reference with leading, high-quality offering	Provide entertainment offering comparable to most livable countries	Aspire for city cultural and artistic activities to compare to the top 10 worldwide culture hubs	Become regional leaders in summer Olympic attendance1	Increase gender equality to become top performer among countries in subsequent livable bracket3	Increase female employment to close the gap with most livable countries	Reduce the prevalence of diabetes in line with the rate achieved in the best living countries	Achieve WHO minimum suggested available green spaces	Reduce traffic deaths to reach top 5 most livable countries
Achieve twentyfold increase in community & neighborhood club engagement	Reach regional champion level by increasing retail space2 & availability of top int'l brands	Make the kingdom a global hub for entertainment by building pioneering venues	Make the kingdom a regional hub for culture and arts through infrastructure development	Reach accessible sports infrastructure offering levels of most livable countries		Achieve PISA reading score to reach top 5 most livable countries	Install enough hospital beds to reach top most livable countries	Enhance people walking habits to reach the top 5 most livable countries	Follow evolution of connectivity to reach double the average global numbers of connected devices

Figure1.2-1 Quality of Life program aspiration overview. (Source: Quality of Life Program, 2020).

1.3. The research objectives

Considering this imperative to characterize and systematize what is a livable arterial street, the key research objective of this thesis was to build an adaptable urban code, particularly in the context of Saudi Arabia (for which it was opportune to select Riyadh as a case study). Three research objectives were developed for this study, formulated as follows:

1) Create an urban morphological code that supports—or even generates—livability at the arterial street level.

2) Contribute to the Quality of Life Program in Saudi Arabia.

3) Test ways of studying and measuring the complexity of arterial street livability and determining the physical characteristics of arterial streets that influence public life.

1.4. The research questions and hypothesis

The main research question for this research is: How to build an urban code for livable arterial streets that can be adapted to the Saudi Arabian context?

From the main research question, the following hypothesis arises:

In their study of the shape of the city, Colin Rowe and Fred Koetter emphasize that the city can be used as an assessment tool and an instrument for teaching and learning. They refer to "the city as a didactic instrument. It is not then a question as to whether it should be so. It is rather a matter that it cannot be otherwise" (Rowe and Koetter, 1978, p. 121). The city and its components, including streets, can be a rich source of knowledge and a valuable tool from which we can learn. Therefore, these components are available as a simple palette of urban ingredients to learn from when constructing or developing a city.

This understanding makes it possible to formulate the hypothesis that there are principles of livable streets. These principles are present and can be deduced from existing livable arterial streets themselves. In other words, studying existing, livable arterial streets in different contexts can be a source of knowledge. Thus, it is possible to discover the composition principles that foster public life through the interpretation and decoding of the physical characteristics of livable international arterial streets compared to local arteries—including how these streets relate to the activities and behaviors of the people. In this regard, the extraction of physical elements contributes to the formulation of a typological urban code as ground rules or recommendations for livable arterial streets that can be adapted to local needs and vision.

In light of this assumption, the following question was developed: **What is the impact of arterial street morphology on street public life?** From this question, the following hypothesis arises:

There is a bidirectional relationship between people and their surrounding built environment that has been emphasized in several studies, as the built environment has the ability to deny or encourage social activities and create certain types of behavior, particularly in public spaces, including streets (Rapoport, 1977; Gehl, 1987; Ellard, 2020). Numerous studies have explored the relationship between the physical layout of a city and the ways in which it can influence public life (Lynch, 1960; Whyte, 1980; Gehl, 2010; Horayangkura, 2012; Mehta, 2013). The effect of the physical form of the street on public life has been discussed from different perspectives that are associated with people's perceptions (Lynch, 1960; Cullen, 1961), behaviors (Gehl, 2010), and activities (Whyte, 1980; Gehl, 1987) at multiple scales.

According to this assertion, the arterial street, as the backbone of an urban area, is a complex urban element composed of different elements at different resolutions that can affect the degree and pattern of public life. Therefore, it can be hypothesized that public life is influenced by the different morphological scales of arterial streets, including the microscale, concerning the street interface; the mesoscale, referring to the street partition; and the macroscale, referring to the urban structure level. In this manner, the effect of arterial street morphology on public life is related to different scales that are understood as parts of a whole system, where each scale has a particular influence on people's behavior and the activities that contribute to street livability. Consequently, the importance of the scales in interpreting, decoding, and coding the livability of streets should be emphasized based on the following three themes:

2.1 The microscale: **What are the most important variables of street interface configurations that influence pedestrians' visual perception?**

The microscale refers to the relationship between the street and the buildings on a micromorphological scale, focusing on the street interface located between urban and architectural dimensions on the ground floors of buildings. In this research, the street interface is defined as a physical and social entity that falls into conditions of betweenness in relation to other dominant spaces (the street and the buildings), which may create or deny potential social and visual interactions. In this regard, this research argues that permeable and accessible configurations influence pedestrians' visual interactions.

2.2 The mesoscale: **How do street partition compositions influence pedestrians' activities?**

The mesoscale refers to the street partition that composes the street layout and its total width. As a vital component and complex element of the urban structure, the arterial street is composed of different partitions that take on various forms and functions that may influence pedestrians' activities. Thus, it can be hypothesized that pedestrian activities occur when the street partition is composed and organized around people and their daily activities.

2.3 The macroscale: **What physical characteristics of the street's permeability with regard to the urban context contribute to facilitating pedestrians' flow at the arterial street level?**

The macroscale refers to the largest scale level of studying arterial streets, focusing on the relationship between the street and the surrounding urban context. In this research, the primary interest at the macroscale is the influence of street and block patterns on the extent to which a street is permeable to pedestrians. As per the hypothesis posited in this study, arterial streets with high permeable qualities and a variety of route options have high pedestrian flows.

1.5. Significance of the study

Despite the significance of arterial streets, the current theoretical and methodological approaches in the canon of urban design appear to be inherited from a long tradition of organizing and forming streets based on automobile use. Not only is there a scarcity of research linking arterial streets as an urban element, but most studies do not recognize livability at the level of arteries. The role of the arterial street as a place for social and collective life has been overlooked, and previous studies of arterial streets have been mainly conducted by professional engineering associations that focus on mobility, speed, and accessibility.

Likewise, in Saudi Arabia, despite the importance of street livability, especially at this moment of change, the discussion of the livability of arterial streets has been absent in the main planning guides, where no urban code has been established to foster the livability of streets. Because of this weak recognition of arterial streets as a place for public life, this research seeks opportunities to explore a new facet of the livable arterial street through the notion of the arterial street as a route and place.

To bridge this gap and to capture an understanding of arterial streets' livability, the research created an urban code for the arterial street. This urban code is significant because it redefines the arterial street as a place and because it introduces and tests an interdisciplinary, multiscale approach for decoding and coding linear urban elements. Thus, the methodology allows for the extraction of arterial streets' morphological characteristics and for the building of a typomorphological code that can be adapted in a Saudi context.

1.6. The research methodology

The urban code, as the research objective, is the result of a process of reading, interpreting, and decoding the arterial street based on an interdisciplinary multiscale approach, which is presented in detail in Chapter 06, including a research case study and study samples. The approach builds a basis for morphological interpretations interrelated with public life research at different resolution levels, offering a more apt and comprehensive view. These scales are not mutually exclusive; instead, they are complementary resolutions to each other, aiming to decode arterial streets' livability through different lenses and to reveal their complexity.

Thus, because this study argues that the city can be read from its physical form, the process of decoding a street is based on morphological interpretations interrelated with the study of public life. The decoding process allows us to reveal the street's physical characteristics and how they relate to the activities and behaviors of pedestrians through different lenses. Thus, the multi-level approach defined three levels of resolution in accordance with the bottom-up approach emphasized by scholars studying cities from a physical standpoint, such as Jacobs (1961), Batty (2007), and Batty and Marshall (2017). Therefore, the three scales selected for this research are the microscale (the street interface), the mesoscale (the street partition), and the macroscale (the urban structure).

First, the microscale determines the street interface's configurational properties and the pedestrians' potential visual perception of it at the ground floor level. The mesoscale refers to the intermediate scale, which examines the components of the street partitions and sub-partitions in relation to pedestrians' activities, allowing for the decoding of the street qualities that promote street livability. Finally, the macroscale represents the study of the street at the urban structure level, where the primary interest is the influence of street and block patterns, and their permeability, on pedestrian flow.

The multi-level interdisciplinary approach that was developed for this research is a mixed method that integrates quantitative and qualitative data to comprehensively address the research questions. Therefore, the research resorted to a set of procedures and methods to collect and analyze data. Certain methods were used depending on the scale, form, and livability of the selected street. Consequently, the creation of an urban code was formulated through three fundamental phases, as follows:

1. The first phase sought to decode international and local case studies.

Decoding the arterial street is based on the interpretative reading of eight international and two local case studies, providing an opportunity for an in-depth investigation of the complexity of arterial streets. The international case studies focus on two primary cases, Avenida da República in Lisbon and Avinguda Diagonal in Barcelona, and six ancillary cases for livable arterial streets that consist of linear centralities with useful morphological qualities. These ancillary cases include Avenue des Champs-Elysées, Paris, France; Ringstrasse, Vienna, Austria; Unter den Linden, Berlin, Germany; Avenida Paulista, São Paulo, Brazil; Avenida 9 de Julio, Buenos Aires, Argentina; and Orchard Road, Singapore.

Additionally, the local case studies focus on Riyadh as a representative case that reflects the notion and formation of arterial streets in Saudi Arabia. Thus, two arterial streets in Riyadh were chosen as local case studies: the streets Khalid Ibn Al Walid and Abi Jafar Al Mansour.

2. The second phase introduced a comparative analysis of the international and local arterial streets to extract the arterial streets' physical qualities.

The complexity of arterial streets, as cities' fundamental urban element, requires learning from different experiences to formulate new lines of inquiry that lead to knowledge creation. Thus, there is an implicit suggestion for recognizing and comparing international experiences in parallel with local case studies. Such a comparative study allows for learning from different experiences, successes, and mistakes, thus morphologically influencing the understanding.

The comparative reading of the three scales allows for an understanding of the differences in the decoded morphological elements that enhance public life in the international case studies compared to the local ones. Thus, this study answered the question related to the impact of street morphology on public life through the three selected scales to be compared internationally and locally, from the microscale to the macroscale.

3. The last phase revealed the morphological qualities of arterial streets that can be used to formulate an urban code and that can be adapted and transformed in other contexts based on different needs.

In this research, "type" acts as an outcome of the decoding process and as an approach to formulating an urban code for livability. As such, between decoding and coding is the concept of "type," which lends itself to an effective approach to locating morphological commonalities. From this point of view, the idea of type in this research refers to a field of communication between decoding and coding, where "type" becomes a tool for communicating meanings between theory and practice and a communication tool from which the urban code is made.

From this perspective, the research approach mediates two interrelated relations: first, that of decoding and coding; second, that of international influence and local adaptation. In this way, this research deciphered both international and local case studies to find the morphological qualities of livable arterial streets and to create with an urban code that can be adapted to fit different contexts.

1.7. Thesis structure

Following the above introduction, this thesis is structured in four parts.

Part 1: The street

This part reviews the concept of the street as it pertains to the city and livability. The literature, theories, and empirical studies are reviewed. The focus of the literature is mainly on the most frequently cited and frequently appearing sources. In this manner, through the review of literature, a theoretical framework was developed for studies on the street and on the street's relation to the city and livability, based on two chapters:

- Chapter 02 builds a comprehensive overview of the street and its relationship to the city from a historical perspective. This chapter focuses on the street's evolution from the pre-industrial city to the contemporary one through a wide review of the literature. It also introduces the historical evolution of cities and the notion of the street in Saudi Arabia.
- Chapter 03 reviews the concept of the street as a pillar of livability. This review chapter explores the relationship between public spaces, streets, and livability. In this research phase, the literature search was expanded to capture attributes of livability at the street level.

Part 2: The street complexity

In this research, the city and its elements can be studied and understood through their form. Therefore, aiming for arterial street livability raises the proposition that street livability is a complex concept directly affected by the street's physical features as well as by its social and cultural aspects. These approaches indicate the value of physical form studies related to public life in decoding the complexity of streets' livability. This part introduces a theoretical and empirical insight into the research methodological approach based on two chapters:

- Chapter 04 reviews studies about urban morphology as an instrument whose methods can be used to decode various urban elements, including streets. It also introduces methods of studying public life that allow a deeper understanding of the various factors influencing pedestrians' behavior and contributing to public life dynamics.

- Chapter 05 introduces a multiscale approach to decoding the complexity of arterial streets and builds a theoretical framework that supports knowledge about street morphology and systematizes the most basic attributes, characteristics, and functions in relation to public life. In this way, an attempt is made to understand the various morphological scales for understanding the complexity of arterial streets.

Part 3: Decoding the street

This part of the research explains the methodological approach and tests the decoding process using international case studies based on three chapters:

- Chapter 06 explains the methodological approach, the international and local case studies, and the tools used to decode the arterial streets on three scales based on morphological interpretations and public life studies.
- Chapter 07 introduces an overview of the two international case studies, Avenida da República (Lisbon) and Avinguda Diagonal (Barcelona). It also includes ancillary case studies from various geographical contexts, including Avenue des Champs-Elysées, Ringstrasse, Unter den Linden, Avenida Paulista, Avenida 9 de Julio, and Orchard Road.
- Chapter 08 decodes the two main international arterial streets.

Part 4: The urban code

In this research, what is implied by "urban code" basically corresponds to the notion of the city as a physical and social process from which we can learn. Thus, after decoding existing international livable, arterial streets at different levels of resolution, the fourth part of this research seeks opportunities and ways to create an urban code for livability. The fourth part is divided into three chapters:

- Chapter 09 introduces Riyadh and presents its urbanization process and urban development. This chapter also decodes two local case studies in Riyadh using the same methodology as the international case studies, based on morphological reading and public life analysis.
- Chapter 10 is a comparative study exploring the results of the international and local case studies. In this regard, after analyzing the case studies, the study introduces a comparative analysis of each scale.
- Chapter 11 reveals the concept behind the urban code. The chapter introduces the "urban code," which is suggested as a typology that can be adapted and transformed in other contexts based on

social and cultural meanings. Thus, the urban code can be assumed to be the foundation of the design stage.

- Chapter 12 offers final considerations, detailing the research contribution to knowledge and recommendations for potential future research.

References

ADA (2001) نحو تطوير نظام نقل عام آمن وفعال في مدينة الرياض *[Toward the Development of a Safe and Efficient Public Transportation System in Riyadh city]*. Riyadh, Saudi Arabia. Available at: https://www.rcrc.gov.sa/res/ada/ar/Researches/development_of_transport_system/index.html.

Al-Fouzan, S. A. (2012) 'Using car parking requirements to promote sustainable transport development in the Kingdom of Saudi Arabia', *Cities*. Elsevier Ltd, 29(3), pp. 201–211. doi: 10.1016/j.cities.2011.08.009.

Al-Hathloul, S. (2017) 'Riyadh Development Plans in the Past Fifty Years (1967-2016)', *Current Urban Studies*, 05(01), pp. 97–120. doi: 10.4236/cus.2017.51007.

Al-Hemaidi, W. K. (2001) 'The metamorphosis of the urban fabric in Arab-Muslim City: Riyadh, Saudi Arabia.', *Journal of Housing and the Built Environment*, 16(2), pp. 179–201.

Al-Rashid, M. A. *et al.* (2020) 'Gender-responsive public transportation in the Dammam metropolitan region, Saudi Arabia', *Sustainability (Switzerland)*, 12(21), pp. 1–17. doi: 10.3390/su12219068.

Al-Said, F. (2003) 'The pattern of structural transformation of the Saudi Contemporary Neighbourhood: The case of Al-Malaz, Riyadh, Saudi Arabia', in *39th ISoCaRP Congress*, pp. 1–10. Available at: http://www.isocarp.net/Data/case_studies/347.pdf.

Aldalbahi, M. and Walker, G. (2016) 'Riyadh Transportation History and Developing Vision', *Procedia - Social and Behavioral Sciences*. Elsevier B.V., 216, pp. 163–171. doi: 10.1016/j.sbspro.2015.12.024.

Alexander, C., Ishikawa, S. and Silverstein, M. (1977) *A pattern language*. Oxford, UK: Oxford University Press.

Alotaibi, O. and Potoglou, D. (2018) 'Introducing public transport and relevant strategies in Riyadh City, Saudi Arabia: a stakeholders' perspective', *Urban, Planning and Transport Research*. Routledge, 6(1), pp. 35–53. doi: 10.1080/21650020.2018.1463867.

Appleyard, D. (1981) *Livable Streets*. Berkeley, CA, USA: University of California Press.

Batty, M. (2007) *Cities and complexity: understanding cities with cellular automata, agent-based models, and fractals*. Cambridge, MA, USA: The MIT Press.

Batty, M. and Marshall, S. (2017) 'Thinking organic, acting civic: The paradox of planning for Cities in Evolution', *Landscape and Urban Planning*, 166, pp. 4–14. doi: 10.1016/j.landurbplan.2016.06.002.

Cullen, G. (1961) *Townscape*. London, UK: The architectural Press.

Doxiadis, C. (1970) 'Ekistics, the Science of Human Settlements', *Science*, 170(3956), pp. 393–404. doi: 10.1126/science.170.3956.3.

Ellard, C. (2020) 'Neuroscience, wellbeing, and urban design: Our universal attraction to vitality', *Psychological Research on Urban Society*, 3(1). doi: 10.7454/proust.v3i1.81.

Forbes, G. (1999) 'Urban Roadway Classification: Before the Design Begins', in *Urban Street Symposium*. Dallas, Texas, USA.

Francis, M. (1987) 'The Making of Democratic Streets', in Moudon, A. V. (ed.) *Public Streets for Public Use*. New York, NY, USA: Van Nostrand Reinhold, pp. 23–39.

Gehl, J. (1987) *Life Between Buildings*. New York, NY, USA: Van Nostrand-Reinhold.

Gehl, J. (2010) *Cities for people*. London, UK: Island Press.

Gehl, J. and Svarre, B. (2013) *How To Study Public Life*. Washington, DC: Island Press/Center for Resource Economics. doi: 10.5822/978-1-61091-525-0.

Hess, P. M. (2009) 'Avenues or arterials: the struggle to change street building practices in Toronto, Canada', *Journal of Urban Design*, 14(1), pp. 1–28. doi: 10.1080/13574800802451049.

Horayangkura, V. (2012) 'Incorporating environment-behavior knowledge into the design process: an elusive challenge for architects in the 21st century', *Procedia - Social and Behavioral Sciences*, 50, pp. 30–41. doi: 10.1016/j.sbspro.2012.08.013.

Jacobs, A. B. *et al.* (1996) *The Uses and Reuses of Major Urban Arterials: A Study of Recycling, Revitalizing, and Restructuring 'Gray Area' Transportation Corridors, Faculty Research Papers*. Berkeley.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York, NY, USA: Vintage Books.

Jukes, P. (1991) *A Shout in the street: an excursion into the modern city*. Berkeley, CA, USA: University of California Press.

Kostof, S. (1992) *The City Assembled: The Elements of Urban Form Through History*. London, UK: Thames and Hudson Ltd.

Lasala, A. (2018) *On the street: Contributions to the urban space through architectural strategies*. Pasadena, California: Typecraft Inc.

Lynch, K. (1960) *The Image of the City*. Cambridge, MA: The MIT Press.

Marshall, W. E. and McAndrews, C. (2017) 'Understanding Livable Streets in the Context of the Arterials that Surround Them', *Transportation Research Record: Journal of the Transportation Research Board*, 2605(1), pp. 1–17. doi: 10.3141/2605-01.

Mehta, V. (2013) *The street: a quintessential social public space*. New York, USA: Routledge.

Middleton, D. A. (2009) *Growth and expansion in post-war urban design strategies: CA Doxiadis and the first strategic plan for Riyadh Saudi Arabia (1968–1972)*. Georgia Institute of Technology.

Misk Art Institute (ed.) (2018) *Spaces in Between*. Misk Art Institute.

Moughtin, C. (1991) 'The European city street, part 1: paths and places', *Town Planning Review*, 62(1), pp. 51–77. doi: 10.3828/tpr.62.1.j0v4j745161766r6.

Moughtin, C. (2003) *Urban design: street and square*. Third Edit. Burlington, MA, USA: Architectural Press.

Mubarak, F. A. (2004) 'Urban growth boundary policy and residential suburbanization: Riyadh, Saudi Arabia', *Habitat International*, 28(4), pp. 567–591. doi: 10.1016/j.habitatint.2003.10.010.

Pinson, D. (2004) 'Urban planning: an "undisciplined" discipline?', *Futures*, 36(4), pp. 503–513. doi: 10.1016/j.futures.2003.10.008.

Quality of Life Program (2020). Available at: www.vision2030.gov.sa/v2030/vrps/qol/ (Accessed: 23 March 2022).

Rapoport, A. (1977) *Human Aspects of Urban Form: Towards a Man–Environment Approach to Urban Form and Design*. Oxford, UK: Pergamon Press.

Rossi, A. (1966) *The Architecture of the City*. Cambridge: The MIT Press.

Rowe, C. and Koetter, F. (1978) *Collage city*. Cambridge: MIT Press.

Rykwert, J. (1982) *The Necessity of Artifice: Ideas in Architecture*. London : Academy Editions.

Rykwert, J. (1991) 'The Street: The Use of its History', in Anderson, S. (ed.) *On Streets*. Cambridge, Massachusetts: The MIT Press.

Southworth, M. and Ben-Joseph, E. (2013) *Streets and the Shaping of Towns and Cities*. Washington, DC: Island Press.

Svensson, Å. *et al*. (2004) *ARTISTS - Arterial streets for people : Guidance for planners and decision makers when reconstructing arterial streets*. Lund.

Tesoriere, G. and Errigo, M. F. (2018) 'Urban travel behavior determinants in Saudi Arabia', *Journal of Land Use, Mobility and Environment*, SP/01(01/18), pp. 3–6. doi: http://dx.doi.org/10.6092/1970-9870/5449.

Tüncalp, S. (1993) 'The Automobile Market in Saudi Arabia: Implications for Export Marketing Planning', *Marketing Intelligence & Planning*, 11(1), pp. 28–36. doi: 10.1108/02634509310024164.

UN-Habitat (2018) *Saudi Cities Report 2018*. Riyadh, Saudi Arabia. Available at: https://unhabitat.org/saudi-cities-report-2018-executive-summary.

Vision2030 (2016) *National Transformation Program*. Available at: https://www.vision2030.gov.sa/ (Accessed: 11 March 2019).

Whyte, W. H. (1980) *The Social Life of Small Urban Spaces*. New York, NY, USA: Project for Public Spaces.

Youssef, Z., Alshuwaikhat, H. and Reza, I. (2021) 'Modeling the modal shift towards a more sustainable transport by stated preference in Riyadh, Saudi Arabia', *Sustainability (Switzerland)*, 13(1), pp. 1–19. doi: 10.3390/su13010337.

Part I

The street

Chapter 02. The street and the city

Chapter 03. The street and livability

"The only legitimacy of the street is as public space. Without it there is no city."

Kostof, 1992

02. The street and the city

Throughout the years, various perspectives have been taken to address the streets, which have been pivotal as turning points in shaping the design of contemporary cities (Jukes, 1990). Consequently, understanding the street requires acknowledging the differences between current and previous cities. The meaning that has been attributed to streets has evolved over time (Morris, 1994), a fact that has produced tangible consequences in cities and changes in how people perceive streets and public spaces. Accordingly, Chapter 02 reviews the theoretical thoughts, evolution, and studies in two key sections: Subchapter 02.1 briefly touches on the history of the street and its evolution from the industrial city to contemporary times, while Subchapter 02.2 introduces the notion of streets in Saudi Arabia, from traditional cities to contemporary ones.

02.1. The historical evolution of the street

02.1.1. The industrial street

"Ordinances related to public health were usually spurred on by the outbreak of epidemics... Congestion was perceived in terms of street width and the overall height of flanking buildings. Narrow canyon-like streets kept sunlight from reaching ground level. The general remedies were to set height limits and to widen streets correspondingly."
(Kostof, 1992, pp. 204–205)

During the 19th century, the emergence of the bourgeoisie, liberal politics, industrialization, economic growth, and the formation of national states resulted in significant urban growth (Fields, 2012). This substantial urban growth brought new civil amenities, including schools, libraries, hospitals, prisons, and new commercial and cultural hubs for social and economic exchanges, such as cafes, theaters, and public spaces. As a result, the city acquired a new image based on the aestheticization of the public spaces that catered to the needs of a society with evolving forms of socialization (Rykwert, 1991).

In this context, the work of Baron George-Eugene Haussmann, who was commissioned by Napoleon III in 1852 to renovate Paris, marked the starting point of modern city development, as they brought new ways of planning cities and forming streets (Giedion, 1959; Busquets, Yang and Keller, 2019). Amidst an industrial boom, Paris served as the archetype for these great public spaces and social life transformations, with the boulevard being its most concrete expression; its wide, tree-lined sidewalks, lighting, and urban furnishings created a novel public space accessible to all users. Designed to accommodate a large and diverse population with different interests, the boulevard featured shops and stores of all kinds, as well as restaurants and cafes on corners. The boulevard emerged on the scene as the embodiment of the new urban life, showcasing the public life of the new bourgeois society (Lasala, 2018).

During the second half of the 19th century, the development of the Industrial Revolution led to cities experiencing several challenges in terms of quality of life due to the rapidly increasing populations. At that time, the physical form of cities was ill-equipped to accommodate such a large influx of people in such a short period. Consequently, these challenges led to urban transformations involving hygiene, health, housing, mobility, and accessibility (Lasala, 2018).

In response, throughout the final decades of the 19th century, several theorists from diverse disciplines, such as architecture, engineering, and sociology, tested a variety of urban models that offered alternative spatial and organizational solutions. Examples include Cerdà's plan of Barcelona in 1859, Soria y Mata's Linear City in 1882, and Ebenezer Howard's Garden City in 1898. These models were driven by a moral reaction and a shared impulse to address the filth and overcrowding of the industrial age (Benevolo, 1977).

For example, Ebenezer Howard's "Garden City of Tomorrow," which was initially titled "To-morrow: A Peaceful Path to Real Reform" in 1898, gave rise to the garden city movement (Howard, 1898). Howard's vision offered a view of towns devoid of pollution and slums, embracing the beauty of nature. His garden city concept transformed cities into radial ones with central parks surrounded by landscaped boulevards and avenues (Trancik, 1991; Vernet and Coste, 2017). This internationally influential proposal led to repercussions that spurred the rise of satellite cities organized around a central city, separated by a greenbelt, and interconnected by rail transport. The garden city movement had a global impact, as evidenced by the iconic Jardim América in So Paulo by architect Barry Parker and the model of extensive North American growth (urban sprawl) that developed in the 1930s (Kostof, 1992).

Following the middle of the 19th century, cities encountered traffic congestion, which had become a significant challenge accompanied by economic, social, and political changes due to two significant inventions: the bicycle and the automobile (Southworth and Ben-Joseph, 2013). The automobile invasion transformed cities and their urban elements, including streets, to accommodate this new mode of transportation. The automobile's impact on cities gave rise to new utopian proposals that responded to the growing demand for motor vehicles (Kostof, 1992). Most of these utopic projects, such as the underground railways in England in the late 19th century and Eugene Henard's multi-level circulation, focused on separating pedestrian spaces from automobile traffic routes (Hass-Klau, 1990; Gold, 1998).

02.1.2. The modern street

The twentieth century witnessed significant developments in all aspects of life, including urban development. Notably, the concept of the traditional street underwent substantial transformations during this period (Lasala, 2018). Modernism emerges as an attempt to address planning concerns and ensure better functionality for both people and cities. Founded in 1928 and closely aligned with the Congrès Internationaux d'Architecture Moderne (CIAM), the philosophy of modernism emerged (Southworth and Ben-Joseph, 2013). Through the efforts of a group of 28 European architects, such as Le Corbusier, Alvar Aalto, Walter Gropius, and Josep Llus Sert, modern philosophy spread the principles of modern architecture into planning. These modern planning principles gained substantial influence, especially after World War Two, when they proposed strict functional segregation and population distribution into tall, widely spaced blocks (Black and Sonbli, 2019).

The widespread acceptance and influence of the Garden City Movement and the Charter of Athens in 1933 had significant impacts on cities, aiming to address the miserable living conditions in industrial areas. These modern movements greatly influenced the concept of the street as a social space, making it an unnecessary social element (Jacobs, 1995). However, the idea of the modern city, at least on an artistic and intellectual level, influenced by the industrial revolution, consisted of tall buildings and public and private means of transport. The cinema of the early twentieth century also provides a foreshadowing of the potential visual effects of the industrial revolution on cities; for example, a noteworthy illustration of this is found in "Metropolis," a film directed in 1927 by the Austrian director Fritz Lang (Lang, 2003).

The Modern Movement was aware of the urban challenges from the second half of the 19th century, including congestion, and proposed the idea of a rational and organized model. Several models were introduced, such as Le Corbusier's Radiant City in 1922 and 1935 and Frank Lloyd Wright's Broadacre City in 1932. These models addressed the overcrowding issue in urban areas by proposing green public spaces that separated buildings and transformed them into articulated structures, resulting in urban fabric segregation. Consequently, the building became an autonomous object, isolated from the street. Additionally, new modes of mobility, such as trains and automobiles, were emphasized to provide solutions for overcoming urban challenges and providing a better quality of life (Berman, 1983).

Le Corbusier's rationalist models, both the Contemporary City (1922) and the Radiant City (1935), were fundamentally based on the need to reform urban structure, making it more efficient and better suited to technological advances. These models aimed to alleviate the center from its compactness and create free space for people to enjoy. The Athens Charter of 1933 developed and systematized this concept, which stated that the city must be structured around four functions: dwelling, work, recreation, and transportation. Le Corbusier's rational conception of the "modern street" emphasized the ample dimensions of streets that catered to the needs of the mechanical era. His formal and spatial principles of the modern movement advocated for "death on the street," considering it a historical heritage (Gold, 1998).

Additionally, Frank Llyod Wright developed the urban model Broadacre City between 1931 and 1958, which he presented in his book "The Disappearing City, 1932." This model sought to provide the space, freedom, and beauty necessary for individual growth (Wright, 1932). In this context, the introduction and widespread use of the automobile played a crucial role in this model, as the vehicle became the primary mode of mobility to establish the connections between various cell units. Thus, the new democratic city was based on modern technology, decentralization, and single-family housing that was infinitely reproducible across a territory served by vast infrastructure networks (Southworth and Ben-Joseph, 2013).

In this regard, the automobile became a symbol of mobility, as the need for the movement of people and goods arose, making the organization of the automobile circulation systems increasingly important (Urry, 2006). Accordingly, from the 1920s and 1930s, the rapid growth in automobile use encouraged investment in motor infrastructure. Several highways began to appear, while others were built to respond to the growing demand for automobile traffic. These elements were intended to connect cities, and they later gained a new feature as elements that served as connectors between different areas within the same urban region. As a result, reduced travel time and easy access to different parts of the city added new value and opportunities to these linear elements (Tarr, 1984).

The influence of these models, which gradually became a global feature, and rapid urban expansion, profoundly transformed cities throughout the twentieth century. In the second half of the 20th century, cities experienced a new acceleration in their urban growth, supported by significant infrastructure development for new modes of mobility, which reduced distance-time relationships. This phenomenon was followed by a sprawling form of low-density development, resulting in some cases of uncontrolled urban expansion (Weston, 2011).

The American Dream is an example of this phenomenon, where urban sprawl, social segregation, and low density were the main characteristics (Duany, Plater-Zyberk and Speck, 2000). In 1964, French geographer and urban growth expert Jean Gottmann studied the significant growth of cities in the northeastern United States and their extraordinary dynamics. Gottmann used the term "Megalopolis," which is derived from the Greek meaning "very large city," to describe the region and its vast expansion (Gottmann, 1964).

Furthermore, within the European urban context, motorized transport emerged as the preferred mode of mobility, which led to a substantial shift in urban forms, fostering fragmentation and extensive growth. Over recent decades, these factors have resulted in a monofunctional structure, segregated urban spaces, and social changes. Consequently, the original function of streets as public spaces transformed into channels that connected the various urban fragments with different typologies (Creutzig, Mühlhoff and Römer, 2012).

02.1.3. The postmodern street

As a result of the crisis of the Modern Movement, which began at the end of the 1950s, the need arose to study historic cities to decode the urban forms that led to new paradigms. The theory of architecture began to question the radicalization of modern ideas in urban projects and uncovered numerous gaps; thus, postmodernity provided new ways of thinking about the city. During the second half of the 20th century, it was recognized that historical cities possessed a public life and active public spaces that new cities lacked.

Although postmodernity introduced a new perspective on street design and was a historical moment for critically assessing modernity, it did not entirely abandon its practice, which was reflected in multiple currents of thought. Numerous theories and studies were introduced, such as Kevin Lynch's on urban space perception (1960), Jane Jacobs' studies on the street (1961), Gordon Cullen's study on urban design (1961), and Aldo Van Eyck's Team X's examination of the boundary between public and private spaces in the early 1950s. Additionally, the studies of Saverio Muratori in the 1950s and the investigations of Carlo Aymonino, Gianfranco Caniggia, Aldo Rossi, Vittorio Gregotti, and others addressed the relationship between urban morphology and building typology in various European cities.

During the 1960s, several remarkable works emerged to reimagine cities and their streets. "The Image of the City," 1960, by Kevin Lynch, represents an integral part of the North American postmodern urban school by studying how people interact with cities. Lynch introduced five elements for studying city images, including paths, edges, districts, nodes, and landmarks, which continue to be used in planning today (Lynch, 1960).

Jane Jacobs, the renowned author of the 1961 book "The Death and Life of Great American Cities," is one of the pivotal references in contemporary street design. Jacobs approached the street from various scales and perspectives, beginning with the human scale, emphasizing her bottom-up approach while criticizing the principles and aims that have shaped the modern city. Through observation and specific examples from her everyday life, Jacobs focused on the value of streets and their sidewalks as generators for active public life (Jacobs, 1961).

Moreover, Gordon Cullen's influential work, "Townscape" (1961), represents a crucial perspective on the street and suggests the possibility of reformulating its very materiality. Cullen's innovative theory introduces a methodology that connects urban elements with psychology to provide visual coherence and organization to the urban environment (Cullen, 1961).

Similarly, the Danish architect Jan Gehl focuses on the study of contemporary cities and public spaces, being guided by the principles of the perspective of the fundamental desires of people. In his classic 1971 book "Life between buildings," Gehl underscores the importance of public life and advocates for quantitative and qualitative analysis as a means to improve public spaces, allowing for a better and healthier urban liviing. His proposal constitutes a significant lasting influence on the future quality of public open spaces, building a bridge between the practices of architectural design and contemporary urbanism (Gehl, 1987).

During the latter half of the 20th century, new perspectives regarding the city and its linearly characterized streets emerged. The 1972 work, "Learning from Las Vegas," undoubtedly served as one of the pioneering studies within the paradigm of urban phenomena, particularly in a consumer and postmodern society dominated by, and dependent, on the automobile. The study, conducted in the late 1960s by three architects, Robert Venturi, Steven Izenour, and Denise Scott Brown, was a landmark in the attention given to urban elements, such as the Las Vegas Strip. The authors focused on the comprehending the spatial and visual relationships established along this main street in Las Vegas. Their focus revolved around understanding the impact and consequences that symbols, advertisements, and lighting exerted on architectural compositions and, consequently, on the urban landscape (Venturi, Izenour and Brown, 1977).

Spiro Kostof, in his work "The City Assembled," dedicates an entire chapter exclusively to the street. The first aspect that Kostof addresses is the notion that the street is a space that embraces economic and social functions, which are of great significance for the city. Kostof highlights two crucial aspects of defining the street: its shape and use. Although both aspects are equally relevant, Kostof places greater emphasis on the physical aspect of the street, as it is more resilient to time, less volatile than its uses, and actively contributes to the construction of the city's public space (Kostof, 1992).

Allan Jacobs studied some of the world's best streets, focusing on their spatial quality. His renowned book, "Great Streets," published in 1993, compiles a collection of streets' physical characteristics, where each street is represented through classic representational drawings, plans, and cross-sections. Jacobs maintained the same scale for all examples, which allowed for a more accessible reading, understanding, and comparison between the various collected cases (Jacobs, 1995).

However, towards the end of the 20th century, several theorists sought to define, classify, or characterize urban spaces' transformations and the emergence of new urban models. The post-industrial period introduced new urban models based on the new era's demands, such as the mobility of goods and services, technological development, rapid communication, and dissemination of information, among others. These factors, in turn, generated new morphological characteristics and urban dynamics. Consequently, cities faced more expansive threats as they grew, including climate change and economic crises, among others. Accordingly, critical texts and concepts, such as Global City (Sassen, 1991), Edge City (Garreau, 1991), Generic City (Koolhaas, 1995), and Postmetropolis (Soja, 2000), attempt to understand the issue of contemporary cities within various global contexts.

Rem Koolhaas's insights regarding the phenomena of the city are fundamental for the analysis of street design and contemporary architecture. In his 1995 work, "The Generic City," the notion of the street becomes the antithesis of Jacobs and Gehl's perspective. According to Koolhaas (1995), the street has evolved into an organizational element, and it has no place in the generic city's new scale.

In his 2004 work "Streets & Patterns," Stephen Marshall highlights the street as providing a fundamental element in the constitution of the city's fabric and explores how this element can be viewed as a generator of new fabrics. Marshall states that streets are venues for social activities and not just movement and that they are also a place where a wide range of activities take place, such as commerce and leisure. He asserts that the urban models developed by the Modern Movement contributed to the dismemberment of the street's functions. The role of the street as a channel was strongly emphasized, whereas its role as an urban element and place was overlooked (Marshall, 2004).

In this context, the street has acquired greater diversity and formal complexity due to various and ongoing urban transformations that have occurred over the last century. Over the years, the street has been the subject of several studies as a fundamental and integral part of urban elements and constituents of an urban layout. Today, the city, urban agglomeration, and street have assumed shapes and, in many cases, extensions that probably few could have imagined. The broad debate on the street that occurred in the late 19th century was accompanied by a set of diverse thoughts that did not directly address this urban element. However, at the beginning of the 20th century, the street acquired greater relevance as an urban element in the urban debate. Notably, a set of theories and ideas concerning the street as an urban element emerged due to its physical or functional attributes.

02.2. The notion of the street in Saudi Arabia

The notion of streets and public spaces in Saudi Arabia has undergone several transformations. From a historical perspective, the consolidation of Saudi Arabia in the early 1930s marked the beginning of a new concept for Saudi cities. Small settlements scattered across vast deserts gradually transformed into metropolises within a few decades. During this period, cities were characterized by their meticulous adaptation to diverse geographical conditions, climates, and environmental realities that varied considerably from one region to another. Given this context, this section starts with a brief review of the transformation of the street from traditional to contemporary cities to facilitate an understanding of the notion of streets and public spaces in Saudi Arabia.

02.2.1. The traditional street

Before the significant urban and population growth that followed the oil boom of the mid-1970s, traditional cities in Saudi Arabia demonstrated a profound consideration and understanding of the locale's social and economic needs, as well as natural conditions. Although each region's geographical context resulted in unique urban forms and architectural languages, streets and public spaces held significant social, functional, and symbolic value (Misk Art Institute, 2018).

For example, in the central region, the adobe courtyard buildings and the narrow, winding streets were the predominant characteristics of the desert communities, designed as a response to the harsh and arid climate (Al Naim, 2013). Conversely, in the western region, the multi-story row buildings constructed with coral stones were characteristic of Red Sea communities. These communities also featured building facades with transparent wooden screens, known as "Mashrabiyah," and marketplaces. These architectural features were adopted as a result of the hot-humid climate as well the influence of pilgrimage and trade (Buchan, 1980). Regarding the eastern region along the Arabian Gulf, windcatchers were used to address the maritime inland desert climate (Attia, 2014), while the farming villages in the southern mountainous region adapted to local cultural conditions and available material (Galea and Boon, 1981).

Amid these diverse urban forms and architectural characteristics, streets played a crucial role in shaping the spatial relationships between different parts of a city. In addition to serving as routes of circulation, the main streets in traditional Saudi settlements functioned as public places for social, cultural, and commercial activities. One of the key features of the streets was a functional and formative hierarchy, where the main and wide streets embodied the principal public space (Alnaim, 2020).

The old city of Riyadh exemplifies a traditional Arabic vernacular city. During the first Saudi state in the eighteenth century, Riyadh adopted its current name (Elsheshtawy, 2021). Riyadh, which translates to "gardens and orchards," was derived name from its geographical location, where it was one of the few areas in the middle of the desert surrounded by fertile lands, abundant water, and lush greenery (Faris, 1982).

However, the city's origins can be traced back to the pre-Islamic era, in the ancient settlement of Al-Yamama (Philby, 1920). Prior to the country's unification in 1932, the old city of Riyadh was located on one of the main historical trading and pilgrim routes that connected the Arabian Peninsula with Africa and Asia. Consequently, Riyadh was initially a link in a chain of small settlements along with the arable land in Wadi Hanifa, also known as the "Hanifa valley" (Faris, 1982).

The old city of Riyadh was characterized by its vernacular form, which was preserved as a traditional Arab Islamic city until the 1950s. At that time, its population totaled less than 84,000 people. The traditional urban fabric of old Riyadh presented a compact and homogeneous configuration, surrounded by a thick mud wall with nine gates (Almahmood, 2017).

J. B. Philby (Harry St John Bridger Philby) described in detail the vernacular city of Riyadh in his book "Sa'udi Arabia" (Philby, 1955). British Arabists who visited Riyadh in 1917 discovered the city structured in an equilateral triangle form, with each side measuring around 600 meters. Moreover, Riyadh was composed of courtyard houses that covered the entire plot, surrounded by complex street patterns and small plots of land held by a variety of different owners. Notably, the focal point of the city was formed by the palace, the Great Mosque, and the marketplace (Elsheshtawy, 2021).

Enclosed within the city walls, a unique hierarchy of streets and buildings, ranging from semi-private to public, gave shape to the urban fabric. This was composed of different residential areas, each characterized by an intricate network of narrow alleys and pathways. The narrow and shaded streets were lined with mud-brick courtyard buildings, typically two or three stories high, constructed as inward-oriented autonomous units in response to climate and privacy needs (Al-Hathloul, 1981).

In this context, each residential area was composed of several traditional buildings connected to the main public spaces through a hierarchy of streets. This hierarchy positioned the streets as an essential component in old Riyadh, enabling them to accommodate the residents' daily lives (Al-Hathloul, 1981). In addition to the streets serving as passageways, markets were hosted on the main arteries, such as Al Thumairi and Al Suwailem. Similar to the design of other old Islamic cities, these main streets connected the city gates to the main buildings, such as the Grand Mosque, Qasr al-Hukm "Rule Palace," Masmak Fort, and the city's main square, "Alsafat Square" (RCRC, 2006).

Thus, major streets were designed and shaped to facilitate a variety of activities. Streets such as Al Thumairi were crafted to support parallel rows of small booths for commercial activity, which were situated inside the bays of lateral arcades. Therefore, the major arteries of ancient Riyadh functioned as venues for public, social, and economic activity (RCRC, 2012).

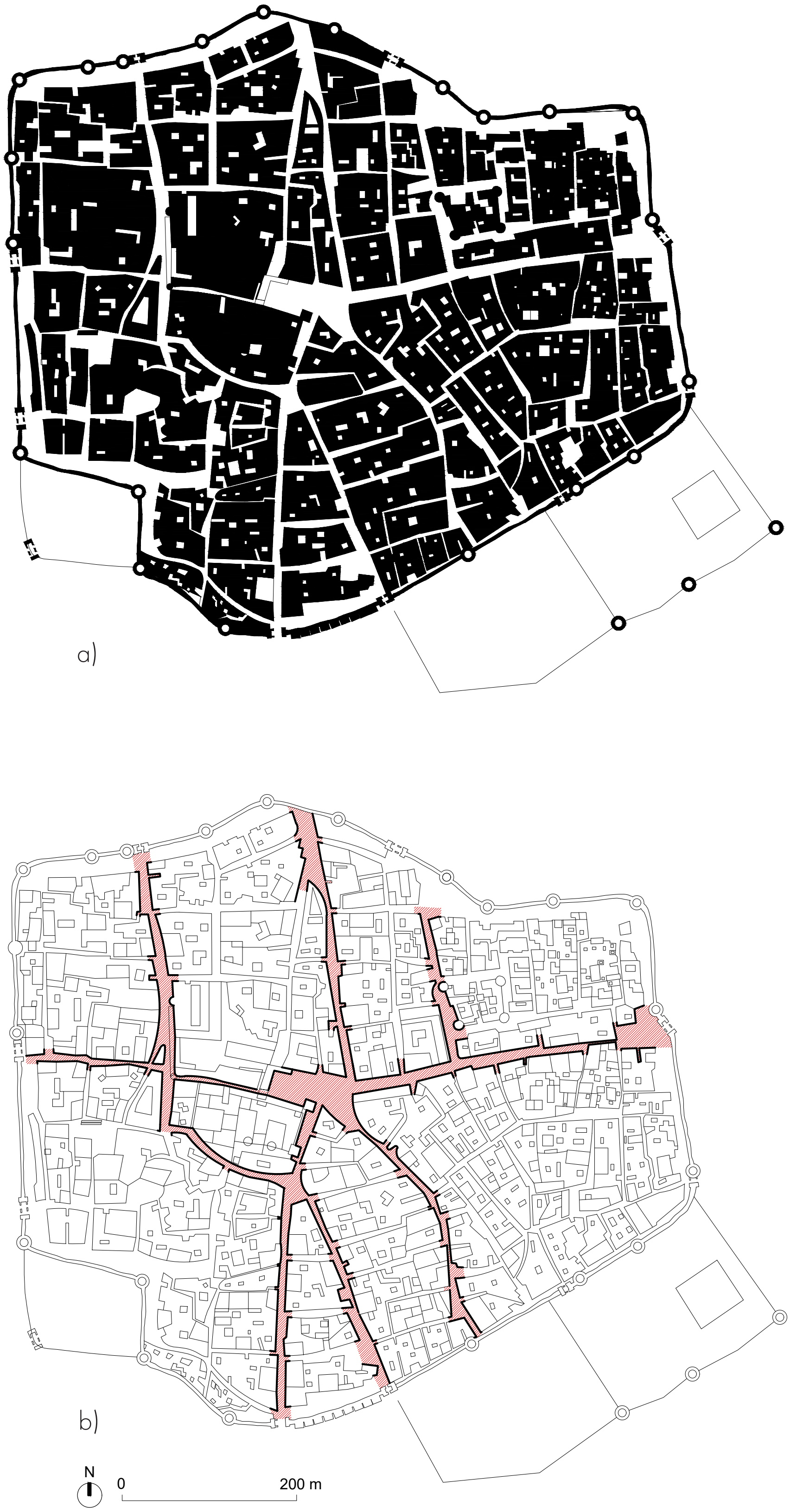


Figure 2.2-1 The old city of Riyadh.
a) The urban fabric of the walled city. (Source: Redrawn from RCRC, 2012).
b) The layout of the old Riyadh's main streets and public spaces. (Source: Author's Edition).

Figure 2.2-2 Photographic documentation of public and social life in the old city of Riyadh, captured between 1943 and 1956. (Source: RCRC, 2012).

Furthermore, the old town of Jeddah, known as "Al-Balad," presents a noteworthy example of a vernacular urban form that has retained its urban heritage. Historic Jeddah is situated on the eastern shore of the Red Sea, spanning a total area of 17 hectares. Al-Balad, the city's original nucleus, has a distinct urban fabric that has remained visible even after the city's walls and monumental gates were demolished in 1947 and the construction of Al-Dahab Street in 1961, a wide street that bisects the traditional urban fabric (SCTH, 2013).

The historical core of Jeddah was initially divided into four main residential quarters, which acquired their names based on their locations within the walled city or famous events: Mazloum quarter to the north, the Sham quarter at the center and toward Mecca Gate, the Yemen quarter to the south, and the Bahr quarter in the southwestern part of the city. Each neighborhood blended commercial, religious, and social life, thereby producing morphological richness and a deterministic relationship between the built form and patterns of public life. Within this context, streets and public spaces acquired significant social value (SCTH, 2013).

The architectural design of these quarters has traditionally been characterized as exhibiting a compact urban form, high building density, and organic patterns that create narrow, shaded streets with rich and multifaceted social interactions. This description is partially similar to other traditional Red Sea cities. The organization of the urban structure of Al-Balad is based on a clear hierarchy, starting from the major city streets, or "souqs," and continuing to the small areas or nodes in the residential districts. These nodes are positioned along streets or alleys, or around semi-private squares (Salagoor, 1990).

Situated within Al-Balad's dense urban pattern, the primary streets—where the marketplaces and major mosques are located—play a vital role in forming the city's morphology while simultaneously affirming the city's cultural and social dimensions. In this context, two main axes running east to west and two additional axes running north to south form the main souks, which serve to maintain the spatial continuity of the urban fabric. These main arteries embody the city's public, social, and commercial life, gradually diminishing toward the inner residential quarters and alleys. From this perspective, the main streets of historic Jeddah are composed not only of fundamental routes that connect the city's quarters and gates but also of places for a wide variety of public and collective activities.

The historical district of Jeddah features narrow, winding streets that were formed in response to climate and socio-spatial conditions. The narrow width of these streets stimulated airflow and created an alternation of light and shade. Moreover, the main streets are bounded by mixed-use ground floors, which blend into the street level both physically and visually.

In this context, examining the historical cities of Riyadh and Jeddah provides insights into the traditional streets and their diverse spatial and physical characteristics. Although there were clear differences between the two cities in terms of urban form, architectural elements, geographical location, and, consequently, climate, both settlements exhibit similar spatial and hierarchical organizations with a significant focus on the main street as a route and a venue for various activities.

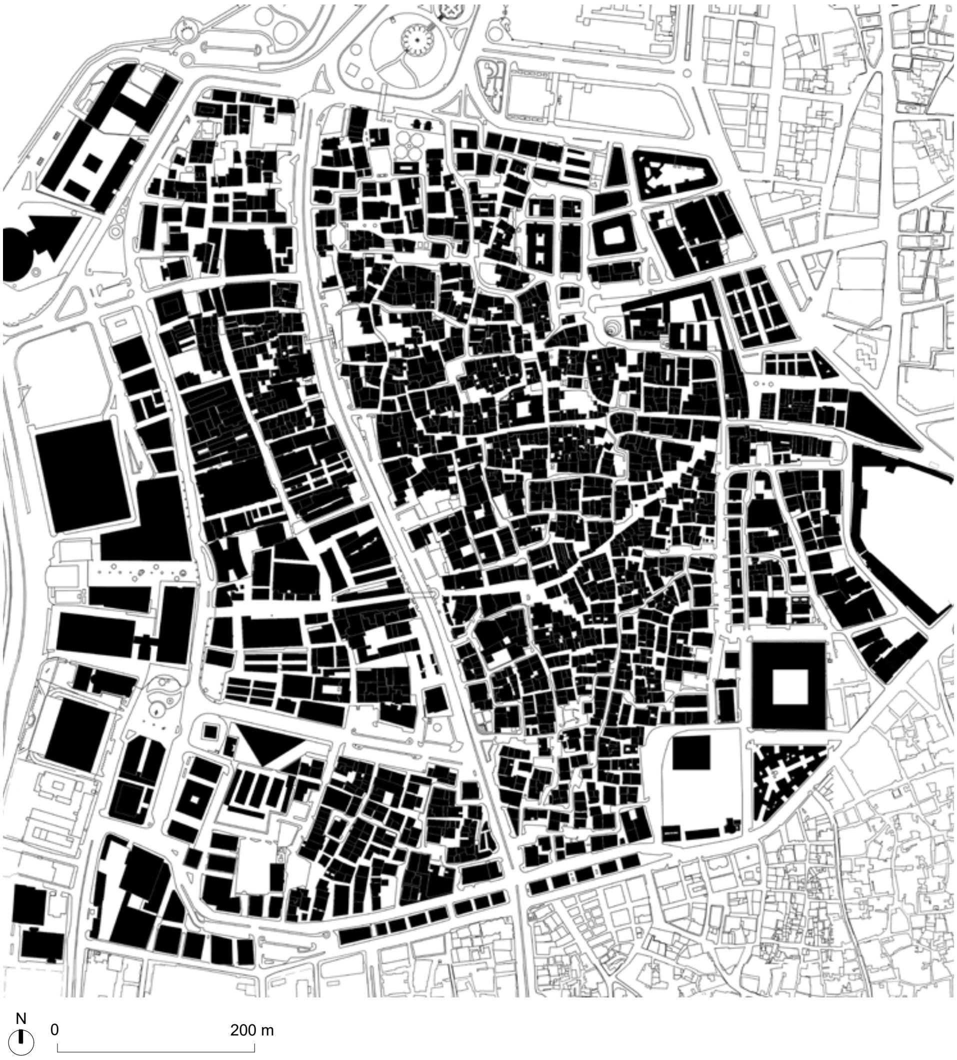


Figure 2.2-3 The current urban form of the old city of Jeddah, "Al-Balad."
a) The urban fabric of Al-Balad, Jeddah. (Source: Author's Edition).

b) The layout of Al-Balad's traditional souks and main axes. (Source: Author's Edition).

Figure 2.2-4 The vibrant public and social life of Al-Balad, Jeddah: A contemporary glimpse into the heart of the historic district. (Source: Author's Edition, 2021).

02.2.2. The transformation

At the inception of Saudi Arabia, the country's primary source of income was based on the revenue from pilgrimages to the Two Holy Mosques in Mecca and Medina. However, the announcement of the Kingdom's formation coincided with a global economic crisis. Consequently, the number of pilgrims reduced to a mere 40,000 in 1932, which adversely impacted the Kingdom's economy. Therefore, embarking on a search for oil was Saudi Arabia's strategy to improve its economy. In this context, on March 3, 1938, the discovery of oil revolutionized the region's economic, urban, human, and political aspects (Faris, 1982). Accordingly, cities in Saudi Arabia underwent a tremendous transformation, from small walled settlements to large urban centers. The transformation was fueled by the oil revenues, providing Saudi Arabia with great resources that have led to the country's development (Misk Art Institute, 2018).

In light of this rapid development, due to rapid population growth and increasing demand for housing and services, most traditional cities started to lose their walls between the 1940s and 1950s. New social groups emerged from business and job growth, which led to unprecedented migration of individuals between cities in search of a better living, which subsequently resulted in the unplanned spatial expansion of cities. By the 1960s and 1970s, substantial changes started to appear in major cities like Riyadh, Jeddah, and Dammam. New master plans were developed to manage the expansion of settlements beyond their walls, such as Abdulrahman Makhlouf's plan in 1963 and Robert Matthew's 1973 plan for Jeddah (Al-Harigi, Yousef and An-Nwisser, 2002), and the Doxaidis master plan of Riyadh in the late 1960s (Al-Hathloul, 2017).

In the case of Riyadh (see Chapter 08), the early 1950s marked the starting point for the sprawling city's expansion. The old city lost its wall as automobiles were introduced into the narrow streets (Figure 2.2-5; RCRC, 2015). Oil revenue played a role in financing future developments, including large-scale projects and planning, where oil prices grew from 10.4 million US dollars in 1946 to 210.7 million in 1952 (Facey, 1992; Al Naim, 2013).

Conversely, on the western coast, Jeddah began to experience the benefits of Saudi oil exports in 1947, and the old city walls were demolished, marking the start of the first phase of urban expansion (Daghistani, 1991). During the following eight years, from 1948 to 1956, the city witnessed a tremendous growth rate, expanding from 300 to 3,300 hectares (SCTH, 2013). In this process, the small trading town was transformed into a sprawling metropolis. New projects, wide streets, and housing were developed to accommodate the new lifestyle. Jeddah's urban growth has gone unabated, and the traditional neighborhoods and their walkable alleys have gradually transformed into wide roads designed for car use (Al-Harigi, Yousef and An-Nwisser, 2002).

The rapid transition in economic and urban growth experienced in Saudi Arabia has had significant and pivotal changes in its cities. Following the 1973 oil boom, the construction of new highways around the cities became an essential need for the modern country. New streets were superimposed on the narrower roadways of most of the cities to facilitate the construction of infrastructure and the movement of goods and services (Figure 2.2-6). This large-scale transformation of the urban fabric has impacted lifestyle and social interaction and has reshaped communal gathering areas, thereby shaping the cornerstone from which the modern Saudi city emerged (Salagoor, 1990).

During the 1980s and 1990s, major cities experienced rapid urban sprawl and population growth. For example, Jeddah's population boomed from 40,000 inhabitants in 1947 to 1,250,000 in 1980 (Figure 2.2-7; SCTH, 2013), while Riyadh reached 4 million inhabitants in the late 1990s (Al-Hathloul, 2017). Amid this scattered sprawl, wide streets for automobile use dominated public spaces, with the automobile becoming the primary mode of transportation. Consequently, the urban sprawl has become the model for contemporary major Saudi cities (Figure 2.2-8).

2.2-5

2.2-6

Figure 2.2-5 Satellite image of Riyadh, 1950. (Source: RCRC, 2015).
Figure 2.2-6 The Beginning of planning the new wide streets within the traditional urban fabric of Riyadh. (Source: RCRC, 2015).

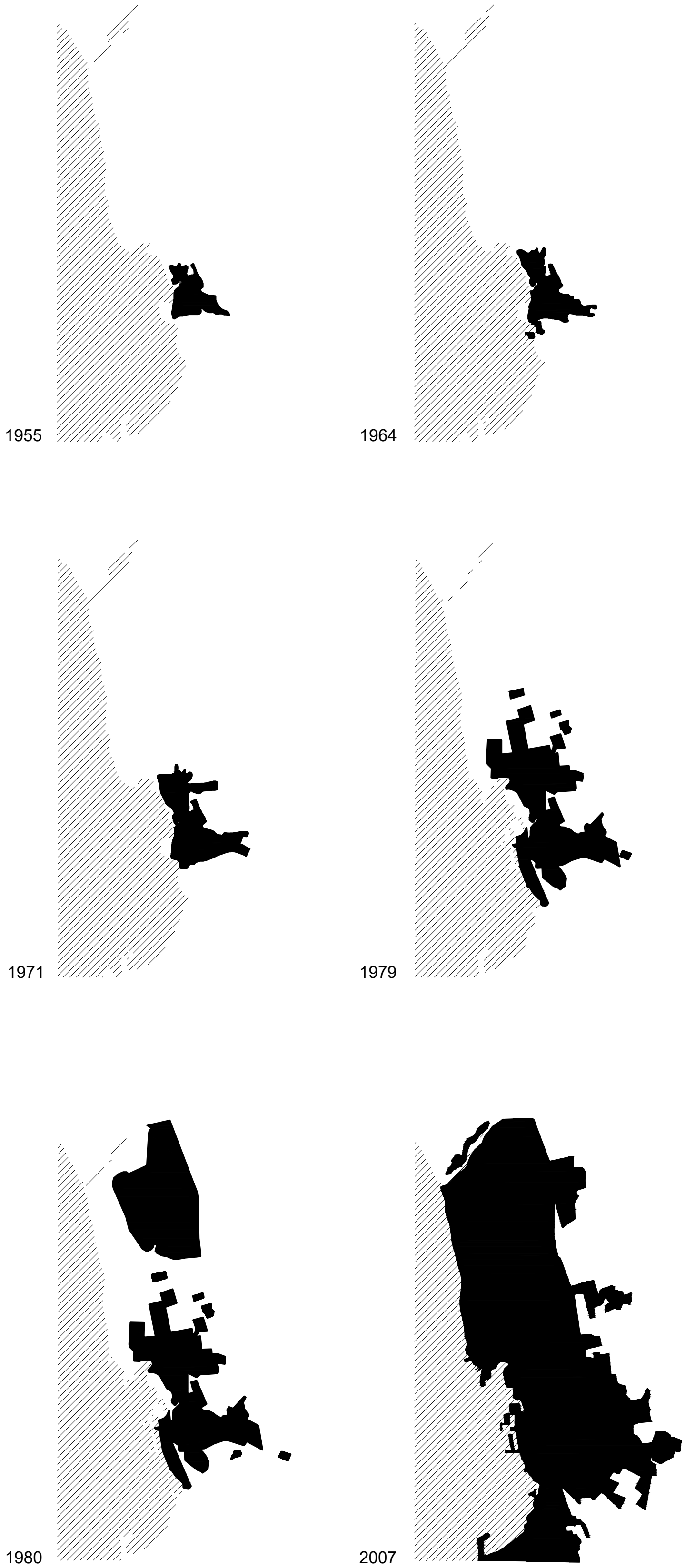


Figure 2.2-7 The urban growth of Jeddah between 1955-2007. (Source: Redrawn from SCTH, 2013).

Figure 2.2-8 Riyadh's lower-density sprawling development, 2018. (Source: Courtesy of Planet Labs, 2018: https://medium.com/planet-stories/earths-wonders-like-you-ve-never-seen-them-before-ac9e2f39aa56).

02.2.3. Saudi 2030 Vision and the Quality of Life Program

Tracing Saudi Arabia's urban growth and transformation has revealed a crucial trajectory of urban, economic, and social transformations and growth exceeding expectations. However, in 2016, Saudi Arabia introduced the "Saudi Vision 2030," a plan focused on building a diversified economy accompanied by a "National Transformation Plan" (Ministry of Municipal and Rural Affairs, 2019). The plan designed 12 vision realization programs, including the Quality-of-Life program, which aims to improve infrastructure and transport, urban design, and environmental factors. In this regard, following the country's Vision 2030 and the Quality-of-Life program, a range of socio-economic and economic changes gradually appeared in Saudi cities. These include a series of projects and initiatives, the promotion of public entertainment, and the creation of public transportation to counteract the deteriorating state of cities and the fragmentation of social ties (Vision2030, 2016).

In this context, Riyadh represents a vital hub through which the Kingdom seeks to position the city as an international benchmark that provides a better quality of life. Accordingly, on March 18, 2019, the Saudi government announced a series of megaprojects aimed at transforming the capital into one of the most livable cities worldwide, complementing Saudi Vision 2030 and the Quality-of-Life Program (Elsheshtawy, 2021). Furthermore, the Riyadh strategy seeks to make the city one of the world's top ten city economies and double its population to approximately 15–20 million residents, with over 40 million visitors by 2030 (Kane, 2021).

Riyadh's vision intends to improve a city's competitiveness through six main pillars, positioning it as an economic power and a critical contributor to the country's economy. These pillars include economic growth across various sectors, the development and attraction of the best national and global talent, the enhancement of the quality of life, world-class urban spatial planning, prudent governance of the city's resources, and the creation of a global brand that bolsters the prominence of the capital while improving its competitiveness (*Quality of Life Program*, 2020).

In this regard, four megaprojects have been launched, requiring a $23 billion investment in the city to transform it into a model capital in accordance with the Kingdom Vision 2030. These projects are also aligned with the UN Sustainable Development Goals to build sustainable cities and communities. The four projects represent a clear direction for the city's future plan: King Salman Park, Sports Boulevard, Green Riyadh, and Riyadh Art. The projects play a crucial role not only in shaping the city's urban form in the foreseeable future but also in shaping social transformations, including lifestyle, which currently depends on automobiles as the main means not only for transportation but also for entertainment, towards a higher quality lifestyle (Klingmann, 2023).

First, “King Salman Park,” one of Riyadh’s four megaprojects, is planned as a future contemporary center composed of cultural, residential, and commercial activities; its aiming is to transform Riyadh into a dynamically competitive city to fulfill a vital goal of the country’s 2030 vision. The project is strategically located within the city, covering an area of around 16 km^2, which is four times larger than Central Park in New York and five times larger than London’s Hyde Park. This project is set to provide an inclusive destination for a variety of public and social life (Elsheshtawy, 2021).

Another megaproject, “Green Riyadh,” is the world’s largest comprehensive urban afforestation project. This project is an example of actions aiming to improve the quality of life and transform the city into a more livable space. The Green Riyadh project’s main objective is to plant 7.5 million trees around the city by 2030 using recycled water. This plan includes neighborhood gardens, public facilities, and streets (Klingmann, 2023).

Furthermore, Riyadh Sports Boulevard is another key project of Saudi Vision 2030 and Riyadh’s 2030 strategy. The Sports Boulevard was launched in 2019 to be a pivotal factor in transforming the current lifestyle into a healthier one. The project extends from the city’s east to west side, spanning a total length of 135 km (Figure 2.2-9). The Boulevard features continuous green pathways for pedestrians and cyclists, along with dwifferent nodes for sporting activities. The project’s aim is to enhance public participation in sports activities and promote a pedestrian-oriented environment (*The Sports Boulevard*, 2022).

The fourth megaproject is the Riyadh Art Project, which aims to transform the city into a local and global hub of art and culture through 12 art programs. As one of the primary goals of the country’s cultural vision and Riyadh’s strategy, the project seeks to populate much of Riyadh’s urban fabric, providing venues for social gatherings (Elsheshtawy, 2021).

In this regard, the Quality-of-Life Program, in cooperation with other sectors, such as the Ministry of Municipal and Rural Affairs (MOMRA) and various regional commissions, is focusing on developing Saudi cities. These entities have developed plans, strategies, and programs that mainly target city improvement and enhancing the quality of life. Aspects of these initiatives include providing safe and walkable streets, enhancing the quality of placemaking, and promoting social, cultural, and entertainment activities.

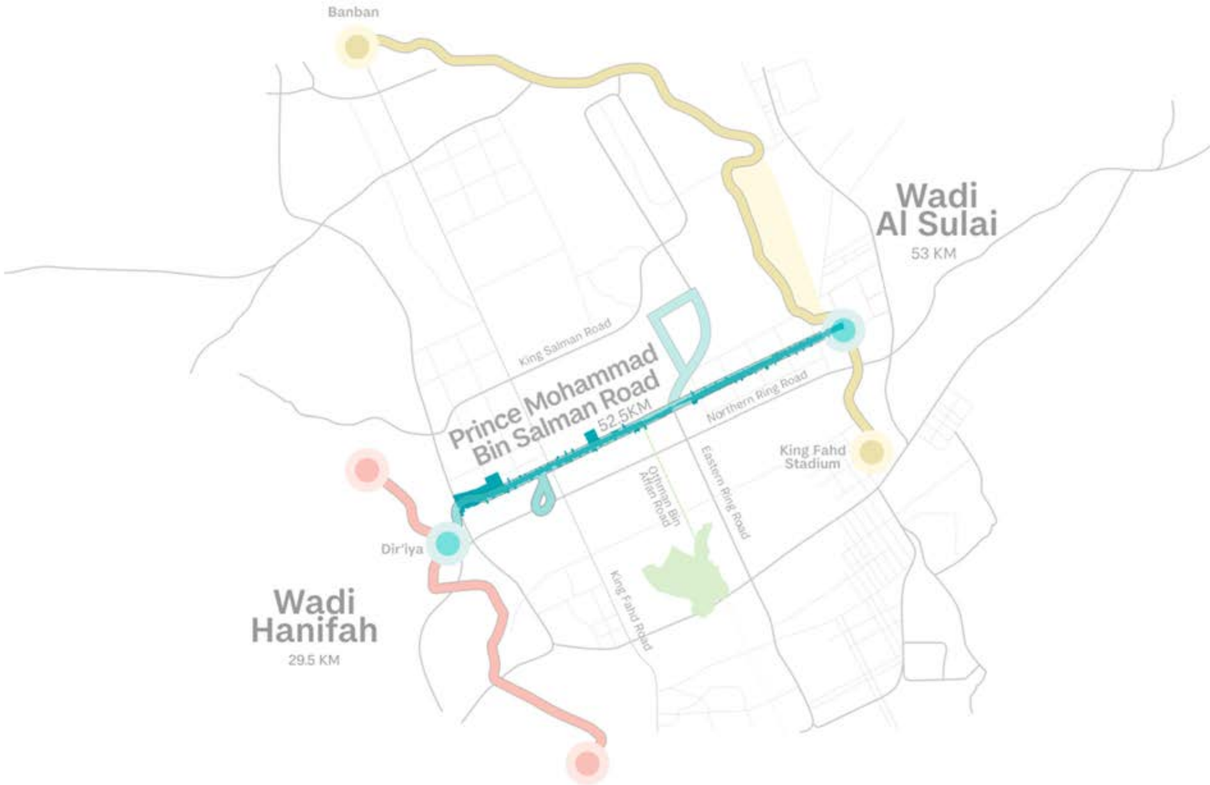


Figure 2.2-9 Map of Riyadh Sports Boulevard spanning a total length of 135 km. (Source: The Sports Boulevard 2022: https://sportsboulevard.sa/).

"Streets and their sidewalks, the main public spaces of the city, are its most vital organs."

Jacobs, 1961

03. The street and livability

Chapter 03 reviews the concept of livability and its relation to the street in international studies based on three key subchapters. First, subchapter 03.1 defines livability and introduces the street as a pillar of livability, an essential urban element that can serve to enhance social and public life. Subsequently, Subchapter 03.2 reviews various studies from the 1960s onwards concerning the quality and livability of the street and public spaces. Furthermore, subchapter 03.3 identifies the main attributes associated with street livability.

03.1. Defining livability

The concept of livability enjoys broad usage and interpretations, with definitions varying according to scholars' particular interests and perspectives, which include defining livability in ways that are fundamentally focused on improving human living (Kaal, 2011). The term "livability" or "liveability" as a noun literally means "the property of being livable" or "suitability for human living" (Ahmed, El-Halafawy and Amin, 2019).

However, the term "livability" lacks a unified definition, and it can be considered as a highly relative term. The concept includes several topics related to social, physical, and safety aspects, as well as economics, education, and public health. Consequently, livability is viewed as an abstract concept that frequently intersects with the concepts of "sustainability," "quality of life," and "well-being" (Ahmed, El-Halafawy and Amin, 2019).

It has been posited that livability serves as an aim and discourse related to sustainability, where they share similar focuses on achieving community well-being (Myers, 1988; Andrews, 2001; De Jong et al., 2015; Valcárcel-Aguiar, Murias and Rodríguez-González, 2018). The body of research and discourse about these concepts reveal the interconnection between livability, sustainability, and quality of life. Nevertheless, the concepts can vary in terms of their subjective connotations. For example, Chazal (2010) clarifies the differences between well-being and livability, arguing that seeking well-being is subjective and differs from person to person; conversely, livability extends beyond the individual perspective and caters to collective needs (De Jong et al., 2015).

In this context, livability is related to human settlements that provide improved living conditions. Doxiadis (1970) first defined "settlement" as a complex system that combined five elements: man, nature, society, buildings, and networks. Doxiadis emphasized the role of a balanced relationship between these elements for a "successful human settlement". Although Doxiadis did not explicitly use the term "livability," his concept respected human dimensions and created a base for the "Quality of Human Settlements."

The relationship between cities and livability has been discussed at various levels, all of which are influenced by an amalgam of factors, including both the built and natural environments, aiming to improve living conditions, economic prosperity, and social stability. According to the American Association of Retired Persons (AARP), "A livable community is one that has affordable and appropriate housing, supportive community features and services, and adequate mobility options, which together facilitate personal independence and the engagement of residents in civic and social life" (Kihl *et al.*, 2005, p. 2). Consequently, a "livable city" typically denotes a safe, affordable, and environmentally friendly city that provides superior living conditions (Hamilton and Atkins, 2008; Kaal, 2011).

Furthermore, the concept of livability has increasingly become a central focus in city development. To illustrate, many organizations and associations annually rank the world's most livable cities, such as the "Global Liveability Ranking" and "Global Liveability Index 2022" (The Economist Intelligence Unit, 2022). Moreover, an increased interest in understanding how the form of the built environment contributes to the livability of communities has been discussed, such as the relationship between neighborhood characteristics and travel behavior (Handy et al., 2002). Additionally, some scholars have proposed conceptual frameworks for the physical characteristics of streets (Ewing and Handy, 2009). In addition, several studies have examined on the impact of urban design on lifestyle, pedestrians activites, and public health (Rodríguez, Brisson and Estupiñán, 2009; Ding and Gebel, 2012).

Prominent authors and thinkers, such as Jane Jacobs, Allan Jacobs, Jan Gehl, William H. White, and Kevin Lynch, are among those who have shown concern about the concept of a livable city. Donald Appleyard's influential 1981 book "Livable Streets" brought the concept of street livability into the field of urban design (Appleyard, 1981). Livability has since emerged as a central concept in urbanism and planning, appearing in both academic and non-academic literature as an essential concept in urban planning, transportation, community development, and housing, among others (Ahmed, El-Halafawy and Amin, 2019; Martino, Girling and Lu, 2021; Sheikh and van Ameijde, 2022).

The street has always represented a constant aspect present in people's lives. Throughout history, the street has been the public space to serve basic survival needs, including communication and entertainment needs, and performed several political, religious, commercial, civic, and social functions (Moughtin, 2003). Streets embody all kinds of public spaces for community activities and offer opportunities for both long- and short-term human interactions (Lofland, 1998; Montgomery, 1998). Thus, numerous scholars across various fields related to urban studies propose considering streets as a social place rather than merely channels for movement (Jacobs, 1961; Appleyard, 1981; Greenbaum, 1982; Gehl, 1987; Lennard and Lennard, 1987; Moore, 1987; Mehta, 2013).

In essence, the street has always been a fundamental component in cities' formations. The street is more than a channel of movement; it also contains social, economic, and leisure places for people (Jacobs, 1961; Moudon, 1987; Lofland, 1998). However, as reviewed in the previous chapter, the street has evolved and taken on different roles and shapes, spanning from the industrial city to contemporary urban settings. The modern movement impacted the street and its social life by favoring automobiles (Dumbaugh, 2005). Additionally, the transformation of numerous streets into roads, largely due to the increasing dominance of the automobile within urban spaces, has impacted the notion of the street (Jacobs *et al.*, 1996).

The early 20th-century understanding between the traffic engineering and planning professions has affected the current form and use of arterial streets. The challenges facing urban arterial streets have been discussed in different fields, including planning, engineering, urban design, and public health (Jacobs *et al.*, 1996; Jensen, 2004; Hebbert, 2005; Dumbaugh and Rae, 2009; Mindell and Karlsen, 2012). These challenges involve traffic safety, the balance between automobiles and pedestrians' needs, direct exposure to noise and pollution, and physical health.

The legacy of street classification, which shapes quiet streets around residential neighborhoods, has resulted in the idea of an urban arterial for automobile use, creating a conflict between traffic movement and livability. Many authors and planners, such as Jacobs (1961), Appleyard (1981) and, Bosselmann, Macdonald and Kronemeyer (1999), have identified street traffic as an underlying issue behind the lack of public and social life.

This concern has been evident since the 1960s and 1970s, when various authors such as Jane Jacobs and Jan Gehl, among others, advocated for a more people-oriented approach, opposing the functionalist vision that prioritized the automobile and caused zoning and spatial segregation (Jacobs, 1961; Gehl, 1987). Moreover, different authors and empirical studies have emphasized the roles and significance of streets in facilitating social and public life (Appleyard, 1981; Lennard and Lennard, 1987; Mehta, 2013; Southworth and Ben-Joseph, 2013).

03.1.1. The street as a pillar of livability

The street has been recognized as a primary multipurpose place that contributes to the success of cities (Appleyard, 1981; Gehl, 1987, 2010; Montgomery, 1998). Several theories and empirical studies have focused on defining a great (or successful) street as a central hub of urban development (Appleyard, 1981; Bosselmann, Macdonald and Kronemeyer, 1999; Mehta, 2008). As articulated by Appleyard (1981, p.1), "The street has always been the scene of this conflict, between living and access, between resident and traveler, between street life and the threat of death."

The question of street livability is intrinsically linked to the fundamental question that urbanists strive to answer, as William Whyte (1980) emphasized: Why do people want to visit and prefer certain places and avoid others? (Whyte, 1980). Indeed, based on the literature review, this research has defined a "livable street" as a vibrant and socially active place that fuels urban vitality, with people and all their activities as the focal points. Therefore, a livable street provides equality between all users and facilitates their activities.

The concept of street livability is a way to change cities for the better, improving social, public health, and economic aspects, among others (Sheikh and van Ameijde, 2022). Many cities prioritize streets and public spaces to meet the needs of their inhabitants. As a prime example of a city that has made livability a top priority, Melbourne, Australia, embarked on an ambitious program to improve its public spaces around the city. Before the transformation in the 1990s, Melbourne's city center was no more than a daytime business district. In response, the city collaborated with Gehl Architects to conduct a social and planning study of the city, enhance its primary commercial streets, convert some streets into permanent or part-time pedestrian zones, and add new public spaces and squares (Blomkamp and Lewis, 2019).

The city transformed into a vibrant metropolis with a significant growth of public spaces, followed by public artworks, street furniture, and, most importantly, public awareness of the importance of livable streets. The overall transformation resulted in a massive upsurge in city life and activities. Additionally, the enhancement of streets and public spaces was succeeded by the improvement of social and economic activities, where the number of outdoor cafes nearly quadrupled, and the number of cafe seats nearly tripled (Gehl, 2018; Blomkamp and Lewis, 2019).

Aside from the social benefits emphasized by many scholars, including Whyte (1980), Gehl (1987), and Gehl and Svarre (2013), a livable street holds significance for public health. Recently, several studies have discussed the relationship between the built environment and public health, providing compelling evidence linking the quality of the built environment, including streets, with lifestyle (Frank and Engelke, 2001; Burton, 2012).

For example, New York's PlaNYC (2007) demonstrates that the improvement and transformation of open spaces into walkable ones can help decrease obesity and asthma rates. Moreover, by maximizing comfort and enhancing walkability, these initiatives promote physical activity (PlaNYC, 2007). Livable streets can also influence public health by reducing fatality rates and traffic injuries, cutting noise levels, and reducing air pollution (Appleyard, 1981; Bosselmann, Macdonald and Kronemeyer, 1999).

Moreover, the connection between livable streets and the economic vitality of a community can improve the local economy, most directly by affecting retail sales and rents, office rents, and commercial property values (Ho and Douglass, 2008; Sohn, Moudon and Lee, 2012). For example, a study by the Commission for Architecture and the Built Environment (CABE) in the United Kingdom demonstrates the extra financial value that good street design can contribute. The study analyzed ten commercial districts in London to measure the quality of the pedestrian environment and its impact on apartment prices and retail rents. The results showed that investment in design quality positively impacts users, with homebuyers willing to pay a premium for livable street outcomes such as easy access and safety (Buchanan, 2007).

03.2. Theories and empirical studies of street and public space livability

The concept of street livability has been developing since the 1960s, responding to the urban development models that have prevailed since the mid-twentieth century, which have been largely based on the automobile as the dominant transportation system. Many works have criticized automobile dominance over streets, aiming to resurrect the street as a place for face-to-face meetings and exchanges where pedestrians and neighbors can find a safe, high-quality space for various activities (Appleyard, 1981; Curtis and Tiwari, 2008; Sauter and Huettenmoser, 2008).

However, although many studies focusing on livable streets have not used the term "livability," they have yielded significant results regarding street life and quality. For example, terms such as "safe," "great," or "lively" streets have revealed livable street attributes (e.g., Jacobs, 1995), referring to physical, functional, or social qualities at different levels. Accordingly, several studies related to street livability are highlighted below.

Jane Jacobs (1961) was the first figure to question the modern planning approach and the dramatic increase in car traffic that resulted in lifeless cities devoid of people. On the street scale, Jacobs underscored the critical importance of street sidewalks and active frontages. Additionally, Jacobs was one of the first scholars to emphasize the role of density and diversity in street quality.

The concept of the "livable street" was first introduced as "Woonerf" or "living streets" in Delft, Netherlands, which views the street as a social space rather than simply a conduit for movement. During the 1970s, a social movement advocated reclaiming residential streets as a response to planning focused on traffic speed (Hass-Klau, 1990). This concept transformed the design of residential streets into places for shared traffic through interventions such as pavements and the insertion of trees, benches, bollards, and other elements that prevent high-speed automobile traffic (Ben-Joseph, 1995).

Furthermore, William H. Whyte's (1980) groundbreaking empirical study on the open spaces in Manhattan titled "The Social Life of Small Urban Spaces" studied public places' design, use, and effectiveness. According to Whyte, the most successful public places have a variety of activities, such as reading, talking, playing, eating, observing, walking, and shopping, in groups or individually. Whyte highlighted that elements such as sitting, water, and trees comprise important parts of public spaces that help make them comfortable and social (Whyte, 1980).

Later, Appleyard (1981) elaborated on the issues of street livability in the field of urbanism. By comparing three residential streets in San Francisco, Appleyard's study established a well-known understanding of street livability, demonstrating that residents on streets with the lowest traffic volume led more active social lives than residents of the other streets. Appleyard further argued that the possibility of meeting neighbors in public spaces increases with the greater use of public transportation or walking. Essentially, people are more likely to meet and get to know each other, thus creating a more livable and safer environment for everyone.

Furthermore, Jan Gehl, a researcher who widely investigated public spaces and public life, developed twelve indicators for designing better and higher-quality public spaces, falling under three main themes: protection, comfort, and enjoyment. Gehl's quality indicators are highly related to the physical design of a place, aiming to create protected, comfortable, and enjoyable spaces (Gehl, 1987).

In his 1995 work "Great streets (1995)," Allan Jacobs introduced several indicators for street design. Jacobs examined the features and characteristics of great streets, noting that physical design plays a significant role in designing great streets. The physical design of the street can create a pleasant, attractive, and sociable place for all users, which can influence the rest of the city. Jacobs argued that streets should be part of urban spaces and be open to all users (Jacobs, 1995).

With a close interpretation of form and context, Jacobs distills eight requirements necessary for street greatness. These points include the street's physical comfort, the human scale, streets as places for leisurely walks, visual complexity and movement, transparency, complementarity, good maintenance, and quality construction and design. Further, Jacobs also listed thirteen additional principles that contribute to great streets: trees, beginnings and endings, diverse buildings, street furniture, places along the way, accessibility, density, diversity, length, slope, parking, contrast, and time (Jacobs, 1995).

Concerning street and public space qualities, several organizations, such as "Project for Public Spaces," have focused more on supporting pedestrian activities. Founded in 1975 by Fred Kent, this organization aimed to apply William H. Whyte's work to create better places for everyday use. However, in 1995, the Project for Public Spaces coined the term "placemaking," which sought to address the question of "What Makes a Great Place?" Accordingly, four significant indicators were identified: accessibility, participation in activities, comfort, and sociability of the location (Kent, 2019).

Later, street livability was also the focus of Peter Bosselmann's empirical investigation, "Revisiting Viable Streets (1999)." Bosselmann studied the livability of residential boulevards based on the "Livable Streets" project by Donald Appleyard. Bosselmann evaluated streets' livability in relation to traffic volume, highlighting the role of balancing vehicular traffic with walkable sidewalks, local accessibility, and tree-planted sidewalks to mitigate the negative effects of heavy traffic. He focused on three indicators, including environmental measurements, social interaction, and street activities, each compared against the traffic volume on each street (Bosselmann, Macdonald and Kronemeyer, 1999).

The growing interest among academics concerning the role of streets and public spaces in urban life and livability has also focused on management. Carmona, Magalhães and Hammond (2008) discussed a variety of theoretical and practical debates regarding streets and public spaces. Their work titled "Public Space: The Management Dimension" explained public space management and explored the nature and dimensions of public spaces. The authors empirically examined questions related to public space management in four international projects.

Furthermore, empirical studies have also discussed street livability at the ground-floor level. For example, the City at Eye Level project, started in 2012, aimed to study the ground floor of streets and public spaces to create higher quality, more livable places. The project included both physical elements—such as the façade, building, sidewalk, street, bikeways, and trees—and emotional and social aspects. The resulting work, "The City at Eye Level: Lessons for Street Plinths," provides lessons regarding the design of the street interface that contributes to improving the overall visual character of a city and enriches public life, including visual interactions. In this context, the project developed a three-layer set of criteria for the analysis and strategy for plinths: building, street, and context, each with its own set of indicators (Glaser *et al.*, 2012).

03.2.1. Relevant attributes of livable streets

Evaluating livability varies from one city to another; each city has unique indicators and needs. The degree of livability depends on several factors, including community values, context, economy, and social and cultural backgrounds (Ahmed, El-Halafawy and Amin, 2019). Streets also possess different characteristics based on their function, location, physical form, socioeconomic status, and the culture of their users and inhabitants (Jacobs, 1995; Mehta, 2013).

Over the years, measuring a place's quality has been a recurring topic of discussion among urban designers. Some scholars, such as Jacobs (1995), have underscored the role of a place's physical characteristics as a measurement tool, examining the quality of the place through its physical dimensions, including the physicality and design styles, features, ornamentation, surrounding buildings, landmarks, gateways, and vistas. Conversely, other scholars, such as Lynch (Lynch, 1960; Alexander, Ishikawa and Silverstein, 1977; Gehl, 1987, 2010), have emphasized the social and psychological dimension of a place, which, according to Montgomery (1998), represents the romantic view of urban design. One common thread among these theorists is that people are the ultimate measure of whether a place is prosperous or failing.

The literature review presented earlier attempted to introduce a number of studies and empirical works beginning in the 1960s, a period that saw the decline of streets as social places during the modern movement. Although the review included studies of public spaces, it contributed to understanding different scholarly perspectives and highlighting attributes related to street livability. Thus, street attributes encompass physical, social, traffic, and functional characteristics.

Regarding the streets' physical attributes, authors and studies have emphasized the role of these characteristics. The physical attributes of streets play a crucial role in creating a sense of place and supporting pedestrian activities. David Canter (1977), in his book "Psychology of Place," describes "place" as the juxtaposition of three major constituent elements: conceptions, activities, and physical attributes. His concept of "place" shapes the inherent structure of everyday urban life based on a place's physical parameters, the people's conceptions about behavior within a physical environment, and the activities associated with that place. Canter combines three perspectives: first, those who consider the morphological attributes of place; second, those concerned with the social and psychological perspective; and finally, those focused on urban activities (Canter, 1977).

Canter's model of place has been used as the central theme for many studies. For example, Montgomery (1998), uses the place model as "a visual metaphor for the nature of places" while writing on the urban environment. He defines the city as a phenomenon of structured complexity and describes successful places as a combination of both physical dimensions and sensory qualities.

Under the theory of environmental affordances, developed by James J. Gibson in 1986, human behavior is directly related to the surrounding space of each individual (Gibson, 1986). This theory, which studies the relationship between the environment and human behavior, argues that a place's characteristics can either support or constrain the behavior of its users. Environment-behavior studies have focused on the relationship and interactions between the physical environment and human behavior. By analyzing the interaction between a person and their environment, these studies stress that there is a reciprocal relationship between the two (Tillas *et al.*, 2017).

Various physical characteristics related to the street have been emphasized to support pedestrian social and collective activities. The importance of block size and street intersection density in creating vibrant streets with an active public life has been demonstrated. Similarly, the accessibility of the street and its connection to surrounding areas, both visually and physically, have been emphasized. Additionally, this accessibility enables users of different ages and needs to quickly access the place without needing vehicles; moreover, it allows reaching the place by various means, including buses, trains, cars, and bicycles (Jacobs, 1995; Montgomery, 1998).

Furthermore, the form and dimension of a street that offers various pedestrian activities (walking, running, cycling, and observing movement) and the availability of places to sit, gather, and socialize have been given importance. A variety of characteristics, such as wide sidewalks, street furniture, landscaping elements, and street trees, have been recommended (Whyte, 1980; Jacobs, 1995; Montgomery, 1998; Ewing and Clemente, 2013).

The street's ground floors have been highlighted as one of the most crucial physical characteristics of street livability, serving as a connection between the private and public realms. The impact of ground floors on users' experiences is critical because if the ground floors are impressive, the street becomes inviting and livable. The ground-floor façades impact public life and livability because pedestrians move slower, stop, and interact socially in front of active ground floors s(Bobić, 2004; Gehl, Kaefer and Reigstad, 2005; Glaser *et al.*, 2012). Similarly, the overall image and perception of the street, including street enclosure, transparency, accessibility, and human scale, have been highlighted by scholars (Appleyard, 1981; Gehl, 2010; Ewing and Clemente, 2013).

Furthermore, social attributes are pivotal determinants of a livable street, creating a sense of place and attachment to the community. Street social attributes refer to those characteristics or qualities associated with social behavior or interactions within the streets. Thus, scholars and empirical studies have demonstrated the significance of the presence of people and social life on the street, contributing to an atmosphere of safety and attracting more people (Jacobs, 1961; Appleyard, 1981; Montgomery, 1998; Ellard, 2015). These attributes can encompass factors such as population density, the level of diversity amongst individuals, the safety of living, and the level of activity. Other possible social attributes of a street might include the level of safety and security, the availability of amenities and resources, and the physical layout and design of the space. These attributes can all play a role in shaping a street's character and can influence how people interact with each other (Franck and Stevens, 2006).

Jacobs (1961) asserted the need to configure the built environment to create safe streets. Jacobs argued for active frontages that keep eyes on the street, which makes the street livelier and creates a sense of natural surveillance that can contribute to street safety. Similarly, scholars have also observed that the presence of people contributes to attracting other people (Whyte, 1980). Moreover, it has been stated that social interactions, including the eye made on the streets while cycling or walking, increase individuals' sense of safety, trust, and happiness (Charles, 2013).

Concerning pedestrians' activities in public spaces, Gehl (1987) argued that human activities play a significant role in the quality of public spaces and contribute to a sense of community and social connection. He categorized pedestrian activities into three categories: necessary, optional, and social.

Functional attributes are considered fundamental building blocks that can generate more pedestrian traffic and a more active public life on the street level (Montgomery, 1998; Vernez Moudon et al., 2002; Ho and Douglass, 2008; Speck, 2012). The diversity and mixed-use nature of an urban area can significantly impact its quality and public life. Streets used for various purposes, including commerce, leisure, and transportation, tend to be more vibrant than those serving only one purpose (Jacobs, 1961). The importance of diversity and a mix of uses on the neighborhood and community scale has been emphasized to attract human activity (Carmona and Tiesdell, 2007; Piracha, 2011; Mehta and Bosson, 2021).

On a smaller scale, the diversity and mixed-use nature of the ground floor has been highlighted as essential attributes of a livable street. An active street's ground floor with various uses, such as shops, cafes, restaurants, and other activities, fosters a vibrant and dynamic public life (Montgomery, 1998; Ho and Douglass, 2008; Glaser *et al.,* 2012). One of the key benefits of a diverse and mixed-use street lies in its ability to create a sense of community and social connection. People's interactions with each other in various forms, such as through shopping, dining, and other activities, can instill a sense of belonging and mutual support. This functionality also includes street amenities such as newspaper kiosks and ambulant vendors, as Whyte (1980) mentioned, attracting more pedestrians and strengthening street life.

Regarding traffic attributes, the street, as a linear urban element, has always been capable of connecting the city, creating urban coherence, and promoting different modes of mobility. The traffic attributes of streets have played a significant role in shaping the character and quality of street life. However, the negative impact of automobiles has been emphasized in numerous studies, particularly because of their impact on street social life (Appleyard, 1981; Marshall, 2004; Marshall, Jones and Plowright, 2004).

For example, streets with high levels of traffic and fast-moving vehicles can be unpleasant for pedestrians and cyclists, as individuals may be less likely to spend time on the street and may have fewer opportunities for social interaction and recreation. Conversely, streets with lower levels of traffic and slower-moving vehicles can be more welcoming and enjoyable for all users (Appleyard, 1981; Bosselmann, Macdonald and Kronemeyer, 1999). Therefore, scholars have advocated for a street as both a link and a place that accommodates multiple street users, balances different transport modes, and creates a more livable and walkable environment (Montgomery, 1998; Dumbaugh, 2005; Clifton, Livi Smith and Rodriguez, 2007; Cervero, 2009; Gehl, 2010).

References

Ahmed, N. O., El-Halafawy, A. M. and Amin, A. M. (2019) 'A Critical Review of Urban Livability', *European Journal of Sustainable Development*, 8(1), pp. 165–182. doi: 10.14207/ejsd.2019.v8n1p165.

Al-Harigi, M. S., Yousef, A. J. and An-Nwisser, S. F. (2002) 'Jeddah urban growth and development process: the underlying factors', *Scientific Journal of King Faisal University (Basic and Applied Sciences)*, 3(1), pp. 111–136.

Al-Hathloul, S. (2017) 'Riyadh Development Plans in the Past Fifty Years (1967-2016)', *Current Urban Studies*, 05(01), pp. 97–120. doi: 10.4236/cus.2017.51007.

Al-Hathloul, S. A. (1981) *Tradition, continuity and change in the physical environment: the Arab-Muslim city*. Massachusetts Institute of Technology. Available at: http://dspace.mit.edu/handle/1721.1/46401.

Al Naim, M. A. (2013) 'Urban transformation in the city of riyadh: A study of plural urban identity', *Open House International*, 38(4), pp. 70–79. doi: 10.1108/ohi-04-2013-b0008.

Alexander, C., Ishikawa, S. and Silverstein, M. (1977) *A pattern language*. Oxford, UK: Oxford University Press.

Almahmood, M. A. M. (2017) *Re-humanising Public Urban Space: Unfolding the influence of socio-cultural norms on the use, experience, and provision of the sidewalk in Riyadh, Saudi Arabia*. University of Copenhagen.

Alnaim, M. M. (2020) 'The Hierarchical Order of Spaces in Arab Traditional Towns: The Case of Najd, Saudi Arabia', *World Journal of Engineering and Technology*, 08(03), pp. 347–366. doi: 10.4236/wjet.2020.83027.

Andrews, C. J. (2001) 'Analyzing quality-of-place.', *Environment and Planning B: Planning and Design*, 28(2), pp. 201–217.

Appleyard, D. (1981) *Livable Streets*. Berkeley, CA, USA: University of California Press.

Attia, M. K. (2014) 'Sustainability in Saudi vernacular built environment: The case of Al-Ahsa', in *Vernacular Architecture: Towards a Sustainable Future*. CRC Press, pp. 107–112. doi: 10.1201/b17393-20.

Ben-Joseph, E. (1995) 'Changing the Residential Street Scene: Adapting the shared street (Woonerf) Concept to the Suburban Environment', *Journal of the American Planning Association*, 61(4), pp. 504–515. doi: 10.1080/01944369508975661.

Benevolo, L. (1977) *History of Modern Architecture*. Vol. 2. Cambridge, Massachusetts: MIT Press.

Berman, M. (1983) *All that is Solid Melts Into Air: The Experience of Modernity*. New York: Verso.

Blomkamp, E. and Lewis, J. M. (2019) 'Marvellous Melbourne: Making the world's most liveable city', in Compton, M. and Hart, P. 't (eds) *Great policy successes*. Oxford, UK: Oxford University Press, pp. 180–200. doi: 10.22459/SPP.2019.05.

Bobić, M. (2004) *Between the Edges: Street-building Transition as Urbanity Interface*. Bussum, The Netherlands: Thoth Publishers.

Bosselmann, P., Macdonald, E. and Kronemeyer, T. (1999) 'Livable Streets Revisited', *Journal of the American Planning Association*, 65(2), pp. 168–180. doi: 10.1080/01944369908976045.

Buchan, J. (1980) *Jeddah old and new*. London, UK: Stacy International.

Buchanan, C. (2007) *Paved with gold: The real value of good street design Design better streets*. London, United Kingdom: Commission for Architecture and the Built Environment. Available at: www.cabe.org.uk/streets.

Burton, E. (2012) 'Streets ahead? The role of the built environment in healthy ageing', *Perspectives in Public Health*, 132(4), p. 161. doi: 10.1177/1757913912449.

Busquets, J., Yang, D. and Keller, M. (2019) *Urban Grids: Handbook for Regular City Design*. San Francisco, CA, USA: ORO Editions.

Canter, D. (1977) *The Psychology of Place*. London, UK: The architectural Press.

Carmona, M., Magalhães, C. de and Hammond, L. (2008) *Public space: the management dimension*. London, United Kingdom: Routledge.

Carmona, M. and Tiesdell, S. (eds) (2007) *Urban design reader*. London, UK: Routledge.

Cervero, R. (2009) 'Transport infrastructure and global competitiveness: Balancing mobility and livability', *The Annals of the American Academy of Political and Social Science*, 626(1), pp. 210–225. doi: 10.1177/0002716209344171.

Charles, M. (2013) *Happy City: Transforming Our Lives Through Urban Design*. Penguin Books.

Chazal, J. de (2010) 'A systems approach to livability and sustainability: Defining terms and mapping relationships to link desires with ecological opportunities and constraints', *Systems Research and Behavioral Science*, 27(5), pp. 585–597. doi: 10.1002/sres.1058.

Clifton, K. J., Livi Smith, A. D. and Rodriguez, D. (2007) 'The development and testing of an audit for the pedestrian environment', *Landscape and Urban Planning*, 80(1–2), pp. 95–110. doi: 10.1016/j.landurbplan.2006.06.008.

Creutzig, F., Mühlhoff, R. and Römer, J. (2012) 'Decarbonizing urban transport in European cities: four cases show possibly high co-benefits', *Environmental Research Letters*, 7(4), p. 044042. doi: 10.1088/1748-9326/7/4/044042.

Cullen, G. (1961) *Townscape*. London, UK: The architectural Press.

Curtis, C. and Tiwari, R. (2008) 'Transitioning urban arterial roads to activity corridors', *Urban Design International*, 13(2), pp. 105–120. doi: 10.1057/udi.2008.10.

Daghistani, A. I. (1991) 'Urban growth management in Jeddah', *Planning Outlook*, 34(1), pp. 2–9. doi: 10.1080/00320719108711883.

De Jong, M. *et al.* (2015) 'Sustainable–smart–resilient–low carbon–eco–knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization', *Journal of Cleaner Production*, 109, pp. 25–38. doi: 10.1016/j.jclepro.2015.02.004.

Ding, D. and Gebel, K. (2012) 'Built environment, physical activity, and obesity: What have we learned from reviewing the literature?', *Health & Place*. Elsevier, 18(1), pp. 100–105. doi: 10.1016/j.healthplace.2011.08.021.

Doxiadis, C. (1970) 'Ekistics, the Science of Human Settlements', *Science*, 170(3956), pp. 393–404. doi: 10.1126/science.170.3956.3.

Duany, A., Plater-Zyberk, E. and Speck, J. (2000) *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream*. New York, USA: North Point Press.

Dumbaugh, E. (2005) *Safe Streets, Livable Streets: A Positive Approach to Urban Roadside Design*. Georgia Institute of Technology, USA.

Dumbaugh, E. and Rae, R. (2009) 'Safe urban form: Revisiting the relationship between community design and traffic safety', *Journal of the American Planning Association*, *75*(3), pp. 309–329. doi: 10.1080/01944360902950349.

Ellard, C. (2015) *Places of the Heart: The Psychogeography of Everyday Life*. New York, NY, USA: Bellevue Literature Press.

Elsheshtawy, Y. (2021) *Riyadh: Transforming a Desert City*. London, UK: Taylor & Francis.

Ewing, R. and Clemente, O. (2013) *Measuring urban design: Metrics for livable places.* Washington, DC: Island Press.

Ewing, R. and Handy, S. (2009) 'Measuring the unmeasurable: Urban design qualities related to walkability', *Journal of Urban Design*, 14(1), pp. 65–84. doi: 10.1080/13574800802451155.

Facey, W. (1992) *Riyadh, the old city: From its origins until the 1950s*. London, UK: IMMEL.

Faris, A. (1982) الرياض : وثبة إزدهار في الصحراء العربية *[Riyadh: A leap of prosperity in the Arabian desert]*. University of Paris.

Fields, G. (2012) 'Urbanization and the Transition from Agrarian to Industrial Society', *Berkeley Planning Journal*, 13(1). doi: 10.5070/BP313113032.

Franck, K. A. and Stevens, Q. (2006) *Loose space: possibility and diversity in urban life*. London, UK: Routledge. Available at: https://www.taylorfrancis.com/books/9781135993184.

Frank, L. D. and Engelke, P. O. (2001) 'The Built Environment and Human Activity Patterns: Exploring the Impacts of Urban Form on Public Health', *Journal of Planning Literature*, 16(2), pp. 202–218. doi: 10.1177/08854120122093339.

Galea, J. M. and Boon, J. J. (1981) 'The Traditional Architecture of the Asir Province, Saudi Arabia', in *Housing*. Elsevier, pp. 118–134. doi: 10.1016/B978-0-08-028066-0.50012-6.

Gehl, J. (1987) *Life Between Buildings*. New York, NY, USA: Van Nostrand-Reinhold.

Gehl, J. (2010) *Cities for people*. London, UK: Island Press.

Gehl, J. (2018) 'Move to Melbourne', in Dovey, K., Adams, R., and Jones, R. (eds) *Urban Choreography: Central Melbourne, 1985–*. Melbourne, Australia: Melbourne University Publishing.

Gehl, J., Kaefer, L. J. and Reigstad, S. (2005) 'Close encounters with buildings', *Urbanistika ir architektūra*, 29(2), pp. 70–80.

Gibson, J. J. (1986) *The Ecological Approach to Visual Perception*. New York, NY, USA: Psychology Press.

Giedion, S. (1959) *Space, Time and Architecture: The Growth of a New Tradition*. Cambridge, MA, USA: Harvard University Press.

Glaser, M. *et al.* (2012) *The City at Eye Level: Lessons for Street Plinths*. Delft, The Netherlands: Eburon Uitgeverij BV.

Gold, J. R. (1998) 'The death of the boulevard', in Fyfe, N. (ed.) *Images of the Street: Planning, Identity and Control in Public Space*. Londres/New York: Routledge, pp. 44–57.

Gottmann, J. (1964) 'Introduction: The Main Street of the Nation', in *Megalopolis*. The MIT Press, pp. 2–15. doi: 10.7551/mitpress/4537.003.0003.

Greenbaum, S. D. (1982) 'Bridging ties at the neighborhood level', *Social Networks*, 4(4), pp. 367–384. doi: 10.1016/0378-8733(82)90019-3.

Hamilton, D. and Atkins, P. (eds) (2008) *Urban and regional policies for metropolitan livability*. Armonk, New York: ME Sharpe.

Handy, S. L. *et al.* (2002) 'How the built environment affects physical activity: Views from urban planning', *American Journal of Preventive Medicine*, 23(2), pp. 64–73. doi: 10.1016/S0749-3797(02)00475-0.

Hass-Klau, C. (1990) *The Pedestrian and City Traffic*. London, UK: Belhaven Press.

Hebbert, M. (2005) 'Engineering, Urbanism and the Struggle for Street Design', *Journal of Urban Design*, 10(1), pp. 39–59.

Ho, K. and Douglass, M. (2008) 'Globalisation and liveable cities: Experiences in place-making in Pacific Asia', *International Development Planning Review*, 30(3), pp. 199–213. doi: 10.3828/idpr.30.3.1.

Howard, E. (1898) *To-morrow: A peaceful path to real reform*. London, UK: Swan Sonnenschein & Co.

Jacobs, A. (1995) *Great Streets*. Cambridge, MA, USA: The MIT Press.

Jacobs, A. B. *et al.* (1996) *The Uses and Reuses of Major Urban Arterials: A Study of Recycling, Revitalizing, and Restructuring 'Gray Area' Transportation Corridors, Faculty Research Papers*. Berkeley.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York, NY, USA: Vintage Books.

Jensen, S. U. (2004) *European Arterial Streets Historic Changes , Existing Situation and Processes.* Atkins, Denmark.

Jukes, P. (1991) *A Shout in the street: an excursion into the modern city.* Berkeley, CA, USA: University of California Press.

Kaal, H. (2011) 'A conceptual history of livability: Dutch scientists, politicians, policy makers and citizens and the quest for a livable city', *City,* 15(5), pp. 532–547. doi: 10.1080/13604813.2011.595094.

Kane, F. (2021) *Saudi crown prince unveils plan to make Riyadh one of world's 10 largest city economies, Arab News.* Available at: https://www.arabnews.com/node/1800231/business-economy.

Kent, E. (2019) 'Leading urban change with people powered public spaces. The history, and new directions, of the Placemaking movement', *The Journal of Public Space,* (Vol. 4 N. 1 | 2019 | FULL ISSUE), pp. 127–134. doi: 10.32891/jps.v4i1.1158.

Kihl, M. *et al.* (2005) *Livable Communities: An Evaluation Guide.* Washington, DC. Available at: http://assets.aarp.org/rgcenter/il/d18311_communities.pdf.

Klingmann, A. (2023) 'Rescripting Riyadh: how the capital of Saudi Arabia employs urban megaprojects as catalysts to enhance the quality of life within the city's neighborhoods', *Journal of Place Management and Development,* 16(1), pp. 45–72. doi: 10.1108/jpmd-06-2021-0062.

Koolhaas, R. (1995) 'The Generic City', in Koolhaas, R. and Mau, B. (eds) *S,M,L,XL.* New York, NY, USA: The Monacelli Press, pp. 123–178.

Kostof, S. (1992) *The City Assembled: The Elements of Urban Form Through History.* London, UK: Thames and Hudson Ltd.

Lang, F. (2003) *Fritz Lang: Interviews.* Edited by B. K. Grant. Mississippi: University press of Mississippi.

Lasala, A. (2018) *On the street: Contributions to the urban space through architectural strategies.* Pasadena, California: Typecraft Inc.

Lennard, S. H. C. and Lennard, H. L. (1987) *Livable Cities: People and Places : Social and Design Principles for the Future of the City.* Southampton, N.Y: Gondolier Press.

Lofland, L. (1998) *The public realm: Exploring the city's quintessential social territory.* New York, USA: Aldine de Gruyter.

Lynch, K. (1960) *The Image of the City.* Cambridge, MA: The MIT Press.

Marshall, S. (2004) *Streets & Patterns*. London, UK: Routledge. doi: 10.4324/9780203589397.

Marshall, S., Jones, P. and Plowright, I. (2004) *A Framework for Classification and Assessment of Arterial Streets*. London, UK. Available at: http://home.wmin.ac.uk/transport/download/ARTISTS_D1.pdf.

Martino, N., Girling, C. and Lu, Y. (2021) 'Urban form and livability: socioeconomic and built environment indicators', *Buildings and Cities*, 2(1), pp. 220–243. doi: 10.5334/bc.82.

Mehta, V. (2008) 'Walkable streets: pedestrian behavior, perceptions and attitudes', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 1(3), pp. 217–245. doi: 10.1080/17549170802529480.

Mehta, V. (2013) *The street: a quintessential social public space*. New York, USA: Routledge.

Mehta, V. and Bosson, J. K. (2021) 'Revisiting Lively Streets: Social Interactions in Public Space', *Journal of Planning Education and Research*, 41(2), pp. 160–172. doi: 10.1177/0739456X18781453.

Mindell, J. S. and Karlsen, S. (2012) 'Community severance and health: What do we actually know?', *Journal of Urban Health*, 89(2), pp. 232–246. doi: 10.1007/s11524-011-9637-7.

Montgomery, J. (1998) 'Making a city: Urbanity, vitality and urban design', *Journal of Urban Design*, 3(1), pp. 93–116. doi: 10.1080/13574809808724418.

Moore, R. C. (1987) 'Streets as Playgrounds', in Moudon, A. V. (ed.) *Public Streets for Public Use*. New York, USA: Van Nostrand Reinhold.

Morris, A. E. J. (1994) *History of urban form before the industrial revolution*. Third Edit. New York, NY, USA: Routledge.

Moudon, A. V. (ed.) (1987) *Public streets for public use*. New York, USA: Van Nostrand Reinhold.

Moughtin, C. (2003) *Urban design: street and square*. Third Edit. Burlington, MA, USA: Architectural Press.

Myers, D. (1988) 'Building knowledge about quality of life for urban planning', *Journal of the American Planning Association*, 54(3), pp. 347–358. doi: 10.1080/01944368808976495.

Philby, H. S. J. (1955) *Sa'udi Arabia*. New York, USA: Frederick A. Praeger.

Philby, H. S. J. B. (1920) 'Southern Najd', *The Geographical Journal*, 55(3), pp. 161–185.

Piracha, A. (2011) 'Collaborative city liveability study using Gehl methodology : pedestrian and bicycle counts and stationary activity survey in Penrith', *Journal of Town and City Management*, 2(3), pp. 287–299.

PlaNYC (2007) *PlaNYC: A Greater, Greener New York*. New York, USA.

Quality of Life Program (2020). Available at: www.vision2030.gov.sa/v2030/vrps/qol/ (Accessed: 23 March 2022).

RCRC (2006) *Ar-Riyadh: The City & the Life*. Riyadh, Saudi Arabia: The Royal Commission for Riyadh City.

Rodríguez, D. A., Brisson, E. M. and Estupiñán, N. (2009) 'The relationship between segment-level built environment attributes and pedestrian activity around Bogota's BRT stations', *Transportation Research Part D: Transport and Environment*, 14(7), pp. 470–478.

Rykwert, J. (1991) 'The Street: The Use of its History', in Anderson, S. (ed.) *On Streets*. Cambridge, Massachusetts: The MIT Press.

Salagoor, J. Y. (1990) *The influence of building regulations on urban dwelling in Jeddah*. Newcastle University. Available at: https://theses.ncl.ac.uk/jspui/handle/10443/863.

Sauter, D. and Huettenmoser, M. (2008) 'Liveable streets and social inclusion', *URBAN DESIGN International*, 13(2), pp. 67–79. doi: 10.1057/udi.2008.15.

SCTH (2013) *Historic Jeddah, the Gate to Makkah*. Riyadh, Saudi Arabia.

Sheikh, W. T. and van Ameijde, J. (2022) 'Promoting livability through urban planning: A comprehensive framework based on the "theory of human needs"', *Cities*, 131, p. 103972. doi: 10.1016/j.cities.2022.103972.

Sohn, D. W., Moudon, A. V. and Lee, J. (2012) 'The economic value of walkable neighborhoods', *URBAN DESIGN International*, 17(2), pp. 115–128. doi: 10.1057/udi.2012.1.

Soja, E. (2000) *No Postmetropolis: Critical Studies of Cities and Regions.* Oxford,London: Blackwell.

Southworth, M. and Ben-Joseph, E. (2013) *Streets and the Shaping of Towns and Cities.*

Washington, DC: Island Press.

Speck, J. (2012) *Walkable city: How downtown can save America, one step at a time.* New York, USA: North Point Press.

Tarr, J. A. (1984) 'The Evolution of the Urban Infrastructure in the Nineteenth and Twentieth Centuries', in Hanson, R. (ed.) *Perspectives on Urban Infrastructure.* Washington, D.C.: National Academies Press, pp. 4–66. doi: 10.17226/561.

The Economist Intelligence Unit (2022) *The Global Liveability Index 2022*. London, United Kingdom. Available at: https://www.eiu.com/n/campaigns/global-liveability-index-2022/#:~:text=The Global Liveability Index quantifies,liveable city in the world.

The Sports Boulevard (2022) *Sports Boulevard.* Available at: https://sportsboulevard.sa/en/about-us/ (Accessed: 11 April 2022).

Tillas, A. *et al.* (2017) 'Can Affordances Explain Behavior?', *Review of Philosophy and Psychology*, 8(2), pp. 295–315. doi: 10.1007/s13164-016-0310-7.

Trancik, R. (1991) *Finding Lost Space: Theories of Urban Design.* New York, NY, USA: John Wiley & Sons.

Urry, J. (2006) 'Inhabiting the Car', *The Sociological Review*, 54(1_suppl), pp. 17–31. doi: 10.1111/j.1467-954X.2006.00635.x.

UN-Habitat (2018) Saudi Cities Report 2018. Riyadh, Saudi Arabia. Available at: https://unhabitat.org/saudi-cities-report-2018-executive-summary.

Valcárcel-Aguiar, B., Murias, P. and Rodríguez-González, D. (2018) 'Sustainable urban liveability: A practical proposal based on a composite indicator', *Sustainability (Switzerland)*, 11(1), p. 86. doi: 10.3390/su11010086.

Venturi, R., Izenour, S. and Brown, D. S. (1977) *Learning from Las Vegas.* Revised Ed. Cambridge, MA, USA: MIT Press.

Vernet, N. and Coste, A. (2017) 'Garden Cities of the 21st Century: A Sustainable Path to Suburban Reform', *Urban Planning.* The second. Edited by 2 edition. London, UK: Sonnenschein & Co., 2(4), pp. 181–196. doi: 10.17645/up.v2i4.1104.

Vernez Moudon, A. *et al.* (2002) 'Pedestrian Location Identification Tools: Identifying Suburban Areas with Potentially High Latent Demand for Pedestrian Travel', *Transportation Research Record: Journal of the Transportation Research Board*, 1818(1), pp. 94–101. doi: 10.3141/1818-15.

Vision2030 (2016) *National Transformation Program.* Available at: https://www.

vision2030.gov.sa/ (Accessed: 11 March 2019).

Weston, R. (2011) *100 Ideas that Changed Architecture*. London, United Kingdom: Laurence King Publishing.

Whyte, W. H. (1980) *The Social Life of Small Urban Spaces*. New York, NY, USA: Project for Public Spaces.

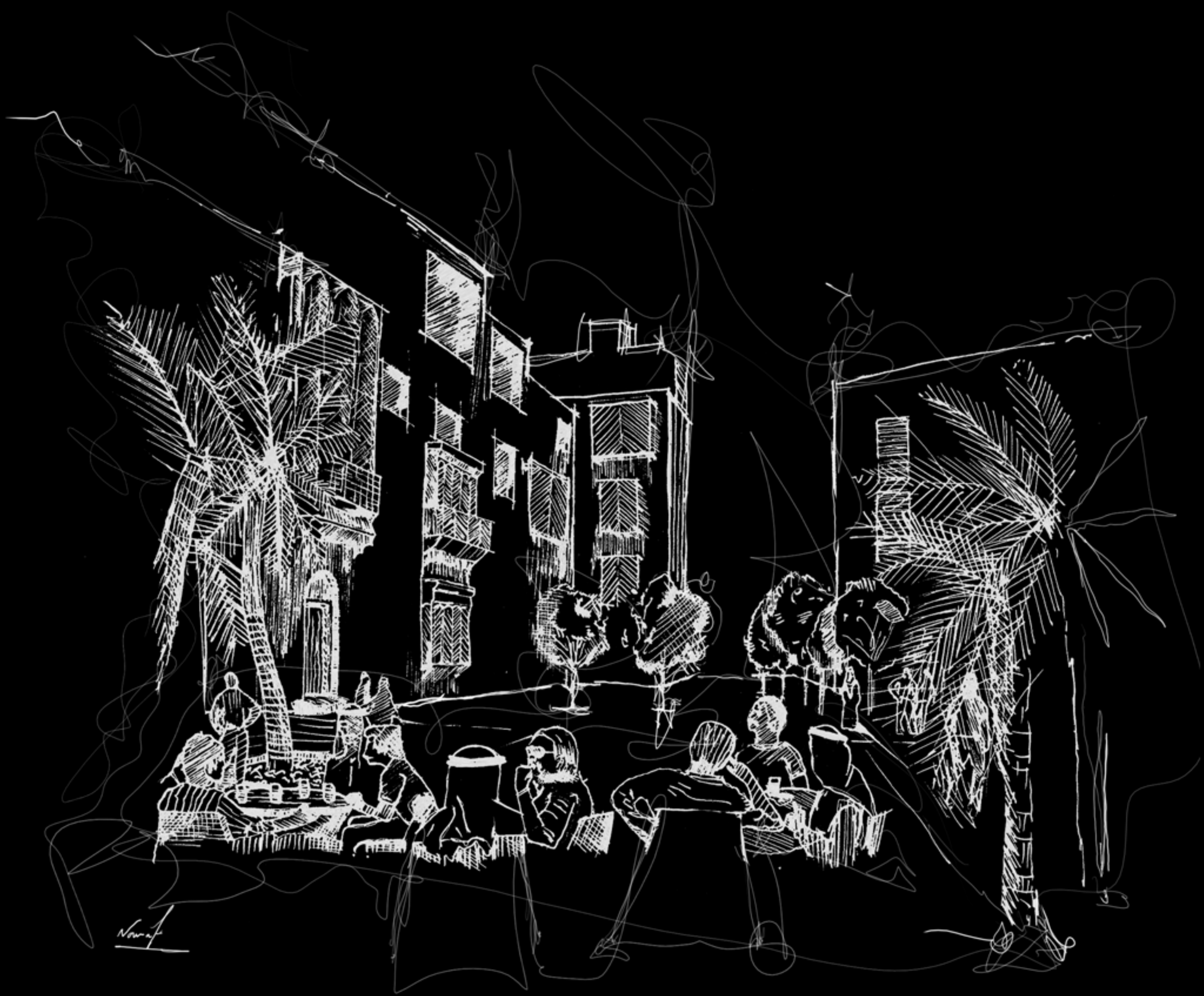
Wright, F. L. (1932) *The Disappearing City*. New York: W. F. Payson.

Part II

The street complexity

"We must consider not just the city as a thing in itself, but the city being perceived by its inhabitants."

Lynch, 1960



04. The street as a physical and social fact

Chapter 04 introduces inquiry methods pertinent to urban street livability, divided into two key sections. Subchapter 04.1 explores the complexity and livability of cities. Subchapter 04.2 introduces urban morphology as an instrument whose methods decode various urban elements, including streets. Subchapter 04.3 presents methods of studying public life, allowing for a deeper understanding of the various factors influencing pedestrian behavior and contributing to public life dynamics.

04.1. Exploring the complexity and livability of cities

Cities are the core venues of boundless opportunity and unprecedented challenges, hubs for exchanging knowledge, culture, and science. A city can be perceived as a physical product and a social process, described from two fundamental, classic, yet intrinsic aspects: Urbs and Civitas (D'Acci, 2019). These fundamental concepts allow for understanding various other meanings associated with urbanism.

The term *"Urbs"* comes from the Latin phrase Urbs - Urbis, meaning "city" in its physical form. Primarily, this reference referred to Rome but later extended to all cities and urban legal regulations under Roman Law within Western culture. Understood in this sense, the city is defined as a physical reality, from its landscape and architecture to its infrastructure. Therefore, Urbs represented the physically constituted city that hosted the Civitas (D'Acci, 2019; Leite and Proença, 2020). In contrast, the term *"Civitas,"* in the Latin etymological sense, denotes the society inhabiting the city. Through this concept, the city is understood as a social and cultural construct, emphasizing its citizens' behaviors and the relationships among individuals and societies (D'Acci, 2019).

A fundamental fact in the origin and development of cities' public spaces was the advent of commerce, which began when cities began to produce surpluses. With the growing need for constant merchandise exchanges, the streets and spaces between buildings were utilized, giving new functions to public spaces and generating areas for circulation, commerce, leisure, and socialization. The creation of public spaces has been part of urban history since its inception. The Agora, the Greek theater, the forum, and the great urban spaces of the Roman Empire offer clear examples of societies' intention to create venues for expressing shared ideas, knowledge, and urbanity (Carr *et al.*, 1992; Morris, 1994).

Therefore, as a nexus of political, social, and economic relations and the exercise of citizen rights and public freedoms, the city embodies a complex system. Complexity emerges from the interactions within a large system's subcomponents (Goldstein, 1999; Batty, 2007). The city represents an example of an extensive, complex system composed of various interconnected elements (de Roo and Rauws, 2012). These elements undergo constant changes, forming public life. Numerous authors have discussed urban forms in terms of their complexity in addressing urban issues, such as structure, connectedness, accessibility, and livability (Plater-Zyberk *et al.*, 2003; Talen, 2003; Portugali, 2006).

The complexity of traditional cities was affected in the 20th century by Le Corbusier and his modernist contemporaries, who sought to transform the physical complexity of cities to set the stage for automobile-oriented cities (Hall, 2014). The modernist top-down approach promoted single-use functional zoning, which affected vital social processes, unlike Jacobs's complex systems that advocated for the bottom-up approach, a view subsequent scholars endorsing the complex systems from the physical aspect have embraced (Batty, 2007; O'Sullivan and Manson, 2015; Batty and Marshall, 2017).

The complexity of cities lies in their complexity of formation, as argued by Jacobs (1961) and Alexander (1964, 1965). This complexity, in its various formations, has been perceived as a significant factor in contributing to livable, healthy, and walkable urban designs (Jacobs, 1961; Putnam, 2000; Macdonald, 2002; Carlson *et al.*, 2012; Marshall, Garrick and Marshall, 2015). Numerous authors have described good city form from various perspectives, referring to spatial quality as an indicator of urban excellence. Jacobs (1961) emphasized density, diversity, and mixed-use as prime indicators of cities' quality. Conversely, Lynch (1981) stressed vitality, sensibility, fit, accessibility, and control, whereas Bently *et al.* (1985) focused on permeability, variety, legibility, robustness, visual appropriateness, and richness.

Complexity in urban design primarily interacts with various notions that include livability. As previously mentioned (see Chapter 03), livability has been discussed from various fields and perspectives. Within the realm of urban design, livability refers to better living conditions at various scales, ranging from the city scale to the street and the eye level (Jacobs, 1961; Appleyard, 1981; Jacobs and Appleyard, 1987; Bosselmann, Macdonald and Kronemeyer, 1999; Glaser et al., 2012). The concept has expanded to include other concepts, such as sustainability, comfort, walkability, and safety, which depend on a city's ability to meet its residents' needs.

In this regard, streets are places of great potential, both economically and socially, where social interaction and exchange can be organized. They are essential to connecting a city's different layers. Streets are crucial to a city's image, organizing routes and connecting other environmental elements (Lynch, 1960). The street, as a linear urban space, enables movement for people and vehicles and provides access to adjacent buildings and lots. The street shapes social spaces (public and collective), presenting unlimited opportunities and possibilities. It is organized in multi-dimensional spaces and assumes a variety of different forms (Jacobs, 1995). Consequently, cities' complexity indicates their components' complexity in all their diverse facets, including streets and livability.

Although there are sparse studies related to livability at the arterial street level, the current research considers the arterial street as a physical platform for social interaction and a symbol-laden representation of society. The arterial street is also conceived as a linear urban hub, a key factor of social integration, and a meeting point for common ideas and interests. As the structural backbone of an urban area, the arterial street represents a crucial component in its formation. This type of street, due to its linear structure, presents high dynamics that mirror the new dynamics of social life. It also permits essential movement within urban settings, thereby enhancing public life, stimulating economic growth, and expanding urbanity.

Aiming for arterial street livability raises the proposition that this concept is complex and is directly influenced by the street's physical attributes (Jacobs, 1995; Ewing and Handy, 2009; Mehta, 2013), social attributes (Gehl, 1987; Lofland, 1998; Hall, 2014), functional attributes (Montgomery, 1998; Ho and Douglass, 2008; Glaser *et al.*, 2012), and traffic attributes (Appleyard, 1981; Bosselmann, Macdonald and Kronemeyer, 1999). These attributes, together with other street and public space studies concerned with the concept of street livability, indicate morphological interpretations and public life studies as a methodological approach to decoding street livability's complexity.

04.2. Urban morphology

The built environment, including streets, is integrally linked with numerous aspects, including morphological and social dimensions. The urban morphological dimension encompasses the layout and configuration of urban form and space, both in shape and evolution, which aim to unfold the complexity of the built environment (Kropf, 2017). Originating from the Greek *"morphos,"* meaning form, morphology refers to the study of an object's configuration and external structure. Morphology studies an object based on its external physical characteristics and evolution over time (Schmid, 2015).

German writer and polymath Johann Wolfgang von Goethe (1749-1832) first used the term. Since then, morphology has been used in other fields, such as geology and geography to describe natural landscapes' forms (Bullock, Stallybrass and Trombley, 1988). In linguistics, morphology relates to the elements and structure of language. Therefore, in each respective field, morphology is the study of the form or structure of an object. Accordingly, in the context of urban morphology, morphology allows for the examination of the city's form and evolution (Marshall and Çalişkan, 2011).

Urban morphology can be traced back to the German geographers' interests in urban layout forms between the nineteenth and twentieth centuries, as they sought to decipher the relationship between people and the city (D'Acci, 2019). The study focus then transitioned from landforms and vegetation cover to the layout of urban areas, the streets and open spaces, and building fabric, as illustrated in the works of Otto Schlüter (1899), Hugo Hassinger (1910), and Walter Geisler (1918) (Hofmeister, 2004). However, European geography in the 1960s witnessed a significant impetus following M.R.G. Conzen's contributions in the British school (Conzen, 1960). Concurrently, in Italy, Muratori and his student Caniggia developed the idea of "studies for an operative history of cities" (Malfroy, 1998). By the late 1960s, the French school emerged under the leadership of Philippe Panerai, Jean Castex, and Jean-Charles DePaule (Moudon, 1997).

Urban morphology is the science of urban form and structure (Cowan, 2005). It serves as an instrument, the methods of which allow for the decoding of urban elements (Lozano, 1990). Urban morphology involves studying and decoding urban changes over time, including spatial organizations, components, configurations, relations, structure, and shape (Marshall and Çalişkan, 2011). As Moudon (1997) suggests, the definition of "urban morphology" is the study of the city, understood as the most complex of human inventions. Moundon argued that the city can be read and analyzed through its physical form, including buildings, plots, and streets, comprising four levels of analysis: "buildings/lots, the street/block, the city, and the region," understanding it as a historical composition in constant evolution.

Concerning street morphology, Conzen (1960) argued that the street plan tends to be the most enduring and common element of a city's public space. The longevity of street forms derives from their capital assets, which are not easily abandoned and provide the foundation for other components. Street plan changes could occur due to comprehensive redevelopment, war destruction, or a natural disaster. Therefore, the street system is key to understanding and navigating a city. The street is an integral element that can determine street blocks and distinguish the city's public, private, and semi-public spaces. It comprises the public and democratic elements of the city (Oliveira, 2016).

Numerous researchers have focused their studies on the morphological dimensions of streets and the resultant effects on the quality of the space. This concept has led to the question: What makes a good street? Allan Jacobs has studied many famous urban streets to answer this question. In his book, Great Streets, Jacobs analyzed and studied in detail the qualities that make great streets. He utilized plans, sections, and perspectives of different streets drawn at the same scale for comparative purposes. His study included the examination of street morphology, buildings, engaging facades, vegetation, and windows that interact with users. Additionally, Jacobs considered intersections, beginnings and endings, stopping places, and walking spaces (Jacobs, 1995).

04.2.1. Schools of urban morphology

There have been numerous studies and approaches to urban morphology. However, according to Moudon (1997), three main schools can be identified: the historical-geographical approach, represented by the work of MRG Conzen; the typological process approach, structured by Saverio Muratori, and later G. Caniggia; and the French school.

The Italian school of urban morphology is characterized by its understanding of the city as an "architectural organism." This perspective was influenced by Gustavo Giovannoni (1873-1947), who introduced the notion of the city as an organism composed of several interconnected parts continuously interacting with the environment and undergoing constant transformation (Menghini, 2002). During the 1950s, the Italian architect Saverio Muratori laid the foundations of the Italian school by creating building typologies as the essence of the urban fabric (Moudon, 1994). In his 1959 study, "Studi per una operante storia urban di Venezia," Muratori comprehensively analyzed Venice over various periods, using time as an interpretive tool to understand the evolutionary processes of the urban fabric (Cataldi, Maffei and Vaccaro, 2002).

Muratori's fundamental concepts: type, tissue, organism, and operational history, were later developed by Gianfranco Caniggia (1933-1987), Muratori's assistant at the University of Rome. Caniggia contributed significantly to expanding Muratori's ideas, proving the applicability of his concepts in professional practice. Caniggia's contributions were fundamental in developing the typological method of interpretation and design, based on the conviction that the only way to analyze and plan cities is to interpret them historically (Menghini, 2002).

For Muratori and Caniggia, the city is a living organism created by humans in continuous evolution that can only be fully understood through history. Conversely, the notion of "type" is understood as a theoretical and abstract extrapolation. Other researchers have continued studies based on Muratori and Caniggia's theories, underscoring the historical dimension as essential in analysis and design and arguing that the "type" is intrinsically related to the context (Oliveira, 2013).

In contrast, the British school of thought is associated with M.R.G. Conzen, as stated by Moudon (1997). The German geographer M. R. G. Conzen, who emigrated to Britain in 1933, introduced a perspective on the urban landscape by studying English towns in a certain historical context. Conzen created a conceptual framework for studying the urban landscape, constituting the historical-geographical approach. His study on Alnwick in northern England analyzed the city's map, building form, function, streets, and their association with the network system (Whitehand, 2001; Sadeghi and Li, 2019). Therefore, the town plan comprises three fundamental morphological elements: streets, plots, and buildings (Çaliskan, 2013).

The fundamental characteristics of the British school of urban morphology are the morphogenetic method, the conceptualization of the historical development process, precise terminology, and cartographic representation. Additionally, Conzen established two concepts regarding the urban development process: (1) the "Fringe-Belt," a belt-like zone located at the edge of a city's built-up area, and (2) the "Burgage Cycle," which concerns the life cycle of a plot (Larkham, 1998).

Finally, in the late 1960s, the French school of thought emerged, echoing the Italian school's response to modernist models and principles (Moudon, 1997). The French school views the city as a living object that always considers the past to build its future. Based on the works of architects such as Philippe Panerai and Jean Caste, in collaboration with Charles Depaule, among others, issues such as the evolution of the urban fabric and the relations between the built elements and public space were addressed in the late 1960s and early 1970s. In this regard, the French school can be seen as a continuation of the Italian school (Sadeghi and Li, 2019).

Despite the three schools of urban morphology sharing the principles of time, form, and resolution, some differences can also be identified. The British school is based on a more descriptive and explanatory approach, primarily focusing on how and why cities are created. In contrast, the Italian school presents a more prescriptive set of studies on urban forms. Finally, the French school focuses on evaluating previous design theories for city construction (Moudon, 1997).

04.3. Public life

There is a reciprocal relationship between people and their surrounding built environment (Karakas and Yildiz, 2020). People typically act based on their interpretation of cues from the built environment—the complex system of a city is based on relationships and interactions between its elements (Rapoport, 1977). This reciprocal relationship between people and their interactions with cities is part of what constitutes livability, as the built environment can encourage social activities and create certain behaviors, particularly in public spaces, including streets (Gehl, 1987). These spaces are closely linked with their users, who spend most of their daily lives interacting with urban environments (Dzebic, Perdue and Ellard, 2013).

The configuration of built environments, including streets, can affect individuals in different ways, including their mental health (Evans, 2003), daily experiences (Goss, 1993), and activities (Gehl, 1987). Accordingly, this research considers arterial streets as linear centers comprising a series of relationships and interactions between the street's physical components and people. The prevailing view is that a livable arterial street satisfies human needs and encourages pedestrian activities. The street's physical form is critical for enhancing public life, as pedestrians' perceptions, activities, and flow are influenced by the street's form. Thus, a deeper understanding of public life in relation to street morphology can lead to a better understanding livability.

Public life studies focus on people's activities and behaviors in public spaces, such as streets, alleys, public buildings, and squares (Mehta, 2013). Public life unfolds in relatively open social contexts, in contrast to private or individual life; therefore, public life incorporates two dimensions: a physical one (space) and a social one (activity) (Gehl and Svarre, 2013). In this context, the dynamics of public life result from the interactions between individuals and their surroundings (Carr *et al.*, 1992).

Numerous studies have explored how the relationship between the physical layout of a city can influence public life (Lynch, 1960; Rapoport, 1977; Whyte, 1980; Mehta, 2008; Horayangkura, 2012; Gehl and Svarre, 2013). These studies, among others, have contributed to a better understanding of how to study public life and its relationship to surrounding public spaces, employing different research techniques and interdisciplinary collaborations.

Although public life in the city is very diverse and challenging to define and predict (Franck and Stevens, 2006; Gehl and Svarre, 2013), considerable empirical works studying public life have developed observational methods (Jacobs, 1961; Alexander, Ishikawa and Silverstein, 1977; Whyte, 1980; Appleyard, 1981; Gehl, 1987). Additionally, several studies have tested and applied behavior-mapping methods (Barker, 1968; Ng, 2016).

The focus on public life in the planning field began more broadly with Camillo Sitte's 1989 work, "The Art of Building Cities: City Building According to Its Artistic Fundamentals" (Gehl and Svarre, 2013). Sitte, a Viennese architect, argued against a dull, monotonous, and mechanical city. He defended the expansion of historicism from buildings to public spaces to redeem humanity from modern technology and utility. Sitte argued that streets and squares should fit the people. Thus, the perspective on cities took a further step from an abstract approach to a more three-dimensional, people-oriented view of urban space.

04.3.1. Pedestrians' movements and activities

Jan Gehl further expanded the view of the social dimensions of cities in his 1971 book "Life Between Buildings: Using Public Space." By observing and documenting human behavior, Gehl explored public space and how it can be designed and used to improve the quality of city life. He argued for the importance of designing urban public spaces to meet people's needs and dimensions, classifying human activity into necessary, optional, and social activities (Gehl, 1987).

Necessary activities according to Gehl (1987), represent carrying out an activity in a somewhat compulsive way, such as going to school, going to work, or waiting for public transport. In contrast, optional activities encompass a wide range of activities dependent on the type of public space. These activities only occur when the place offers suitable conditions for them. Therefore, optional activities include activities that people perform by using public space in their own unique way, seeking interactions with others or the surrounding space, such as strolling, standing around, sunbathing, and so on. Finally, social activities require other people, which suggests opportunities for meetings and social interactions.

Furthermore, one of the most influential empirical contributions to studying public life was William Whyte's work, "The Street Life Project (1980)." White started by observing urban public spaces to study human behavior. He stated that activities such as eating, observing, reading, and sitting occur because the physical characteristics of a space support these optional activities (Whyte, 1980).

Whyte's works have underscored the necessity of observational studies and investigations into people's social activities in small-scale public spaces. Whyte described the substance of public life in several measurable ways, introducing a new approach to urban research, characterized by time-lapse photography, film, observation, activity mapping, pedestrian path analysis, and personal interviews. This method became a popular way to study the relationship between people and public spaces.

Concerning street social life, Donald Appleyard's 1981 book "Livable Streets" employed various methods to study the relationship between street design and people's social interactions and activities. Appleyard conducted on-site observations of three different streets to identify patterns in how people used the space. He also interviewed residents and gathered data on various neighborhood aspects, such as traffic volume, land use, and population density (Appleyard, 1981).

Later, the study of livable streets was further detailed and complicated with the work of Bosselmann, Macdonald and Kronemeyer (1999) in "Livable Streets Revisited," compared to the Appleyard study. Bosselman et al.'s study selected different types of streets, including major boulevards, that had not been previously examined.

Several studies have explored pedestrians' movements for different purposes using various methods, including direct observation, photographs, time-lapse films, and direct simulation (Pauls, 1984; Whyte, 1988; Helbing *et al.*, 2001; Karakas and Yildiz, 2020). However, pedestrian movement can vary according to individual purposes and preferences for using a street, underscoring the significant role the street's composition plays.

Furthermore, Hillier *et al.* (1993) introduced the concept of "configurational attractiveness," referring to how a city's spatial layout can influence pedestrian movement. He argued that the most attractive areas of a city are linked to its configuration, a fundamental element that attracts pedestrian movement. However, he does not deny the role of land use on movement, acknowledging that attractors such as shops and restaurants also have a multiplier effect on attracting movement.

Hillier identifies two types of street layouts based on how people perceive them: a system of routes or a system of destinations, which differ based on the purpose of the street and its composition (Hillier *et al.*, 1993). For example, a street can be a destination when pedestrians use it for walking, socializing, or other activities that occur on the street. Conversely, a street can serve as a route to a destination when pedestrians use it as a passage.

04.3.1.1. Systematic observation: methods and tools

Pedestrians' movements and activities have been investigated in different empirical studies using various approaches and tools (Lynch, 1960; Cullen, 1961; Whyte, 1980; Appleyard, 1981; Gehl, 1987, 2010; Gehl and Svarre, 2013; Mehta, 2013). However, direct observation has been primarily used for collecting data about the interactions between pedestrians and their surrounding public space. In this research, Jan Gehl's methodology is selected as a key work related to this thesis.

Gehl has developed a comprehensive method and approach for evaluating cities and public spaces from the users' perspectives. His focus has centered on people and their activities, posing questions about how public spaces are occupied. Gehl's method applies continuous and systematic observation to examine existing issues and implement improvements.

In his book "How to Study Public Life" (2013), Gehl brings a more methodological focus to public life studies by introducing a comprehensive overview and providing a guide for studying and understanding how people interact with public spaces. His premise is that the design of cities and public spaces significantly impacts public life. Gehl's approach to creating lively and sociable public places emphasizes people's needs and activities in their surrounding public spaces as critical for creating livable and vibrant communities (Gehl and Svarre, 2013).

He presents a methodology for studying and understanding people's behavior and interactions with public spaces. Gehl's method includes observation, interviews, surveys, counting, mapping, tracing, photographing, and analyzing existing data sources. This approach became a vital tool for researchers seeking to answer questions about public life (Gehl and Svarre, 2013).

Consequently, Gehl's strategy addresses questions related to public life. The first question is, "How many?" which pertains to the number of people moving (pedestrian flow) and how many stay in one place (stationary activity). In this context, counting is a method to collect quantitative data. The second question is, "How long?" As time is a necessary factor in public life studies, the question is concerned with how long people stay in a specific place and how long the activity lasts. The third question is, "Who?" which is related to who uses the place, especially the proportion of women, children, and groups of two or more people. The fourth question is, "Where?" which pertains to where people move and stay in the public space. Finally, "what kinds of activities are there?" Activities can be necessary, optional, or social, including sitting, eating, or walking (Gehl and Svarre, 2013).

Gehl's methodology, recognized for its applicability in real-world scenarios, has been used in many empirical studies. These studies have sought to gain an understanding of the quality of urban environments and public spaces (Cerrone *et al.*, 2021; Silvennoinen *et al.*, 2022). Considering street physical and social studies, Mehta (2013), in his book "The Street- A quintessential social public space," argues that streets play a crucial role in shaping a city's character and quality of life. He further contends that the design and use of streets are essentials elements that influences street social life. Mehta has studied pedestrian behavior and activities using behavioral mapping techniques, including pedestrian counts, walk-by observations, and direct observations.

04.3.2. Pedestrians' visual perception

> *"Great streets require physical characteristics that help the eyes do what they want to do, must do: move. Every great street has this quality."*
> (Jacobs, 1995, p. 282)

The city's physical structure represents a complex set of urban elements (Batty, 2007), each with a unique morphological character determined by several factors. Understanding these elements and how individuals perceive or interpret their physical features is essential in shaping a livable built environment. This importance stems from the fact that individuals both influence and are influenced by their surrounding built environment. Perception refers to the various senses that allow individuals to experience their world: the link between people and their environment (Rapoport, 1977).

The visual perception process of the surrounding built environment involves understanding and responding to external attractions that influence behavior (Rapoport, 1977). This visual perception of an environment is a crucial to understanding public life because it results from the interaction between individuals and the city. The interaction is predominantly achieved by visual perception, whereby perception forms the basis of each attitude toward the city (Perovic and Folic, 2012).

In his seminal work, "The image of the city (1960)," Kevin Lynch was one of the pioneers in studying the impact of space on people. Lynch created mental maps to examine how individuals orient themselves and interact within a space. According to Lynch (1960, p.1), "Nothing is experienced by itself, but always in relation to its surroundings, the series of events leading up to it, the memory of past experiences." Although Lynch's work focused on physical elements, he invented a social usage approach that treats cities as social spaces instead of the three-dimensional approach. Because of people's dependence on their surroundings for orientation, he emphasized that these elements must be comprehensible to those using the space.

Lynch presented five image elements to organize cities: paths, edges, nodes, districts, and landmarks. His work offered in-depth design knowledge and an understanding of the urban form, consisting of physical and psychological elements represented symbolically on maps. The physical elements in Lynch's theory refer to the perceptual form of the city in its interaction with its perceivers. He emphasized the importance of the city's image by considering its visual quality, focusing on four elements: legibility, image, identity, and imageability (Lynch, 1960).

In contrast to Lynch's imageability concept, which primarily concentrates on urban elements that pedestrians perceive, Cullen (1961) studied their characteristics, scales, and complexity. Cullen introduced "Serial Visions" that analyze a sequence of images from the pedestrians' eye-level perspective, using sketches and photographs to describe urban design's aesthetics.

Lynch and Cullen's approaches aim to understand the urban experience and the experiential qualities of urban environments by using symbols and urban elements. Their theories suggest that people perceive an urban environment from different perspectives, primarily based on their experience or knowledge of urban space. This perspective underscores a significant point: environments built differently provide different dialogues that influence individual behavior. These dialogues are perceived as non-verbal communications between the individual and the city's physical elements. Therefore, people's behavior is based on their interpretation of the environment, thus, the importance of understanding visual perception in the study of public life.

Furthermore, Donald Appleyard and his colleagues' (1964) work, "The View from the Road," focuses on the visual requirements for the potential esthetics of urban highways. Their research addressed American cities' visual formlessness, arguing that highways could enhance the American urban landscape's visual perception. Their experimentation investigated the problem of designing visual sequences from the perspectives of both the driver and passengers. Inspired by Kevin Lynch's spatial cognition work, the study used sequences of annotations, sketches, tape recordings, films, and photographs to analyze participant reactions (Appleyard, Lynch and Myer, 1964).

The empirical works of Lynch (1960), Cullen (1961), and Appleyard *et al.* (1964) emphasized the important role of studying human visual perception from the users' perspectives to evaluate the environment. These ground-breaking works of environmental cognition drew upon the foundations of studying users' visual perception and experience in urban settings. Over time, many researchers and studies have been influenced by these works, including Bacon (1976), Banerjee and Loukaitou-sideris (2011), and Perovic and Folic (2012).

04.3.2.1. **Eye-tracking system**

Eye-tracking studies, which began in the late 1800s, have a long history of contributing to understanding the relations between the brain and the visual system (Duchowski, 2017). Initially, the studies were expensive and complicated due to the constraints of available tools and techniques. Advances in systems utilizing eye movement recordings led to improvements in eye-tracking studies. However, the primitive nature of early eye-tracking made it impossible to examine the real world. The evolution of these systems in the 1960s and 1970s offered possibilities for further uses and analyses. In the late 1990s, a new generation of eye-trackers paved the way for modern systems, creating new opportunities beyond the academic arena and into commercial use (Bergstrom and Schall, 2014). However, it is essential to note that most eye-tracking experiments have been conducted in controlled laboratory settings, sometimes leading to inconsistent results (Fotios *et al.,* 2015).

Eye-tracking methodology offers opportunities to perform eye-related studies (Holmqvist *et al.,* 2011). It is a tool that measures gaze patterns, including fixations and saccade points, and the duration a person focuses on a defined point. Additionally, eye tracking defines eye movements, pupil dilation, and blink frequency (Zurawicki, 2010). Fixations and saccades are considered the main matrix to measure eye movements that draw out gaze patterns. Fixations comprise the periods when the eye remains focused on a specific visual field area, facilitating visual processing and memory encoding. Saccades are the eye's rapid movements, which assist in gaining a sense of what is being looked at (Matin, 1974; van Renswoude *et al.,* 2018). Eye trackers provide a highly accurate representation and understanding of three attributes of an individual's eye-movement behavior: location, duration, and movement (Duchowski, 2017).

Eye tracking offers various methods to monitor the eye's position, facilitating an understanding of where an individual is looking, enabling studies of cognitive processes and evaluation of the user experience (UX). It is a critical methodology for every domain involving human interaction, including those that users cannot describe, such as visual perception (Bergstrom and Schall, 2014). Eye tracking has become an established research tool that empowers researchers to study human cognition and behavior quantitatively (Rahal and Fiedler, 2019), aspects missing in Cullen's and Appleyard's sketches and film recordings. One of the main advantages of eye tracking is its applicability across a broad range of research areas. Many psychological disciplines, medical fields, and marketing studies have employed eye-tracking as an experimental tool (Santos *et al.,* 2015; Duchowski, 2017; Harezlak and Kasprowski, 2017; Krstić *et al.*, 2018; Kaakinen, 2020).

Technological innovations in data science have increasingly enabled the measurement of human experience in architectural spaces using different tools

(Ergan *et al.*, 2018). These tools have substantially contributed to understanding the influence of architecture and urbanism on many aspects, including social, mental, and physical health (Dzebic, Perdue and Ellard, 2013; Rahal and Fiedler, 2019). Technological innovations in data science have made it increasingly possible to measure the visual perception of space and the function of architecture within it (Lisińska-Kuśnierz and Krupa, 2020). Additionally, eye-tracking systems have been applied to measure the impact of architectural design features on users' experiences in laboratory-based investigations (Zou, 2018; Rusnak and Rabiega, 2021).

In the field of urbanism, recent studies have used eye tracking as a research method, conducting investigations in laboratory settings and outdoor environments (Andreani and Sayegh, 2017; Noland *et al.*, 2017; Uttley, Simpson and Qasem, 2018; Hollander *et al.,* 2019; Simpson, Thwaites and Freeth, 2019; Vainio *et al.,* 2019). For instance, Noland *et al.* (2017) applied eye tracking in lab-based investigations to understand user preferences for sample images that represented different urban environments' components, such as cars, parking buildings, people, nature, and essential street elements. The study assessed areas of interest (AOIs) into positive and negative categories based on the participants' preferred visual elements.

Similarly, Andreani and Sayegh (2017) combined objective quantification and perception of the built environment concerning different urban qualities to analyze user experience. Their research investigated four design research experiments, which included an eye-tracking system, to gain a more human-centered approach to reading users' attention during walking. More recently, several studies have been conducted to evaluate structures, spaces, and external stimuli in architecture and urbanism through the lens of visual perception (Vainio *et al.*, 2019).

The emerging hybrid field of neuroscience and urbanism provides novel insights into studying inhabitants' visual experiences and perceptions of streets and street edges. For example, Simpson *et al.* (2019) provided empirical insights into pedestrians' visual engagement with different street AOIs using a mobile eye-tracking system. Their study demonstrated that street edges attracted more visual attention than other components across the streets (AOIs), including the ground, people, the sky, adjacent realms, and objects. This heightened attraction to street edges was attributed to several factors, including everyday activities, variable functions, and facilities. Another investigation followed the study to measure visual engagement with street edges in pedestrianized and non-pedestrianized streets by utilizing mobile eye tracking. The study found that pedestrians visually engaged more with the ground-floor street edge than the upper floor (Simpson, Thwaites and Freeth, 2019).

Further, Spanjar and Suurenbroek (2020) added another layer to this explorative research by focusing on the design of streetscapes within high-rise environments, relying on eye-tracking systems to assess people's visual experiences. Thirty-one participants partook in a laboratory-based investigation that considered three design principles related to the human scale: rhythms and variety, an active ground floor, and tactile materials of the street edge and street space. The researchers then examined the effects of these principles on design solutions at eye level.

Previous studies have discussed the use of eye tracking as a research tool and its suitability in urban design and architecture. They also integrated various tools from other research fields, in both laboratory-based investigations and outdoor experiments. These methods have not only provided alternative design research methods but also facilitated new opportunities to make valuable contributions to architecture and urban design. However, to the author's knowledge, morphological studies using eye tracking are relatively new.

"Linkage is simply the glue of the city. It is the act by which we unite all the layers of activity and resulting physical form in the city. . . . Urban design is concerned with the question of making comprehensible links between discrete things. As a corollary, it is concerned with making an extremely large entity comprehensible by articulating its parts."

Maki, 1964

05. The multiscale approach

The concept of street livability involves subjective and objective attributes at varying degrees. Most previous studies concerning streets and public spaces have used different methods with different resolutions (see Chapter 04). The breadth of scales employed range from the microscale to encompass the city and metropolitan levels. Therefore, the importance of these scales in decoding the livability of streets warrants emphasis. Appleyard (1981) underscored the role of examining the street at various levels, classifying it as a multi-scalar issue. Concurrently, Hillier *et al.* (1993) asserted the configurational relations of urban space to the broader urban system.

Additionally, Moudon (1997) has noted a consensus among researchers from different fields that three principles underpin the reading and analysis of urban morphology: form, resolution, and time. Form is defined by three elements: buildings, plots, and streets. The resolution levels correspond to the building/lot, the street/block, the city, and the region. Finally, time refers to the urban form's historical reading as the elements continually transform.

Furthermore, the term "complexity" in urbanism refers to the bottom-up approach rather than the top-down system. Batty (2007) argued that complexity refers to the impossibility of a regulative approach. Moreover, Jacobs also proposed that the city, as a complex system, should be organized based on a small number of local variables, referring to the small urban elements that shape the urban fabric. For Jacobs, the bottom-up approach contributes in creating cities that are more diverse and vibrant, and livable, capable of better adapting to changing circumstances and meeting residents' needs over time (Jacobs, 1961).

Considering arterial street livability, it becomes essential to understand the street as an integral part of a larger context. Recognizing the morphology of the arterial street as the backbone of an urban area (Jacobs et *al.*, 1996) contributes to unearthing its spatial properties that affect public life and enhance livability. Despite the scarcity of studies examining livability at the arterial street within the literature, evaluating the morphological characteristics of arterial streets at various scales of resolution could play a crucial role in addressing their complexity.

These scales are understood as components of a whole system, where each level reveals distinct properties that influence street livability. Accordingly, chapter 05 introduces three key sections, each introducing a distinct spatial scale, commencing from the smallest street unit and culminating at the urban structure. Subchapter 05.1 introduces the microscale (the street interface); Subchapter 05.2 explores the mesoscale (the street partition); and Subchapter 05.3 examines the macroscale (the urban structure).

05.1. The microscale (the street interface)

The livability of arterial streets is associated with their interfaces, a defining characteristic of street livability. Gehl (1987) highlighted that a living city is one where the buildings' interior spaces are complemented by the external environment, which depends on the boundary between public and private spaces. The street interface and its collective spaces represent a city's pores through which the urban fabric breathes. Jacobs (1995) defined great streets as those having boundaries that keep one's eyes engaged on the streets and raise them into more pleasant and healthy places.

Gehl, Kaefer and Reigstad (2005) described the historical relationship between streets and buildings, wherein towns emerged from the exchange between travelers traversing pathways and vendors stationed in their wayside booths. However, the exchange zone between pathways and wayside booths has remained crucial in shaping the urban form. In this context, buildings' ground floors along the street are crucial, as they offer dynamism, memories, and cultural values when architecture is set as the street interface. The street interface can denote social and leisure places and environments that reflect a society's contradictions, expressions, and lifestyles (Franck and Stevens, 2006).

The term "street interface" refers to the spaces between urban and architectural dimensions on buildings' ground floors, forming collective spaces. As a public space, the street comprises a horizontal plane delimited by two vertical planes acting as edges or boundaries, which can include interfaces as part of the building façade on the ground floor. At eye level, street interfaces play a significant role in shaping the pedestrian experience, as argued by Glaser *et al.* (2012, p.12), who stated that "the ground floor maybe only 10% of a building, but it determines 90% of the building's contribution to the experience of the environment." However, it is also common to observe urban boundaries defined solely through physical barriers or edges, which contribute to the city as part of its urban experience by raising various potentials.

The street interface can be defined based on several factors, including its urban context, use, and configuration. Many authors have discussed the notion of the street interface (Jacobs, 1961; Alexander, Ishikawa and Silverstein, 1977; Bently *et al.*, 1985; Hillier and Hanson, 1989; Anderson, 1991; Gehl, Kaefer and Reigstad, 2005; Dovey and Wood, 2015). Authors have variously defined the space between private and public spaces as a public/private boundary, an edge, a betwixt, a threshold, a soft edge, a liminal space, or an interface. In this thesis, the research explores the composition of the street interface, defined as a physical and social entity experiencing a state of betweenness relative to other dominant spaces (the street and the buildings), which may either create or preclude potential social and visual interactions.

Jacobs' observation regarding "eyes on the street" underscores the street interface's value as a physical entity that enhances the interaction between the building and the street users (Jacobs, 1961). This transitional space's essential role has traditionally been critical in shaping better urban spaces and active public life. The street interface represents one of the street's significant purposes: enabling communication between users and their surroundings. The great value of street interfaces appeared early on in the accompanying literature of different graphic representations, such as Giambattista Nolli's New Plan of Rome (Nuova Pianta di Roma, 1748) (see Figure 5.1 -1), which depicted the city's public space (Madanipour, 2003).

Alexander's renowned work, "A Pattern Language (1977)," emphasized the crucial part of the public space's edge in shaping more attractive public spaces. "The life of the public square forms naturally around its edge, if the edge fails, then the space never become lively" (Alexander, Ishikawa and Silverstein, 1977, p. 600). More specifically, public life thrives at the interfaces between urban public spaces and their surrounding buildings. The study of street interface prompts the question of urban porosity, which composes an integrated dialogue in the urban context, as introduced by Benjamin and Lacis in their 1924 portrayal of Naples' tenements (Wolfrum, 2018; Smith, 2021; Stevens, 2022).

The street interface examination emerges with classifications and assorted terminologies in several empirical studies, such as "Life Between Buildings" (Gehl, 1987). Additionally, Hillier and Hanson's work, "The social logic of space (1989)," emphasized the role of insides and outsides in shaping the relationship between the two realms (Hillier and Hanson, 1989). The relationship between public and private interfaces has long been considered as a significant dimension comprising a livable urban public space. This relationship is a crucial commercial and social exchange element, reflected in active edges (Bently *et al.*, 1985). These active edges play a vital role in representing society's social, cultural, economic, and individual values and experiences.

Figure 5.1-1 Map of Rome, Nolli (1756). (Source: La nuova topografia di Roma Comasco by Giambattista Nolli, ca. 1692-1756. UC Berkeley Library: https://www.lib.berkeley.edu/EART/maps/nolli.html).

05.1.1. The configurations of the street interface

Gehl classified the street interface from the pedestrian's perspective, varying from soft to hard edges to address blank limits. Soft edges represent social, permeable, and active ground floors, while hard edges are deemed antisocial and impermeable (Gehl, 1987, 2010). Gehl, Kaefer, and Reigstad (2005) further incorporated indicators including scale and rhythm, transparency, multi-sensory appeal, texture and details, diversity, and vertical façade rhythms.

Further, Bobić (2004) introduced a novel interface classification based on the vast phenomenon of urbanity. He proposed a topological classification grounded on the interrelation between private and public spaces— the primary variable from the public realm's standpoint—where urbanity occurs. Bobic's classification includes the interface's spatial, visual, and psychological variables and extends beyond the interface to analyze the in-between spaces. The classification includes transparency, setback, and behavior as design-quality principles (Figure 5.1 -2).

Subsequently, Dovey and Wood (2015) developed more comprehensive, detailed typologies of the street interface, representing typical forms of connectivity between private and public spaces (Figure 5.1 -3). The study introduced four primary variables for characterizing the street interface: (1) accessible/inaccessible, referring to the degree of accessibility between public/private domains; (2) direct/setback, referring to the entry type of the private space, which creates an interstitial space between the two realms; (3) opaque/transparent, relates to the visual communication from public spaces into private spaces, where the visual connection is significant in commercial and social exchange; (4) car/pedestrian, which indicates the access mode, either by car or on foot. In this context, the street interface acts as a connector between two domains, both visually and physically. It connects people to places and each other, consumers to products, streets to buildings, and public spaces to private spaces.

Similarly, Kamalipour (2016) suggested a comparable typological framework based on accessibility and proximity as the two primary variables. This proposal draws interrelationships between two variables to create six typological interfaces: (1) adjacent/impermeable, (2) adjacent/accessible, (3) adjacent/porous, (4) distant/impermeable, (5) distant/accessible, and (6) distant/porous. The study provides an understanding of the potential configurations of different interfaces based on accessibility and proximity (Figure 5.1 -4).

Examining interface typologies provides an understanding of the most common variables: permeability, proximity, access mode, and interface geometry. Accordingly, these spatial variables can present various interface configurations that may affect users' perceptions of a place. They also convey a specific message to street users, which can enhance or impede physical and visual communication between the public and private realms, offering either an invitation for social interaction or closure and isolation. Therefore, defining the configurations of the street interface in relation to pedestrians' visual perceptions can offer insights into the processes that contribute to a positive or negative pedestrian experience and, in turn, the street's livability. Nevertheless, there is sparse empirical research that details a morphological code or method to categorize street interfaces concerning public life and visual perception.

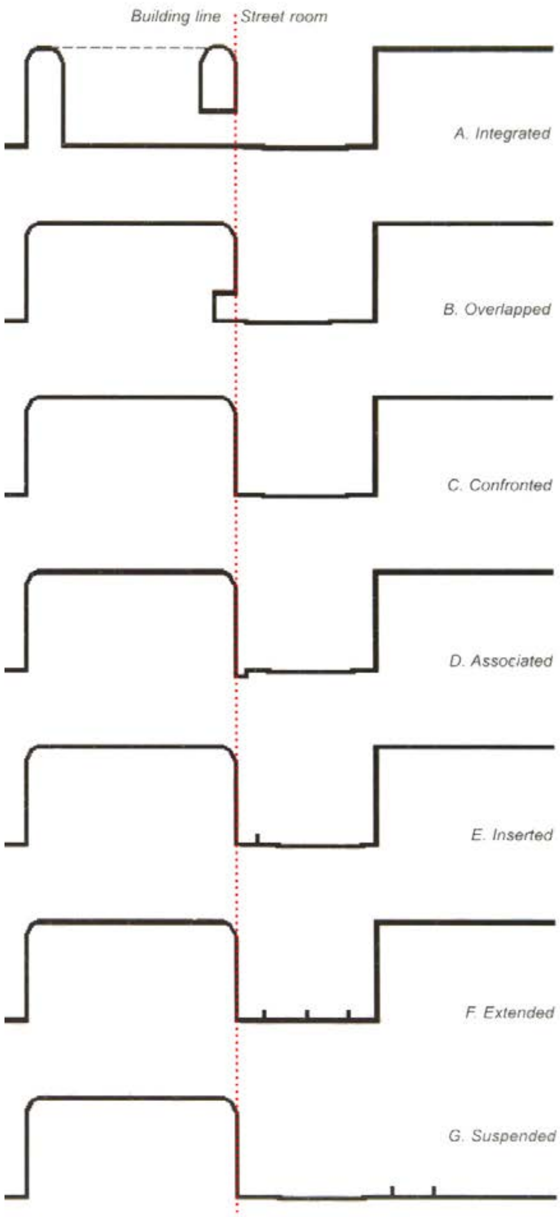
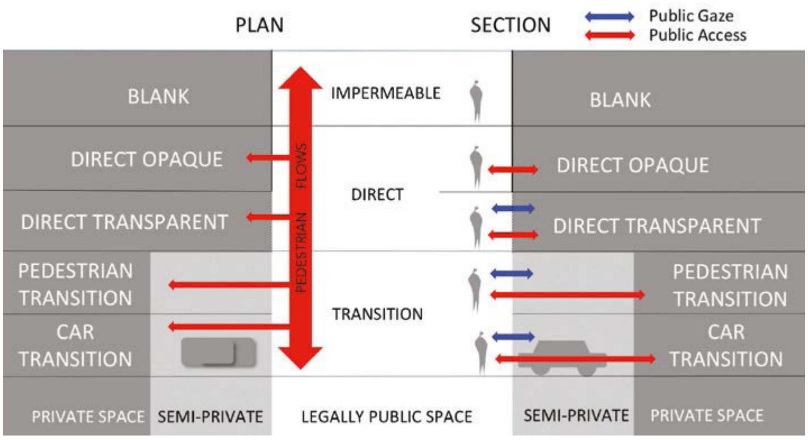


Figure 5.1-2 Bobić's classification of interface types. (Source: Bobić, 2004, pp. 87).

5.1-3



5.1-4

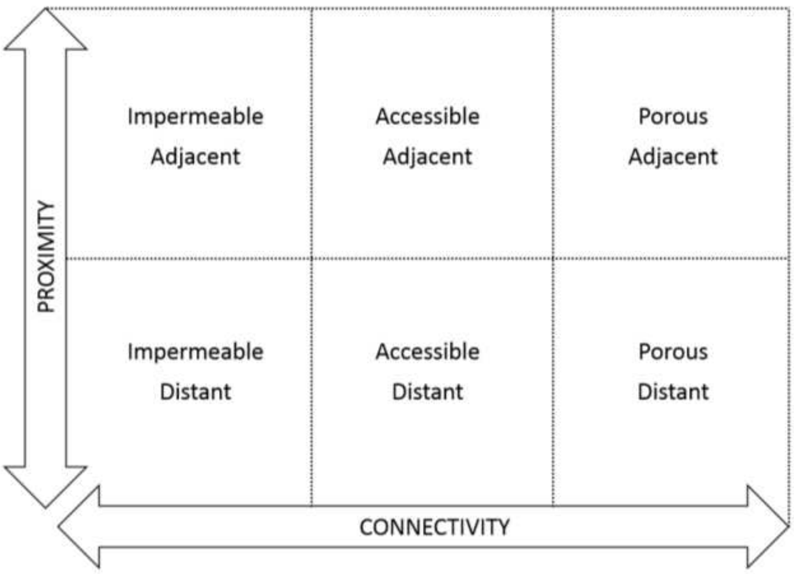


Figure 5.1-3 Dovey and Wood's typology of the street interface. (Source: Dovey and Wood, 2015, p. 6).
Figure 5.1-4 Interface types extracted from Kamalipour. (Source, Kamalipour, 2016, p. 4).

05.2. The mesoscale (the street partition)

Streets exhibit various types and variations of typologies (Marshall, 2004), which, according to their function, can be divided into two categories: multi-functional or monofunctional streets. Multi-functional streets are diverse and complex, with a wider range of different functionalities, attracting various groups and users. These streets also have significant social meanings and values. Conversely, monofunctional streets comprise spaces with one primary function that, in most cases, are disconnected from their surrounding areas (Casas-valle, 2018).

In this regard, this research considers a livable street as a diverse urban element occupying various functions and urban activities (Francis, 1987). It is both a channel for movement from one place to another and a place for social and public life. As multi-functional public spaces, streets are composed of various configurations that cater to a variety of users. These different configurations create the street's image and contribute to the urban spectacle. Therefore, the street can be defined by its length and width and by its different spatial and functional partitions, which compose the street layout (Proença, 2014).

Nevertheless, arterial streets' characteristics—their strategic and urban location, mobility logic, regulations, and design principles—are deeply interconnected with the inhabitants' needs and daily lives. Arterial streets' forms and spaces have become more complex in response to their multi-functional and various needs. Therefore, arterial street composition consists of various components that serve diverse, sometimes divergent, but often complementary roles. These spatial compositions can be organized in different orders, materials, elements, levels, furniture, sizes, and uses, which define the street's spatial configuration.

Streets typically have two primary partitions: the automobile central movement canal and sidewalks. Each of these elements has a specific function and width that shape the street form. The primary purpose of the central movement canal, or roadway, is vehicle mobility, including segregated space for public transport. A roadway provides dedicated space for motorized vehicles, distinct from the sidewalk and stationary activities. It is a dominating and influential element of the street. Factors such as the number of lanes, parking, and the roadway's width significantly influence a street's spatial structures, function, and public life (Jacobs, Macdonald and Rofé, 2001).

Conversely, the sidewalk organizes social life and pedestrian movements and activities (Jacobs, 1995). Active sidewalks are essential to the streets' economic, cultural, and social health (Jacobs, 1961). Therefore, understanding sidewalk organization is instrumental to enhancing public life, as they are places where people move in and out of buildings and where shops and commercial activities occur. Moreover, sidewalks are the core of public life, where users lean, sit, talk, and eat; they are also typically designated as the pedestrian circulation area along a street (Mehta, 2013).

05.2.1. The composition of the street partition

The street evokes a variety of experiences and powerful symbols. As multi-dimensional spaces, streets have allowed users to experience different events in cities' evolutions. The street is composed of different partitions that embody public life rhythms according to the inhabitants' needs. Therefore, it can be said that the street is more than a static object; it is a dynamic urban element that adapts to different constraints, opportunities, and unexpected events. Although street layout is an essential fixed element of city formation, it is also a spatial entity that evolves and changes according to city events and public life rhythms. These rhythms can reshape street partitions to cater to the needs of the different periods.

From this perspective, streets exhibit flexibility over time, allowing for modifications, upgrades, or even complete functional transformations. Recently, streets have occupied innumerable uses, practices, and functions, in addition to accommodating emerging changes in transportation and mobility modes and technologies that intersect and interact with each other (Sheller and Urry, 2006; Sevtsuk and Davis, 2019). Furthermore, the increasing rates of urban congestion and densification have made streets even more complex urban elements (Wen, Chin and Lai, 2017).

Over time, streets have evolved to include sub-partitions, where the basic street partitions are divided into more or fewer parts. Additional partitions have also appeared, complementing each other and corresponding to the various roles of the street, constituting the total street width (Loukaitou-Sideris and Ehrenfeucht, 2009). However, this complementary relationship between the street partitions also implies competition for space, making it essential to reveal these partitions' uses, widths, and ratios to make them readable, fluid, and more efficient.

This need was exemplified by the coronavirus disease (COVID-19) and its urban implications, which resulted in actual and potential urban change and transformation in public life, including shifts in travel patterns and people's activities (De Vos, 2020). In response, street partitions were adapted and reshaped to reorganize the streets under public health measures. Permanent or temporary transformations, such as new cycleways and sidewalk widening, were introduced, redefining street partition (Finn, 2020). Notably, these transformations, linked to COVID-19, have revealed the role of the spatial composition of street partitions as a tool for understanding street morphology and tracking its temporal changes.

In the context of arterial streets, the composition of street partitions can vary in terms of the ratios of pedestrian and automobile spaces and street enclosures. These partitions, either permanent or temporary, are significant components of the street space and can have numerous negative or positive impacts on public life. The analysis of a street and its partition can be done both vertically and horizontally, as stated by Jacobs (1995, p. 277), "Streets are defined in two ways: vertically, which has to do with height of buildings or walls or trees along a street; and horizontally, which has most to do with the length of and spacing between whatever is doing the defining".

Therefore, street partitions can be designated horizontally by changing the surface material, textures, or widths based on the functions and occupations for either traffic circulation or public life. These primary divisions between pedestrians and traffic can affect the proportion of streets that are either car-oriented or pedestrian-friendly. Additionally, vertical elements such as different levels or street trees can create a division between partitions and enclosures, affecting the degree to which the street is framed. These vertical elements may affect the spatial concentration of public life and pedestrian activity.

The total width of the street partition, representing the overall street width, significantly relates to the buildings' height and other vertical items, such as trees, in terms of public life and a sense of enclosure (Ewing and Handy, 2009). Many urban design theorists have argued that the width-to-height ratio is critical in establishing a sense of enclosure (Lynch and Hack, 1984; Trancik, 1991; Jacobs, 1995; Collins and Collins, 2006). Street enclosure frames it and affects its public life—a well-enclosed street encourages social interaction and increases the degree of security, influencing users' emotionally and psychologically (Gorgul *et al.*, 2019).

Various theorists have proposed different width-to-height ratios. For example, Sitte (1889) suggested a ratio between 1:1 or 2:1 (Collins and Collins, 2006), Alexander, Ishikawa and Silverstein (1977) proposed a ratio less than 1/1, Jacobs(1995) suggested a ratio less than 2:1, and Lynch and Hack (1984) suggested that a ratio between 2:1 and 3:1 would be suitable. However, most studies have proposed an optimal width and height ratio between 1:1 and 3:1.

The two primary partitions of a street, the central automobile movement canal and the sidewalk, can be further subdivided into other sub-partitions, each with its important characteristics in terms of street quality. The street partitions are essential to understanding the livability of arterial streets and decoding their configurations. Understanding a street through the composition of its partitions does not mean ignoring the permanent street layout. However, considering the street in cross-section can reveal its flexibility and present its capability to adapt or transform in response to specific needs over time. This adaptability can be explored by retracing the evolution of street partitions and their adaptation to public life rhythms and inhabitants' needs.

05.3. The macroscale (the urban structure)

"Street and block patterns reflect differences among cities beyond those of scale, complexity, available choices, and the nature of spaces. They relate to the time period when the city was built, to geography, to differing cultures, to city functions or purposes, to design or political philosophies, and to technological demands, to name some of the more obvious. They are, as well, the settings within which great and not so great streets are to be found."
(Jacobs, 1995, p. 202)

A street cannot be understood in isolation from its urban context, as it is an integral part of the urban structure. The street always exists in a symbiotic relationship with its surrounding urban elements, including urban blocks (Çaliskan, 2013). Therefore, the complexity of arterial street livability can be argued to extend beyond the micro- and mesoscales, necessitating consideration of the street's context at a macroscale.

As a major linear urban element of the urban environment, the arterial street unifies individual buildings, plots, and urban blocks, as these have no life without the other. Arterial streets facilitate connectivity within the urban context on a macroscale level. Therefore, this study considers the physical characteristics of street and block patterns on a large scale, providing relevant information about the physical structure of urban areas and the contextual physical variables of arterial streets. Moreover, the macroscale level can help decode the characteristics of street and block patterns and their impact on public life.

The physical pattern of streets and urban blocks has always been a fundamental component of city formation (Jacobs, 1995), and these patterns can transform and change in response to the demands of urbanization (Panerai *et al.*, 2004). Several studies have analyzed street and block patterns from different perspectives, such as size and dimensions, function, and shape (Jacobs, 1961; Krier, 1979; Siksna, 1997, 1998; Pafka and Dovey, 2017; Busquets, Yang and Keller, 2019; Shakibamanesh and Ebrahimi, 2020; Tarbatt and Tarbatt, 2020). These studies emphasized the fact that streets cannot be studied in isolation from their surrounding urban context.

Regarding the urban block, Towers (2005) defined it as a group of buildings situated on a piece of land defined by a street network. It is an intermediary morphological element that shapes the relationship between the city's public and private spaces (Bürklin and Peterek, 2008), and can be seen as a form resulting from street patterns (Panerai *et al.*, 2004).

An urban block can be defined as a piece of land typically composed of numerous plots or a single property in exceptional cases (Krier, 1979). Urban blocks can assume various formations, including rectangular, square, triangular, or even polygonal. Moreover, they can vary in size and orientation, as well as use and function. All these factors play a decisive role in shaping the urban structure (Siksna, 1997; Shakibamanesh and Ebrahimi, 2020).

In this way, street patterns are associated with the arrangement of urban blocks, as streets surround and connect blocks on all sides. Moreover, block edges directly connect with the surrounding streets, creating a clear distinction between the block's exterior and interior spaces (Bürklin and Peterek, 2008; Komossa, 2010). Therefore, street patterns dictate a city's physical public spaces and movement channels, as well as the size, shape, and orientation of urban blocks. Street patterns include different types, such as grids, curvilinear overlays, and diagonal overlays, producing various street layouts and urban patterns (Panerai *et al.*, 2004). Additionally, street patterns are intertwined with the urban structure and can contribute to creating better urban places and an active social life (Marshall, 2004).

Urban grid patterns are considered the most prevalent form of spatial organization among the different urban patterns (Tarbatt and Tarbatt, 2020). According to Lynch (1981), grid patterns are characterized by their simple layout, regular building plots, and logical orientation, all of which promote flexibility in movement flow. Grid patterns provide several urban benefits, as well as adaptability to morphological components. The grid city has been implemented throughout history in different cultures and periods based on social and technological norms, such as the Baixa Pombalina of Lisbon (Proença, 2014), the plan for New York's Manhattan (Busquets, Yang and Keller, 2019), Cerdà's plan for Barcelona (Rueda, 2020), and Doxiadis's plans for Islamabad and later in Riyadh (Middleton, 2009; Al-Hathloul, 2017).

In this respect, the comprehensive research project of Busquets, Yang and Keller (2019), addresses and emphasizes the immense value of urban grid patterns and their unique flexibility. Their book focuses on cities and their grid patterns, highlighting the grids' capacity to absorb and control urban growth and transformation, among other advantages. The work presents and analyzes 101 case studies of grid cities globally. The investigation is divided into six parts and is interpreted and redrawn based on classical elements of the representation to compare them and explore the common characteristics of their spatial values.

In summary, the literature pertaining to the relationship between streets and blocks strongly suggests that the public life that occurs in-between is affected by this relationship. As stated by J. Tarbatt and C. Tarbatt (2020, p. 3), "Without the block, there would be no streets, just roads. Without streets, there would be no street life, just traffic. Without street life, there would be no city, just buildings.

In more prosaic terms, the block is no more than the land and building area defined by streets. But it is the nature of the interface between the two that has a critical impact on the quality of the spaces between those buildings". Therefore, the reciprocal relationship between streets and blocks influences each other and shapes the physical characteristics of urban areas.

05.3.1. Urban permeability

The characteristics of street and block patterns are critical in determining street quality and livability as they contain critical information, such as permeability, a morphological variable linked to public life. Jacobs (1995) studied the context of numerous global urban streets by analyzing the block size and scale of the surrounding area where the streets were situated. The work suggested that the organization of street patterns can contribute to understanding the city and the quality of its streets.

Jacobs examined the complexity of block sizes and street intersections in a square-mile area of different case studies using the same scale and conventions. His comparative interpretation suggests that understanding street patterns and their impact on individual streets is crucial to analyzing and designing streets (Jacobs, 1995). Thus, understanding the relationship between individual streets and street patterns is essential to decoding the permeability of livable arterial streets.

The concept of permeability explains the extent to which a given urban area facilitates easy access to public space and the choice between different routes (Marshall, 2004; Pafka and Dovey, 2017). Permeability is a physical feature that determines the degree and quality of public spaces and their convenience and security (Carmona *et al.*, 2003). It can also refer to an area's capability to allow movement and easy access (Montgomery, 1998).

Numerous authors have highlighted the role of permeability in pedestrian accessibility, walkability, and urban vitality. Permeability enhances the quality of streets and public spaces by providing opportunities for socio-cultural and business activities (Bently *et al.*, 1985; Carmona *et al.*, 2003; Pafka and Dovey, 2017). According to Pafka and Dovey (2017), two lenses reveal urban permeability: one lens measures the morphological aspect by focusing on inaccessible public spaces of the city, while the other lens focuses on network connectivity.

However, various methods for evaluating permeability in urban design literature have identified block size and street intersection density as comprising significant variables in shaping street vitality. Many urbanists have emphasized the benefit of smaller blocks as a tool that augments street intersection density and promotes pedestrian accessibility. In this regard, street intersection frequency can determine pedestrian connectivity and walkability, street livability, and physical and visual permeability (Jacobs, 1961; Bently *et al.,* 1985; Montgomery, 1998; Pafka and Dovey, 2017).

Decades ago, Jacobs (1961) argued that urban block size impacts pedestrian movement and walkability. In her influential book, "The Death and Life of Great American Cities," Jacobs devoted a chapter to discussing her concerns about city block size and its multiplier effect on streets and pedestrian choices. Jacobs argued that the traditional model of urban planning that focused on creating large blocks was detrimental to cities because it promoted automobile use and created a less pedestrian-friendly environment. Moreover, she proposed that smaller, more diverse mixed-use blocks were better for cities because they fostered a sense of community and allowed for more diverse interactions between people, potentially leading to a more vibrant and livable urban environment.

Furthermore, Bently *et al.* (1985) introduced the concept of permeability, enabling accessibility and social choice, both physically and visually. Their work emphasized the critical role of block size in shaping better permeability, as small blocks offer alternative routes and, thereby, greater accessibility to public spaces. Therefore, smaller blocks provide more permeability and ease of orientation. The book discusses ways of achieving permeability based on understanding street and block patterns in the surrounding context of the study area. It also presented three factors that affect permeability, including the increasing scale of development, hierarchical layouts, and pedestrian/vehicle segregation (Figure 5.3-1).

Furthermore, Siksna (1997, 1998) systematically analyzed the urban blocks of 12 North American and Australian cities regarding an urban block's optimum form and dimensions. The comparative analysis sought to analyze the effect of different urban blocks in terms of size, form, and arrangement on urban form, pedestrian circulation, and vehicular circulation. The study findings classified urban blocks' size into three groups: small (under 10,000 m2), medium (between 10,000–20,000 m2), and large (over 20,000 m2).

In conclusion, it could be stated that the spatial configuration of street and block patterns significantly increases the opportunities for street permeability and allows pedestrian movement to flow through the urban structure. Regarding arterial streets, this permeability can contribute to a range of livability-related objectives. It can also enhance public life by increasing walking and cycling potential and promoting social interactions by facilitating more activities.

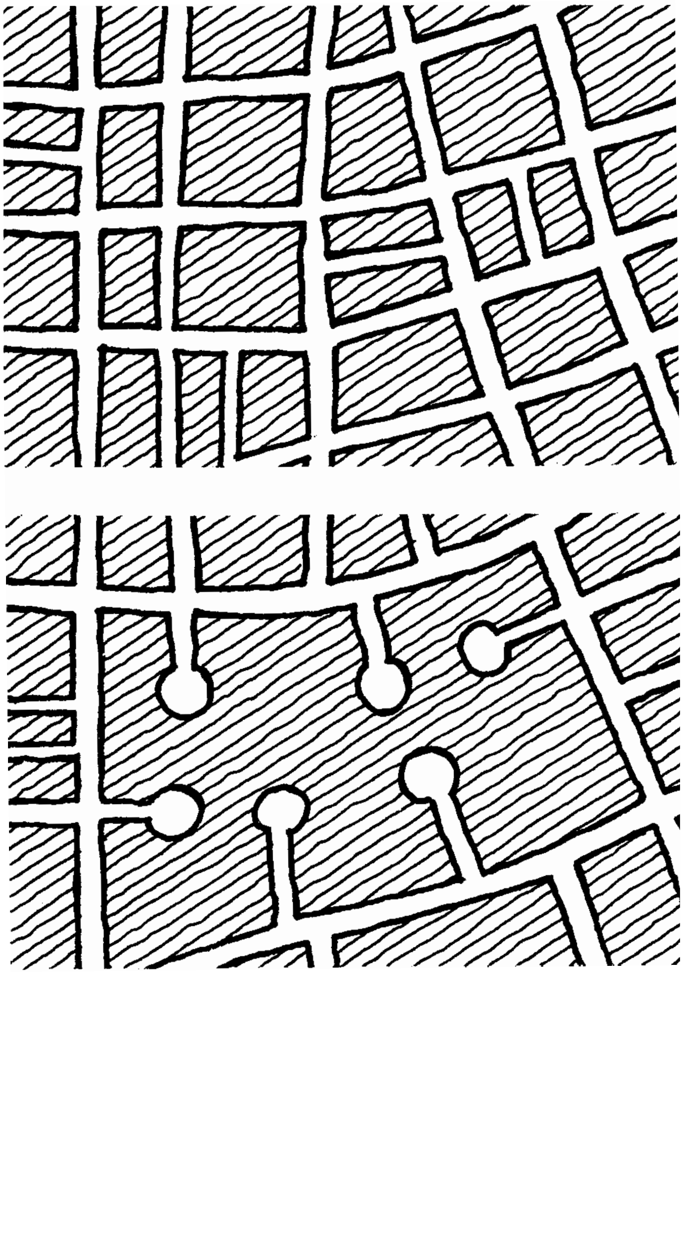


Figure 5.3-1 Comparative diagram illustrating the impact of permeability on route options in urban environments. (Source: Bently et al., 1985, pp. 10).

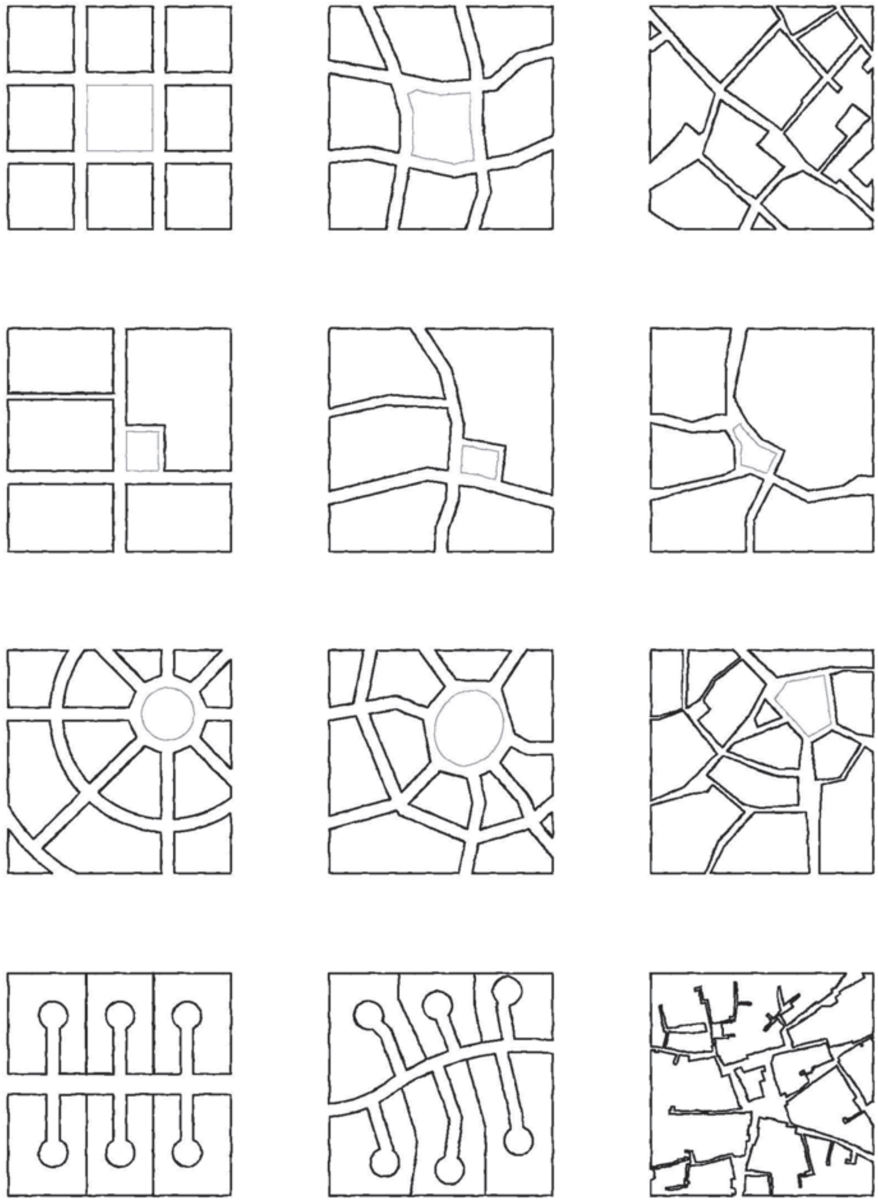


Figure 5.3-2 Urban structure and permeability. Left to right from top: highly permeable (small blocks): orthogonal grid; warped grid; 'organic grid'; medium permeability (mid-large blocks): orthogonal grid; warped grid; 'organic grid'; varied permeability (small–large blocks): radial grid; warped radial grid; 'organic radial'; impermeable (large blocks with dead ends): orthogonal cul-de-sacs; warped cul-de-sacs; 'organic cul-de-sacs'. (Source: Tarbatt and Tarbatt, 2020, p. 76).

References

Alexander, C., Ishikawa, S. and Silverstein, M. (1977) *A pattern language*. Oxford, UK: Oxford University Press.

Anderson, S. (1991) *On Streets: Streets as Elements of Urban Structure*. Cambridge, MA, USA: MIT Press.

Andreani, S. and Sayegh, A. (2017) 'Augmented Urban Experiences: Technologically Enhanced Design Research Methods for Revealing Hidden Qualities of the Built Environment', in *the 37th Annual Conference of the Association for Computer Aided Design in Architecture*. Cambridge, MA, USA, pp. 82–91.

Appleyard, D. (1981) *Livable Streets*. Berkeley, CA, USA: University of California Press.

Appleyard, D., Lynch, K. and Myer, J. R. (1964) *The View from the Road*. Cambridge, MA, USA: The MIT Press.

Bacon, E. N. (1976) *Design of cities*. Revised Ed. London, UK: Penguin book.

Banerjee, T. and Loukaitou-sideris, A. (eds) (2011) *Companion to urban design*. New York, NY, USA: Routledge.

Barker, R. G. (1968) *Ecological Psychology: Concepts and Methods for Studying the Environment of Human Behavior*. Stanford, CA, USA: Stanford University Press.

Batty, M. (2007) *Cities and complexity: understanding cities with cellular automata, agent-based models, and fractals*. Cambridge, MA, USA: The MIT Press.

Batty, M. and Marshall, S. (2017) 'Thinking organic, acting civic: The paradox of planning for Cities in Evolution', *Landscape and Urban Planning*, 166, pp. 4–14. doi: 10.1016/j.landurbplan.2016.06.002.

Bently, I. *et al.* (1985) *Responsive environments: A manual for designers*. London, UK: Architectural Press.

Bergstrom, J. R. and Schall, A. (2014) *Eye Tracking in User Experience Design.* Waltham, MA, USA: Morgan Kaufmann.

Bosselmann, P., Macdonald, E. and Kronemeyer, T. (1999) 'Livable Streets Revisited', *Journal of the American Planning Association*, 65(2), pp. 168–180. doi: 10.1080/01944369908976045.

Bullock, A., Stallybrass, O. and Trombley, S. (eds) (1988) *The Fontana dictionary of modern thought.* 2nd editio. London, UK: Fontana Press.

Bürklin, T. and Peterek, M. (2008) *Basics Urban Building Blocks.* Basel, Switzerland: Birkhäuser.

Busquets, J., Yang, D. and Keller, M. (2019) *Urban Grids: Handbook for Regular City Design.* San Francisco, CA, USA: ORO Editions.

Çaliskan, O. (2013) *Pattern Formation in Urbanism. A critical reflection on Urban Morphology, Planning and Design.* Delft University of Technology. Available at: https://research.tudelft.nl/en/publications/pattern-formation-in-urbanism-a-critical-reflection-on-urban-morp.

Carlson, C. *et al.* (2012) 'Complexity in built environment, health, and destination walking: A neighborhood-scale analysis', *Journal of Urban Health*, 89(2), pp. 270–284. doi: 10.1007/s11524-011-9652-8.

Carmona, M. *et al.* (2003) *Urban spaces-public places: The dimensions of urban design.* Oxford, UK: Architectural Press.

Carr, S. *et al.* (1992) *Public space.* New York, NY, USA: Cambridge University Press.

Casas-valle, D. (2018) *Streets & Urbanisation. theory, case, tool-reflections on the intermediary scale in the Porto region.* Universidade do Porto.

Cataldi, G., Maffei, G. L. and Vaccaro, P. (2002) 'Saverio Muratori and the Italian school of planning typology', *Urban Morphology*, 6(1), pp. 3–14.

Cerrone, D. *et al.* (2021) 'Implementing Gehl's Theory to Study Urban Space. The Case of Monotowns', *Sustainability*, 13(9), p. 5105. doi: 10.3390/su13095105.

Collins, G. R. and Collins, C. C. (2006) *Camillo Sitte: The Birth of Modern City Planning: with a translation of the 1889 Austrian edition of his City Planning*

According to Artistic Principles. New York, NY, USA: Dover Publications.

Conzen, R. G. M. (1960) *Alnwick, Northumberland. A Study in Town-Plan Analysis*. London, UK: George Philip And Son Ltd.

Cowan, R. (2005) *The Dictionary of Urbanism*. Tisbury, Wiltshire, UK: Streetwise Press.

Cullen, G. (1961) *Townscape*. London, UK: The architectural Press.

D'Acci, L. (2019) 'On urban morphology and mathematics', in D'Acci, L. (ed.) *The mathematics of urban morphology*. Cham, Switzerland: Springer International Publishing (Modeling and Simulation in Science, Engineering and Technology). doi: 10.1007/978-3-030-12381-9.

De Roo, G. and Rauws, W. S. (2012) 'Positioning planning in the world of order, chaos and complexity: On perspectives, behaviour and interventions in a non-linear environment', in Portugali, J. et al. (eds) *Complexity theories of cities have come of age: An overview with implications to urban planning and design*. Berlin, Heidelberg: Springer, pp. 207–220. doi: 10.1007/978-3-642-24544-2.

De Vos, J. (2020) 'The effect of COVID-19 and subsequent social distancing on travel behavior', *Transportation Research Interdisciplinary Perspectives*, *5*, p. 100121. doi: 10.1016/j.trip.2020.100121.

Dovey, K. and Wood, S. (2015) 'Public/private urban interfaces: type, adaptation, assemblage', *Journal of Urbanism*, 8(1), pp. 1–16. doi: 10.1080/17549175.2014.891151.

Duchowski, A. T. (2017) *Eye Tracking Methodology: Theory and Practice*. 3rd ed. Cham, Switzerland: Springer International Publishing. doi: 10.1007/978-3-319-57883-5.

Dzebic, V., Perdue, J. S. and Ellard, C. G. (2013) 'The influence of visual perception on responses towards real-world environments and application towards design', *Intelligent Buildings International*, *5*, pp. 29–47. doi: 10.1doi.org/10.1080/17508975.2013.807766080/17508975.2013.807766.

Ergan, S. *et al.* (2018) 'Quantifying Human Experience in Architectural Spaces with Integrated Virtual Reality and Body Sensor Networks', *Journal of Computing in Civil Engineering*, 33(2), p. 04018062. doi: 10.1061/(ASCE)CP.1943-5487.0000812.

Evans, G. W. (2003) 'The built environment and mental health', *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 80(4), pp. 536–555. doi: 10.1093/jurban/jtg063.

Ewing, R. and Handy, S. (2009) 'Measuring the unmeasurable: Urban design qualities related to walkability', *Journal of Urban Design*, 14(1), pp. 65–84. doi: 10.1080/13574800802451155.

Finn, D. (2020) 'Streets, Sidewalks and COVID-19: Reimaging New York City's Public Realm as a Tool for Crisis Management', *Journal of Extreme Events*, 07(04), p. 2150006. doi: 10.1142/S2345737621500068.

Fotios, S. *et al.* (2014) 'Using eye-tracking to identify pedestrians' critical visual tasks, Part 1. Dual task approach', *Lighting Research & Technology*, 47(2), pp. 133–148. doi: 10.1177/1477153514522472.

Francis, M. (1987) 'The Making of Democratic Streets', in Moudon, A. V. (ed.) *Public Streets for Public Use*. New York, NY, USA: Van Nostrand Reinhold, pp. 23–39.

Franck, K. A. and Stevens, Q. (2006) *Loose space: possibility and diversity in urban life*. London, UK: Routledge.

Gehl, J. (1987) *Life Between Buildings*. New York, NY, USA: Van Nostrand-Reinhold.

Gehl, J. (2010) *Cities for people*. London, UK: Island Press.

Gehl, J., Kaefer, L. J. and Reigstad, S. (2005) 'Close encounters with buildings', *Urbanistika ir architektūra*, 29(2), pp. 70–80.

Gehl, J. and Svarre, B. (2013) *How To Study Public Life*. Washington, DC: Island Press/Center for Resource Economics. doi: 10.5822/978-1-61091-525-0.

Glaser, M. *et al.* (2012) *The City at Eye Level: Lessons for Street Plinths*. Delft, The Netherlands: Eburon Uitgeverij BV.

Goldstein, J. (1999) 'Emergence as a construct: History and issues', *Emergence*, 1(1), pp. 49–72. doi: 10.1207/s15327000em0101_4.

Gorgul, E. *et al.* (2019) 'Measuring street enclosure and its influence to human physiology through wearable sensors', in *Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers*. New York, NY, USA, pp. 65–68. doi: 10.1145/3341162.3343794.

Goss, J. (1993) 'The "magic of the mall": an analysis of form, function, and meaning in the contemporary retail built environment', *Annals of the Association of American Geographers*, 83(1), pp. 18–47. doi: 10.1111/j.1467-8306.1993.tb01921.x.

Hall, P. (2014) *Cities of tomorrow: An intellectual history of urban planning and design since 1880*. Hoboken, NJ, USA: John Wiley & Sons.

Harezlak, K. and Kasprowski, P. (2017) 'Application of eye tracking in medicine: A survey, research issues and challenges', *Computerized Medical Imaging and Graphics*. Elsevier Ltd, 65, pp. 176–190. doi: 10.1016/j.compmedimag.2017.04.006.

Helbing, D. *et al.* (2001) 'Self-organizing pedestrian movement', *Environment and Planning B: Planning and Design*, 28(3), pp. 361–383. doi: 10.1068/b2697.

Hillier, B. *et al.* (1993) 'Natural movement: or, configuration and attraction in urban pedestrian movement', *Environment and Planning B: Planning and Design*, 20(1), pp. 29–66. doi: 10.1068/b200029.

Hillier, B. and Hanson, J. (1989) *The social logic of space*. Cambridge, UK: Cambridge University Pres.

Hofmeister, B. (2004) 'The study of urban form in Germany', *Urban Morphology*, 8(1), pp. 3–12.

Hollander, J. B. *et al.* (2019) 'Seeing the city: using eye-tracking technology to explore cognitive responses to the built environment', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 12(2), pp. 156–171. doi: 10.1080/17549175.2018.1531908.

Holmqvist, K. *et al.* (2011) *Eye tracking A comprehensive guide to methods, paradigms, and measures*. Oxford, UK: Oxford University Press.

Horayangkura, V. (2012) 'Incorporating environment-behavior knowledge into the design process: an elusive challenge for architects in the 21st century', *Procedia - Social and Behavioral Sciences*, 50, pp. 30–41. doi: 10.1016/j.sbspro.2012.08.013.

Jacobs, A. (1995) *Great Streets*. Cambridge, MA, USA: The MIT Press.

Jacobs, A. and Appleyard, D. (1987) 'Toward an urban design manifesto', *Journal of the American Planning Association*, 53(1), pp. 112–120. doi: 10.1080/01944368708976642.

Jacobs, A. B. *et al.* (1996) *The Uses and Reuses of Major Urban Arterials: A Study of Recycling, Revitalizing, and Restructuring 'Gray Area' Transportation Corridors, Faculty Research Papers*. Berkeley.

Jacobs, A. B., Macdonald, E. and Rofé, Y. (2001) *The boulevard book history, evolution, design of multiway boulevards*. Cambridge, MA, USA: MIT Press.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York, NY, USA: Vintage Books.

Kaakinen, J. K. (2020) 'What Can Eye Movements Tell us about Visual Perception Processes in Classroom Contexts? Commentary on a Special Issue', *Educational Psychology Review*, 33(1), pp. 169–179. doi: 10.1007/s10648-020-09573-7.

Kamalipour, H. (2016) 'Mapping Urban Interfaces A Typology of Public/Private Interfaces in Informal Settlements', *Spaces and Flows: An International Journal of Urban and ExtraUrban Studies*, 8(2).

Karakas, T. and Yildiz, D. (2020) 'Exploring the influence of the built environment on human experience through a neuroscience approach: A systematic review', *Frontiers of Architectural Research*, 9(1), pp. 236–247. doi: 10.1016/j.foar.2019.10.005.

Komossa, S. (2010) *Atlas of the Dutch Urban Block*. Nijmegen, Netherlands: Vantilt.

Krier, R. (1979) *Urban Space*. London, UK: Academy editions.

Kropf, K. (2017) *The Handbook Of Urban Morphology*. Hoboken, New Jersey, USA: Wiley. doi: 10.1002/9781118747711.

Krstić, K. *et al.* (2018) 'All good readers are the same, but every low-skilled reader is different: an eye-tracking study using PISA data', *European Journal of Psychology of Education*, 33(3), pp. 521–541. doi: 10.1007/s10212-018-0382-0.

Larkham, P. J. (1998) 'Urban morphology and typology in the United Kingdom', in Petruccioli, A. (ed.) *Typological Process and Design Theory*. Cambridge, Massachusetts, USA: Aga Khan Program for Islamic Architecture, pp. 159–170. Available at: https://archnet.org/publications/4251.

Leite, J. S. and Proença, S. B. (2020) 'Spatial ambiguity in singular buildings . Timeless composition principles', in Strappa, G., Carlotti, P., and Ieva, M. (eds) *5th ISUFitaly International Conference*. Rome, Italy, pp. 601–612. Available at: www.isufi taly.com/.

Lisińska-Kuśnierz, M. and Krupa, M. (2020) 'Suitability of Eye Tracking in Assessing the Visual Perception of Architecture—A Case Study Concerning Selected Projects Located in Cologne', *Buildings*, 10(2), p. 20. doi: 10.3390/buildings10020020.

Lofland, L. (1998) *The public realm: Exploring the city's quintessential social territory*. New York, USA: Aldine de Gruyter.

Loukaitou-Sideris, A. and Ehrenfeucht, R. (2009) *Sidewalks: Conflict and Negotiation over Public Space*. Cambridge, MA, USA: The MIT Press. doi: 10.7551/mitpress/7423.001.0001.

Lozano, E. E. (1990) *Community design and the culture of cities: the crossroad and the wall*. Cambridge, MA, USA: Cambridge University Press.

Lynch, K. (1960) *The Image of the City*. Cambridge, MA: The MIT Press.

Lynch, K. and Hack, G. (1984) *Site Planning*. Cambridge, MA, USA: MIT Press:

Macdonald, E. (2002) 'Structuring a landscape, structuring a sense of place: The enduring complexity of Olmsted and Vaux's Brooklyn Parkways', *Journal of Urban Design*, 7(2), pp. 117–143. doi: 10.1080/1357480022000012203.

Madanipour, A. (2003) *Public and private spaces of the city*. London, UK: Routledge.

Maki, F. (1964) *Investigations in Collective Form*. A Special. St. Louis, MO, USA: School of Architecture, Washington University.

Malfroy, S. (1998) 'Urban tissue and the idea of urban morphogenesis', in *Typological Process and Design Theory*. Cambridge, Massachusetts, USA: Aga Khan Program for Islamic Architecture.

Marshall, S. (2004) *Streets & Patterns*. London, UK: Routledge. doi: 10.4324/9780203589397.

Marshall, S. and Çalişkan, O. (2011) 'A joint framework for urban morphology and design', *Built Environment*, 37(4), pp. 409–426. doi: 10.2148/benv.37.4.409.

Marshall, W., Garrick, N. and Marshall, S. (2015) 'Street networks', in Hickman, R. et al. (eds) *Handbook on Transport and Development*. Edward Elgar Publishing, pp. 208–226. doi: 10.4337/9780857937261.00020.

Matin, E. (1974) 'Saccadic suppression: A review and an analysis', *Psychological Bulletin*, 81(12), pp. 899–917. doi: 10.1037/h0037368.

Mehta, V. (2008) 'Walkable streets: pedestrian behavior, perceptions and attitudes', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 1(3), pp. 217–245. doi: 10.1080/17549170802529480.

Mehta, V. (2013) *The street: a quintessential social public space*. New York, USA: Routledge.

Menghini, A. B. (2002) 'The city as form and structure: the urban project in Italy from the 1920s to the 1980s', *Urban Morphology*, 6(2), pp. 75–86. doi: 10.51347/jum.v6i2.3902.

Middleton, D. A. (2009) *Growth and expansion in post-war urban design strategies: CA Doxiadis and the first strategic plan for Riyadh Saudi Arabia (1968–1972)*. Georgia Institute of Technology.

Montgomery, J. (1998) 'Making a city: Urbanity, vitality and urban design', *Journal of Urban Design*, 3(1), pp. 93–116. doi: 10.1080/13574809808724418.

Morris, A. E. J. (1994) *History of urban form before the industrial revolution*. Third Edit. New York, NY, USA: Routledge.

Moudon, A. V. (1994) 'Getting to Know the Built Landscape: Typomorphology.', in Franck, K. A. and Schneekloth, L. H. (eds) *Ordering space: types in architecture and design*. New York, NY, USA: Van Nostrand Reinhold, pp. 289–314.

Moudon, A. V. (1997) 'Urban morphology as an emerging interdisciplinary field', *Urban Morphology*, 1(1), pp. 3–10.

Ng, C. F. (2016) 'Behavioral Mapping and Tracking', in Gifford, R. (ed.) *Research Methods for Environmental Psychology*. Wiley, pp. 29–51. doi: 10.1002/9781119162124.ch3.

Noland, R. B. *et al.* (2017) 'Eye-tracking technology, visual preference surveys, and urban design: preliminary evidence of an effective methodology', *Journal of Urbanism*, 10(1), pp. 98–110. doi: 10.1080/17549175.2016.1187197.

O'Sullivan, D. and Manson, S. M. (2015) 'Do Physicists Have Geography Envy? And What Can Geographers Learn from It?', *Annals of the Association of American Geographers*, 105(4), pp. 704–722. doi: 10.1080/00045608.2015.1039105.

Oliveira, V. (2013) 'Morpho: A methodology for assessing urban form', *Urban Morphology*, 17(1), pp. 21–33.

Oliveira, V. (2016) *Urban Morphology: An Introduction to the Study of the Physical Form of Cities.* Cham, Switzerland: Springer International Publishing (The Urban Book Series).

Pafka, E. and Dovey, K. (2017) 'Permeability and interface catchment: measuring and mapping walkable access', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 10(2), pp. 150–162. doi: 10.1080/17549175.2016.1220413.

Panerai, P. *et al.* (2004) *Urban Forms: The Death and Life of the Urban Block.* Oxford, UK: Architectural Press.

Pauls, J. (1984) 'The movement of people in buildings and design solutions for means of egress', *Fire Technology*, 20(1), pp. 27–47. doi: 10.1007/BF02390046.

Perovic, S. and Folic, N. K. (2012) 'Visual Perception of Public Open Spaces in Niksic', *Procedia - Social and Behavioral Sciences.* Elsevier B.V., 68(December), pp. 921–933. doi: 10.1016/j.sbspro.2012.12.277.

Plater-Zyberk, E. *et al.* (2003) *The lexicon of New Urbanism.* Miami, FL, USA: Duany, Plater-Zyberk & Co. Available at: http://www.dpz.com/uploads/Books/Lexicon-2014.pdf.

Portugali, J. (2006) 'Complexity theory as a link between space and place', *Environment and Planning A*, 38(4), pp. 647–664. doi: 10.1068/a37260.

Proença, S. dos S. B. (2014) *A Diversidade da Rua na Cidade de Lisboa: Morfologia e Morfogénese*. Universidade de Lisboa.

Putnam, R. D. (2000) *Bowling alone: The collapse and revival of American community*. New York, NY, USA: Simon & Schuster. Available at: http://library1.nida.ac.th/termpaper6/sd/2554/19755.pdf.

Rahal, R.-M. and Fiedler, S. (2019) 'Understanding cognitive and affective mechanisms in social psychology through eye-tracking', *Journal of Experimental Social Psychology*. Elsevier, 85, p. 103842. doi: 10.1016/j.jesp.2019.103842.

Rapoport, A. (1977) *Human Aspects of Urban Form: Towards a Man–Environment Approach to Urban Form and Design.* Oxford, UK: Pergamon Press.

Rueda, S. (2020) *Regenerating the Cerdà Plan. From Cerdà's Block to the Ecosystemic Urbanism Superblock*. Baecelona, Spain: Agbar.

Rusnak, M. A. and Rabiega, M. (2021) 'The Potential of Using an Eye Tracker in Architectural Education: Three Perspectives for Ordinary Users, Students and Lecturers', *Buildings*, 11(6), p. 245. doi: 10.3390/buildings11060245.

Sadeghi, G. and Li, B. (2019) 'Urban Morphology: Comparative Study of Different Schools of Thought', *Current Urban Studies*, 07(04), pp. 562–572. doi: 10.4236/cus.2019.74029.

Santos, R. D. O. J. dos *et al.* (2015) 'Eye Tracking in Neuromarketing: A Research Agenda for Marketing Studies', *International Journal of Psychological Studies*, 7(1), pp. 32–42. doi: 10.5539/ijps.v7n1p32.

Schmid, H.-J. (2015) 'Morphology', in Braber, N., Cummings, L., and Morrish, L. (eds) *Exploring Language and Linguistics*. Cambridge: Cambridge University Press, pp. 77–110. doi: 10.1017/CBO9781139548922.

Sevtsuk, A. and Davis, D. E. (2019) 'Future of Streets', in D'Acci, L. (ed.) *The Mathematics of Urban Morphology, Modeling and Simulation in Science, Engineering and Technology*. Cham, Switzerland: Birkhäuser, pp. 537–546. doi: 10.1007/978-3-030-12381-9_29.

Shakibamanesh, A. and Ebrahimi, B. (2020) 'Toward practical criteria for analyzing and designing urban blocks', in Almssad, A., Almusaed, A., and Hong, L. T.- (eds) *Sustainability in Urban Planning and Design*. IntechOpen. doi: 10.5772/intechopen.90504.

Sheller, M. and Urry, J. (2006) 'The New Mobilities Paradigm', *Environment and Planning A: Economy and Space*, 38(2), pp. 207–226. doi: 10.1068/a37268.

Siksna, A. (1997) 'The effects of block size and form in North American and Australian city centres', *Urban Morphology*, 1(1), pp. 19–33.

Siksna, A. (1998) 'City centre blocks and their evolution: A comparative study of eight American and Australian CBDs', *Journal of Urban Design*, 3(3), pp. 253–283. doi: 10.1080/13574809808724429.

Silvennoinen, H. *et al.* (2022) 'Effects of Gehl's urban design guidelines on walkability: A virtual reality experiment in Singaporean public housing estates', *Environment and Planning B: Urban Analytics and City Science*, 49(9), pp. 2409–2428. doi: 10.1177/23998083221091822.

Simpson, J. *et al.* (2019) 'Visual engagement with urban street edges: insights using mobile eye-tracking', *Journal of Urbanism*. Routledge, 12(3), pp. 259–278. doi:

10.1080/17549175.2018.1552884.

Simpson, J., Thwaites, K. and Freeth, M. (2019) 'Understanding Visual Engagement with Urban Street Edges along Non-Pedestrianised and Pedestrianised Streets Using Mobile Eye-Tracking', *Sustainability*, 11(15), p. 4251. doi: 10.3390/su11154251.

Smith, D. (2021) 'Porosity and the Transnational: Travelling Theory between Naples and Frankfurt (Walter Benjamin, Asja Lacis and Ernst Bloch)', *Forum for Modern Language Studies*, *57*(2), pp. 240–259. doi: 10.1093/fmls/cqab001.

Spanjar, G. and Suurenbroek, F. (2020) 'Eye-tracking the city: Matching the design of streetscapes in high-rise environments with users' visual experiences', *Journal of Digital Landscape Architecture*, *5*, pp. 374–385. doi: 10.14627/537690038.

Stevens, J. (2022) 'Urban porosity: a chronicle of spatial inclusion in Matonge, Brussels', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 15(1), pp. 61–83. doi: 10.1080/17549175.2020.1858443.

Talen, E. (2003) 'Measuring urbanism: Issues in smart growth research', *Journal of Urban Design*, 8(3), pp. 195–215. doi: 10.1080/1357480032000155141.

Tarbatt, J. and Tarbatt, C. S. (2020) *The Urban Block: A Guide for Urban Designers, Architects and Town Planners*. London, UK: RIBA Publishing.

Towers, G. (2005) *At Home in the City: An Introduction to Urban Housing Design*. Oxford, UK: Architectural Press.

Trancik, R. (1991) *Finding Lost Space: Theories of Urban Design*. New York, NY, USA: John Wiley & Sons.

Uttley, J., Simpson, J. and Qasem, H. (2018) 'Eye-tracking in the real world: Insights about the urban environment', in *Handbook of Research on Perception-Driven Approaches to Urban Assessment and Design*, pp. 368–396. doi: 10.4018/978-1-5225-3637-6.ch016.

van Renswoude, D. R. *et al.* (2018) 'Gazepath: An eye-tracking analysis tool that accounts for individual differences and data quality', *Behavior Research Methods*, 50(2), pp. 834–852. doi: 10.3758/s13428-017-0909-3.

Vainio, T. *et al.* (2019) 'Towards Novel Urban Planning Methods -- Using Eye-tracking Systems to Understand Human Attention in Urban Environments', in *the 2019 CHI Conference on Human Factors in Computing Systems*. Glasgow, Scotland, UK, pp. 1–8.

Wen, T.-H., Chin, W.-C.-B. and Lai, P.-C. (2017) 'Understanding the topological characteristics and flow complexity of urban traffic congestion', *Physica A: Statistical Mechanics and its Applications*, 473, pp. 166–177. doi: 10.1016/j.physa.2017.01.035.

Whitehand, J. W. R. (2001) 'British urban morphology: the Conzenian tradition', *Urban Morphology*, 5(2), pp. 103–109. doi: 10.51347/jum.v5i2.3896.

Whyte, W. H. (1980) *The Social Life of Small Urban Spaces*. New York, NY, USA: Project for Public Spaces.

Whyte, W. H. (1988) *City: Rediscovering the Center*. 1st edn. New York: Doubleday. Available at: papers2://publication/uuid/00B3A17A-EDF2-49D2-9B39-2821BE014E3C.

Wolfrum, S. (2018) *Porous City: From Metaphor to Urban Agenda*. Boston, MA, USA: Birkhäuser Architecture.

Zou, Z. (2018) 'Where Do We Look? An Eye-Tracking Study of Architectural Features in Building Design', in *the 35th CIB W78 2018 Conference: IT in Design, Construction, and Management*. Chicago, IL, USA, pp. 439–446.

Zurawicki, L. (2010) *Neuromarketing: Exploring the Brain of the Consumer*. Boston, MA, USA: Springer.

Part III

Decoding the street

"The way boundaries are established, articulated and related to the private or public spheres often has a major impact on the character of each side, defining many characteristics of urbanism in general. The boundaries are simultaneously means of separation and communication."

Madanipour, 2003

06. The research methodology

The methodology used in this research was built to answer the primary research objectives and the research questions, which are as follows:

1. How to build an urban code for livable arterial streets that can be adapted to the Saudi Arabian context?
2. What is the impact of arterial street morphology on street public life?
   - 2.1 What are the most important variables of street interface configurations that influence pedestrians' visual perception?
   - 2.2 How do street partition compositions influence pedestrians' activities?
   - 2.3 What physical characteristics of the street's permeability with regard to the urban context contribute to facilitating pedestrians' flow at the arterial street level?

This methodology chapter is instrumental in establishing an urban code for arterial street livability. As the methodology is based on reflection about the selected case studies, the first subchapter presents the research case studies, the selection parameters, and the selected samples. The case studies are divided into international and local case studies. The international case studies are eight in total, with Lisbon and Barcelona being the main cases analyzed in depth. The local case studies are two representative arterial streets in Riyadh, Saudi Arabia. The second subchapter explains the interdisciplinary multiscale approach. The multiscale approach to studying arterial street livability consists of three resolution levels based on the study of street morphology and public life, where each scale has its own method of interpreting arterial streets. The third subchapter describes in detail the methodology used on each scale, starting from the smallest level of resolution and following the bottom-up approach. The first microscale studies the street interface per research question 2.1. The second mesoscale decodes the relationship between arterial street partition and pedestrians' activities per research question 2.2. The final macroscale considers the influence of urban structure on pedestrians' flow per research question 2.3.

06.1. The research case studies

Decoding the arterial streets of this study requires an interpretative reading of international livable arterial streets that consist of linear centralities with morphological qualities and that can be compared to local case studies. The selected international case studies allow for an in-depth investigation of arterial street complexity. This approach was intended to reveal the selected arterial streets' physical characteristics that foster livability to build a typomorphological code of arterial street livability.

The local case studies differ from these in context, culture, and formation time, but the objective of the study was to analyze the international case studies as morphological objects, compare them, and build a theoretical and practical morphological-based code. Therefore, the study of the international arterial streets was a fundamental step of the investigation from which the researchers could decode morphological features for similar cases. The two local case studies focus on Riyadh as a representative case study that reflects the formation of arterial streets in Saudi Arabia.

The combination of these cases formed a comparative study to extract "types" of each street morphology scale (see Chapter 11). These types represent the basic properties that influence streets' public life and provided a reference for building the urban code. Thus, this research emphasizes the role of urban morphology in promoting codes, concepts, tools, and techniques for interpreting and analyzing the urban form and its elements. Finally, the deficiencies and potentialities of the local case studies were evaluated to provide responses that could be extended to analogous situations.

06.1.1. The international case studies

The international case studies consist of eight livable arterial streets.

The main case studies

1. Avenida da República, Lisbon.
2. Avinguda Diagonal, Barcelona.

The ancillary case studies

1. Avenue des Champs-Elysées, Paris, France.
2. Ringstrasse, Vienna, Austria.
3. Unter den Linden, Berlin, Germany.
4. Avenida Paulista, São Paulo, Brazil.

5. Avenida 9 de Julio, Buenos Aires, Argentina.
6. Orchard Road, Singapore.

The urban forms of Lisbon and Barcelona have historically been composed of streets and squares. Street form and use have been linked to the different needs of the inhabitants. Thus, Lisbon and Barcelona are cities with a strong tradition of social appropriation of streets. The streets are a place for social interactions, economic activities, and daily life, even in times when they seem less valued, politically restricted, or transformed for automobile use. Collective memories have found a perfect setting in the public life of the street (Guardia, Monclús and Oyón, 1995). These two cities resulted from different processes of urban renewal and transformation based on theories conceived and developed by various historical authors, positioning them as references that bring together physical, social, cultural, and environmental interests. Both cities have faced massive transformations (Guardia, Monclús and Oyón, 1995). In this regard, streets play a fundamental role, having experienced several urban changes and developments that can teach and inspire.

Lisbon and Barcelona were chosen as the main international case studies in this research for three reasons. First is their urban morphological richness due to the various interventions that have occurred throughout their history. Recently advanced interventions in the selected streets, for promoting and regenerating public spaces to improve quality of life, can be examined, decoded, and adapted to other cities based on differing social and cultural needs. Thus, the street morphology and public life of Avenida da República in Lisbon and Avinguda Diagonal in Barcelona provided ideal examples for the creation of an urban code for arterial street livability that could be adapted to Riyadh, Saudi Arabia. Second, these streets are representative case studies for this project due to their particular characteristics, as listed in the next paragraph. Third are the personal knowledge and living experiences associated with these cities—due to the research objectives and methodology, there was a need for personal observation and field experiments.

These cities have a high density and evenly distributed mixed land uses with diverse activities that meet linear centers' functional and spatial roles, a public transport system that meets the function of the arterial street as a route, and physical features that support public and social life. Nevertheless, only using two representative case studies would have rendered the urban code narrow and excluded many other outstanding arteries worth learning from. Thus, six other livable arterial streets are considered ancillary case studies here, confirming or complementing the results obtained from the reading of the two main international case studies. The selection of these streets was based on four characteristics: morphological richness, different geographical and cultural contexts, linear centrality, and location in cities included in "The Economist Intelligence Unit's (EIU) Global Livability Ranking."

06.1.1.1. The study samples

After selecting the streets, three representative samples for the main case studies were selected. This was done following several drive-by and walk-by observations. The samples were then thoroughly investigated during fieldwork to provide a clear view of street morphology and public life. The sample selection was based on the diversity of the morphological elements, public life, and formation time and the representativeness of the common morphological character that can be found in other segments of the streets.

The selection considered the variety of interface configurations, partition compositions, and street and block patterns. It also considered the presence of street furniture and the range of activities possible in each selected segment. Although the selected samples are representative, they present three different forms of the street with different public life rhythms. Thus, these different samples could be compared and analyzed to decode street livability in relation to their specific morphological characteristics.

For Avenida da República in Lisbon, Samples A and B were part of Lisbon's 2014 regeneration strategy (see Chapter 07.1.1). Sample C is located near Entrecampos and represents different morphological characteristics. Each sample has been divided into two parts, east "E" and west "W." For Avinguda Diagonal in Barcelona, Sample A is in the first and central section of the street, built between 1860 to 1955. Sample B is in the second section, located between Plaça Frances Macià and the upper part of the Zona Universitaria, built between 1932 and 1993. Sample C is in the most recent section of the street formation. Each sample has been divided into two parts, south "S" and north "N."

06.1.2. The local case studies

Saudi Arabia is undergoing various transformations, with the main cities at their core. These economic and social transformations, combined with urban growth, pose new challenges and opportunities. During this period of change, other cities can be a source of inspiration for responding to the complex challenges with an exploration that can be transferred and adapted to the local context and thus improve public life. After decoding the international case studies and creating types by the rational abstraction of each scale and theme, the local case studies were unfolded.

Riyadh, the capital city, is exemplary of the current situation and of the future vision for the country. Therefore, Riyadh can be used as a local case study to reveal morphological characteristics through two selected representative arterial streets. These have recent development and transformation combined with new public transportation modes. Khalid Ibn Al Walid and Abi Jafar Al Mansour Streets are located on the northeast side of Riyadh and part of the King Abdulaziz Project for Riyadh Public Transport.

06.1.2.1. The study samples

The study samples for the local case studies were chosen in the same way as the samples for the international case studies. Khalid Ibn Al Walid Street, one of the most known streets in Riyadh, has faced a recent transformation due to the introduction of the bus rapid transit (BRT) system. Samples A and B are located within the BRT line, while Sample C is at the end of the street and has different characteristics. Each sample has been divided into two parts, east "E" and west "W." Abi Jafar Al Mansour Street has also faced a major transformation during the last several years due to the introduction of the new tram line. Samples A and B are within the tram line, while Sample C is at the end of the street, representing different morphological characteristics. Each section has been divided into two parts, south "S" and north "N."

06.2. An interdisciplinary multiscale approach

The interdisciplinary multiscale approach was aimed to build a basis for morphological interpretations interrelated with public life research on different resolution levels, offering a more comprehensive view. These scales are not mutually exclusive; instead, they are complementary resolutions, decoding arterial streets' livability through different lenses and revealing their complexity. As mentioned in Chapter 05, several authors have emphasized that the urban form can be interpreted at different resolutions, from the scale of an individual building to urban districts (Hillier *et al.,* 1993; Moudon, 1997; Kropf, 2017). This multiscale approach includes three levels of resolution: street interface (microscale), street partition (mesoscale), and urban structure (macroscale). The mixed method study integrated quantitative and qualitative data to address the research question comprehensively. The set of procedures for collecting and analyzing data differed depending on the scale for decoding the form and livability of the selected street.

06.2.1. The morphological interpretations and public life studies

Methodologically, the study considers that the city can be read from its physical form and that the morphological interpretation is a process that allows us to reveal the street form from different lenses. The process uses interpretative drawings as an abstraction approach rather than detailed design solutions. These drawings not only represent what exists or has existed but also reveal and transmit ideas and interpretations. The process "allows us to 'see' certain formal configurations that are not perceivable in reality and, therefore, affects the way in which we see the city" (Gandelsonas, 1991, p. 26). In this way, the drawings act as a narrative loaded with meanings capable of building an urban code.

Morphological representation and interpretation drawings allow a comprehensive examination of the relations between the street morphology that constitute the physical space in relation to public life studies. In this research, the interpretation of the case studies was based on classic drawings: plans, cross-sections, and elevations. This allowed us to extract the selected case study's characteristics and place them in a comparison of the same representation scales. The representation was intended to integrate classical architectural representation with photography, thus demonstrating street spaces and daily public life.

Street public life is greatly influenced by physical settings, where the way streets are formed and framed can create lively or lifeless streets. Gehl's goal when he introduced public life theory in the 1960s was to recapture public life as an essential dimension of planning a meaningful and attractive city. He argues that public life must be the focus when designing spaces or, at the very least, must be as valued as dimensions like buildings and transport systems (Gehl, 2010).

In this research, public life was studied on each morphological scale to understand the relationship between it and the street physical form Based on Gehl and Svarres's methods from "How to study public life" (Gehl and Svarre, 2013), and previous eye-tracking studies (Zou, 2018; Simpson, Thwaites and Freeth, 2019; Milliken *et al.,* 2021), this investigation was designed to provide information on what pedestrians visually perceived; where they walked, sat, stood, gathered, and socialized; and which facilities they used, either as a part of their daily functional activities or for recreational purposes.

The study of public life is measured through two methods: systematic personal observation of pedestrians' activities and flows and mobile eye-tracking through engaging pedestrians as the main users of the street space to study their visual perception. In the present work, such direct personal observation and pedestrian experiments were focused on each of the three scales to decode the physical dimensions and characteristics of arterial street livability in each selected case study.

06.3. The three scales of decoding the street

Arterial street complexity in this research was decoded through a multidisciplinary approach that combines morphological interpretation with public life study and observation. This approach was applied on different scales to decode the arterial street through various lenses . The research began at the smallest scale, adopting a bottom-up approach related to the human scale as the focus of the research. However, the representation starts from the top-down to deliver readable case studies.

06.3.1. Street interface (Microscale)

"The way boundaries are established, articulated, and related to the private or public spheres often has a major impact on the character of each side, defining many characteristics of urbanism in general... The boundaries are simultaneously means of separation and communication."
(Madanipour, 2003, p. 210)

The term "street interface" refers to the collective spaces between urban and architectural dimensions on the ground floors of buildings. As a public space, the street is composed of a horizontal plane delimited by two vertical planes acting as edges or boundaries, which can include interfaces as part of the building façade. We chose to analyze the composition of the street interface, defined as a physical and social entity that falls into conditions of betweenness in relation to other dominant spaces, like the street and the buildings, which may create or deny potential social and visual interactions.

Several urban studies have emphasized the significance of pedestrians' experience at eye-level, where movement, occupation, and interaction occur (Glaser *et al.,* 2012). However, the human dimension concerning the street interface and its influence on pedestrians' visual perception has been overlooked. Street interface configurations created for pedestrians' visual perception remain limited and are rarely analyzed quantitatively. Instead, user perceptions are estimated based on intuition, observation, or surveys. The current study addressed this gap, using measurable evidence to unfold the relationship between street interface configurations and pedestrians' visual perception. This then relates to street livability. The current study gathered evidence by engaging pedestrians as the main users of the street and utilizing mobile eye-tracking glasses to analyze visual perception. On the microscale, the study thus attempted to answer research question 2.1.

From previous research that has demonstrated the value of active street frontages, street interface typology, and mobile eye-tracking glasses, the result was anticipated that permeable and accessible configurations would influence pedestrians' visual interactions with the street interface (Jacobs, 1995; Bobić, 2004; Gehl, Kaefer, and Reigstad, 2005; Dovey and Wood, 2015; Simpson, Thwaites, and Freeth, 2019). The microscale provided an opportunity to determine whether public life occurs more actively when the interfaces are visually and physically permeable. Morphological interpretation integrated with the mobile eye-tracking results was hoped to provide a deeper understanding of the street interface's physical–visual perceptual interrelationship. This would decode public space qualities essential to building a spatial framework for livability, beyond simple data collection.

The microscale contains both the street interface's configurational properties and the pedestrians' visual perception of these properties at ground floor level. As a first and fundamental step, the street interface configurations were analyzed for the most common variables: permeability (visual/physical), proximity (distance/adjacent), and rhythm (doors/windows frequency). The juxtaposition of this information allowed us to extract results.

06.3.1.1. The morphological analysis

Urban morphology reads the built environment and identifies its fundamental urban elements: the building, the plot, and the street (Conzen, 1960; Moudon, 1997; Oliveira, 2016). The study of how these elements overlap is critical in urban design, planning, and architecture. One of the relationships that can be identified is between morphological elements, such as the relationship between the street and the buildings on a micromorphological scale. This relationship and its impact on the creation of collective spaces with various social activities represents one of many ways public and private spaces meet; they are interconnected and substantially different from each other. The myriad intermediate spaces involved in this are considered cases for study by themselves and can be decoded differently. The microscale comprises various types of street interface configurations, pedestrians' visual interactions with these configurations, and, consequently, the street's livability.

The variables of interface configuration

The interpretation of street configuration usually occurs on a neighborhood scale, neglecting the human scale and interrelations with the surrounding built environment. Studying the overlapping of urban morphological elements and their relationship with public life requires a finer scale. As mentioned in Moudon's framework (1997), the smallest "cell" of the city is the individual parcel of land with its streets and buildings. This concept was initially argued by Jane Jacobs (1961). The micromorphological analysis of the street interface could here contribute to unraveling the main inquiries.

Based on previous empirical studies of the street interface (see Chapter 05.1.1), which emphasize the interface configuration variables of permeability, proximity, and rhythm, the study applied a configuration study to interpret these three variables for the street interface on the ground floor level. As these are morphological characteristics, they contribute to decoding the urban space qualities that contribute to the richness of public life and social interaction.

1. "Permeability" refers to the capacity for connection between one domain and another. Visual permeability allows visual interactions between the two delimited spaces. This is a crucial feature in this discussion that encourages active interfaces and improves the urban experience. As stated by Jacobs (1995, p.286), "they invite you in, they show you what is there and, if there is something to sell or buy, they entice you." Visibility was measured herein by studying whether the interfaces were visually permeable or impermeable. An interface was considered visually permeable when the visuality degree was 50% or more. Visibility also considers the use of space that is visible to the pedestrian. Therefore, mapping the ground floors' uses was also necessary to reveal which uses encouraged or conversely discouraged interaction between the street and the building.
2. Physical permeability allows pedestrians to physically enter a building's ground floor from the street. It refers to public entrances that connect two realms. The access creates potential social activity and ensures pedestrians circulate in and near the interface. This variable was measured by studying interfaces that allowed pedestrians to cross from public space to private space without restrictions. Analysis was based on mapping each interface's collective spaces in the selected samples.
3. "Proximity" refers herein to the distance between the interface and the street or setback. This variable was measured by studying whether the interface was direct (without a setback) or involved a space (with a setback).
4. "Rhythm" refers herein to the number of doors and windows located at different street interfaces that pedestrians can perceive. These passages communicate between the public space and the private one and are intended primarily for pedestrians. This variable was measured by quantifying the frequency of doors and windows in the different interface configurations pedestrians could encounter along their journey across the street.

06.3.1.2. Public life study

The study of public life on the microscale investigates how people perceive different configurations of the street interface, which involves studying real-life situations and engaging users as the basis for determining what creates livable and active streets. As Canter (1991) states, understanding of a place depends on people's activities in and feelings toward that place, as the individual is continuously influenced by the perceived environment (Appleyard, Lynch and Myer, 1964; Canter, 1991). In turn, an individual's mental image significantly influences their behavior within the spatial environment (Shum, 1990; Downs and

Stea, 2011). Mental images acquire great significance since they influence public life and pedestrians' engagement with the street interface as a spatial entity. Their analysis is essential to understanding public life.

However, identifying and analyzing these mental images can be challenging since they are subjective and often difficult to articulate. Therefore, this study used mobile eye-tracking glasses that provide a more significant opportunity to analyze, quantify, and visualize the individual experience of the built environment. This allows a highly detailed investigation into the well-established relationship between pedestrians' visual perception and street interface configurations. Currently, mobile eye tracking is being applied by psychologists, neuroscientists, marketers, designers, and researchers in the fields of architecture and urbanism (Andreani and Sayegh, 2017; Duchowski, 2017; Simpson, Thwaites and Freeth, 2019; Milliken *et al.,* 2021). It has been used in several studies to investigate the relationship between visual engagement and various urban settings, including streets and public spaces (Fotios *et al.,* 2015; Uttley, Simpson, and Qasem, 2018).

Eye-tracking experiment

Participants

Ten volunteers participated in the experiment, five male and five female, with an average age of 30 years (min. 23, max. 38, *SD* 4.52). Although this sample size does not accurately represent the entire population of interest, the volunteer contributions provided valuable preliminary data for the investigation. The participants' vision was normal or corrected to normal. During the experiment, the participants were aware of the eye-tracking system's use and function, but were not informed of the study's intentions, which helped them act naturally and without bias related to interface design. None of the participants had an architectural or urban design background. Additionally, none of the participants lived or worked at the experiment location.

Apparatus

The eye-tracking system used for this study was Pupil Invisible glasses, a head-mounted eye tracker created by Pupil Labs. Pupil Invisible is a wearable glasses set-up resembling a normal pair of glasses, thus reducing social distortion and allowing for work in all environments. This system provides robust gaze estimation in any environment, including streets, which was essential for this study. The tracker contains two inner cameras mounted onto the frame to record eye movements, one on each side, and one exterior camera attached by a magnetic connector to the left temple, with a 90° × 90° field of view to record the environment. The right temple contains a USB-C connector that connects the Pupil Invisible glasses to a smartphone running the tracker app. The output used for this study was recorded videos that displayed the participants' gaze position and coordinates as related to the outside image.

Design and procedure

Five areas of interest (AOIs) were defined based on the variables of the interface configurations. These AOIs were permeable/accessible (PA), impermeable/accessible (IA), permeable/inaccessible (PI), impermeable/inaccessible (II), and doors/windows (DW). Because the main aim of this experiment was to identify interface types that attract pedestrians' attention, the current study examined fixation points as the metric for analysis of the different AOIs (Figure 6.3-1). "Fixation" is a period of time for which the eyes are relatively still, which indicates the points on which pedestrians are focused (van Renswoude *et al.*, 2018). Irwin (1992) defines the minimum duration for fixation as being at least 150 ms, which was used in this study. The study analyzed the points where fixations occurred and their duration. The ratio of fixation and time spent on each AOI was determined.

Experiment period and sampling

The eye-tracker was connected via a cable to a smartphone as the companion device, with all computation and storage of the recorded data handled in the Pupil Cloud. The calibration was undertaken using the Pupil Invisible Companion app for each participant to perform gaze estimation. This procedure involved asking participants to fixate on a series of specific points from various angles and distances to measure and calibrate their gaze accuracy. Multiple calibrations were undertaken to yield a precise result.

After the calibration, each participant was introduced to their task. To reveal causal relationships and test the hypotheses, the researchers divided tasks among participants based on whether the walking was necessary or optional. The participants were divided into two equal-sized groups. One had the necessary task, and the other had the optional tasks. These tasks have been categorized (Gehl, 2010) and tested in several urban studies and in previous eye-tracking experiments in outdoor environments (Simpson, Thwaites, and Freeth, 2019). The optional activities were strolling around the street or walking for a break; the necessary activity was walking to a destination.

Participants were asked to wear the eye-tracker and walk on each side of the street at each selected sample location, whereby each participant walked on each side of the three samples for a total of six routes. After each experiment, the participants expressed their feelings and opinions about the place in a few short statements. The duration of data collection required a maximum of two experiments a day. Therefore, the study was carried out on different days of the week, during the daytime, in fair weather conditions, as follows:

Lisbon:

7th April 2021 to 13th April 2021.

Barcelona:

12th January 2022 to 25th January 2022.

Riyadh "Summer":

Khalid Ibn Al Walid: 12th December 2022 to 23rd December 2022.

Riyadh "Winter":

Abi Jafar Al Mansour: 15th August 2021 to 26th August 2021.

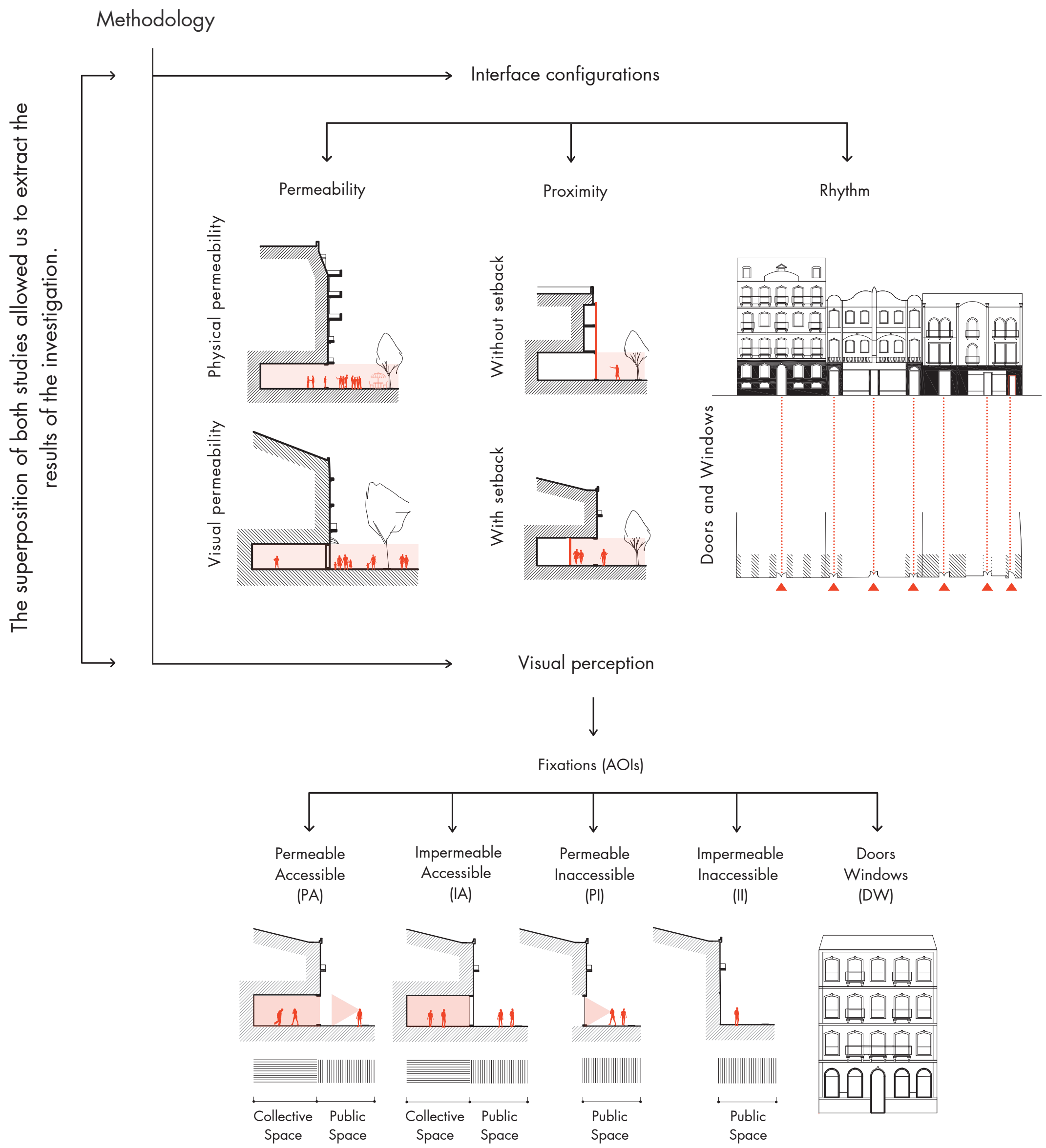


Figure 6.3-1 The microscale methodology: Interface configuration + Visual perception.

06.3.2. Street partition (Mesoscale)

> *"Streets are defined in two ways: vertically, which has to do with the height of buildings or walls or trees along a street; and horizontally, which has most to do with the length of and spacing between whatever is doing the defining."*
> (Jacobs, 1995, p. 277)

The advancement of technology and the evolution of communication and transportation modes over time have affected the way people live (Mehta, 2013), which is reflected in the street partition. The composition of the street partition is always in a dynamic state corresponding to the public life rhythm. However, few studies have read the street from its partition to investigate pedestrians' activities and public life. The reading of street partitions can be a lens to reveal public life dynamics and decode street quality. Tracing the partition compositions in which pedestrians' activities occur is essential for evaluating a street's public life.

As a vital component and complex element of the urban structure, the arterial street is composed of different partitions, both horizontal and vertical, each with different functions. The mesoscale includes the street partitions and subpartitions that compose the street width and the partitions' function and organization. A morphological reading of this for the current study was aimed to decode the relationship between street partitions and public life. The investigation was based on reading the street composition in terms of the partitions' physical appearance, ratios, and street enclosure, which could stimulate the permanence and performance of public life.

Studies of street public life consider various factors to evaluate pedestrians' activities based on systematic observation. This provides information on what people do on the streets; where they walk, sit, stand, gather, and socialize; and which facilities they use, either as part of their daily functional activities or for recreational purposes. This study's examination of the mesoscale was intended to reveal how street partition influences pedestrians' activities, per research question 2.2, leading to a spatial framework of the street's partitions and their influence on public life.

From previous research that has examined street composition (Jacobs, 1995; Proença, 2014), the result was anticipated that public life would occur when the street partitions were shaped and organized around people and their daily activities. Thus, the morphological reading of the street partitions was intended to contribute to understanding the physical features that support public life by investigating the affinity that existed between the configuration of the street partitions and the types of pedestrians' activities observed in these partitions.

06.3.2.1. The morphological analysis

Considering a decomposition of streets into three components—layout, cross-section, and partition—when compared to its layout or section, the partition of the street is less permanent, generated from the use or urban role conferred by the contemporary needs of society (Proença, 2014, p. 675). The morphological interpretation herein was aimed to decode the relationship between different partition compositions and pedestrians' activities, which thus allowed for decoding the street qualities that promote street livability.

As Gandelsonas (1991) states, drawing is a process that allows us to see formal configurations that are not perceived in reality but that affect how we view the city. Classic morphological representation was used in this study to describe the street partitions' spatial characteristics. In "Great Streets" (Jacobs, 1995), emphasis is placed on the representation of the street edges, the street compositions, and the relationship between buildings and the street. These aspects of graphic representation are essential for morphological analysis. The form analysis for this study focused on the physical indicators and features of the street partition, their ratios of pedestrians and automobiles, and street enclosure.

The two most common street compositions are the roadway, which is used primarily by motor vehicles and public transit, and the sidewalk area, which represents the pedestrian realm. The sidewalk area may be partitioned into one or more subpartitions, such as the frontage area, the pedestrian area, the amenity area, and cycling lanes. The ratio of pedestrians (P) and automobiles (A) variable measures the percentage of pedestrians and automobile spaces in relation to the street width. For the calculation, metro and tram spaces and the central median were not counted, while parking areas adjacent to a street were counted as automobile spaces.

The street enclosure was measured on the mesoscale based on each selected sample's cross-section width (W) in relation to the average building heights (H). Based on previous research (Lynch and Hack, 1984; Jacobs, 1995; Collins and Collins, 2006), ratio between 1:1, 2:1, and 3:1 are considered optimal. In this regard, a proper cross-section offers a width that is longer than two or three times the average building's height.

Interpretative morphological drawing was methodologically used to reveal street partition in relation to pedestrians' activities and public life. The drawing was based on plans and cross-sections of the three selected samples of each street with the same scale and representation criteria. The comparative reading of the selected samples revealed the partition compositions integrated with the public life study and defined each sample ratio and enclosure.

06.3.2.2. Public life study

The study of public life on the mesoscale for this research involved various techniques based on Gehl's intensive research and methodology. This included observing and experiencing pedestrian activities and determining pedestrians' ages and genders in relation to the street partition by recording people's daily activities for each selected sample (Gehl and Svarre, 2013).

Pedestrians' activities

According to Gehl (1987), pedestrians' activities can be categorized into necessary, optional, and social activities. This study of pedestrians' activities at the mesoscale was based on these three categories. Necessary activities include walking, cycling, and using public transport. Optional activities include stationary activities with a duration of more than 15 seconds, such as standing, sitting, or any lingering. Social activities are optional activities carried out with two or more people.

Ages and genders count

The presence of various social groups, distinguished by age or gender, reveals the street's quality for all users and indicates the street's adaptability. This study of public life related to street partition considered pedestrian count by gender (female and male) and by age (kids 0 – 12, teenagers 13 – 19, adults 20 – 66, and seniors 66+ years), leading to six different categories, as follows:

- K: Kid.
- TF: Teenager female.
- TM: Teenager male.
- AF: Adult female.
- AM: Adult male.
- SF: Senior female.
- SM: Senior male.

Direct observation and counting

Building on previous research that applied direct observation and behavioral mapping to public life study (Gehl, 1987; Kim, Park, and Kim, 2009; Gehl and Svarre, 2013; Mehta, 2013), this study was based upon systematic personal observation and street partition composition interpretation. The direct observation occurred through slow walking to observe people's activities using coding sheets and photography. The structured observation provided exploratory, inductive, and deductive data that represented in charts and tables. The results contributed to decoding the relationship between street partition's temporal and spatial compositions and pedestrians' activities and interactions.

Observation period and sampling

The observations were carried out to obtain an idea of the types of activities occurring in the case studies. Public life rhythm and pedestrians' activities were defined based on the plan of each selected sample, with a symbology representing the activities recorded as optional, necessary, and social. The observations included recording pedestrians' activity type and location, tracking pedestrians to capture their occupation of the street partition, and taking field notes and photographs.

The observation periods occurred three days a week and three times each day, taking into consideration weekdays and weekends as well as working hours and day and night times. For each observation point, records were made for 15 minutes. These field observations were repeated randomly for all samples when needed. The observation periods were as follows:

Lisbon:

21st November 2019 to 4th December 2019.

16th November 2020 to 23rd November 2020.

Barcelona:

14th April 2021 to 21st April 2021.

12th January 2022 to 25th January 2022.

Riyadh "Summer":

Khalid Ibn Al Walid: 8th August 2021 to 14th August 2021.

Riyadh "Winter":

Abi Jafar Al Mansour: 5th December 2021 to 11th December 2021.

06.2.4. Urban structure (Macroscale)

Street and block patterns embody the urban structure. The urban structure contains a large amount of information that can be interpretated to contribute toward decoding arterial street livability. To better understand arterial streets' livability, the study attempted herein to redefine arterial streets as places that are part of their surrounding urban structure, not as isolated routes. Studying arterial streets at the macroscale was thus crucial.

Permeability, as previously stated (see Chapter 05.3.1), relates to the ease of movement through an urban area as well as the multiplicity of route choices between any two points (Marshall, 2004; Pafka and Dovey, 2017). It has an impact on street public life and pedestrian flow (Bently *et al.,* 1985; Carmona *et al.,* 2003). High permeability has a positive impact on street vitality; through studying this, it may be possible to understand how the urban structure influences arterial street livability.

The primary interest on the macroscale was the influence of street and block patterns and their permeability on pedestrians' flow for the sake of decoding the livability of arterial streets. This scale was aimed to introduce the fundamental role of urban permeability in facilitating or disrupting pedestrians' flow and, in turn, public life. The macroscale investigation, like the others, was based on morphological interpretation integrated with public life study in the context of the selected case studies.

Quantification of the relationship between urban permeability and street public life, particularly pedestrians' movement, has not occurred in previous studies. Thus, this study focused on developing an empirical analysis to assess pedestrian flow, adopting a series of quantitative and qualitative measurements of the urban structure to demonstrate the degree of relationship between urban permeability and pedestrian volumes. The intention was to answer research question 2.3.

This study suggests the hypothesized that arterial streets that incorporate high permeable qualities would have a high pedestrian flow. A high permeability creates permanent, active, pleasing, and safe streets. Permeability can differ markedly at different scales; however, in this work, we focused on the pedestrian permeability of arterial streets in relation to their surrounding urban structure. A comparative analysis of different samples was used to clarify this relationship.

06.2.4.1. The morphological analysis

Street and block patterns impact streets' public life and pedestrian flow (Montgomery, 1998; Zacharias, 2020). Their permeability allows pedestrians to move easily and directly; thus, high permeability within the urban structure can have a positive impact on arterial street vitality. The objective of this study of arterial streets at the macroscale was to decode morphological factors, such as street and block patterns, that affect pedestrians' flow. The study considered urban structure to be composed of the street layout, so the morphological interpretation at the macroscale was based on the street layout, its continuities, and its intersections. Street layouts contribute to identifying the street typology in an urban context in terms of length and width to decompose the urban structure hierarchy.

Street intersections, the "intersection frequency" variable, revealed pedestrians' and cyclists' degrees of street permeability by examining the number of street intersections and block size. The number of intersections along the length of each selected street was determined, where a higher number meant greater degrees of permeability and connectivity between the street and its context. The study of block size addressed the essential role of urban block size and shape in forming permeability, where a greater number of intersections implied a smaller block size and, therefore, greater pedestrian connectivity.

The "street typology" variable referred to the degree of street hierarchy. This was aimed to unfold the street typologies that compose urban structure into categories based on the street's length and width. The study of urban structure revealed not only the street and urban block patterns but also the street hierarchy. It reinforced the arterial street's superior hierarchical position in its urban context and its role in the creation of the spatial identity and image of the city.

06.2.4.2. Public life study

This study of public life on the macroscale was aimed to capture pedestrians' flow in each selected case. The volume of pedestrians provides information related to the degree and conditions of accessibility, thus offering a sense of how permeable and connected the street is to the surrounding context. People's movement counts were herein categorized into cyclists and pedestrians, with the second label including walking, running, being supported by a wheelchair, and rolling on skateboards.

Manual count

The pedestrian count measures pedestrians' flow through time and location. This method offered herein quantitative data to evaluate the degree of permeability. This data was correlated with each selected sample to indicate pedestrians' and cyclists' traffic patterns. The counting was based on a randomly selected imaginary line axis perpendicular to the pedestrians' path in both directions of each sample at various locations. During the counting, every person that passed in each direction was counted for 10 minutes, even if they crossed the imaginary line more than once. Pedestrian counts were conducted three times at 15-minute intervals to calculate an average, which was then used to estimate hourly pedestrian volumes. The researchers used tally sheets and hand-counters to classify pedestrians' flow. This could further indicate the degree to which street intersections and urban block size influenced arterial street livability.

Sampling and counting period

The counting periods are crucial for accurate results. Thus, the collection of the field data occurred during good weather conditions, and the study avoided counting during special events involving parades. The counting periods occurred over a week and three times each day, taking into consideration weekdays and weekends as well as working hours and day and night times. The counting hours of this investigation depended on the case study. However, in all instances, the count fell between the hours of 9 a.m. and 9 p.m., including peak hours.

Lisbon:

5th December 2019 to 11th December 2019.

Barcelona:

26 January 2022 to 1st February 2022.

Riyadh "Summer":

Khalid Ibn Al Walid: 8th August 2021 to 14th August 2021.

Riyadh "Winter":

Abi Jafar Al Mansour: 5th December 2021 to 11th December 2021.

"First we shape the cities — then they shape us."

Gehl, 2013

07. The international case studies

Learning from other streets embodies the concept of international influence (see Chapter 10) as a fundamental part of decoding the arterial street. Before we report on the analysis of the selected streets, this chapter overviews the international case studies. It unfolds the transformation process of the two main cases, Lisbon and Barcelona, and introduces the ancillary livable arterial streets. There are several purposes of this review chapter: to reveal the nature of the selected arterial streets and the urban development processes and strategies that framed their formation; to confirm the importance of the selected main cities in confirming knowledge about streets as public spaces that enhance livability; This chapter visits various livable arterial streets located in different contexts. There are three key subchapters: 07.1 and 07.2, which are divided between Lisbon and Barcelona and discuss the historical growth and development of the cities and the selected arterial streets, and 07.3, which discusses the ancillary livable arterial streets.

07.1. Lisbon

Since its formation, Lisbon has passed through several transformations, reconstructions, and expansions that have wrought profound urban changes. The street has always played valuable and crucial roles in forming the city's growth, circulating goods and people, shaping private and public spaces, and determining environmental challenges (Câmara Municipal de Lisboa, 2015b). Since the second half of the 19th century, under the aegis of regeneration, the city's growth and modernization have begun to be defined. A new plan marked a new era in Lisbon's development, which had two notable phases from 1858 to 1878 and from 1878 to 1891. The incentive for urban transformation in Lisbon has been multi-faceted; the government has aimed to revive and modernize the city in order to face a sanitary crisis and epidemic outbreaks, develop circulation, improve living conditions, and embellish the city (Silva and Sousa, 2009).

In Portugal, the first urban planning law was the Law of 1864, which emphasized the need for a unified vision of urban growth, including street and building construction. The ambitious law proposed an overall city intervention, highlighting the role of streets in improving quality of life, inhabitants' safety, and cities' decoration. The law also established a new framework for public intervention and determined the preparation of "improvement plans" (Silva and Sousa, 2019). Lisbon's improvement and embellishment project sought to increase the capital's urban salubrity and aesthetics, to design more livable and pleasant streets.

In the late 1860s, several public interventions opened new connections between the city's parts. A city that for centuries had developed predominantly along the river began to gain a modern urban identity and expanded to the north side. The opening of Avenida da Liberdade in 1885 represented an essential milestone in the city's growth, attraction, and rehabilitation (Figure 7.1-1). Avenida da Liberdade was the most emblematic project of the city's improvement plan. It was the first avenue of the city, which, together with Avenida Fontes Pereira de Melo and Avenida da República, forms the city's central axis (Silva, 2006; Silva and Sousa, 2009; Proença, 2014).

Avenida da Liberdade, or "the avenue," as it became known, represented the first organized expansion of Lisbon. Its creation quickly became a benchmark for urbanity. Thus, the avenue is considered the city's most striking social, architectural, and urban linear structure. It is also one of the main avenues in Lisbon that connects Praça dos Restauradores to Praça do Marquês de Pombal. This reveals the importance of communication between the traditional city center along the riverside and the city's north side. The avenue is 90 m wide and 1,100 m long, with several lanes and sidewalks that feature gardens and decorated Portuguese pavement (Figure 7.1-2). The avenue's landscaping and decorative elements, such as sculptures and small lakes, establish the avenue as a public promenade without walls (Câmara Municipal de Lisboa, 2015b; Morais and Roseta, 2017).

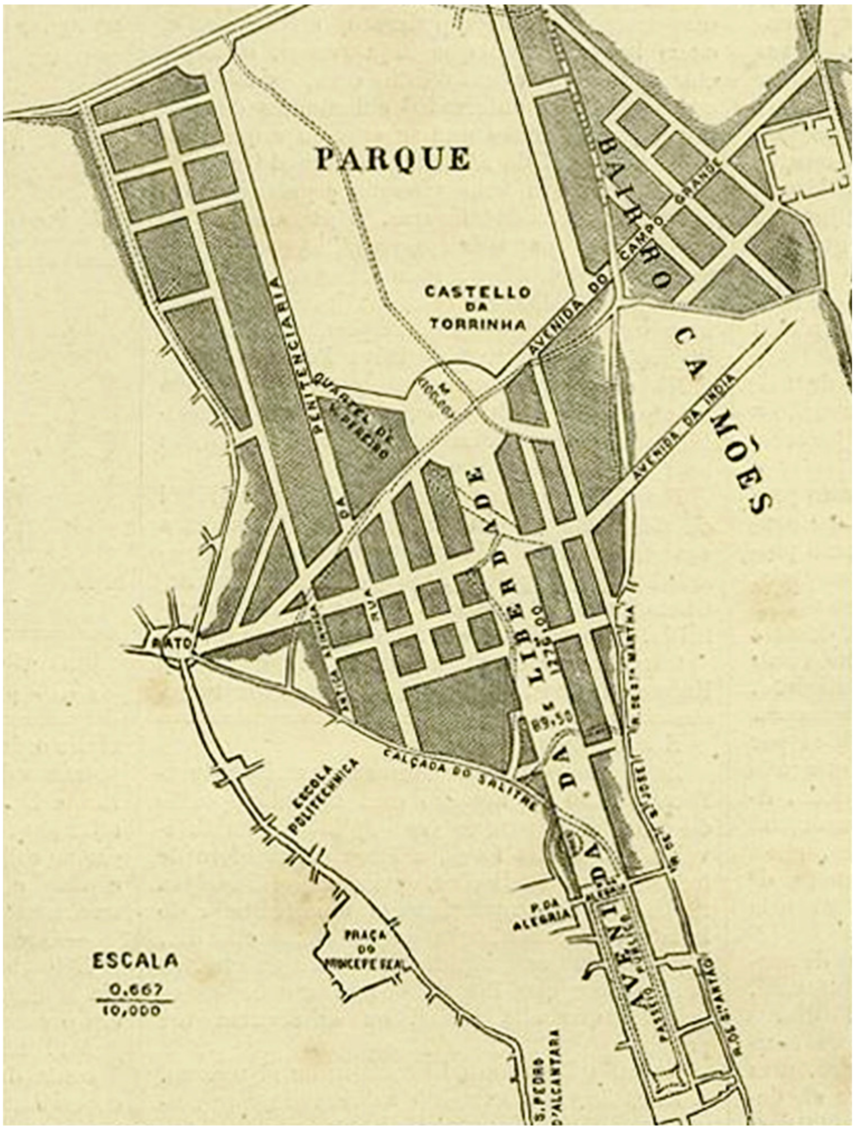


Figure 7.1-1 The plan of Avenida da Liberdade in 1881. (Source: Câmara Municipal de Lisboa: http://lisboa-e-o-tejo.blogspot.com/2018/12/.)

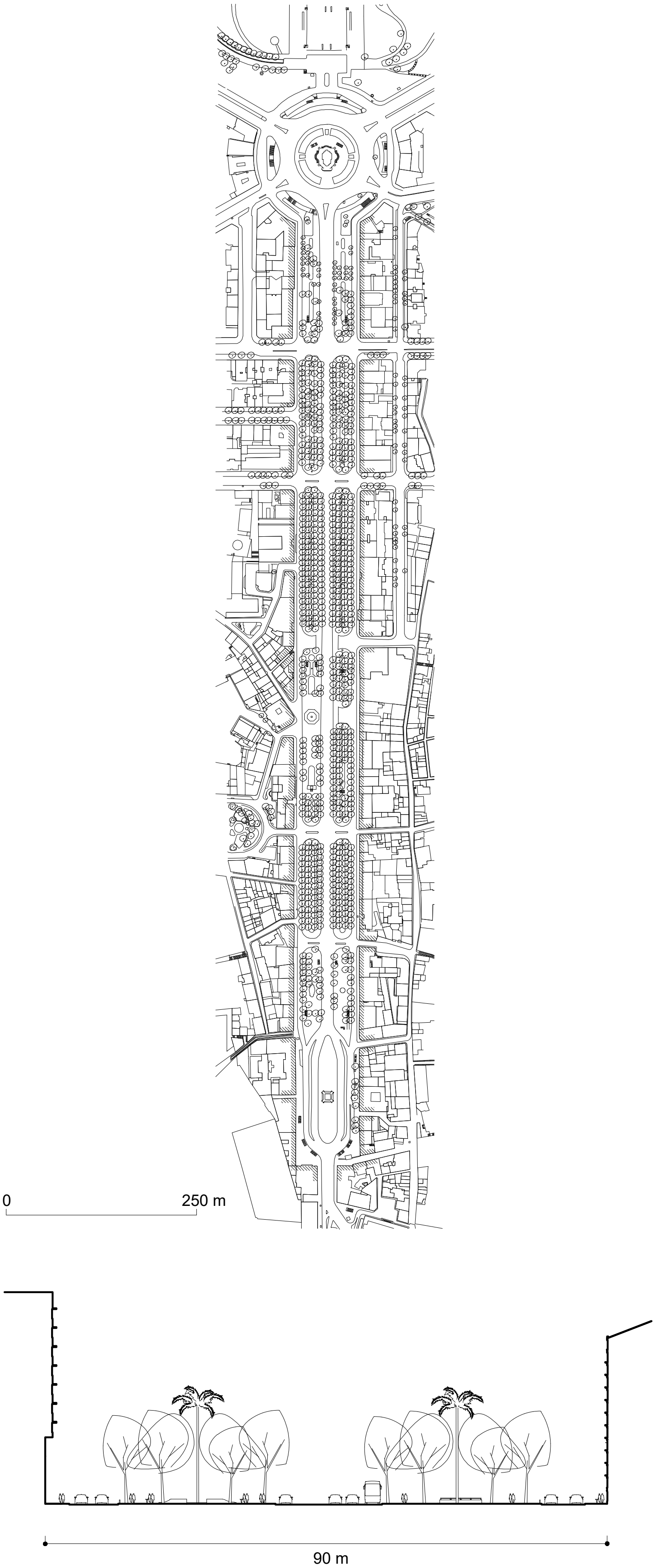


Figure 7.1-2 Avenida da Liberdade, Lisbon, Portugal.
a) Plan and cross-section of Avenida da Liberdade. (Source: Author's Edition)

b) An aerial view of Avenida de Liberdade. (Source: Author's Edition, 2022).

The avenue was planned as a large artery preceding an enormous urbanistic transformation in Lisbon, in terms of both the city's growth and the development of its morphology. Avenida da Liberdade was built as a place to live, work, and move. Its establishment created a new linear center, decisive in the city's new administrative-financial and commercial center (Consiglieri, 2005). The avenue was the first link in the city's growth to fulfill modern needs. Therefore, Haussmann's Parisian urban renewal plan was a source of inspiration. Lisbon's extension plans were designed by a team coordinated by Frederico Ressano Garcia, who was a former student of the Parisian École Impériale des Ponts et Chaussées, one of the most important international schools in urbanism at the time (Figure 7.1-3). In 1877, this team outlined not only the Plan of Avenidas Novas, the most emblematic urban initiative of this phase, ranging from Avenida da Liberdade to Campo Grande, but also new neighborhoods, such as Campo de Ourique and Estefânia; the extension of Avenida 24 de Julho to Alcântara; and the opening of Avenida Almirante Reis (Silva, 2006).

In 1888, Ressano Garcia expanded the city of Lisbon from Praça from Marquês do Pombal to Campo Grande, creating new streets like Avenida Fontes Pereira de Melo, Praça do Saldanha, and Avenida da República. These expansion projects stemmed from the need to grow the city and renew its image as a European capital (Correia, 2018). The Avenidas Novas were not only new spaces in the city, but also represented new ways of life intended to oppose the closed city around its center. From the beginning, this new area was equipped with an innovative set of infrastructures, such as water, gas, electricity, and sewage supply networks.

The plan of 1888 was divided into three parts: the Avenida-Parque complex; Avenida Fontes Pereira de Melo; and Avenida da República with its rectangular blocks, which were inspired by the design of Avenida da Liberdade. The set of the Avenues Liberdade (90 m width), Fontes Pereira de Melo (30 m width), and República (60 m width) articulate in evident continuity from Praça do Comércio, the riverside, to the north (Figure 7.1-4). Therefore, it can be said that the Avenidas Novas Plan developed the Pombaline Plan and created a connection to the north side of the city (Silva, 2006).

The various modes of locomotion in the city were together in the same space for centuries without segregating flows. The public spaces were shared spaces for all users, regardless of activities or events. At the beginning of the 20th century, due to the city's growth, however, mobility was revolutionized with the instillation of a network of trams and public elevators led to the top of the hills. Lisbon's streetcars were the proper response for such a steep city (Câmara Municipal de Lisboa, 2015b).

Before World War II, the public spaces in the city were fundamentally shaped for pedestrians. However, in the post-war period, the government aimed to reduce travel times and increase traffic speed and fluidity. The city's planning thus underwent a profound transformation (Neves and Pinto, 2019). The mobility system began to favor car-based mobility (Figure 7.1-5). This caused a degradation of public spaces and a transformation of the form and use of streets. The automobile took over public spaces. The street lanes widened and occupied more space, the sidewalks shrunk, and open spaces gave way to parking spaces. The new neighborhoods in Lisbon were designed with ever-wider streets to decongest the central areas. The increased use of automobiles led to new urban highways, such as the 2nd Circular, where neither pedestrians nor cyclists can circulate. All these massive transformations caused public life to become more individualistic, reducing the city's social cohesion (Câmara Municipal de Lisboa, 2015b).

In the middle of the 20th century, the center moved from Baixa-Chiado to the north of Marquês de Pombal and began to be formed by the Marquês de Pombal extensions and Avenidas Novas. This vast shift created new centralities, where Avenidas Novas entered a period of transformation that led to changed movement patterns. The city's growth was followed by the emergence of shopping centers and new office buildings that impacted street activities and created a new car-oriented network that has had radical consequences for the use of public spaces. The new center is dedicated mainly to offices, commercial centers, and banking, while the traditional center remains the administrative, financial, religious, cultural, and political center (Pinto, 2018).

The city's growth shifted from the center to the suburbs in the 1950s and 1960s, which led to the growth of metropolitan and regional road infrastructures that were mainly destined for private automobiles. Thus, an increased dependency on private automobiles and a decline in the public transportation system occurred. This divided the city and created barriers that forced pedestrians to travel long distances. The road network expansion in the Lisbon metropolitan area was accompanied by a change in land use, which affected mobility patterns and increased the number of daily trips (Pinto, 2018). Private automobiles have thus not only invaded and appropriated streets and public spaces but have also generated a transformation of the city's form and public life. At the turn of the century, the automobile was the most common mode of transport in all municipalities in Lisbon. Census data reveals that the individual use of automobiles increased from 38% in 2001 to 48% in 2011, while the use of public transport was only 34% (The European Commission, 2020).

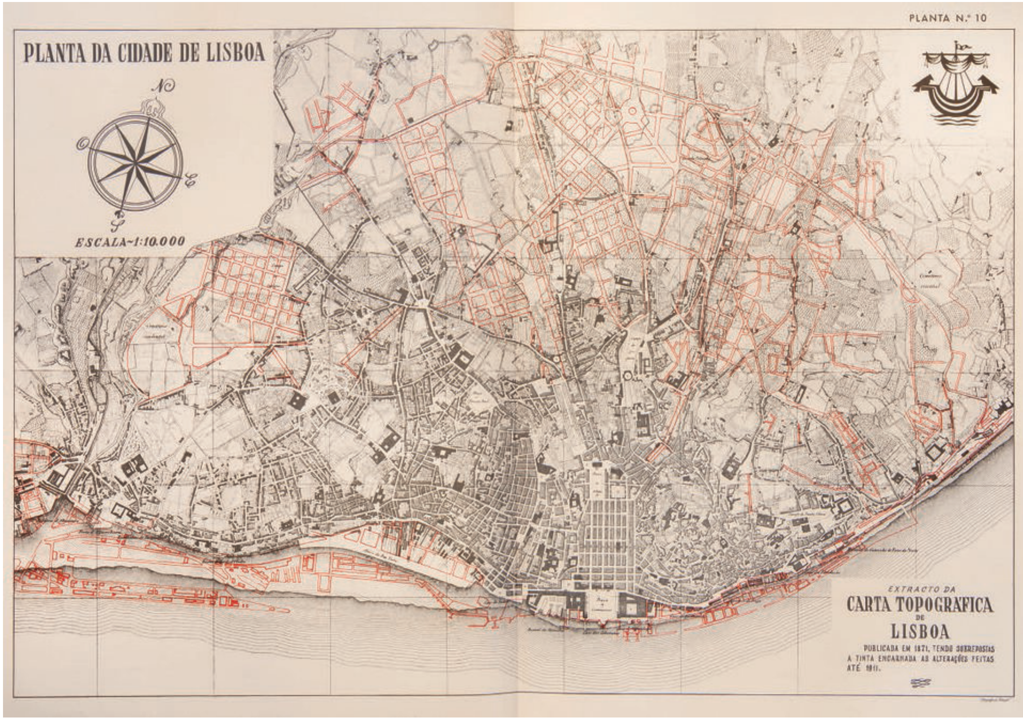


Figure 7.1-3 Plan of Lisbon by Frederico Ressano Garcia Lamas, 1874-1911 in 1871. (Source: Ildefonso et al., 2019).

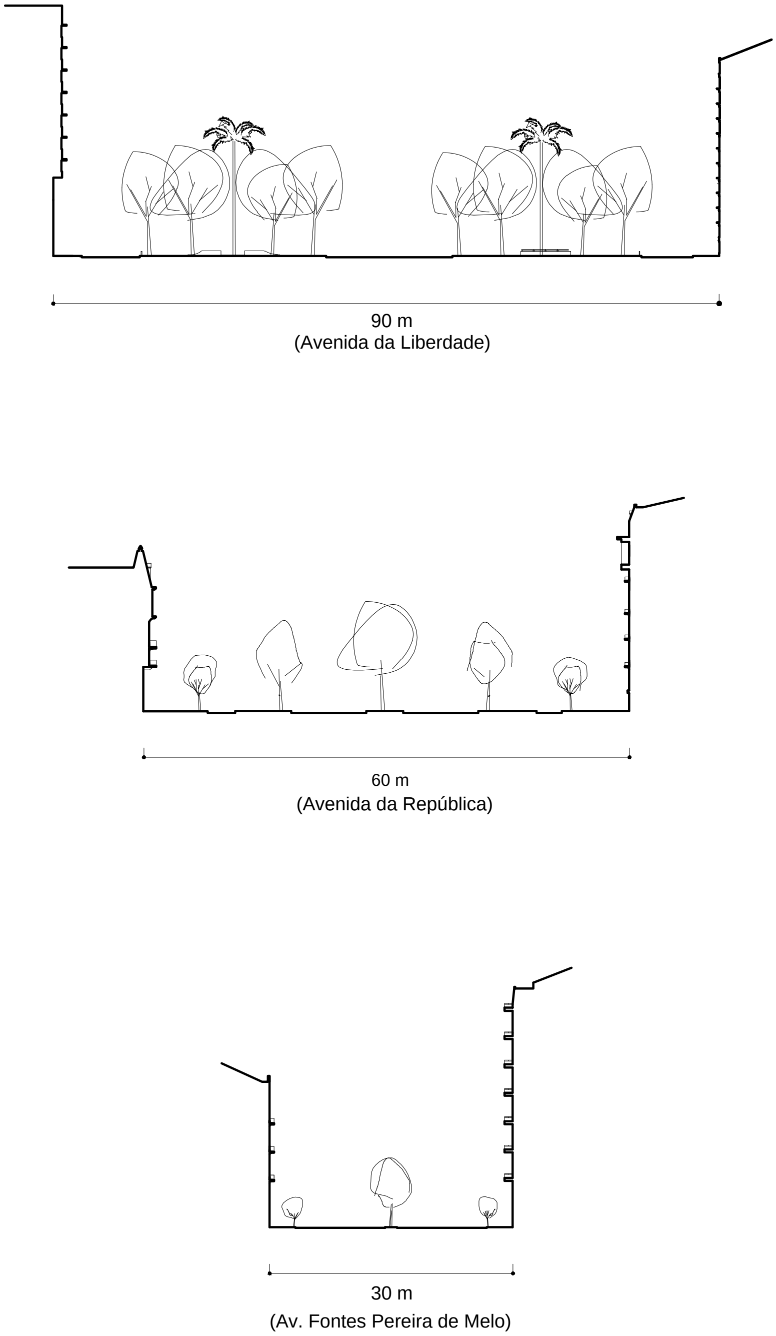


Figure 7.1-4 Cross-sections of the major avenues in the Avenidas plan. (Source: Author's Edition).

a)


b)


Figure 7.1-5 A Temporal Shifts: Praça do Comércio, Lisbon.
a) Automobiles invasion during the second half of the 20th century. (Source: Lisbon municipal archive: https://arquivomunicipal3.cm-lisboa.pt/X-arqWEB/Result.aspx?id=229219&type=PCD).
b) Praça do Comércio in 2022. (Source: Author's Edition).

07.1.1. Lisbon today

Lisbon today has its role as a great contemporary city with redoubled motivations. The government has a clear vision aimed to create a more livable, inclusive city with public spaces for everyone. There is a growing understanding that the streets are not just channels for movement but are, above all, spaces that support public life. In contemporary Lisbon, new ways of sharing public space are sought, promoting coexistence between the various modes of travel and facilitating walking and cycling. The municipality has been fostering new strategies based on several significant axes, such as inclusivity, entrepreneurialism, sustainability, and globalism. The city is being formed and shaped according to the human scale, with streets as structuring elements, places for living, meeting points, and points of commerce and communication.

During the last few years, the city has moved toward achieving strategic objectives within the scope of urban regeneration. In 2012, a transformation in the urban paradigm occurred based on "Lisbon's Strategic Charter 2010/2024," which includes economic, social, environmental, and territorial policies towards in a planning revolution. This plan set a spatial organization model and drew the new master plan for the city with an approach to land use, density, and re-zoning to ensure human centricity. This was aimed to change the capital city from a car-centric city to a livable one that promotes inclusive pedestrian accessibility and qualifies public spaces to face contemporary challenges (The European Commission, 2020).

The strategy marked a new stage in the relationship between physical planning, economic planning, and the various levels of public administration. Six strategic questions were posed for the future development of the city:

- How could the government recover, rejuvenate, and socially balance the population?
- How could the government make Lisbon a friendly, safe, and inclusive city for everyone?
- How could the government make Lisbon an environmentally sustainable and energy-efficient city?
- How could the government transform Lisbon into an innovative, creative city able to compete globally and generate wealth and employment?
- How could the government affirm the identity of Lisbon in a globalized world?
- How could the government create an efficient, participatory, and financially sustainable model of government?

This resulted in four major strategic priorities: affirming Lisbon in the global networks, regenerating the city, promoting urban requalification, and stimulating participation and improving the governance model (Câmara Municipal de Lisboa, 2015a).

Lisbon's experience indicates that it is challenging to create fundamental transformations that take advantage of opportunities without a plan. Intending to make Lisbon accessible for everyone, including pedestrians, the government approved in 2014 "O Plano de Acessibilidade Pedonal de Lisboa (PAPL)." This was aimed to create more livable public spaces in the context of global competitiveness, to improve pedestrian accessibility, and to promote the quality of streets (Câmara Municipal de Lisboa, 2013). Based on PAPL, the Lisbon City Council launched the program "Uma Praça em Cada Bairro" (literally, "a square in every neighborhood"). This program was aimed to improve the livability of the city's streets and public spaces and to contribute to improving environmental quality and the local economic base. The rehabilitation processes have resulted in the regeneration of 150 locations around the city (Câmara Municipal de Lisboa, 2015b).

The transformations of public spaces and streets have occurred on different levels from microscale to macroscale. In 2015, the City Council of Lisbon launched "O Programa Pavimentar Lisboa," (The Paving Program), which aimed to achieve urban regeneration on a microscale to promote inclusive pedestrian accessibility and the requalification of public spaces. The program planned to rehabilitate about 100 km streets for a total of 150 streets between 2015 and 2017. The interventions included transforming streets' morphology and recomposing sidewalks and traffic lanes, which widened pedestrians' sidewalks and reduced traffic lanes and speed limits (Câmara Municipal de Lisboa, 2015b).

Lisbon's strategic plan established a common strategic basis aimed at integrating the city into the international Smart Cities programs. In this regard, since January 2016, the city has been part of "The Sharing Cities' lighthouse' program," which responds to energy-environmental challenges in the hopes of creating more sustainable cities. This approach is at the heart of the city's urban requalification programs, which is aimed to improve the general conditions of public space and create more sustainable mobility. The measure was revolutionary and significantly contributed to mitigating various traffic issues in the city, including decreasing travel time and creating more pedestrian and cycling routes (The European Commission, 2020).

Lisbon has faced several challenges throughout its history, including the last economic crisis in 2008; these challenges became an inspiration to adapt and thrive in difficult times. As the first European capital city to sign the New Covenant of Mayors for Climate and Energy in 2016, Lisbon created a strong, coordinated, and innovative investment in urban regeneration and environmental sustainability, becoming the European Green Capital in 2020 (The European Commission, 2020). The city invested in green areas, removing car lanes, increasing spaces for pedestrians, and adding cycling lanes. With all these programs, Lisbon has become a reference for urban initiatives that combine urban livability, sustainability, and economic growth.

7.1.2 Avenida da República

Avenida da República is part of the central axis, a late 19th century expansion plan for Lisbon conceived by Frederico Ressano Garcia. The street is a part of the Marquês de Pombal–Entrecampos axis, which has a total length of approximately 2.5 km. With a 1.5 km length and 60 m width, the street is also part of the Avenidas Novas (Figure 7.1-6). Several landmarks exist within the avenue's morphological region, such as the bullfight arena in Campo Pequeno and the new Parish Church of Nossa Senhora de Fátima (Câmara Municipal de Lisboa, 2015b).

From the mid-20th century until recently, the increased use of automobiles transformed the avenue into a car-oriented street with more than ten traffic lanes in some parts. In addition to a lack of safe and proper pedestrian spaces, the sidewalks had variable widths, physical barriers, and a lack of adequate facilities, which resulted in fatal consequences (Figure 7.1-7; Câmara Municipal de Lisboa, 2015b). However, the street is currently undergoing sociospatial transformations in conjunction with the urban regeneration strategy of 2014, giving rise to the new configuration of the urban profile that attracted this research interest. The municipality's strategy of "a square in every neighborhood" has aimed to promote the quality of public spaces, including streets. In addition, the plan promotes soft mobility modes, such as walking and cycling, and increases accessibility to public transportation.

The main concept that has guided the transformation of the axis is returning the street to pedestrians as the primary users by increasing the dimensions of the sidewalks and reviving the initial concept of a boulevard with new tree alignments. Additionally, the transformation has aimed to reduce the speed limit of private automobiles, minimize car parking, and balance the use of the space with different modes of transport, including public transportation, which has created a robust urban image that promotes the continuity of the central axis (Figure 7.1-8). However, this has only been applied to one part of the avenue, dividing the avenue into two sections: the southern section, located from Saldanha square until the Campo Pequeno, and the northern section to the Entrecampos roundabout (Câmara Municipal de Lisboa, 2015b).

This case study is a significant transit node with numerous bus stops and subway entrances. In this area live 13,484 individuals, corresponding to a density of 99.1 inhabitants/ha, which is relatively low compared to other city areas.

The average family size is 2.09 individuals. However, the avenue is surrounded by mixed-use developments, mainly offices and services. This concentration of business activities attracts many inhabitants and visitors, resulting in intensive utilization of the avenue during the day. The buildings along the street are constructed in different architectural styles; some were built from the end of the 19th century to the middle of the 20th century with two to six floors. However, most buildings (39.60%) are between 10 and 12 floors in height (Figure 7.1-9).

Figure 7.1-6 Avenida da República, Lisbon, Portugal.
a) The layout of Lisbon. (Source: Formaurbis research laboratory archive).

b) Avenida da República and the central axis of Lisbon within the built environment. (Source: Formaurbis research laboratory archive).

c) An aerial view of Avenida da República, 2023. (Source: Author's Edition, 2023).

a)

b)

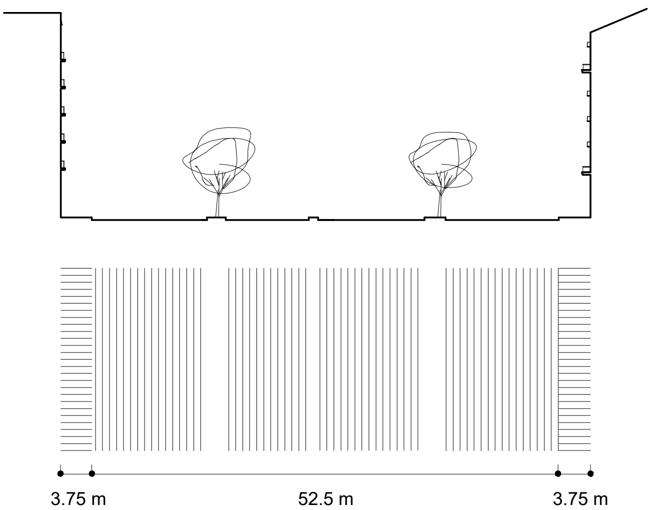


Figure 7.1-7 Avenida da República before the recent intervention.
a) An aerial view of Avenida da República prior to the intervention, displaying the street partition and layout. (Source: Câmara Municipal de Lisboa, 2015).
b) Cross-section of the avenue before the intervention. (Source: Author's Edition).

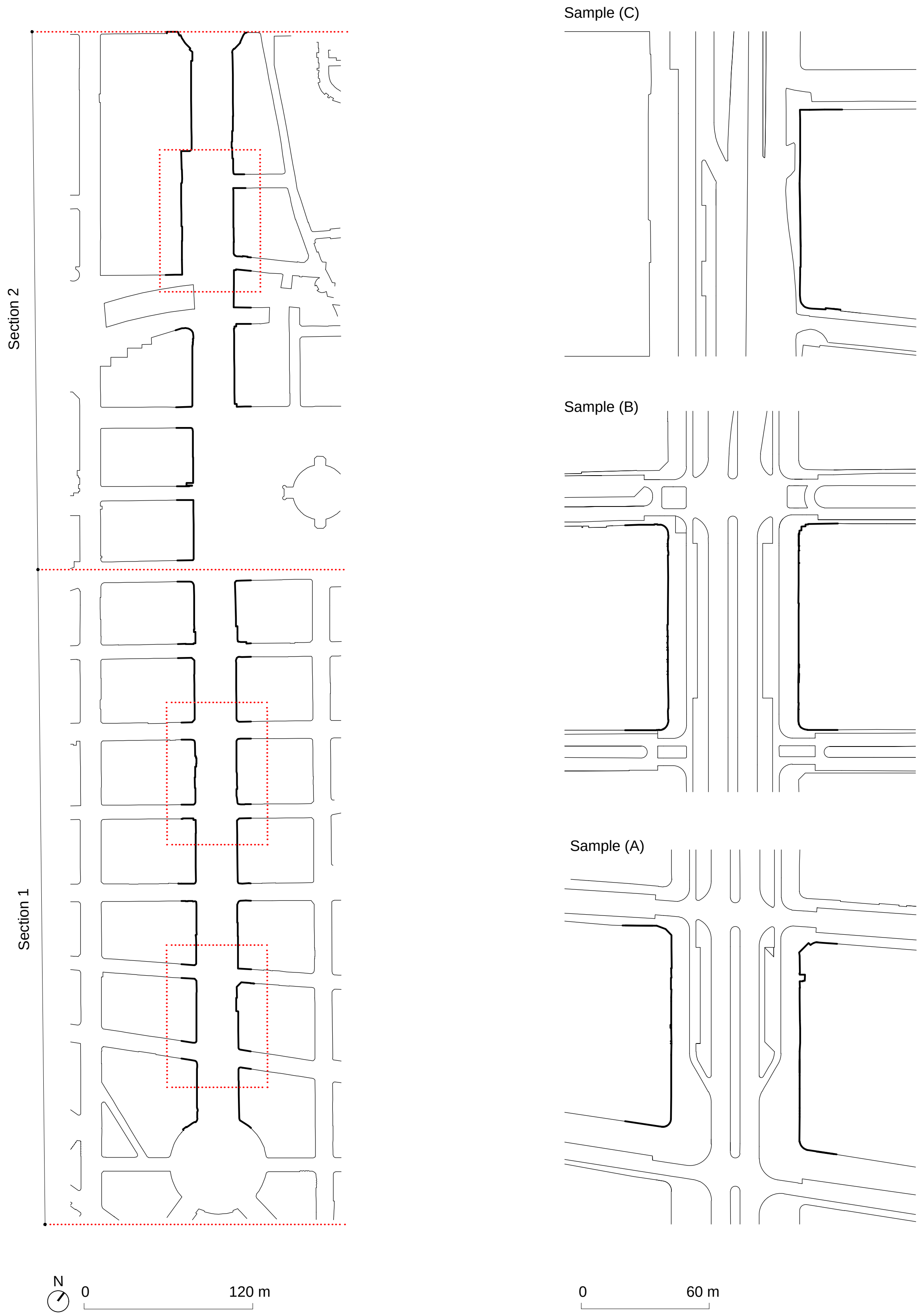


Figure 7.1-8 The two distinct sections of Avenida da República and the selected samples for the study in each section. (Source: Author's Edition).

Figure 7.1-9 Maps depicting the ground floor uses and building heights along Avenida da República. (Source: Author's Edition).

07.2. Barcelona

Barcelona has a long history that begins as a Roman colony founded in the 5th century BC. This history is very apparent in the city's streets, with architectural styles of different eras coexisting side by side, creating a rich urban fabric. This capital of the Catalonia region is in northern Spain, bordering the provinces of Tarragona to the southwest, Girona to the northeast, Lleida to the northwest, and the Mediterranean Sea to the southeast (Calavita and Ferrer, 2000). The old city of Barcelona was characterized by a medieval wall that surrounded the entire city and separated the urban center from the surrounding agricultural lands (Ajuntament de Barcelona, 2010). Over time, Barcelona has faced several transformations in its urban development, with profound political and economic consequences. However, the city has established its identity, values, and aspirations through this historical process. Nowadays, Barcelona is one of the most important cities globally in terms of urban, cultural, and social values (Solà-Morales, 2007). The case study, Avenida Diagonal, is one of the most important avenues in Barcelona. Its historical evolution is linked to the Expansion "Eixample in Catalan" and the reform plan of Barcelona.

The second half of the 19th century was one of the most critical stages in the modernization of Barcelona, when the city council decided to announce an expansion competition in 1859. Ildefons Cerdà (1815-1875), a Catalan engineer, was commissioned to study the extension of Barcelona. Cerdà's plan was selected by the central government in Madrid. The plan's main objective was to expand the city beyond its medieval walls due to challenges with hygiene and high population growth amid the rise of the industrial revolution (Urbano, 2016; Rueda, 2020; Araujo *et al.,* 2021). Cerdà, who invented the word "urbanization" (Rueda, 2020), planned the expansion of Barcelona beyond its historic center, which resulted in a future morphological ordering of the city's form (Figure 7.2-1). The renovation plan was articulated with economic and social strategies that highlighted the importance of streets as public spaces, where Ildefonso Cerdà aimed to improve the living conditions of the society and create an egalitarian city to accommodate people from different social classes in the same area (Mueller *et al.,* 2020).

The layout consisted of a system of geometrically equal blocks called *"manzanas,"* a theoretical concept defined by Cerdà (Roca, 1977; Ajuntament de Barcelona, 2010). The manzana supported Cerdà's vision of an egalitarian city, where geometric egalitarianism would produce less social segregation. He created octagonal blocks, 113.3 x 113.3 sq m, with interior green spaces that offered natural ventilation, reinforcing essential measures for a future city (Rueda, 2020). Cerdà, being a railway engineer, also considered future mobility to accommodate pedestrians, horse-drawn carriages, stream trams, and infrastructural works (Figure 7.2-2). Thus, the plan proposed a chamfer of each corner of the city block at a 45º angle in all block corners to facilitate visuality, in line with his theory that the steam tram would dominate the future of transport in Barcelona (Urbano, 2016).

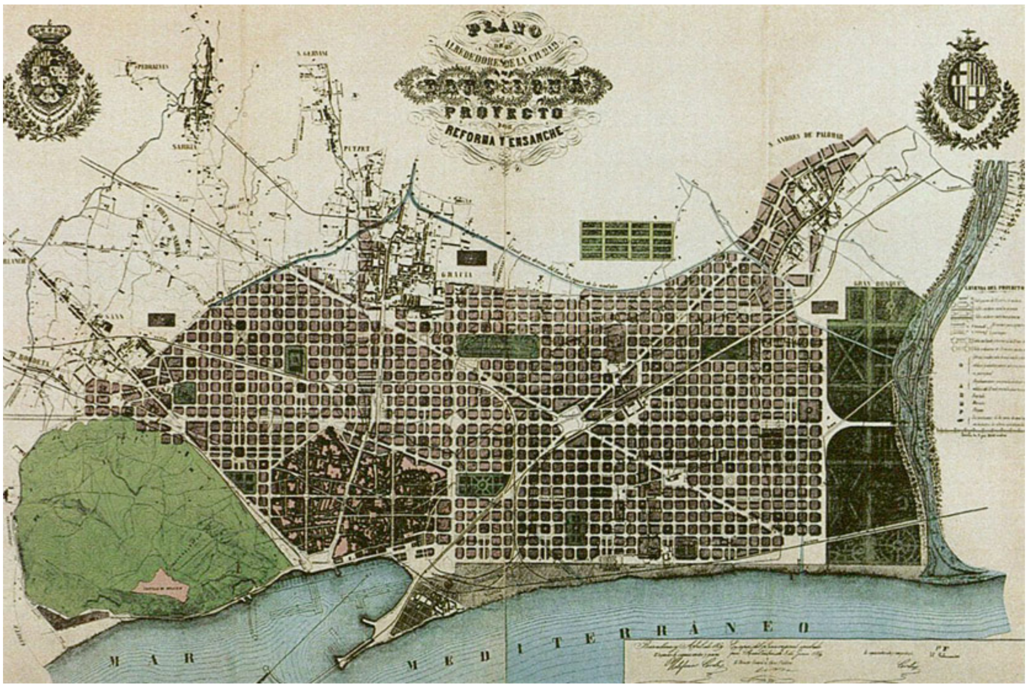


Figure 7.2-1 Cerdà's plan for Barcelona, 1859. (Source: Rueda, 2020).

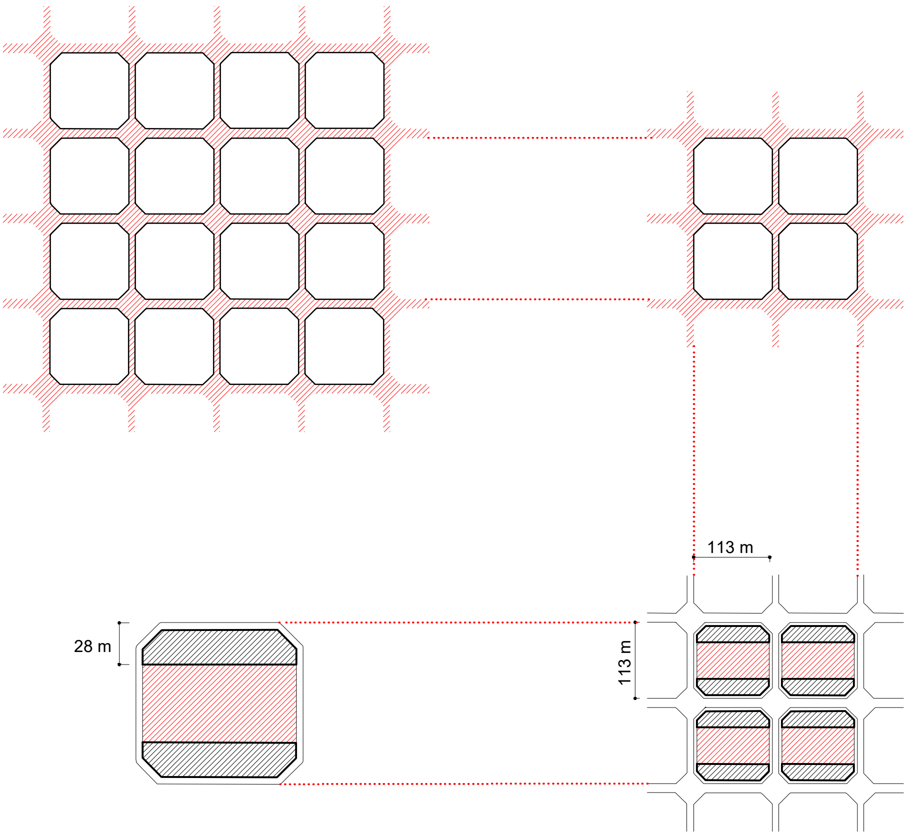


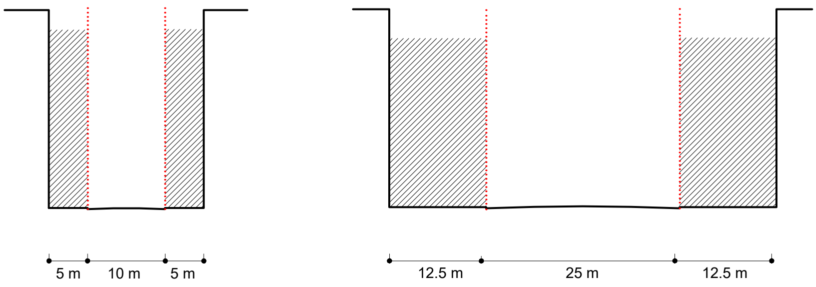
Figure 7.2-2 Cerdà's basic orthogonal grid. (Source: Author's Edition).

His proposal for the extension of Barcelona resulted from an intense study of the street hierarchy based on the principle of spatial flexibility, which has been maintained until today (Figure 7.2-3). The plan organized a regular grid of internal streets between 20 and 30 m of width with five meters on each side for pedestrian use and major streets of a 50 m width that would control the city's future growth and connect the urban fabric (Urbano, 2016; Yang, Busquets and Keller, 2019). The urban space was planned to be shared between pedestrians (50%) and horse-drawn carriages (50%) on every street (Urbano, 2016). A series of axes would create the grid of the future urban form of Barcelona, within which Avenida Diagonal is located. These axes were proposed to structure the city and connect it to future metropolitan growth (Figure 7.2-4). They included the Diagonal, the Meridiana, the Parallel, the Gran Vía de las Cortes Catalanas, and the Paseo de Gracia (Rueda, 2020).

In the 1930s, the city witnessed rapid population growth, with Barcelona reaching one million inhabitants, followed by urban growth extending the city limit. In 1934, Barcelona underwent a modern movement with a new plan to organize the city's growth and reform its existing network. The 1934 plan "Pla de la Nova Barcelona," or as it became known, "the Macià Plan," was proposed by the GATPAC together with Le Corbusier and P. Jeanneret (Solà-Morales, 2007; Ares, 2010). The proposal had several aims, such as remodeling the Eixample and creating a political and cultural city. The Macià Plan was presented in the exhibition "Future Barcelona" in 1934, which highlighted preserving the city of Cerdà and foreseeing the city's future (Figure 7.2-5). This project occurred at the height of the modern movement, which supported delimiting the city by zones depending on function, such as an administrative center, a civic center, a historical zone, l'Eixample, the industrial zone, the commercial port, and the tourist port (Ares, 2010).

Although the proposal respected the original plan of Cerdà, it reinterpreted its characteristics. Modules of 400 x 400 m were proposed, which was equivalent to nine blocks of the Ensanche. As in the case of Ville Contemporaine and Ville Verte, the modern project responded to the future demands of mobility by proposing wider spaces for traffic movement that would enhance the city's urban quality. The Macià Plan thus reinterpreted the 1859 plan with less dense superblocks, *"supermanzanas"* (Wynn, 1979). The GATCPAC developed these based on the idea that the whole city would be one large park, and, therefore, the ground floors should be permeable. Le Corbusier aspired to organize society and cities in a new civilization, "the machine age," abandoning the streets' traditional organization.

7.2-3



7.2-4

Figure 7.2-3 Cross-sections of Cerda's streets hierarchy for the internal and main streets. (Source: Author's Edition).
Figure 7.2-4 Vertical and Horizontal layout of Barcelona with the city's major streets. (Source: Author's Edition).

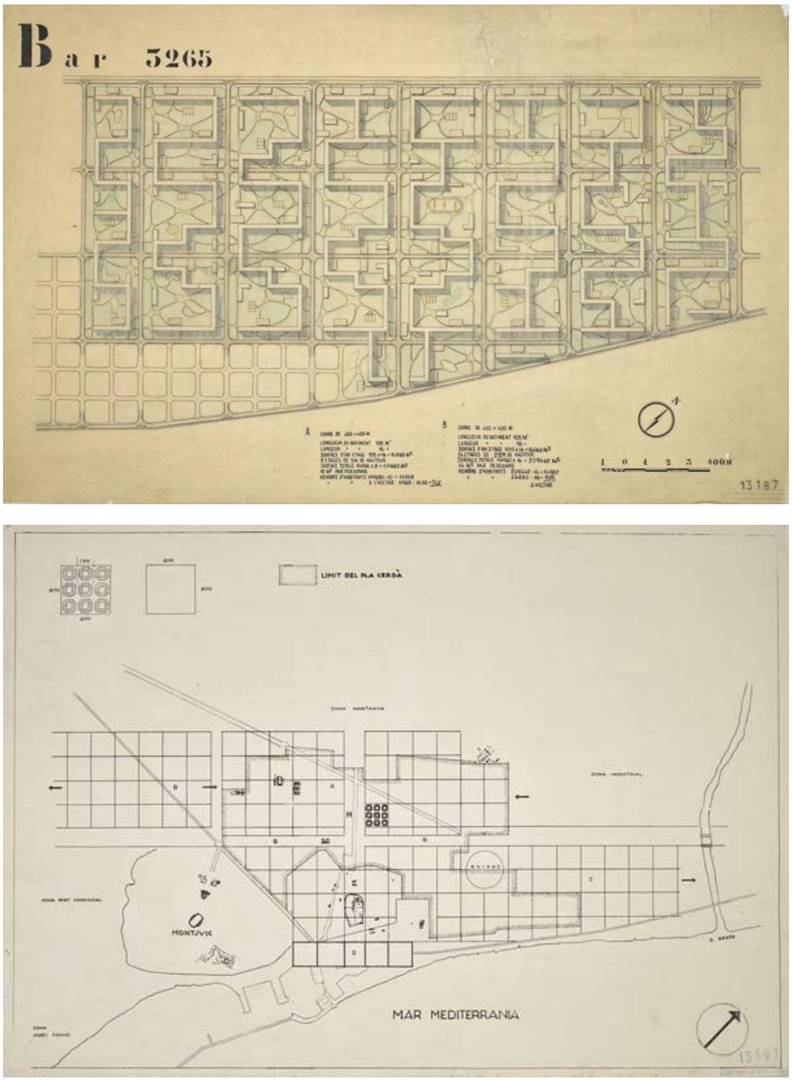


Figure 7.2-5 Macià Plan 1932-1935. (Source: Rueda, 2020).

However, in the end, due to political disagreements and the outbreak of the Civil War, the Macià Plan was never implemented (Wynn, 1979; Rueda, 2020). From the 1950s, Barcelona's mobility system was mainly based on private vehicles, bringing urban challenges such as increased traffic accidents, congestion, and pollution (Rueda, 1995). From 1960 to 1972, the city faced urban growth, resulting in the construction of several highways surrounded by low-density residential developments (Figure 7.2-6; Busquets, 2004). Further, in 1975, the Spanish political transition to democracy occurred concurrently with a general economic crisis experienced in most European countries. Because of this, in mid-1979, Barcelona faced many deficiencies, including sluggish income and urban challenges like lacks in housing, public spaces, and public transport systems (Solà-Morales, 2007).

At the beginning of the 1980s, Barcelona considered the reorganization of the city based on a series of operations, "urban microsurgery," collected in a famous volume entitled "Plans i Projectes per a Barcelona, 1981-1982" (Ajuntament de Barcelona, 1983). After the proclamation of democracy between 1981 and 1988, Barcelona introduced more than 140 highly efficient urban public spaces (Acebillo, 2006). This was an innovative, moderate, and careful plan, far removed from European urban planning after World War II. Thus, a new process of urban regeneration began. The street as a public space was formalized through rethinking transport policy, recovering the city's human scale, and promoting livability. The city achieved several successes and numerous awards, including the Prince of Wales Award for Urban Planning from Harvard University (Neuman, 2011).

The European Union also rewarded its planning strategy at the beginning of the nineties (Neuman, 2011). During this time, the Catalan capital was planned to be one of the leading European cities. The government had applied to host the Olympic Games that would take place in 1992, leading to a unique moment in the city's history preceding the games, when the most significant change in Barcelona's urban policy began. The Olympics provided an excellent opportunity for large urban intervention projects (Garcia-Ramon and Albet, 2000). This came with several main economic and competitive growth objectives, including job opportunities and environmental requalification. The city's fundamental projects in structural terms were the construction of the ring road, the constitution of the Olympic village, the creation of Olympic zones and several new centers, and the transformation of the waterfront into one of Barcelona's main attractions. The tremendous international event of 1992 required essential changes within the city's form to accommodate future megaprojects with an economic and cultural infrastructure capable of being competitive internationally (Solà-Morales, 2007).

This transformation changed the city from an industrial city, especially on the seafront, into an international city. The post-Olympic period continued the same management model and the same foundations. Some areas were still without urban development. However, the "Universal Forum of Cultures 2004" was as decisive for the city's transformation as other international megaevents like the industrial exposition of 1888, the world exposition of 1929, and the Olympic Games of 1992. The Forum promoted the regeneration of several areas, turning them into new urban centers with high potential for environmental, economic, and cultural developments (Garcia-Ramon and Albet, 2000; Solà-Morales, 2007). However, with population growth and increased density, the built area occupied open and shared spaces, creating a lack of public spaces in the city. Barcelona gradually lost the characteristics from the plan of Cerdá that considered public life by dividing the urban block into two equal parts.

Moreover, during the 20th century, the city witnessed a massive presence of vehicles in response to the need to travel longer distances. This gave rise to a car-oriented city lacking public spaces and pedestrian sidewalks. Therefore, the main modern challenge has been considerably reducing the number of private cars and applying an efficient and sustainable mobility policy that allows for living and moving around the city without private cars. Barcelona has had to remodel its mobility and reconsider the form of its streets and public spaces to improve quality of life and enhance the city's livability (Palenzuela, 2007).

07.2.1. Barcelona today

a)


b)


Figure 7.2-6
a) Plaça Cerdà in 1970. (Source: SOLÁ-MORALES, 2007).
b) Avinguda Meridians in the 1970s. (Source: SOLÁ-MORALES, 2007).

With the city organized in blocks that are the basic unit of the urban structure, the Barcelona Agency of Urban Ecology (Agéncia d'Ecologia Urbana) has updated the concept of supermanzanas to be quintessential for the new structure. The proposed reorganization of the urban fabric has thus not involved major changes in the city's original structure but has reorganized its concept. As proposed by the GATPAC in the 1934 Maciá Plan, Cerdà's manzanas enhanced the use of streets as public spaces and created new shared spaces that allow various social activities with priority to pedestrians over vehicles (Rueda, 1995). The new supermanzanas have been combined with a mobility model to increase the quality of urban life. In September 2016, the first pilot superblock *"superilla"* was applied in the Poblenou area. The intention was to reshape the urban structure of Barcelona based on this formation (Rueda, 2020).

This 21st century plan has superblocks that reorganize the existing urban blocks, composed of nine manzanas 400 x 400 m. The perimeter comprises streets for vehicles and public transport. This means the new urban cell allows more public space for shared pedestrian use (Rueda, 1995), solving many urban challenges due to the domination of streets by cars. Automobile access will now be restricted except for resident and emergency vehicles moving at a maximum speed of 10 km/h (Figure 7.2-7). In this regard, the creators of the superblock propose two types of streets: inner streets for pedestrian use and mix-use streets outside the superblock (Rueda, 2020).

Excess unplanned public space can sometimes actually inhibit activities, since people must be making use of the space to attract other people. The significant amount of accessible open space created by this project has been a significant social challenge. Filling these spaces with social activities, playgrounds, and redefined streets has been necessary. The superblocks function as small neighborhoods where walkability is the primary mode of mobility. This urban restructuring has created opportunities for active spaces where multiple squares, parks, and walkways interconnect activities. It also has a sense of compactness with mixed uses and public transportation to reduce the need for private vehicles (Palenzuela, 2007).

Given the multiple interventions carried out in Barcelona during the last 30 years towards reclaiming streets and public spaces, Barcelona is now an international model for the sustainable urban form that can be adapted to other cities. Its urban transformation has limited the growing dominance of the automobile and has reconverted roads into streets for public use. The transformation processes have led to a city for human inhabitants, with streets and public spaces shaped around people down to their most minor details. The city's streets, squares, and corners form a space for coexistence that people make into welcoming and livable places (Mueller *et al.*, 2020).

07.2.2. Avinguda Diagonal

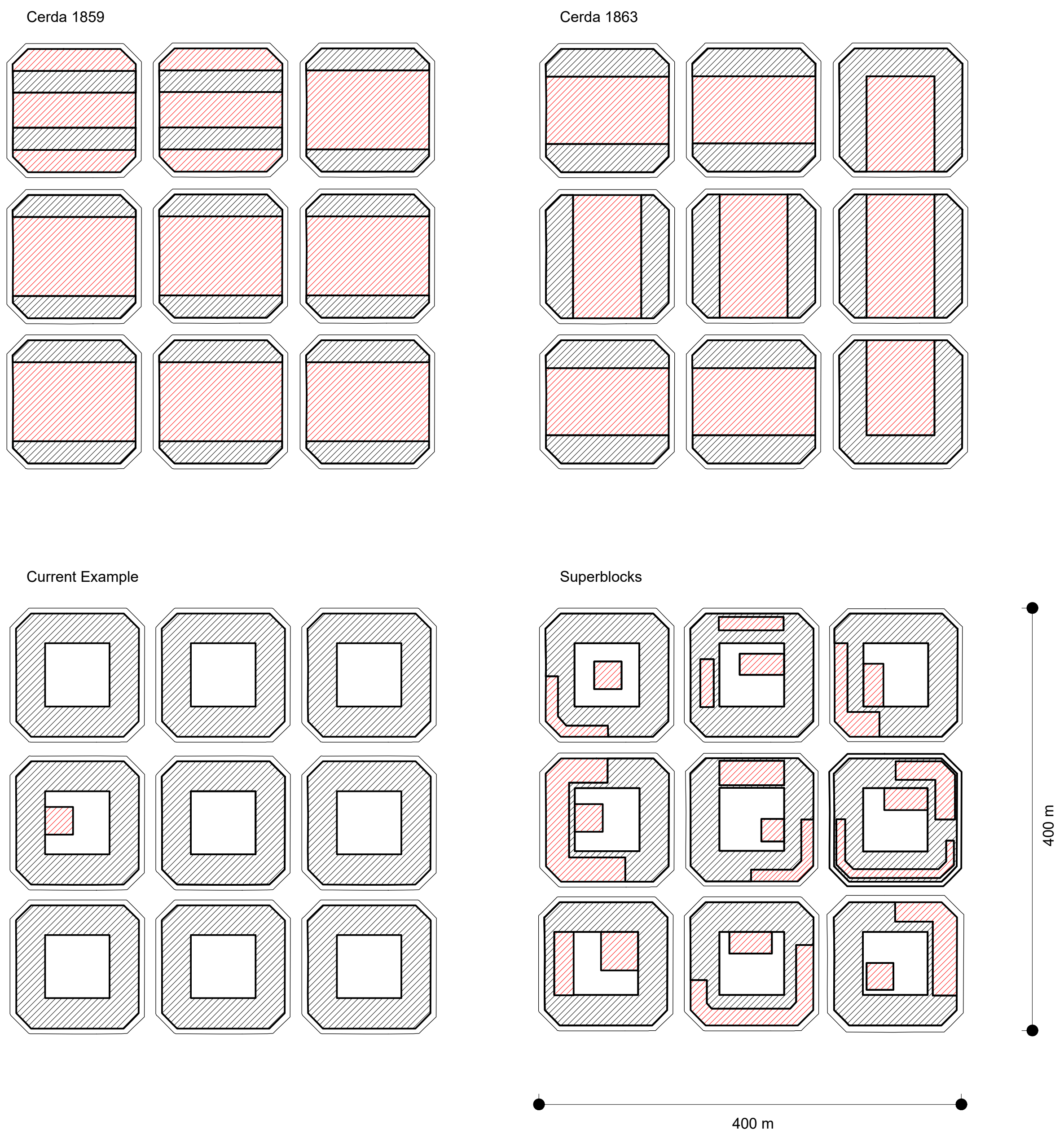


Figure 7.2-7 Green urban area in the 1895 Cerdà plan, in the 1863 Cerdà plan, in the current situation, and in a superblock scenario. (Source: Redrawn from Rueda, 2020).

Avinguda Diagonal, as the building block of the city's historical evolution, is one of the most remarkable streets in Barcelona. The link between the Diagonal and Barcelona's public life is inseparable; the avenue has always been an essential linear center of the city. It connects city neighborhoods and facilitates the mobility of people and goods. In addition, the Diagonal is a place for important cultural, political, economic, and social events, such as the famous victory parade in 1939 and the celebration of the Eucharistic Congress in 1952 (Llano, 2016; Araujo *et al.,* 2021).

Being the longest avenue in the city, at around 10 km, Avinguda Diagonal crosses from its extreme northeast to its extreme southwest, interrupting the horizontal and vertical rhythm of the city's urban grid with an angle of 26º. The width of the avenue varies from 50 to 105 m in some parts, depending on transportation modes. The Diagonal provides for five types of transport: the Metro, bicycle, bus, tram, and private vehicles. Although these transportation modes are not integrated along the avenue, they provide connectivity and facilitate movement and efficient mobility around the city (Figure 7.2-8).

The Diagonal has been composed section-by-section in very different stages, with more than a century passing between the first and the last stage. The execution of each stage has been driven by the realization of essential events in the city. Three major transformations have occurred: The first embodied the birth of the avenue and its first extension, which was driven by the development of "The Expansion of Barcelona,"; the second aligned with the creation of the Palau Reial, "the Grand Royal Palace,"; and the Olympic Games promoted the third and last execution of the avenue (Llano, 2016).

The first and central section of the avenue, built between 1860 and 1955, is located between the current Plaça Frances Macià and the Plaça de Les Glòries Catalanes, with a total length of approximately 3.7 km. The second section is about 3.8 km long and is located between Plaça Frances Macià and the upper part of the Zona Universitaria, built between 1932 and 1993. This section has differing street partitions from the central one and bourgeois architecture. The Diagonal, at that time, was a stately and charming place for pedestrians. By the seventies and eighties, however, the street had consolidated as a business and commercial leisure hub. Finally, the third section, built between 1992 and 2010, runs from Plaza de Glorias to Parque del Fórum (Figure 7.2-9). The construction of this section, with a total length of approximately 2.8 km located in the vicinity of the Mediterranean, culminated the city's urban fabric and reformed the urban industrial form (Llano, 2016).

Throughout its history, the Diagonal has faced several challenges as a space for public life. Recently, the street has undergone several transformation projects, such as the one proposed by the Barcelona City Council in 2008, headed by then Mayor Jordi Hereu (2006 – 2011), who sought reform that would provide more excellent value to the street while also balancing the form, partitions, and connectivity to accommodate various circulation systems like motor vehicles, pedestrians, cyclists, and public transport (Llano, 2016). On January 30, 2009, a second government measure was approved, including citizen participation in transforming the Diagonal's design. The citizen participation process targeted all citizens from the different areas of the city and was promoted in schools, universities, and public spaces (Figure 7.2-10). In 2014, the Diagonal underwent another transformation that aimed to change the central section of the Diagonal, the Plaza de las Glorias, and its surrounding areas (Llano, 2016). The proposal consisted of altering sidewalks to respond to public life needs and mobility conflicts. All these morphological transformations of the street form have created a livable street that supports the need for mobility and for social spaces.

07.3. The ancillary case studies

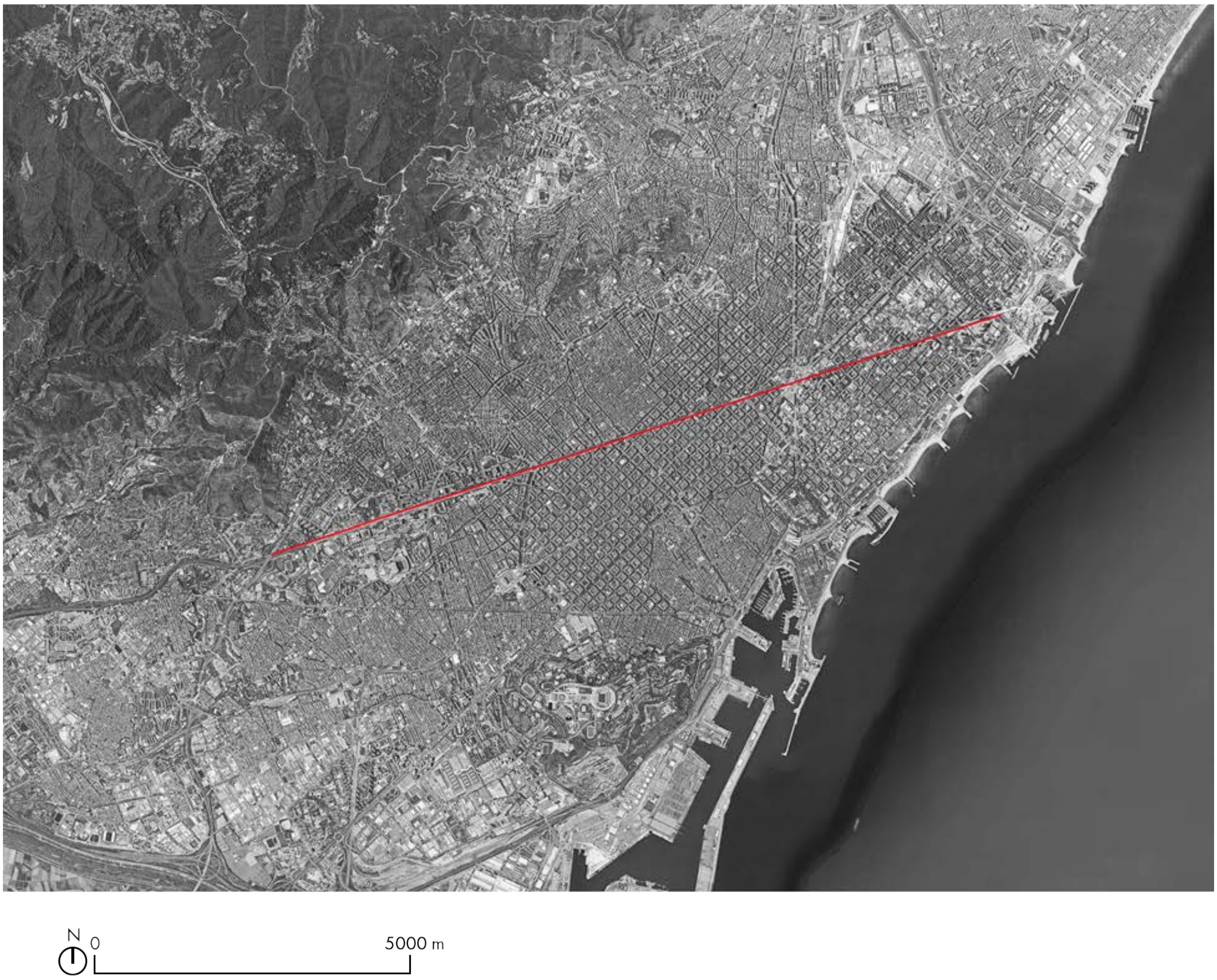


Figure 7.2-8 Satellite view of Barcelona indicating Avinguda Diagonal. (Source: Google Earth with modifications by the author).

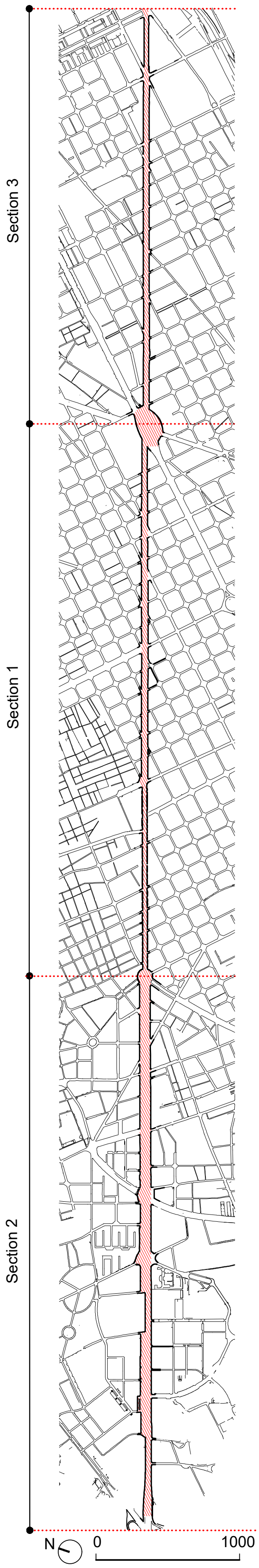


Figure 7.2-9 Avinguda Diagonal, Barcelona.
a) Map of the three distinct sections of the Diagonal. (Source: Author's Edition).

b) An aerial view of Avinguda Diagonal. (Source: Author's Edition, 2022).

Figure 7.2-10 Citizen participation in shaping the future of the Diagonal's design. (Source: Llano, 2016).

Ancillary case studies of existing livable arterial streets provide a greater opportunity for decoding the different factors from real-world situations. One essential contribution here was a more in-depth understanding of the complexity of livable arterial streets in different geographies. Ancillary case studies also contributed to sharpening, confirming, and complementing the morphological principles decoded in the main international case studies. The two types of cases are complementary sources that assert the morphological qualities of livable arterial streets on different scales. Each case is briefly introduced in its urban context, configurations, and opportunities. The following provides street-by-street descriptions of each secondary case study, with urban context maps of each street and plans and sections revealing existing physical dimensions.

07.3.1. Avenue des Champs- Elysées, Paris, France

Avenue des Champs-Elysées, the world's most famous street (Jacobs, 1995), is a prominent artery that establishes a strong connection with urban life. The 2-km-long and 70-m-wide avenue runs through the heart of Paris and connects the southeast to the northwest (Figure 7.3-1). As an outstanding linear urban element of Paris, it can be traced to the seventeenth century with origins in market gardens.

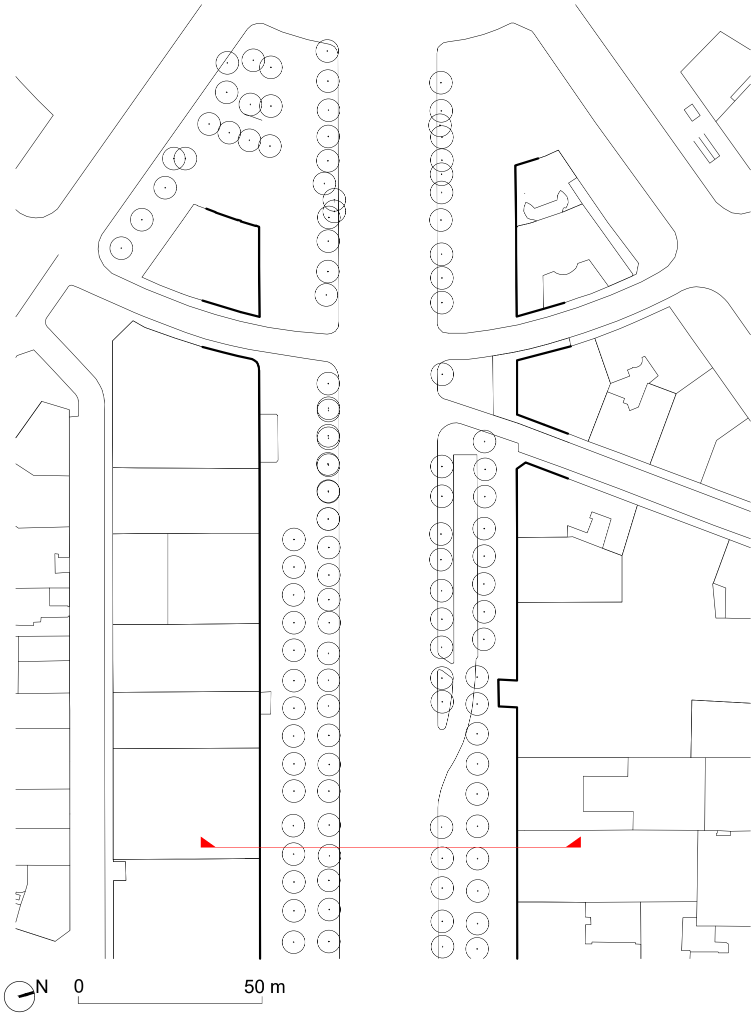
The avenue presents an extraordinary reference for the great potential of arterial streets. It consists of two different sections: The northwest section has high density and diversity, while the southeast section is characterized by gardens and open spaces that host festivals and events. The avenue offers a variety of uses that attract both locals and visitors. It is surrounded by businesses, arts and culture, gardens and playgrounds, accommodations, fine cuisine, and sports activities.

The existing roadway has no median and accommodates three lanes of traffic in each direction. It offers a favorable setting to welcome pedestrians with approximately 22-m-wide sidewalks on each side, which compose 2/3 of the overall cross-section. The pedestrian space has diverse partition compositions, including double rows of trees that buffer pedestrians from traffic and create comfortable and shaded sidewalks. The extra-wide sidewalks provide a connection to the street interface and ground floors and adequate space to accommodate the outdoor seating of cafes and restaurants (Figure 7.3-2).

In 2020, the Champs-Élysées, which over 350 years has faced numerous transformations, became part a new plan for "Re-enchanting the Champs-Élysées" ahead of the 2024 Olympic Games. Due to a transformation of the avenue's partition, the Champs-Élysées will once again become an extraordinary garden with symbolic power. Opposing the increased use of automobiles, the new project will increase pedestrian space by reducing the roadway into a two-lane dual carriageway with underground car parking (O'Sullivan, 2021).

07.3.2. Ringstrasse, Vienna, Austria

Figure 7.3-1 Satellite view of Paris indicating Avenue des Champs- Elysées. (Source: Google Earth with modifications by the author).



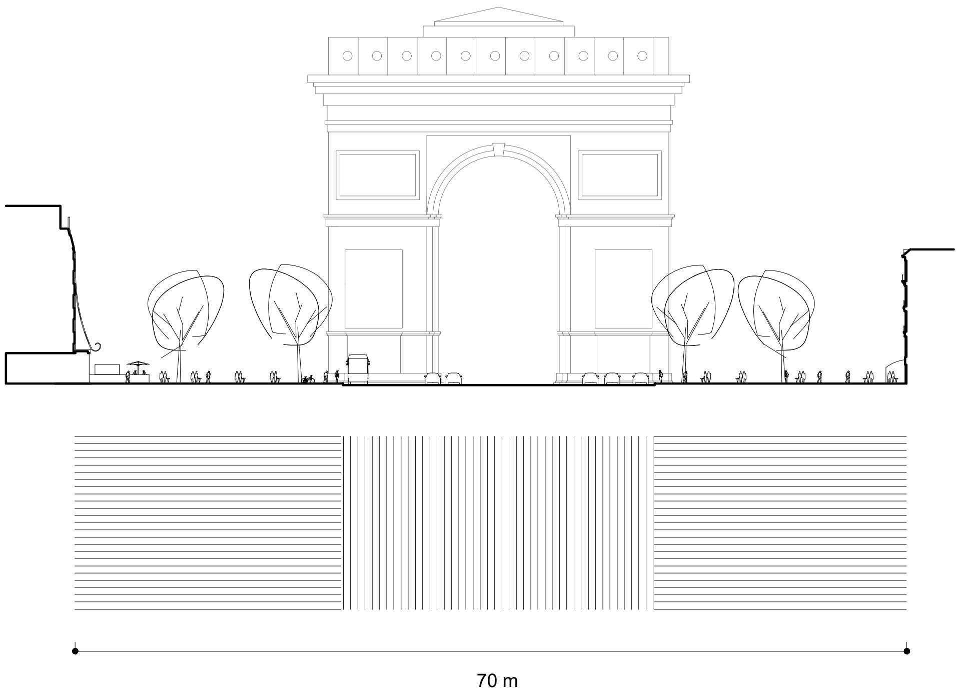


Figure 7.3-2 Plan and cross-section of Avenue des Champs- Elysées, Paris. (Source: Author's Edition).

The Ringstrasse, located in Vienna, Austria, opened in 1865 to serve as a replacement for the city's old defensive wall. The grand boulevard has been an essential urban element throughout Vienna's history and represents the city's identity. It is one of the most famous boulevards in Europe, with many monumental buildings and diverse architectural styles (Vamberg, 2015). The street encloses the city's historical part and provides permeability for the surrounding urban context. Along its margins stand the most important institutions in the city, such as the State Opera via the Kunsthistorisches Museum, the Natural History Museum, the National Library, and the University of Vienna. This street is the perimeter of an irregular polygon with a 5.3 km length and a variable width ranging from 57 to 85 m. The Ringstrasse has several connected sections that shape a dynamic center of cultural, social, business, and commerce activities. The sections include Stubenring, Parkring, Schubertring, Kärntner Ring, Opernring, Burgring, Dr. Karl Renner-Ring, Universitätsring, and Schottenring (Figure 7.3-3).

As the city's central street, the Ringstrasse is always subject to transformation. In 2015, on its 150th anniversary, the government planned a new strategy to comprehensively reform and improve the street, aiming to increase pedestrian friendliness. The Ringstrasse 2030 plan was developed in collaboration with Gehl Architects and Barcelona Regional. The long-term project with multiple phases includes a range of measures to enhance quality of life for Vienna's residents and visitors, including improving public transport, creating more green spaces, and enhancing cultural and recreational facilities. One of the key aims of the project is to reduce car traffic and increase the number of bike lanes and pedestrian zones (Vamberg, 2015).

Although the Ringstrasse is composed of several sections, it has a similar transversal cross-section configuration. The central roadway includes three lanes of traffic measuring between 10 and 14 m and flanked by a tram lane on each side. The central space for pedestrians and cyclists is around 12 m wide on each side, with two rows of trees. Currently, it is flanked by a local roadway with on-street parking with a width in total around 7.5 to 10 m, which will be replaced, when the project is completed, by extended sidewalks. The sidewalks along the street vary from between 6 and 16 m wide, connecting the public realm to the surrounding restaurants and cafes (Figure 7.3-4).

07.3.3. Unter den Linden, Berlin, Germany

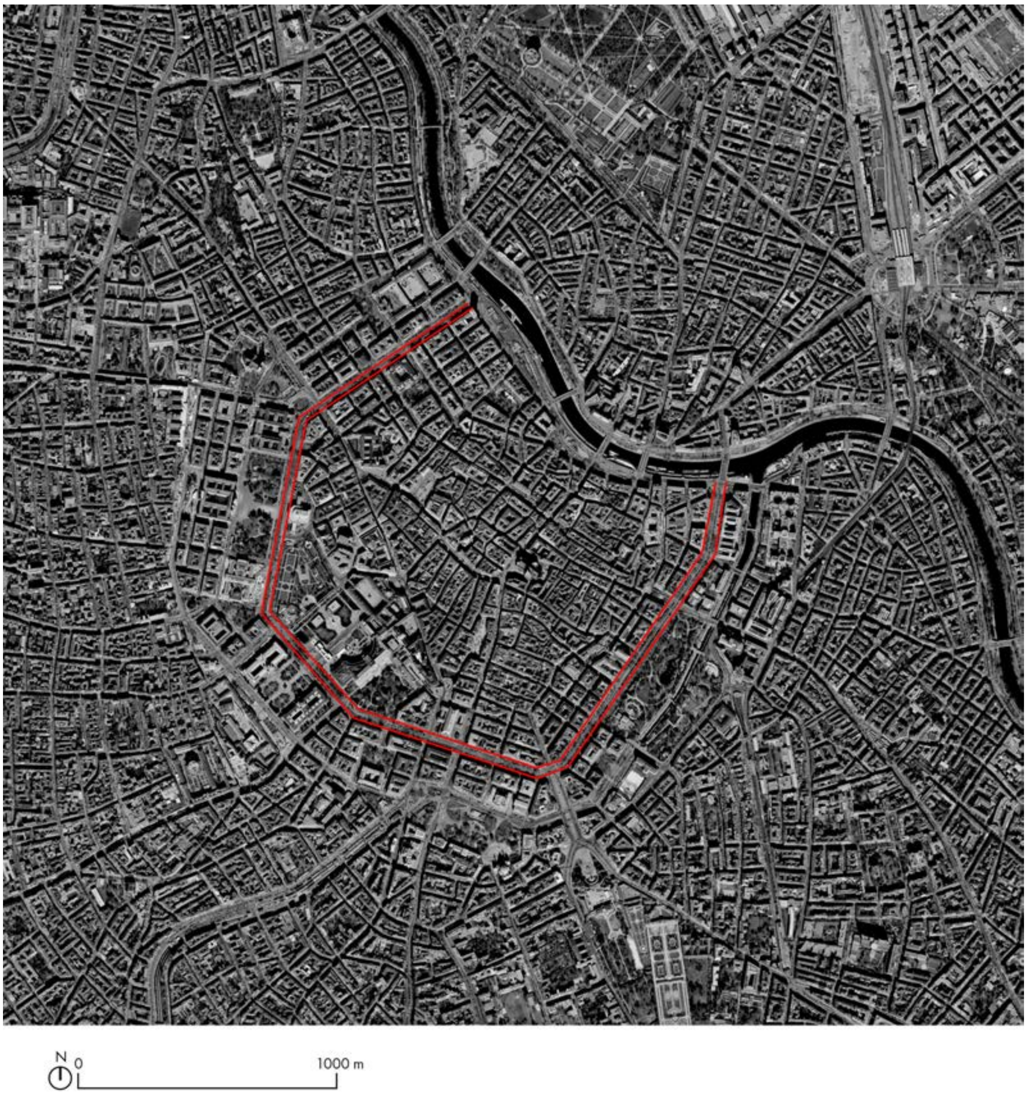


Figure 7.3-3 Satellite view of Vienna indicating Ringstrasse. (Source: Google Earth with modifications by the author).

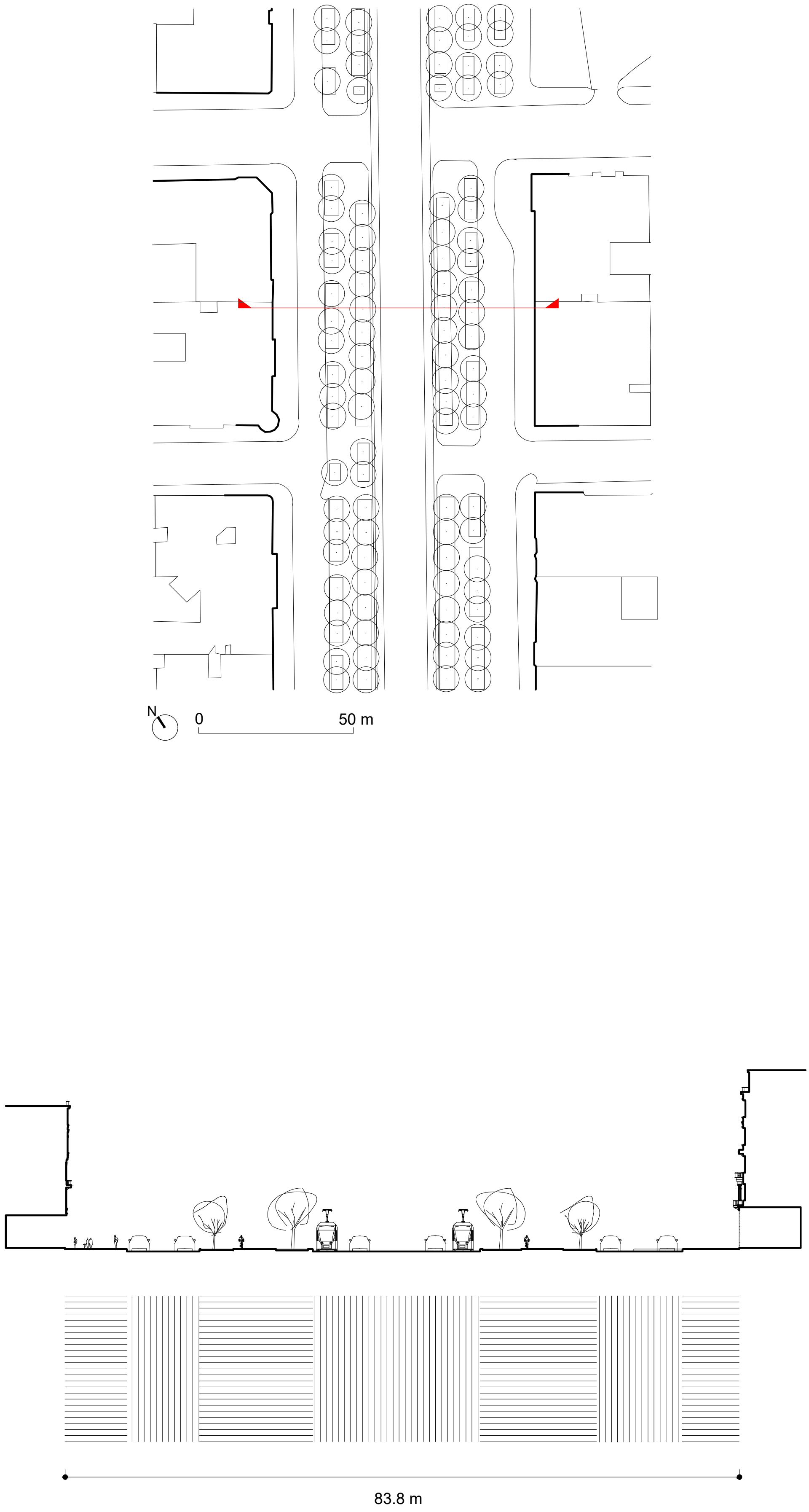


Figure 7.3-4 Plan and cross-section of Ringstrasse, Vienna. (Source: Author's Edition).

Unter den Linden is a major arterial street in Berlin that runs east to west and carries high-volume traffic with three lanes in each direction. The grand boulevard is almost 1.4 km long and 60 m wide, connecting the German Historical Museum to Pariser Platz. It is surrounded by mixed-use developments, including offices, hotels, apartments, shops, theaters, and commercial developments, with various offerings on the ground floor (Figure 7.3-5).

The street is divided into three distinct sections: the roadway, the central pedestrian space, and the sidewalk, each with different uses and widths. The roadway of about 14 m accommodates three lanes of traffic, one dedicated to busses in each direction. The central pedestrian space measures about 17 m wide. The sidewalks on each side of the boulevard connect the pedestrians with the surrounding buildings and are 5 to 10 m wide, accommodating outdoor sittings for restaurants and cafes on a lively, active street. (Figure 7.3-6). More recently, the city has planned to redesign the avenue for pedestrian friendliness by reducing the three lanes on each side in favor of walking, cycling, and public transport. The project will widen the central pedestrian space and cycle paths with two further rows of trees (Marcus, 2021).

7.3.4 Avenida Paulista, São Paulo, Brazil

Figure 7.3-5 Satellite view of Berlin indicating Unter den Linden. (Source: Google Earth with modifications by the author).

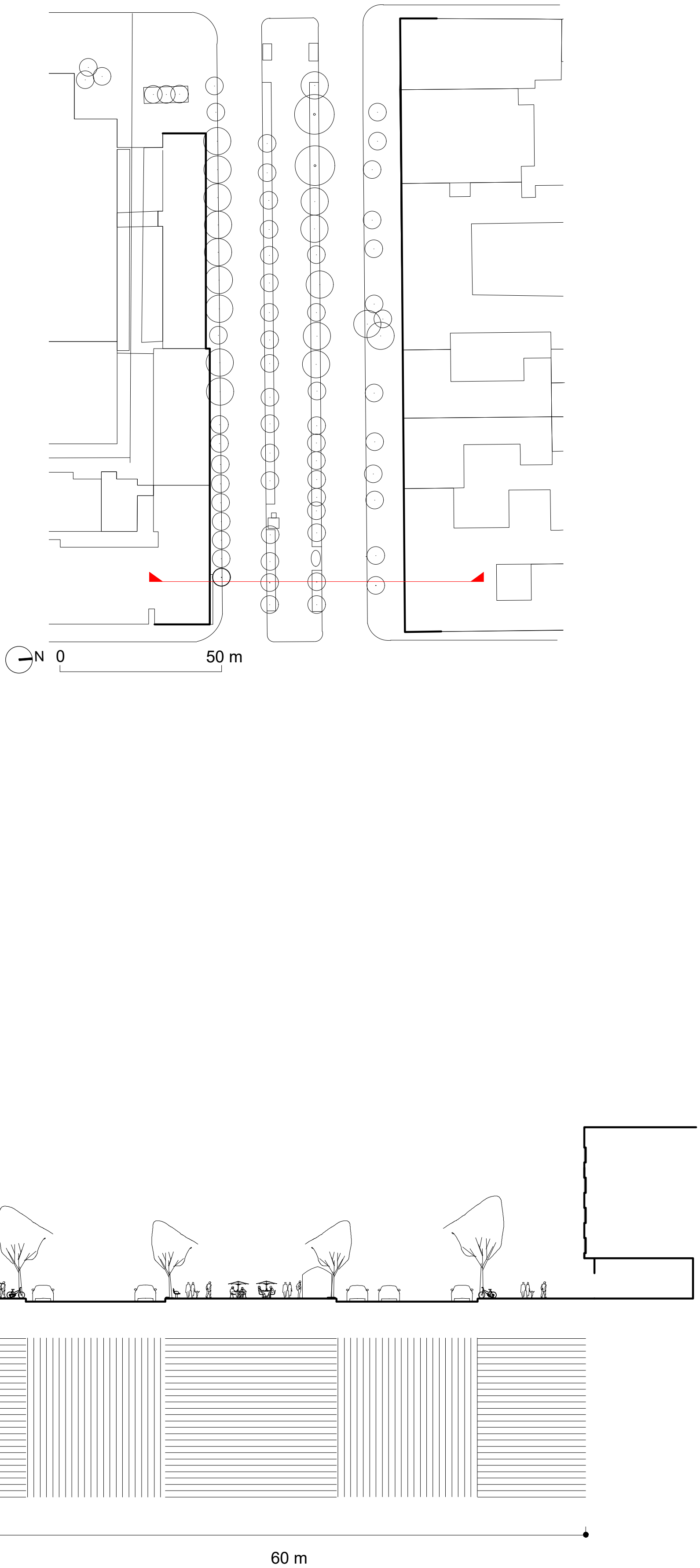


Figure 7.3-6 Plan and cross-section of Unter den Linden, Berlin.

Avenida Paulista, the symbolic linear center of São Paulo and the most crucial artery in the city (Lima, 2007), is a multifunctional urban street that combines several roles. The avenue, at 2.8 km in length and 40 to 70 m in width, creates efficient mobility through a variety of transportation modes and provides a diverse and dynamic place for public use. It is one of the most iconic and diverse morphological references in the city, with rich art, education, culture, business, and leisure activities (Figure 7.3-7).

The avenue is surrounded by high density, mixed-use plots that include commercial, cultural, residential, financial, and educational services and parks. Today, the street is a financial center, cultural hub, and tourist spot surrounded by symbolic buildings that influence the street space, generate public life, and enrich the city's image (Macedo, Lorellay and Guidoti, 2019). It is integrated with the surrounding buildings on the ground-floor level, which generates dialogue between public and private spaces.

As a linear center, Avenida Paulista balances the needs of pedestrians and different modes of transportation. The pedestrian space varies between 6 and 16 m wide, with a central cyclist's lane (Figure 7.3-8). This space is well-connected to the surrounding urban structure through several buildings that generate porosity, such as the Museu de Arte de São Paulo and Conjunto Nacional. The avenue's permeability promotes sociability, contributes to ordering the space, enriches spatiality, and encourages public life. In 2015, the avenue witnessed a transformation aimed at fostering pedestrians' use of the street space by banning vehicles on Sundays and holidays. This demonstrates the avenue's symbolic prominence in the city's dynamic public life needs (Figueiredo, 2022).

07.3.5. Avenida 9 de Julio, Buenos Aires, Argentina

Figure 7.3-7 Satellite view of São Paulo indicating Avenida Paulista. (Source: Google Earth with modifications by the author).

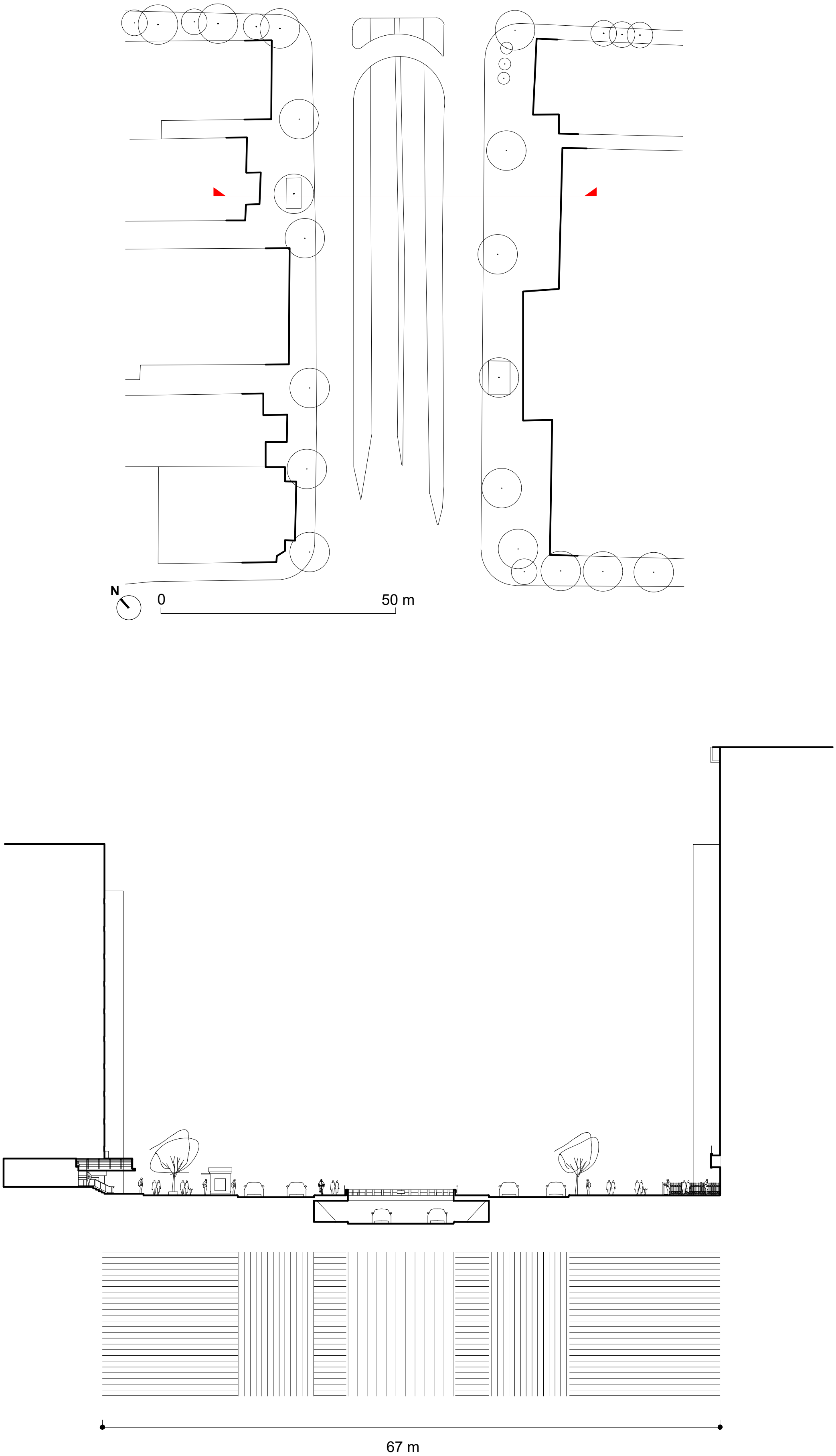


Figure 7.3-8 Plan and cross-section of Avenida Paulista, São Paulo. (Source: Author's Edition).

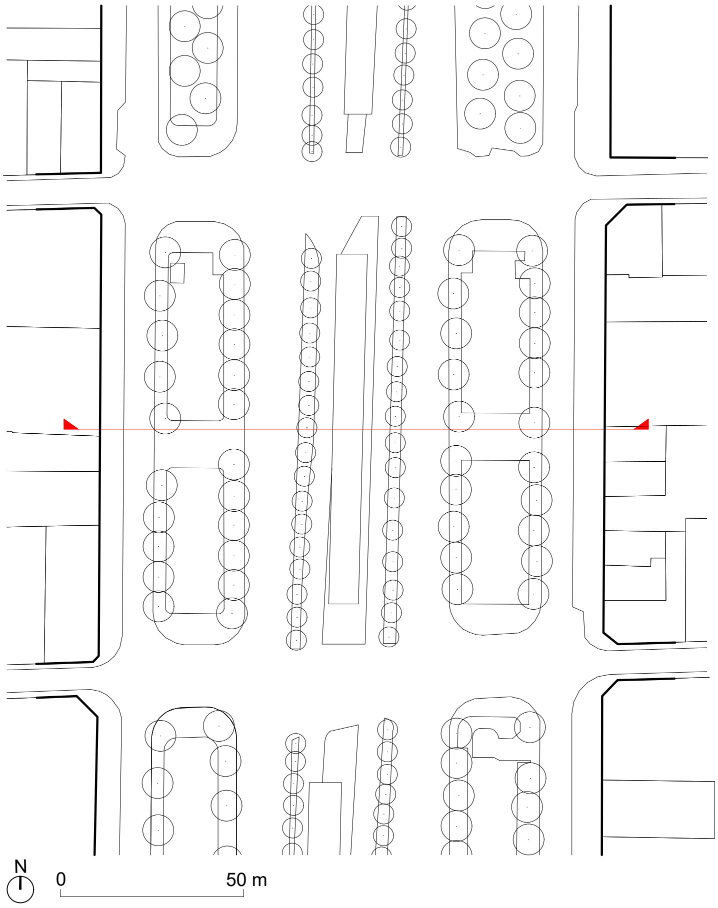
Avenida 9 de Julio is one of the widest avenues in the world at approximately 140 m, with a length of 3 km. The street was constructed in 1935 to form a symbolic linear urban element that runs north to south through the eastern part of Buenos Aires (Figure 7.3-9). It represents an iconic public space, as its name refers to the independence day of Argentina (ITDP, 2020).

In 2013, Avenida 9 de Julio witnessed an extensive transformation aimed to create pedestrian friendliness. Before the intervention, the avenue was mainly dominated by automobiles in 20 lanes. As part of a citywide sustainable mobility plan, the recent project reformed the street profile through the introduction of the bus rapid transit (BRT) project and the creation of wide pedestrian spaces to encourage walking and cycling, prioritizing people over cars (ITDP, 2020).

The avenue offers a significant route with multiple transportation modes. Its partition comprises complex and diverse compositions that accommodate users' needs. Although the cross-section is uniquely wide, the street balances pedestrians and automobiles. Its composition is characterized by a central BRT space of 20 m, with one lane in each direction. The roadway has a central part with five lanes measuring 16 m and a local part with three lanes and on-street parking measuring 10 m. These are separated by a central pedestrian space with two rows of trees. The sidewalk on each side measures 5 to 10 m (Figure 7.3-10).

07.3.6. Orchard Road, Singapore

Figure 7.3-9 Satellite view of Buenos Aires indicating Avenida 9 de Julio. (Source: Google Earth with modifications by the author).



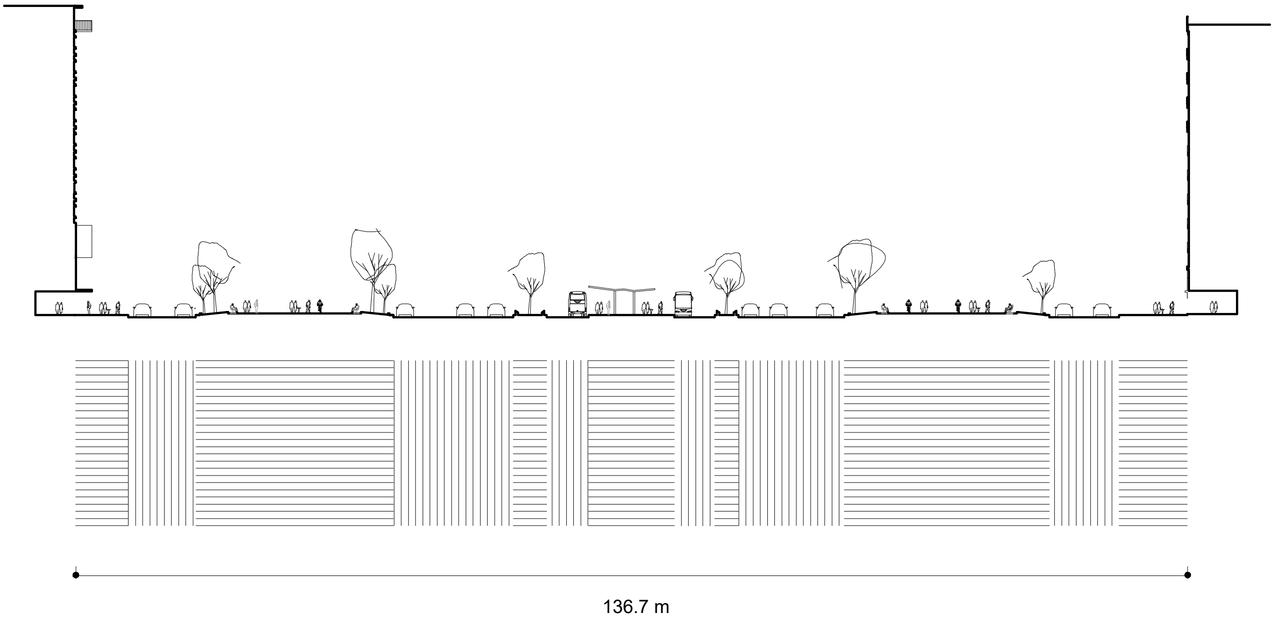
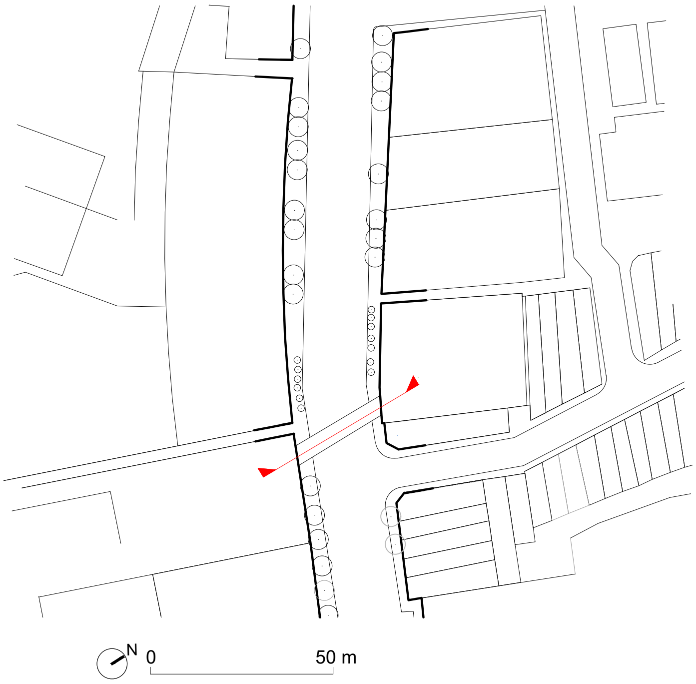


Figure 7.3-10 Plan and cross-section of Avenida 9 de Julio, Buenos Aires. (Source: Author's Edition).

Orchard Road is Singapore's premier shopping belt. The grand boulevard provides a vibrant public space lined with shopping malls, hotels, and other commercial and business activities (Yeung and Savage 1996). Orchard Road, at 2.5 km long and 30 and 50 m wide, has overlapping functions between the street and the surrounding context, providing interaction between pedestrians and the street interface (Figure 7.3-11). The interface is configured to promote the connection between public and private spaces. The individual buildings enhance permeability and strengthen pedestrians' access to the street by offering all-weather-protected pedestrian walkways with a high degree of visual and physical porosity.

The street has a comprehensive pedestrian network on the first, basement, and second stories, providing convenience and comfort. The sidewalk on both sides varies in width between 4 and 14 m and is flanked by trees, providing staging grounds for various pedestrian activities. The street partition is composed of separated spaces between pedestrians and automobiles, with a balanced height-to-width ratio of buildings providing a sense of enclosure (Figure 7.3-12).

Figure 7.3-11 Satellite view of Singapore indicating Orchard Road. (Source: Google Earth with modifications by the author).



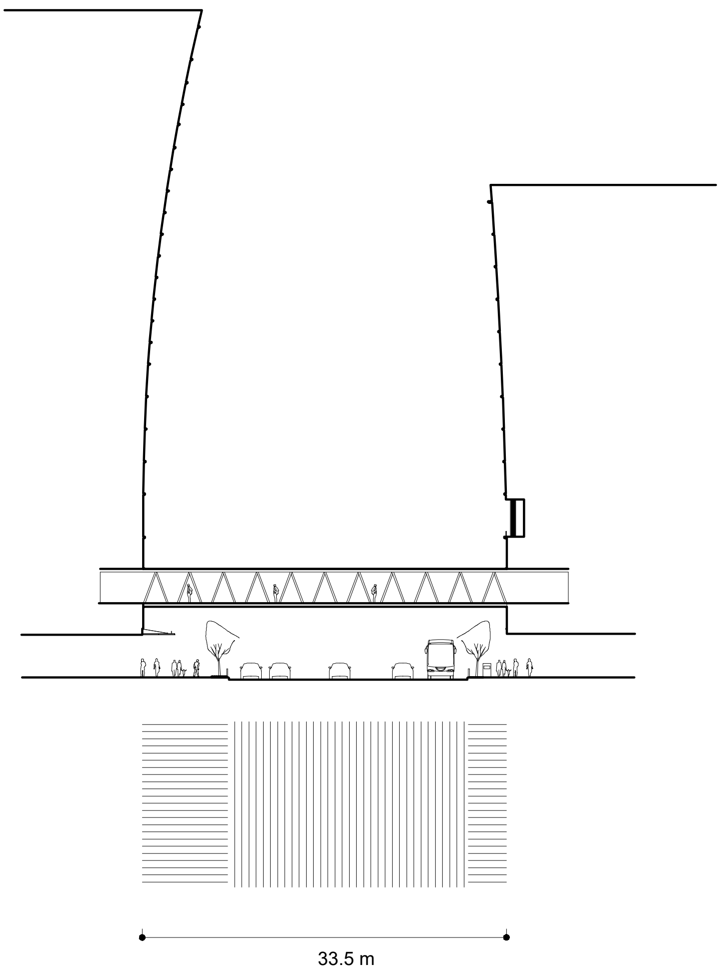
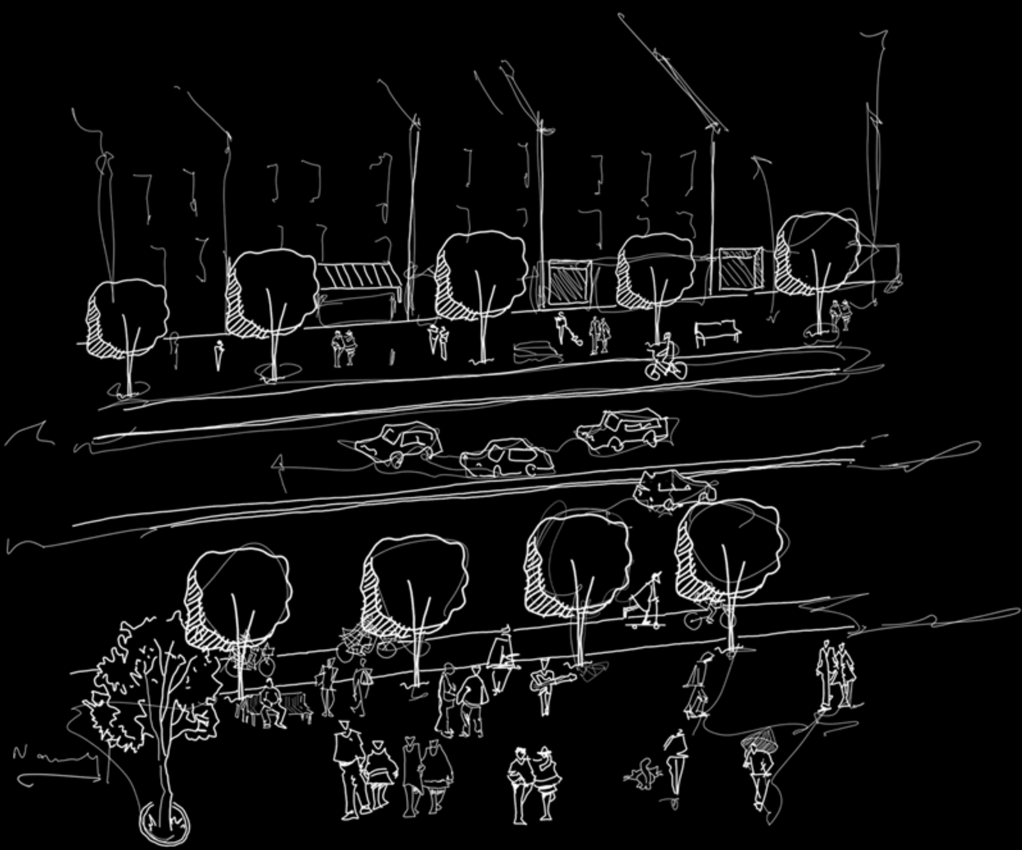


Figure 7.3-12 Plan and cross-section of Orchard Road, Singapore. (Source: Author's Edition).

"Only places which are accessible to people can offer them choice. The extent to which an environment allows people a choice of access through it, from place to place, is therefore a key measure of its responsiveness."

Bently *et al.*, 1985



08. Decoding arterial street livability

This chapter introduces an analysis of the main case studies supported by other livable streets. The author describe the applied research methodology for decoding the complexity of the arterial street through an interdisciplinary multiscale approach. The morphological interpretation and comparative study of public life are organized from the macroscale to the microscale. Each of the three subchapters addresses both Avenida da República, Lisbon, and Avinguda Diagonal, Barcelona, starting with the urban structure on a macroscale, then the street partition on a mesoscale, and then the arterial street interface on a microscale.

08.1. The urban structure

08.1.1. The urban structure: Avenida da República

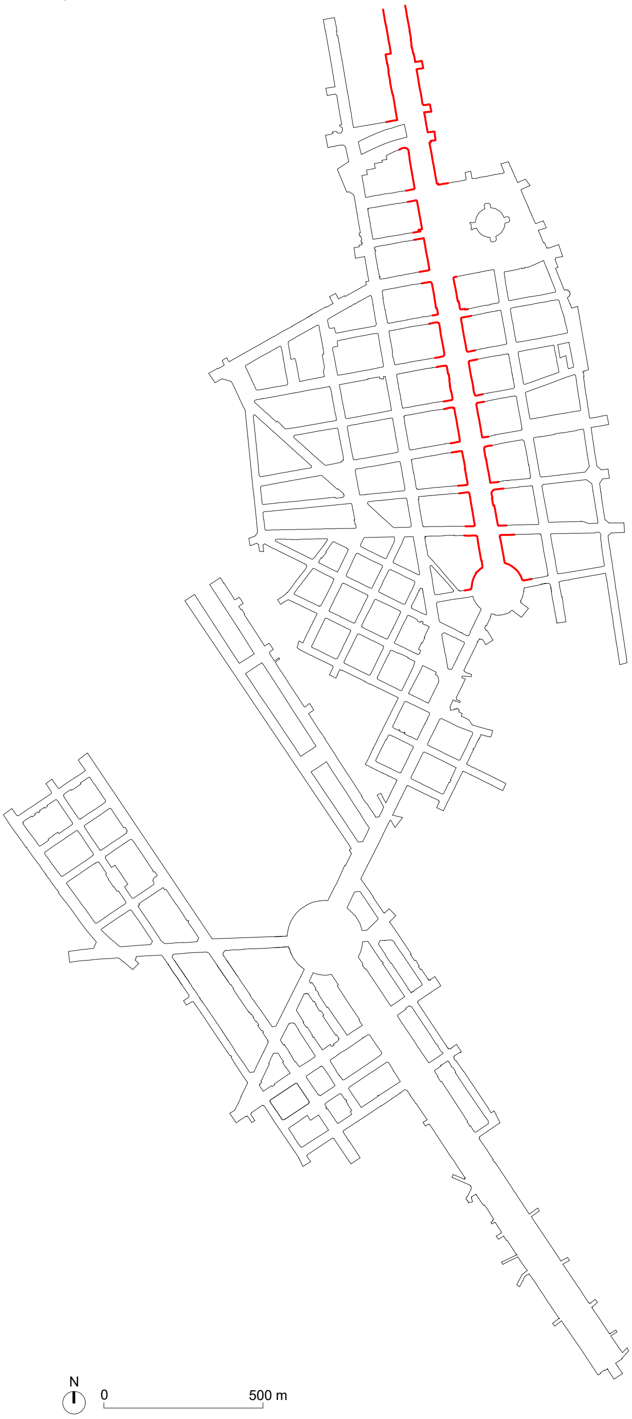
The urban form of Lisbon has faced several historical moments due to its placement on a land managed by different peoples and cultures, from the twelfth century BC Phoenicians to the thirteenth century Muslims, which inevitably left marks on the city's structures. As previously discussed, the capital has, throughout its history, various examples of urban expansion and rebuilding. One of the most significant expansion operations was carried out in the second half of the 19th century, structured around the city's main artery, Avenida da Liberdade, which replaced the previous Passeio Público and extended its layout northwards along the Valverde Valley. Population growth at the end of the 19th century then led to the development of the Avenidas Novas Plan, which constituted a node of articulation with other points in the city (Silva, 2006). This study of Avenida da República on a macroscale covered the urban structure of the Avenidas Novas area.

The urban structure of the Avenidas Novas is based on an orthogonal grid adapted to preexisting paths and rural roads and rotated according to the topography and land availability at the time of its establishment. The Avenidas Novas area has by a gridiron street pattern with long, straight streets intersecting at right angles. These linear elements organize the urban structure and support movement patterns and connections to the rest of the city. The area is well-connected to the central area of Lisbon by the city's main axis, which runs from south to north and is composed of the Avenida da Liberdade, the Avenida Fontes Pereira de Melo, and the Avenida da República. Avenida da República represents the widest and longest avenue in the morphological region of the Avenidas Novas, the main linear element of the urban composition, with a leading role in ordering the orthogonal street and block pattern (Figure 8.1-1).

The Avenida Novas area has a clear hierarchy in the width and length of the streets that generates a functional differentiation of street types and provides spatial organization. In parallel to Avenida da República, the north-south-oriented streets include Avenida 5 de Outubro, Avenida Defensores de Chaves, Avenida Marquês de Tomar, and R. Dona Filipa de Vilhena. West-east-oriented streets include Avenida de Berna, Avenida Duque de Ávila, Avenida João Crisóstomo, and Avenida Miguel Bombarda. This underlying structure implies permeability, as the grid pattern has a hierarchy of movement beginning with the Avenida da República and progressing into the narrower cross streets (Figure 8.1-2).

This study of the Avenidas Novas revealed different urban blocks with inhabited rear courtyards (Figure 8.1-3). The gridiron street pattern creates a regular pattern of a predominantly rectangular blocks, a few irregular-shaped blocks, and square blocks in the Picoas zone located northwest of Avenida Fontes Pereira de Melo. Avenida da República and the south-north parallel streets contribute to this urban block orientation and their morphological characteristics. The east-west streets define the blocks' front length and determine the intersection frequency. However, there is a contrast between the southern section of the street and the northern one. According to the study, each section had various permeability opportunities or problems that affected its accessibility. The study revealed that the southern section of the avenue has small rectangular blocks ranging from 100 x 120 to 100 x 150 m, with street intersections every around 110 m. However, after Campo Pequeno, the northern part of the avenue has a large block size of around 200 m long and fewer street intersections (Figure 8.1-4).

8.1-1



8.1-2

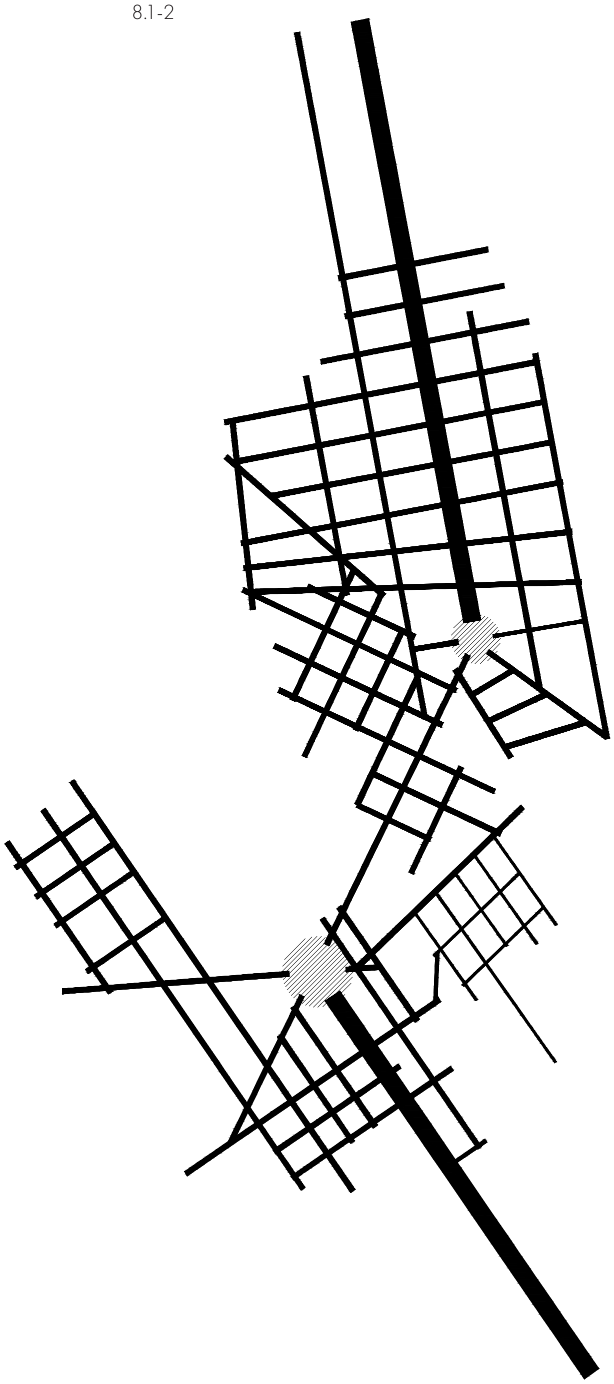


Figure 8.1-1 The urban layout of Avenidas Novas, Lisbon. (Source: Proença, 2014).
Figure 8.1-2 The street hierarchy of Avenidas Novas, Lisbon. (Source: Proença, 2014).

Figure 8.1-3 An aerial view shows the common occupation of the urban blocks' courtyards of Avenidas Novas, Lisbon. (Source: Author's Edition, 2022).

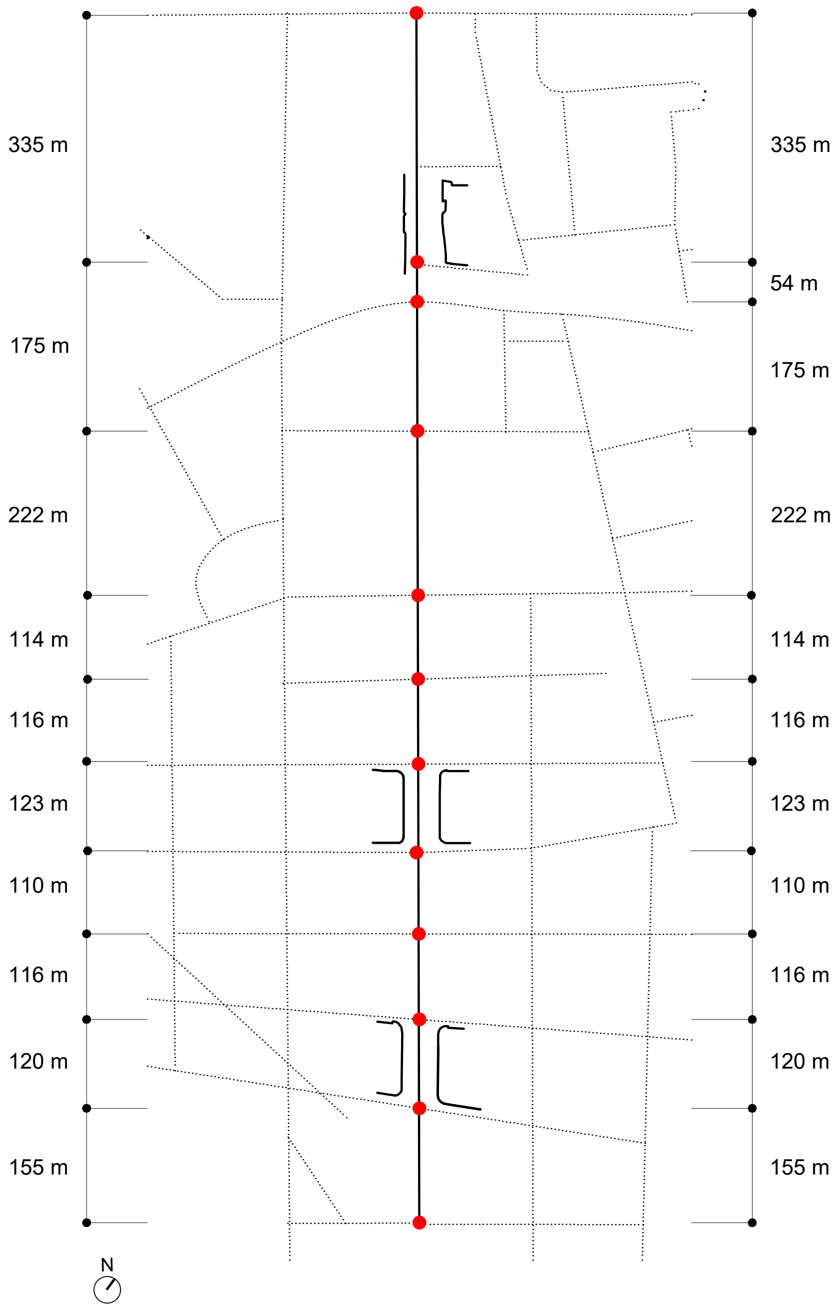


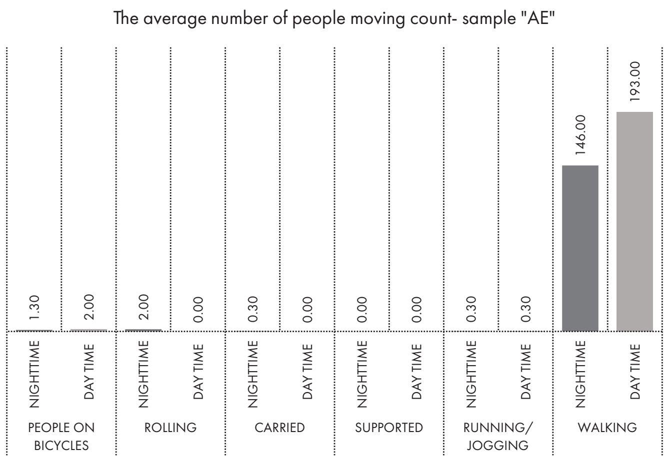
Figure 8.1-4 The street intersection frequency of Avenida da República. (Source: Author's Edition).

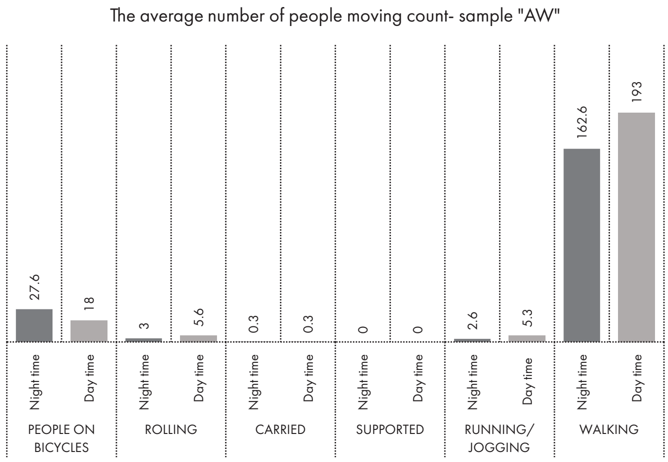
08.1.1.1. Avenida da República pedestrians' flow

Avenida da República, as a part of the city's main axis, has continuous public space connected to its surrounding areas. According to the public life study results, the avenue stimulates and invites public life. The physical characteristics of the urban structure were reflected in the maintenance of pedestrian flow day and night and in the positive interactions between pedestrians of different ages and genders. The spatial layout of street and block patterns thus seems to play a vital role in pedestrian volume and movements.

Nevertheless, the study found a significant contrast in pedestrians' flow between the northern and southern sections. The southern samples, including Samples AE, AW, and BW, had a high number of pedestrians and cyclists compared to Sample BE and the northern Samples CE and CW. On average, the number of people counted in Sample AW indicated high pedestrian volume, with 418.3 people per 10 minutes, while Sample AE had 345.20 people per 10 minutes and Sample BW had 337.1 people per 10 minutes (Figure 8.1-5). These samples have a high frequency of transversal streets that facilitated pedestrians' and cyclists' movement. Pedestrian flow was significant in these three samples during the day and night, which translated the role of block size and street intersection frequency in pedestrians' movements. However, other factors, such as permeability within the block, play a role in pedestrian flow and volume. Thus, Sample BE presented fewer pedestrians with 123.8 people per 10 minutes (Figure 8.1-6).

The study found a contrast in the northern samples, where the average number of pedestrians per 10 minutes was 52.6 in Sample CE and 119.1 in Sample CW. Although these samples are next to several attractions, bus stops, metro stations, and a train station, they had less than half of the southern samples' pedestrian volume. This casts light on how lack of permeability and proper pedestrian and cycle access affect pedestrian flow (Figure 8.1-7).





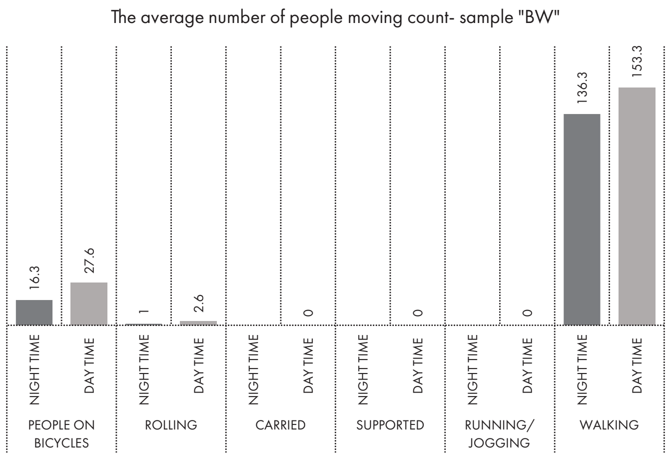
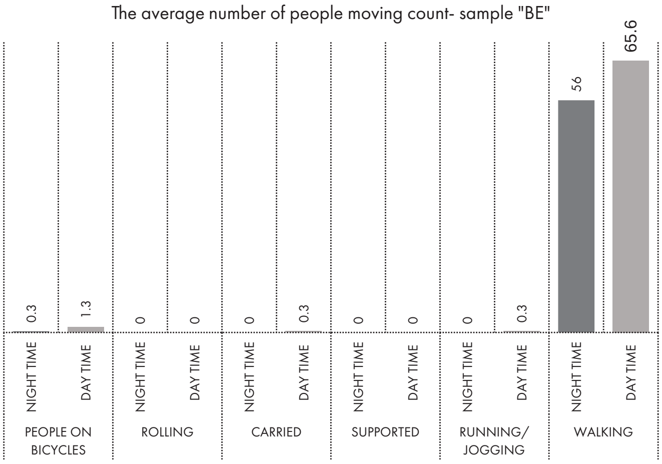
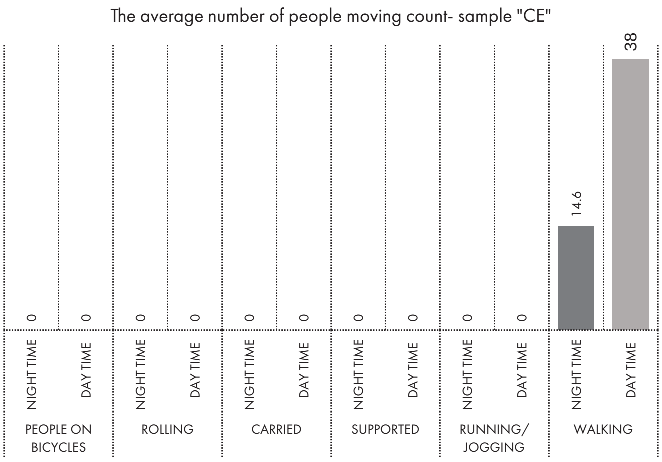


Figure 8.1-5 The average pedestrian count for samples "AE," "AW," and "BW" along Avenida da República.





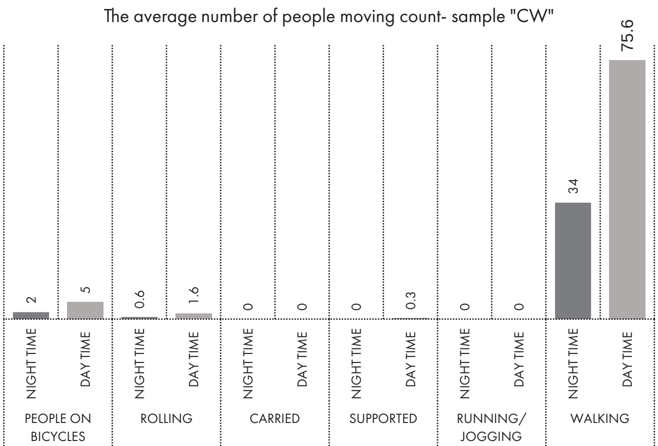


Figure 8.1-6 The average pedestrian count for sample "BE".
Figure 8.1-7 The average pedestrian count for samples “CE” and “CW”.

08.1.2. The urban structure: Avinguda Diagonal

The Diagonal is the spine of Barcelona's urban fabric, a linear element inseparable from its surrounding urban structure. The mountains on one side and the sea on the other side embody the avenue's identity. As previously mentioned, this street runs from northeast to southwest and is one of a series of axes that break into the regular streets with block patterns measuring about 113 x 113 m. The Diagonal has faced three notable periods of construction that created three sections in the avenue's form (Llano, 2016).

The first section is the Diagonal's central section, originally designed by Cerdá when he planned the Eixample. The section runs from Francesc Macià to Plaza de Les Glòries and is approximately 3.7 km long and 50 to 60 m wide. It is a vibrant and active place with about 7-to-9-m-wide sidewalks to both the north and south dedicated to pedestrians, cyclists, and bus stops aligned with Platanus x hispanica trees every five meters. This study indicated the essential role of the section as a movement link, with four lanes in the southwest direction and four in the northeast direction (Figure 8.1-8). The central section has mixed uses, including residential, commercial, and institutional with uses on the ground floor level including restaurants, services, and specialties. The buildings surrounding the section vary in height, with most being between seven and nine floors (Figure 8.1-9). One of the distinctive features of this section is that it reflects the architectural evolution of Barcelona.

The second section is an entrance to the city from the Municipality of Esplugues de Llobregat, with a total length of 3.8 km and a width range of 85 to 110 m. This section is the widest of the entire Diagonal with different partition compositions, including pedestrian sidewalks, around 15 m of central pedestrian space, bike lanes, a tram line, and a central roadway with four lanes in the southwest and five in the northeast. The south side has an active sidewalk with different bus and tram stops, while the north side is composed of different partitions and sidewalk levels (Figure 8.1-10). There are several landmarks in this section, such as Cervantes Park, the university courts, the tennis club, the Congress Palace, the university faculties, the Royal Palace of Pedralbes, and the Plaza Pius XII. The front of the Royal Palace and the Cervantes Park are configured as large gardens. On the ground floor, there are mixed uses, including commercial buildings. This section represents a critical institutional and commercial area with large buildings mostly between seven and nine floors (Figure 8.1-11).

The last section, which runs from Plaza de las Glorias to the Fórum, is the extension of the Diagonal to the Mediterranean Sea, 50 to 110 m wide and 2.85 km long. The section is composed of a roadway with three lanes in the southwest direction and three in the northeast direction, a tram lane in both directions, sidewalks, and around 15 m of central pedestrian space (Figure 8.1-12). This is one of Barcelona's most recently developed areas, with service and commercial uses (hotels, administrative towers, shopping centers, and offices) and green areas.

Large parks such as Parc del Center del Poblenou, designed by Jean Nouvel, and the Diagonal Mar Park, designed by Enric Miralles, characterize the section. There are also emblematic city buildings such as La Torre Agbar, the Centro Comercial Glorias, and the Centro Comercial Diagonal Mar and important hotels such as the Silken Diagonal, Novotel Barcelona, Amrey Diagonal, and ME Barcelona Hotel, with others still under construction. The buildings surrounding the street vary in height, with most between nine and ten floors (Figure 8.1-13).

Figure 8.1-8 The Diagonal central section and the study selected sample "A." (Source: Author's Edition).

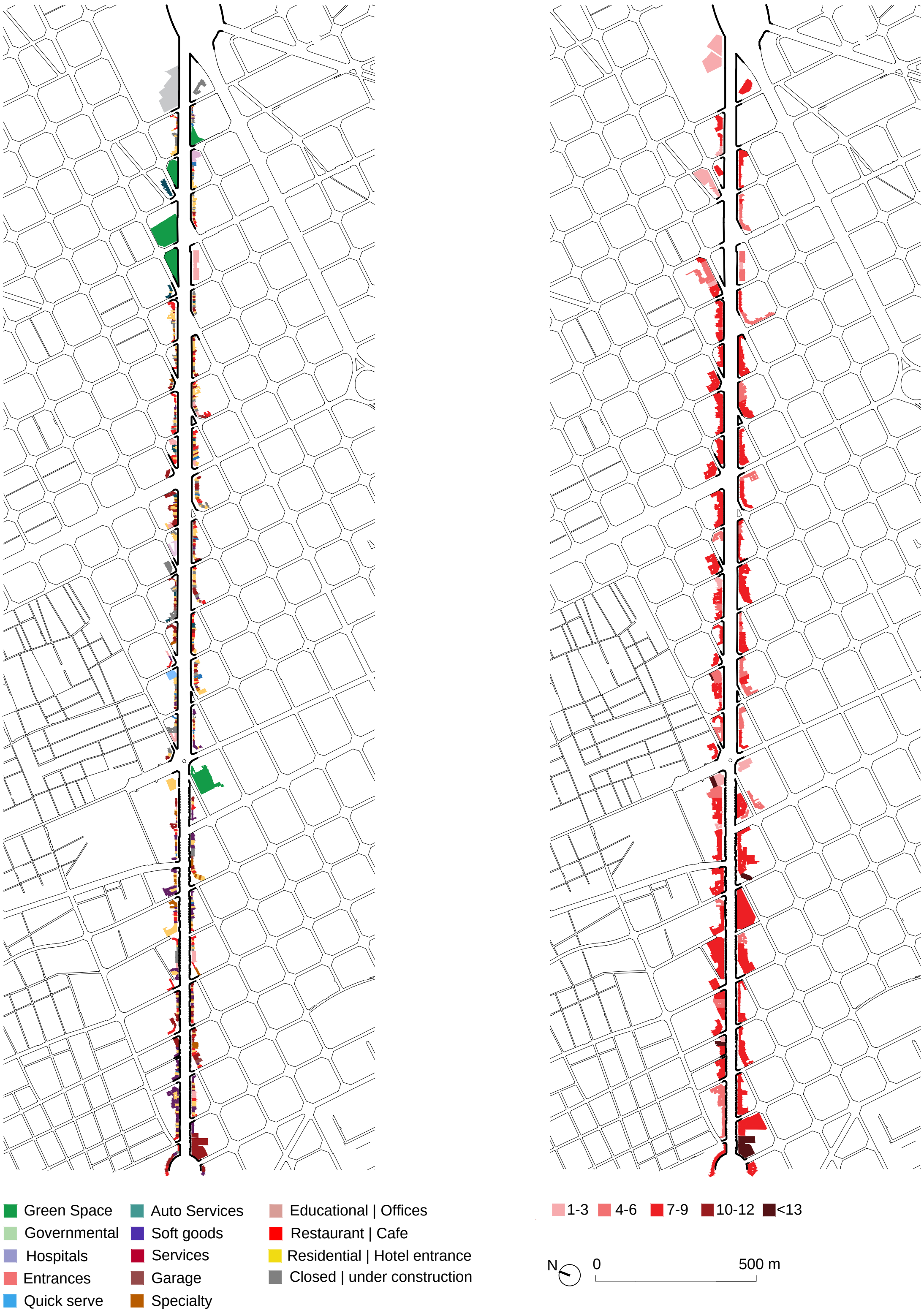


Figure 8.1-9 The ground floor uses and building heights along the central section of the Diagonal. (Source: Author's Edition).

Figure 8.1-10 The Diagonal second section and the study selected sample “B.” (Source: Author’s Edition).

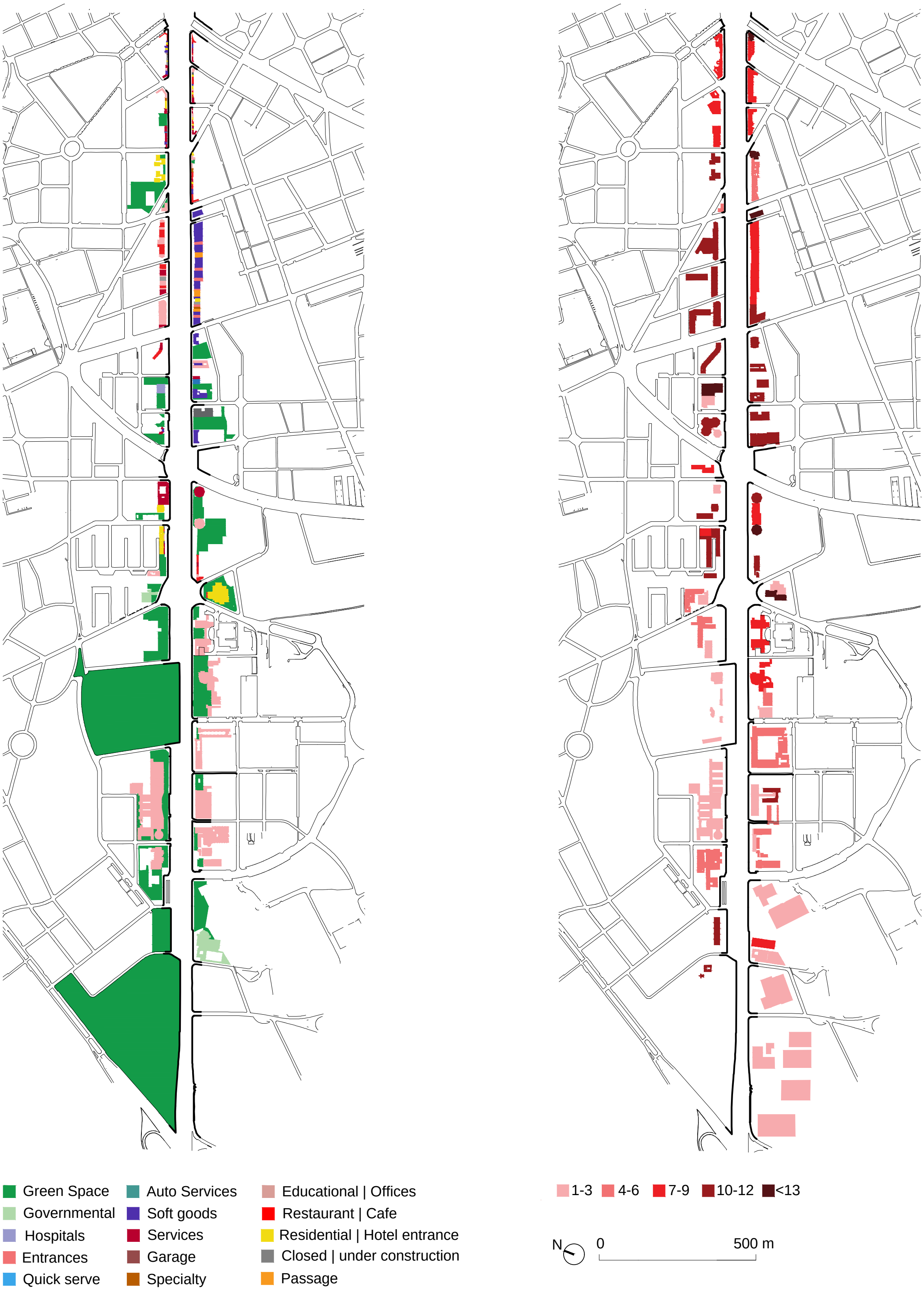


Figure 8.1-11 The ground floor uses and building heights along the second section of the Diagonal. (Source: Author's Edition).

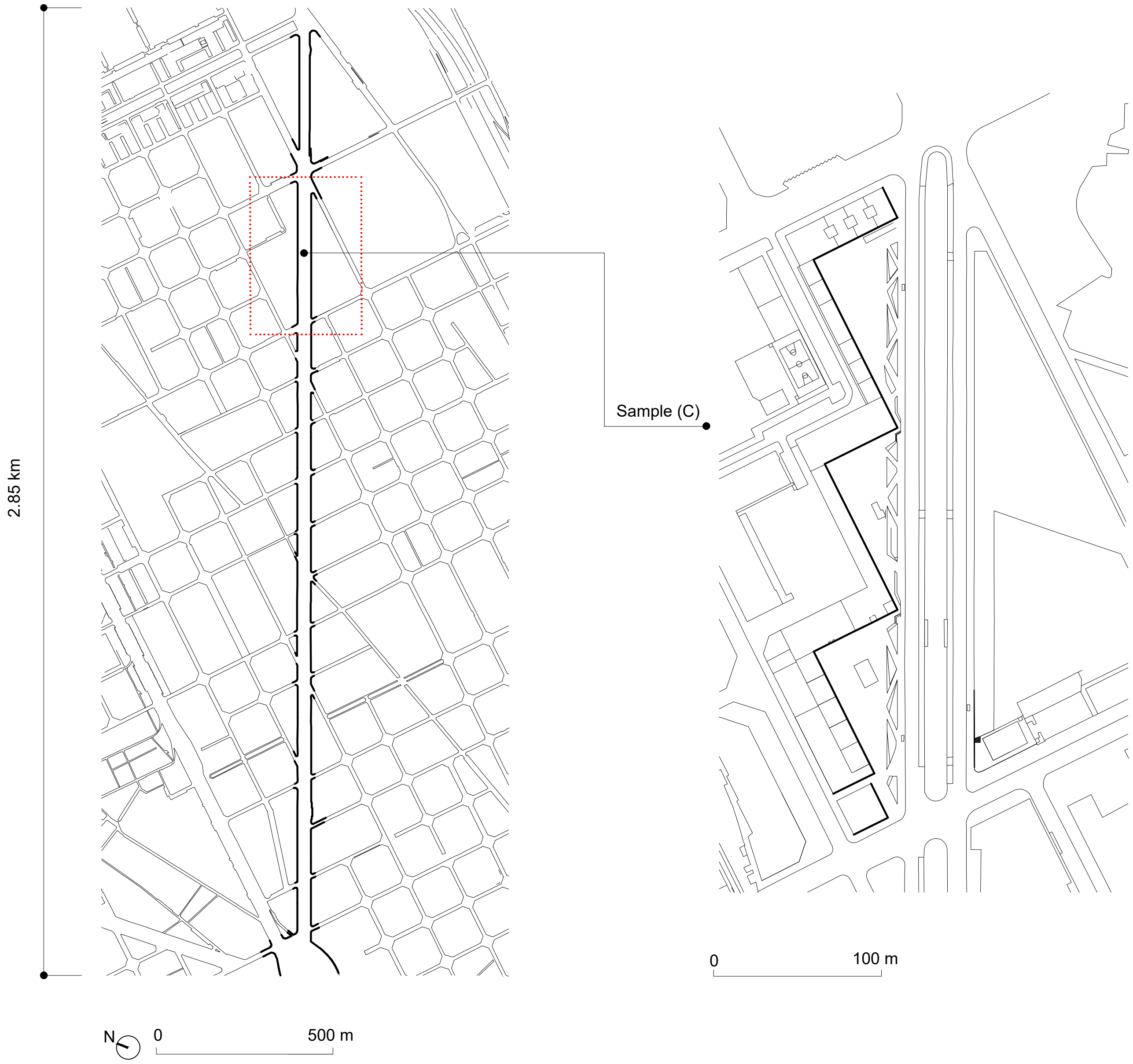


Figure 8.1-12 The Diagonal last section and the study selected sample "C". (Source: Author's Edition).

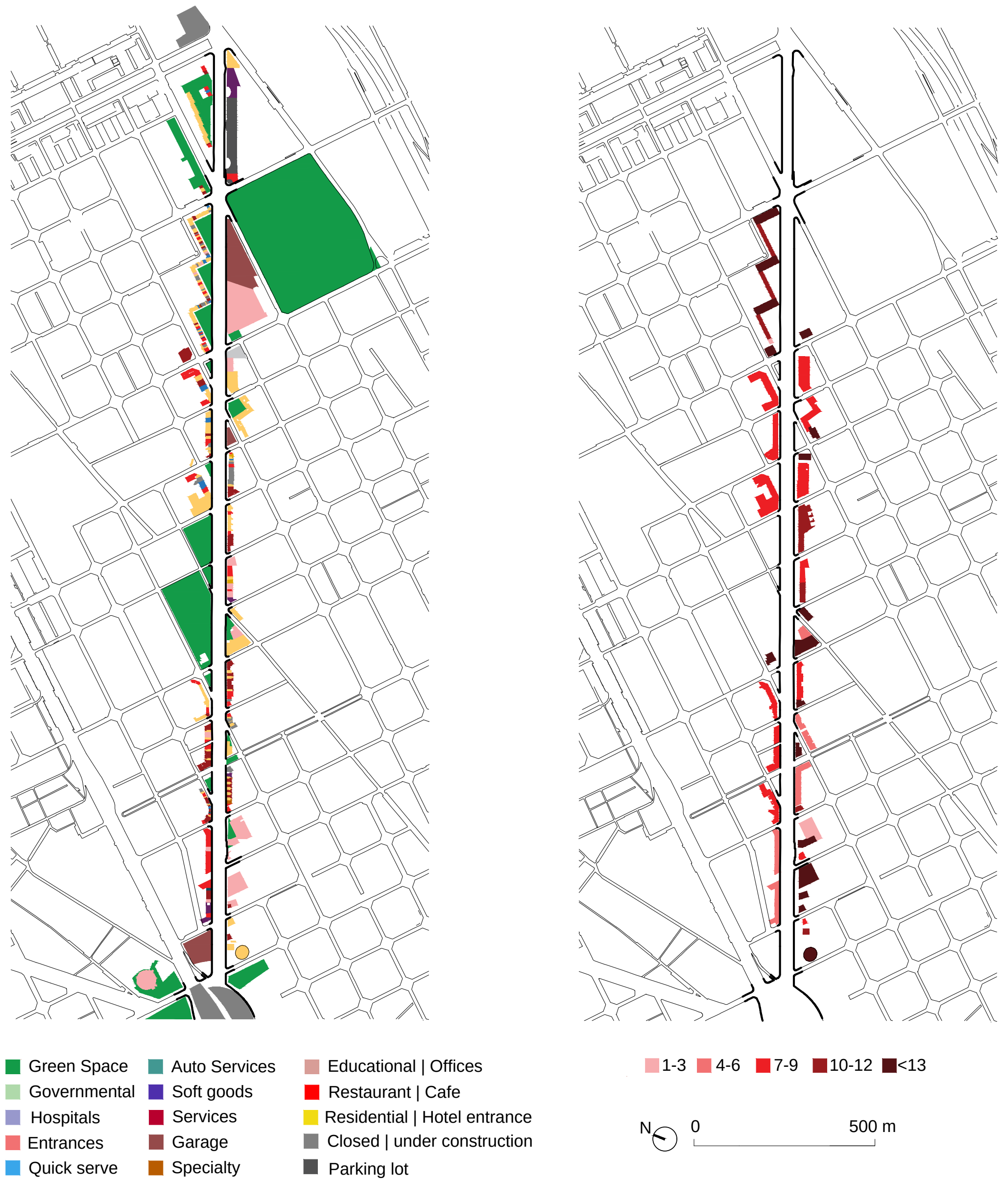


Figure 8.1-13 The ground floor uses and building heights along the last section of the Diagonal. (Source: Author's Edition).

08.1.2.1. The street and block patterns

The urban structure surrounding the three sections of the Diagonal has the urban block with chamfered corners as the basic structural cell (Figure 8.1-14). These manzanas, although maintaining the same rhythm and composing a unique urban fabric, support variations that produce a rich diversity of urban spaces. Thus, the city has different spaces for sociability and continuity of pedestrian and vehicle flows. The study of the street and urban block patterns found that a grid of streets separates the block arrangement with 20 m width for secondary streets or 50 m width for major streets. The intersections provide a strong image of the city and highlight the equitable distribution of urban open space for pedestrians and vehicles. The street and block pattern analysis indicated an equal proportion of spaces between pedestrians (50%) and vehicles (50%). Such spatial patterns remained constant, whether on 20-m-wide streets or on large avenues that cross the entire city.

This suggests a clear hierarchy in street layout, which contributes to the city's legibility. The street widths range from 20 to 60 m, which supports the importance of the streets' spatial order. Major avenues such as the Diagonal, the Meridiana, the Parallel, the Gran Vía de las Cortes Catalanas, and the Paseo de Gracia are between 50 and 60 m wide. They were formed to be major linear elements of the urban structure and share formal characteristics. Thus, the Diagonal's notable wide cross-section plays a role in the city's spatial identity but also reinforces the street's hierarchal place in its urban context. Although each street corresponds to a unique morphological character, some streets share a similar hierarchy in terms of width and length. The city's urban layout's major linear elements stand out due to their great size (Figure 8.1-15).

Although the urban pattern of Barcelona appear rigid and repeated, it provides enormous spatial flexibility and has allowed for variations in the city's development. The morphological adaptability of the manzana as the basic organizational unit allows innumerable solutions for pedestrians' and cyclists' urban permeability. The urban block chamfers in the first, central section are composed of buildings and sidewalks cut at a 45º angle, allowing for continuous street intersections. The amplitude of the generated spaces encourages complementary activities such as shops and outdoor seating, providing space for public life. In the central section, the block plays a prominent role in permeability. The intersections every 130 to 140 m enable various possibilities for accessibility and maintain good traffic flow (Figure 8.1-16). The block's frontage allows frequent connection between the avenue and the surrounding streets, thus encouraging movement and providing easy access from and to the avenue (Figure 8.1-17).

Though similar in nature, the second section, located in the area known as Zona Universitária, has different urban patterns in some parts due to the large buildings and dissimilar uses. This section includes most of Barcelona University's faculty buildings, office blocks, hotels, and the famous Pedralbes Palace Gardens and Parc de Cervantes (Figure 8.1-18). It offers different block shapes and sizes, starting from 116 x 95 m and ranging to 260 x 320 m, while the street intersections are every 150 to 200 m (Figure 8.1-19).

The third section of the avenue has a variety of block sizes and shapes, from chamfered blocks to large triangle blocks. However, in some of the surrounding areas, such as the district of Sant Martí de Provençals, the study found continuity of the Eixample district urban pattern with different occupations, allowing for more open spaces and less building density (Figure 8.1-20). This adaptability came from the existence of a fixed pattern, which is reflected in the frequency of street intersections, almost every 150 m (Figure 8.1-21).

The city's urban structure, based on an orthogonal grid diagonally overlapped by the avenue, facilitates mobility, allowing permeability along the Diagonal and throughout the city. This was found during the study of the avenue intersection frequency. Though street intersection density is just one facet that encourages public life, the grid patterns offered direct routes for navigation during the study. Inside city blocks are open spaces that connect the urban pattern and serve as a pedestrian getaway. As seen in Sample B, these spaces offer pedestrian permeability that enriches public and collective life. For example, the morphological interpretation in Sample BS found a large block size 343 m long occupied by the L'illa Diagonal shopping center. The block introduces a series of passageways that interconnect commercial galleries and patios, opening to the perimeter streets around the block. This network of permeable collective spaces combines architecture and streets around the block, thus generating settings for pedestrian permeability and social encounters (Figure 8.1-22). These threshold private spaces of public use, in a defined period of the day, provide expansions of the public space and catalysts of public life.

Figure 8.1-14 An aerial view shows the typical chamfered urban block of Barcelona and the common occupation of the blocks' courtyards. (Source: Author's Edition, 2022).

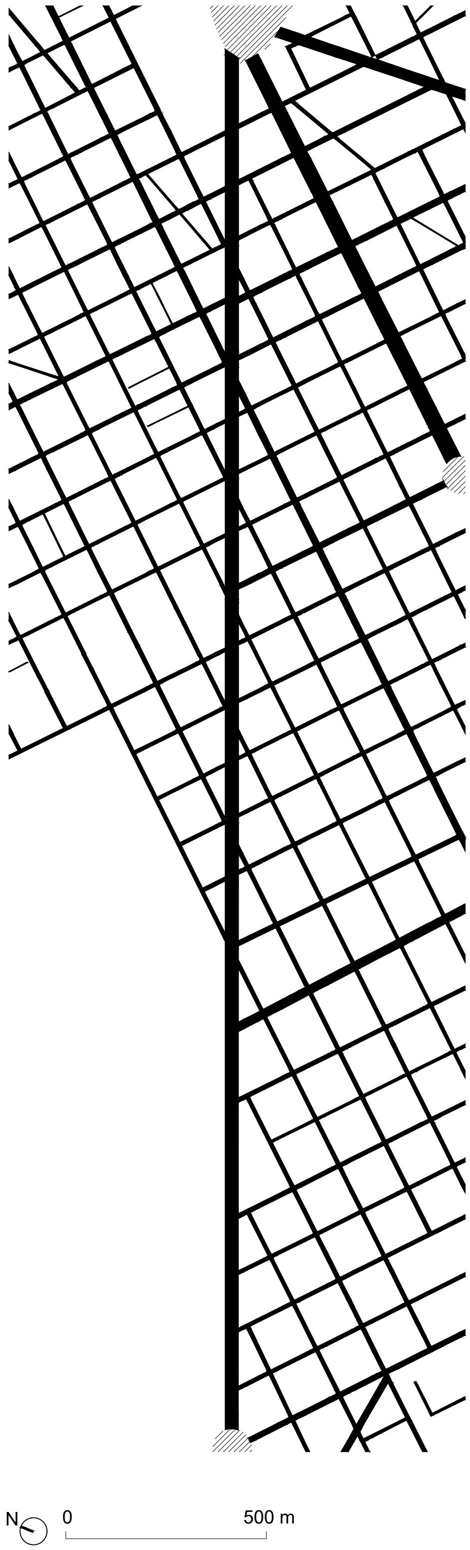
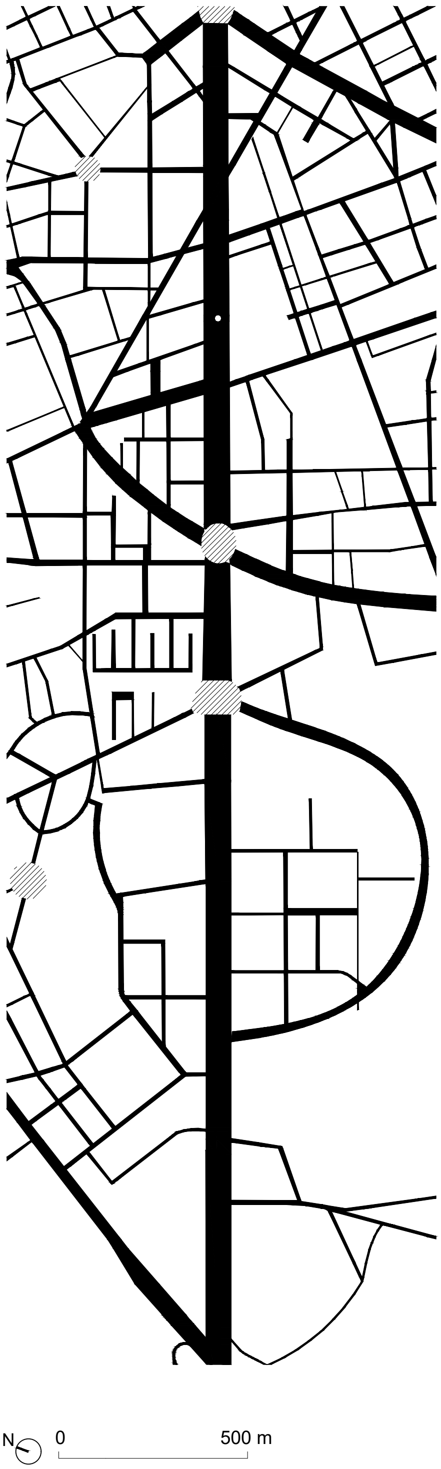
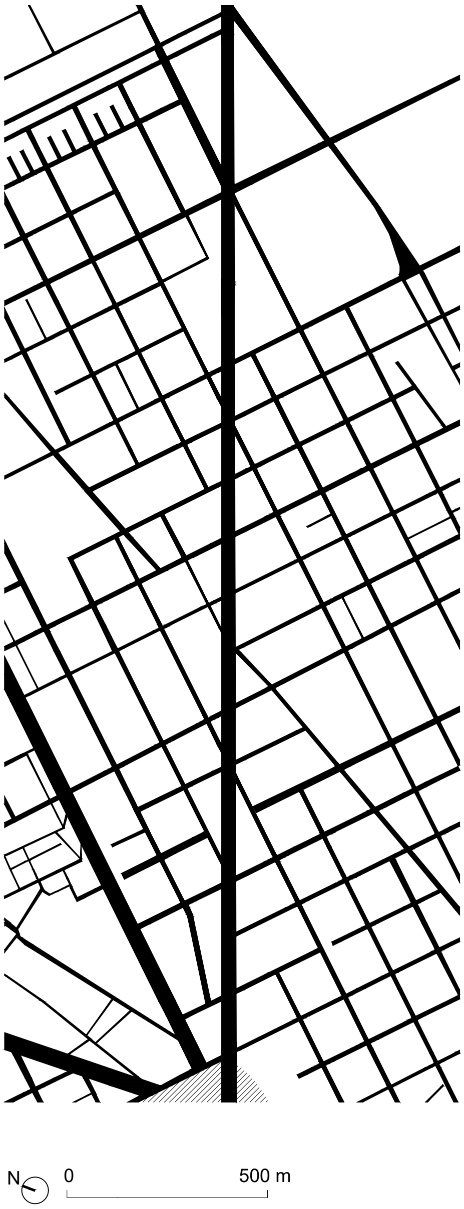


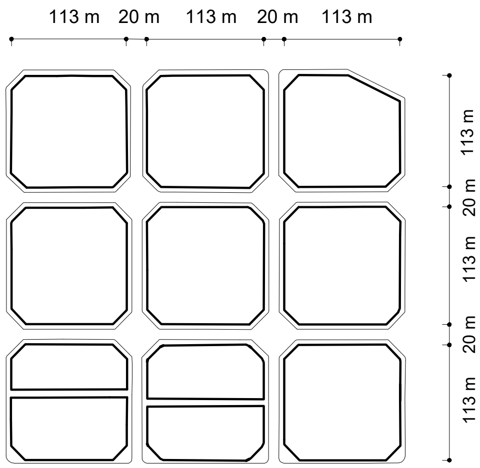
Figure 8.1-15 Maps of the Diagonal's street hierarchy. (Source: Author's Edition).
a) The central section.



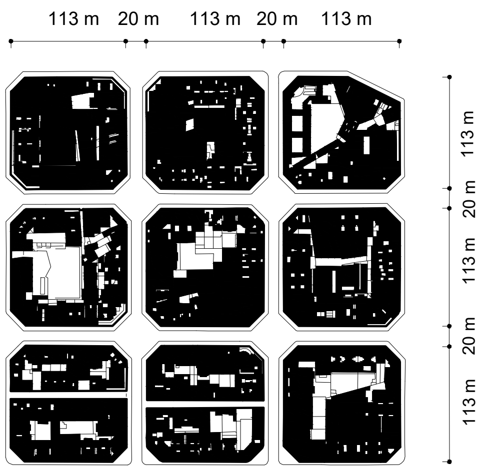
b) The second section.



c) The third section.



a)



b)

Figure 8.1-16
a) The Diagonal central section's surrounding public and private spaces of urban blocks. (Source: Author's Edition).
b) The urban block built form surrounding the Diagonal central section. (Source: Author's Edition).

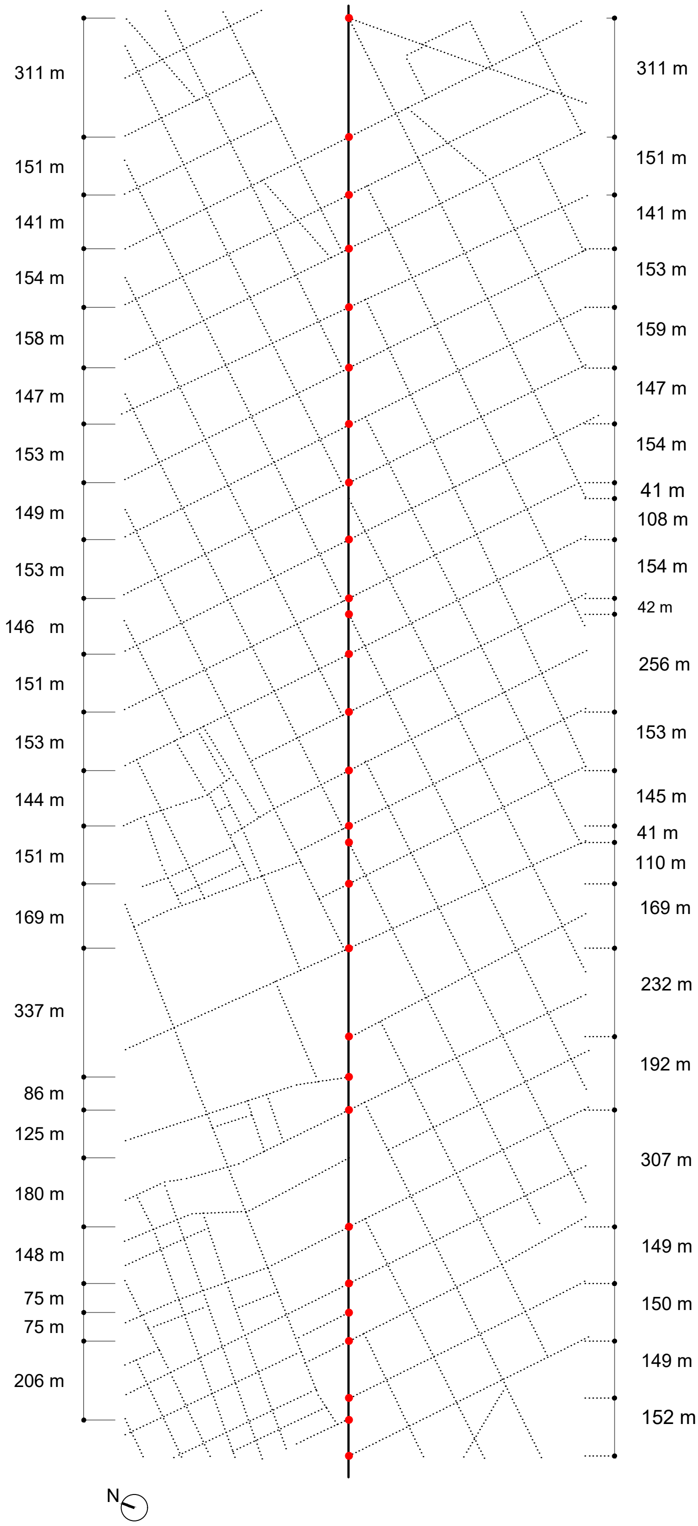


Figure 8.1-17 The street intersection frequency of the Diagonal central section. (Source: Author's Edition).

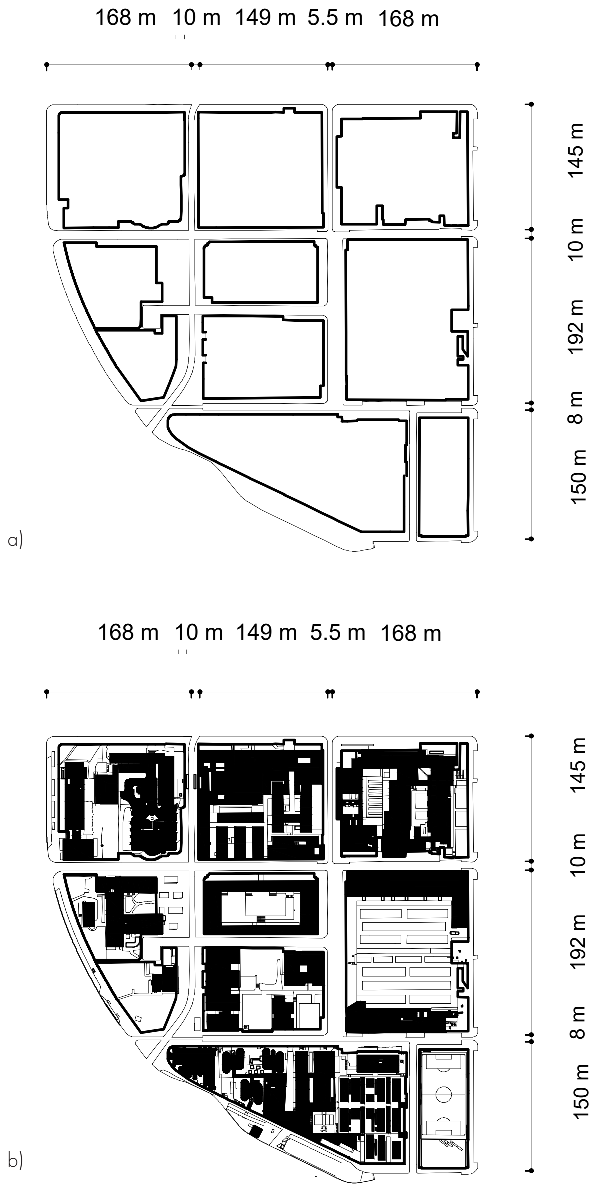


Figure 8.1-18
a) The Diagonal second section's surrounding public and private spaces of urban blocks. (Source: Author's Edition).
b) The urban block built form surrounding the Diagonal second section. (Source: Author's Edition).

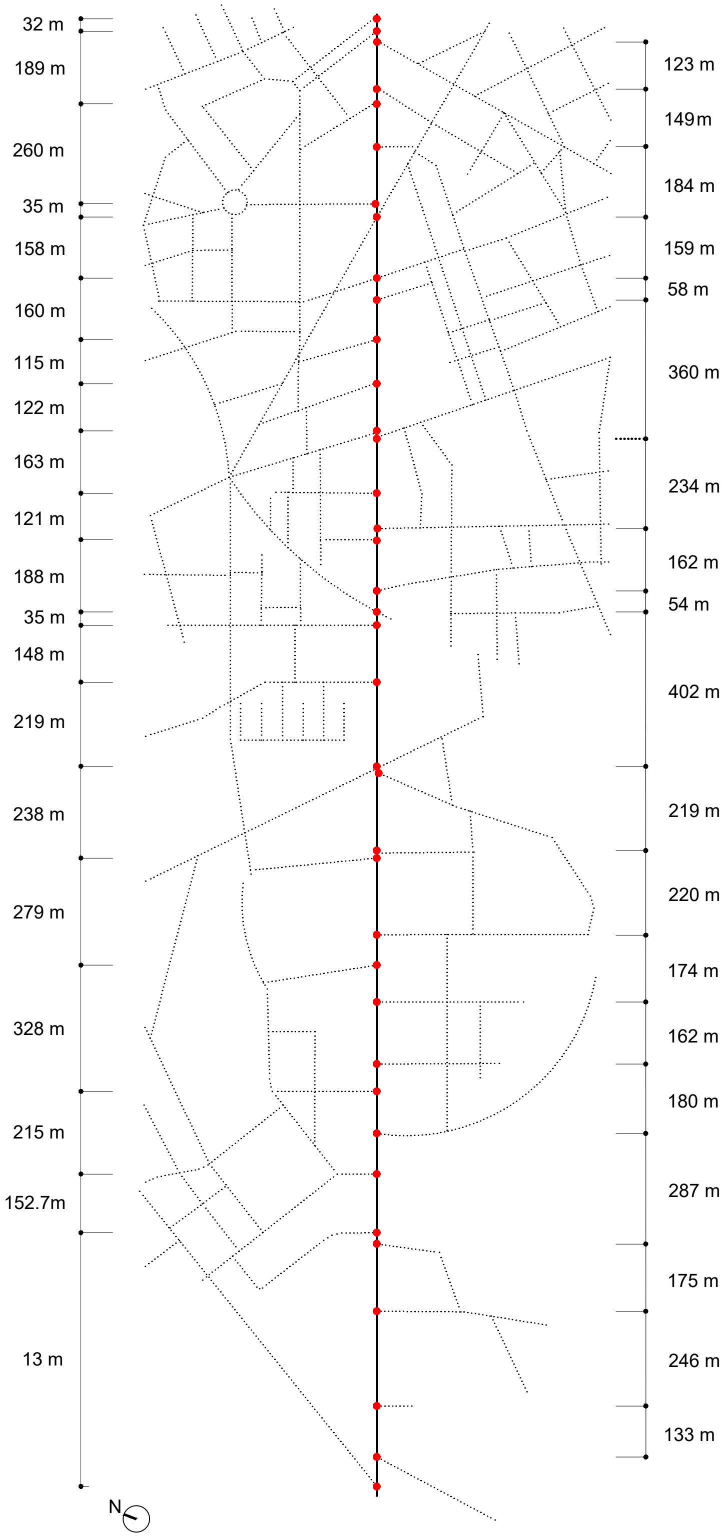
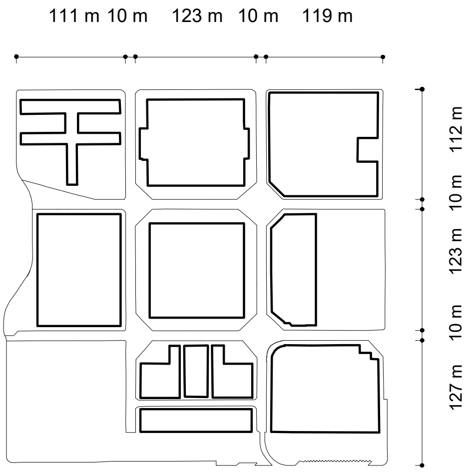
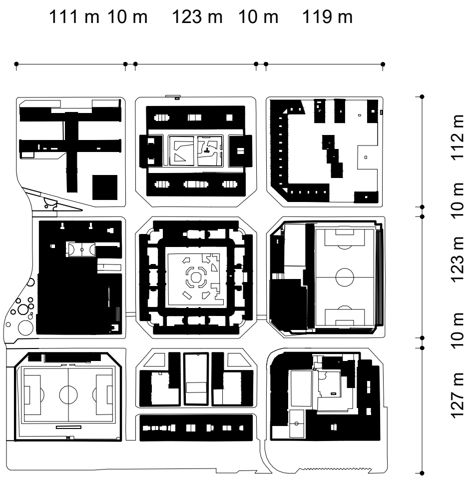


Figure 8.1-19 The street intersection frequency of the Diagonal second section. (Source: Author's Edition).



a)



b)

Figure 8.1-20
a) The Diagonal third section's surrounding public and private spaces of urban blocks. (Source: Author's Edition).
b) The urban block built form surrounding the Diagonal third section. (Source: Author's Edition).

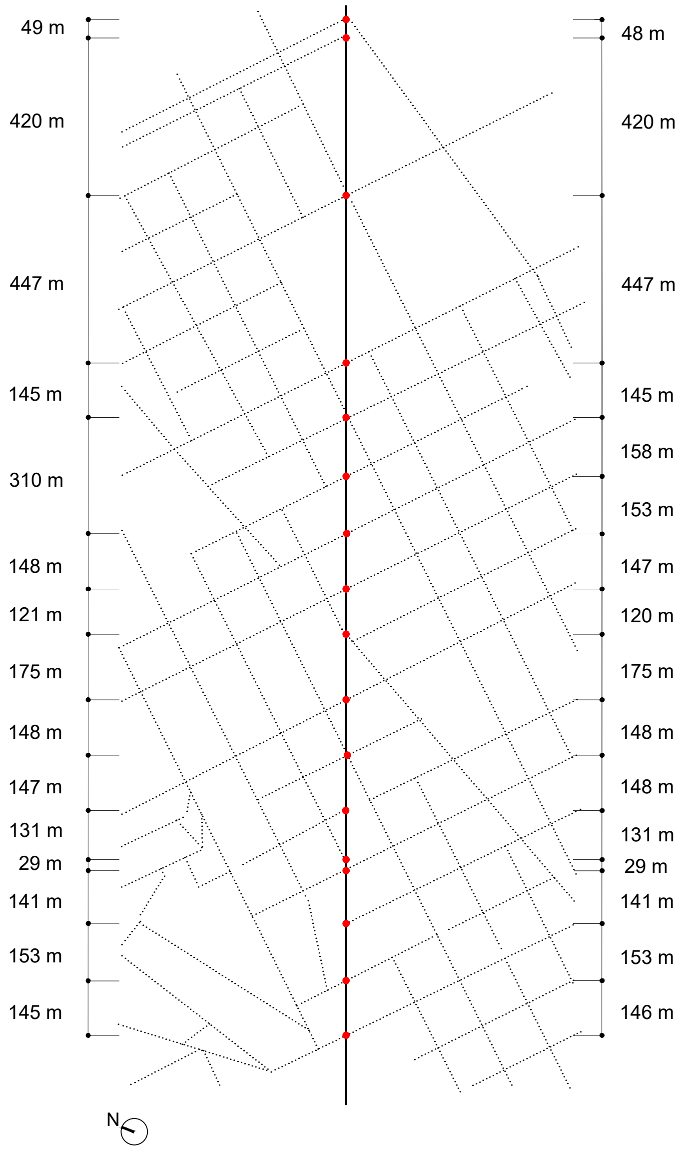
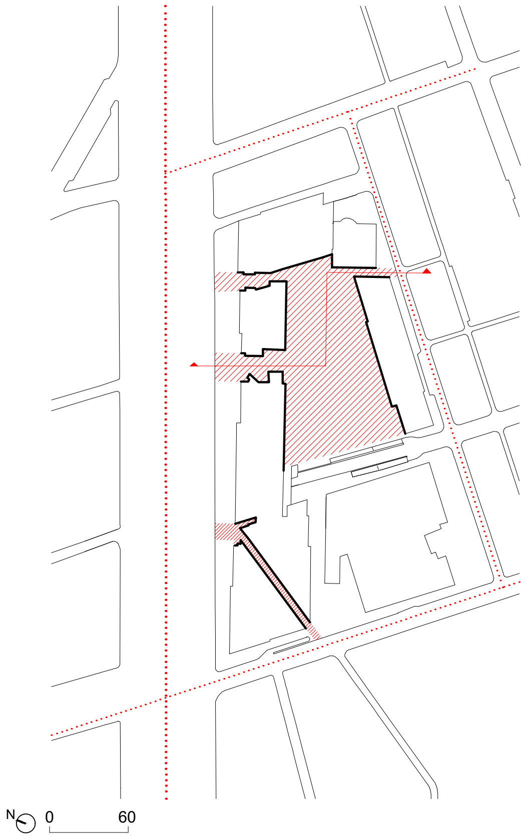


Figure 8.1-21 The street intersection frequency of the Diagonal third section. (Source: Author's Edition).



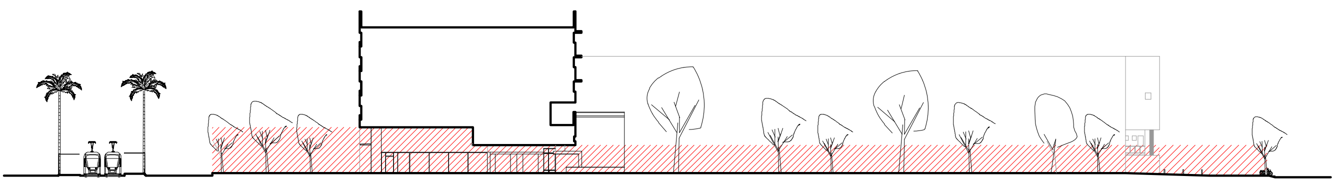
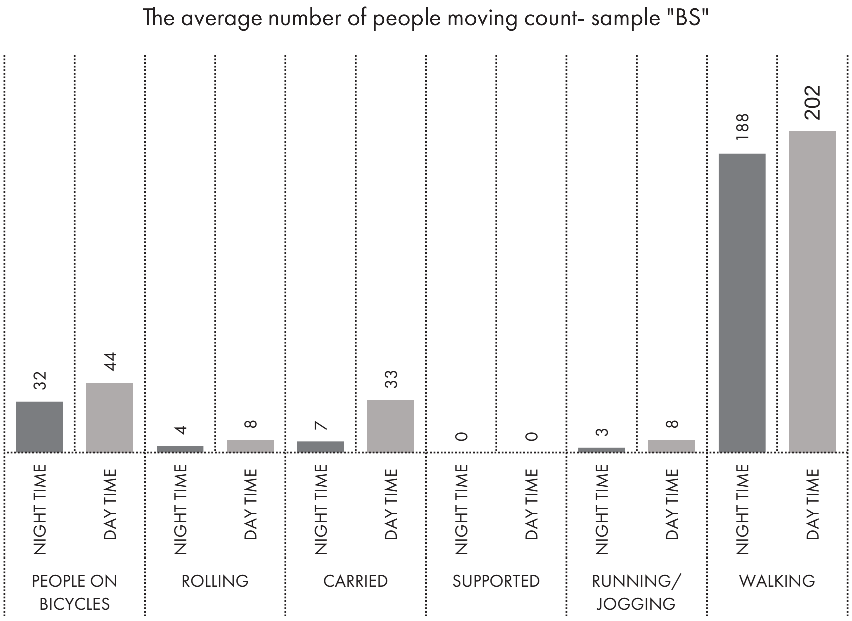


Figure 8.1-22 Plan and cross-section show the passageways in the L'illa Diagonal shopping center. (Source: Author's Edition).

08.1.2.2. Avinguda Diagonal Pedestrians' flow

The Diagonal is a continuous public space with street and block patterns that facilitate pedestrian and cyclist movement, which was revealed in the significant pedestrian volume during day and night times. The street also facilitates various circulation systems, including public transport, which confirms its role as a route and a place. Despite the high flow of pedestrians on this major city artery, a contrast was found between the avenue's different sections. Samples BS and AN had the highest number of pedestrians and cyclists compared to other samples. On average, the number of people counted per 10 minutes in Sample BS was 529, while for Sample AN, it was 370.2. These samples have permeable blocks allowing pedestrians to access the street as a part of their daily activity (Figure 8.1-23). Sample AS at 336 pedestrians per 10 minutes and Sample BN at 319 pedestrians per 10 minutes demonstrated an active public life with a high volume of pedestrian circulation (Figure 8.1-24). These two samples also have a high degree of permeability with continuous street intersections, which allows connectivity during the day and night times for pedestrians and cyclists.

This is compared to Sample CS at 97 pedestrians per 10 minutes and Sample CN at 102.2 pedestrians per 10 minutes. These samples had a lack of pedestrian flow, as pedestrians were observed opting for other routes with greater dynamism (Figure 8.1-25). This suggests that pedestrians' flow is linked to block sizes and available destinations within the blocks. The spatial layout and street intersection density increase walkability by facilitating permeability and maximizing the number of destinations. Samples AN and BS, in the first and second sections, presented as the most active and have small blocks and a greater number of street intersections. Sample C has a large block size and presented with less pedestrian volume.



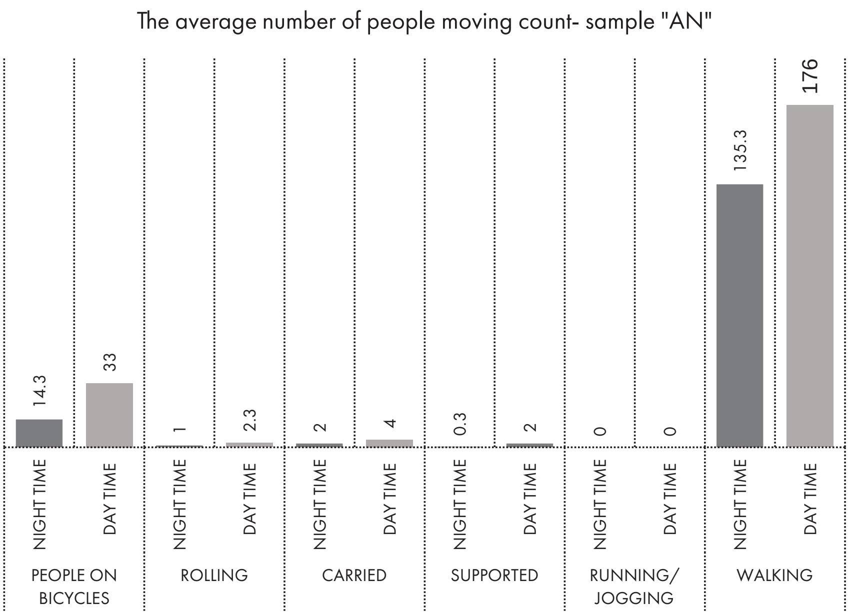
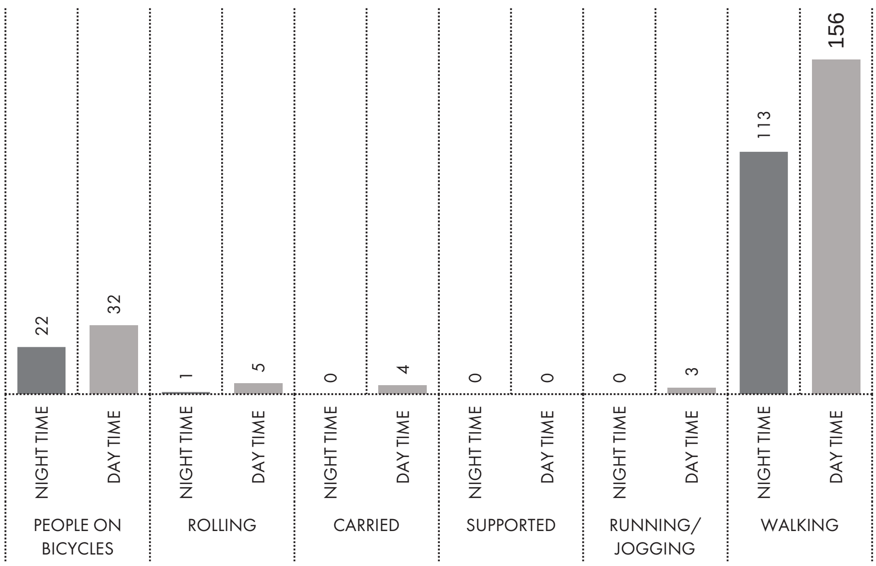


Figure 8.1-23 The average pedestrian count for samples "BS" and "AN" of the Diagonal.

The average number of people moving count- sample "AS"



The average number of people moving count- sample "BN"

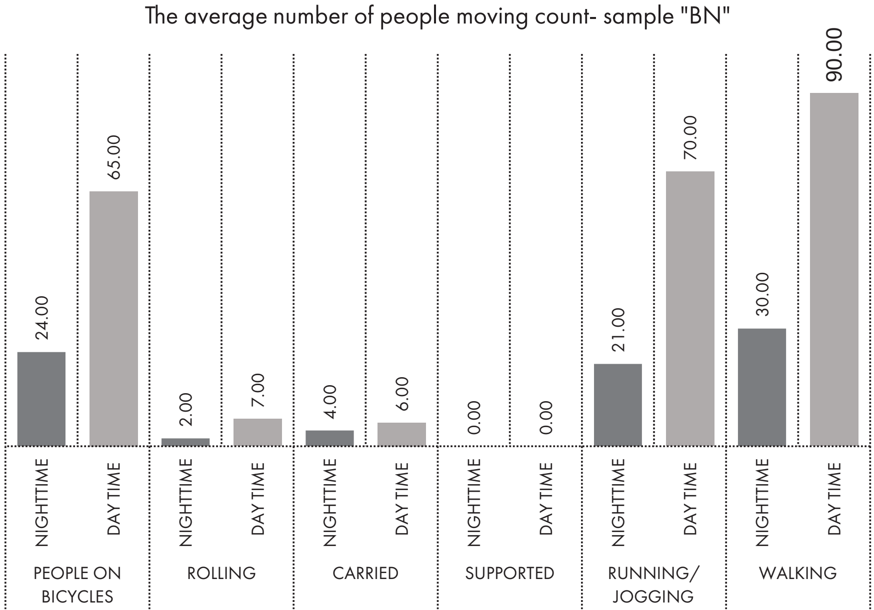
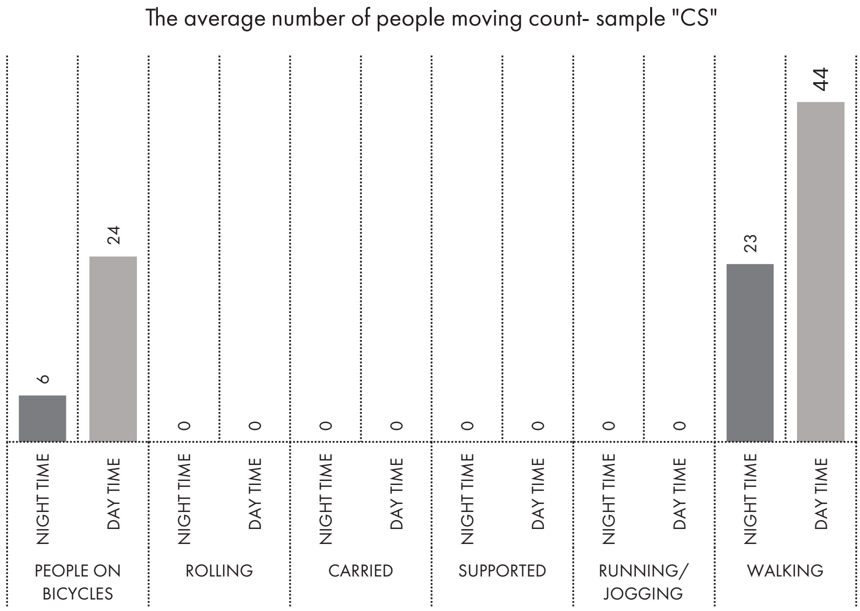


Figure 8.1-24 The average pedestrian count for samples "AS" and "BN" of the Diagonal.



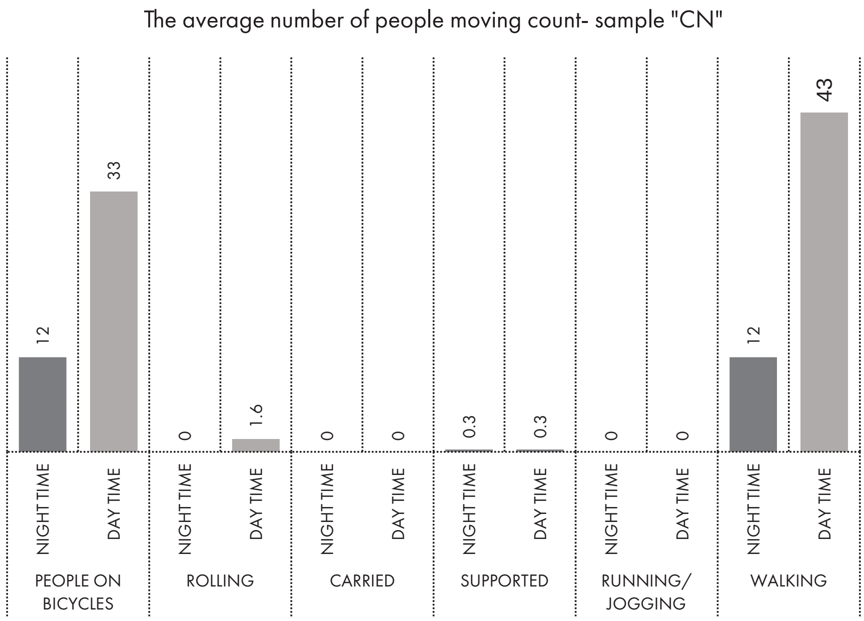


Figure 8.1-25 The average pedestrian count for samples “CS” and “CN” of the Diagonal.

08.2. The street partition

08.2.1. Avenida da República street partition

Avenida da Republica has a decisive and diverse role as a linear public space in Lisbon. The 60-m-wide and 1,500-m-long avenue includes multiple compositions that emerged from several urban transformations. Throughout the street's history, new elements, infrastructure, and other types of construction have been added to respond to the changing needs of the city. The avenue, as a place, thus acts as the collective image of the city. The morphological analysis of the street at this scale attempted to understand it as a composition element, decoding its partition to reveal its livability. The street has two main sections. The southern section, stretching from Saldanha Square to Campo Pequeno, features wide sidewalks, ranging from 7.5 to 10.5 m and lined with trees, soft mobility infrastructure, kiosks, seating areas, and bus stops. In contrast, the northern section is more car-centric, with a lack of adequate pedestrian space that negatively impacts public life.

In the southern section, the sidewalk area is clearly divided into three zones: frontage, pedestrian, and amenity zones. The frontage zone offers spaces for sidewalk cafés, store entrances, retail displays, and landscaping. The pedestrian zone is wide enough to allow for unobstructed movement, is free of barriers, and is well-lit. The amenity zone features streetscape elements, landscaping, seats, and kiosks. The street partition, as found in Samples A and B, has a flex area of aisles on the sides, each with two service lanes and on-street parking separated from the central roadway by lateral separators of 2.5 m holding alignment trees. The roadway has a balance between pedestrian and vehicular uses, where the street here consists of a central aisle with six traffic lanes, three in each direction, and divided by a central green median about 4 m wide.

The northern part of the avenue has a markedly different partition composition. The wide roadway, spanning up to ten lanes in certain areas, has significant implications. Unlike the southern section, the northern section has an uneven distribution between pedestrian and vehicular uses. Moreover, the study indicated a lack of proper sidewalks, with most areas featuring narrow walkways, ranging from 2 to 3 m, which are perilously adjacent to the bustling roadway, thus presenting a significant hazard to pedestrians.

The morphological study of Sample A, located in the southern section at 50 m wide and 130 m long, found a two-way through traffic. The street partition in this sample has diverse functions and compositions that balance the street's role as a route and a place. The partition corresponds to the various existing transportation modes, including automobiles, buses, cycle lanes, and the underground metro. It also provides a primary diverse space for day-to-day public life, with different spaces for public activities like walking, running, cycling, sitting, and shopping during the day and night, as well as during weekdays and weekends.

Sample A has multiple roadways for local and nonlocal traffic. The central space is composed of three lanes in each direction with a total width of 20.5 m, including 2.5 m for the median between the opposing roadway directions. This central roadway is separated from local traffic lanes on each side by a grassy median with an total width of 2.5 m in Sample AE and 3 m in Sample AW, which includes a bike lane. The local traffic, which includes the flex area located between the sidewalk area and the roadway area, has flexible spaces that accommodate one lane and parking on both sides. This area has a width of 8.6 m in Sample AE and 8 m in Sample AW.

The sidewalk area in Sample A also has a wide pedestrian space of 7 to 9 m in Sample AE and 8 to 9 m in Sample AW, divided into three zones. The frontage zone is a shy zone directly adjacent to the buildings' line with a width of 0.5 to 0.9 m. Although the zone occupies a narrow width, it offers a clear space for people to enter and exit buildings and is delineated by a different paving material. The pedestrian zone, located between the frontage zone and the amenity zone, has a width ranging between 2.5 and 3.5 m. This zone is also characterized by different concrete. Finally, the amenity zone has a width of 4.2 to 14 m and features street furniture such as lighting, benches, newspaper kiosks, and bicycle parking (Figure 8.2-1).

Sample B, also located in the southern section, has a cross-section of 60 m and a length of 150 m. It has a similar composition to Sample A, with a central roadway, three lanes in each direction, of 22 m total width including the central median. The local traffic area functioned as a clear division between the pedestrian and the central roadway with one traffic lane and parking on both Samples BE and BW. This area is separated from the central roadway by a median with a width of 3 m in Sample BE and of 8 m, including 5 m for a bike lane, in Sample BW. The sidewalk area has a width of 9 m. These wide sidewalks include active and inactive frontage zones based on the use of the building and the design of the sidewalk area. The pedestrian zone in both samples provides a safe, fast, and comfortable travel path. The amenity zone includes a portion of the public right of way, with a width of 4.2 m in Sample BE and 9 m in Sample BW (Figure 8.2-2).

Sample C, on the northern side, has a wide unbalanced cross-section with around ten traffic lanes. The frontage zone is more defined in Samples A and B than in Sample "C, which has a lack of space to accommodate store entrances, retail displays, landscaping, transit stop amenities, or other features. The complexity of pedestrian space that characterizes Samples A and B gradually disappeared as we moved toward the northern section of the avenue. The sidewalk in Sample CE lacks proper width and does not have the same streetscape elements, landscaping, and public seats as located near Saldanha Square in the southern section. The 3 m narrow sidewalk in Sample CE has several barriers obstructing pedestrian movement. Additionally, it is adjacent to the roadway area, which creates less safety for pedestrians. Though Sample CW has a wider sidewalk of 8 m, fewer people were also observed using the pedestrian space here. This relates to the sidewalk composition, which has an absence of active street edges and a lack of physical spaces that support outdoor seating and other pedestrian needs (Figure 8.2-3).

The study of the pedestrian-to-automobile ratios found that the avenue to be better baanced in the southern section compared to the northern section. However, the ratio of all selected samples was approximately (1:1) (Figure 8.2-4). The avenue generally has enclosure, where the average heights of buildings vary between seven and 12 floors. This is a morphological feature that constitutes a homogeneous cross-section in Samples A and B, with an enclosure ratio of (1:1). However, the northern part, as in Sample C, presents asymmetry of the cross-section due to the white land in Sample CW (Figure 8.2-5).

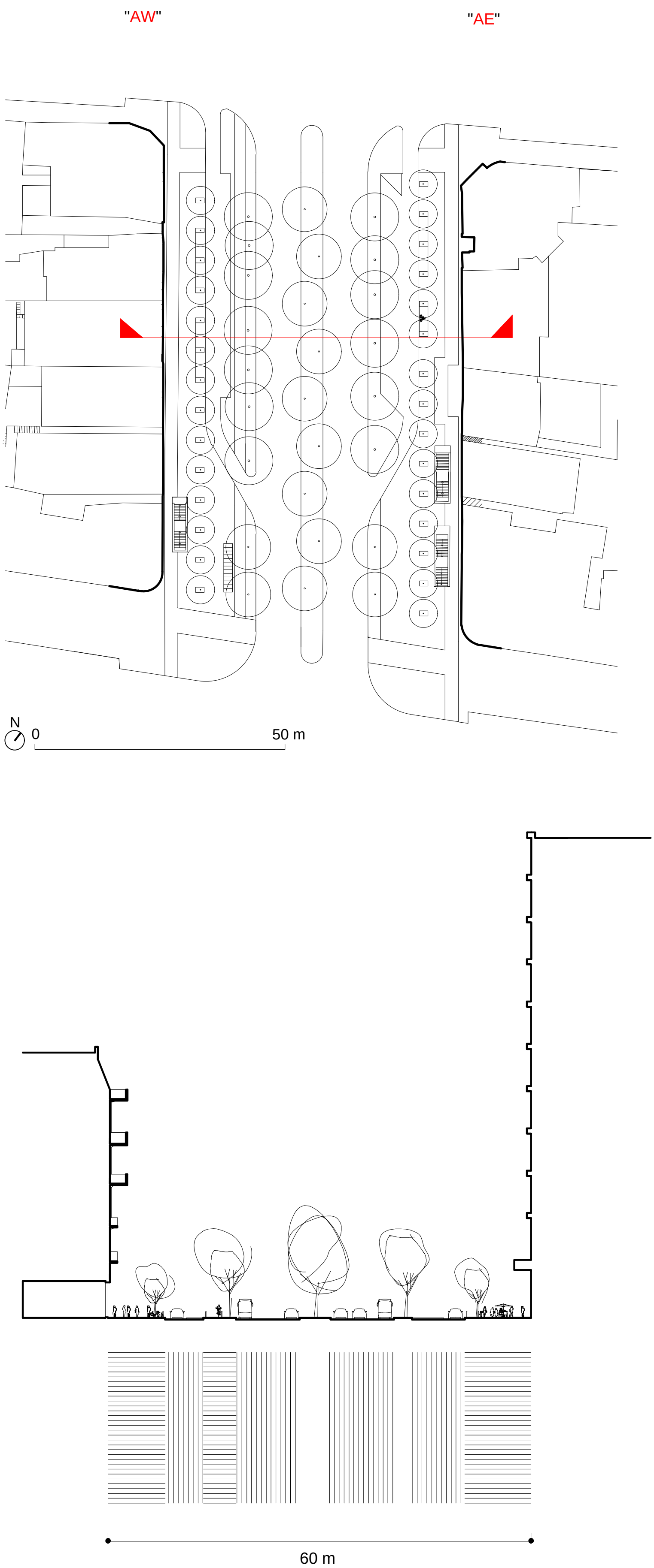


Figure 8.2-1 Sample "A", Avenida da República.
a) Plan and cross-section of sample "A". (Source: Author's Edition).

b) Top-down photo of sample "A", showcasing the overall layout of the sample. (Source: Author's Edition, 2023).

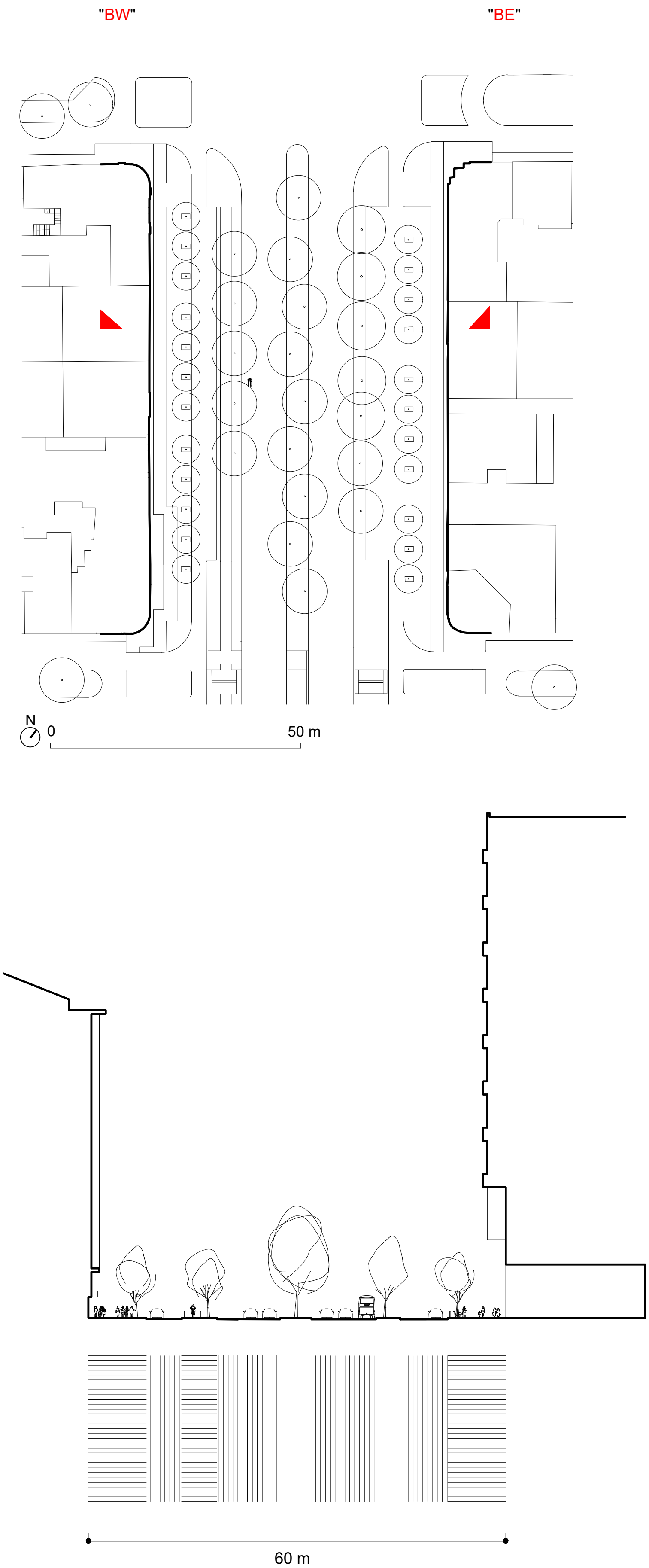
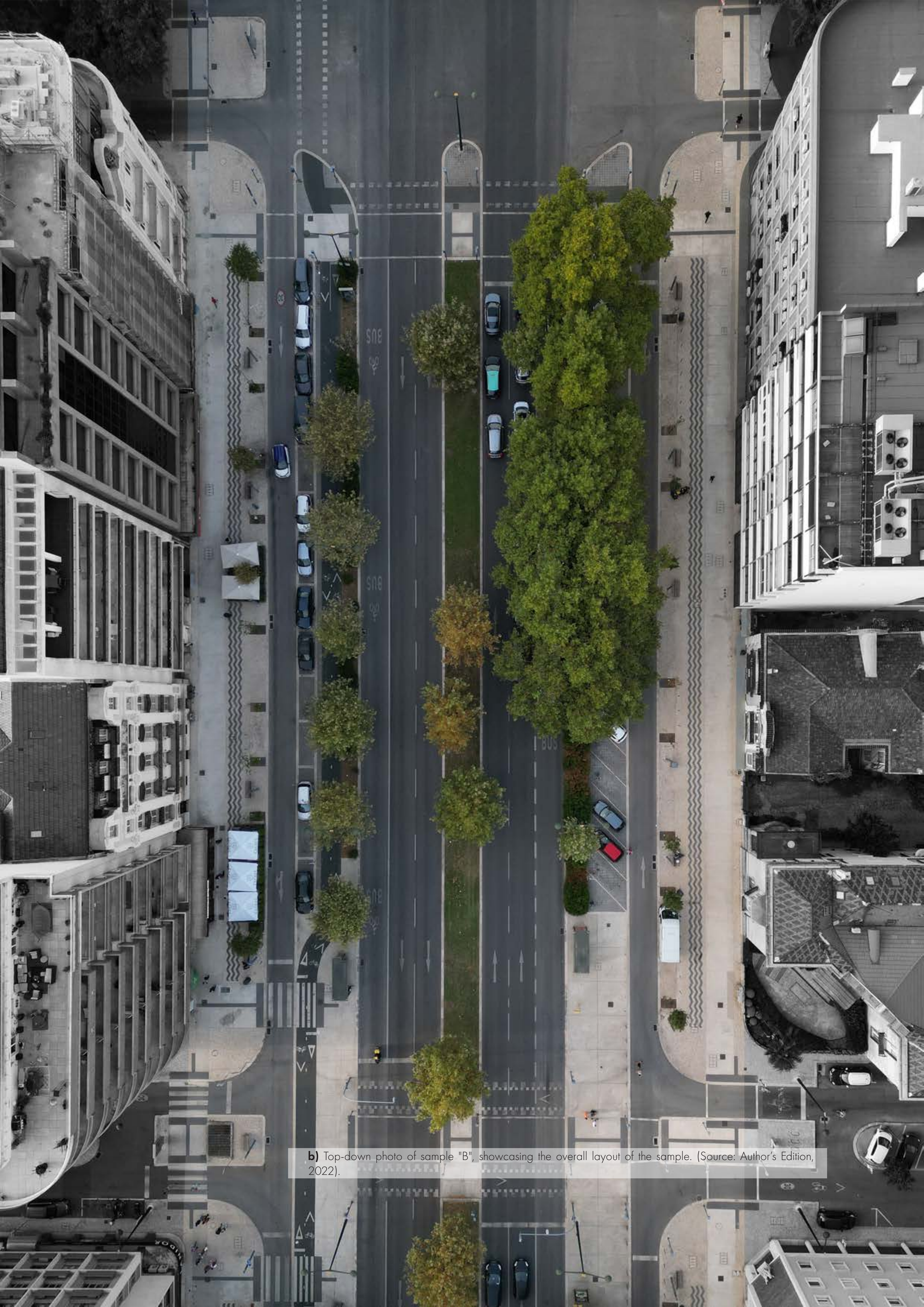
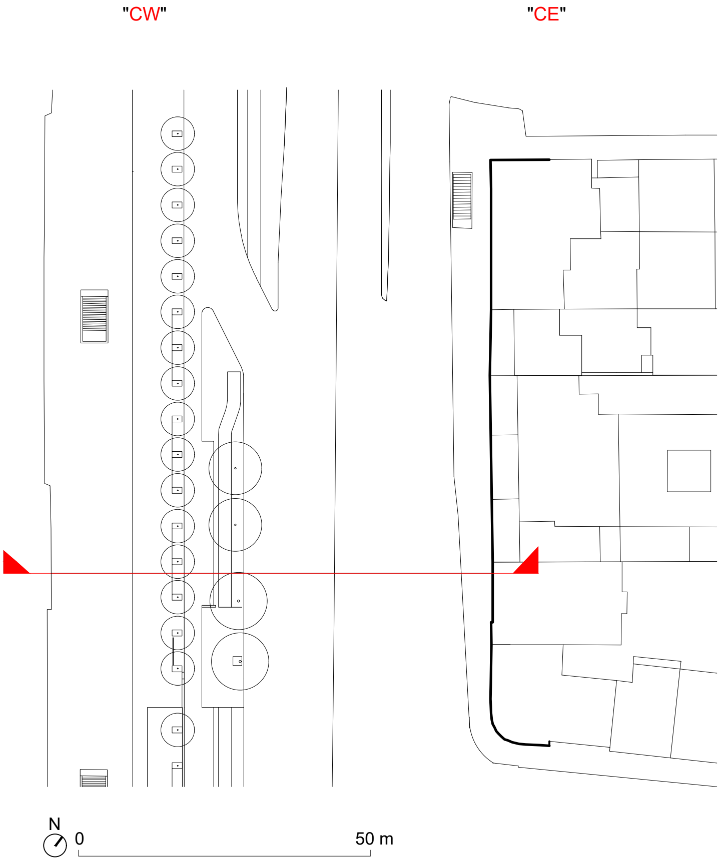


Figure 8.2-2 Sample "B", Avenida da República.
a) Plan and cross-section of sample "B". (Source: Author's Edition).



b) Top-down photo of sample "B", showcasing the overall layout of the sample. (Source: Author's Edition, 2022).



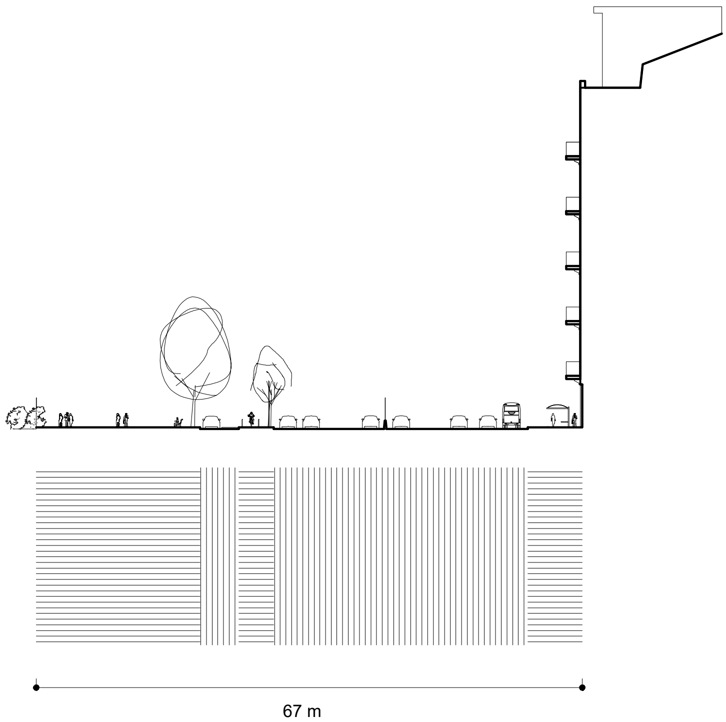


Figure 8.2-3 Sample "C", Avenida da República.
a) Plan and cross-section of sample "C". (Source: Author's Edition).

b) Top-down photo of sample "C", showcasing the overall layout of the sample. (Source: Author's Edition, 2021).

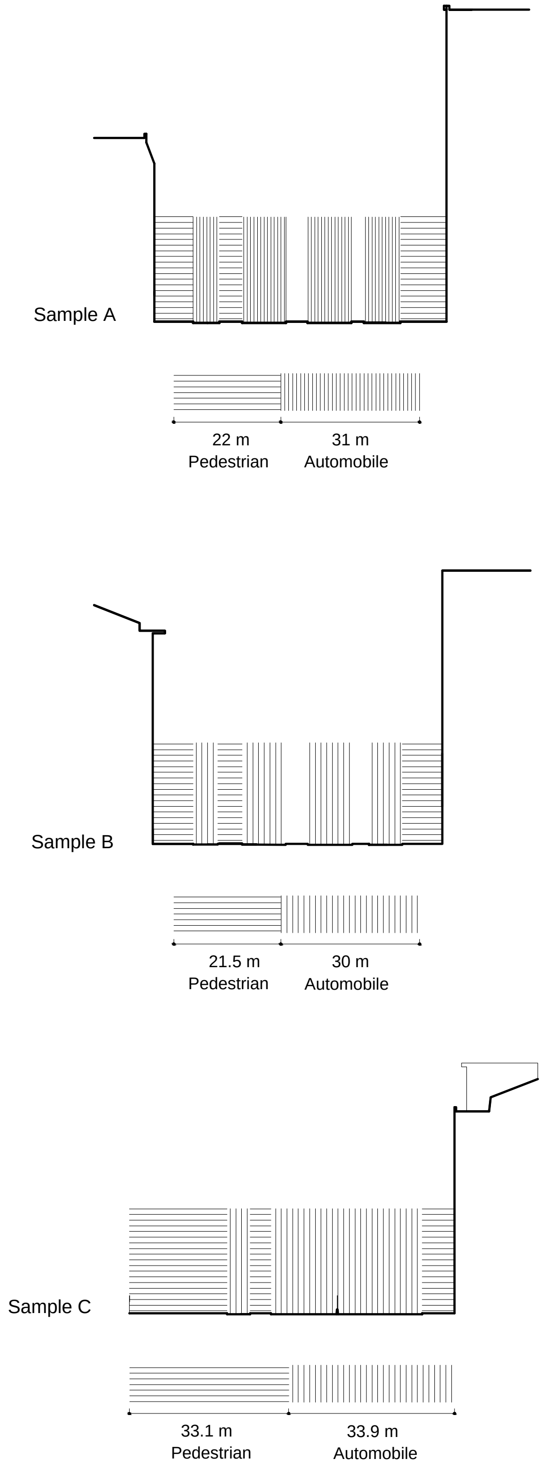


Figure 8.2-4 Cross-sections of Samples "A, B, and C" in Avenida da República show the pedestrians and automobile ratios. (Source: Author's Edition).

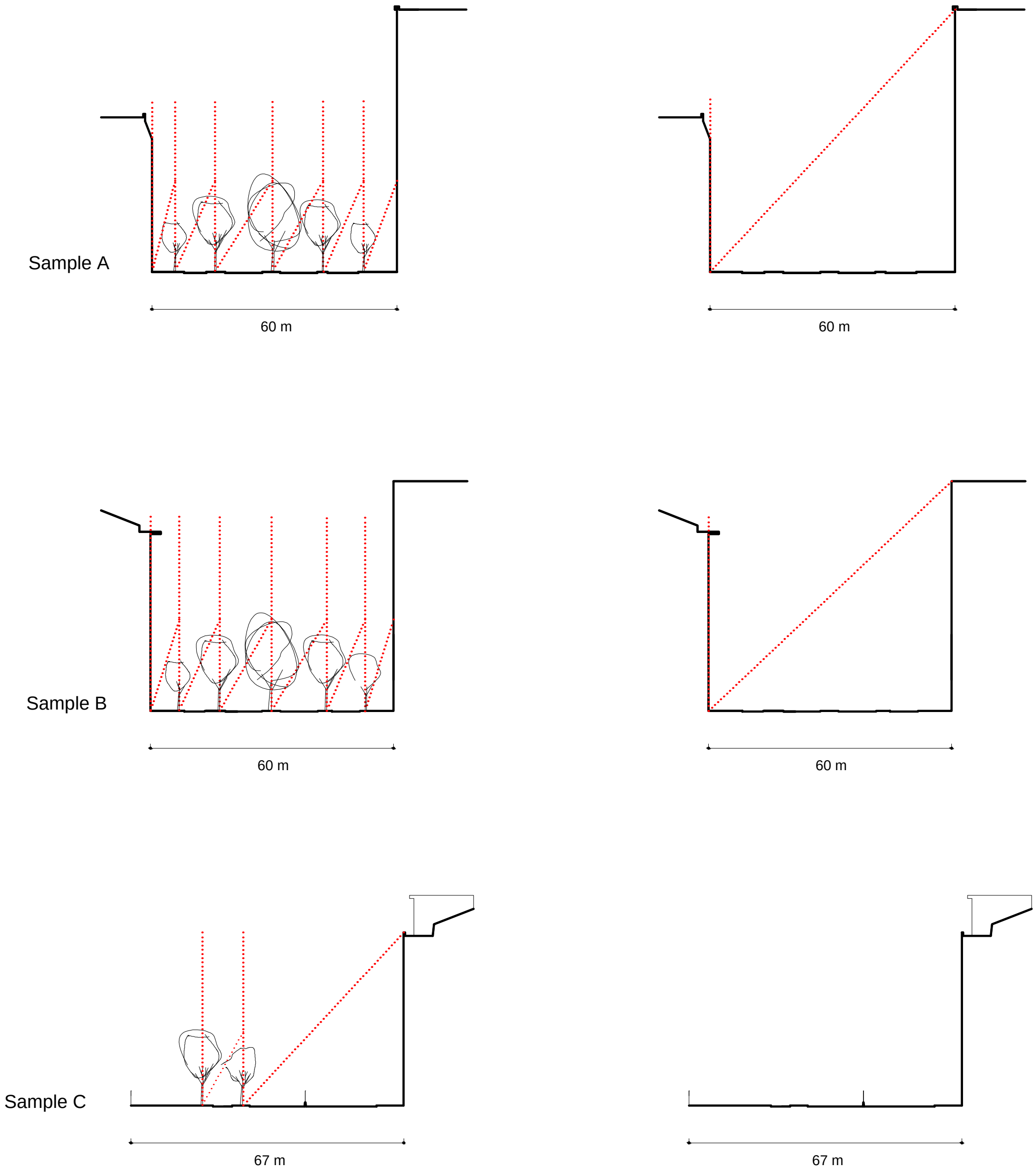


Figure 8.2-5 Cross-sections of the three selected samples in Avenida da República show the street width and building height ratios. (Source: Author's Edition).

08.2.1.1. Avenida da República pedestrians' activities

The public life study, including pedestrian activities and ages and gender counts, was carried out at different times of the day to capture various activities, such as chatting with friends, standing alone, eating at a food vendor stand, or conducting business. This provided information about pedestrians' activities in relation to physical characteristics and partition compositions. The avenue's physical characteristics embody the accumulation of the polis' wills that have formed the space over time and contributed to creating a setting for different social activities and public life needs. Just as the morphological study revealed a complex and diverse street partition, the visual observation also demonstrated a complex and diverse set of pedestrian activities. The avenue's partition composition produced various experiences and played a role in activity types.

The analysis of pedestrian activities found a clear contrast between Samples A and B in comparison to Sample C for all activity types, including necessary, optional, and social activities. There was a notable difference in the number of people using the space. Though the avenue is an essential link for pedestrians and cyclists, it was more active in the southern section. In Samples A and B, the avenue was a place and a destination in its own right. It supported economic, social, and leisure activities, and the street frontage in these samples provided a space for pedestrians to stand, shop, or socialize, which was absent in Sample C.

The study found samples A and B to be active day and night, as many people were seen enjoying the street's amenities, returning to their destinations, carrying shopping bags, or just walking out of apartments or offices to spend their break time there. This was related to the street partition composition that offers a wide pedestrian space divided into parts, each accommodating a particular type of activity (Figure 8.2-6). The study conducted on pedestrians' gender and age identified the following age groups: children, teenagers, adults, and seniors. All age groups had affluence patterns well-distributed throughout the day, particularly in the southern section of the avenue, revealing it as a multifunctional area that accommodated all ages. However, the northern section lacks proper-sized sidewalks, pedestrian amenities, and quality surfaces, which led to a gradually reduced vitality.

Samples A and B had all three types of pedestrian activities during different times of the day and during weekends. Pedestrians of different ages and genders were observed using the street for different purposes and activity types, including resting and reading, with a dominance of adults. Samples A and B represented the characteristics of their surrounding areas, where commercial, institutional, and educational uses are the overwhelming functions.

Sample AE was an active and diverse place with various shops and commerce activities that attracted different groups of people of different ages and genders. The study found that the volume of male adults was highest during the daytime, with an average of 38.6 per 10 minutes. This was compared to female adults at 35 per 10 minutes, male seniors at 8.6 per 10 minutes, female seniors at eight per 10 minutes, and teenagers and children at less than 6.6 per 10 minutes. During the nighttime, the study found a higher number of pedestrians with a notable presence of 78 female adults per 10 minutes, in comparison to male adults at 63.6 per 10 minutes, which reflected how the proper design of the sample offers pedestrian safety and accommodates different activities (Figure 8.2-7). The systematic observation of Sample AW found a similar rhythm of public life. The number of adults and teenagers was higher than seniors and children. During the daytime, the average number of male adults was 44.3 per 10 minutes, and the average number of female adults was 42 per 10 minutes. However, at night, there were 70.6 female adult pedestrians per 10 minutes (Figure 8.2-8).

The study conducted on Sample B also reflected the quality of the morphological characteristics of the southern section. During the investigation, the sample presented different ages and genders. In Sample BE, male adults were most common, with 29.3 per 10 minutes during the daytime and 22.6 per 10 minutes during the nighttime. Although this was almost half of the number of pedestrians in Sample A, the sample did offer a place for different ages and genders (Figure 8.2-9). Sample BW had even more activity. Optional and social activities for different ages and genders were observed, such as sitting, reading, eating, and standing. During the daytime, there were 46.3 female adult pedestrians per 10 minutes, while there were 37 male adult pedestrians per 10 minutes. During the nighttime, there were 40.3 female adult pedestrians per 10 minutes and 29.3 male adult pedestrians per 10 minutes (Figure 8.2-10).

On the northern side of the avenue, Sample C had a significant decrease in users and activities. These findings could be incorporated with the morphological setting and partition composition in to reveal the interrelationship between street partition and pedestrian activities. In Sample CE, female adults were the most presented users at 16.6 per 10 minutes during the daytime and 7.6 per 10 minutes during the nighttime (Figure 8.2-11). Sample CW had more male adult pedestrians. During the daytime, the number of male adults per 10 minutes was 40, compared to female adults at 25 per 10 minutes. During the nighttime, the number of male adults was 21.6 per 10 minutes, compared to female adults at 10 per 10 minutes (Figure 8.2-12).

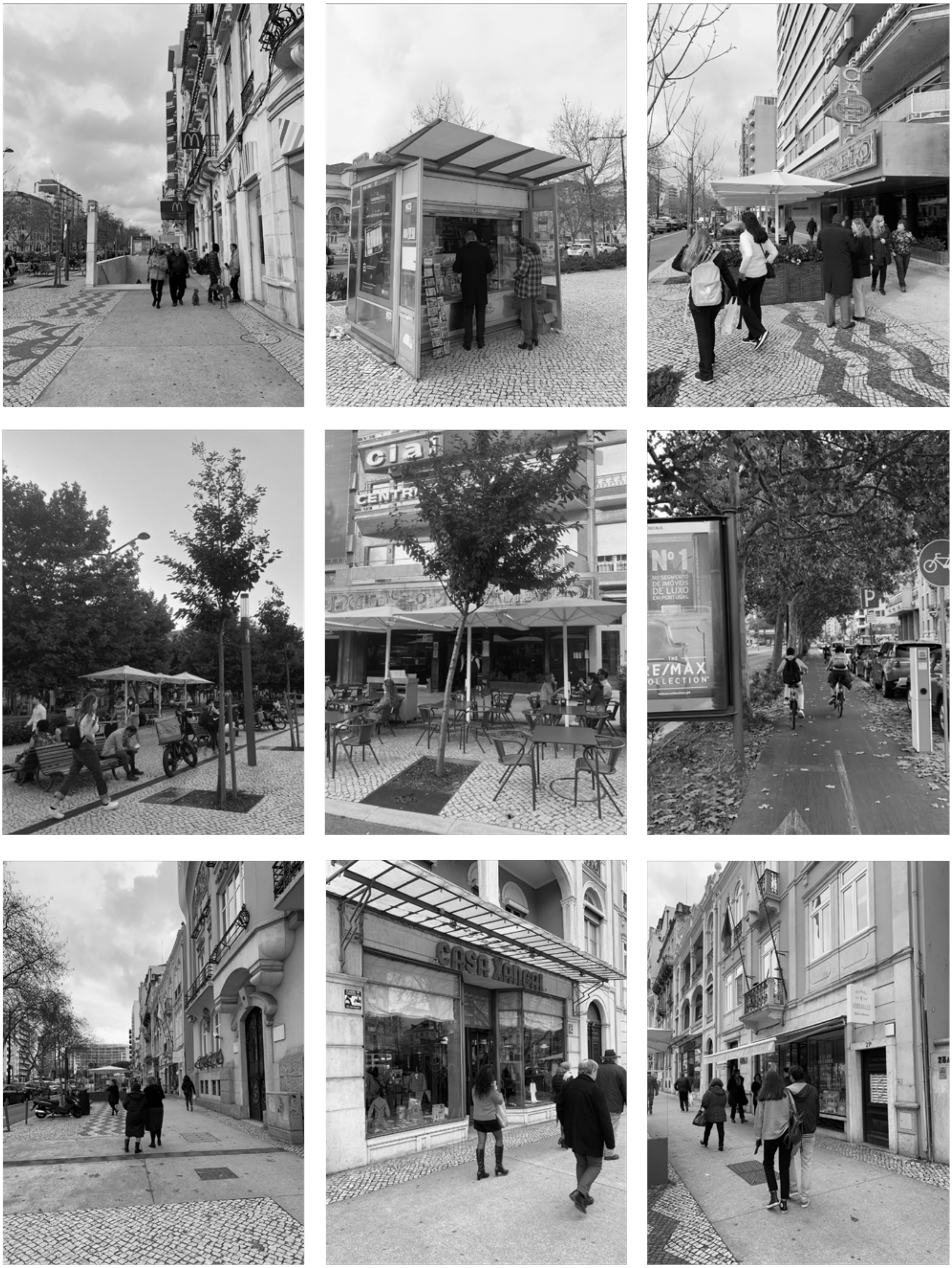
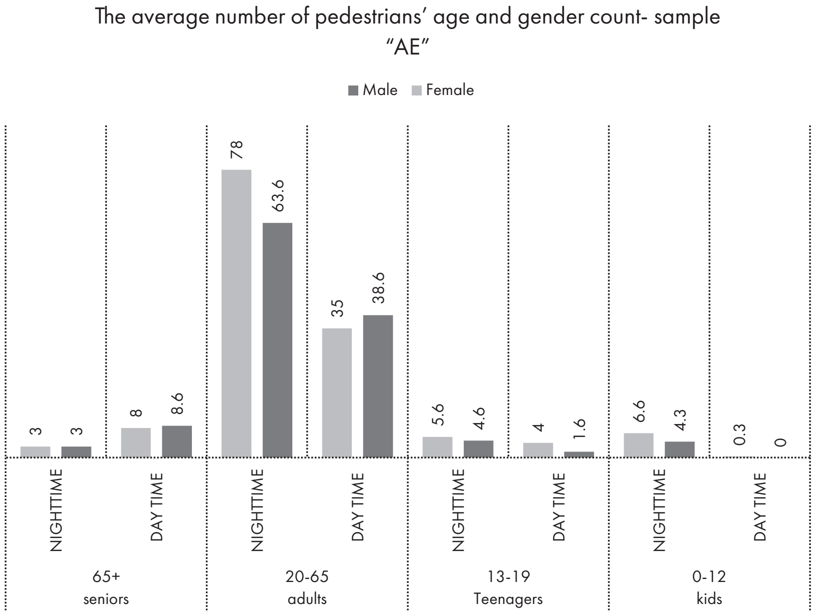


Figure 8.2-6 A series of photographs capturing the pedestrian activities of three selected samples of Avenida da Republica.
a) Sample "A." (Source: Author's Edition, 2020).

b) Sample "B." (Source: Author's Edition, 2020).

c) Sample "C." (Source: Author's Edition, 2020).



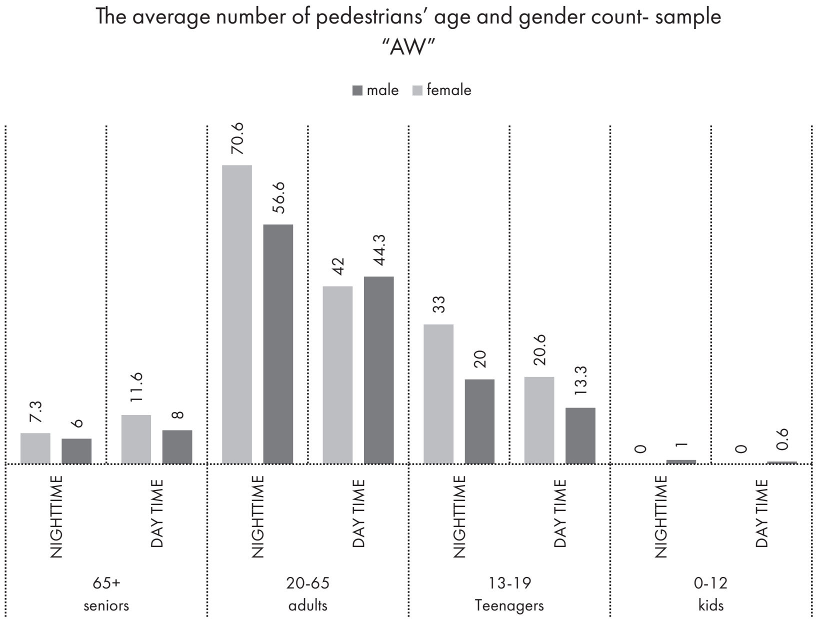
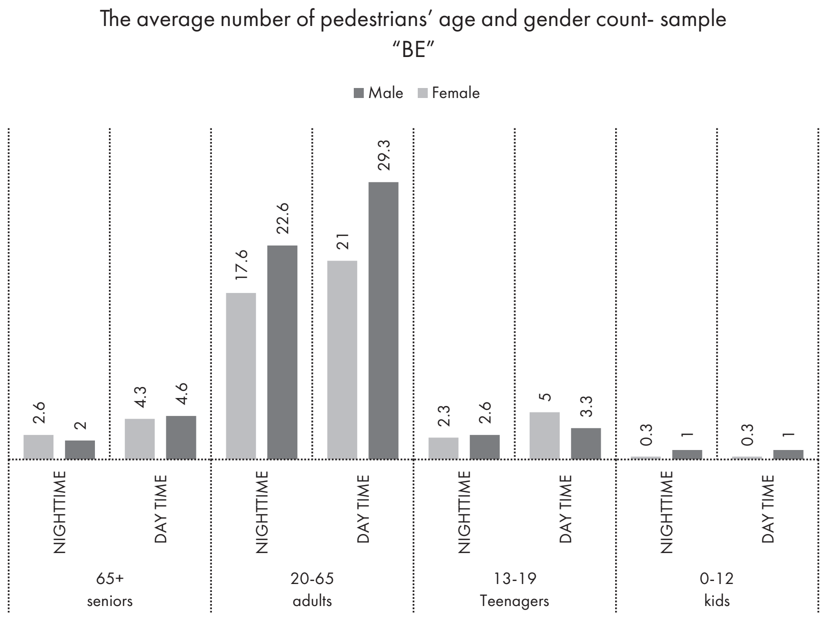


Figure 8.2-7 The average number of pedestrians' age and gender count of sample "AE."
Figure 8.2-8 The average number of pedestrians' age and gender count of sample "AW."



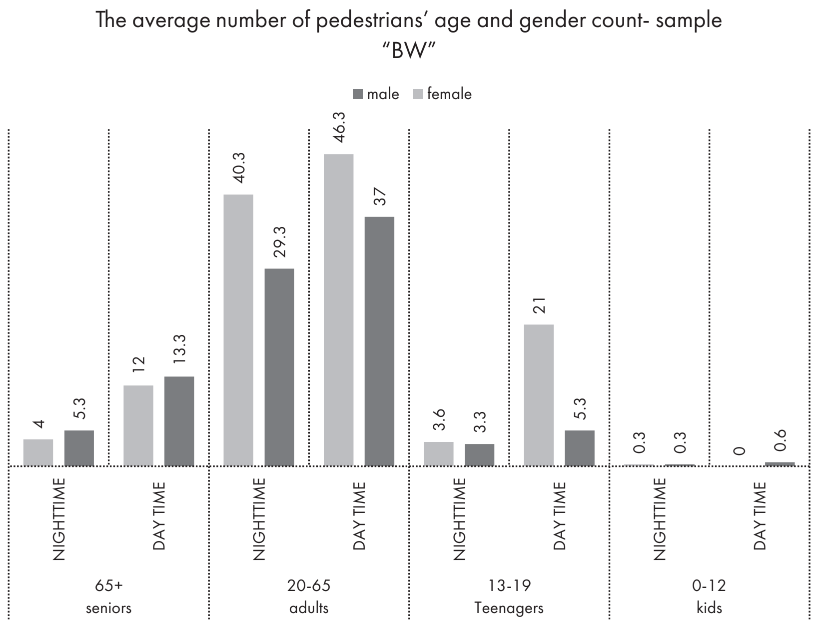
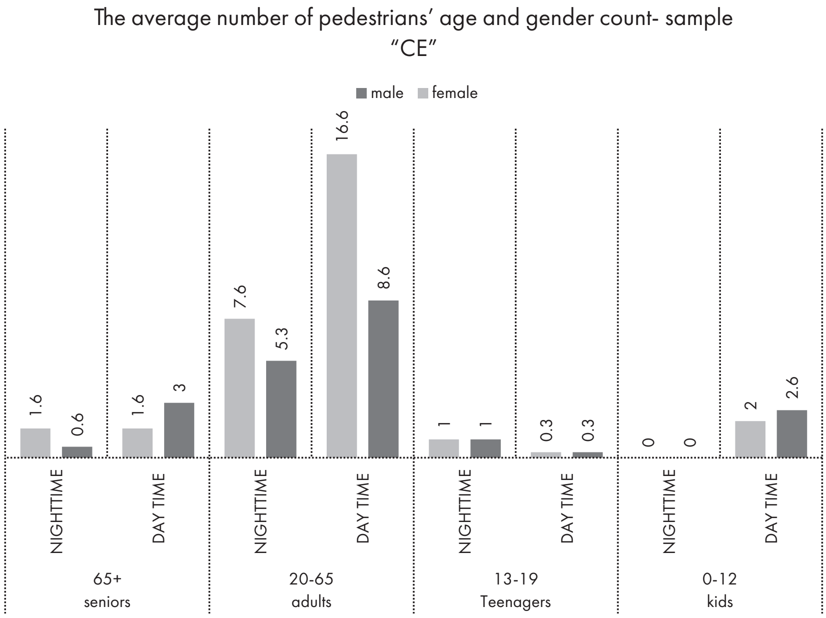


Figure 8.2-9 The average number of pedestrians' age and gender count of sample "BE."
Figure 8.2-10 The average number of pedestrians' age and gender count of sample "BW."



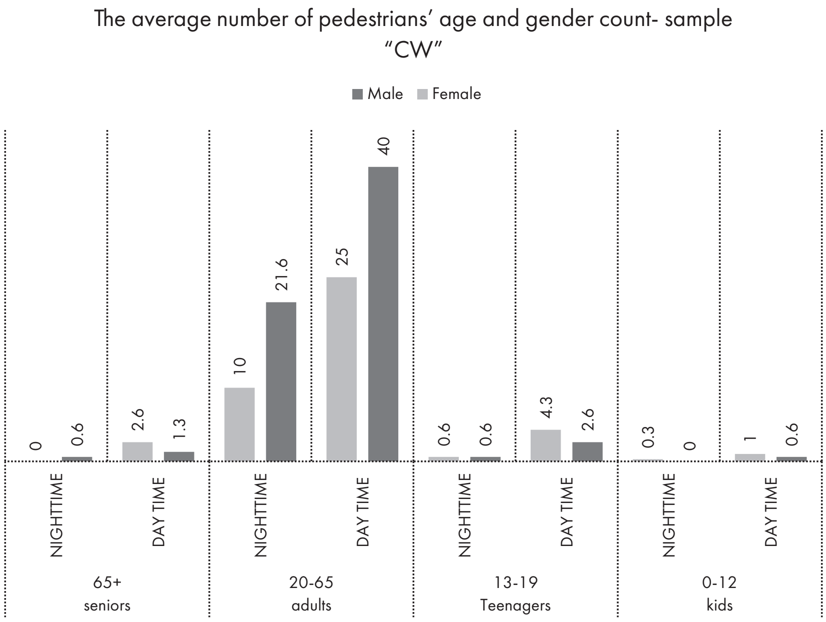


Figure 8.2-11 The average number of pedestrians' age and gender count of sample "CE."
Figure 8.2-12 The average number of pedestrians' age and gender count of sample "CW."

08.2.2. Avinguda Diagonal street partition

The Diagonal, as a prominent urban artery, is a diverse linear spatial element with vibrant public life that summoned the interest of the researchers. The 10-km-long avenue has spanned different moments of construction, which is reflected in the street layout and partition composition. The street partition compositions correspond to the various transportation modes and needs from pedestrians and cyclists. Thus, the partition offers a privileged setting that balances the use of automobiles, buses, trams, underground train lines, and soft mobility and that acts as a space for public and collective use.

Sample A has various compositions of the street partition. The 50-m-wide and 130-m-long sample is part of the central and oldest section of the Diagonal and was active in terms of public life and traffic volume. However, unlike Samples B and C, this sample does not have a space intended for tram lines. The central roadway includes five lanes, three lanes on the south and two on the north with a total width of 16 m. In both directions, the local traffic lanes are separated from the central roadway by a median accommodating a row of large trees. In Sample AS, the median is 2.5 m wide, separating the bike lane from the central roadway. The bike lane represents 8% of the total cross-section at 2 m wide. Unlike in Samples B and C, the bike lane in Sample A is aligned with the local traffic lane, which has a width of 3 m. Motorcycle parking spaces can also be found in both directions of the sample with a width of 2.2 m.

Sample A is bounded by a row of trees that separate the sidewalk from the roadway. In Sample AS, the unique 45-degree cut corners of the block created a pleasant environment for pedestrians' activities. The sidewalk is between 7.4 and 20 m wide and contains cafes and restaurants with outdoor seating. However, in Sample AN, the sidewalk has no outdoor seats due to the ground floor uses. It is 7 m and separated from the roadway space by a row of Platanus and palm trees, configuring a vertical partition (Figure 8.2-13).

Sample B, located in the second section of the avenue, has a two-way through traffic with a total length of 377 m and a width of 94 to 113 m. The street partition creates diverse functions and compositions responding to the street's role as both a route and a place. The study found that the sample carried a high traffic volume, especially during the morning and early evening hours, with different modes of transportation, such as automobiles, buses, and a tram. It also provided a diverse space for day-to-day public life, with public activities like walking, running, cycling, sitting, and shopping. There are multiple roadways for local and nonlocal traffic. The central space comprises seven lanes with a total width of 20.5 m. The central roadway is separated on the south from local traffic lanes by grassy tram tracks with an approximate total width of 11.4 m, including 2.8 m for the tram station. The local traffic consists of three lanes with a total length of 8.6 m, including the bus lane. On the north side, the local traffic is composed of two lanes and one parking lane, separated from the central roadway by a space for pedestrians' and cyclists' uses. The width of the bicycle path is 6 m, representing 15.3% of the total central pedestrian space. The space is well-separated from the roadway with two rows of trees and occupies 24% of the total width of the street partition. It is paved and provided with pedestrian amenities such as benches and bicycle parking.

The sidewalk in Sample BS was an active space for public use, with a total width of 19.3 m. It has concrete pavement divided into three subpartitions by three rows of trees. These vertical elements contribute to organizing the sidewalk space, pedestrians' activities, and street furniture. The sidewalk in Sample BN comprises three blocks with different partition levels. Two levels with approximately a 1.8-m height difference typify this sample, where the lower sidewalk width is 3.5 m and the upper sidewalk width is 5.8 m. The sample has a continuous tree-lined border that bounds the partition, which abates the negative impacts of traffic and creates a comfortable pedestrian environment (Figure 8.2-14).

Sample C is in the last section of the avenue. It is 424 m long and between 50 and 97 m wide and includes a central pedestrian space that is 14.7 m wide, in which two bike lanes, one in each direction, have a width of 1.6 m each. The central pedestrian realm is bounded by a line of large trees that separate the central pedestrian space and the tramlines in each direction. The roadway in this sample is composed of three lanes in each direction, 8.7 m wide. The 5-m-wide sidewalk in Sample CS lacks street furniture and has a space for a bus stop and a row of trees that separate the sidewalk from the roadway space. The sidewalk in Sample CN is divided into public and semipublic spaces, each with a different level. The upper sidewalk is 5 to 5.5 m wide and bounded by two rows of large trees. The lower sidewalk is a large semipublic realm interconnected with the surrounding residential buildings that varies in width from 8 to 45 m (Figure 8.2-15).

The study found that the avenue is well-balanced in the ratios of pedestrian and automobile space. This translates to a high level of public life. The avenue provides multiple mobility modes, being divided into different uses corresponding to specific users. The pedestrian-to-automobile ratio was (1:1) in Sample A, (2:1) in Sample B, and 1:1 in public spaces of Sample C but 3:1 when including the semipublic spaces (Figure 8.2-16). The avenue generally has enclosure in the relationship between the street width and building height. However, the study found different street enclosures due to the varying average heights of buildings. Sample A has an enclosure ratio of (1:1), Sample B has a ratio of (2:1), and Sample C has an asymmetrical cross-section due to the white land in Sample CS (Figure 8.2-17). The morphological reading found that trees such as palm trees play a role in the alignment of the street layout. These tall elements create a sense of human scale and enclosure. The Diagonal's tree alignment also constitutes a vertical division that separates the street partitions and creates a sense of place for pedestrians and cyclists.

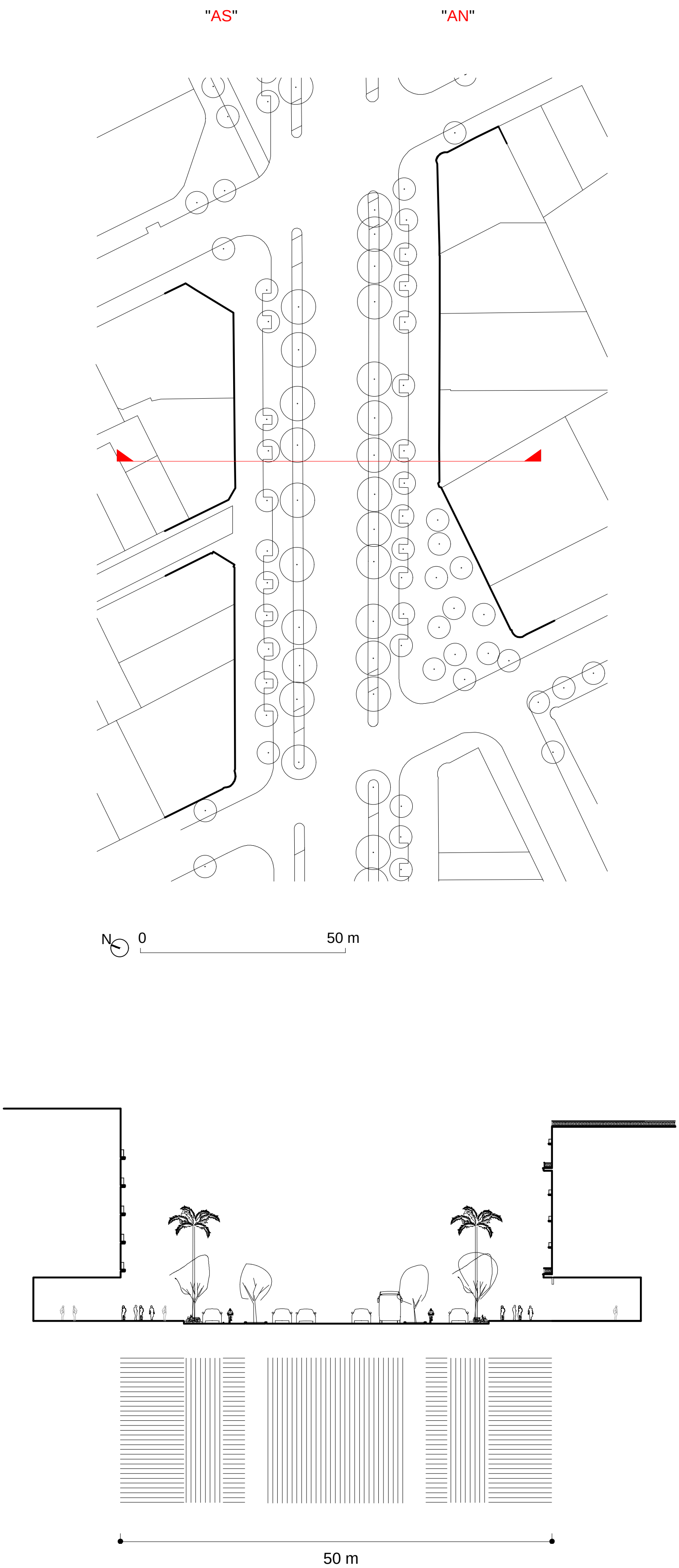
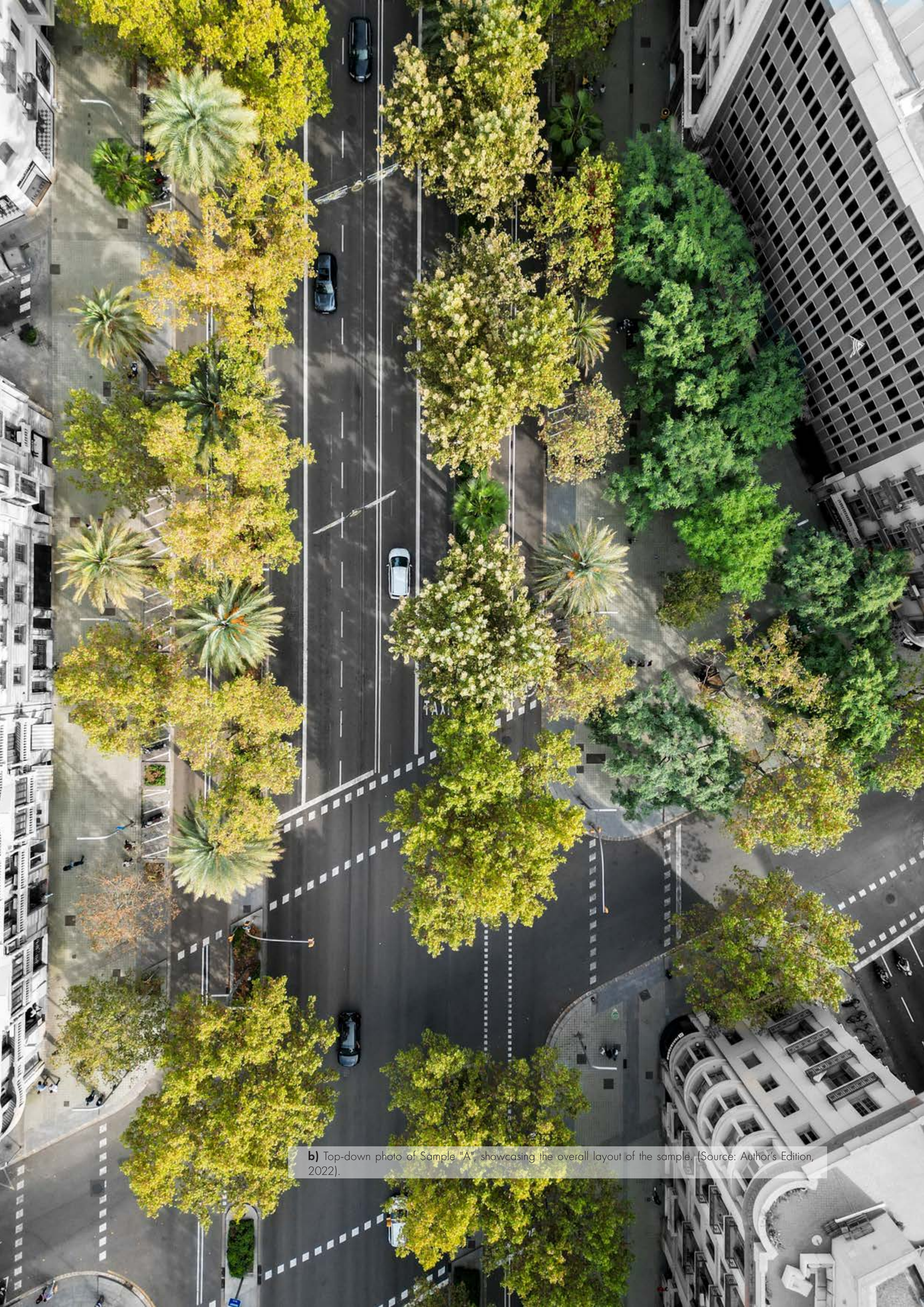
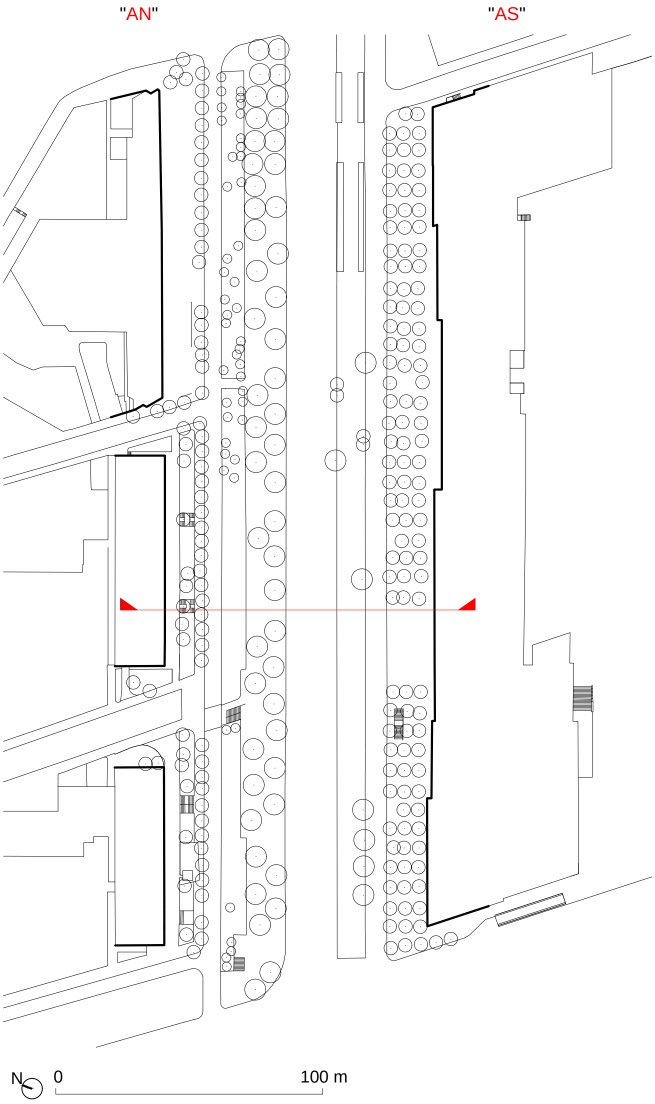


Figure 8.2-13 Sample "A", Avenida Diagonal.
a) Plan and cross-section of sample "A." (Source: Author's Edition).



b) Top-down photo of Sample "A", showcasing the overall layout of the sample. (Source: Author's Edition, 2022).



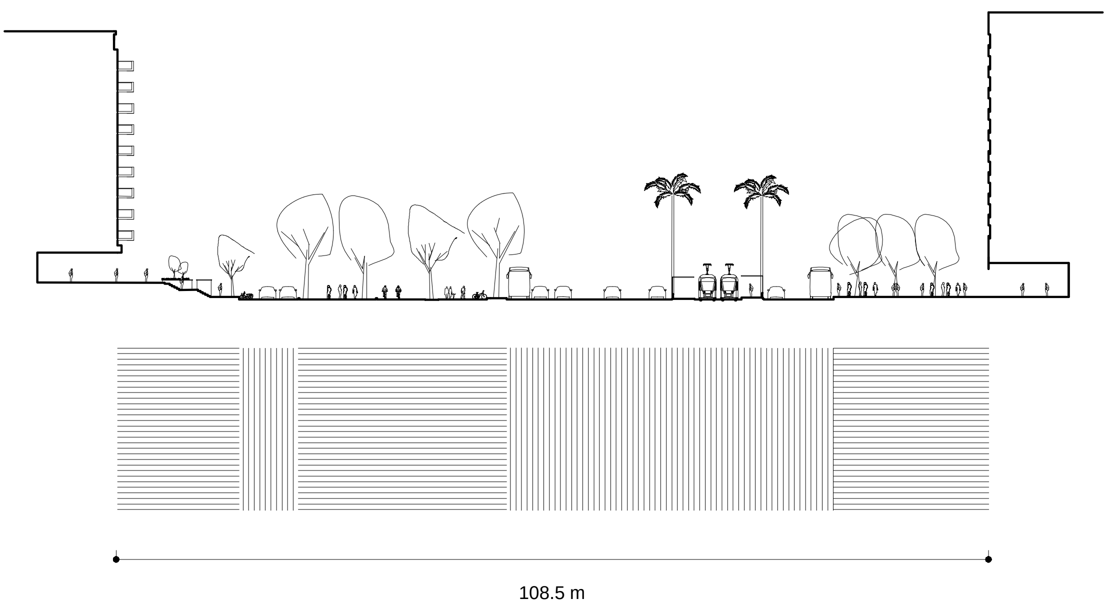
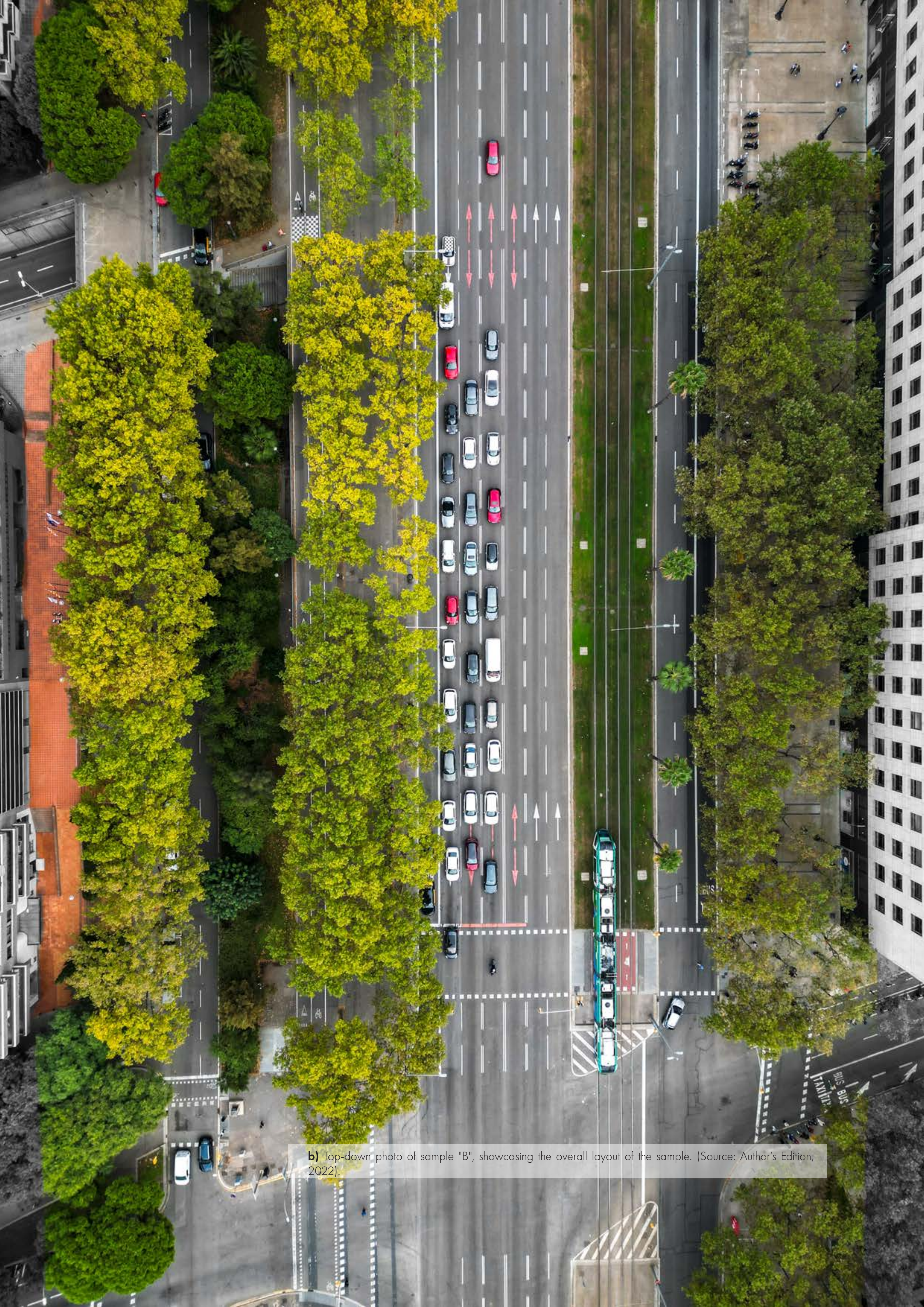


Figure 8.2-14 Sample "B", Avenida Diagonal.
a) Plan and cross-section of sample "B." (Source: Author's Edition).



b) Top-down photo of sample "B", showcasing the overall layout of the sample. (Source: Author's Edition, 2022).

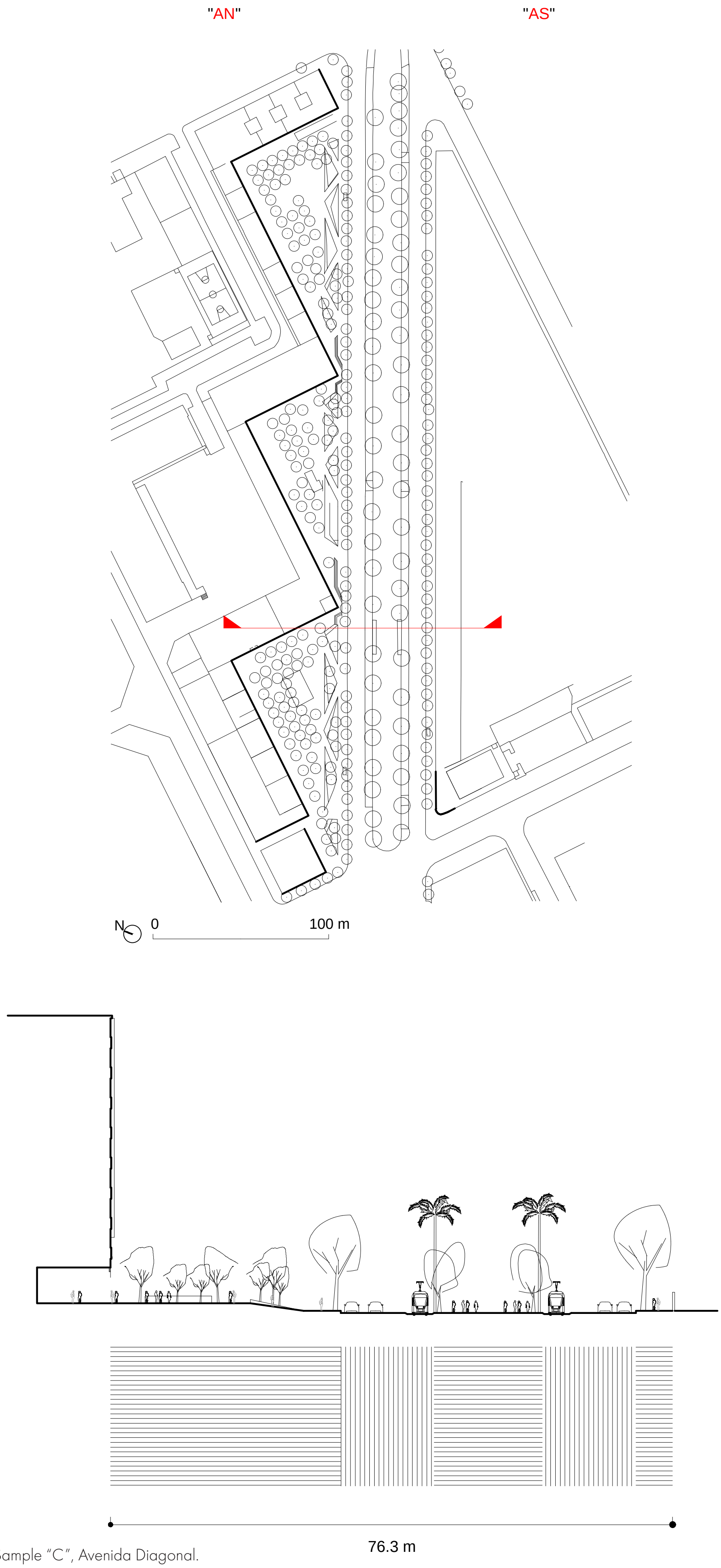


Figure 8.2-15 Sample "C", Avenida Diagonal.
a) Plan and cross-section of sample "C." (Source: Author's Edition).

b) Top-down photo of sample "C", showcasing the overall layout of the sample. (Source: Author's Edition, 2022).

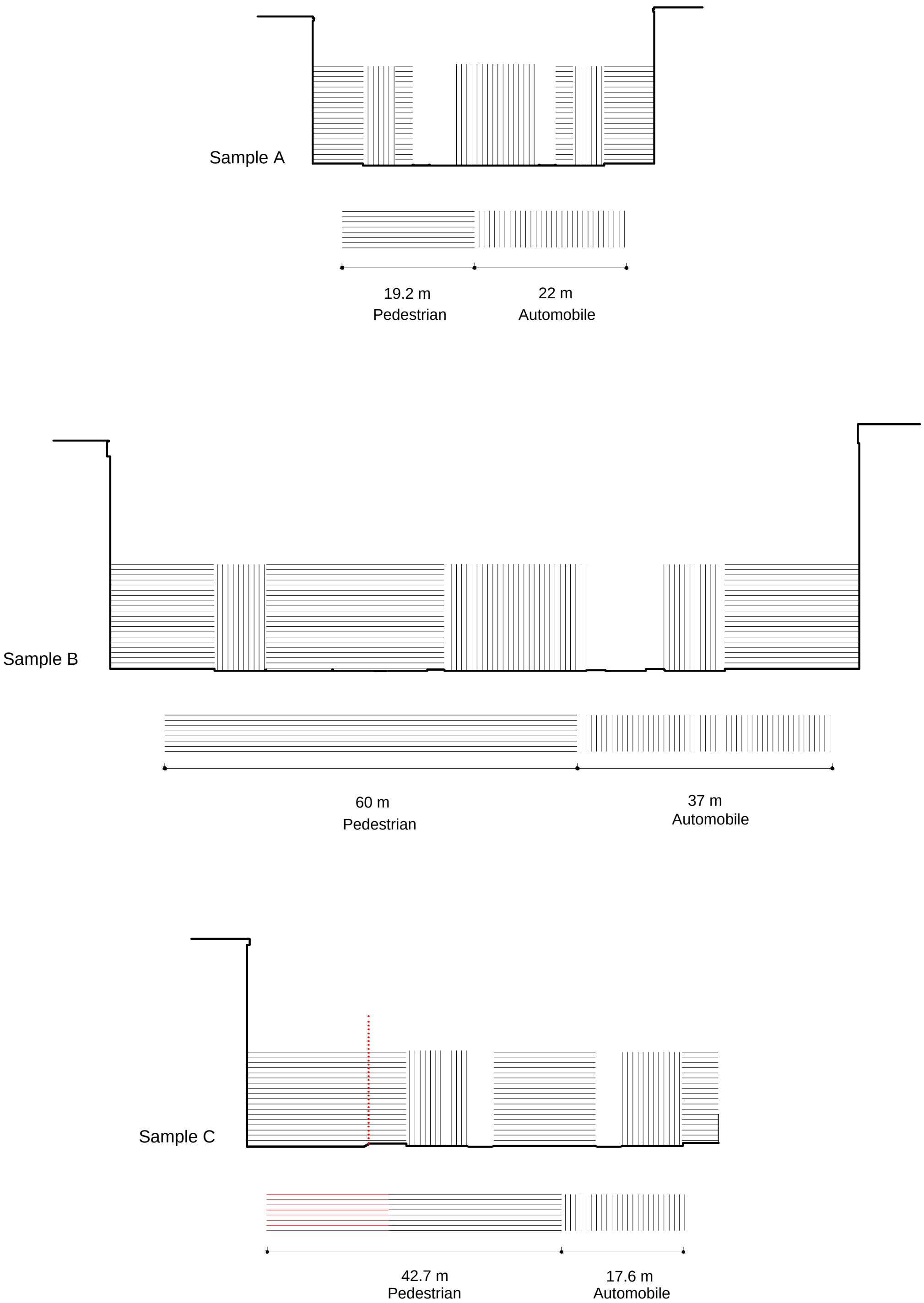


Figure 8.2-16 Cross-sections of samples "A, B, and C" show the pedestrian-to-automobile ratio. (Source: Author's Edition).

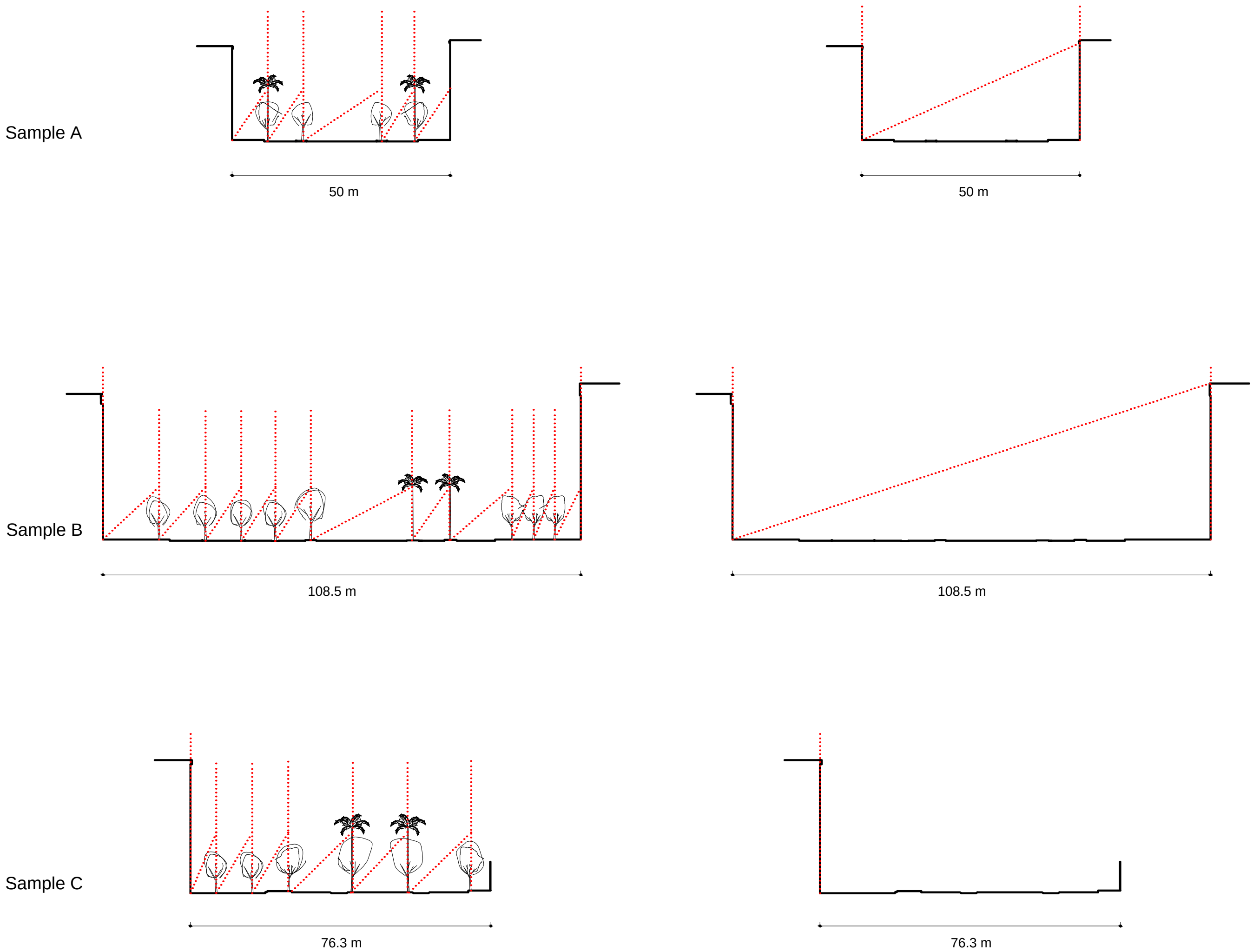


Figure 8.2-17 Cross-sections of the three selected samples show the street width and building height ratio. (Source: Author's Edition).

08.2.3.1. Avinguda Diagonal pedestrians' activities

The observation study provided insight into pedestrian activities on the avenue during the day and night, along with information correlated to age and gender counts and the street partition composition. The pedestrians' activities varied between walking, sitting, standing, running, or cycling from one sample to another. As a significant local and tourist destination, the Diagonal proved to be a critical route and an active place for public life. The avenue connects several landmarks, businesses, and economic and educational activities. The partition of the avenue in the three selected samples responds to the daily public life rhythm, with different compositions that provide a multifunctional place. The richness of uses that the street partition supported emphasizes how it is shaped to accommodate such diversity.

The analysis of pedestrian activities found a notable number of pedestrians using the avenue as a route to reach their destination, either by walking in the pedestrian zone or cycling in the central street area, more commonly in Samples B and C. This necessary activity depended on the time of the day, being more common from 7 to 9 am and from 5:30 to 7:30 pm. The avenue also provided an opportunity for optional activities, where pedestrians were observed interacting with the surrounding street elements and edges through shopping, sitting, or photographing, among other activities. Notably, these optional activities were observed occurring along the frontage zone that offers a dialogue between public and private spaces, more commonly in Samples A and B. The avenue further provided a place for social interactions between two or more people. Street elements such as street furniture and places such as outdoor seating for cafes and restaurants were observed to provide a setting for such activities. Most social activities occurred in the frontage zone and the amenity zone (Figure 8.2-18).

Furthermore, the central pedestrian and cyclist area created connectivity along the avenue, as observed in Samples B and C. Pedestrians and cyclists actively occupied this space, as it offered a perfect setting for essential daily trips. During both weekdays and weekends, the central pedestrian area generated a vibrant public life, which encouraged street livability and contributed to the richness of social interactions. The area provided a sufficiently wide space capable of adapting to the type of activity without losing its dynamic character.

The public life observation found that besides the use of movement, the central area accommodated optional and social activities, which were more active in Sample B (Figure 8.2-19). Many social or cultural events occurred, with activities that reinforce the avenue's historical, traditional, and cultural character. However, Samples A and B had more optional and social activities across different ages and genders. Sample C occupied less variety, mainly presenting necessary activities. The analysis of pedestrians' gender and age identified the following age groups: children, teenagers, adults, and seniors. All age groups had affluence patterns well-distributed throughout the day, particularly in Samples A and B. This highlighted that the study area is a linear center in the city and a cultural and recreational place that can appeal to various age groups, though adults were the most represented at any time of day.

In Sample A, different types of pedestrian activities occurred both individually or in small and large groups. The study observed people sitting and reading or eating, stopping and standing, engaging with a group, and shopping, where the sample provided a set of shops, restaurants, and cafes that attracted pedestrians. There was a significant difference between pedestrians' volume during the day and during the night. Most of the activities were optional and social and occurred on the sides of the avenue. However, due to the absence of a central pedestrian area, similarly to Samples B and C, activities such as running were less likely.

In Sample AS, the proportion of adult pedestrians was significantly higher. The study found that the average number of male adult pedestrians during the daytime was 66 per 10 minutes, compared to 36 male teenage pedestrians per 10 minutes. This can also be seen during the nighttime, when the average number of male adults was 56 per 10 minutes, compared to male seniors and teenagers at 12 per 10 minutes. Sample AN presented a similar rhythm of public life and pedestrian activities. During the daytime, there were 58 male adult pedestrians per 10 minutes and 35 male teenage pedestrians per 10 minutes. There was also a more significant volume of adult males than other ages and genders during the nighttime (Figure 8.2-20).

In Sample B, all three types of pedestrian activities occurred during different times and on weekdays and weekends. Pedestrians of different ages and genders were observed using the street for different purposes. However, the sample represented the characteristics of its surrounding area, where commercial, institutional, and educational uses dominate. The people who used this sample were mostly students or locals.

In Sample BS, which is characterized by a large shopping center that occupies the entire block, most activities occurred between 8 am and 8 pm, with shopping as the main activity. The shops and commerce activities attracted people of different ages and genders. During the daytime, female adults were the most observed pedestrians at an average of 63.3 per 10 minutes, compared to female teenagers at 62 per 10 minutes, male adults at 55 per 10 minutes, and male teenagers at 54 per 10 minutes, while seniors and kids were 16 and 9 per 10 minutes. During the nighttime, activity corresponded perfectly with the opening hours of the shopping center. There were fewer activities than during the daytime. Female adults were the most observed pedestrians at an average of 56 per 10 minutes, compared to male adults at 53.6 per 10 minutes, male teenagers at 40 per 10 minutes, and female teenagers at 38.6 per 10 minutes.

Sample BN had a different public life with optional activities such as sitting, eating, and standing. The partition composition allowed such activities. The width of the sidewalk allowed outdoor seating and was a perfect setting for social interactions. Most pedestrians preferred to walk on the lower sidewalk, while the upper level represented their social and optional activities and offered an extension for the cafes and restaurants. The sample provided a place for all genders and ages during the day and night. The study found more adult and teenage pedestrians than senior and child pedestrians. During the daytime, there were 58.3 male adult pedestrians per 10 minutes, while male teenagers averaged 44.3 pedestrians per 10 minutes. The volume of users decreased during the nighttime, as the uses and activities were primarily educational (Figure 8.2-21).

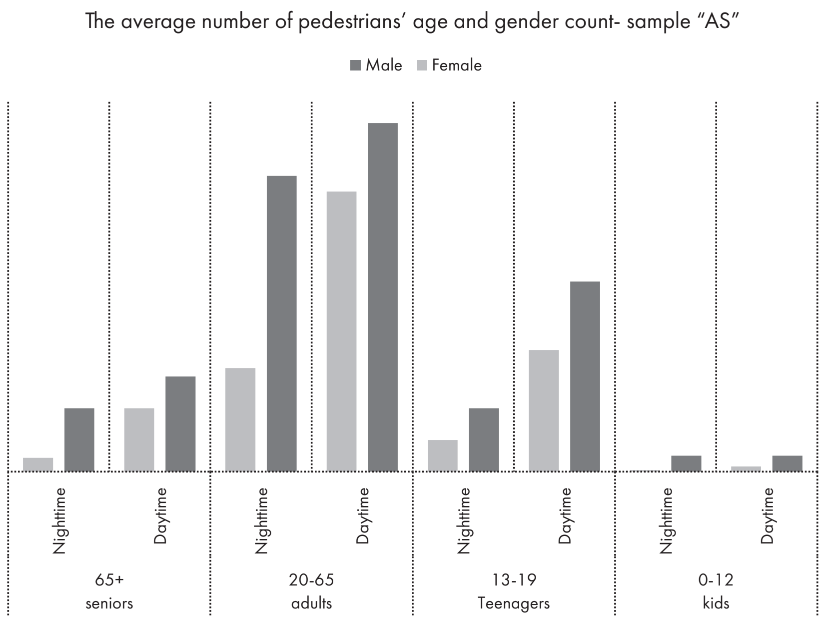
Sample C, which is on the last section of the avenue, contrasted Samples A and B. Despite the sample's variety of transportation modes and location at the end of the avenue, fewer social and optional activities were observed. The main pedestrian activities were necessary ones that occurred in the central pedestrian area, like walking, running, and cycling. Pedestrians' activities were observed to be more active during the daytime compared to the nighttime. The lack of wide sidewalks had an apparent impact. In Sample CS, the volume of male adult pedestrians during the daytime, as the most active user group, was 22 per 10 minutes. This was a significant decline compared to Samples A and B. Sample CN presented similar results, with 22 adult male pedestrians per 10 minutes during the daytime and 11 adult male pedestrians per 10 minutes during the nighttime (Figure 8.2-22).

Figure 8.2-18 A series of photographs capturing the pedestrian activities of three selected samples of Avenida Diagonal.
a) Sample "A." (Source: Author's Edition, 2022).

b) Sample "B." (Source: Photos: Al Mushayt, 2022).

c) Sample "C." (Source: Photos: Al Mushayt, 2022).

Figure 8.2-19 Photos of pedestrian activities in the pedestrian central area of Sample "B." (Source: Author's Edition, 2022).



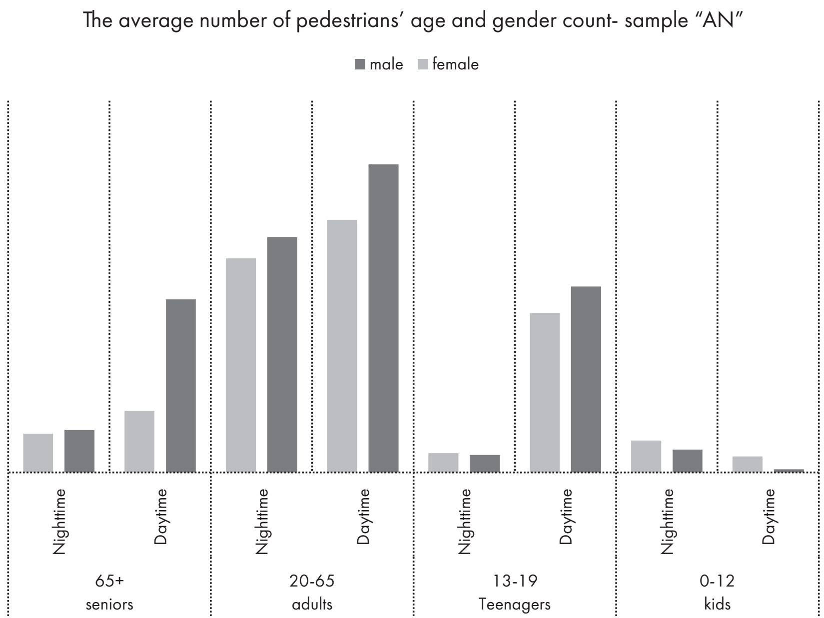
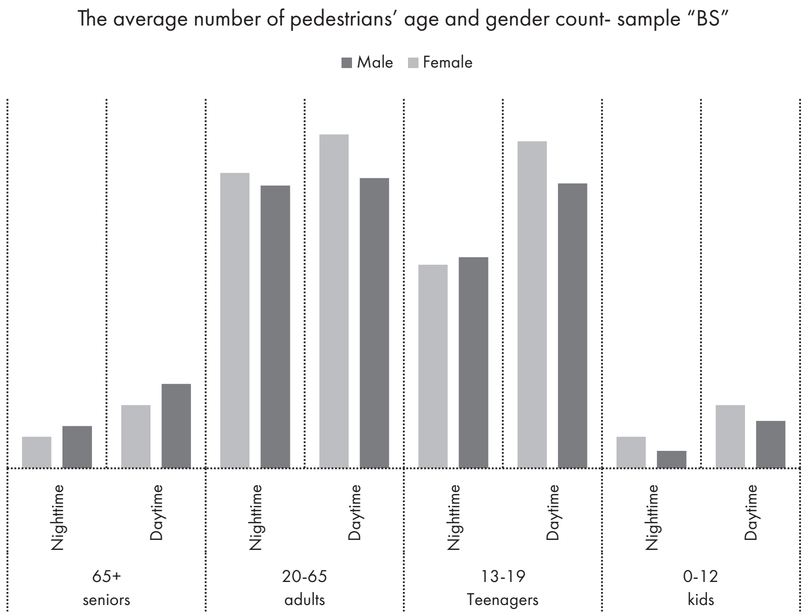


Figure 8.2-20 The average number of pedestrians' age and gender count of Avenida Diagonal, sample "A."



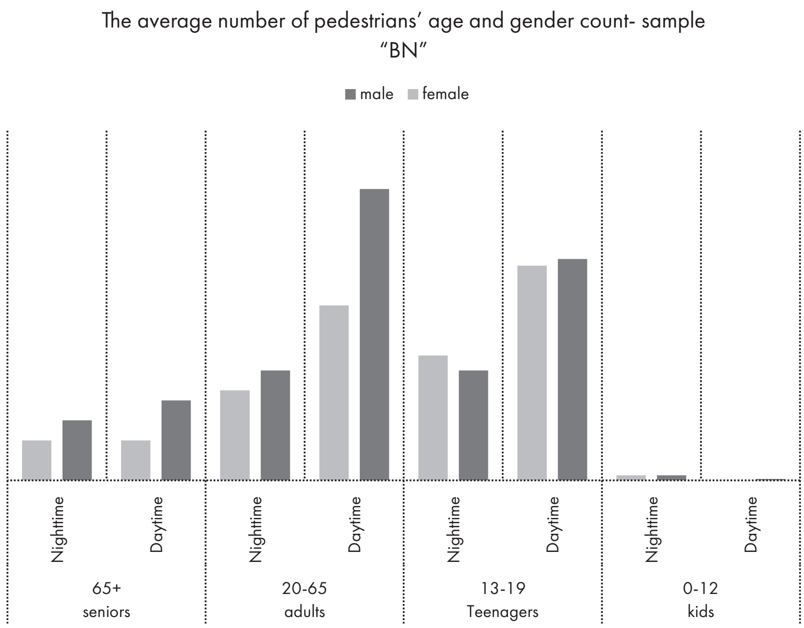
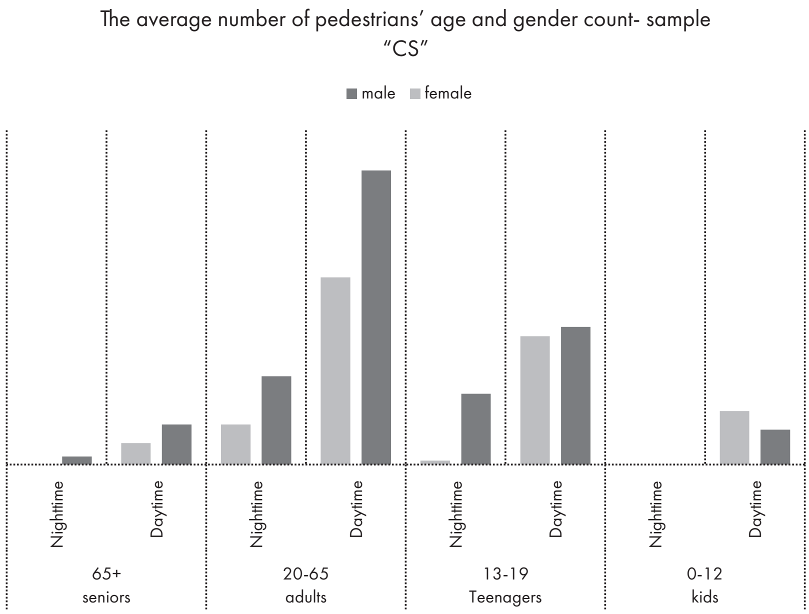


Figure 8.2-21 The average number of pedestrians' age and gender count of Avenida Diagonal, sample "B."



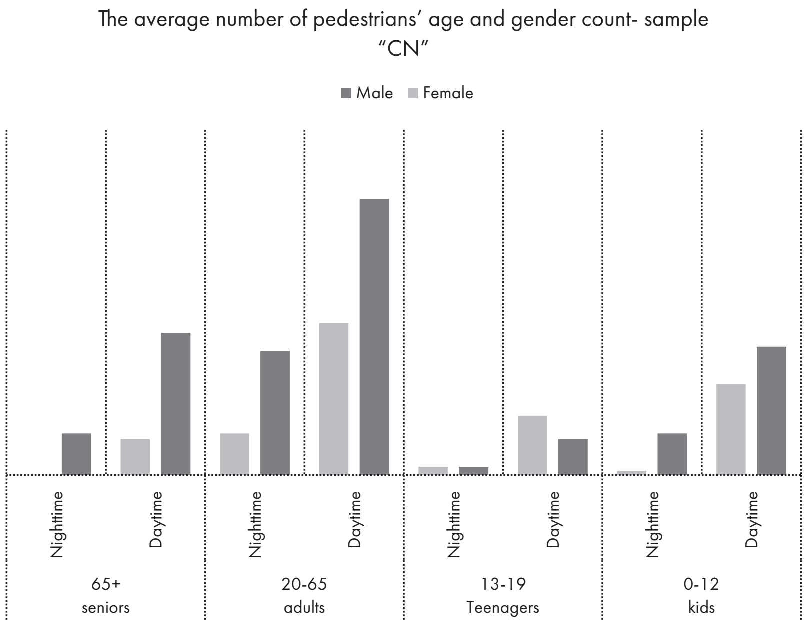


Figure 8.2-22 The average number of pedestrians' age and gender count of Avenida Diagonal, sample "C."

08.3. The street interface

08.3.1. Avenida da República street interface

Avenida da República is a lively street in a strategic location surrounded by commercial and tertiary activities. Three commercial centers meet here: the Atrium Saldanha, the Monumental, and Campo Pequeno. The street has mixed uses and a variety of activities in view, creating a stimulating place for people. The study found that the three most common uses on the ground floor along the street are services such as banks and telecom stores (18.32%), residential buildings and hotels (15.27%), and restaurants and cafes (14.50%). Because of the various uses and the century-old construction of this artery, there are different forms of interfaces. They compose a diverse and dynamic public realm that allows interaction and connection between the morphological components. In a 1.5 m stretch, the street interfaces on the ground floor offer various shared spaces with different uses, structured as continuous spaces, whether public or private, contributing to the street's vitality.

The study found two general categories of street, both offering a continuous rhythm of doors and windows connecting the public and private spaces (Figure 8.3-1). The first category, in Samples A and B, has all five types of interfaces—PA, IA, PI, II, and DW—with different percentages of occupation. These samples offer a variety of proximities, with some interfaces adjacent to the sidewalk and others having a setback. The interfaces provided windows into ground floor uses that varied from restaurants to soft goods and specialty, governmental, and residential services. Sample A is characterized by a wider sidewalk, from 17 to 9 m, than Sample B, at 9 m, which supports, facilitates, and distributes pedestrian flows.

Sample AE is 120.7 m wide and has an interface height between 4.5 and 5 m. Most of the interfaces (49.69%) are PA, compared to II interfaces at 24.35%. This demonstrated that the ground floor on this side offers diverse entrances to restaurants, office buildings, and furniture stores. They all provide access to the street, which presents a continuity that creates a consistent rhythm in terms of doors and windows. Sample AW is 116.4 m wide and between 4.5 and 5 m in interface height. II interfaces are the most established, with a percentage of 36.29%. Regardless, this sample offers more variety of uses on the ground floor than Sample AE, including entrances to restaurants, a fashion store, residential fronts, a beauty salon, and offices (Figure 8.3-2).

Sample B accommodates all the selected variables of street interface configurations (Figure 8.3-3). The architecture of the buildings provides richness to the streetscape through characteristics like painted ceramic tiles and carved traditional windows and columns. The interfaces of Sample BE are 104.1 m wide and between 4 to 4.5 m in interface height, with a majority of II interfaces (33.38%). This is reflected in the residential use of the ground floor. However, the rhythm of doors and windows was found to confer a vibrant visual texture. Sample BW had a more significant number of possible uses, whereby a single building may accommodate multiple uses at eye level. The interfaces are 101.6 m wide and between 4 and 5 m in height, most being II (34.54%).

The eye-tracking for Samples A and B found that the PA interfaces induced the greatest eye fixation for most participants (Figure 8.3-4 and 8.3-5) In Sample A, participants were visually attracted to PA interfaces 28.95% of the time, IA interfaces 25.57% of the time, DW interfaces 19.90% of the time, II interfaces 16.5% of the time, and PI interfaces 9.09% of the time. In Sample B, participants likewise spent more time looking at the PA interfaces, 29.77% of the time, with doors/windows occupying 29.72%.

The second found street category occurred in Sample C, which presented different street morphology, street interface configurations, and visual preferences (Figure 8.3-6). Sample CE is 107.6 m long, and Sample CW is 151.06 m long. Sample CE mainly has II interfaces, which dominated at a percentage of 74.07%, while DW interfaces occupy 21.01% and PA interfaces occupy only 4.92%. This sample lacked a diversity of street interface typologies and uses. The street interfaces do not allow communication between the street and the buildings, despite the continuous rhythm of doors and windows. The absence of interactive interfaces creates an unlivable street with a lack of social activities, designed only for movement. Sample CW is margined by a vacant plot, offering a PI interface without setback and a strong rhythm of doors and windows compared to the other samples. The eye-tracking found that participants were attracted to the II interfaces 41.73% of the time, DW interfaces 33.8% of the time, and PA interfaces 24.29% of the time (Figure 8.3-7).

The overall eye-tracking for Avenida da República found PA interfaces to be the most visually attractive (Figure 8.3-8). On average, participants were visually attracted to these 25.49% of the time, in comparison to the DW interfaces at 21.60%, PI interfaces at 19.15%, IA interfaces at 17.73%, and II interfaces at 16.03%. Participants were more visually attracted to the interfaces of Sample A, occupying 43.63% of their time, compared to Sample B (34.11%) and Sample C (22.26%; Figure 8.3-9).

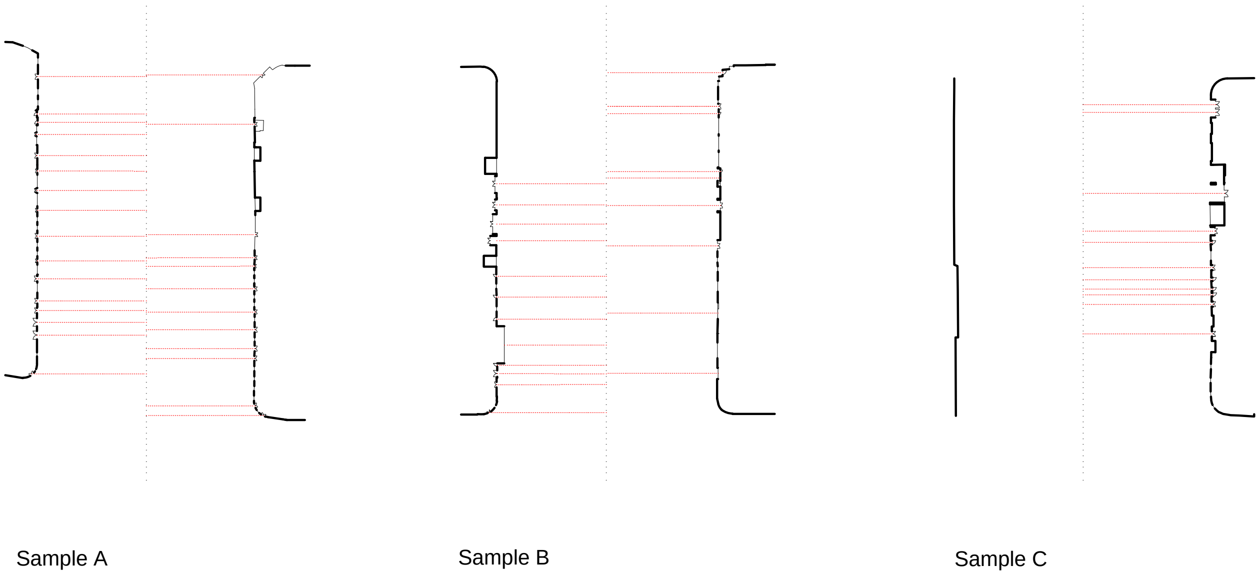
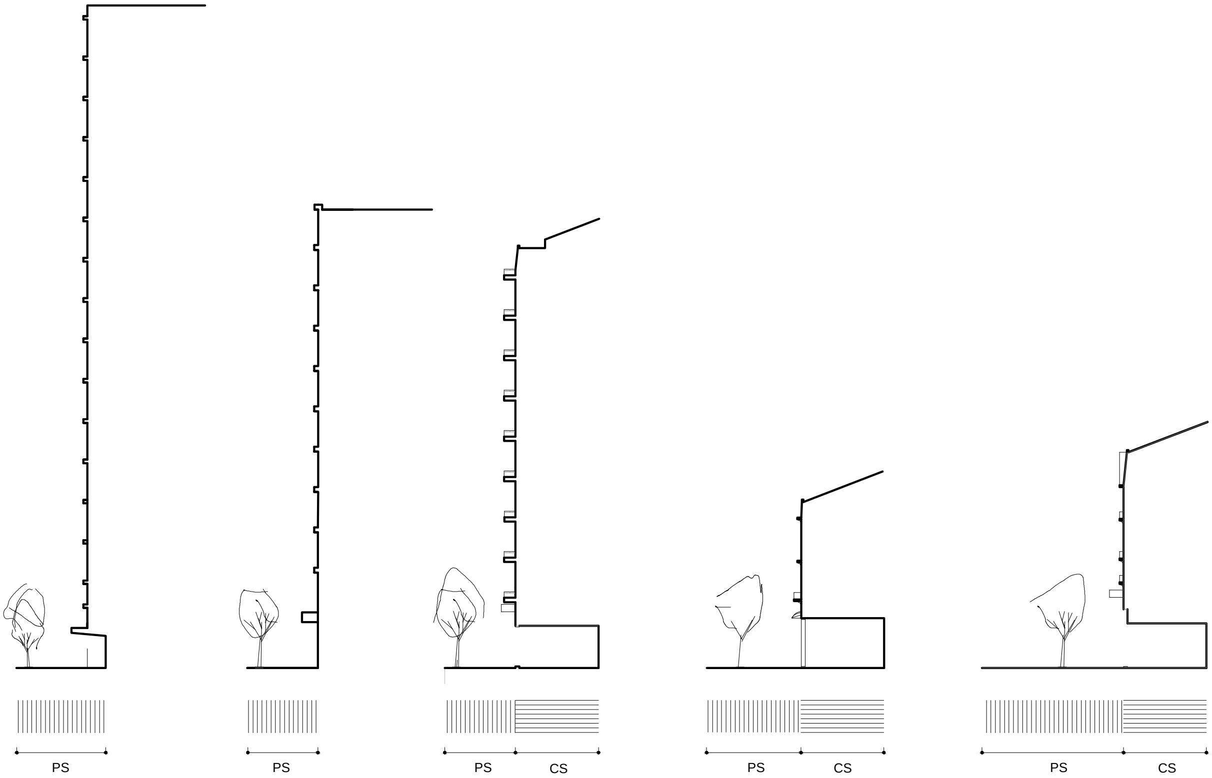
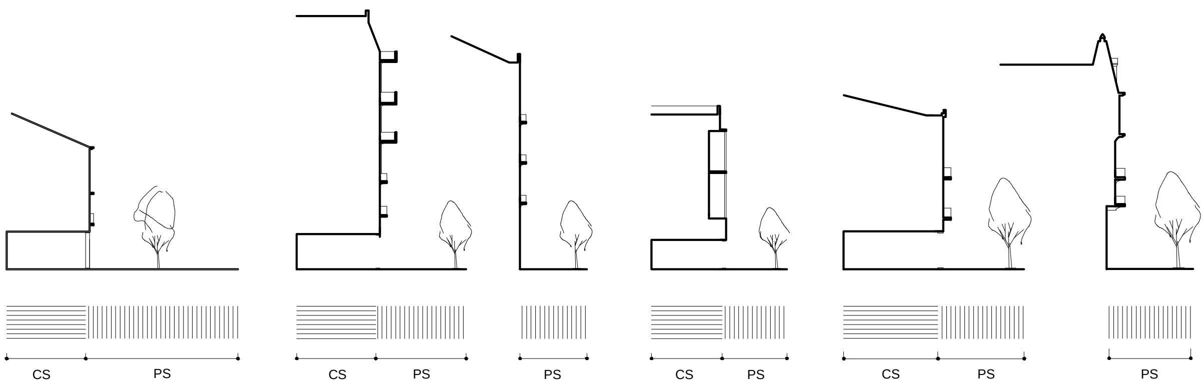


Figure 8.3-1 Plans of the three selected samples "A", "B" and "C" of Avenida da República show the rhythm and proximity of the street interfaces. (Source: Author's Edition).



Sample "AE"



Sample "AW"

Figure 8.3-2 Cross-sections of sample "A" in Avenida da República, show visual and physical permeability of the street interfaces. (Source: Author's Edition).

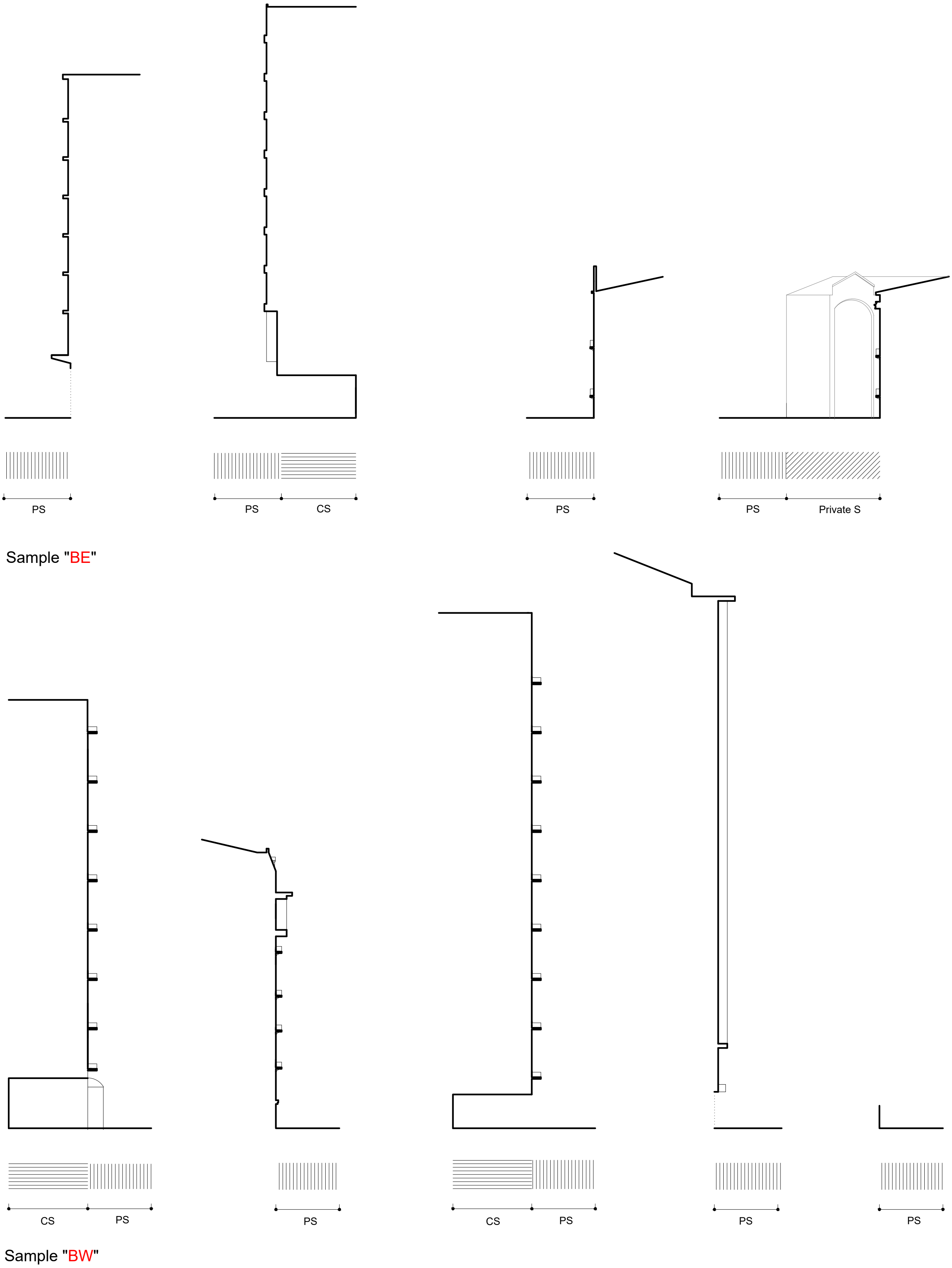


Figure 8.3-3 Cross-sections of sample "B" in Avenida da República show visual and physical permeability of the street interfaces. (Source: Author's Edition).

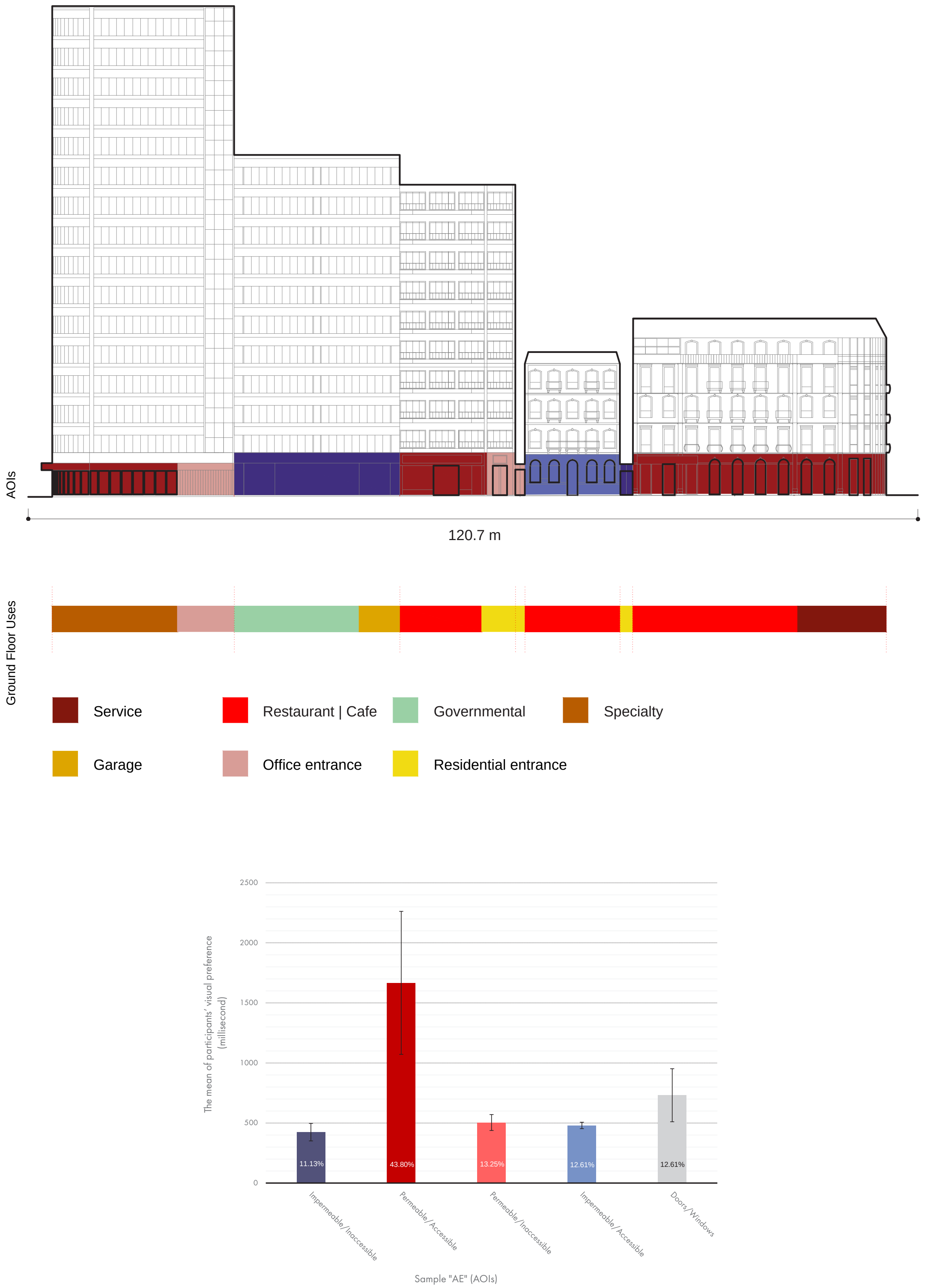
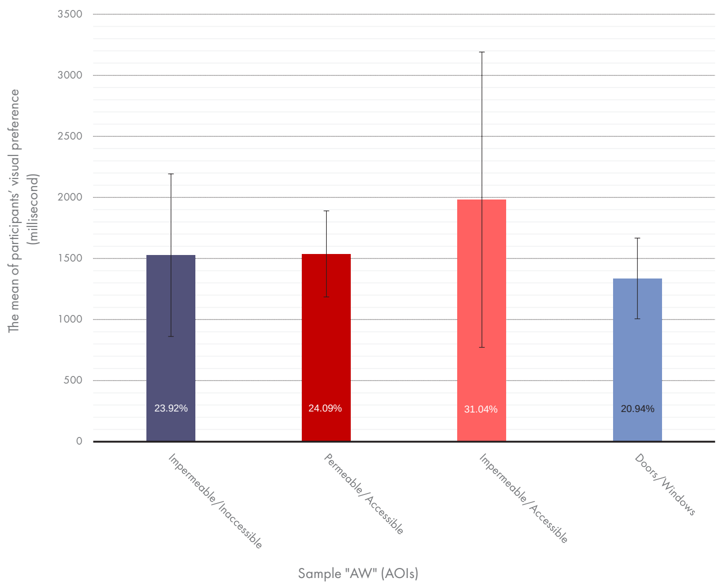
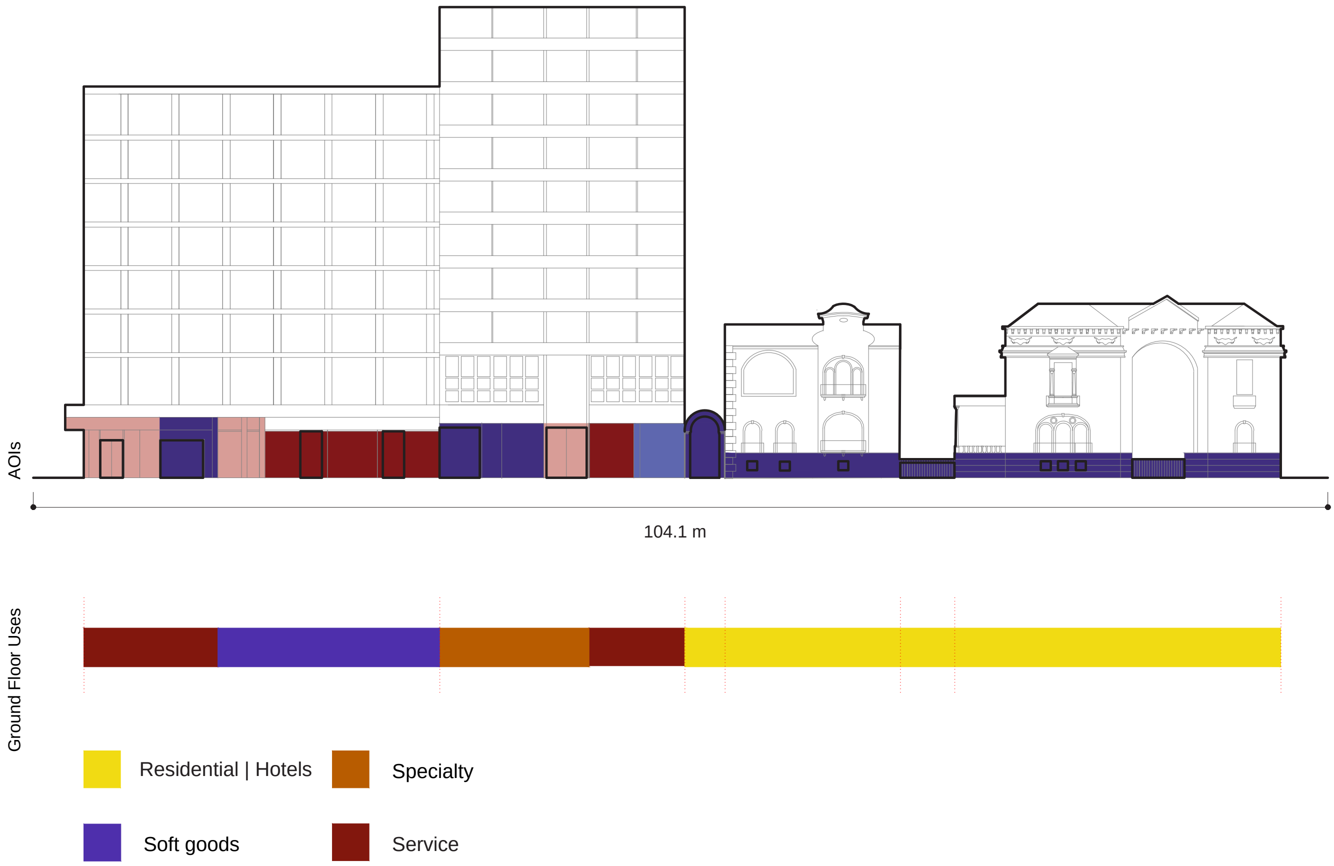


Figure 8.3-4 The percentage of participants' visual preference for street areas of interest (AOIs) in Avenida da República, sample "A."
a) Sample "AE". (Source: Author's Edition).



b) Sample "AW." (Source: Author's Edition).



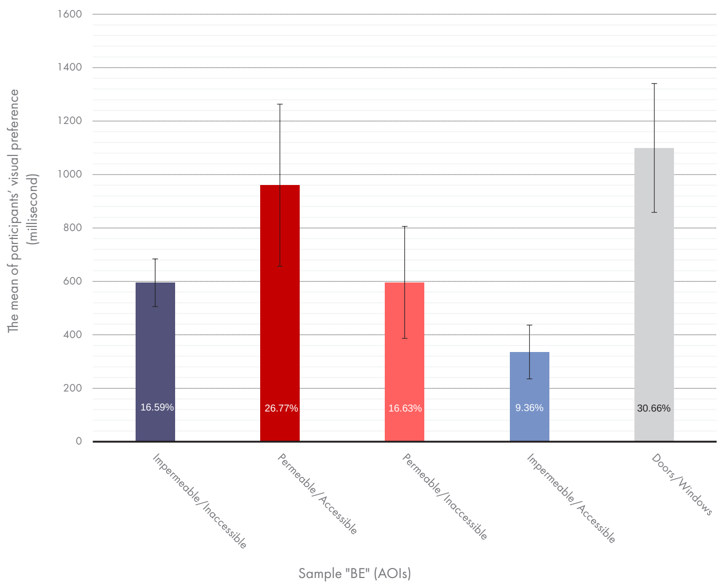
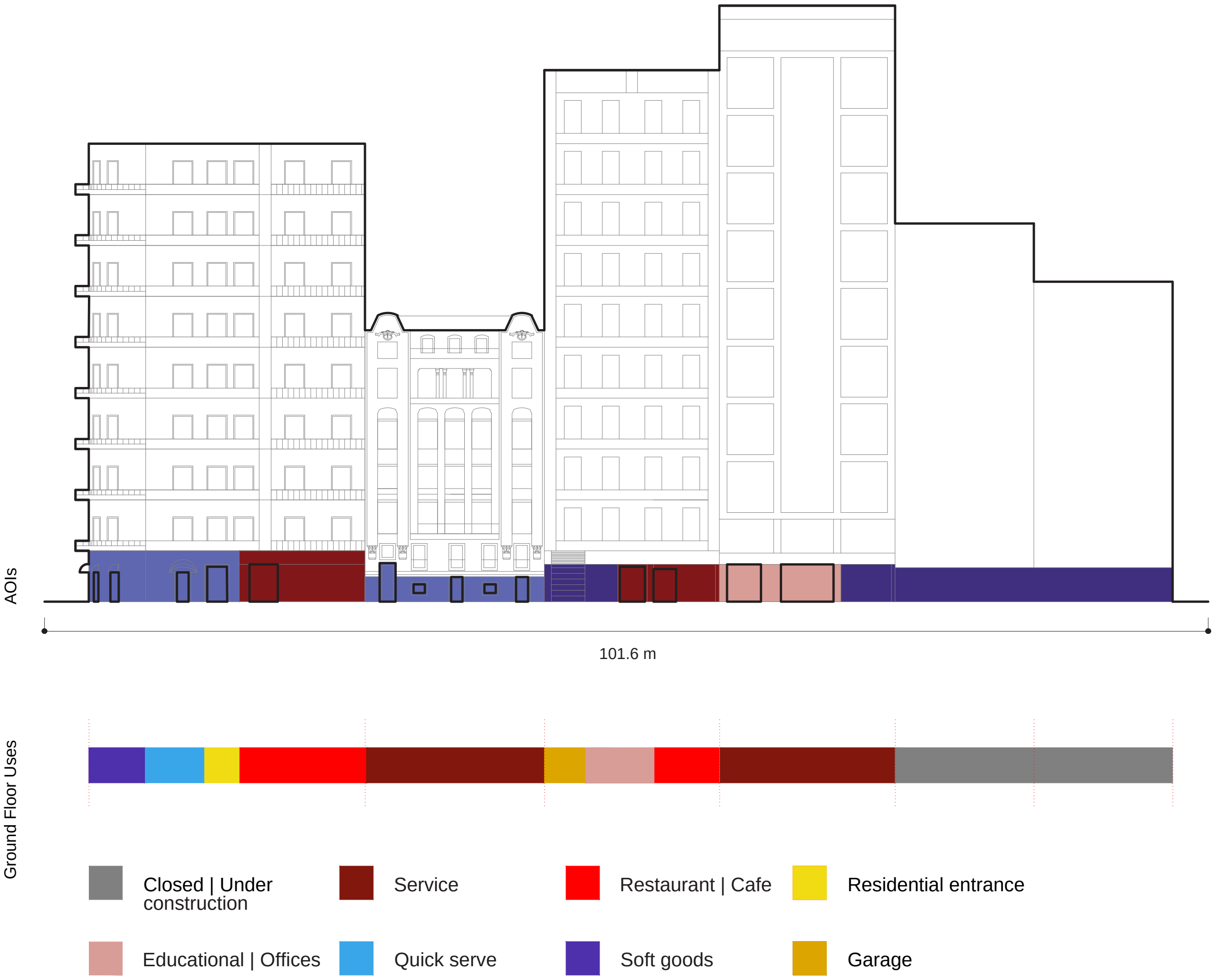
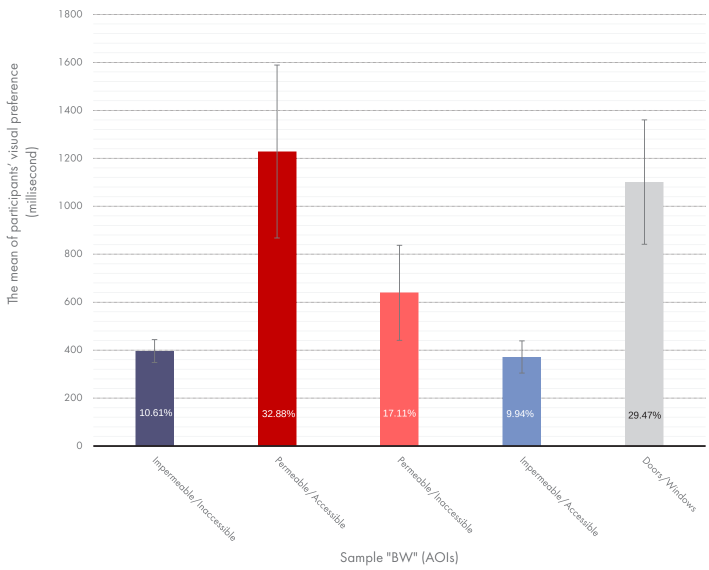
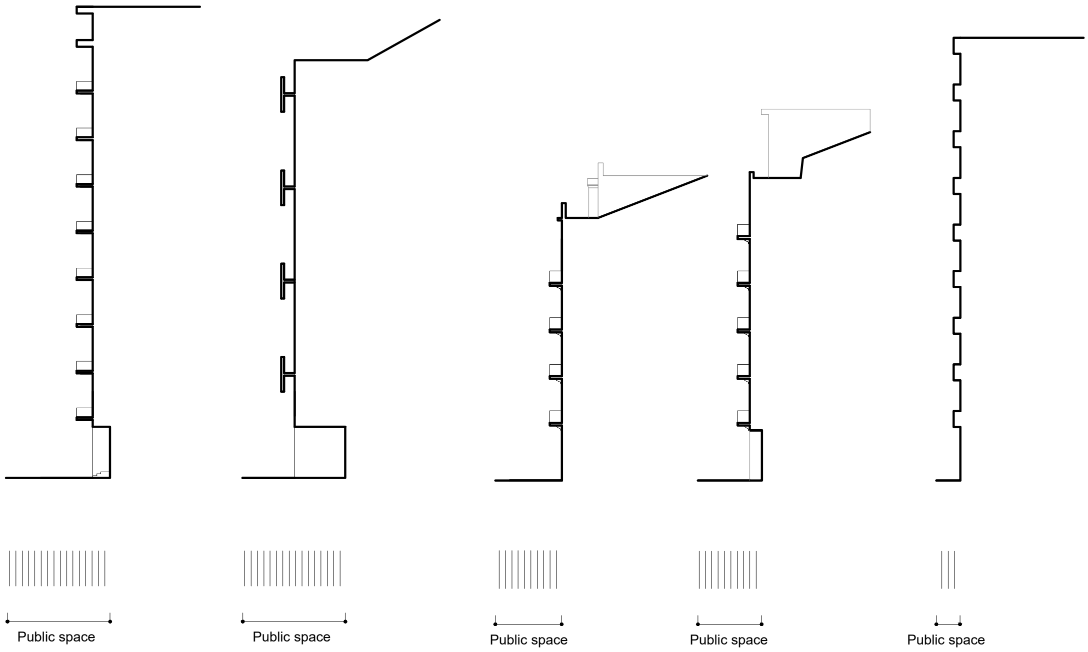


Figure 8.3-5 The percentage of participants' visual preference for street areas of interest (AOIs) in Avenida da República, sample "B."
a) Sample "BE." (Source: Author's Edition).

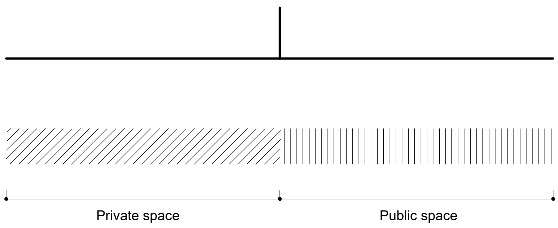




b) Sample “BW.” (Source: Author’s Edition).

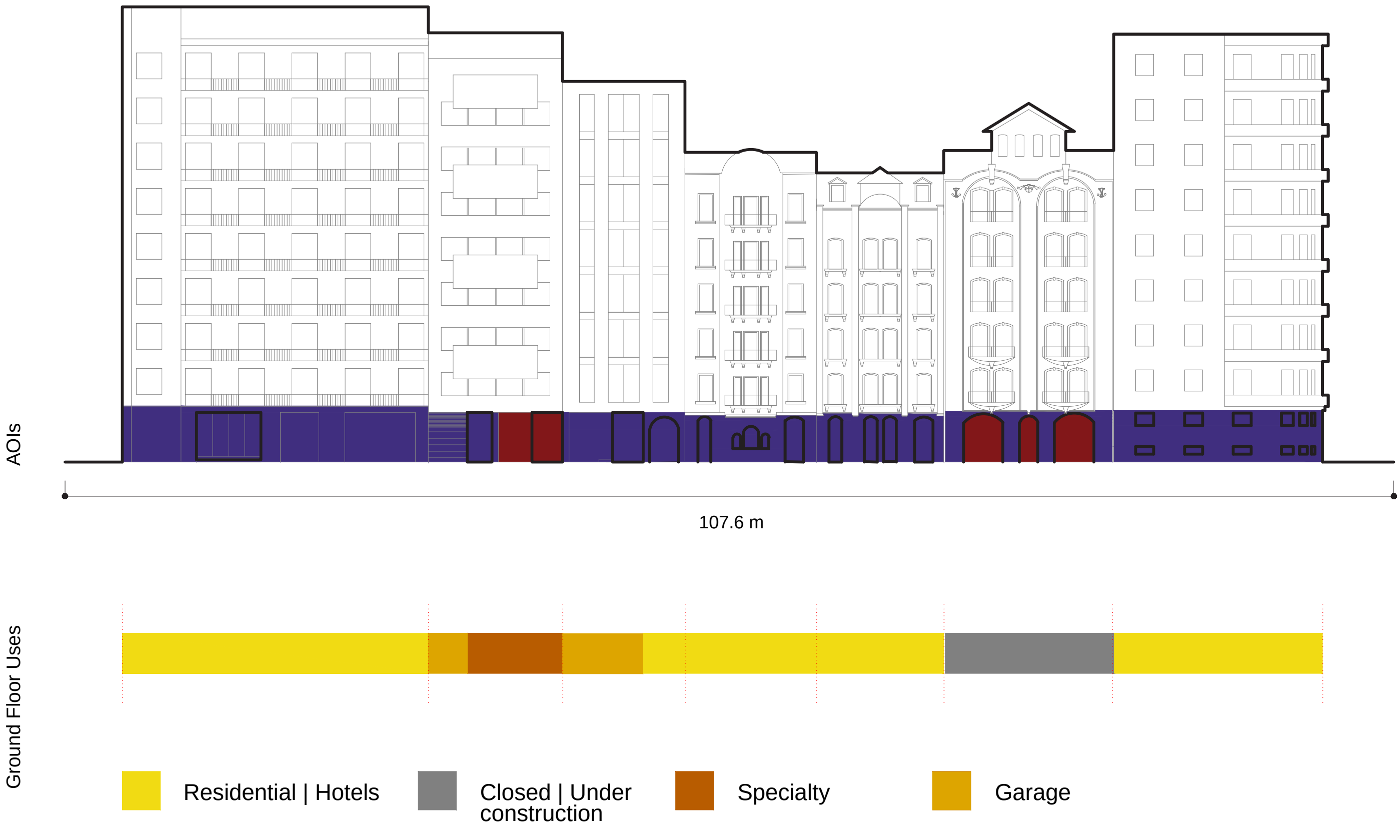


Sample "CE"



Sample "CW"

Figure 8.3-6 Cross-sections of sample "C" in Avenida da República, show the visual and physical permeability of the street interfaces. (Source: Author's Edition).



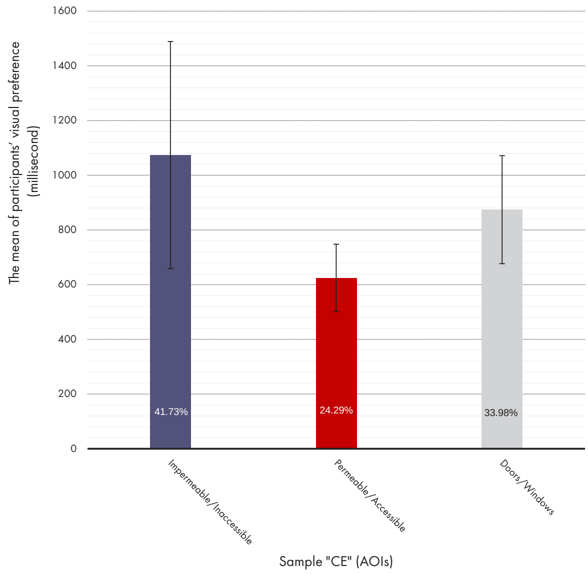
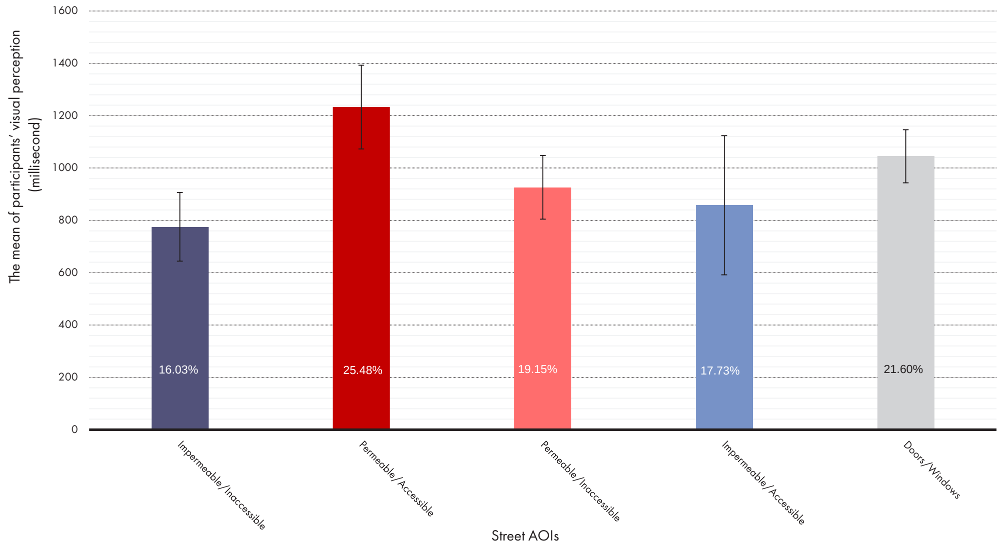


Figure 8.3-7 The percentage of participants' visual preference for street areas of interest (AOIs) in Avenida da República, sample "C."
a) Sample "CE." (Source: Author's Edition).

b) Sample "CW." (Source: Author's Edition).

8.3-8



8.3-9

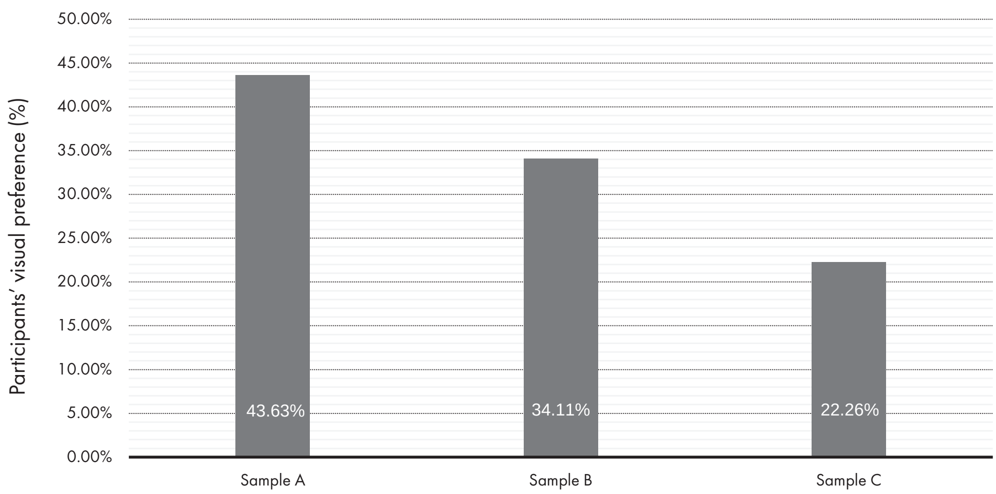


Figure 8.3-8 The percentage of participants' visual preference for street areas of interest (AOIs).
Figure 8.3-9 The percentage of participants' visual preference with the three samples "A", "B", and "C" of Avenida da República.

08.3.2. Avinguda Diagonal street interface

Avenida Diagonal is an active and vibrant street with social and commercial activities occurring on or adjacent to the avenue. It is considered a destination in its own right, with a wide variety of activities attract various users, creating stimulating places for pedestrians to view at ground floor level. The ground floor uses range from restaurants to soft goods and specialty, government, and residential services. As building block of the city formation, the avenue includes configurations of the street interface that respond to the functions at the ground floor level and the construction time period. The street interfaces are a diverse and dynamic part of the street's public realm that allow interaction and connection between the morphological components. In a 10 km length, the street interface configurations offer shared spaces with different uses, structured as various continuous spaces, whether public or private, contributing to the avenue's vitality. The study found all five types of street interfaces on the avenue with different percentages of occupation. Some interfaces are adjacent to the sidewalk, and others have a setback. The street interface offered a continuous rhythm of doors and windows connecting the public and private spaces (Figure 8.3-10).

Sample A accommodates four street interface configurations: PA, IA, II, and DW (Figure 8.3-11). The architecture of the buildings here in the oldest part of the avenue provides richness to the streetscape, through characteristics such as the carved traditional windows and columns. The rhythm of doors and windows was found to confer a vibrant visual texture to the street interfaces on both sides of the sample. The interfaces of Sample AS are 124.4 m wide and between 4 to 5 m in height. They are mostly PA interfaces, with a percentage of 68%, and II interfaces, with a percentage of 31%. This is reflected in the use of the ground floor, where restaurants and cafes provide outdoor seating for social and public life. Sample AN is 115.6 m wide and between 4 and 5 m in height, with most interfaces being PA at a percentage of 87%.

The eye-tracking found that the PA interfaces caused the most visual interactions for participants. In Sample AS, participants were visually attracted to PA interfaces 81.59% of the time, compared to PI interfaces at 13.16% and DW interfaces at 5.25%. In Sample AN, the results were also that participants spent most of their time looking at the PA interfaces, with an average of 92.39%, while DW interfaces occupied 7.61% of the time. The IA and II interfaces did not indicate any visual interactions from participants (Figure 8.3-12).

Sample B has all five types of street interface configurations (Figure 8.3-13). Sample BS is 343 m wide and had an interface height of 7 m. Most of the interfaces are PA, with a percentage of 50%, and IA, with a percentage of 33%. The ground floor here offers mainly commercial uses, as the block is composed of the L'illa Diagonal shopping center. However, the physical permeability of the urban block allows access to restaurants and office building entrances. Sample

BN is 290.8 m wide and has an interface height between 3.5 and 6 m. Two levels characterize the sample, with the sidewalk's upper part presenting the street interface in this sample. Most interfaces are PA, at a percentage of 58%.

The eye-tracking of Sample B found that the PA interfaces induced the greatest eye fixation for most participants. In Sample BS, participants were visually attracted to PA interfaces 51.89% of the time, in comparison to IA interfaces at 17.67%, PI interfaces at 12.37%, II interfaces at 11.24%, and DW interfaces at 6.84%. In Sample BN, participants also spent more time looking at the PA interfaces, 65.61% of the time, while the lowest time was spent on DW interfaces at 8% (Figure 8.3-14).

Finally, Sample C presents all five types of street interfaces (Figure 8.3-15). However, Sample CS, 454.6 m long, is occupied with white land, creating a lack of interface configuration. Sample "CN" is 550.5 m long and between 4 to 4.5 m in interface height, with the five types of interface configurations on the edge of the semipublic space. Participants were attracted to the PA interfaces more than the other interface configurations. In Sample CS, they visually engaged with PA interfaces 83.42% of the time and PI interfaces 16.58% of the time. In Sample CN, II interfaces occupy most of the sample, being 54% of the interfaces. However, the same visual preferences were found, where PA interfaces attracted engagement 65.66% of the time (Figure 8.3-16).

The overall eye-tracking for Barcelona found that PA interfaces were the most visually attractive (Figure 8.3-17). On average, participants were visually attracted to PA interfaces more than half of the time (58.48%), in comparison to the IA interfaces at 15.95% of the time, II interfaces at 10.31% of the time, DW interfaces at 8.49% of the time, and PI interfaces at 6.76% of the time. The participants were more visually attracted to the interfaces of Sample A, occupying 42.99% of their time, compared to Sample B (32.31%) and Sample C (24.69%; Figure 8.3-18).

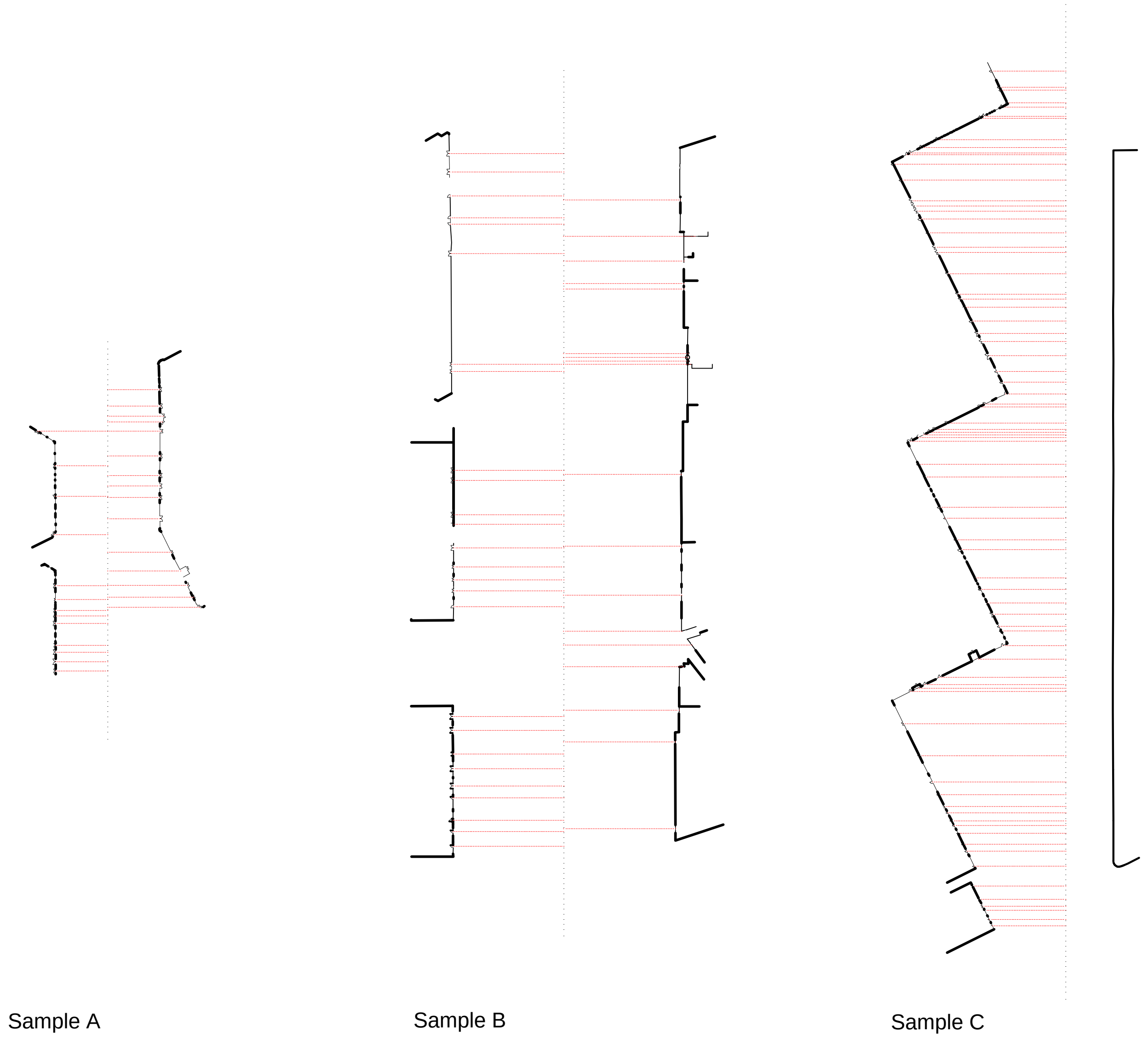


Figure 8.3-10 Plans of the three selected samples "A", "B" and "C" of Avinguda Diagonal, show the rhythm and proximity of the street interfaces. (Source: Author's Edition).

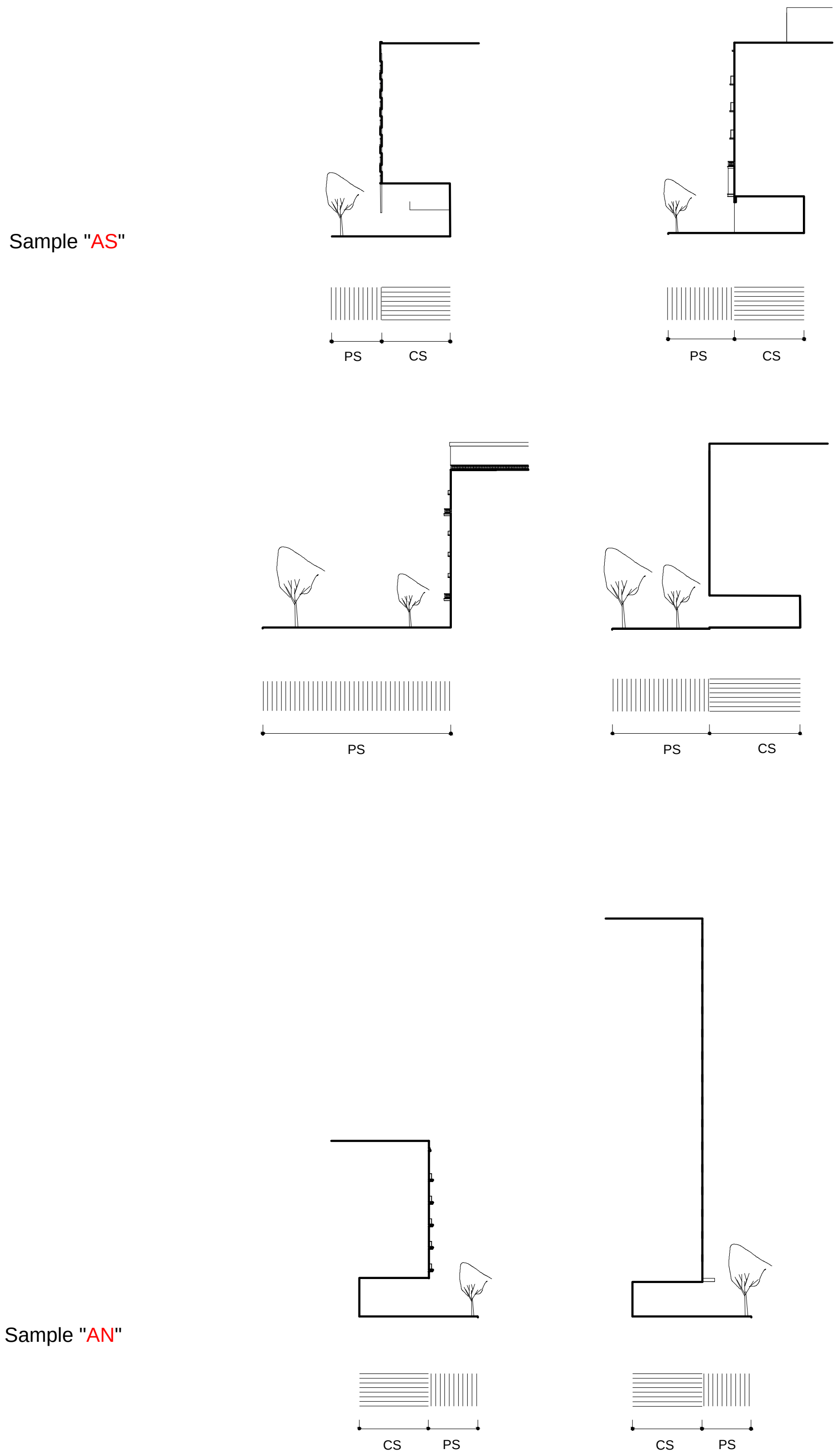
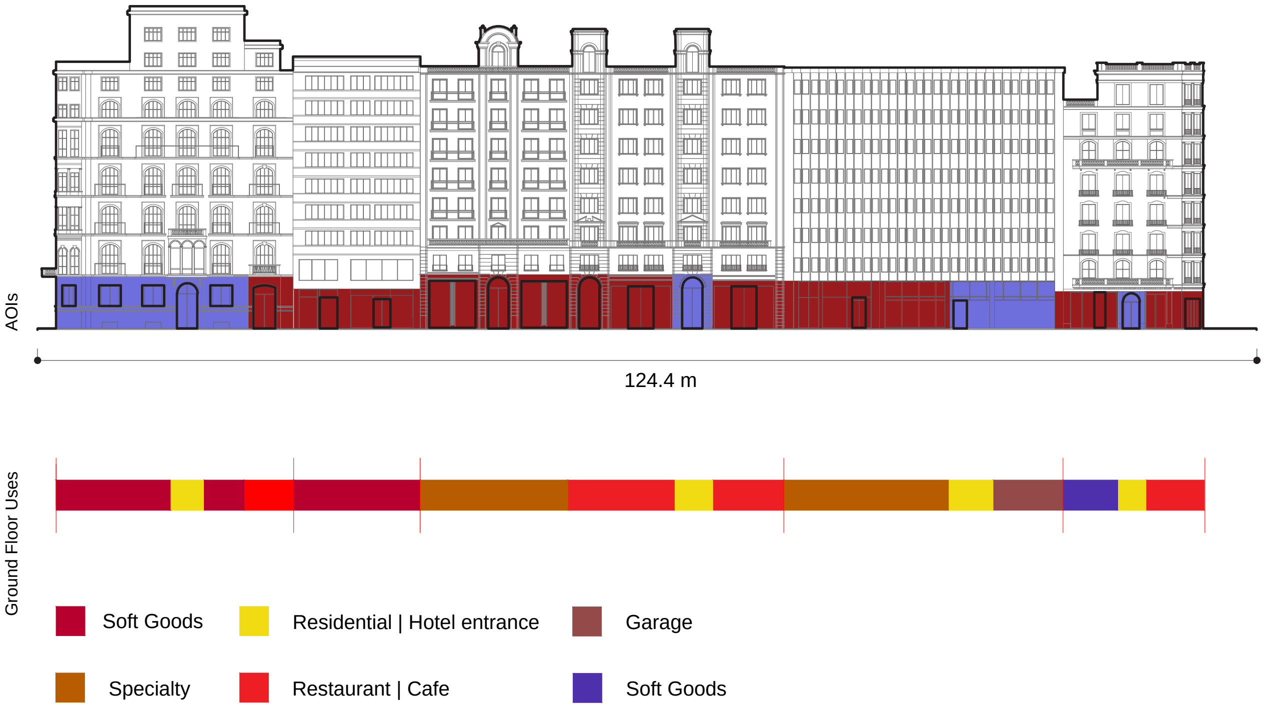


Figure 8.3-11 Cross-sections of sample "A" in Avinguda Diagonal show visual and physical permeability of the street interfaces. (Source: Author's Edition).



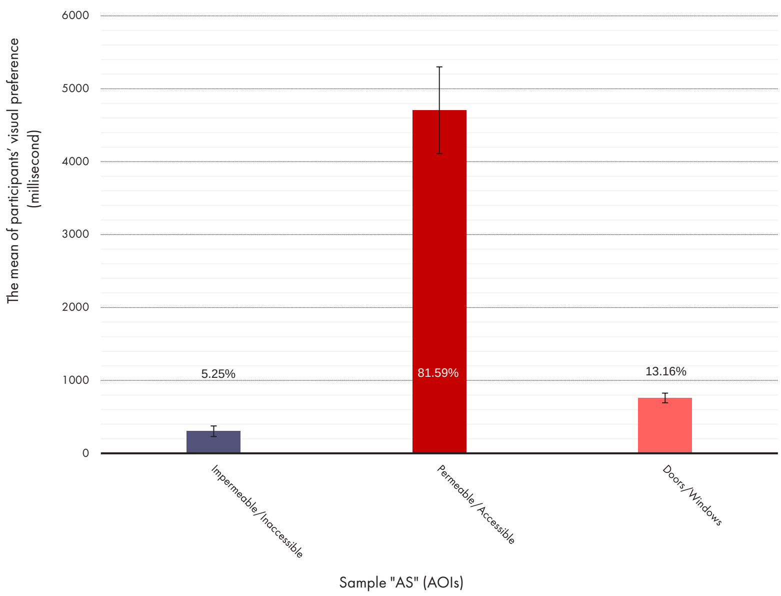
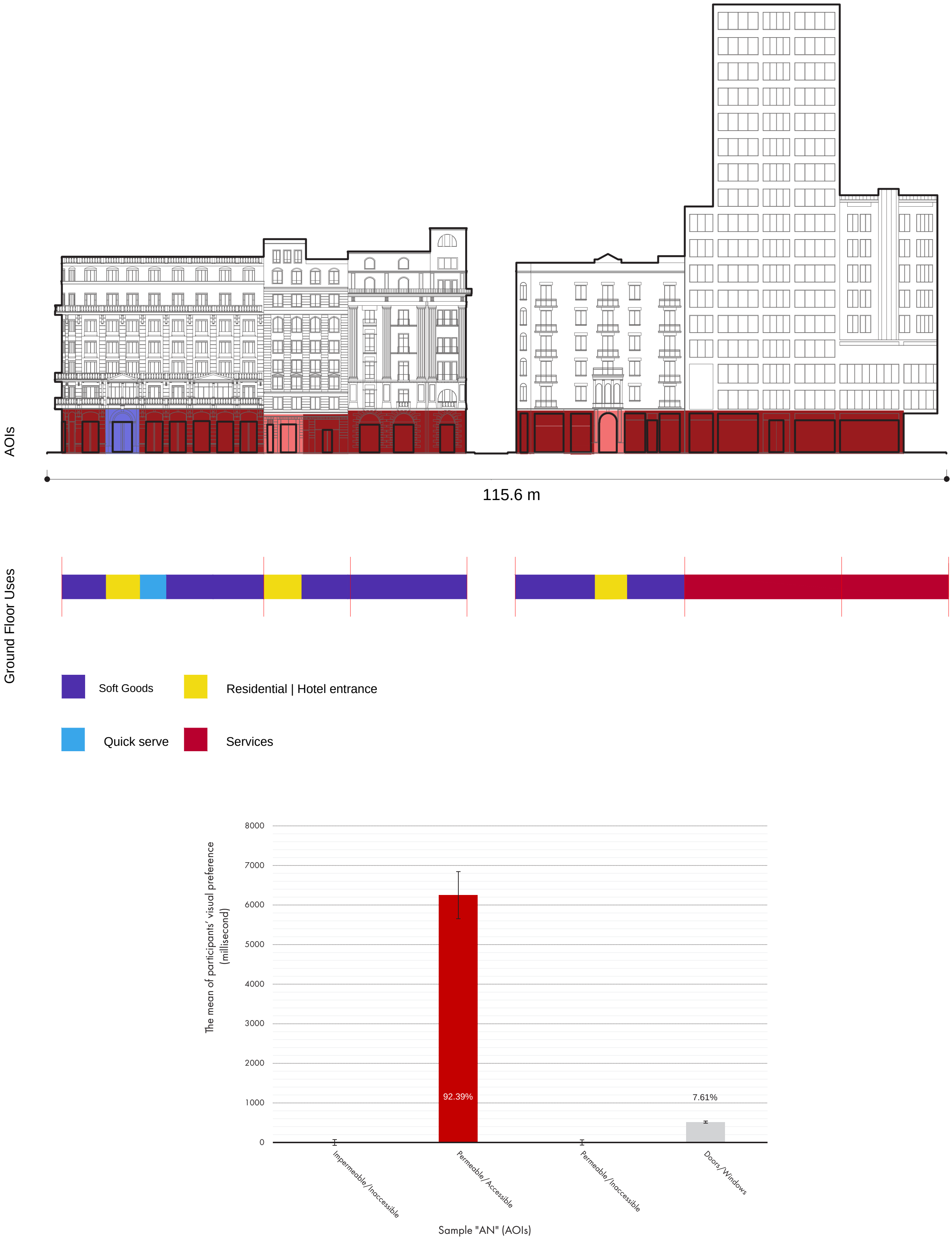


Figure 8.3-12 The percentage of participants' visual preference for street areas of interest (AOIs) in Avinguda Diagonal, sample "A."
a) Sample "AS." (Source: Author's Edition).



b) Sample "AN." (Source: Author's Edition).

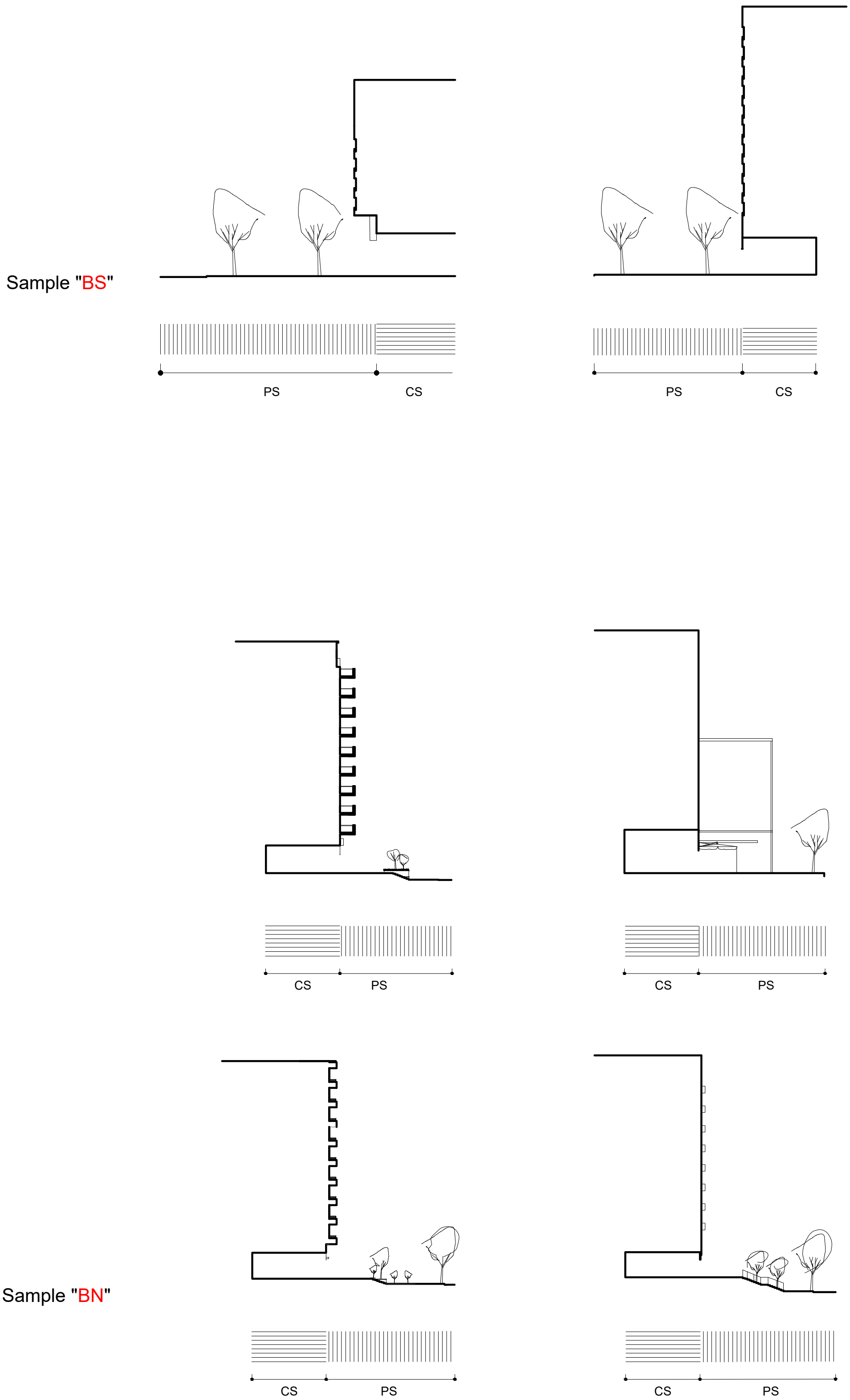


Figure 8.3-13 Cross-sections of sample "B" in Avinguda Diagonal show visual and physical permeability of the street interfaces. (Source: Author's Edition).

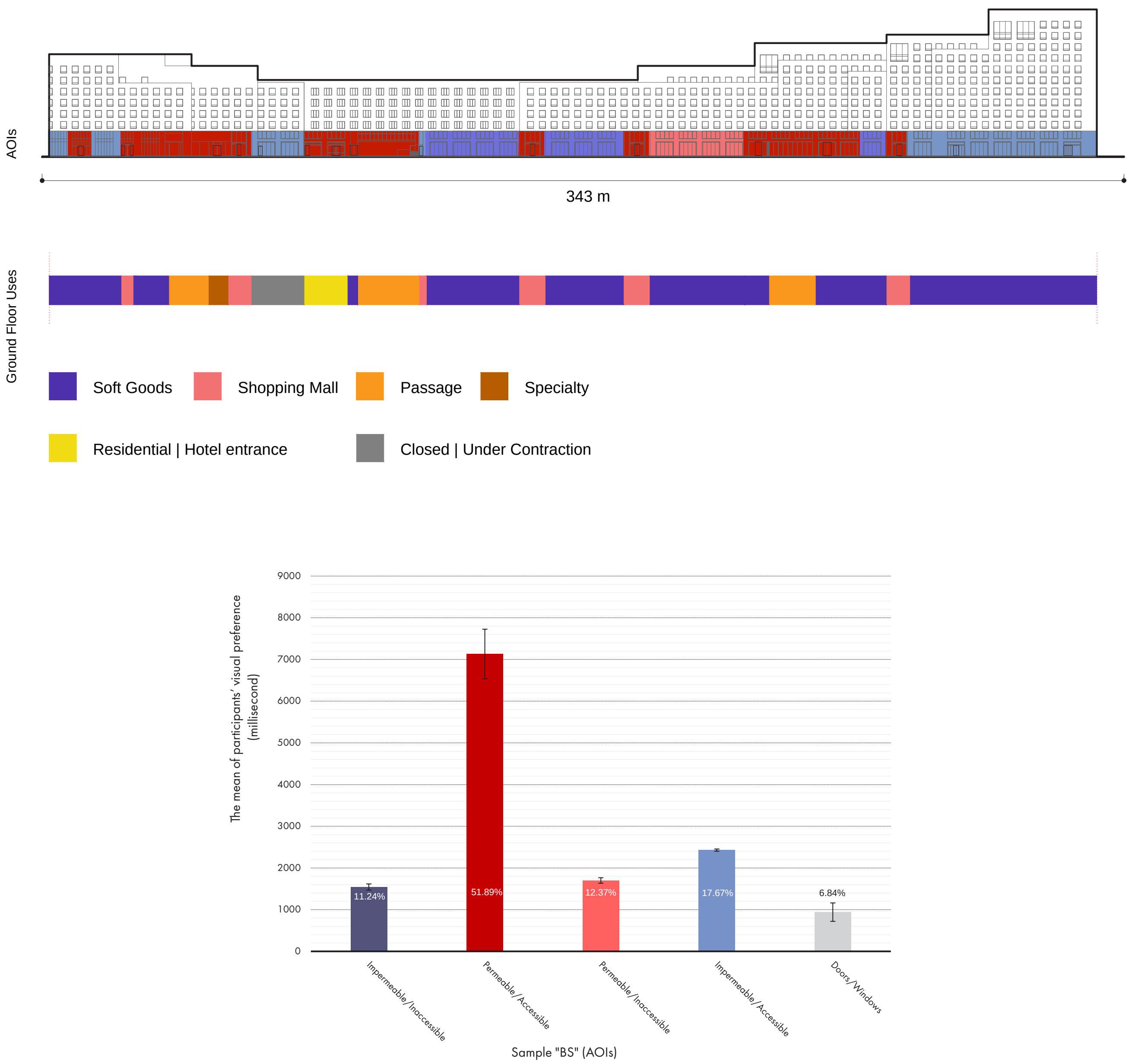
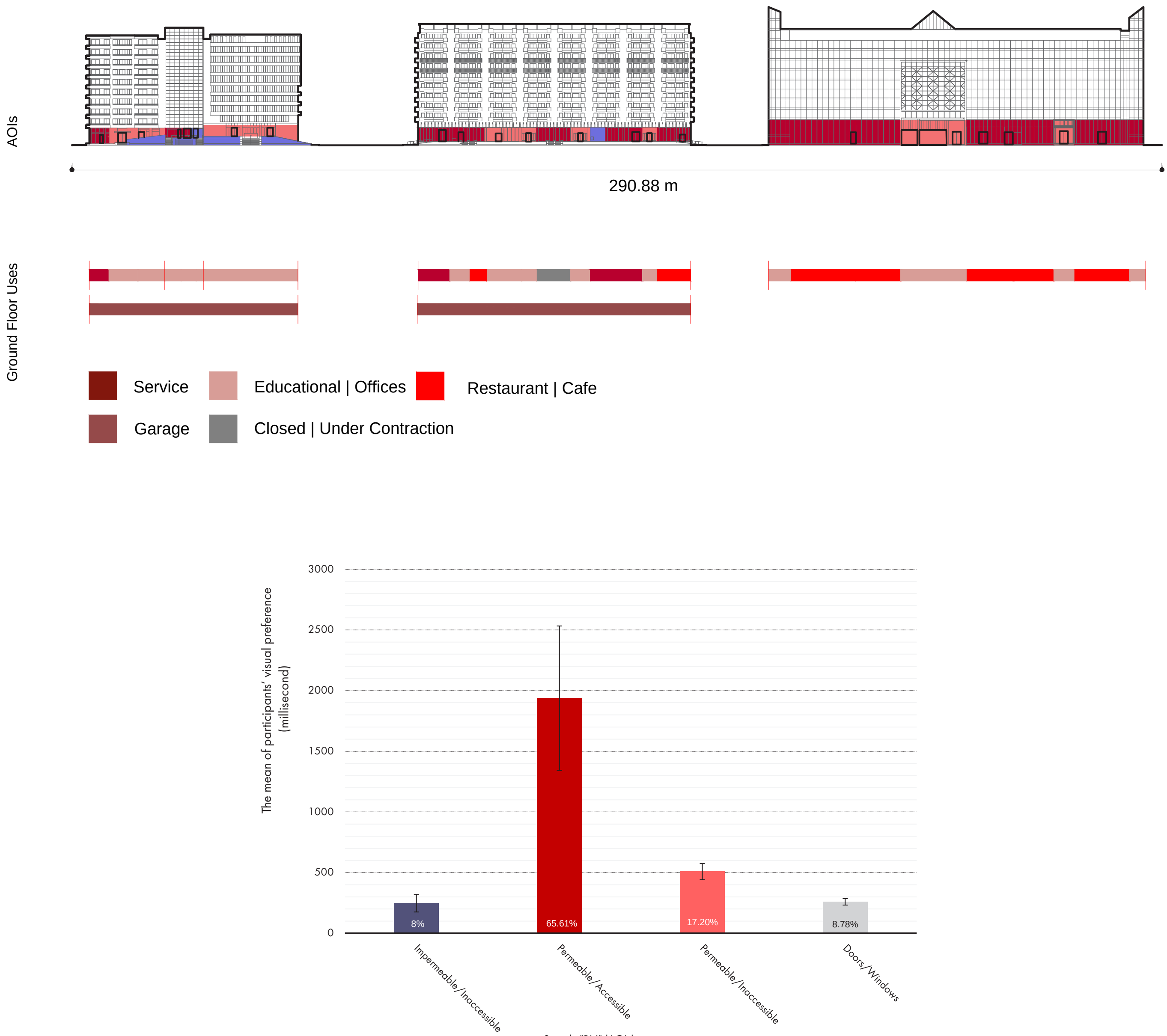


Figure 8.3-14 The percentage of participants' visual preference for street areas of interest (AOIs) in Avinguda Diagonal, sample "B."
a) Sample "BS." (Source: Author's Edition).



b) Sample "BN." (Source: Author's Edition).

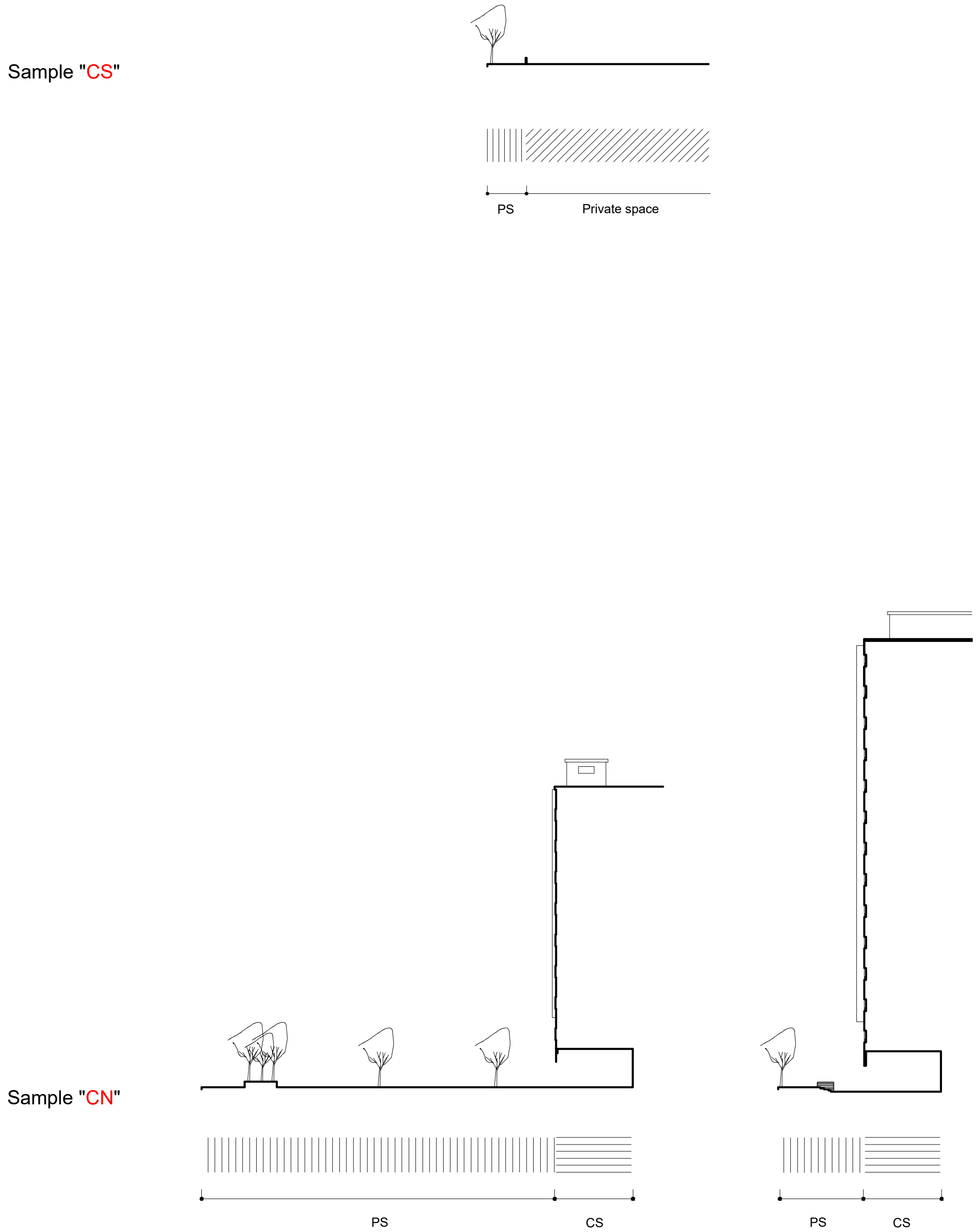
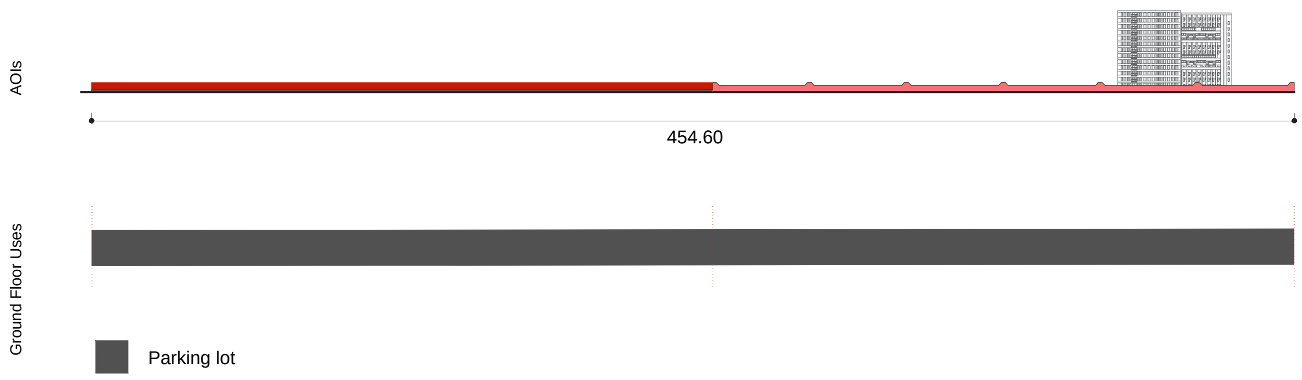


Figure 8.3-15 Cross-sections of sample "C" in Avinguda Diagonal show the visual and physical permeability of the street interfaces. (Source: Author's Edition).



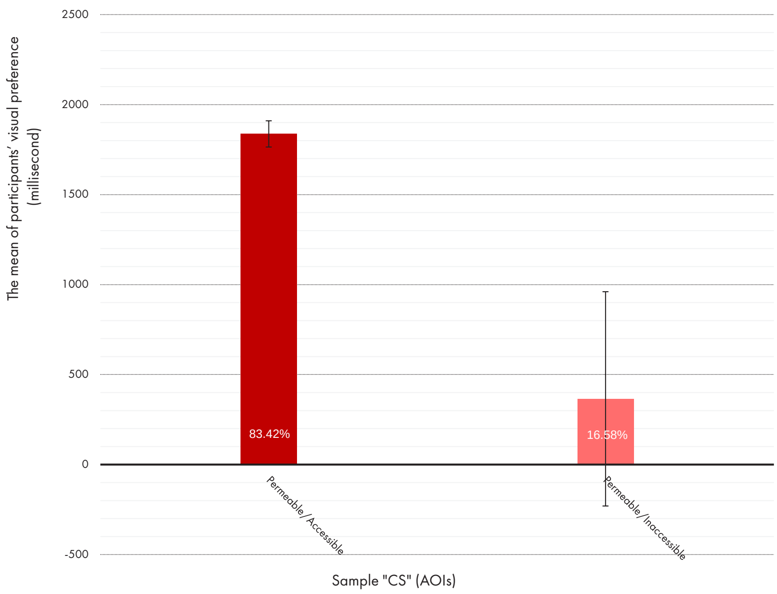
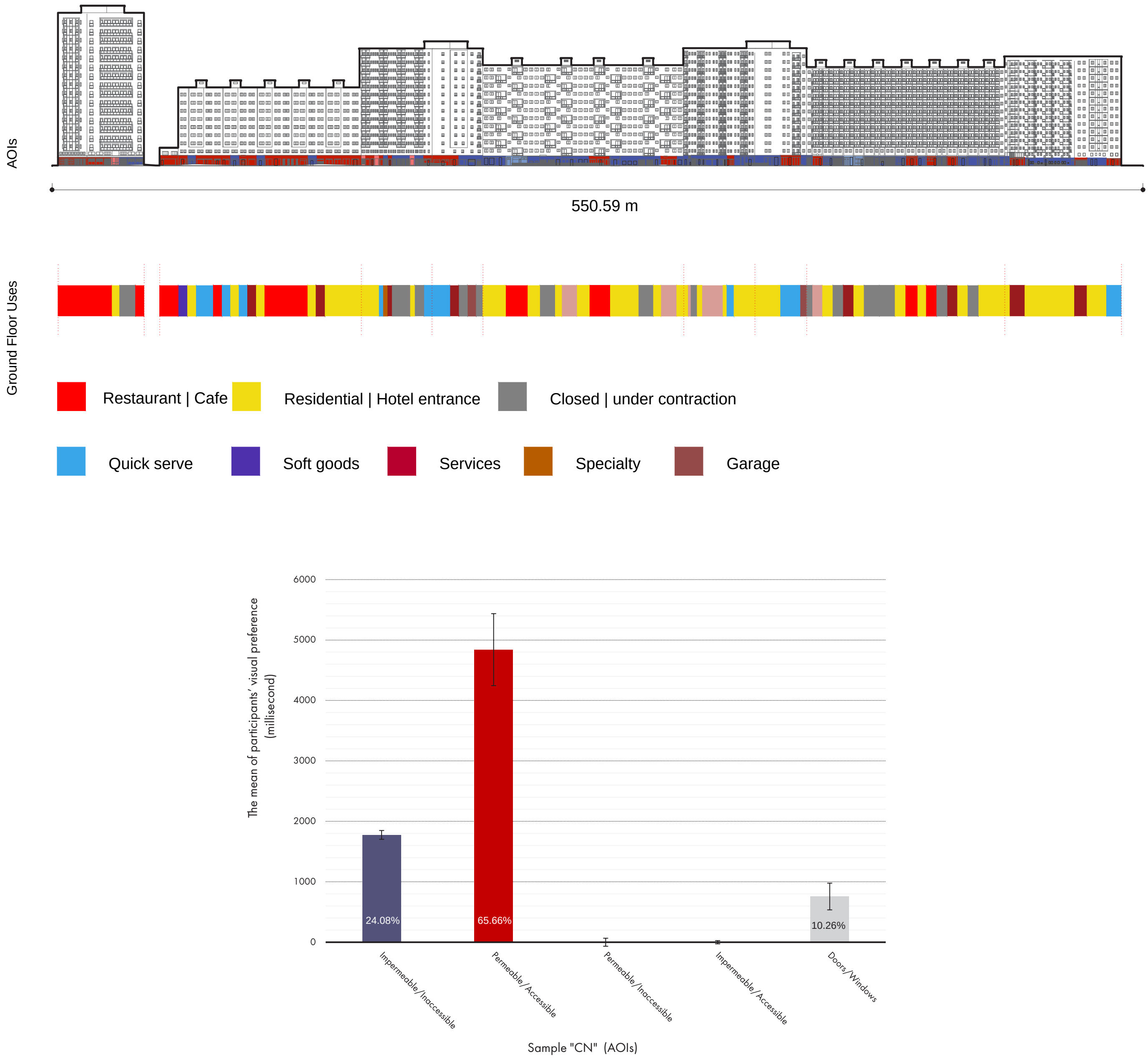
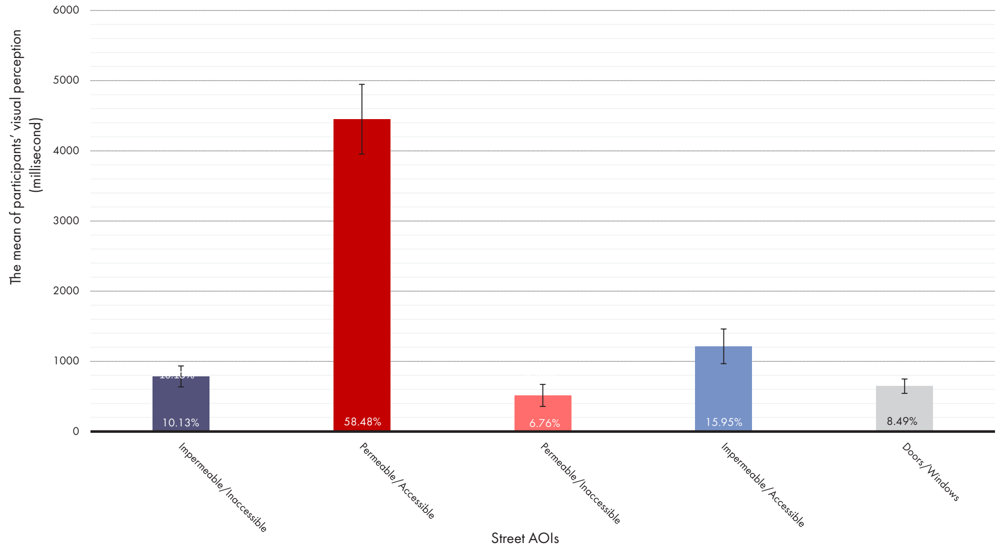


Figure 8.3-16 The percentage of participants' visual preference for street areas of interest (AOIs) in Avinguda Diagonal, sample "C."
a) Sample "CS." (Source: Author's Edition).



b) Sample "CN." (Source: Author's Edition).

8.3-17



8.3-18

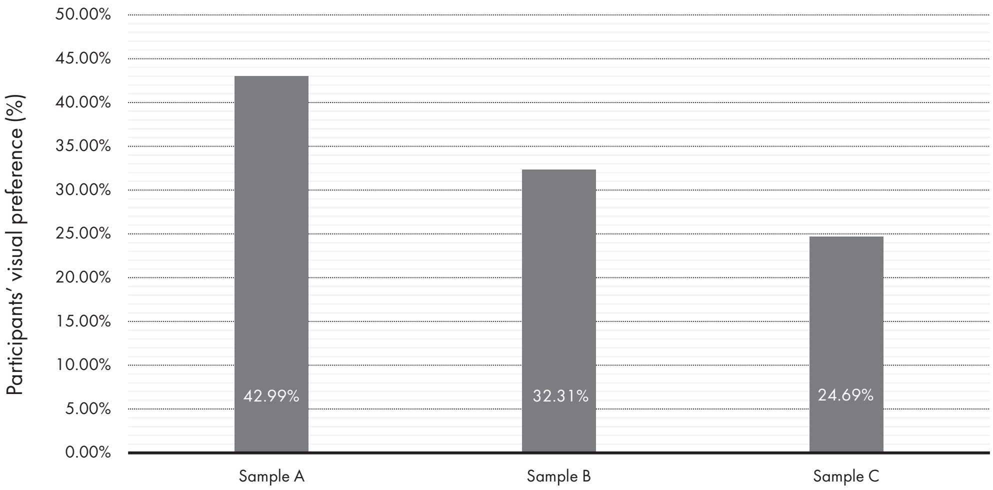


Figure 8.3-17 The percentage of participants' visual preference for Avinguda Diagonal street areas of interest (AOIs).
Figure 8.3-18 The percentage of participants' visual preference with the three samples "A", "B", and "C" of Avinguda Diagonal.

References

Acebillo, J. (2006) 'Barcelona: Towards a new urban planning approach', *Spatium*, *5*(13–14), pp. 55–59. doi: 10.2298/SPAT0614055A.

Ajuntament de Barcelona (1983) *Plans i Projectes per a Barcelona 1981/1982*. Barcelona, Spain: Ajuntament de Barcelona, Area d'Urbanisme.

Ajuntament de Barcelona (2010) *Cerda and the First Barcelona Metropolis, 1853-1897*. Edited by M. L. Guallar. Barcelona, Spain: MUHBA, Barcelona City Council, Institute of Culture and SECC.

Andreani, S. and Sayegh, A. (2017) 'Augmented Urban Experiences: Technologically Enhanced Design Research Methods for Revealing Hidden Qualities of the Built Environment', in *the 37th Annual Conference of the Association for Computer Aided Design in Architecture*. Cambridge, MA, USA, pp. 82–91.

Appleyard, D., Lynch, K. and Myer, J. R. (1964) *The View from the Road*. Cambridge, MA, USA: The MIT Press.

Araujo, A. *et al.* (2021) 'O Plano Especial Diagonal-Poble Nou: da importância do protagonismo público na gestão e produção do espaço urbano à emergência do Urbanismo liberal (I)', *urbe. Revista Brasileira de Gestão Urbana*, 13(I), pp. 1–29. doi: 10.1590/2175-3369.013.e20190364.

Ares, Ó. (2010) 'Sert, Le Corbusier y el Plan Macià: heterodoxia y contradicciones formales', *DC. Revista de crítica arquitectónica*, (19–20), pp. 173–182. doi: 10.5821/dcpapers.v0i19-20.984.

Bently, I. *et al.* (1985) *Responsive environments: A manual for designers*. London, UK: Architectural Press.

Bobić, M. (2004) *Between the Edges: Street-building Transition as Urbanity Interface*. Bussum, The Netherlands: Thoth Publishers.

Busquets, J. (2004) *Barcelona: la construcción urbanística de una ciudad compacta*. Baecelona: Ediciones del Serbal, S.A.

Busquets, J., Yang, D. and Keller, M. (2019) *Urban Grids: Handbook for Regular City Design*. San Francisco, CA, USA: ORO Editions.

Calavita, N. and Ferrer, A. (2000) 'Behind Barcelona's Success Story', *Journal of Urban History*, 26(6), pp. 793–807. doi: 10.1177/009614420002600604.

Câmara Municipal de Lisboa (2013) *Plano de Acessibilidade Pedonal de Lisboa*. Lisboa. Available at: http://acessibilidade.cm-lisboa.pt.

Câmara Municipal de Lisboa (2015a) *Pavimentar Lisboa 2015-2020*. Available at: https://www.lisboa.pt/atualidade/noticias/detalhe/pavimentar-lisboa-2015-2020.

Câmara Municipal de Lisboa (2015b) *Uma Praça em Cada Bairro: Intervenções em Espaço Público*. Lisboa. Available at: http://www.cm-lisboa.pt/fileadmin/VIVER/Urbanismo/urbanismo/planeamento/termosaprovados/campus/apresentacao.pdf.

Canter, D. (1991) 'Understanding, Assessing, and Acting in Places: Is an Integrative Framework Possible?', in Garling, T. and Evans, G. W. (eds) *Environment, Cognition, and Action: An Integrated Approach*. New York, NY, USA: Oxford University Press, p. 634.

Carmona, M. *et al.* (2003) *Urban spaces-public places: The dimensions of urban design*. Oxford, UK: Architectural Press.

Collins, G. R. and Collins, C. C. (2006) *Camillo Sitte: The Birth of Modern City Planning: with a translation of the 1889 Austrian edition of his City Planning According to Artistic Principles*. New York, NY, USA: Dover Publications.

Consiglieri, C. (2005) *Dos Restauradores à Liberdade em Postal Antigo*. Lisboa, PT: Livros Horizonte.

Conzen, R. G. M. (1960) *Alnwick, Northumberland. A Study in Town-Plan Analysis*. London, UK: George Philip And Son Ltd.

Correia, N. (2018) 'The disintegration of the urban limits of Lisbon in the early 1960's.', in *La Città Altra*. CIRICE-FeDOA University Pres, pp. 77–87.

Dovey, K. and Wood, S. (2015) 'Public/private urban interfaces: type, adaptation, assemblage', *Journal of Urbanism*, 8(1), pp. 1–16. doi: 10.1080/17549175.2014.891151.

Downs, R. M. and Stea, D. (2011) 'Cognitive Maps and Spatial Behaviour: Process and Products', in *The Map Reader*. Chichester, UK: Wiley, pp. 312–317. doi: 10.1002/9780470979587.ch41.

Duchowski, A. T. (2017) *Eye Tracking Methodology: Theory and Practice*. 3rd ed. Cham, Switzerland: Springer International Publishing. doi: 10.1007/978-3-319-57883-5.

Figueiredo, P. (2022) *Taking Back São Paulo's Streets, One Sunday At A Time, Next City*. Available at: https://nextcity.org/urbanist-news/taking-back-saeo-paulos-streets-one-sunday-at-a-time.

Fotios, S. *et al*. (2014) 'Using eye-tracking to identify pedestrians' critical visual tasks, Part 1. Dual task approach', *Lighting Research & Technology*, *47*(2), pp. 133–148. doi: 10.1177/1477153514522472.

Gandelsonas, M. (1991) *The Urban Text*. Chicago, IL, USA: MIT Press.

Garcia-Ramon, M.-D. and Albet, A. (2000) 'Pre-Olympic and Post-Olympic Barcelona, a "Model" for Urban Regeneration Today?', *Environment and Planning A: Economy and Space*, 32(8), pp. 1331–1334. doi: 10.1068/a3331.

Gehl, J. (1987) *Life Between Buildings*. New York, NY, USA: Van Nostrand-Reinhold.

Gehl, J. (2010) *Cities for people*. London, UK: Island Press.

Gehl, J., Kaefer, L. J. and Reigstad, S. (2005) 'Close encounters with buildings', *Urbanistika ir architektûra*, 29(2), pp. 70–80.

Gehl, J. and Svarre, B. (2013) *How To Study Public Life*. Washington, DC: Island Press/ Center for Resource Economics. doi: 10.5822/978-1-61091-525-0.

Glaser, M. *et al*. (2012) *The City at Eye Level: Lessons for Street Plinths*. Delft, The Netherlands: Eburon Uitgeverij BV.

Guardia, M., Monclús, J. and Oyón, J. L. (1995) *Atlas histórico de ciudades europeas : península ibérica*. vol. I. Barcelona, Spain: Salvat.

Hillier, B. *et al*. (1993) 'Natural movement: or, configuration and attraction in urban pedestrian movement', *Environment and Planning B: Planning and Design*, 20(1), pp. 29–66. doi: 10.1068/b200029.

Ildefonso, S. *et al*. (2019) 'A proto-habitação social na cidade de Lisboa: uma leitura integrada da vila operária no contexto urbano atual', *urbe. Revista Brasileira de Gestão Urbana*, 11. doi: 10.1590/2175-3369.011.001.ao05.

ITDP (2020) *Buenos Aires: 1985 and Today, Institute for Transportation and Development Policy*. Available at: https://www.itdp.org/2020/01/27/buenos-aires-1985-and-today/.

Jacobs, A. (1995) *Great Streets*. Cambridge, MA, USA: The MIT Press.

Kim, B.-S., Park, K. and Kim, Y.-W. (2009) 'Endurance Analysis of Automotive Vehicle's Door W/H System Using Finite Element Analysis', *Journal of Software Engineering and Applications*, 02(05), pp. 375–382. doi: 10.4236/jsea.2009.25050.

Kropf, K. (2017) *The Handbook Of Urban Morphology*. Hoboken, New Jersey, USA: Wiley. doi: 10.1002/9781118747711.

Lima, Z. R. M. A. (2007) 'Architecture and Public Space: Lessons From São Paulo', *Places*, 19(2), pp. 28–35.

Llano, S. E. P. (2016) 'La reforma de la Avenida Diagonal. ¿Éxito o fracaso de un proceso participativo?', *On the W@terfront*, 46, pp. 7–84.

Lynch, K. and Hack, G. (1984) *Site Planning*. Cambridge, MA, USA: MIT Press:

Macedo, A. C., Lorellay, J. and Guidoti, C. (2019) 'Paulista Avenue , São Paulo , at Ground Level', *Academic Star Publishing Company*, 5(1), pp. 24–36. doi: 10.15341/mese(2333-2581)/01.05.2019/004.

Madanipour, A. (2003) *Public and private spaces of the city*. London, UK: Routledge.

Marcus, I. (2021) *The Metamorphosis of Berlin's 'Unter den Linden' Boulevard, The Berlin Spectator*. Available at: https://berlinspectator.com/2021/09/07/the-metamorphosis-of-berlins-boulevard-unter-den-linden/.

Marshall, S. (2004) *Streets & Patterns*. London, UK: Routledge. doi: 10.4324/9780203589397.

Mehta, V. (2013) *The street: a quintessential social public space*. New York, USA: Routledge.

Milliken, P. *et al.* (2021) 'Identifying Biophilic Design Elements in Streetscapes A Study of Visual Attention and Sense of Place', in Hollander, J. B. and Sussman, A. (eds) *Urban Experience and Design: Contemporary Perspectives on Improving the Public Realm*. New York, NY, USA: Routledge. doi: 10.4324/9780367435585.

Montgomery, J. (1998) 'Making a city: Urbanity, vitality and urban design', *Journal of Urban Design*, 3(1), pp. 93–116. doi: 10.1080/13574809808724418.

Morais, J. S. and Roseta, F. (2017) *Avenida da Liberdade: Arquitectura e Cidade*. Lisbon, Portugal: Caleidoscópio.

Moudon, A. V. (1997) 'Urban morphology as an emerging interdisciplinary field', *Urban Morphology*, 1(1), pp. 3–10.

Mueller, N. *et al.* (2020) 'Changing the urban design of cities for health: The superblock model', *Environment International*. Elsevier, 134(May 2019), p. 105132. doi: 10.1016/j.envint.2019.105132.

Neuman, M. (2011) 'Centenary paper: Ildefons Cerdà and the future of spatial planning : The network urbanism of a city planning pioneer', *Town Planning Review*, 82(2), pp. 117–144. doi: 10.3828/tpr.2011.10.

Neves, J. da R. and Pinto, P. T. (2019) 'Logradouros do Montepio Geral. Heranças e contextos na avenida alferes malheiro e na estrutura verde do bairro de alvalade (1940-1970)', *Cidades, Comunidades e Territórios*, (38), pp. 117–151. doi: 10.15847/citiescommunitiesterritories.jun2019.038.art04.

O'Sullivan, F. (2021) *A Green Transformation for the 'World's Most Beautiful Avenue'*, *CityLab*. Available at: https://www.bloomberg.com/news/features/2021-01-14/paris-dreams-of-a-calmer-greener-champs-elys-es.

Oliveira, V. (2016) *Urban Morphology: An Introduction to the Study of the Physical Form of Cities*. Cham, Switzerland: Springer International Publishing (The Urban Book Series).

Pafka, E. and Dovey, K. (2017) 'Permeability and interface catchment: measuring and mapping walkable access', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 10(2), pp. 150–162. doi: 10.1080/17549175.2016.1220413.

Palenzuela, S. R. (2007) *Barcelona, cuidad mediterranea, compacta y compleja. Una visión de futuro más sostenible*. Barcelona: Agència d'Ecologia Urbana de Barcelona.

Pinto, F. (2018) 'Recomposições e representações sociais das Avenidas Novas numa cidade em transformação.', in *X Congresso Português de Sociologia*. Covilhã, pp. 1–22.

Proença, S. dos S. B. (2014) *A Diversidade da Rua na Cidade de Lisboa: Morfologia e Morfogénese*. Universidade de Lisboa.

van Renswoude, D. R. *et al*. (2018) 'Gazepath: An eye-tracking analysis tool that accounts for individual differences and data quality', *Behavior Research Methods*, 50(2), pp. 834–852. doi: 10.3758/s13428-017-0909-3.

Roca, F. (1977) *El Pla Macià*. Barcelona: Edicions La Magrana.

Rueda, S. (1995) *Ecologia urbana: Barcelona i la seva regió metropolitana com a referents*. Barcelona: Beta Editorial.

Rueda, S. (2020) *Regenerating the Cerdà Plan. From Cerdà's Block to the Ecosystemic Urbanism Superblock*. Baecelona, Spain: Agbar.

Shum, S. (1990) 'Real and Virtual Spaces: Mapping from Spatial Cognition to

Hypertext', *Hypermedia*, 2(2), pp. 133–158. doi: 10.1080/09558543.1990.12031179.

Silva, Á. F. da and Sousa, M. L. (2009) 'In search of the urban variable : Understanding the roots of urban planning in Portugal1', *Métropoles*, (6). doi: 10.4000/metropoles.4029.

Silva, R. H. da (2006) 'Das Avenidas Novas à Avenida Berna', in *Revista de História da Arte*, pp. 126–141.

Simpson, J., Thwaites, K. and Freeth, M. (2019) 'Understanding Visual Engagement with Urban Street Edges along Non-Pedestrianised and Pedestrianised Streets Using Mobile Eye-Tracking', *Sustainability*, 11(15), p. 4251. doi: 10.3390/su11154251.

Solà-Morales, M. (2007) *Diez Lecciones Sobre Barcelona/Ten Lessons on Barcelona*. Edited by 2nd Edition. Barcelona, Spain: Collegi d'Arquitectes de Catalunya (COAC).

The European Commission (2020) *Lisbon: European Green Capital 2020*. Luxembourg. doi: 10.2779/17846.

Urbano, J. (2016) 'The Cerdà Plan for the Expansion of Barcelona: A Model for Modern City Planning', *Focus*, 12(1). doi: 10.15368/focus.2016v12n1.2.

Uttley, J., Simpson, J. and Qasem, H. (2018) 'Eye-tracking in the real world: Insights about the urban environment', in *Handbook of Research on Perception-Driven Approaches to Urban Assessment and Design*, pp. 368–396. doi: 10.4018/978-1-5225-3637-6.ch016.

Vamberg, H. (2015) *Visions for Vienna's Ringstrasse, Gehl Architects*. Available at: https://gehlpeople.com/blog/visions-for-viennas-ringstrasse/.

Wynn, M. (1979) 'Barcelona: Planning and Change 1854 - 1977', *Town Planning Review*, 50(2), p. 185. doi: 10.3828/tpr.50.2.w8q42x4125j70576.

Yeung, H. W. and Savage, V. R. (1996) 'Urban Imagery and the Main Street of the Nation: The Legibility of Orchard Road in the Eyes of Singaporeans', (April). doi: 10.1080/00420989650011870.

Zacharias, J. (2020) 'The contribution of a tramway to pedestrian vitality', *Tema. Journal of Land Use, Mobility and Environment*, 13(3), pp. 445–457.

Zou, Z. (2018) 'Where Do We Look? An Eye-Tracking Study of Architectural Features in Building Design', in *the 35th CIB W78 2018 Conference: IT in Design, Construction, and Management*. Chicago, IL, USA, pp. 439–446.

Part IV

The urban code

"The best new streets need not be the same as the old, but as models the old have much to teach. Delightful, purposeful streets and cities will surely follow."

Allan B. Jacobs, 1995

09. The local case studies

The results of decoding the international case studies provide an analytical understanding of existing livable arterial streets and why they work or fail to do so. Chapter 09 introduces two local arterial streets based on two key subchapters: Subchapter 9.1 introduces an overview of Riyadh's historical growth and development as well as the selected arterial streets, Khalid bin Al-Waleed and Abi Jaffar Al Mansour. Subchapter 9.2 decodes the selected arterial streets based on three scales, from the macroscale to the microscale.

9.1. Riyadh: urbanization process

As in many traditional Arab cities, the spatial structure of the old Riyadh was characterized by a compacted vernacular form surrounded by a thick mud wall with nine gates (see Chapter 02). In 1932, the Kingdom of Saudi Arabia was established and asserted itself as a state with its own identity and vision, earning international recognition. Several major transformations and events followed this early stage of the establishment and composition of the city. In this regard, the construction of "Al-Murabaa" (literally "the Square Palace"), which is a mud-brick castle completed in 1938, marked a new stage in Riyadh's urban growth (Bonnenfant, 2014). Al-Murabaa was a summer palace located about 1 kilometer north of the old walled city. The palace, in terms of architectural form and urban space, was unprecedented, where its size and form brought a new transformation to the traditional city (Misk Art Institute, 2018).

In the 1950s, concrete was introduced to replace the mud-brick construction material after demolishing the city's wall, which changed the future of planning residential communities. New, wide streets replaced the traditional urban fabric, followed by a series of infrastructure projects, including the Riyadh-Eastern Coast Railway (Al-Naim, 2008).

Furthermore, in 1957, Riyadh established several projects that directly impacted the city's future and expansion. For example, the city witnessed the construction of new ministries, a university, and the first modern residential neighborhood, Al-Malaz. These new projects brought a new notion of the street, block patterns, public spaces, and building types (Al-Hathloul, 1981; Al-Said, 2003; Middleton, 2009).

The new grid residential neighborhood, Al-Malaz, was constructed about 4 kilometers northeast of the old city. The urban layout was planned to cover an area of 5 square kilometers for middle- and high-income inhabitants. The grid concept, with rectangular blocks, large square lots, and a hierarchy of wide streets, was introduced during that time, resulting in considerably more parking spaces for cars. The new neighborhood introduced wide streets, 60 meters wide, with new public buildings, a library, and a public garden, among other new features (Figure 9.1-1). Moreover, the introduction of the free-standing villa as a new way of living resulted in low-density neighborhoods, which later became a symbol and model of social prestige all over the country. This shift was followed by constant migration from people from surrounding rural areas looking for a better life (Al-Hemaidi, 2001; Al-Hathloul, 2017).

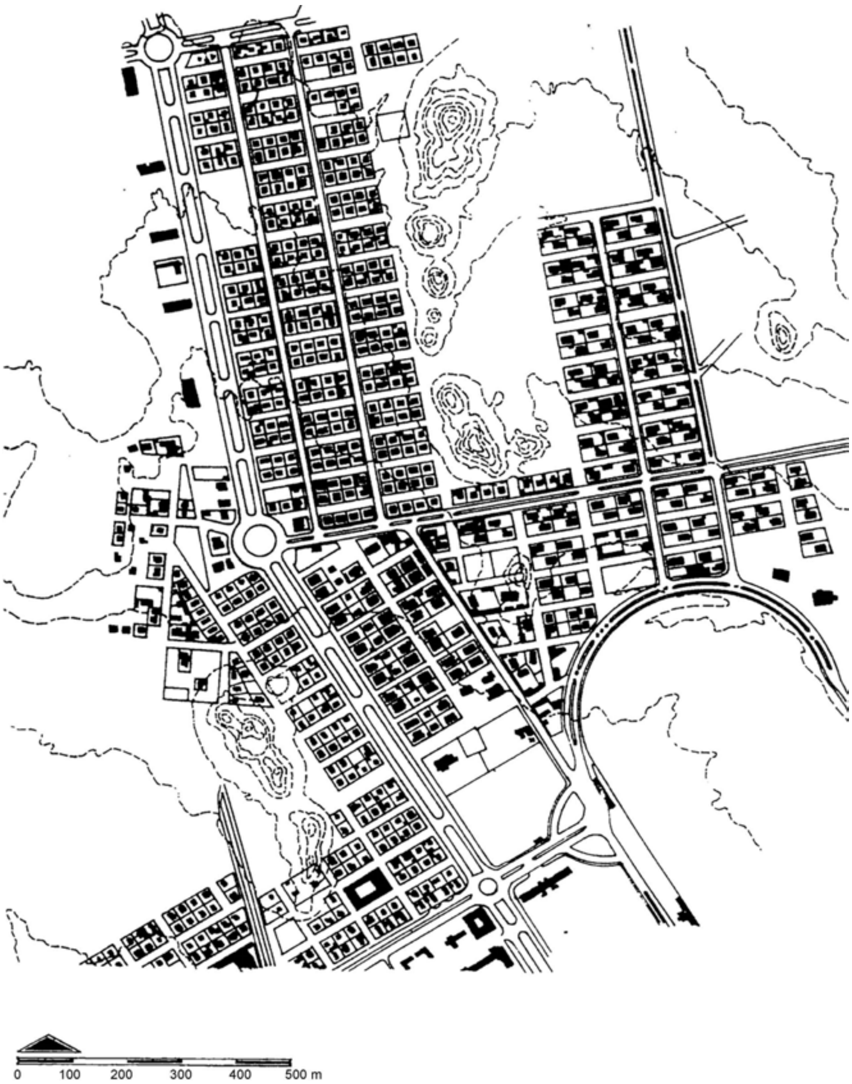


Figure 9.1-1 A layout plan of Al-Malaz District, 1953. (Source: Al-Hathloul, 2017, p. 103).

What had once been a small, semi-isolated, mud-walled settlement with less than 1 square kilometer and a population of 14,000 in 1902 grew rapidly and attracted many new residents (Al-Hathloul, 2017). In the 1970s and early 1980s, following the 1973 oil boom, the newly built highways and major streets facilitated the establishment of mixed-use developments and more expansive residential quarters (see Chapter 2.2). Thus, the government of Saudi Arabia took a further step to manage this rapidly unplanned urban sprawl (Al-Hathloul and Mughal, 2004).

Therefore, during that critical moment in Riyadh's history, at the end of 1967, Doxiadis Associates was assigned to plan the capital, which in 1973 was approved by the Saudi Arabian Council of Ministers (Mubarak, 2004). The Greek architect and city planner A. Doxiadis (1913–1975) and his approach to dealing with human settlements, known as "Ekistics," were a popular choice at the time because of their involvement in the planning of some cities in the region, including Islamabad and Baghdad (Figure 9.1-2). His vision of the future city, "Dynapolis," concentrated on establishing a central spine that would organize the city's growth based on a rational strategy (Middleton, 2009).

Doxiadis Associates faced several challenges centered around the dramatically increased population and growth that had no official studies (ADA, 2003). Doxiadis's studies and analysis of the existing condition at the time estimated that Riyadh, the country's main administrative, cultural, and educational capital, would have a population of 1,400,000 by 2000 (Al-Mogren, 2022), which drove the new master plan for the city.

One of the main challenges that Doxiadis aimed to address was the spatial form, which did not meet the city's functions and symbolic nature. Therefore, the study of the city's challenges and opportunities led Doxiadis to propose ten directions for future development:

- Constructing and improving the city's major roads and arteries;
- The provision of residential communities that correspond to the city's growth of 10,000 families;
- The improvement of around 4,000 residential units in the old quarter of the city;
- The plan of developing 20 hectares of land for the use of civic and commercial industries;
- The development of industrial land to cover 125 hectares;
- Restoration and rehabilitation of the first capital of the Saudi State;
- New development of the old city's significant squares;
- Legal approval of Riyadh's master plan;
- Expropriation and reallocation of land by law;
- Promulgation of taxation for vacant, undeveloped lands (Middleton, 2009).

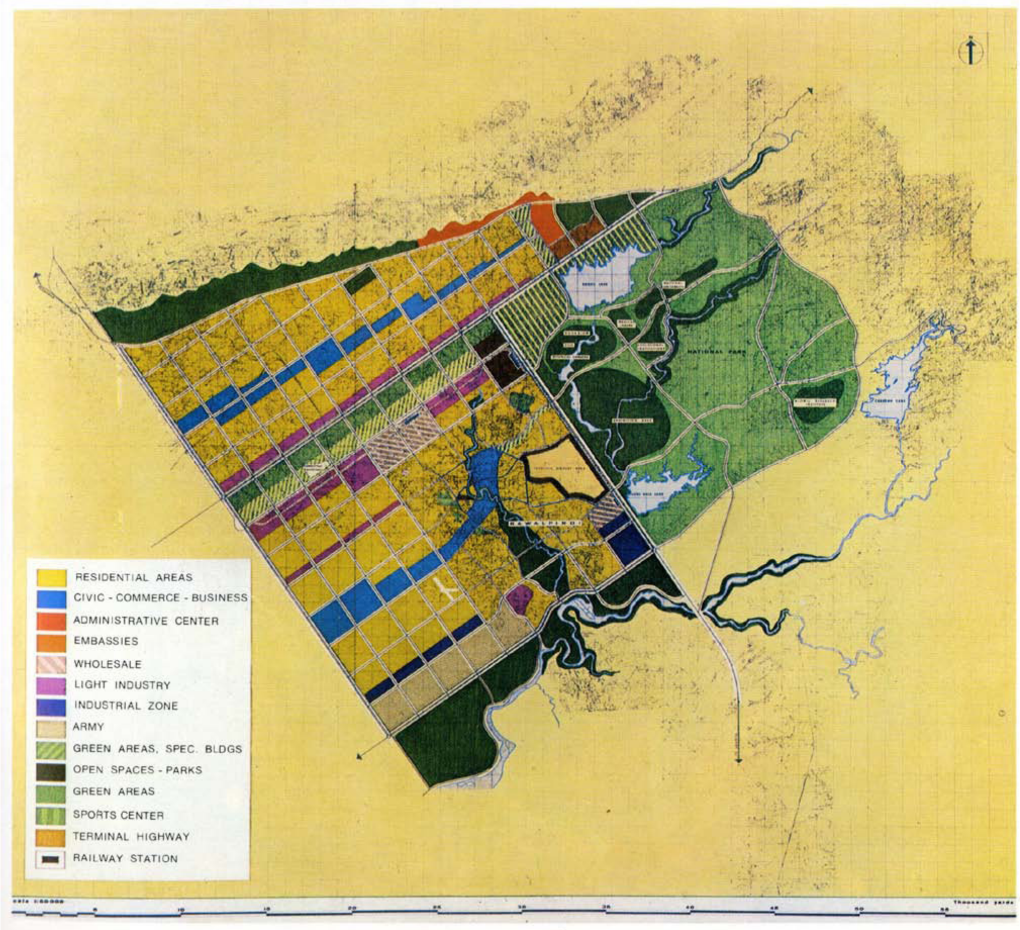


Figure 9.1-2 Doxiadis's master plan of Islamabad in the 1960s. (Source: Capital Development Authority Archives, Iqbal Hall, G-7, Islamabad: https://www.cda.gov.pk/about_islamabad/mpi/MasterPlan).

Accordingly, Doxiadis proposed a north-south supergrid that respected the natural boundary of the city, which was divided into six areas and consisted of modular units measuring 2 square kilometers as a base unit (Figure 9.1-3). The 2 x 2 km grid imposed a single development direction to the northwest, transforming Riyadh's traditional urban form. The spatial framework focused on connecting new and existing areas by developing a single linear spine (ADA, 2003; Al Naim, 2013; Al-Hathloul, 2017).

In this way, the northern axis was established to accommodate the expansion of the urban center. This decision was significant in gradually integrating the historic core and the new super grid structure. By orienting density and growth toward new urban centers, Doxiadis proposed integrating the spatial transition between existing and new urban structures (Al-Hathloul, 2017; Middleton, 2009).

The street structure of the master plan for Riyadh was initially based on land use and the expected population growth and was organized into north-south and east-west principal roads. Moreover, the hierarchical classification of the road network was established to respect the city's main roads and balance traffic distribution. The design approach for streets defined the width of traffic lanes based on the amount and type of traffic, with around 3.5 meters of lane width. This standard was applied to new construction and the reconstruction of existing streets during that period (Middleton 2009).

In this sense, the plan determined the street hierarchy with a specific function, which included four major highways, expressways, arterial roads, collector roads, and local roads (Figure 9.1-4). The major highways aimed to create a connection between Riyadh and other cities, while the expressways were intended to accommodate large volumes of high-speed urban trips. The arterial roads were also planned to facilitate the traffic movement of a large to medium volume of long-distance urban trips. Concerning collector roads, they were planned to connect the city with communities. Finally, local roads were planned to serve short trips and provide access to properties (Al-Hathloul, 2017; Elsheshtawy 2021).

Further, the 2 x 2 km modular units were composed of three sections for each unit: the car traffic section, the car parking section, and the section for human beings. The layout was organized to allow a 10-minute walk from the center to the farthest point of the unit. The modulus spatial urban pattern defined the edges of each modulus unit for large commercial and service uses. The spatial hierarchy of the internal division of the module was composed of plots that varied from a minimum of 150 square meters to 1500 square meters (Middleton 2009).

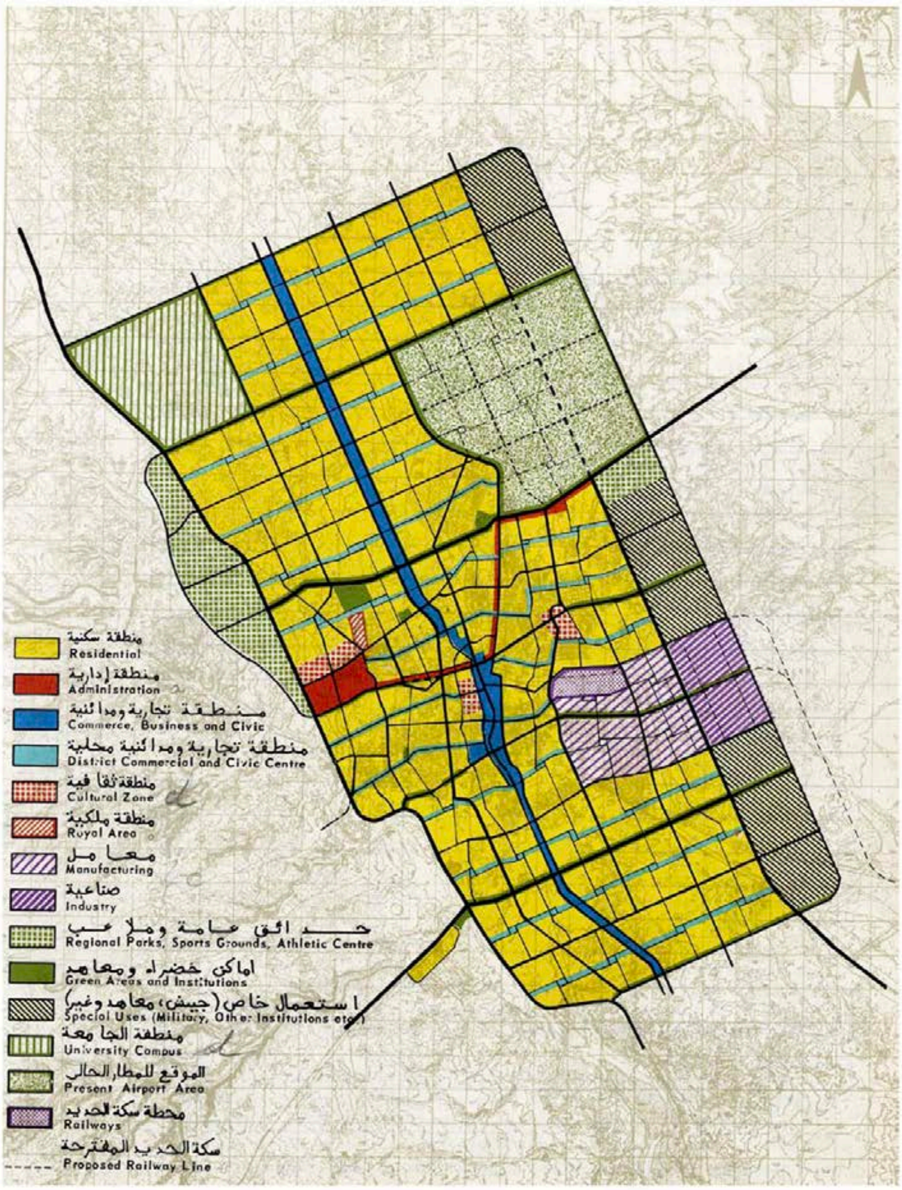
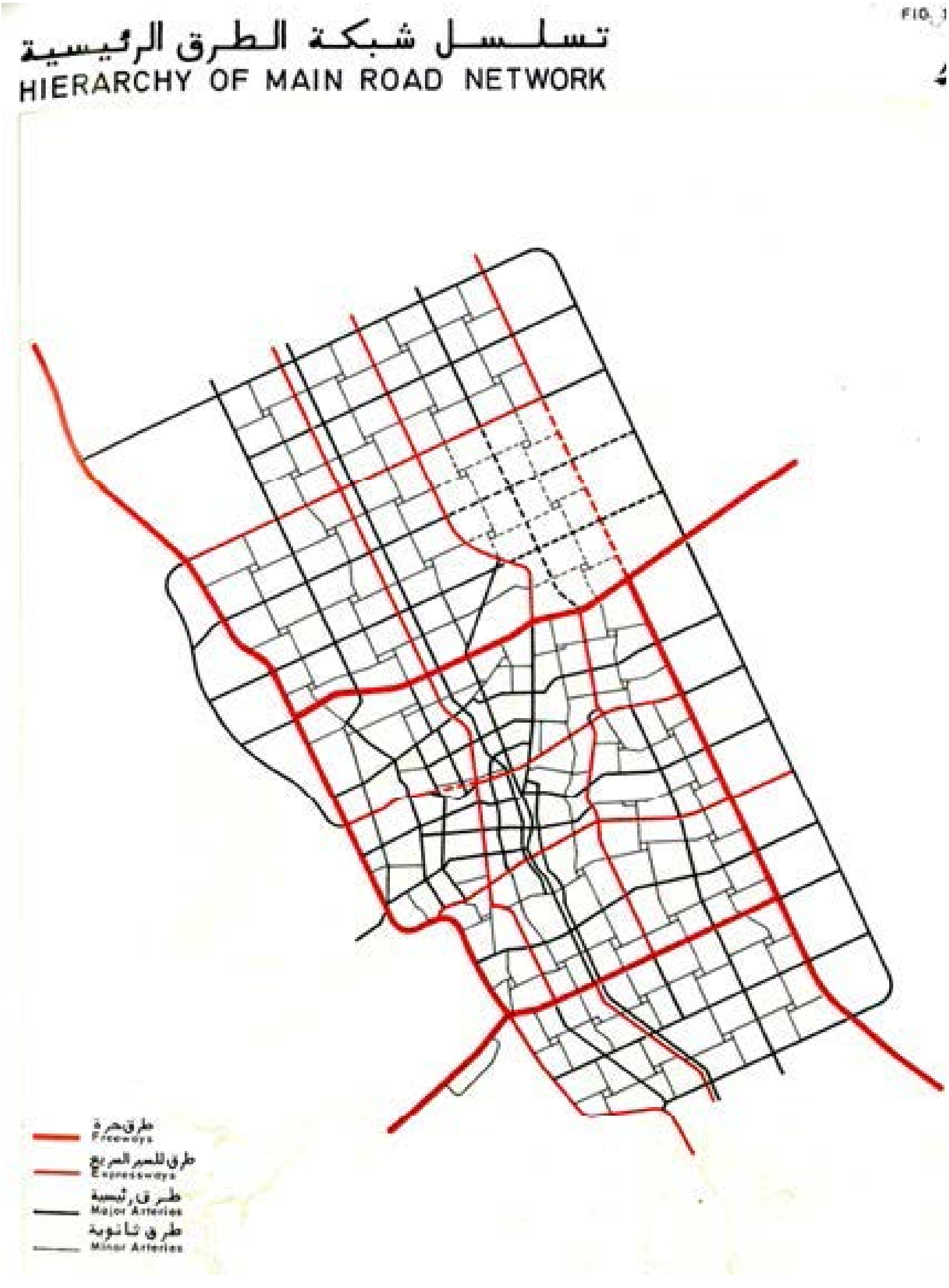


Figure 9.1-3 Doxiadis Master Plan of Riyadh.
a) The First Strategic Master Plan of Riyadh, 1972. (Source: Middleton, 2009, p. 102).



b) Road Network Hierarchy, 1972. (Source: Al Naim, 2013, p. 74).

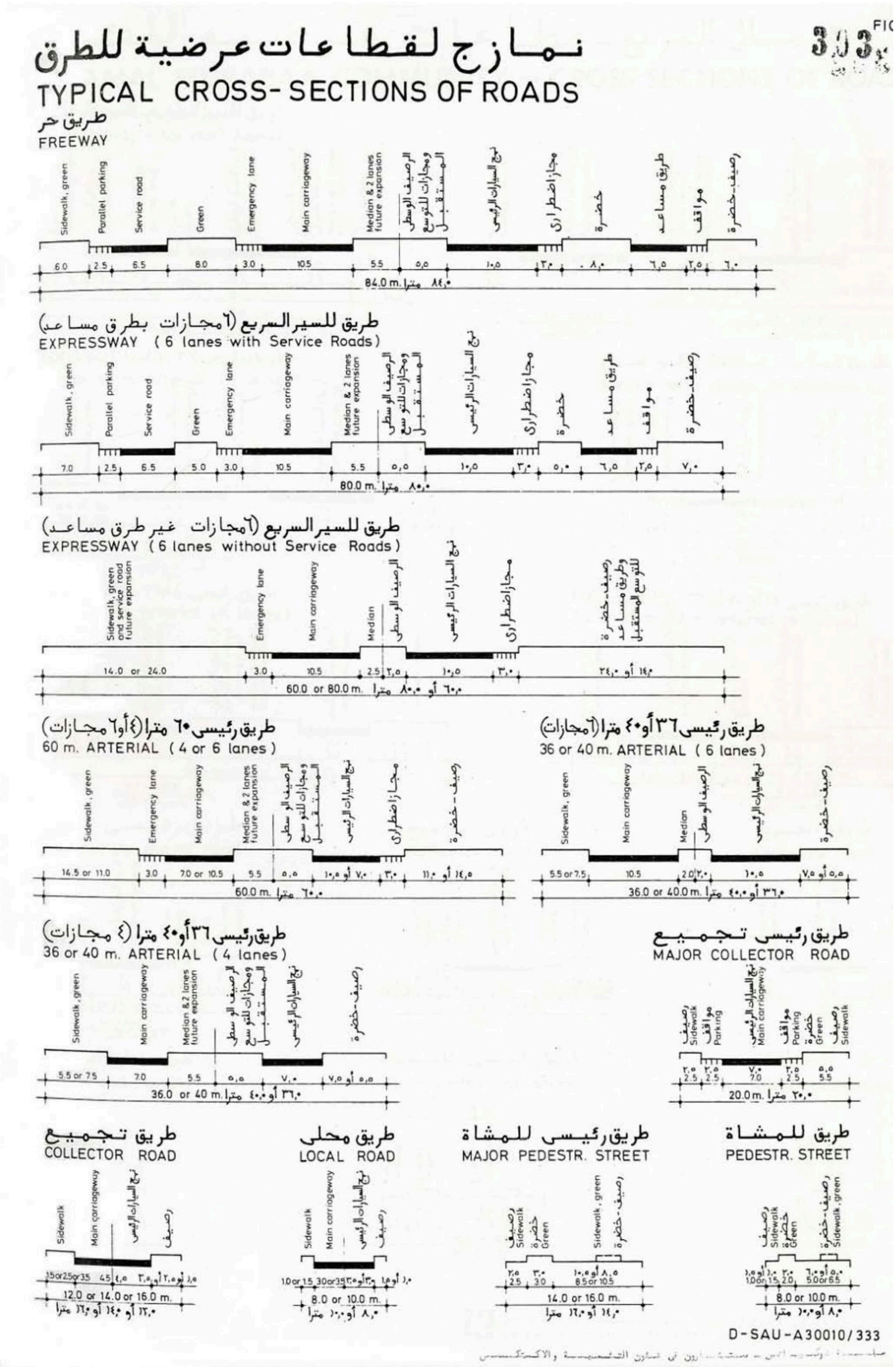


Figure 9.1-4 Doxiadis' typical Cross Section of Roads, 1972. (Source: Middleton, 2009, p. 114).

In the second half of the twentieth century, the city faced a new wave of rapid growth due to the vast market demand for residential development following the oil boom. Residential developments extended beyond the city boundary as demand outpaced supply (Mubarak, 2004). Single-family houses as the prevailing trend in urban development, aligning with the growing reliance on automobiles, resulted in a fragmented urban fabric. Therefore, there was an urgent need to revise the master plan and develop a new study that took into account the massive urban growth (Al-Hathloul, 2017; Elsheshtawy, 2021).

Therefore, in 1976, SCET International/Sedes of Paris was assigned by the Ministry of Municipal and Rural Affairs to revise and incorporate new elements and approaches to the Doxiadis plan (Figure 9.1-5). The SCET plan proposed increasing density along critical arterial roads while retaining the city's basic unit of 2 x 2 km. The revised plan concentrated on land use, including promoting the development of commercial centers. It also focused on the transportation network, which later defined the spatial character of the city in the eastern and southern expansions (Al Naim, 2013; Al-Hathloul, 2017).

The plan focused on creating more opportunities for new commercial projects along the northern spine in order to guide growth toward the north. The northern spine and the superblock of 2 x 2 km began to shape the new city form and determine the central direction of urban expansion. Moreover, a new ring road was proposed, allowing for further commercial developments and residential areas that were not included in Doxiadis's plan. The SCET proposal allowed commercial uses on arterial and collective streets that defined neighborhoods. This major transformation changed the notion of local streets from active and well-served streets into channels for movement, affecting pedestrian use of the street (Garba, 2004; Elsheshtawy, 2021).

However, urban and population growth outpaced the planning process. As a result, in 1977, the city continued its expansion to reach a total area of 400 square kilometers, compared to Doxiadis's projections of 304 square kilometers. Several mega residential projects were constructed, such as the Ministry of Foreign Affairs housing (1979), the Diplomatic Quarter (1982), and the Ministry of Municipal and Rural Affairs (MOMRA) initiatives to develop residential communities (Al-Hathloul, 2017).

According to Al Mubarak (2004), the city at the time faced a new trend of urban growth that was controlled by real estate speculators and their "subdivision frenzy." This massive, unplanned expansion was a sign of the need for a new strategy to manage and control this sprawling growth. Therefore, by the end of the 1980s, MOMRA had applied restrictions and established boundary controls on the urban sprawl to contain the phenomenal expansion of the city. Despite this, growth continued, with more original residents migrating to the northern suburbs (Garba, 2004; Al Naim, 2013; Al-Hathloul, 2017).

In the 1990s, the city's population doubled to more than 3 million inhabitants and began to expand in all directions. Accordingly, the Royal Commission for Riyadh City (RCRC) proposed a strategic plan to guide the city's development. The 1996 strategic plan resulted in an urban development vision for the next 50 years for Riyadh. The plan included a metropolitan structure plan (Al-Hathloul, 2017). The comprehensive plan proposed several strategies, including new metropolitan sub-centers located 15–20 km from the city center, with between 2 and 5 square kilometers for 1 million inhabitants. Furthermore, the plan also aimed to link the metropolitan sub-centers with the historical center by major axes, transforming the historical center into a cultural, governmental, and regional center. Finally, the plan proposed an effective public transportation system, which was one of the primary deficiencies of the Doxiadis plan (Al-Mosaind, 2018).

The MEDSTAR strategy (Metropolitan Development Strategy for Arriyadh Region), which was approved in 2001, significantly affected Riyadh's spatial form. A set of plans and programs—including the metropolitan structure, the development of the central Riyadh area, the northern and eastern city extensions, and the significant axes—were established. Moreover, three major actions have had a significant impact on Riyadh today—namely, the subcenters, the new suburban cities, and the public transportation system. The subcenters, such as King Abdullah Financial Center, support the city center by providing activities and services, including economic, socio-cultural, and recreational activities (Al-Hathloul, 2017).

Regarding the public transportation system, in 2012, the RCRC approved the MEDSTAR comprehensive transportation plan for Riyadh. The King Abdulaziz Project for Riyadh Public Transport started in 2014 and was expected to be in operation by 2021. It is now nearing completion, and test runs have begun. The comprehensive transportation plan for the city of Riyadh has been developed to transform the face of transportation in the city as well as relieve vehicular dominance and reliance (Alotaibi and Potoglou, 2018).

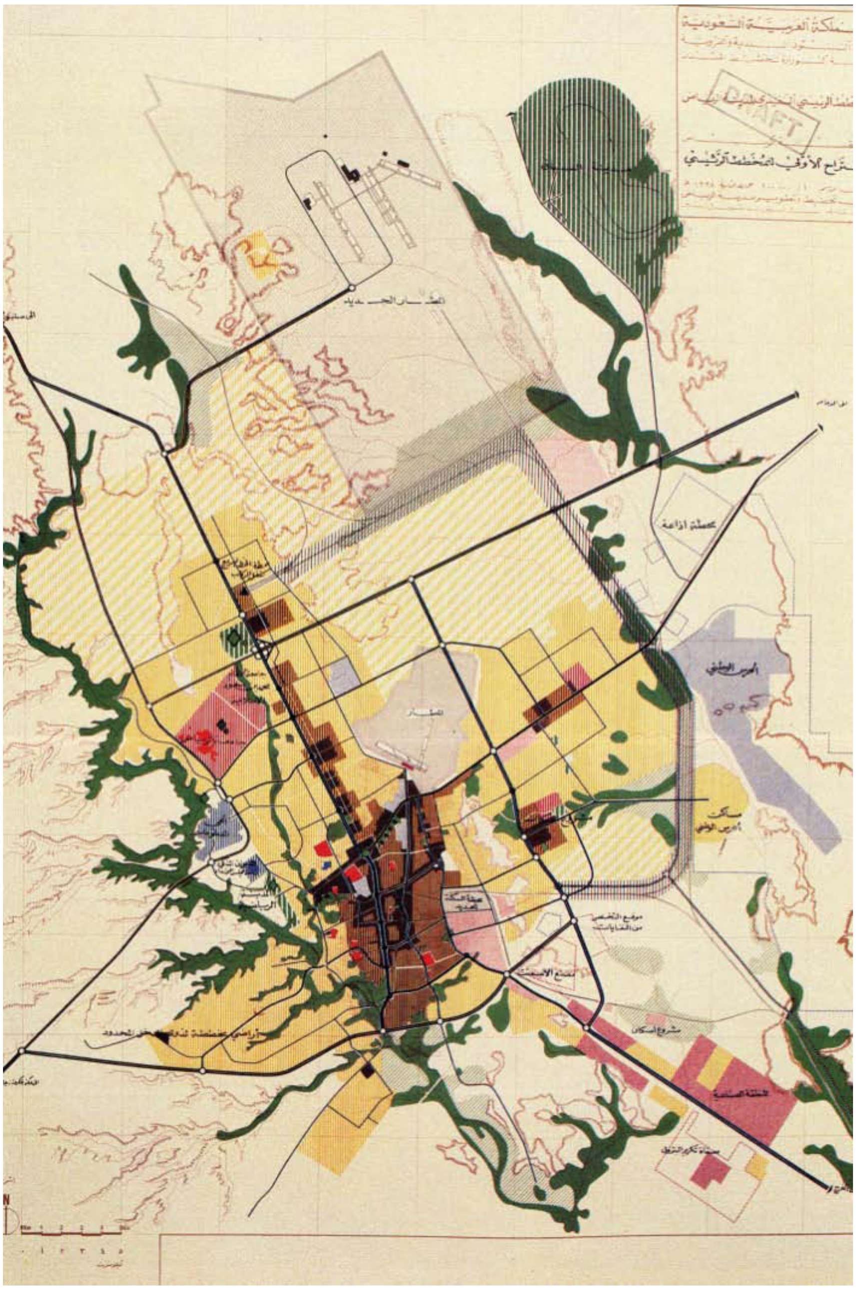


Figure 9.1-5 SCET revision to the Doxiadis Master Plan, 1978. (Source: Middleton, 2009, p. 136).

9.1.1. Riyadh today

Tracing Riyadh's urban growth and urbanization process reveals that the city has experienced massive urban expansion over the last few decades. What was once a chain of mud-walled settlements for trading caravans has become a global political and economic hub. In 2019, the city hosted about 19% of the total population of Saudi Arabia, with around 6,500,700 people and an average density of 71.8 p/ha (UN-Habitat, 2018). As a result, Riyadh is pursuing new strategies that support more sustainable and resilient growth as well as economic diversification to improve residents' quality of life and to contribute to the Kingdom's future vision. The introduction of public transportation is a significant element shaping the future of Riyadh, as the city currently experiences heavy traffic congestion (Youssef, Alshuwaikhat and Reza, 2021). Thus, Riyadh's public transportation system is considered the centerpiece of the city's new vision and has opened a new chapter in the development chronology of the capital.

The public transportation project links the city's main destinations, such as King Khalid International Airport and the King Abdullah Financial District. It consists of six metro lines (176.5 km and 85 stations), a bus rapid transit (BRT) network, and neighborhood buses (total routes of over 600 km and around 6,700 stops) (Figure 9.1-6). The project is estimated to provide access to 34–74% of the population within a 5–10-minute driving distance, and 5–14% of the population within a 5–10-minute walking distance. Moreover, the BRT network will be accessible to about 23% of the population (Al Hosain and Alhussaini, 2021).

The Riyadh Metro comprises six lines that will be operated fully automatically, without drivers, and the following lines are included:

1. Line 1 (Blue Line) runs in a north-south direction. The metro line is mostly underground in a bored tunnel along Olaya and King Faisal streets and elevated on a viaduct along Batha Street.
2. Line 2 (Red Line) runs in an east-west direction along King Abdullah Road, between King Saud University and the Eastern subcenter, mainly on an elevated strip in the middle of the freeway.
3. Line 3 (Orange Line) runs in an east-west direction. The metro line is mostly elevated along the western part of Al Madinah Al Munawwarah Road. It continues underground in bored and mined tunnels along the central section of the line and generally at grade along Prince Saad Ibn Abdulrahman Road.
4. Line 4-6: route 4 (Yellow Line) reaches King Khalid International Airport from King Abdullah Financial District, mainly on a mixture of elevated and at-grade alignments.
5. Line 4-6: route 6 (Purple Line) follows a half-circular axis start-

ing at King Abdullah Financial District (KAFD), passing by Iman Mohamed Bin Saud University and ending at Prince Saad Ibn Abdulrahman Al Awal Road.

6. Line 5 (Green Line) runs underground in a bored tunnel along King Abdulaziz Street, between King Abdulaziz Historical Centre and the Riyadh Airbase, before connecting with King Abdullah Road (RCRC, 2020).

The bus network comprises three BRT lines, 21 community bus lines (including one circular line), a feeder bus system of nearly 800 km, and demand-responsive transport (DRT) services.

1. The three BRT lines of the RPTN serve the main corridors with high frequency.
2. The community bus lines serve other secondary corridors to complement the transport network and feed the main transit lines. These lines are partly operated on the dedicated bus lanes of the BRT network. In some instances, it is planned to build additional dedicated bus lanes on the secondary bus line network.
3. Feeder buses serve residential districts (approx. 70 communities), and services are provided by a mixture of fixed lines and demand responsive transport services (DRT) operated by smaller vehicles (RCRC, 2022).

Accordingly, in 2018, the Royal Commission for Riyadh City (RCRC) launched the Transit-Oriented Development (TOD) plan as a part of the action plan for the city that transforms conceptual proposals into concrete and implementable action. The plan aims to develop the locations surrounding public transportation stations within a range of 800 meters. The Riyadh TOD vision is based on making the city more interconnected, attractive, and prosperous through a series of systemic interventions, including the following:

- Control the development of the surrounding areas around the public transport stations.
- Contribute to increasing urban density and economic development in these areas.
- Increase the number of public transport users to enhance the efficiency of the public transport system.
- Create a mixed-use development of areas surrounding the stations that depend on public transport (RCRC, 2022).
-

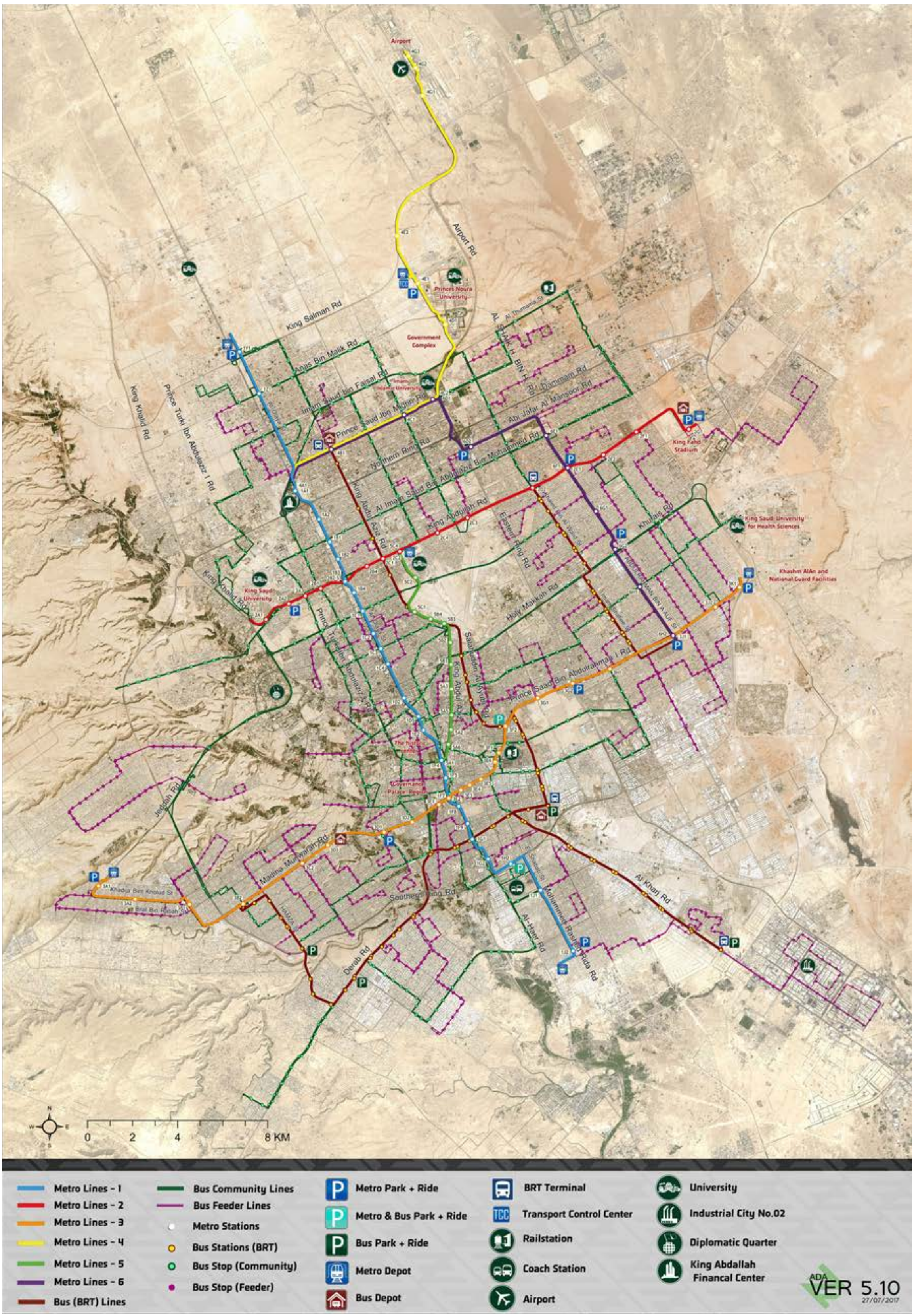


Figure 9.1-6 Map of Riyadh's Public Transport Network. (Source: Royal Commission for Riyadh City, 2017: https://www.rcrc.gov.sa/en/projects/king-abdulaziz-project-for-riyadh-public-transport).

9.1.2. Khalid bin Al-Waleed and Abi Jaffar Al Mansour streets

The public transportation system, hand in hand with the recent transit-oriented development, seeks to create a valuable instrument to promote public transportation, create attractive urban environments, and improve Riyadh's competitiveness. Riyadh's metro project is considered not only a historic chance for improving the city but also a catalyst for further long-term enhancement of Riyadh's quality of life. In this regard, the project has developed major streets and locations along with the metro project as an essential stage in turning this vision into a reality.

As part of the overall strategy, Khalid bin Al-Waleed and Abi Jafar Al Mansour streets underwent a significant transformation, emerging as exemplary urban elements and subsequently being selected as case studies. These streets intersect with each other, forming part of Riyadh's main northeast arteries (Figure 9.1-7). Khalid bin Al-Waleed Street, 9 km long and varying between 45 and 100 meters wide, runs from north to south, while Abi Jafar Al Mansour Street, 8.4 km long and 40 to 50 meters wide, runs from east to west. The streets are part of the urban intervention that caters to notions of livability and well-being, incorporating principles of walkability. The quality of these main arteries, though, was largely substandard, with a modest physical layout that lacked essential components for creating a conducive atmosphere for public activities. The before–after aerial images of these streets show a complete transformation after the introduction of the BRT in Khalid bin Al-Waleed Street and "line 6" in Abi Jaffar Al Mansour Street (Figure 9.1-8).

Although the overall goal of this intervention was to enhance pedestrians' use of the streets, increase pedestrian spaces, and provide street furniture, some sections of Khalid bin Al-Waleed and Abi Jaffar Al Mansour streets remain characterized by a wide cross-section mainly occupied by vehicular traffic.

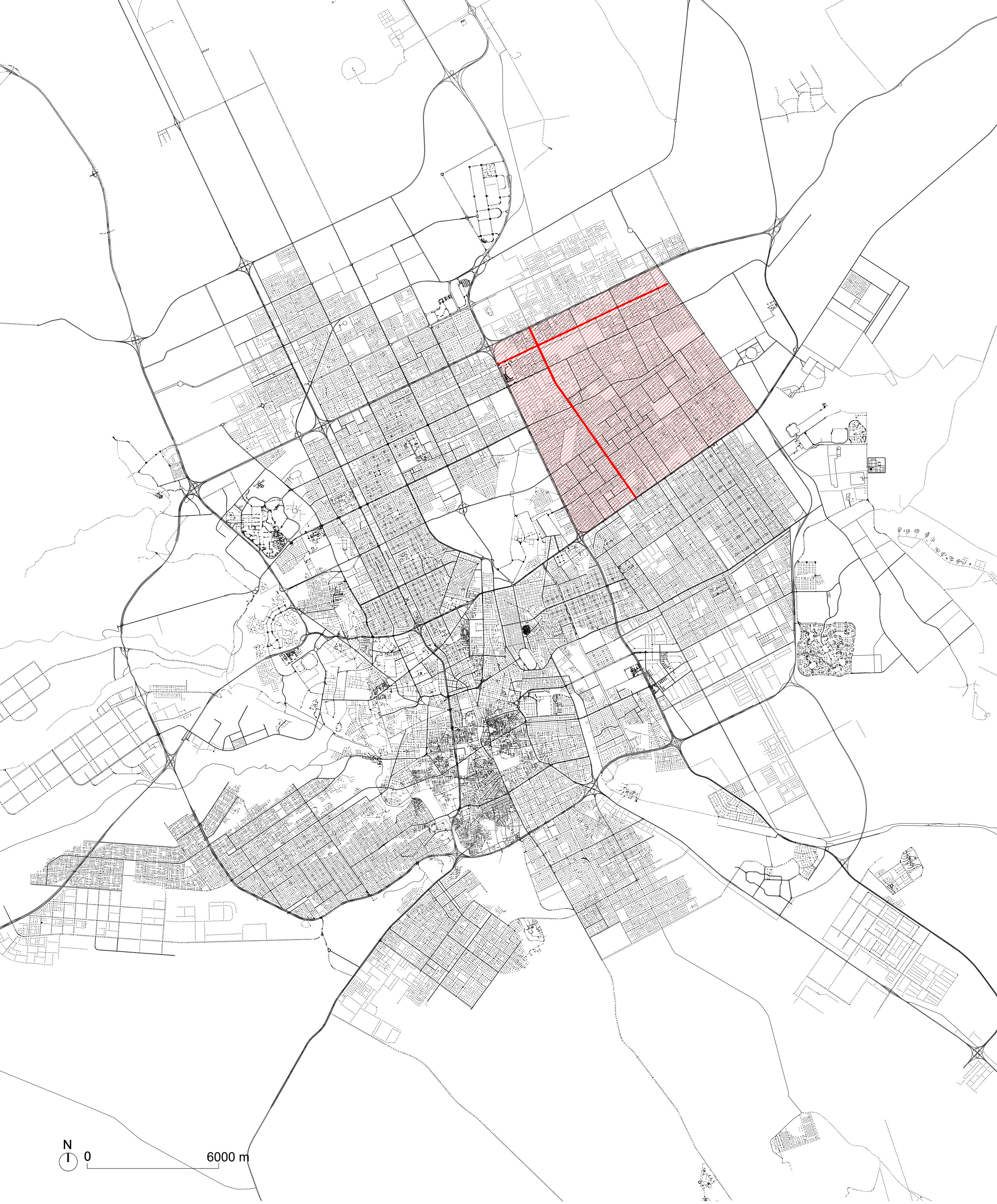


Figure 9.1-7 Map of Riyadh displaying the locations of the selected case studies. (Source: Author's Edition).

a) Khalid bin Al-Waleed.

b) Abi Jaffar Al Mansour.

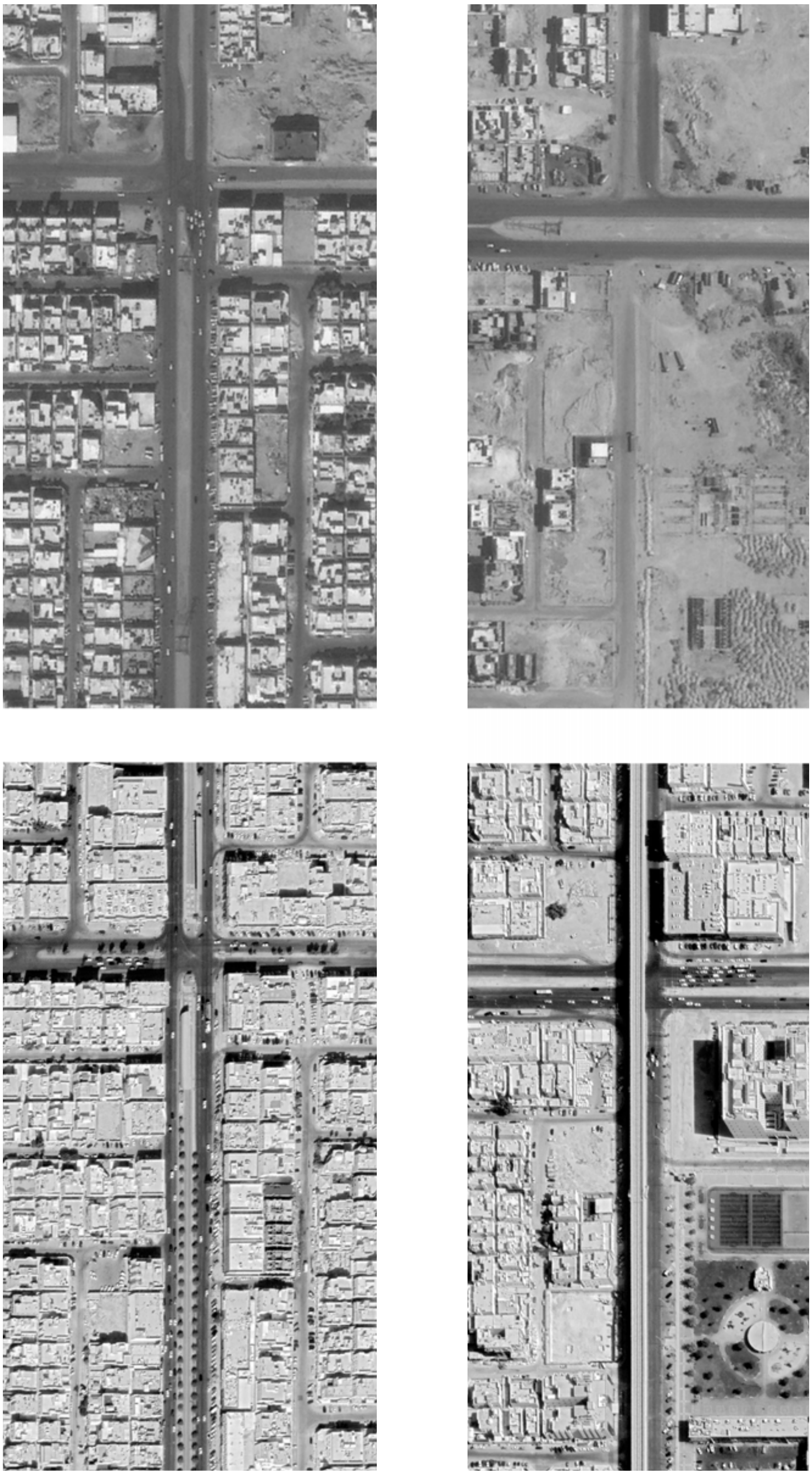


Figure 9.1-8 Comparative aerial view of the local case studies, illustrating the visible changes and progress over a span of 23 years, from 2000 to 2023. (Source: Google Earth with modifications by the author).
a) Khalid bin Al-Waleed.
b) Abi Jaffar Al Mansour.

9.2. Decoding the local case studies

In light of this general overview of Riyadh and the selected arterial streets, a multiscale analysis was conducted. This subchapter decodes the complexity of the arterial street locally through an interdisciplinary, multiscale approach. Morphological interpretations and public life studies are presented in three sections, from the macroscale to the microscale: Section 9.2.1 studies the urban structure; section 9.2.2, the street partition; section 9.2.3, the arterial street interface from a microscale; and section 9.2.4, public life.

9.2.1. The urban structure

As mentioned above, starting in the mid-twentieth century, the Saudi capital faced rapid growth followed by rapid development. The city form has transformed from a narrow and compact urban fabric into a massive metropolitan city of 1,973 km^2. Riyadh has imposed a strict grid structure that has guided the city's form and growth based on the main axes running from north to northwest, from south to southeast, and from west-southwest to east-northeast.

The macroscale analysis of the city reveals two main axes running from north-northwest to south-southeast, parallel to the dry basin of Wadi Hanifah to the west, and orthogonal with two main axes running from west-southwest to east-northeast, which draw nine major areas (Figure 9.2-1). Apart from the central area developed before the 1960s, each urban area comprised several super grids of 2 x 2 km. In this regard, Doxiadis's moduli of 2 x 2 km can be considered the basic urban unit that composes the urban structure of each area.

9.2.1.1. Riyadh's central area

Riyadh's central area, at the original city's core, is characterized by many significant historical buildings and structures with architectural and cultural value. These include remaining sections of the old city walls and the nineteenth-century Al Masmak Fort, which played a significant role in the establishment of the Kingdom, as well as several restored buildings in the distinctive Nejd style, which now form the King Abdulaziz Historical Centre and National Museum (Figure 9.2-2).

The area, which covers around 15 km2, has undergone several transformations over time due to several challenges, including the deterioration of many valuable historic buildings, high levels of pollution and noise, and deteriorating social conditions. The area has faced many changes over time, from a traditional and human-scale environment to an area dominated by automobiles. Its urban form has changed, as has its physical condition, with neglect in many parts apparent. Thus, these challenges have led to the continued outward emigration of its original residents toward the north.

Figure 9.2-1 Diagram illustrating Riyadh's orthogonal grid system with emphasis on the city's main axes. (Source: Author's Edition).

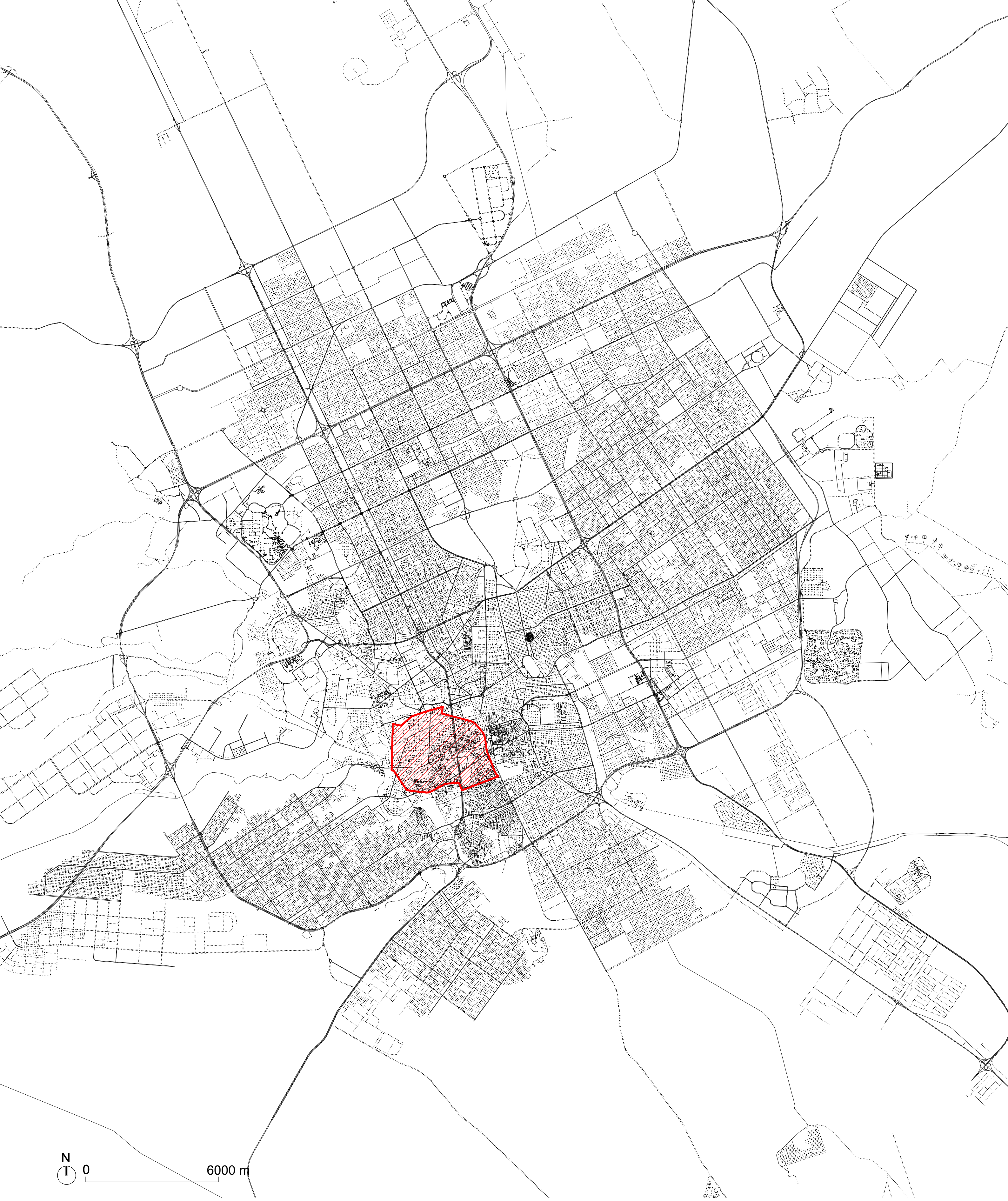


Figure 9.2-2 Riyadh's central area within the city's urban layout. (Source: Author's Edition).

During the last few decades, the central area has witnessed new regeneration projects that seek to invest in its future, aiming at a series of objectives. These projects have renewed many of the city's significant landmarks, government buildings, and civic spaces, including Qasr Al Hokm, the King Abdulaziz Historical Centre, and Salam Park, where some 1.8 million people come annually to enjoy the landscape in the heart of the city (Misk Art Institute, 2018).

The central area measures approximately 3.85 km (north–south) and 4.5 km (east–west) in extent and covers an area of approximately 15 km2. The central area is relatively well defined by an outer ring of public roads, namely:

- • Alwashm Street and Omar Ben Alkhattab Road to the north;
- • Ammar Bin Yasser Street to Alasha Street to the south;
- • Alkharj Road to the east; and
- • Imam Abdulaziz bin Mohammed Bin Saud Street to the west.

This central area benefits from strong global connections, which serve as critical strategic links to the larger sub-regional movement network. This connectivity is characterized by a significant number of both "to" and "through" routes that converge on and within the central area at several key intersections. The four key through routes are considered as follows:

- • King Fahad Road (north–south);
- • Al Bat'ha Road (north–south);
- • Al Madina Al Munawwarah Road (east–west); and
- • Abu Ayyub Al-Ansari Road (east–west).

The area provides a rich and varied urban area that is significantly influenced by the land use range (Figure 9.2-3). Somewhat unusually for a central area of a major city, the dominant land use within the area is residential, and even more significant is the fact that it is mainly made up of densely packed single- or double-story villas and traditional Arabic houses.

While residential uses are distributed throughout the center of Riyadh at varying densities and typologies, there is a clear distinction between the northern portions of the central area, with its gridiron street pattern and large plots, and the central and southern portions, which reflect a more organic street pattern, with small plots. These arrangements create particular urban forms, characteristics, and environments to be found within each of the areas.

Commercial land uses also compose a significant part of the overall land use. The components of commercial land use, however, create a range of formal, less formal, and informal commercial opportunities premised on their location and the communities they aim to serve. Thus, the main formal commercial activity is centered along Al Bat'ha Street and King Faisal Street, with a large node created by the Al Tameer Complex in Al Duhaira. Stepping back from these formal commercial corridors are the range of market retail areas, which provide the majority of commercial retail opportunities within the central area.

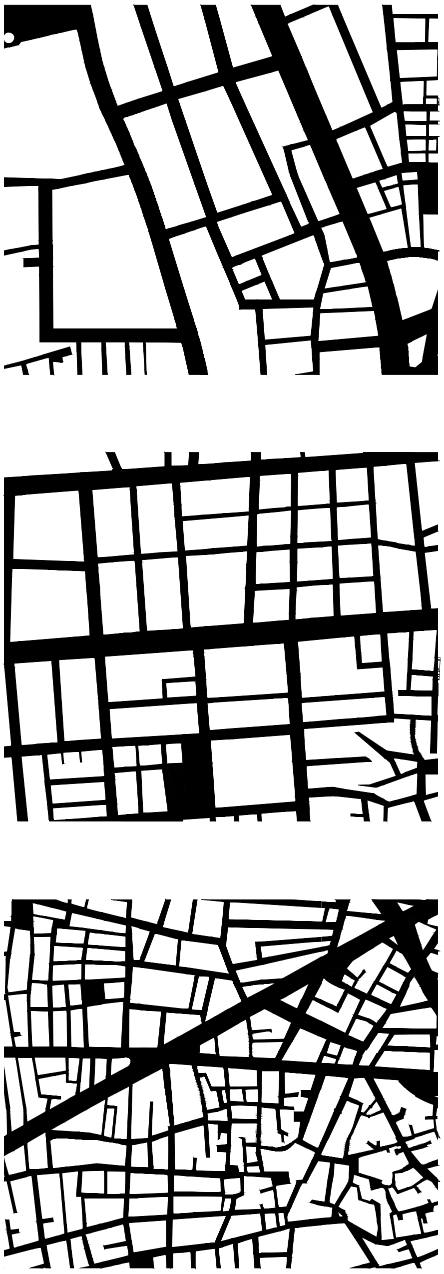
An analysis of this area's urban structure shows three distinct urban patterns (Figure 9.2-4). These patterns can be put into the following groups:

First, one pattern is the irregular grid that supports large development blocks, predominantly within the central core of the area. In this pattern, the urban block size routing onto the primary public road network typically ranges from 110 to 240 m. The urban blocks are generally characterized by mixed-use buildings, shopping centers, institutional uses, light industrial uses, and storage warehouses. Streets are also dominated by car movements and are generally unfriendly for pedestrian use.

Second, the orthogonal grid is composed of contemporary planning principles commonly observed in other areas of the city. The urban blocks fronting the primary public road network typically range from 65 m to 120 m. These blocks provide a range of uses, such as residential, commercial, business, and public facilities.

Finally, the organic pattern is composed of older communities comprising traditional houses, which can only be found within the central area. These areas are characterized by small, irregular-shaped plots, narrow streets, and multiple owners. The urban blocks fronting the primary public road network typically range in length from 20 to 70 m. These blocks also provide a range of uses such as residential, commercial, mixed-use, and more; however, the traditional residential house is the predominant building type.

Figure 9.2-3 Series of photographs capturing the essence of Riyadh's central area, offering a visual narrative of its streets, iconic landmarks, and urban atmosphere, 2021. (Source: Author's Edition).



a)

b)

c)

Figure 9.2-4 Urban patterns in Riyadh's central area. (Source: Author's Edition).
a) The Irregular Grid.
b) The Orthogonal Grid.
c) The Organic Grid.

9.2.1.2. Riyadh's model of growth

Regarding the case studies, the morphological interpretation of the urban structure surrounding Khalid bin Al-Waleed and Abi Jafar Al Mansour streets considered the 2 x 2 km gridiron as the cornerstone, the basic structural cell, and the city's growth module. The two streets are located in the same urban area, on the city's northeast side. The area is formed by the aggregation of urban units that are organized in a repetitive manner. The urban structure of this area of the city is considered a representative model that has been applied or will be applied in other areas. Therefore, the analysis of the case studies on this scale focuses on their surrounding urban structure.

As found, the area is composed of a number of urban units and is limited by an outer ring of major roads, namely:

- Dammam Road to the north;
- Khurais Road to the south;
- Eastern Ring Road to the west; and
- Al Sheikh Jaber Al Ahmad Al Sabah Road to the east.

The urban units are oriented to align with the main axis of the master plan, with a dimension of 8.5 from the north, 9.5 km from the south and west, and 8 km from the east. The single 2 x 2 km² urban unit inside the urban area is framed by major streets that are wide (about 100 meters), which define the urban unit and connect it with other surrounding urban units. Inside the urban unit, at the module's core, there are major rectangular open public spaces that are mainly used as a public building, a grand mosque, or a park. From the urban unit's core, four major streets, 45 meters wide, are connected to the boundary of the unit and divide the single urban unit into four quarters.

Thus, each 2 x 2 km urban unit is divided into four quarters, each representing a small-scale model of the 2 x 2 km urban unit, which draws the urban pattern of the area and defines its characteristics. The analysis of each quarter reveals a clear hierarchy of the urban structure, starting from the main urban area to the smallest quarter of the urban unit, thus revealing the impact of Doxiadis's plan in the current urban structure of the city (Figure 9.2-5).

This model of the 2 x 2 km urban unit suggests a hierarchy of the street layout, where the boundary of the urban unit presents wide streets with a 100-meter cross-section that divides the urban area into a number of urban units. Two orthogonal streets of 40 to 45 meters wide also divide the urban units, creating four quarters in each urban unit. Each quarter is also divided by 25–30-meter-wide streets connecting the core of the quarter to the core of the urban unit, while inner streets are 15 meters wide (Figure 9.2-6).

Regarding Khalid bin Al-Waleed Street, the street runs from north to south with a total length of 9 km and 45 to 100 meters in width. In this sense, the street is considered the main artery in the urban area; it divides and connects the urban units. Notably, the street can be divided into two sections: the northern and the southern. The northern section consists of long, thin blocks that can reach up to 400 meters in length, while the southern section is also characterized by long, thin blocks, typically measuring around 200 meters in length, with a BRT line (which is lacking in the northern section).

On the other hand, Abi Jafar Al Mansour Street spans a total length of 8.4 km and measures 45–60 meters in width, extending from the far east to the far west of the urban unit. According to the street classification and the organization of the urban unit, the street is designated as a collector street that primarily serves its corresponding 2 x 2 km urban unit. However, because of the need in this specific area, it has evolved into an arterial street that runs through the entire urban area from west to east. Similar to Khalid bin Al-Waleed Street, Abi Jafar Al-Mansour Street can be divided into two sections. The western section features large buildings and an elevated metro line, while the eastern section retains the original street layout with no metro line (Figure 9.2-7).

The street and block pattern of each urban unit is typically composed of rectangles and orthogonal blocks that exhibit variations in their dimensions, typically ranging between 60 x 200m and 60 x 130m. However, the urban blocks are characterized by low building density and lack pedestrian walkways connecting the module core to its boundary, where the automobile dominates public spaces (Figure 9.2-8). Thus, the street and block patterns surrounding the selected streets show a lack of street intersection frequency intended for pedestrians and cyclists (Figure 9.2-9).

a)

b)

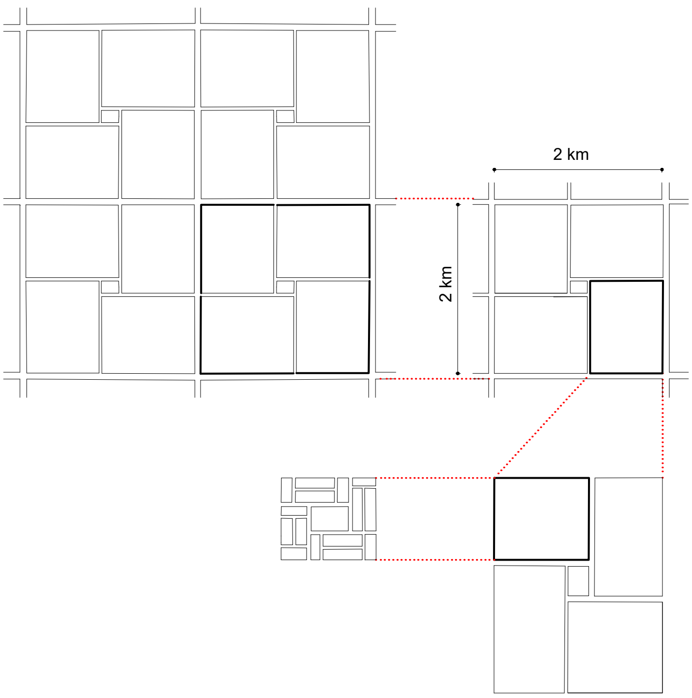


Figure 9.2-5
a) The urban layout of the selected urban area. (Source: Author's Edition).
b) Riyadh's 2X2 km basic structure unit. (Source: Author's Edition).

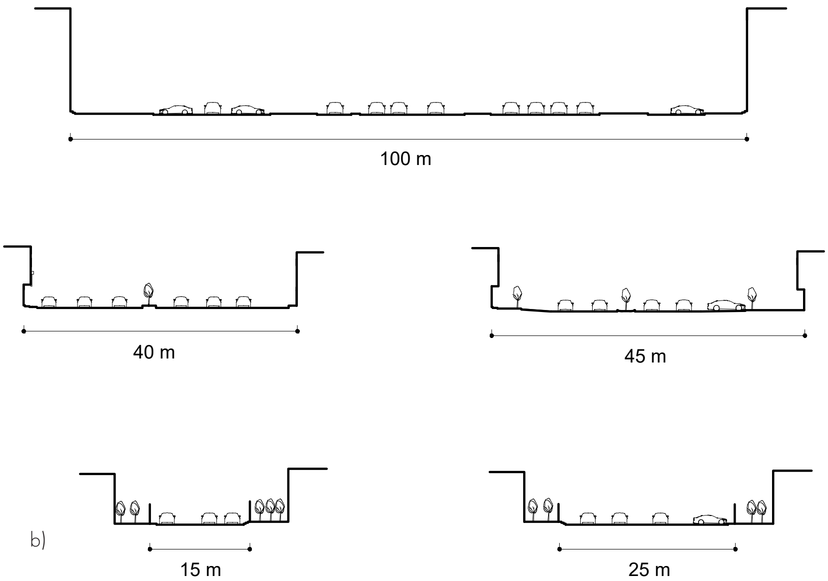
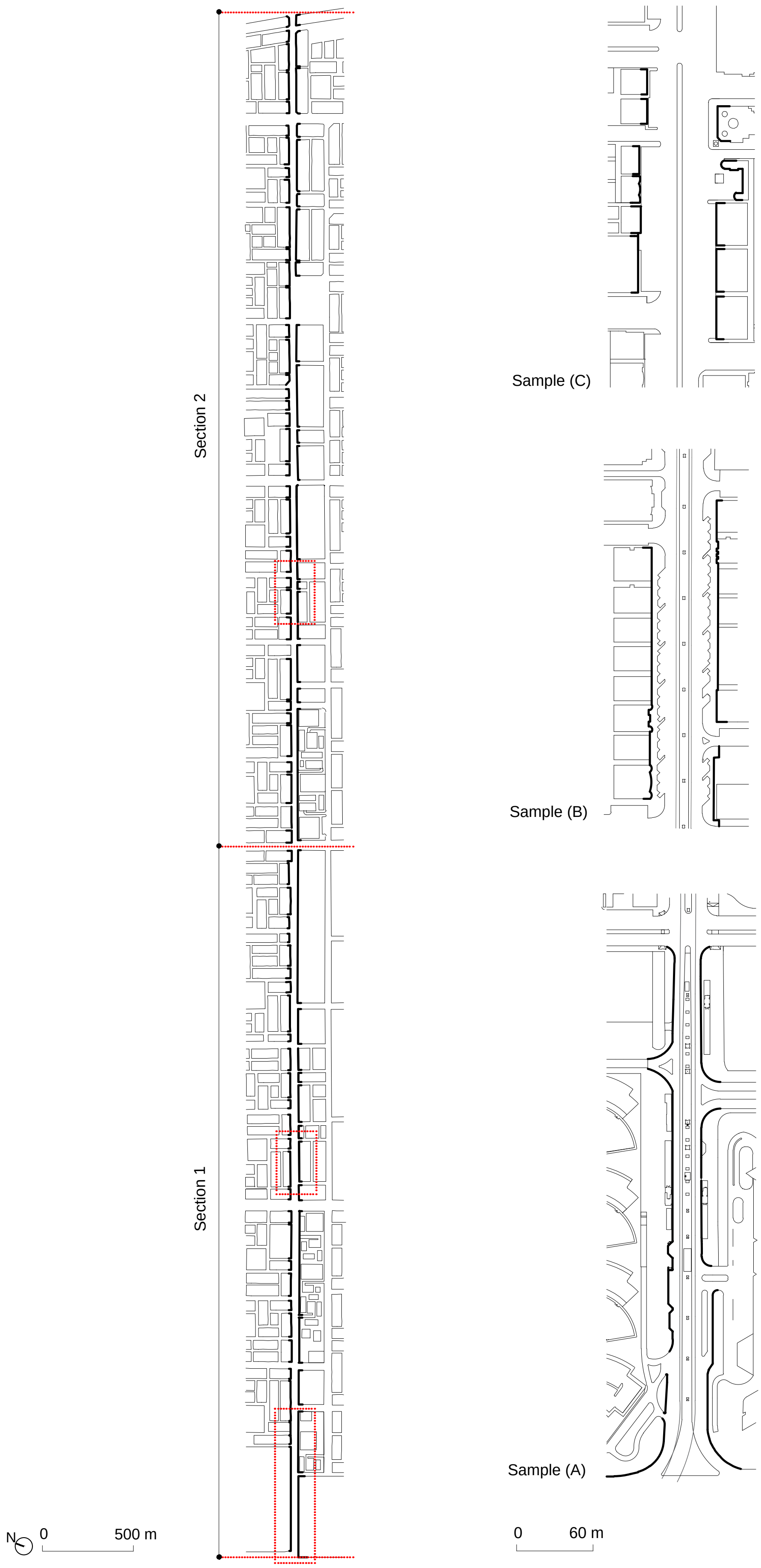


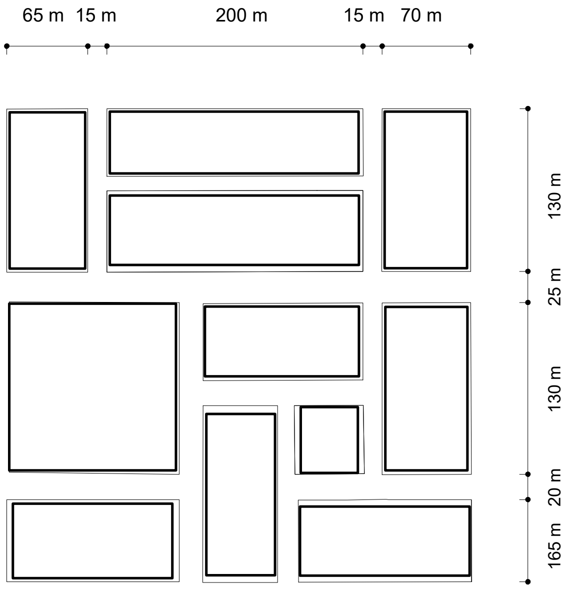
Figure 9.2-6
a) Street hierarchy of the selected urban area. (Source: Author's Edition).
b) Cross-sections of the street hierarchy within the urban area. (Source: Author's Edition).

Figure 9.2-7 The selected samples for analysis of the local case studies.
a) The two distinct sections of Khalid bin Al-Waleed Street and the selected samples for the study. (Source: Author's Edition).



b) The two distinct sections of Abi Jafar Al Mansour Street and the selected samples for the study. (Source: Author's Edition).

a)



b)

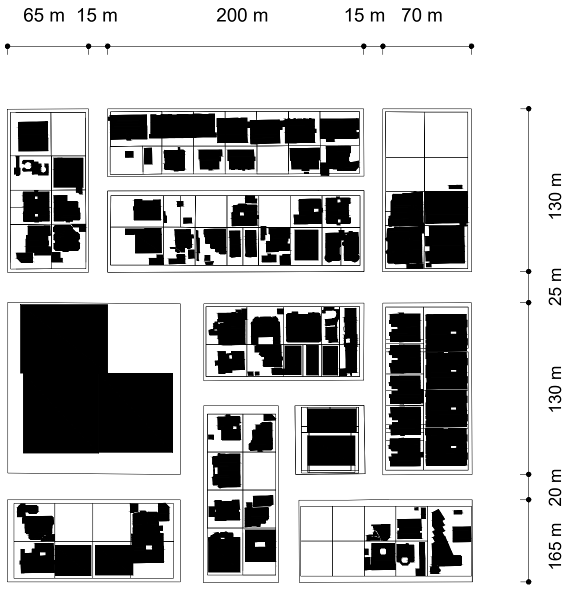


Figure 9.2-8
a) The public and private spaces of the surrounding common urban blocks. (Source: Author's Edition).
b) The urban block built form surrounding the local case studies. (Source: Author's Edition).

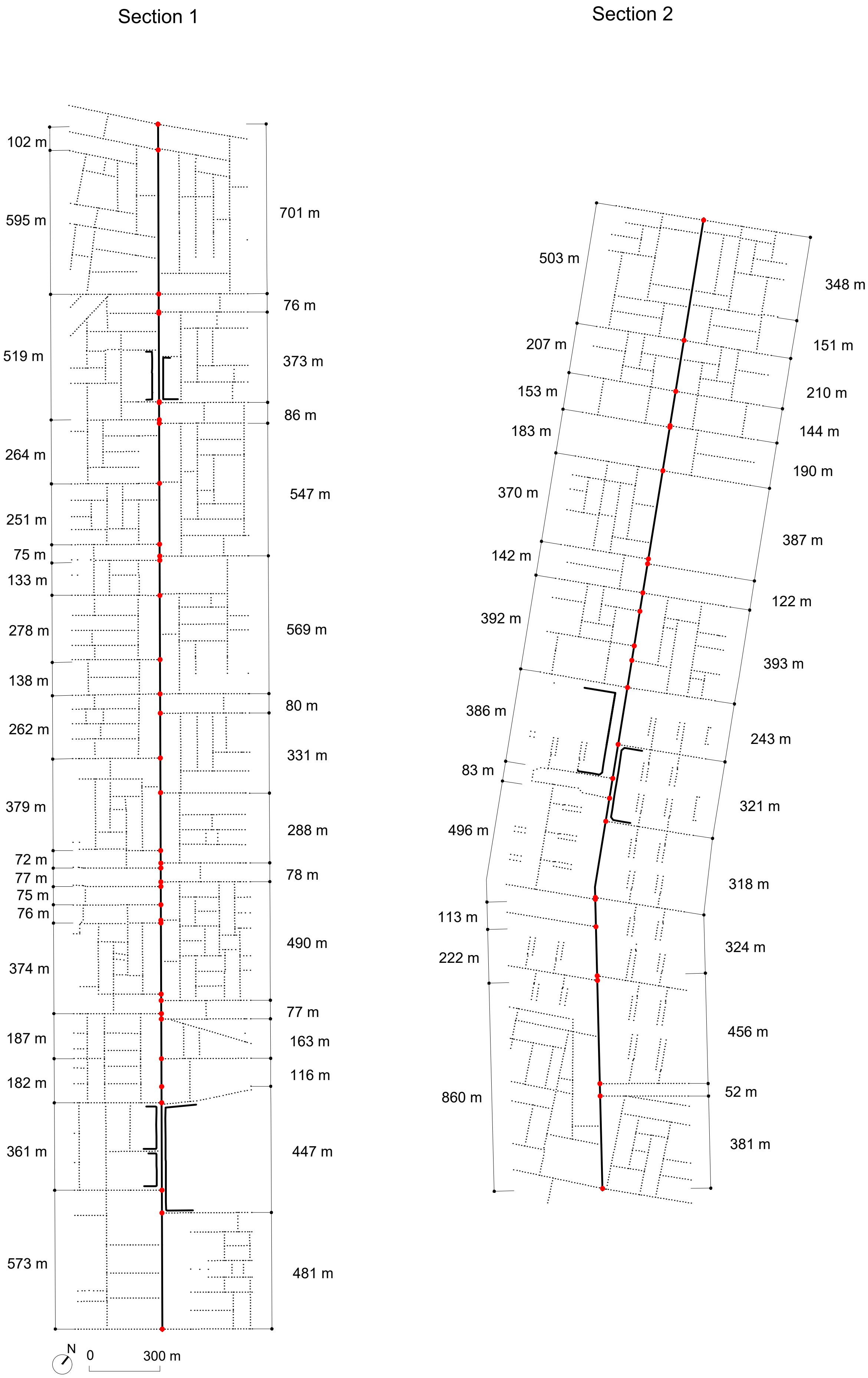
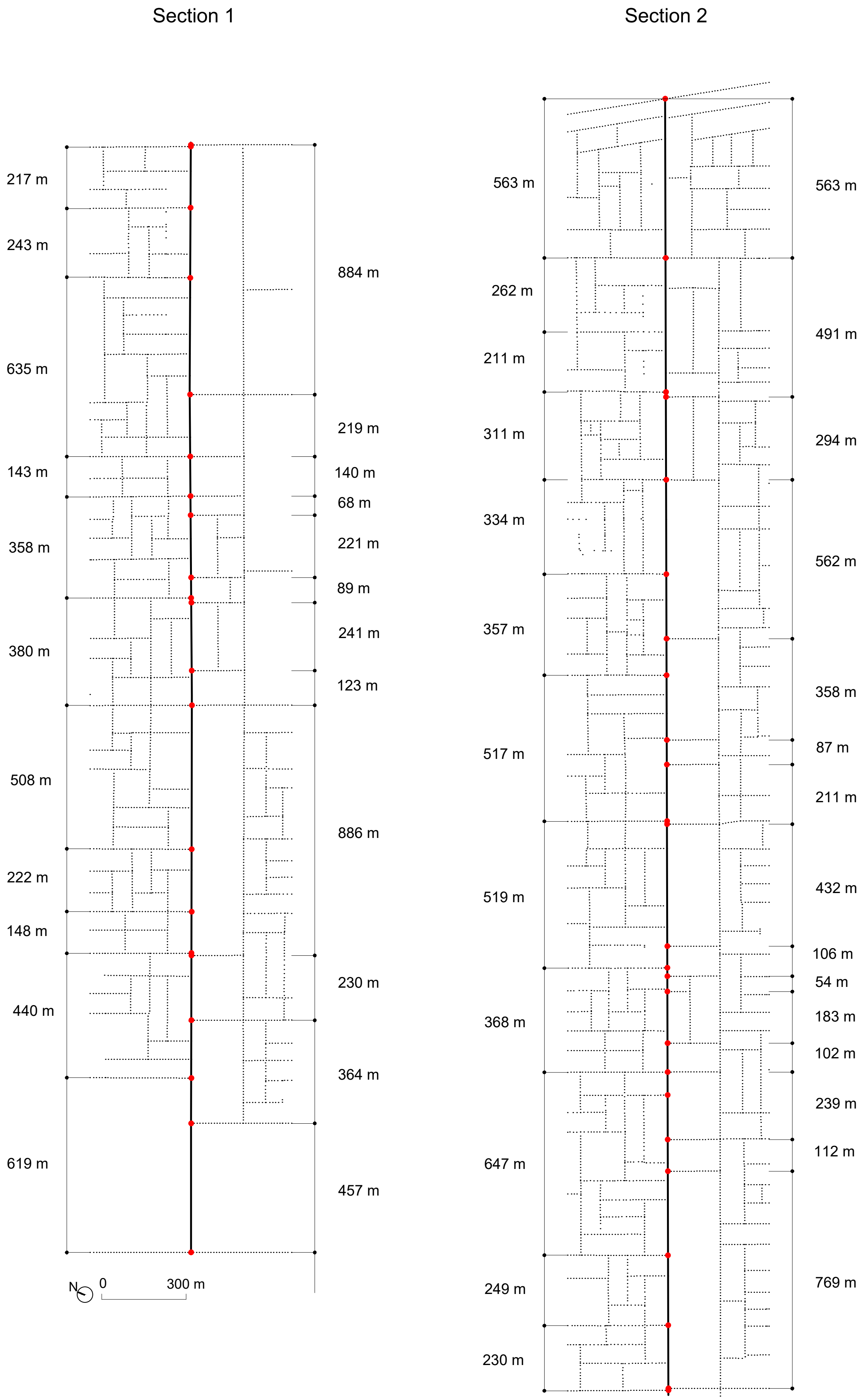


Figure 9.2-9 The street intersection frequency of the local case studies.
a) Khalid bin Al-Waleed Street. (Source: Author's Edition).



b) Abi Jafar Al Mansour Street. (Source: Author's Edition).

9.2.2. The street partition

As highlighted earlier, Khalid bin Al-Waleed and Abi Jafar Al Mansour were transformed in light of socio-spatial goals, which mainly coincide with the introduction of the public transportation project and the new configuration of their profile. Recently, both streets have undergone significant configuration and partition composition transformations. Following are street-by-street descriptions of the compositions of their partitions at the mesoscale.

9.2.2.1. Khalid bin Al-Waleed street partition

Regarding the partition characteristics of Khalid bin Al-Waleed, the street can be divided into two main sections, the southern and the northern, each with a particular composition. The southern section of the street goes from Khurais Road to King Abdullah Road and is characterized by a central BRT lane that has transformed the preexisting street profile. On the other hand, the northern section, from King Abdullah Road to Dammam Road, shows a lack of public transportation, as the section was not included in the recent project.

Samples A and B are situated in the southern section and share similar physical features, such as three to four traffic lanes in each direction, a narrow sidewalk, and a segregated central space designated for BRT use. In contrast, Sample C in the northern section features a different configuration, with a wide cross-section intended for automobile use. Nevertheless, both sections exhibit common traits, including high volume traffic, lengthy blocks that promote swift vehicular movement, pedestrian accessibility challenges, the absence of greenery and trees, and low-rise structures lining the street.

The analysis of the first sample, denoted as A and located in the southern section, reveals a broad cross-sectional area of 65 meters in width and approximately 230 meters in length. This sample features a dual carriageway with two-way traffic, separated by a central BRT lane that is 12 meters wide. On the eastern side of the sample, marked as AE, a U-shaped retail complex is arranged around a parking area. The roadway in this section of the sample consists of three to four lanes spanning a width of 12–15 meters. Additionally, a sidewalk measuring 2–5 meters in width is present on this side, separating the roadway from the U-shaped retail strip. However, there are no pedestrian amenities or street furniture in this section of the sample.

On the opposite side, Sample AW exhibits a similar configuration to Sample AE, with a roadway composed of three to four traffic lanes that have widths ranging from 12 to 15 meters. Similar to the previous sample, AW also lacks a designated pedestrian sidewalk and features only a narrow 2-meter walkway. An analysis of both samples indicates the prioritization of automobile usage over pedestrians, which is further evident in the layout design of the partitions. These partitions allocate more space to the roadway area and on-street parking, as illustrated in Figure 9.2-10.

Upon analyzing Sample B, which is situated in the southern section, a comparable configuration of the street partition was observed. This sample is part of the public transportation project in Riyadh and encompasses a central BRT space that segregates the two sides of the street in this section. The BRT space has a total width of 16 meters and is lined with trees on both sides. An examination of Samples BE and BW reveal a roadway that is 12 meters wide in each direction, with on-street parking occupying a total width of 6 meters on each side. As a result, the sidewalks in this section are relatively narrow, measuring only 2–3 meters in width, and lack essential pedestrian amenities such as trees, shade devices, and street furniture (Figure 9.2-11).

The last sample, denoted as C, is situated in the northern section of the street, spanning a total width of 88 meters and a length of 420 meters. This section is primarily dominated by automobile usage, with a noticeable absence of public transportation and pedestrian walkways. The analysis reveals a wide roadway in each sample, CE and CW, with approximately four lanes in each direction. In contrast to the previous samples, A and B, this section is characterized by long blocks that incorporate setbacks for car parking. The sidewalks in this sample are not interconnected and primarily serve the purpose of separating the roadway from the adjacent buildings. Furthermore, this sample features an unplanted and wide median, varying in width from 13 to 20 meters, as depicted in Figure 9.2-12.

The analysis of this study indicated that vehicular movement was given priority over pedestrians, as evidenced by the street partition compositions. The majority of the street cross-section was found to be occupied by automobiles, effectively transforming the street into a mere channel of movement. The study of the ratios between pedestrian and automobile spaces sheds light on the level of public activity in the street, which was found to be lacking. The narrow sidewalks appeared to serve merely as a means of facilitating quick and easy access to the shops. This was observed in all three selected samples, as the pedestrian-to-automobile space ratio was found to be (1:3) in all samples, A, B, and C, as shown in Figure 9.2-13.

Regarding the street enclosure, the buildings surrounding the street correspond to the overall situation in Riyadh, where low-rise and low-density buildings are the main characteristics of development. The street is generally bounded by low-rise buildings that affect the extent to which buildings and other vertical items, such as street trees, frame the street, where the average building height is 4–6 floors. In this regard, the W:H ratio, on average, was found to be (3:1) in all samples, as depicted in Figure 9.2-14.

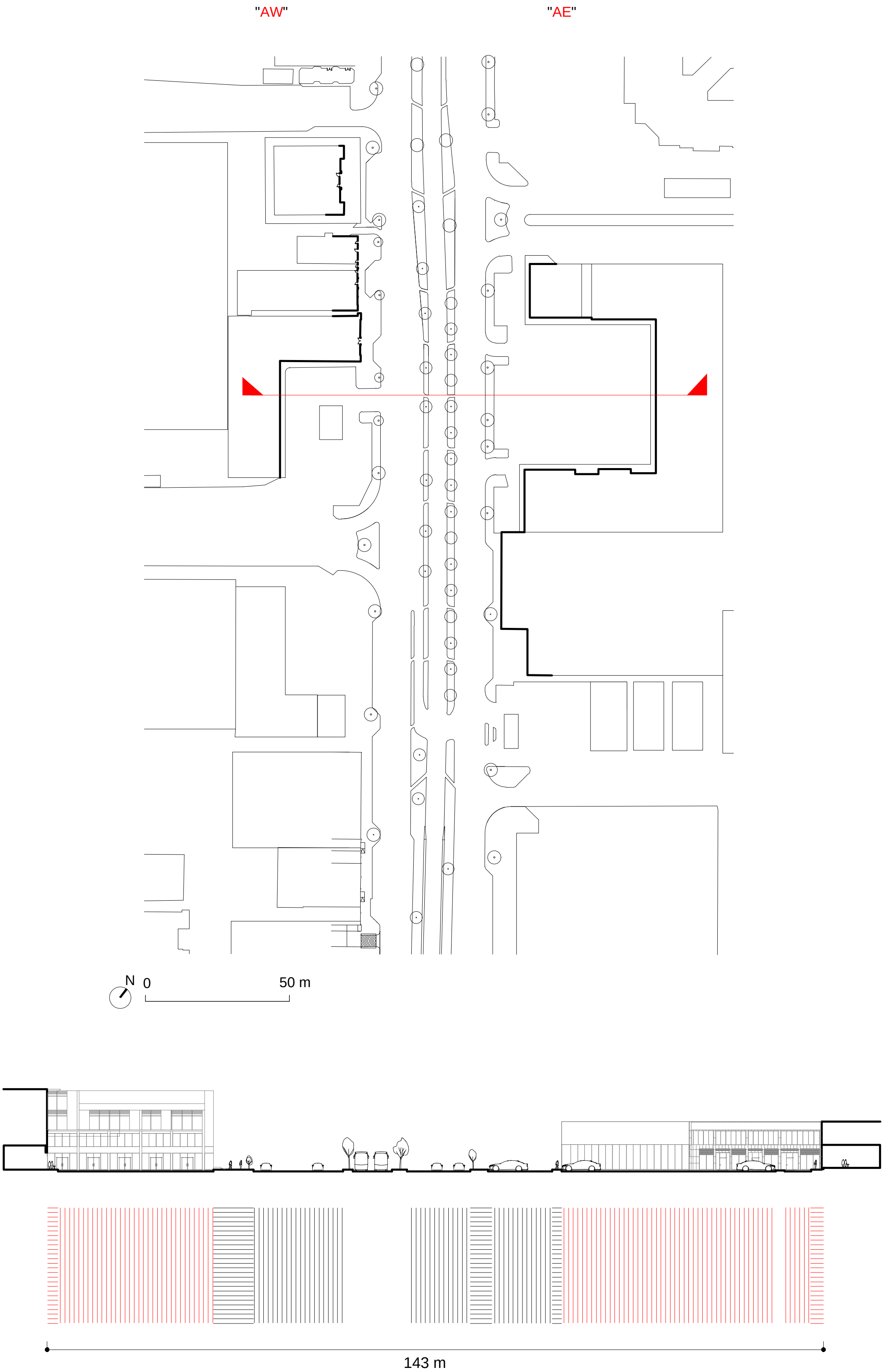


Figure 9.2-10 Khalid bin Al-Waleed Street: Plan and cross-section of sample "A." (Source: Author's Edition).

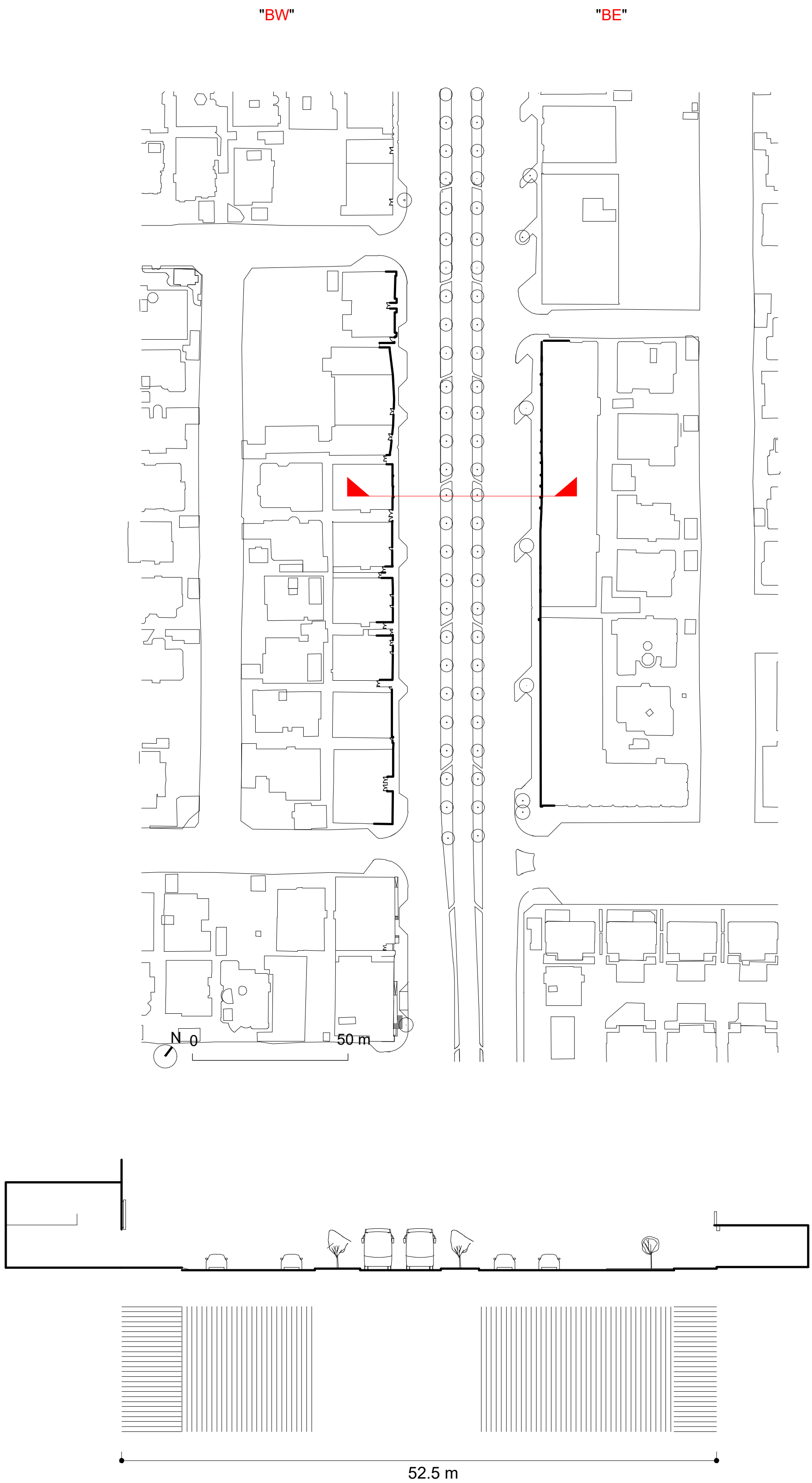
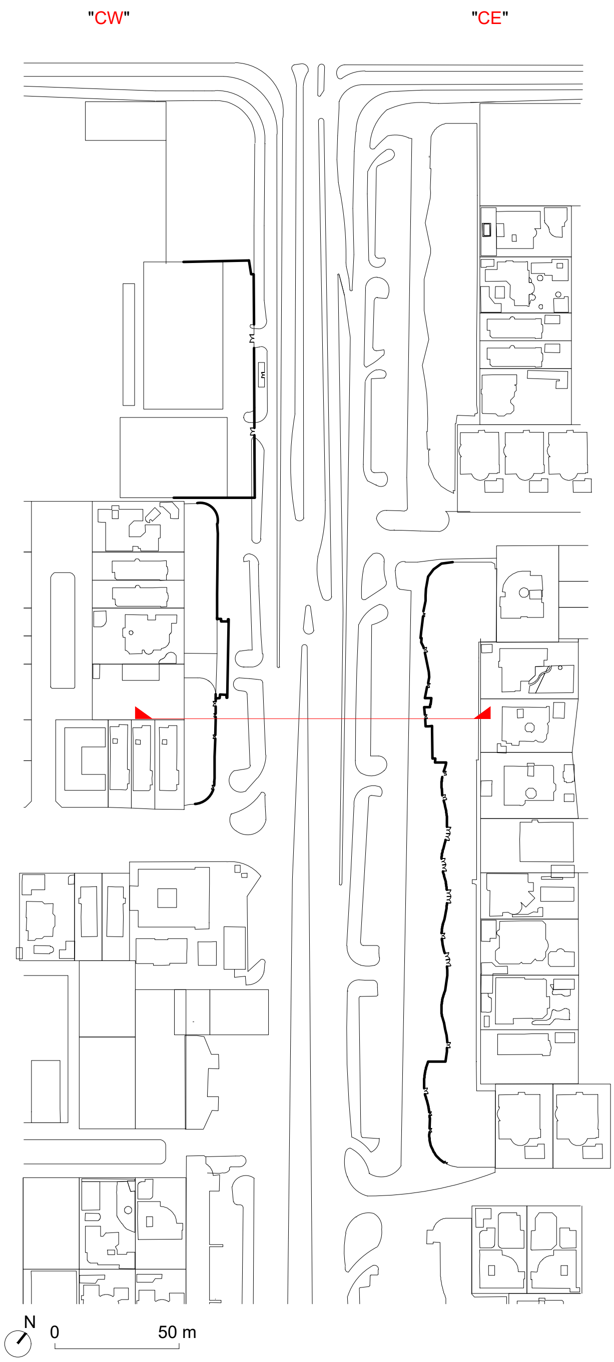


Figure 9.2-11 Khalid bin Al-Waleed Street: Plan and cross-section of sample "B." (Source: Author's Edition).



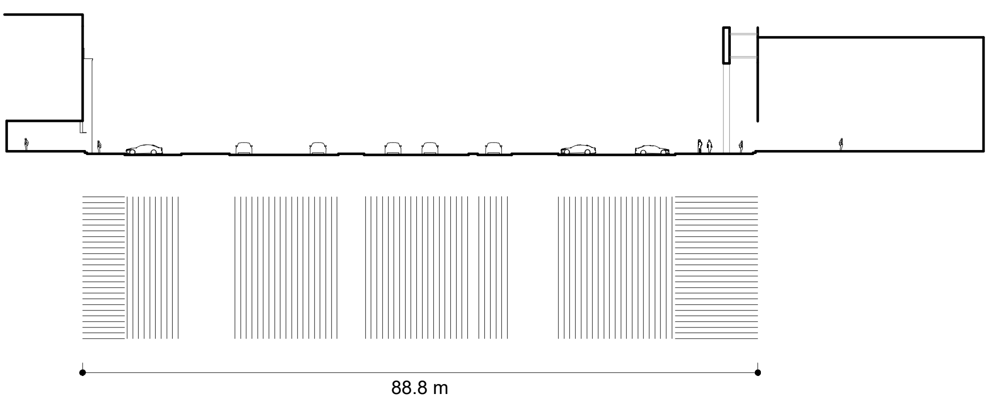


Figure 9.2-12 Khalid bin Al-Waleed Street: Plan and cross-section of sample "C." (Source: Author's Edition).

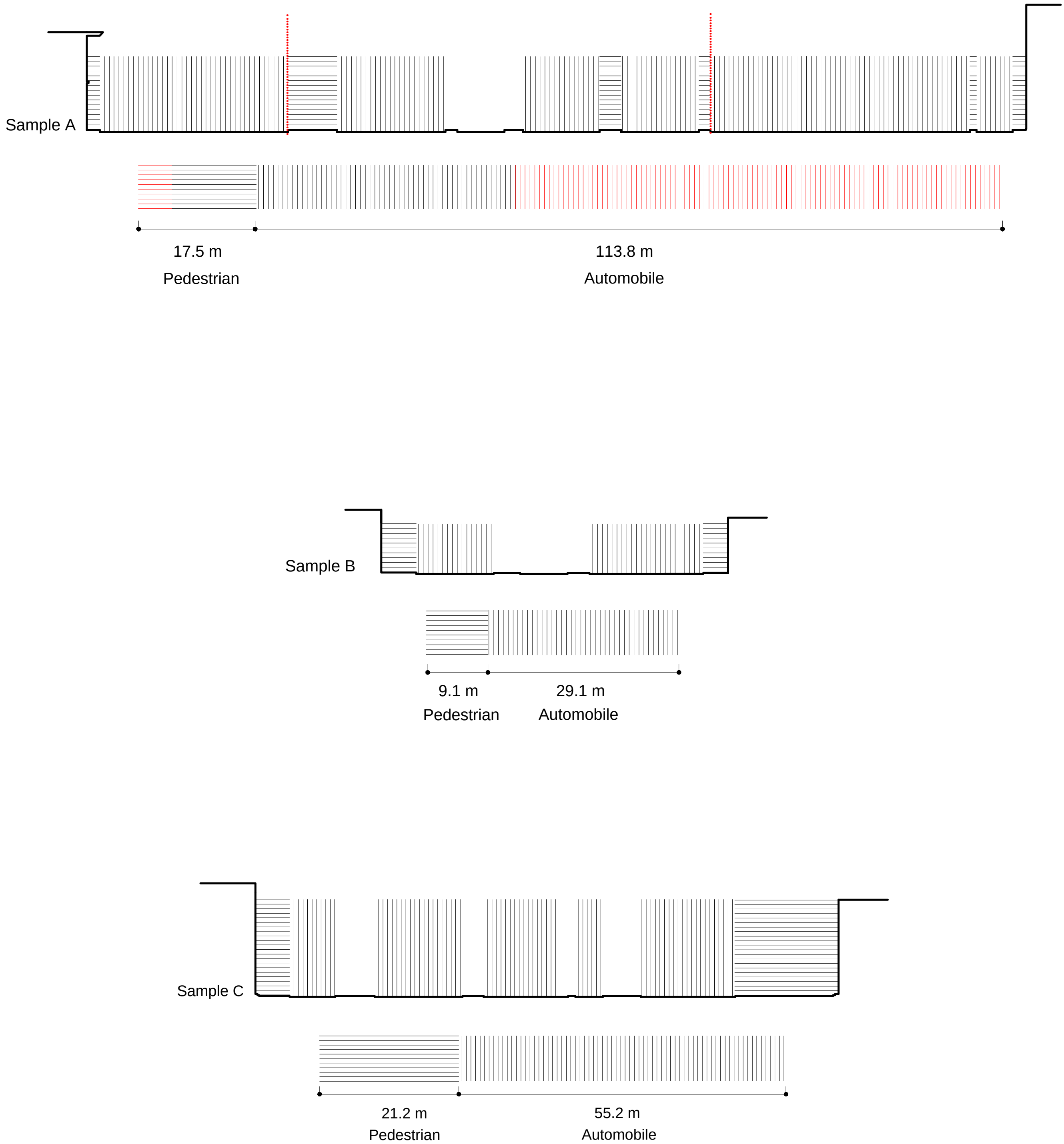


Figure 9.2-13 Khalid bin Al-Waleed Street: Cross-sections of samples "A, B, and C" show pedestrian-to-automobile ratios. (Source: Author's Edition).

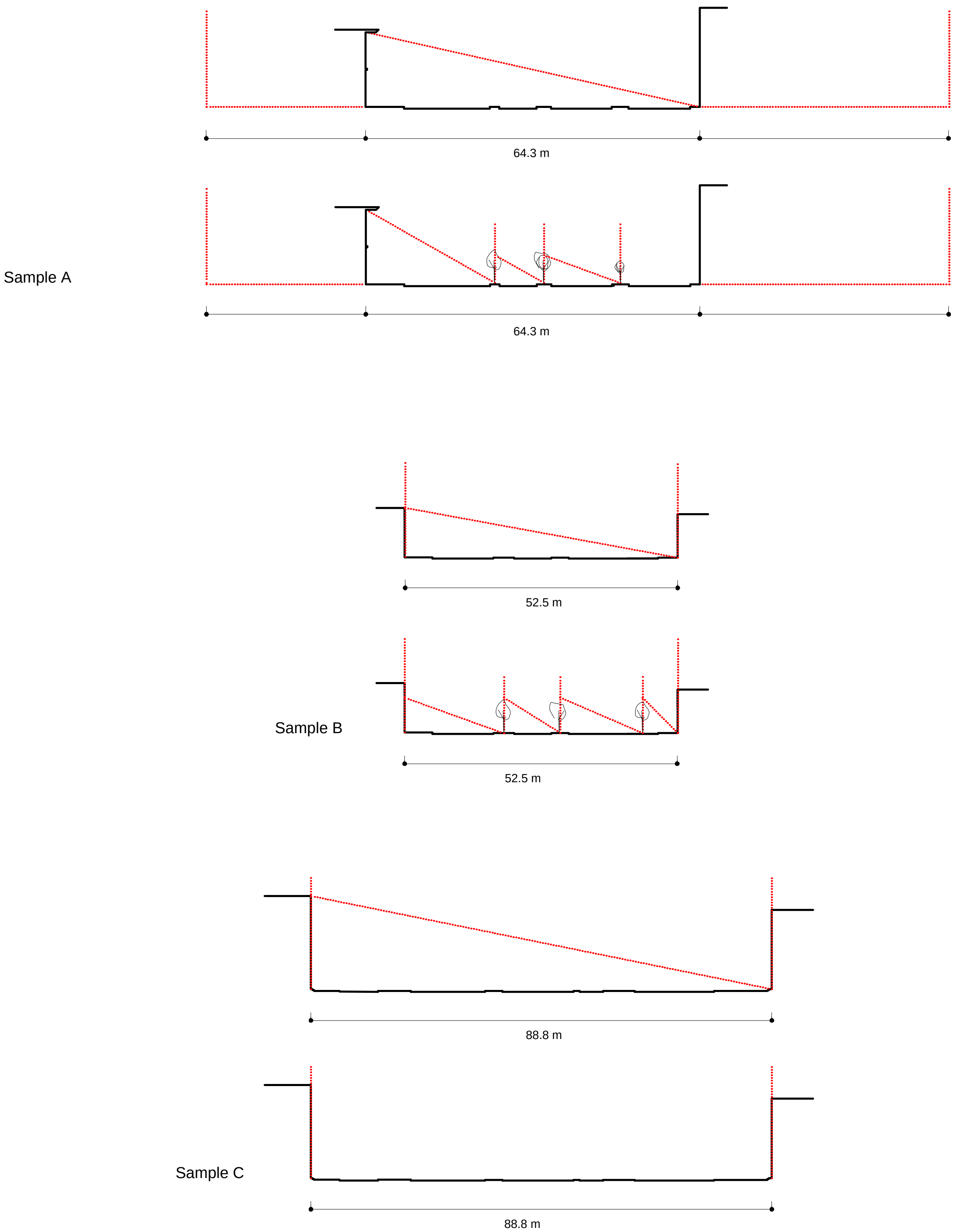


Figure 9.2-14 Khalid bin Al-Waleed Street: Cross-sections of samples "A, B, and C" show the street width and building height ratios. (Source: Author's Edition).

9.2.2.2. Abi Jafar Al Mansour street partition

Abi Jafar Al Mansour Street recently underwent several transformations to its profile, mainly on the western section of the street, where the center median configuration was transformed by widening the median and turning it into an elevated metro line. The introduction of the elevated metro line in the western section of the street led to the creation of two different compositions of the street partition. In this regard, the analysis of the street partition can be divided into two sections: the western and the eastern sections.

Sample A, located in the western section, shows a busy and critical sample at the beginning of the street, connecting the area with the Eastern Ring Road. The sample is about 60 meters wide and 410 meters long. The roadways along either side of the median are narrowed to 8 meters, allowing two traffic lanes in each direction, AS and AN. Sidewalks on both Samples AS and AN range from 2 to 16 meters wide, lacking pedestrian amenities and street furniture.

Despite the extensive modifications in the western section of the street, the morphological analysis suggests that the automobile-centric nature remains prevalent. The assessment of Sample AS demonstrates a fragmented sidewalk obstructed by various obstacles, leading to an unfavorable pedestrian environment. Furthermore, the sample lacks essential pedestrian amenities and is enclosed by walls that segregate the pedestrian realm from the surrounding buildings, as illustrated in Figure 9.2-15.

On the other hand, Sample B shows a cross-section of around 50 meters and a length of 220 meters. The sample is located in the western section of the street, and it shows a similar composition to Sample A. The sample is characterized by a central elevated tram line with a width of 7 meters. It also shows a symmetrical partition composition in terms of the number and width of the roadway lanes and sidewalks. In both directions, the roadway in this section comprises three lanes of 11 meters in width, followed by diagonal parking spaces of 6 meters in width.

In both Samples BS and BN, the sidewalks demonstrate a range of widths, typically varying from 3 meters adjacent to the on-street parking to 6 meters in some parts of the segment. While a row of saplings separates the sidewalks from the parking spaces, neither sample includes essential pedestrian amenities, such as benches or kiosks, that could promote the use of the street space for social activities, as shown in Figure 9.2-16.

Situated in the eastern section of the street, Sample C spans 60 meters in width and 200 meters in length, showcasing the original design and configuration of the street prior to the western section's intervention. The investigation of this research reveals a broad cross-section primarily dedicated to vehicular traffic, where both directions of the roadway (Sample CS and CN) comprise four traffic lanes that are roughly 14 meters wide, promoting high-speed traffic movement. Unlike Samples A and B, Sample C lacks sidewalks, with buildings directly abutting the parking space, as illustrated in Figure 9.2-17.

The morphological study shows that the pedestrian-to-automobile space ratios result in an unbalanced composition of street partitions in terms of function. As found, the pedestrian-to-automobile (P:A) space ratio is around (2:1) in Sample A, while Sample B is (1:2), and Sample C was fully dedicated to automobiles (Figure 9.2-18).

Regarding the street enclosure, the street is bounded by low-rise buildings that frame the street, where the average building height is 2 to 6 floors. In this regard, the W:H ratio, on average, was (1:1) in Sample A. Sample B was around (2:1), while Sample C was (3:1). However, the metro viaduct in the western section of the street provided a sense of enclosure (Figure 9.2-19).

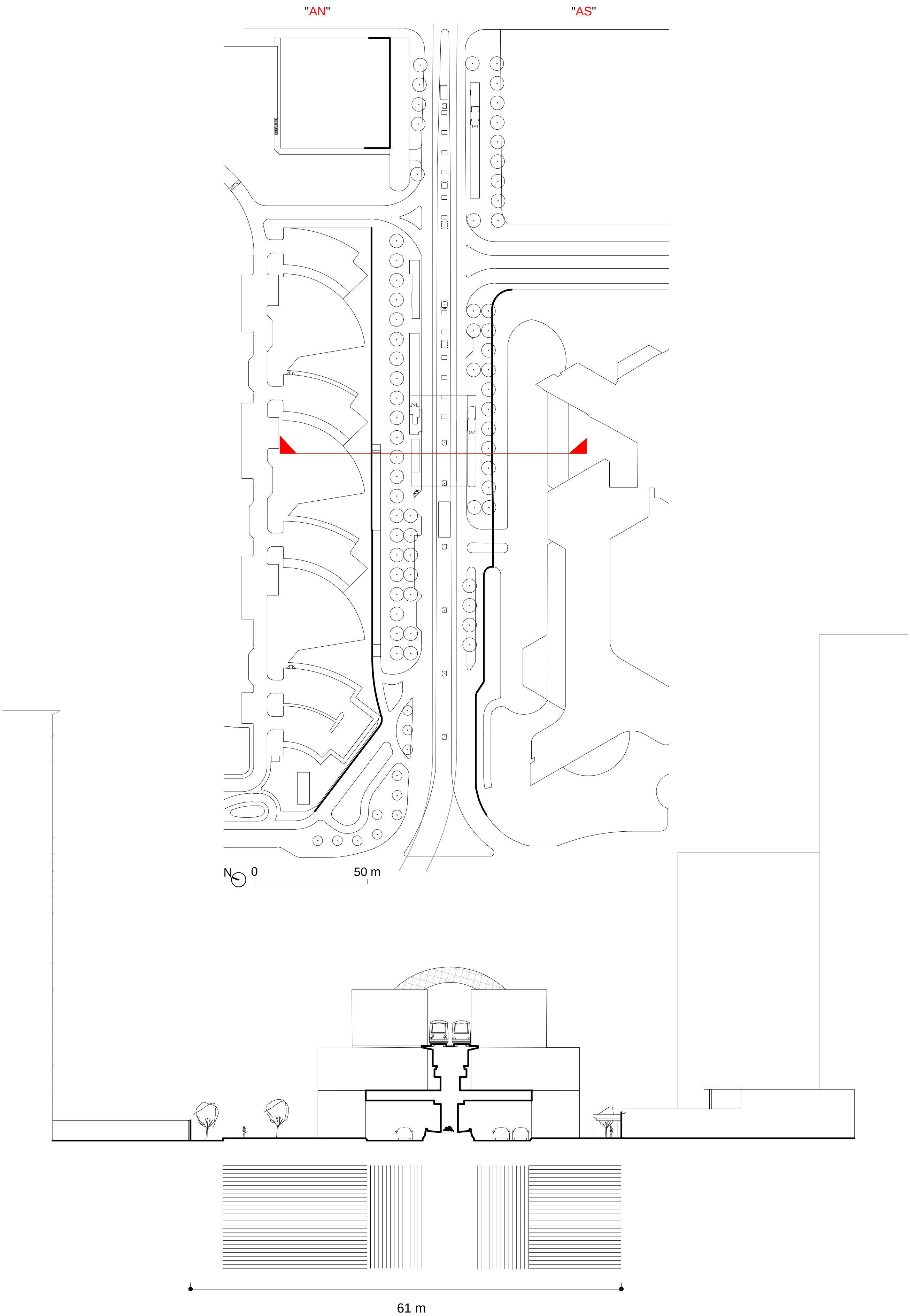


Figure 9.2-15 Abi Jafar Al Mansour Street: Plan and cross-section of sample "A." (Source: Author's Edition).

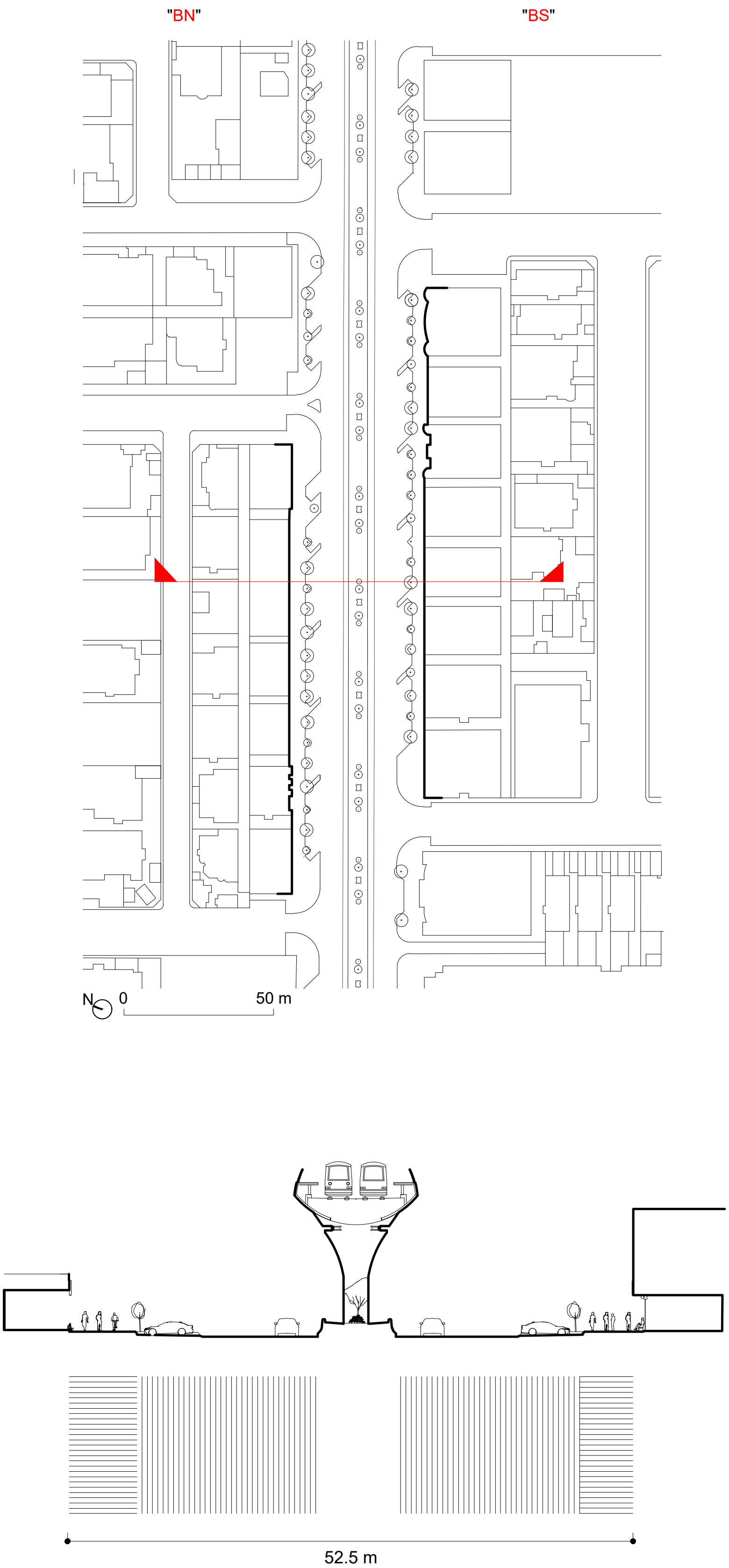
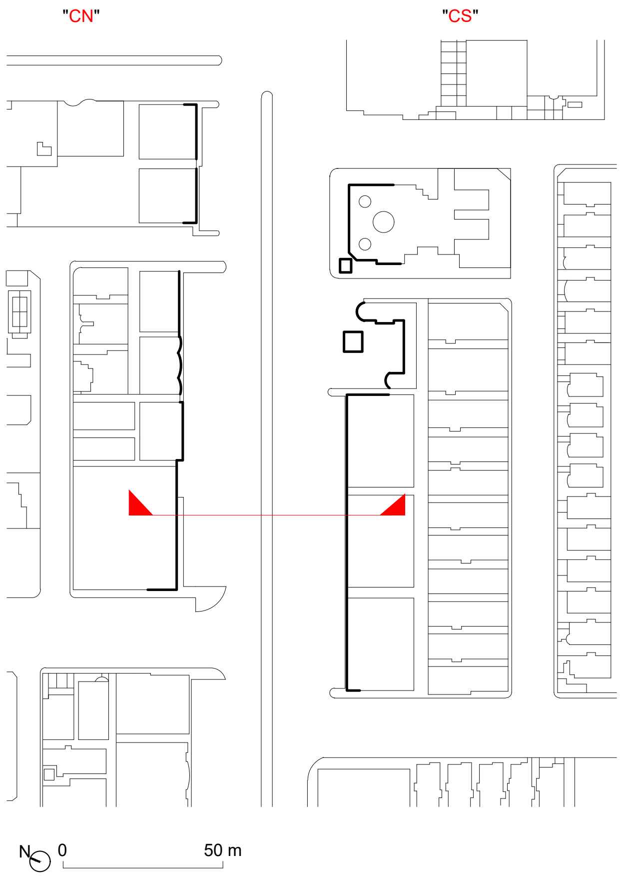


Figure 9.2-16 Abi Jafar Al Mansour Street: Plan and cross-section of sample "B." (Source: Author's Edition).



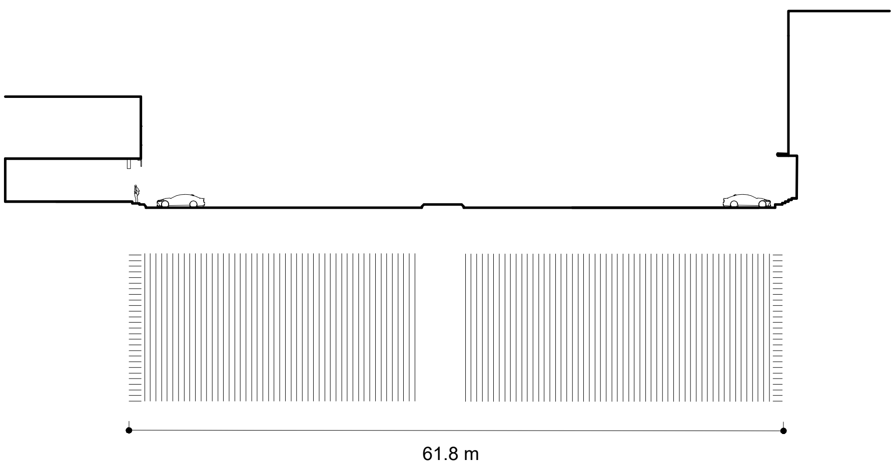


Figure 9.2-17 Abi Jafar Al Mansour Street: Plan and cross-section of sample "C." (Source: Author's Edition).

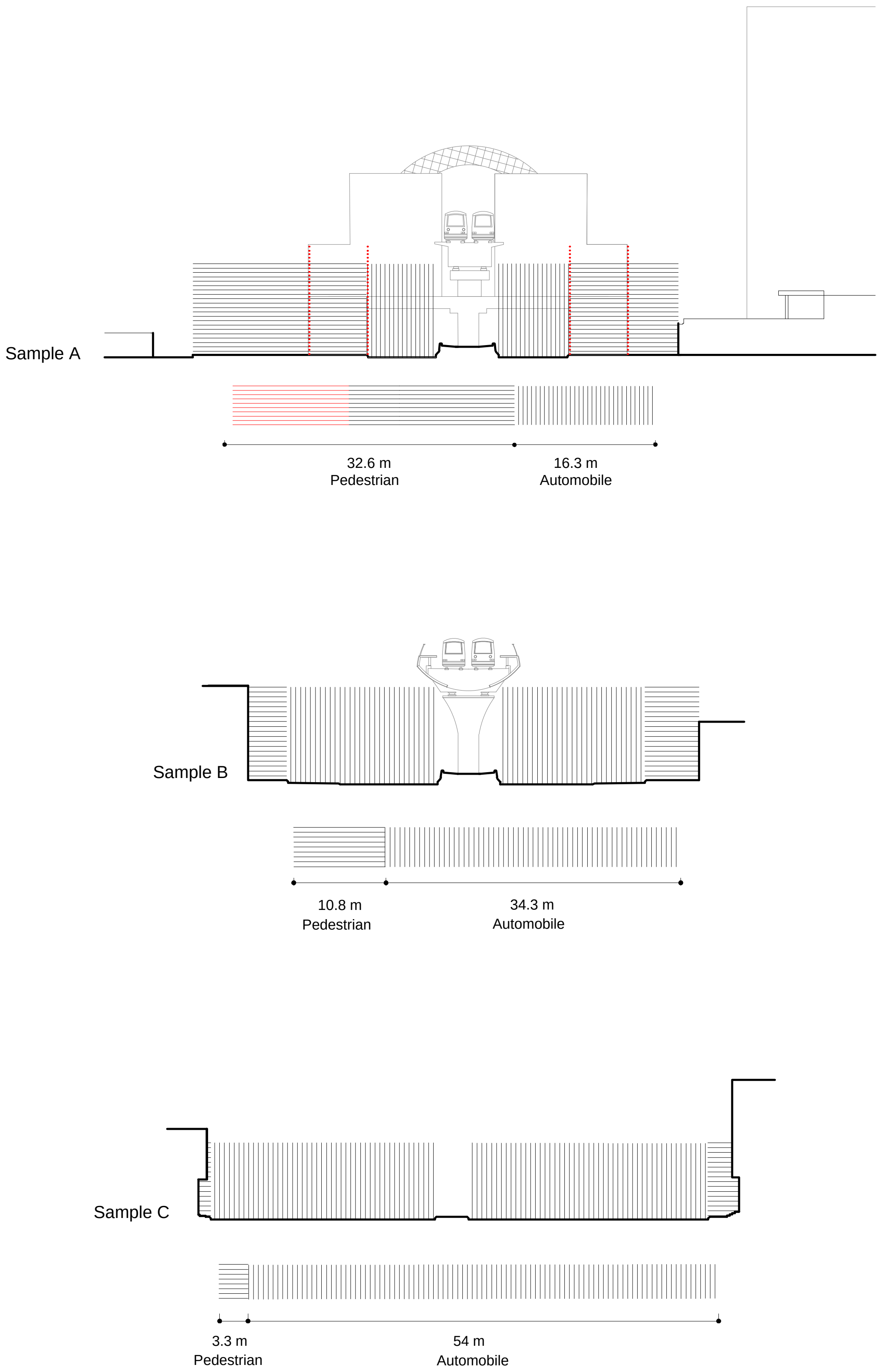


Figure 9.2-18 Abi Jafar Al Mansour Street: Cross-sections of samples "A, B, and C" show pedestrian-to-automobile ratios. (Source: Author's Edition).

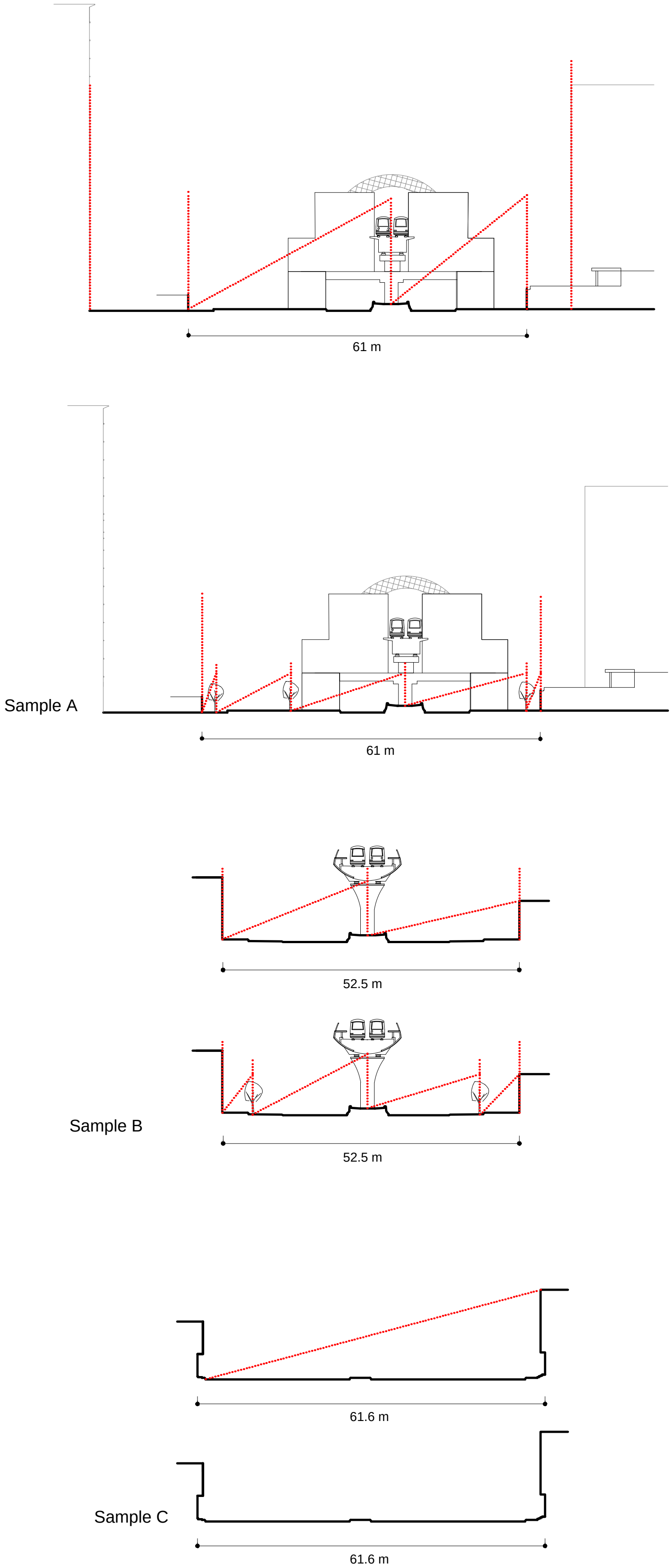


Figure 9.2-19 Abi Jafar Al Mansour Street: Cross-sections of samples "A, B, and C" show the street width and building height ratios. (Source: Author's Edition).

9.2.3. The street interface

9.2.3.1. Khalid bin Al-Waleed street interface

Khalid bin Al-Waleed Street is composed of similar street interface configurations that correspond to the functions at the ground floor level. As the study revealed, the street at the ground-floor level mainly offers services and specialties such as construction materials retailers, furniture, lighting, and electrical stores (Figure 9.2-20).

Although the morphological study and experiment into pedestrians' visual preferences revealed the five types of street interfaces: permeable/accessible (PA), impermeable/accessible (IA), permeable/inaccessible (PI), impermeable/inaccessible (II), and doors/windows (DW), with different percentages of occupation, the street interfaces on the ground floor show a lack of shared and social spaces.

In a 9-kilometer stretch, the street interface presented a variety of proximities, whereby some interfaces were adjacent to the sidewalk (without setback) and others had a setback. In some cases, shop owners extend their commercial space onto the sidewalk itself or extend the setback to provide more parking spaces. Along the street, the street interface offered a continuing rhythm of doors connecting public and private spaces (Figure 9.2-21).

Regarding Sample A, the sample accommodated four variables of street interface configurations: permeable/accessible (PA), permeable/inaccessible (PI), impermeable/inaccessible (II), and doors/windows (DW). The sample provides a steady rhythm of doors and windows on both sides of the street (Figure 9.2-22).

The interfaces of Sample AE were 188 m wide and 3–4 m in height, with a majority of permeable/accessible (PA) interfaces and impermeable/inaccessible (II) interfaces. On the other side of the street, the sample AW was 220 m wide and 4–5 m in height, most of which was permeable/accessible (PA) interface.

The eye-tracking results of Sample A show that the permeable/accessible (PA) interfaces presented the greatest visual interactions for participants. As shown in the study of visual perception in Sample AE, the results also show that participants spent most of the time looking at the permeable/accessible (PA) interfaces, an average of 68% of the time, followed by impermeable and inaccessible interfaces (18%), and doors and windows that were occupied (13%). On the other side of the sample, AW, the results show that participants were visually attracted to permeable/accessible (PA) interfaces on average (40.05%) of the time as well as doors/windows (34.66%), permeable/inaccessible (22.10%), and impermeable/inaccessible (3%) (Figure 9.2-23).

The study of Sample B, located in the southern section, was characterized by five types of street interface configurations: permeable/accessible (PA), impermeable/accessible (IA), permeable/inaccessible (PI), impermeable/inaccessible (II), and doors/windows (DW). The sample shows a continued rhythm of doors and windows on both sides of the sample. Compared to Sample A, Sample B shows interface configurations without setbacks (Figure 9.2-24).

Sample BE was 228 m wide and had an interface height between 3.5 and 5 m. The majority of the street interface configurations were permeable/accessible (PA) interfaces. On the other side, Sample BW was 330 m wide and had an interface height of 4 m. The majority of the interfaces are permeable/accessible (PA) and impermeable/accessible (IA).

The eye-tracking results of Sample B show that the permeable/accessible (PA) interfaces induced the greatest eye fixation for most participants. Regarding the study of visual perception in Sample BE, participants spent more time looking at the permeable/accessible (PA) interfaces, an average of 67.23% of the time, in comparison to doors/windows (29.49%), impermeable/inaccessible (2%), and permeable/inaccessible (1.44%). Regarding Sample BW, the results show that participants were visually attracted to permeable/accessible (PA) interfaces on average 69.44% of the time, in comparison to doors/windows (20.01%), impermeable/inaccessible (5.94%), and permeable/inaccessible (4.61%) (Figure 9.2-25).

Finally, the morphological analysis of Sample C presented the four types of street interfaces: permeable/accessible (PA), impermeable/accessible (IA), permeable/inaccessible (PI), and doors/windows (DW). However, Sample C, in contrast to Samples A and B, showed different components of the street interface due to the large buildings and long blocks surrounding the sample (Figure 9.2-26).

Sample CE was 330 m wide and had an interface height of 4 m. The majority of the interfaces are permeable/accessible (PA). The results demonstrate that the ground floor of the sample's CE offered services and specialty uses. On the other side, Sample CW was 228 m wide and had an interface height between 3.5 and 5 m. The majority of street interface configurations were permeable/accessible (PA) interfaces, followed by permeable/inaccessible (PI) interfaces.

The sample CE showed that participants were visually engaged with permeable/accessible (PA) interfaces, an average of 54.19%, doors/windows (39.18%), permeable/inaccessible (3.32%), and impermeable/accessible (3.31%). Regarding Sample CW as found, permeable/inaccessible (PI) interfaces showed the most visual preferences with an average of 43.88%, compared to permeable/accessible (39.90%) and doors/windows (16.22%) (Figure 9.2-27).

The eye-tracking results show that permeable/accessible (PA) interfaces were the most visually attractive out of the three samples. On average, participants were visually attracted to permeable/accessible (PA) interfaces, an average of 53.64%, in comparison to doors/windows (26.07%), permeable/inaccessible interfaces (13.46%), impermeable/inaccessible interfaces (3.64%), and impermeable/accessible interfaces (3.19%) (Figure 9.2-28). The study also highlights that those participants were more visually attracted to the interfaces of Sample C, which occupied 51.63% of their time, compared to Sample B (38.98%) and Sample A (9.39%) (Figure 9.2-29).

Section 1

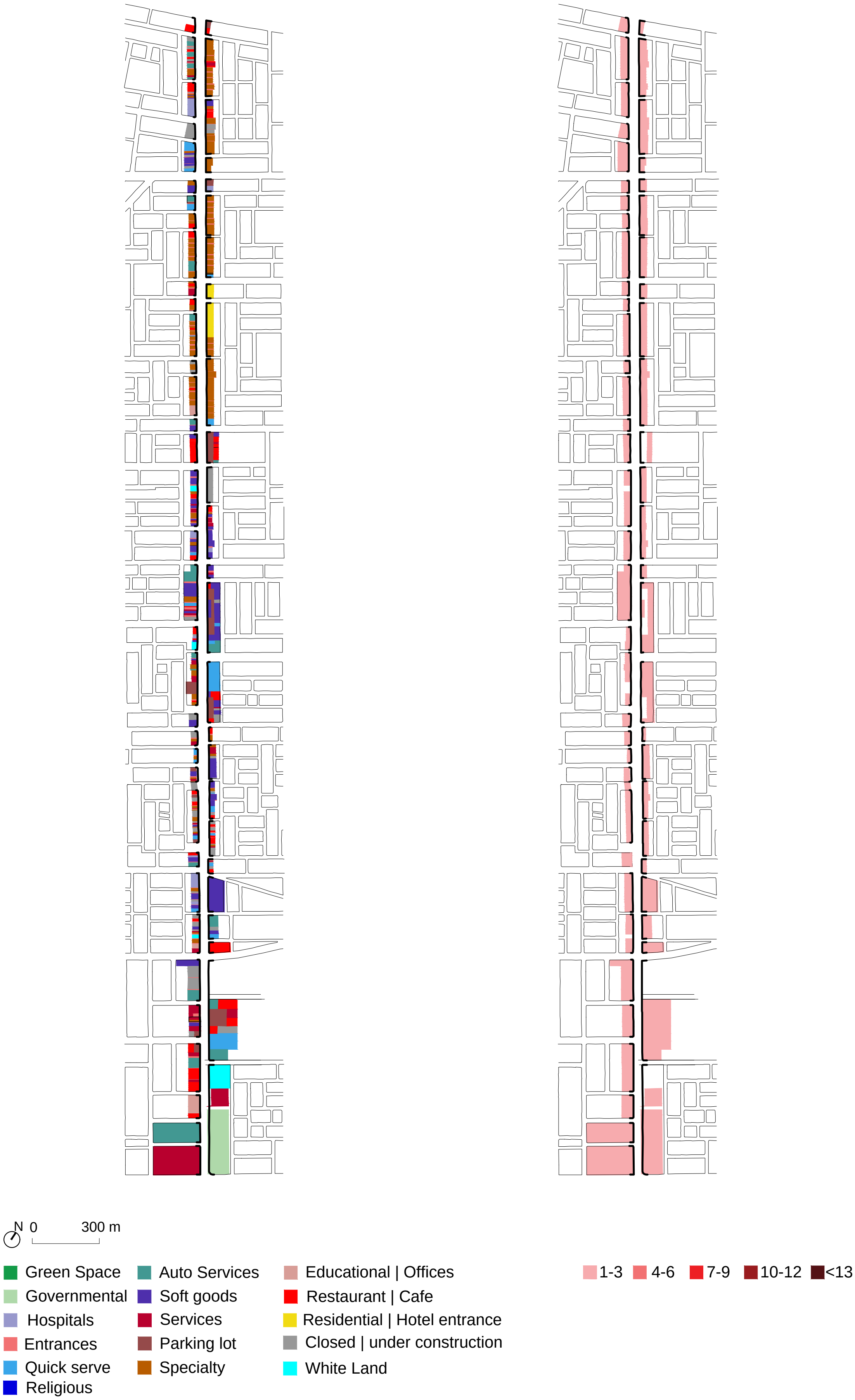
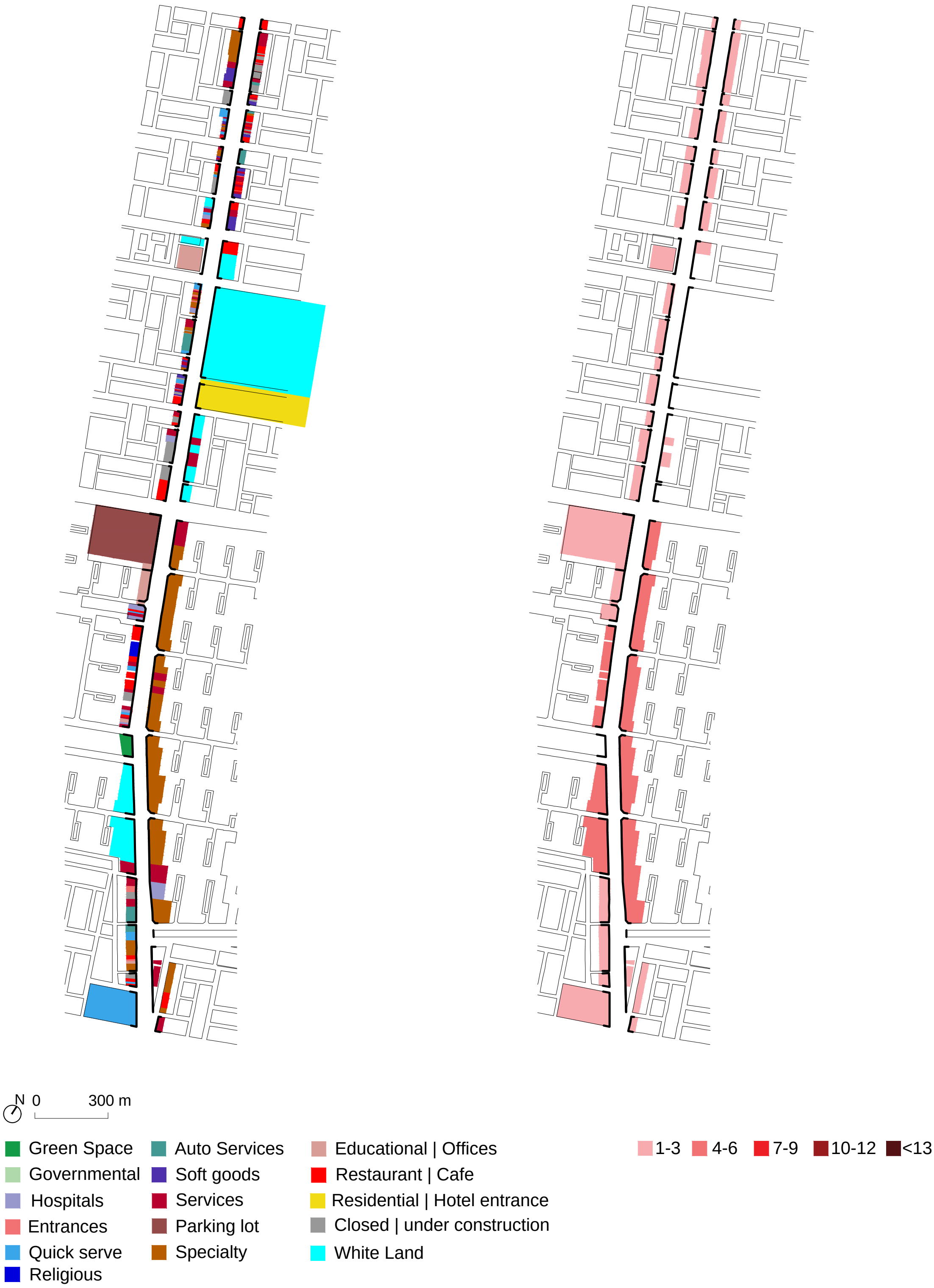


Figure 9.2-20 The ground floor uses and building heights along Khalid bin Al-Waleed Street.
a) The first section. (Source: Author's Edition).

Section 2



b) The second section. (Source: Author's Edition).

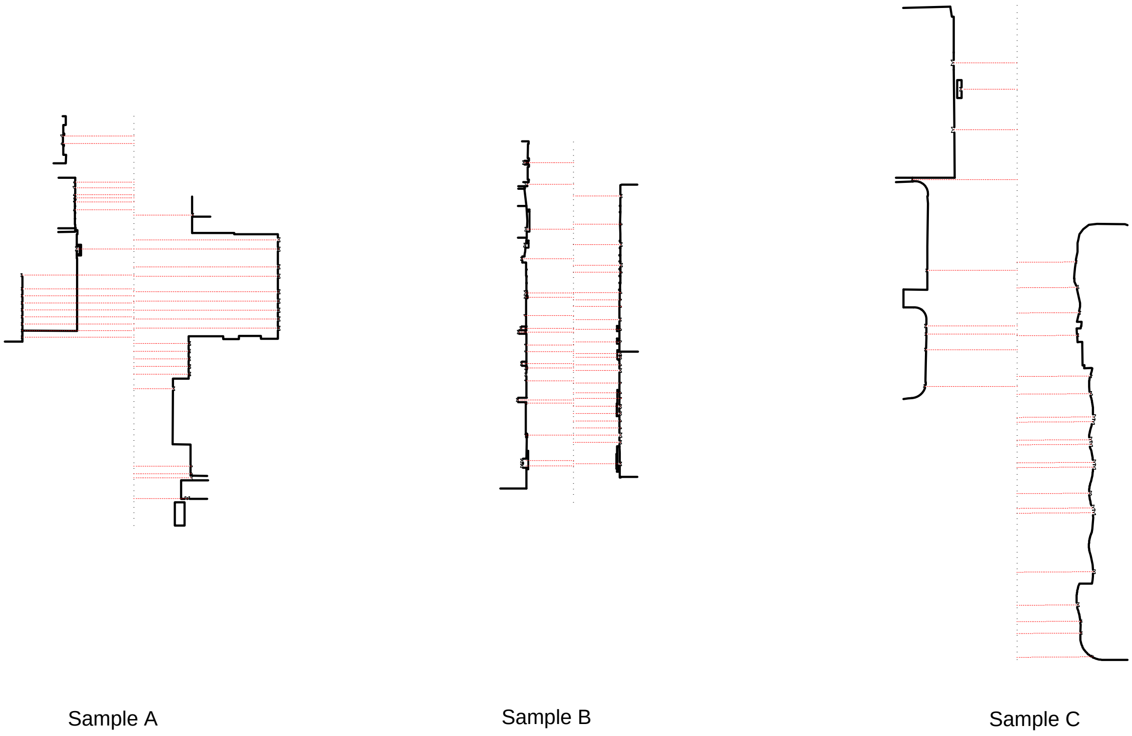
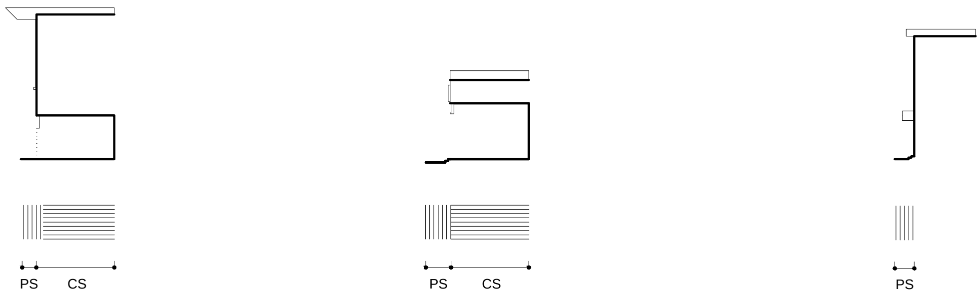
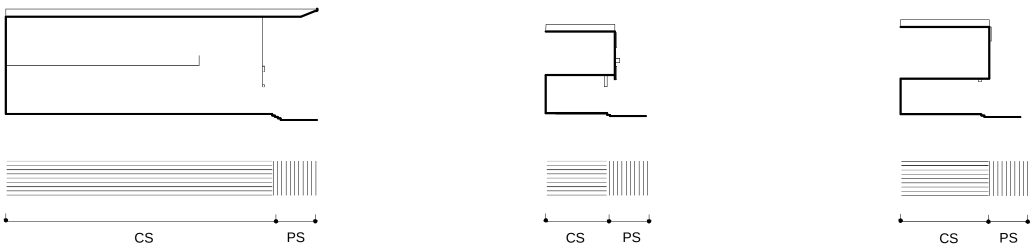


Figure 9.2-21 Plans of the three selected samples "A", "B" and "C" of Khalid bin Al-Waleed Street show the rhythm and proximity of the street interfaces. (Source: Author's Edition).

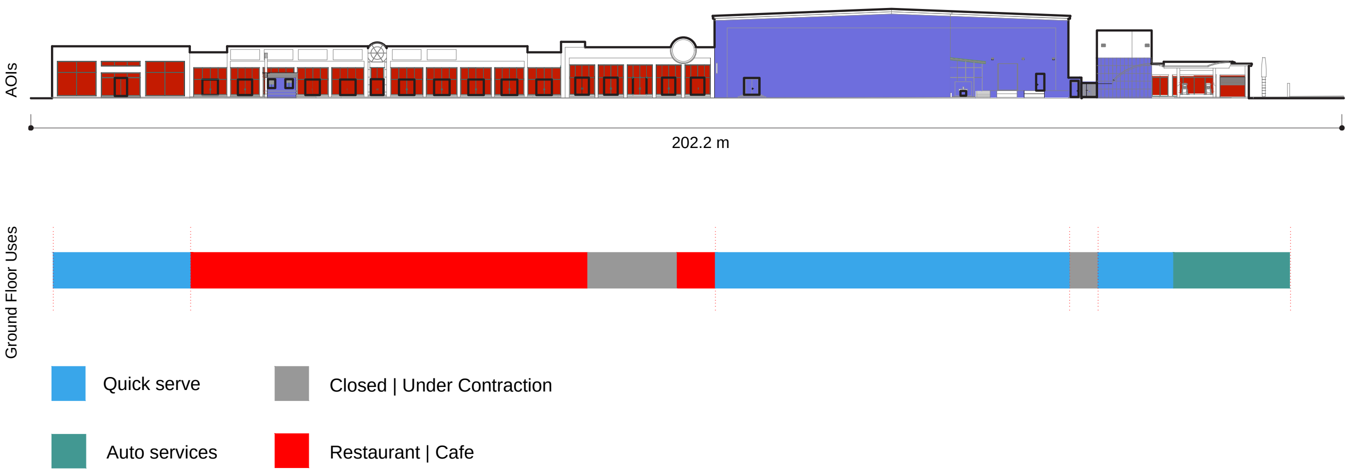


Sample "AE"



Sample "AW"

Figure 9.2-22 Cross-sections of sample "A" of Khalid bin Al-Waleed Street show the visual and physical permeability of the street interfaces. (Source: Author's Edition).



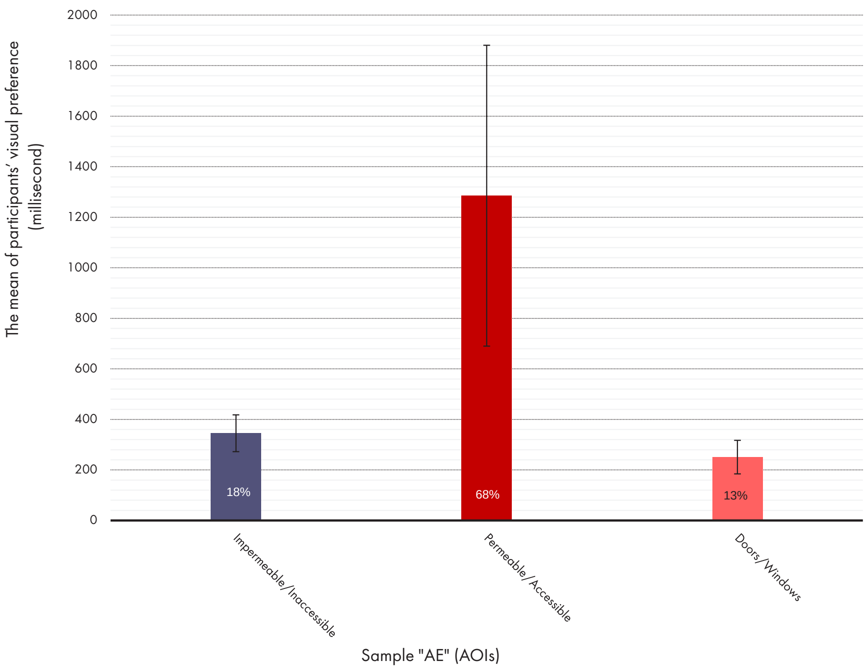
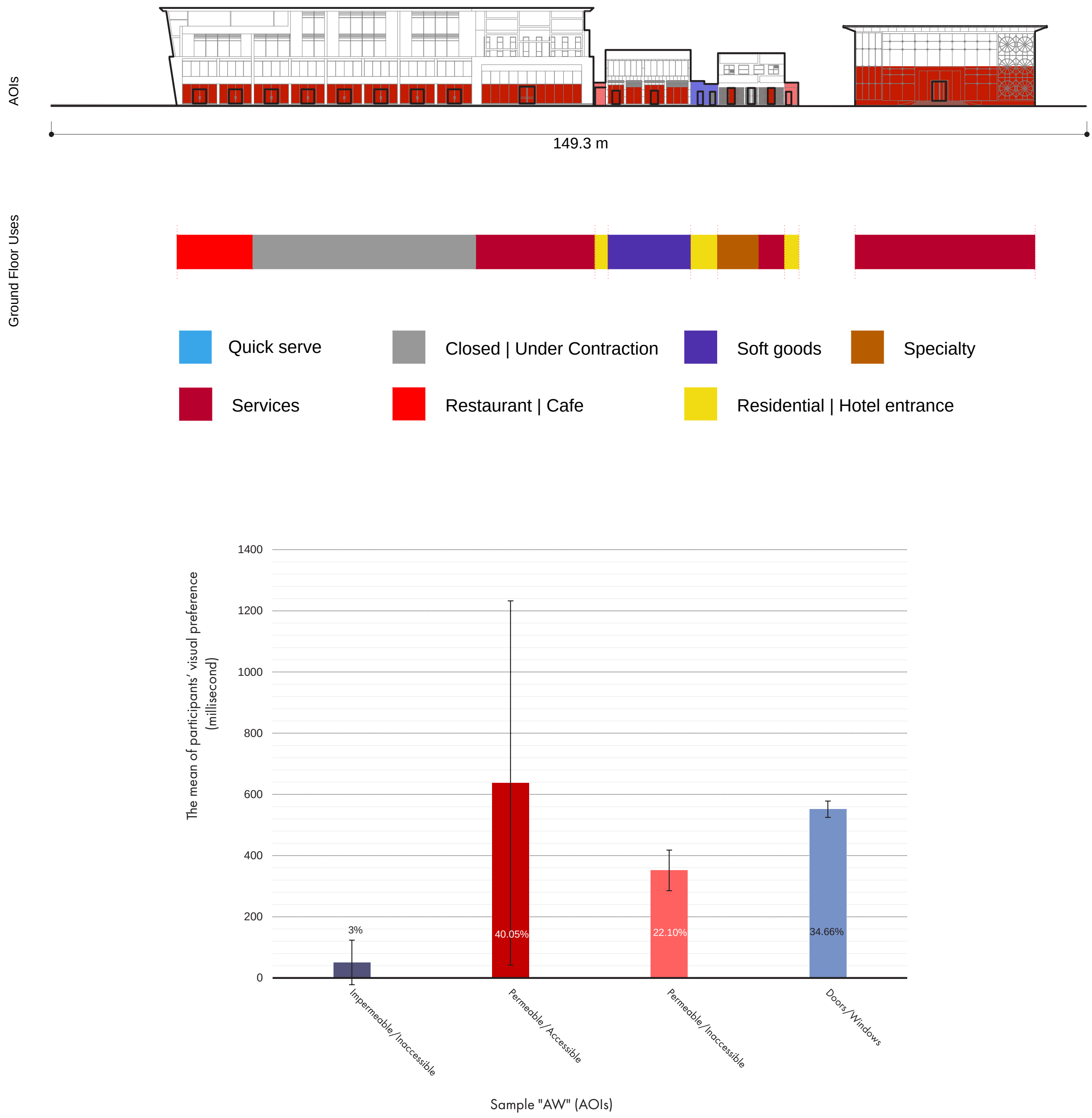
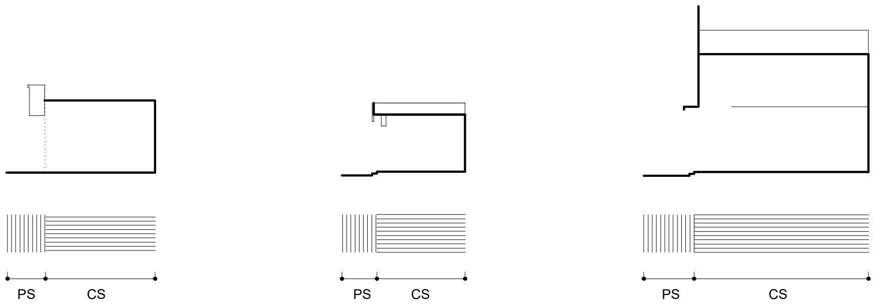


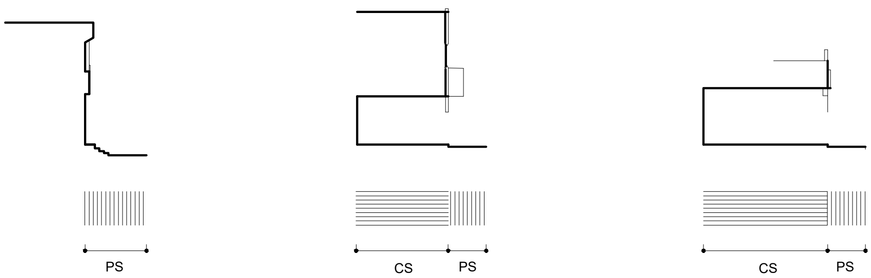
Figure 9.2-23 The percentage of participants' visual preference for street areas of interest (AOIs) in Khalid bin Al-Waleed, sample "A."
a) Sample "AE." (Source: Author's Edition).



b) Sample "AW." (Source: Author's Edition).

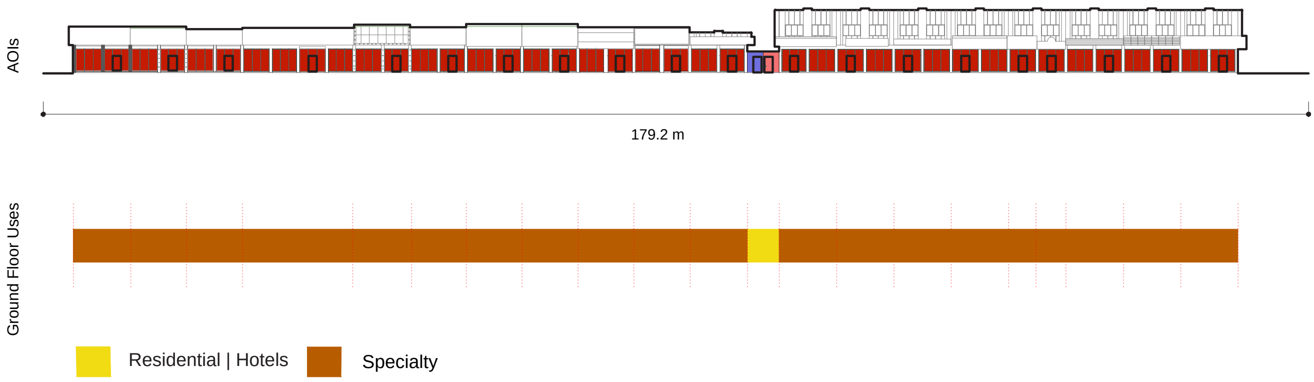


Sample "BE"



Sample "BW"

Figure 9.2-24 Cross-sections of sample "B" of Khalid bin Al-Waleed Street show the visual and physical perme-ability of the street interfaces. (Source: Author's Edition).



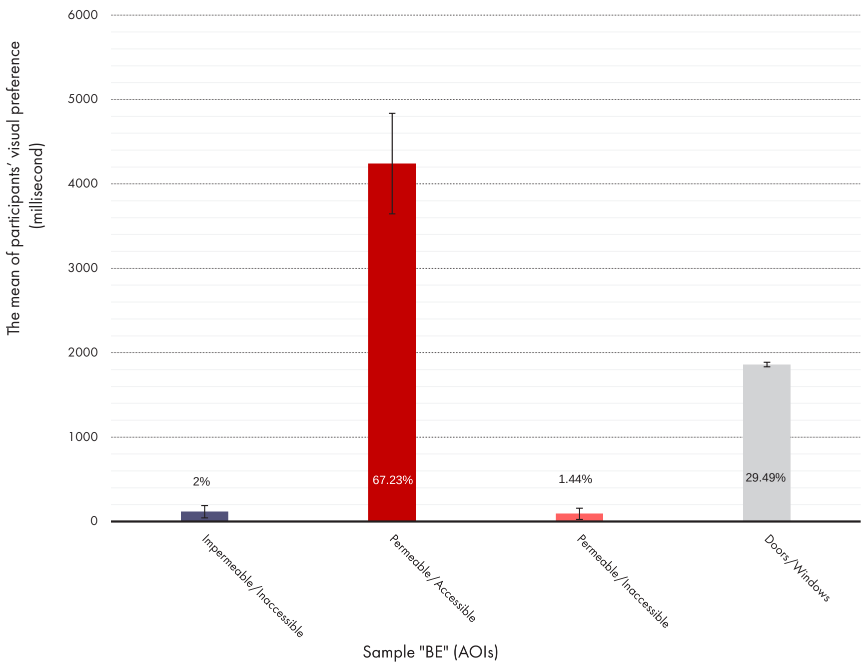
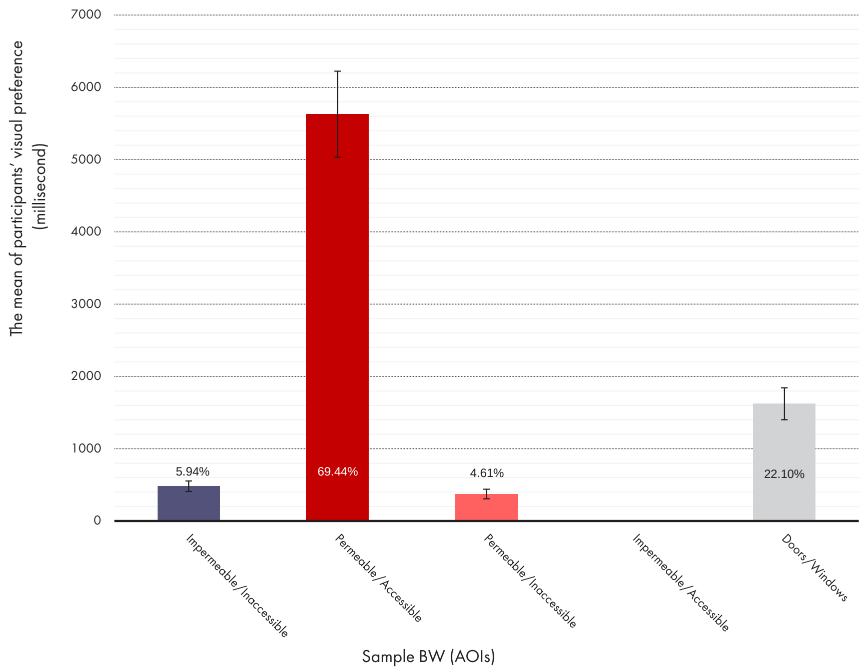
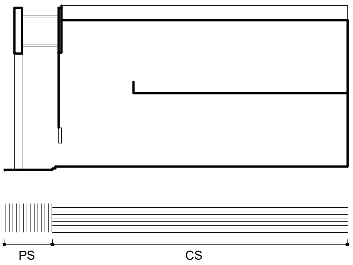


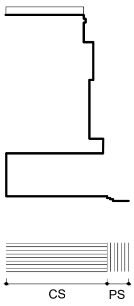
Figure 9.2-25 The percentage of participants' visual preference for street areas of interest (AOIs) in Khalid bin Al-Waleed, sample "B."
a) Sample "BE." (Source: Author's Edition).



b) Sample "BW." (Source: Author's Edition).

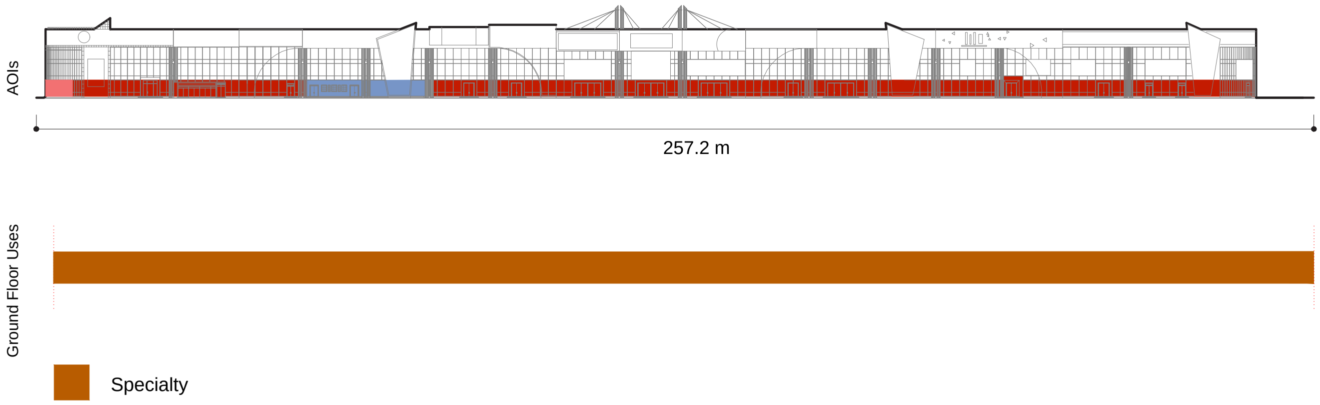


Sample "CE"



Sample "CW"

Figure 9.2-26 Cross-sections of sample "C" of Khalid bin Al-Waleed Street show the visual and physical perme-ability of the street interfaces. (Source: Author's Edition).



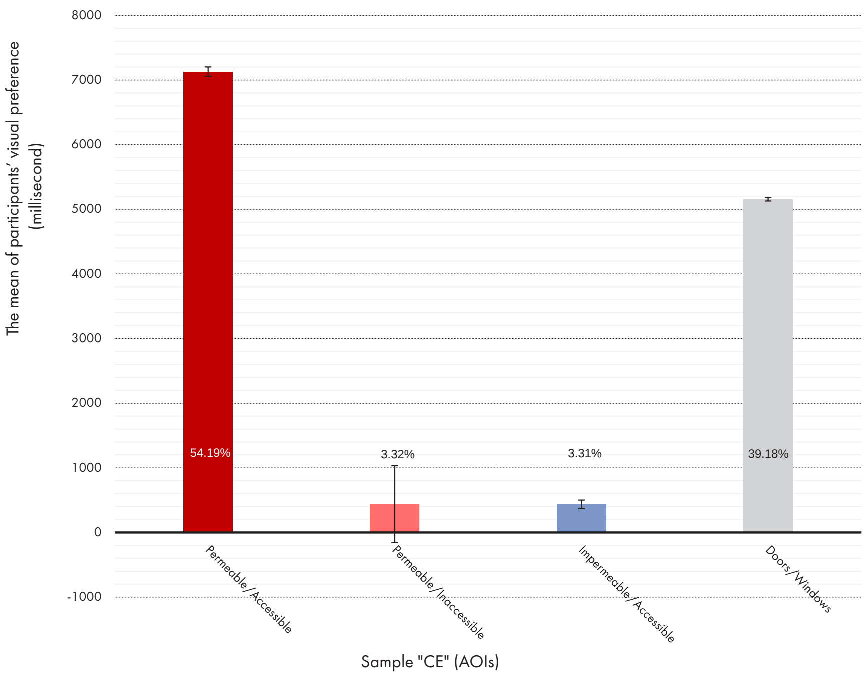
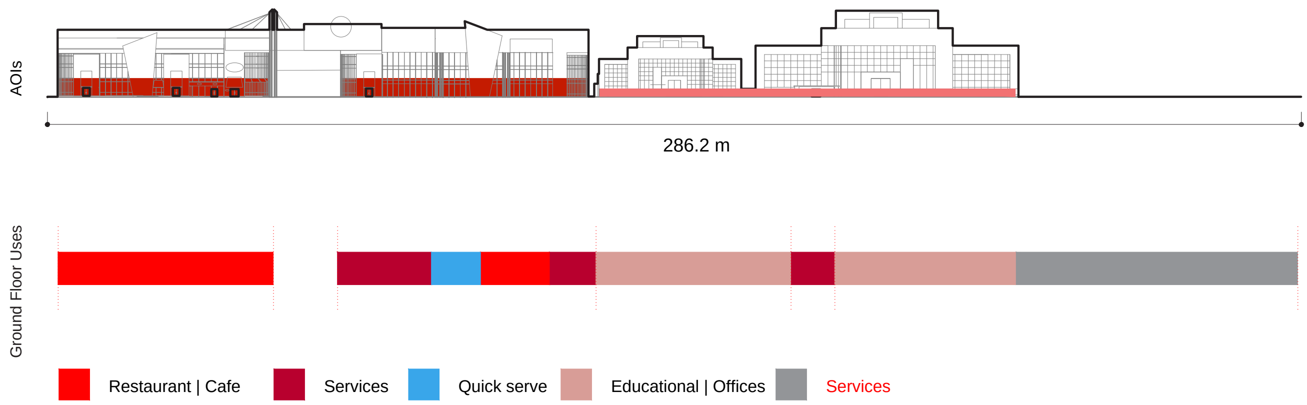
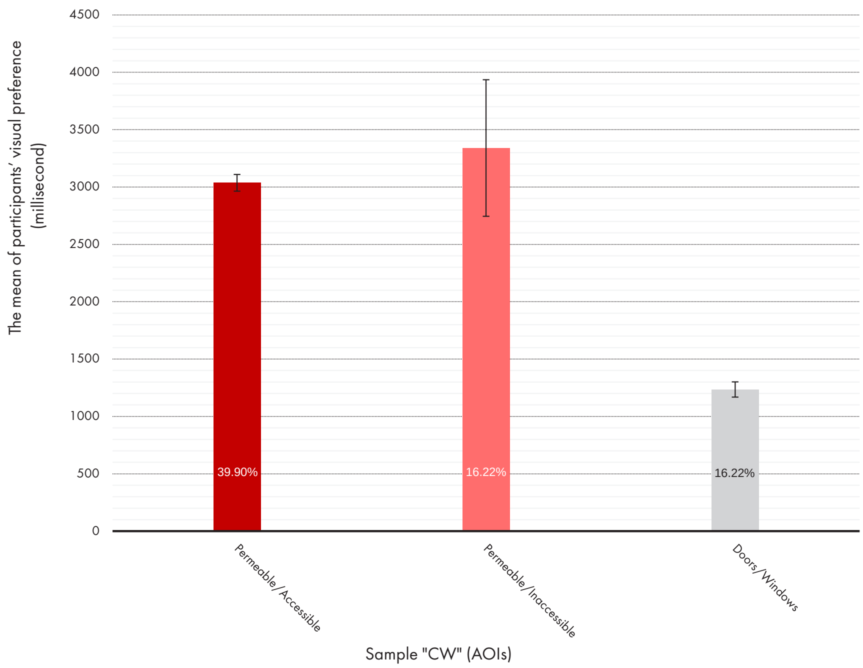


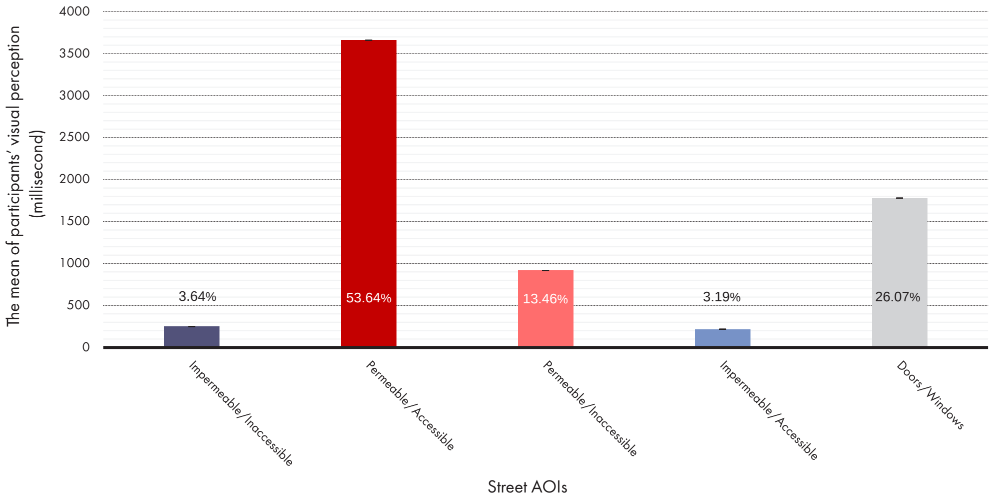
Figure 9.2-27 The percentage of participants' visual preference for street areas of interest (AOIs) in Khalid bin Al-Waleed, sample "C."
a) Sample "CE." (Source: Author's Edition).





b) Sample "CW." (Source: Author's Edition).

9.2-28



9.2-29

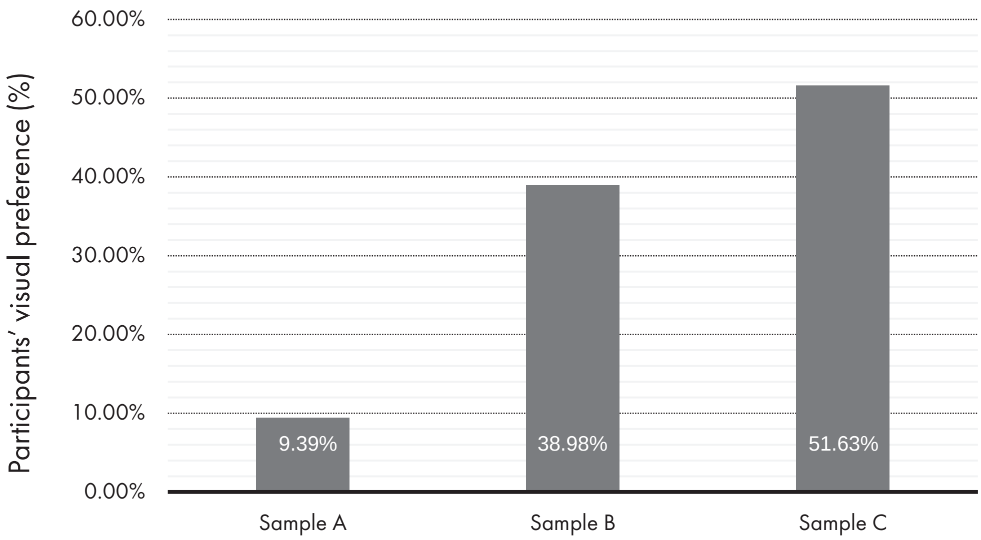


Figure 9.2-28 The percentage of participants' visual preference for Khalid bin Al-Waleed street areas of interest (AOIs).
Figure 9.2-29 The percentage of participants' visual preference with the three samples "A", "B", and "C" of Kha-lid bin Al-Waleed.

9.2.3.2. Abi Jafar Al Mansour street interface

Abi Jafar Al Mansour is a relatively new artery in a strategic location surrounded by significant commercial buildings and hotels. The street gained its current value because of the introduction of the new metro line and main station. The study has shown that the three most common uses that occupy the ground floor along the street are services such as banks and telecom stores (18.32%), residential buildings and hotels (15.27%), and restaurants and cafes (14.50%) (Figure 9.2-30).

The morphological study and experiment of pedestrians' visual preferences showed that the street manifested four types of street interfaces: permeable/accessible (PA), impermeable/accessible (IA), permeable/inaccessible (PI), and impermeable/inaccessible, with different percentages of occupation. Although the sample has a central metro station, there is a lack of pedestrian realm and connections between public and private spaces. The sample mainly offered interfaces without setbacks, with a lesser variety of ground-floor uses (Figure 9.2-31).

Sample AS was 98.1 m wide and had an interface height between 4.5 and 5 m. The majority of the interfaces are impermeable/accessible (IA), with a percentage of 49.69%, compared to permeable/accessible (PA) interfaces, at 24.35%. The results demonstrate that the ground floor on this side of Sample A offered a single use with limited access to the street. On the other hand, Sample AN was 92.54 m wide and between 4.5 and 5 m in interface height. The impermeable/inaccessible (II) interfaces were the most established interfaces, with a percentage of 36.29%. It can be seen that Sample AN also provided a narrower range of ground floor uses (Figure 9.2-32).

The study of visual perception in Sample AS found that participants spent more time looking at the impermeable/accessible (IA) interfaces, an average of 80.77% of the time, in comparison to the permeable/accessible (PA) (19.23%). Regarding Sample AN, the results show that participants were visually attracted to impermeable/inaccessible (II) interfaces on average 58% of the time, in comparison to permeable/inaccessible (PI) interfaces (41.63%) (Figure 9.2-33).

The study of Sample B showed that the sample accommodates four types of street interface configurations. The interfaces of Sample BS were 96.3 m wide and between 4 and 4.5 m in interface height (33.38%), with a majority of permeable/accessible (PA) interfaces. This is reflected in the rhythm of doors and windows, which added a vibrant visual texture to the street interfaces. On the other side of the street, the sample's interface was 95.75 m wide and between 4 and 5 m in height, most of which were permeable/accessible (PA) interfaces, with a percentage of 34.54% (Figure 9.2-34).

Regarding visual perception, the study of Sample BS found that participants spent more time engaging with the permeable/accessible (PA) interfaces, an average of 64.44% of the time, in comparison to permeable/inaccessible (16.95%), impermeable/inaccessible (9.77%), and doors/windows (8.83%). On the other hand, in Sample BN, the results show that participants were also visually attracted to permeable/accessible (PA) interfaces, on average 81.13% of the time, in comparison to permeable/inaccessible (11.71%), impermeable/inaccessible (7%), and doors/windows (0.66%) (Figure 9.2-35).

The last sample, Sample C, which is located in the northern section of the street, presented a different form among the selected samples. The study of Sample C showed that the sample accommodates the five types of street interface configurations. The sample CS interface was 96.3 m wide and between 4 and 4.5 m in interface height (33.38%). On the other side of the street, the sample CN was 95.75 m wide and between 4 and 5 m in height (Figure 9.2-36).

The eye-tracking results show that in Sample CS, participants spent more time looking at the permeable/accessible (PA) interfaces, an average of 50.13% of the time, in comparison to impermeable/accessible (36.63%), doors/windows (8.70%), and permeable/inaccessible (4.54%). On the other hand, in Sample CN, the results show that participants were also visually attracted to permeable/accessible (PA) interfaces, on average 71.87% of the time, in comparison to impermeable/inaccessible (20.86%), impermeable/accessible (3.55%), permeable/inaccessible (2.30%), and doors/windows (1.42%) (Figure 9.2-37).

The eye-tracking results show that permeable/accessible (PA) interfaces were the most visually attractive out of the three samples. On average, participants were visually attracted to these 51% of the time, in comparison to impermeable/accessible interfaces (21.22%), impermeable/inaccessible interfaces (12.20%), permeable/inaccessible interfaces (10.84%), and doors/windows (4.73%) (Figure 9.2-38). The study also highlights that those participants were more visually attracted to the interfaces of Sample B, occupying (59.12%) of their time compared to Sample C (21.87%) and Sample A (19.01%) (Figure 9.2-39).

Section 1

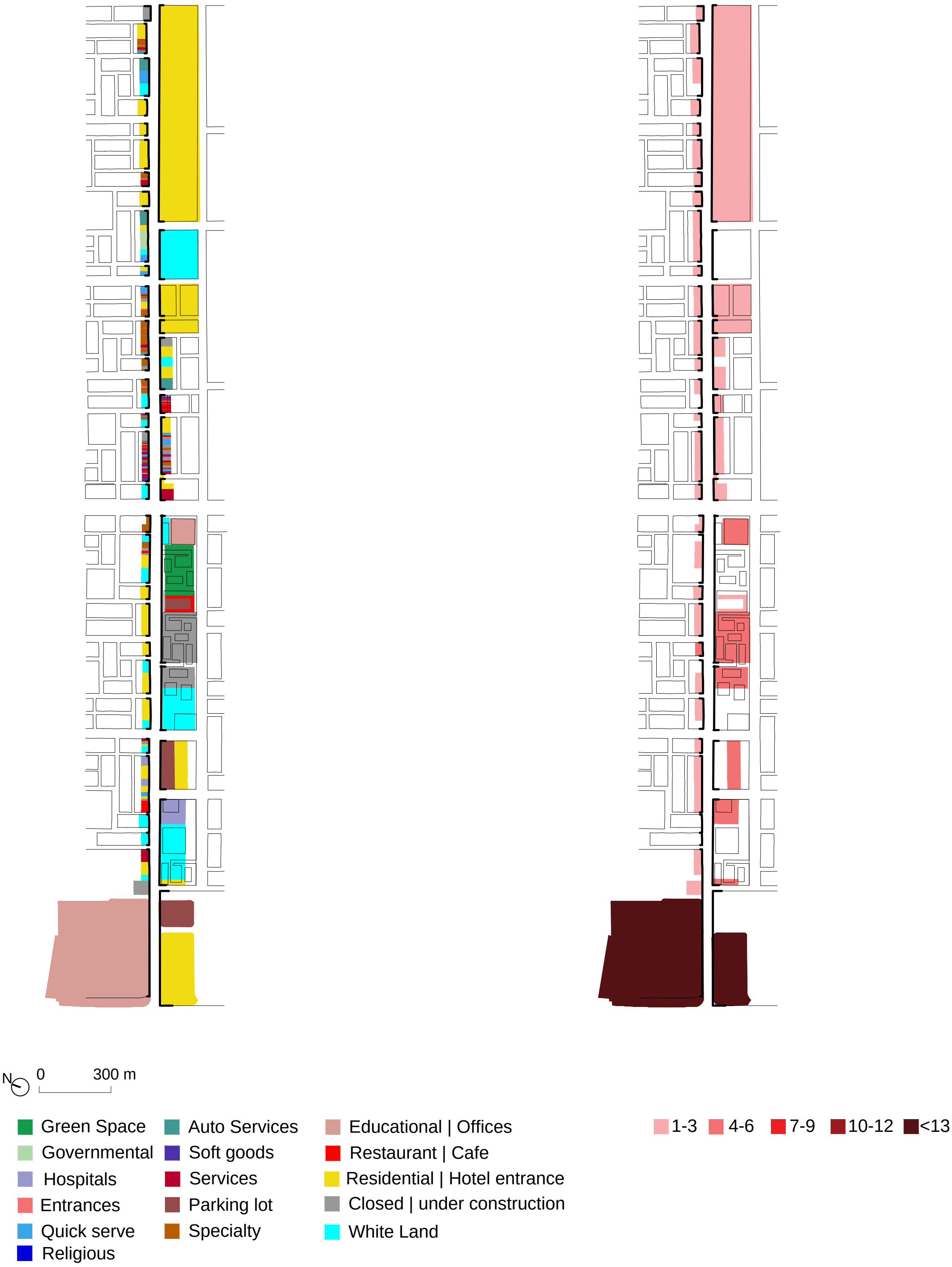
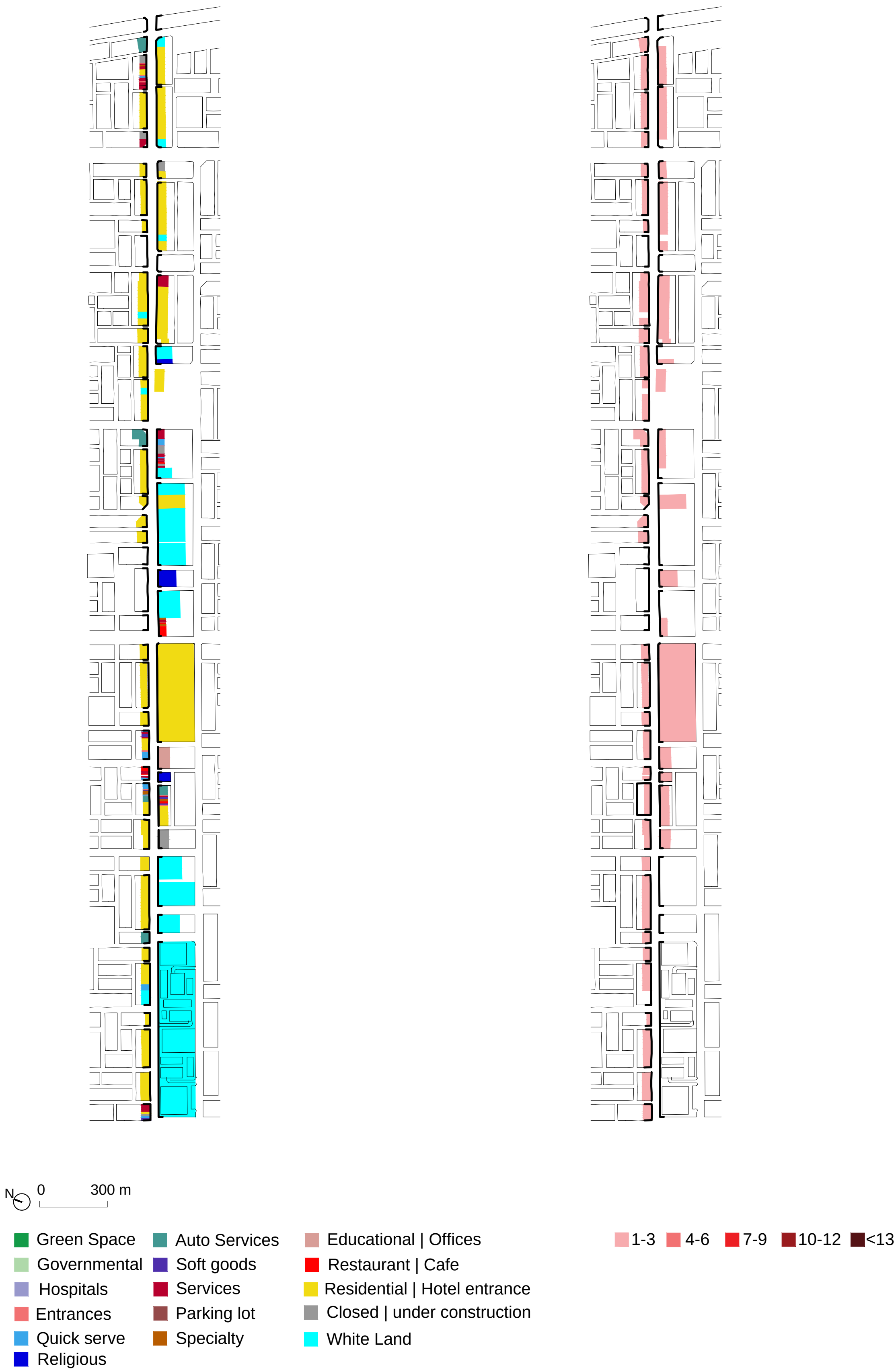


Figure 9.2-30 The ground floor uses and building heights along Abi Jafar Al Mansour Street.
a) The first section. (Source: Author's Edition).

Section 2



b) The second section. (Source: Author's Edition).

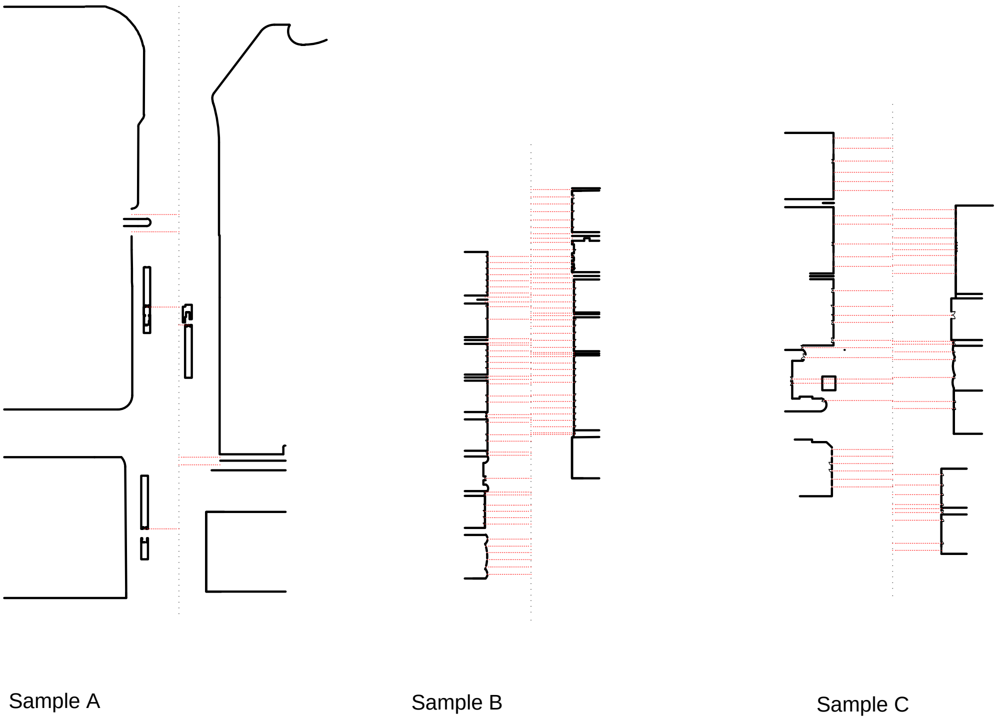
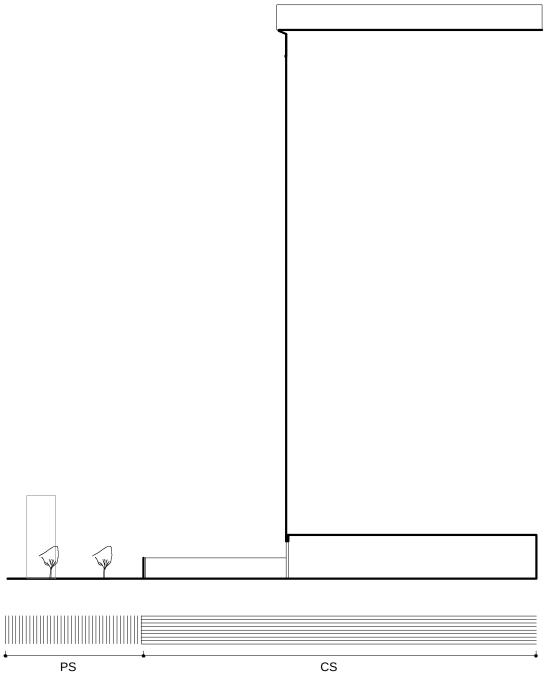
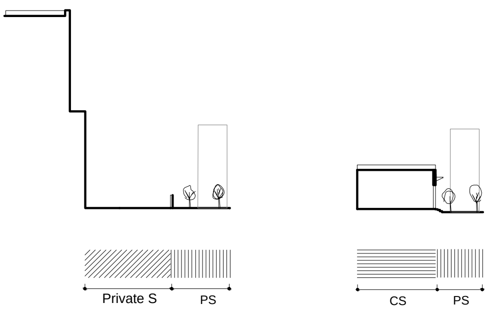


Figure 9.2-31 Plans of the three selected samples "A", "B" and "C" Abi Jafar Al Mansour Street show the rhythm and proximity of the street interfaces. (Source: Author's Edition).



Sample "AS"



Sample "AN"

Figure 9.2-32 Cross-sections of sample "A" of Abi Jafar Al Mansour Street show the visual and physical permeability of the street interfaces. (Source: Author's Edition).

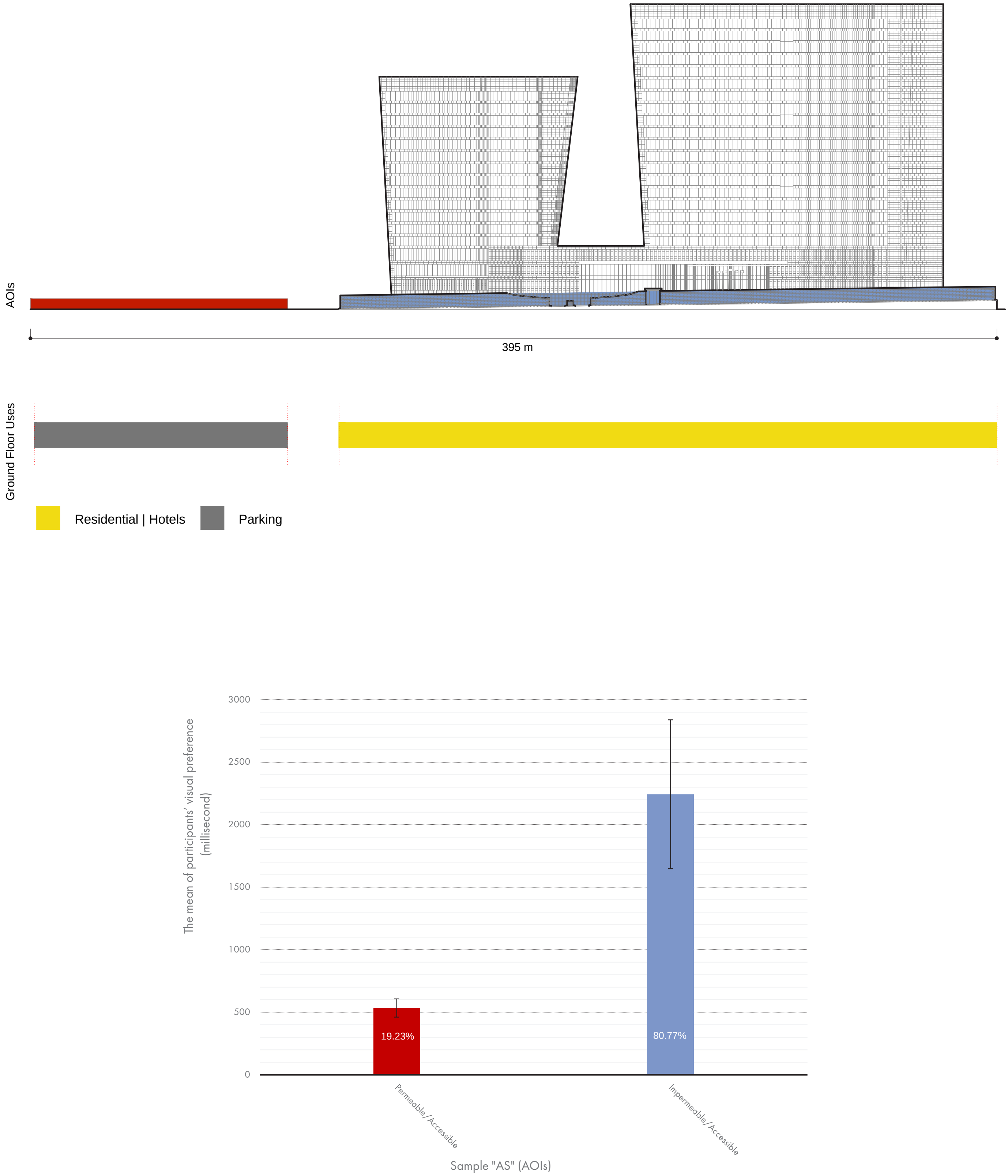
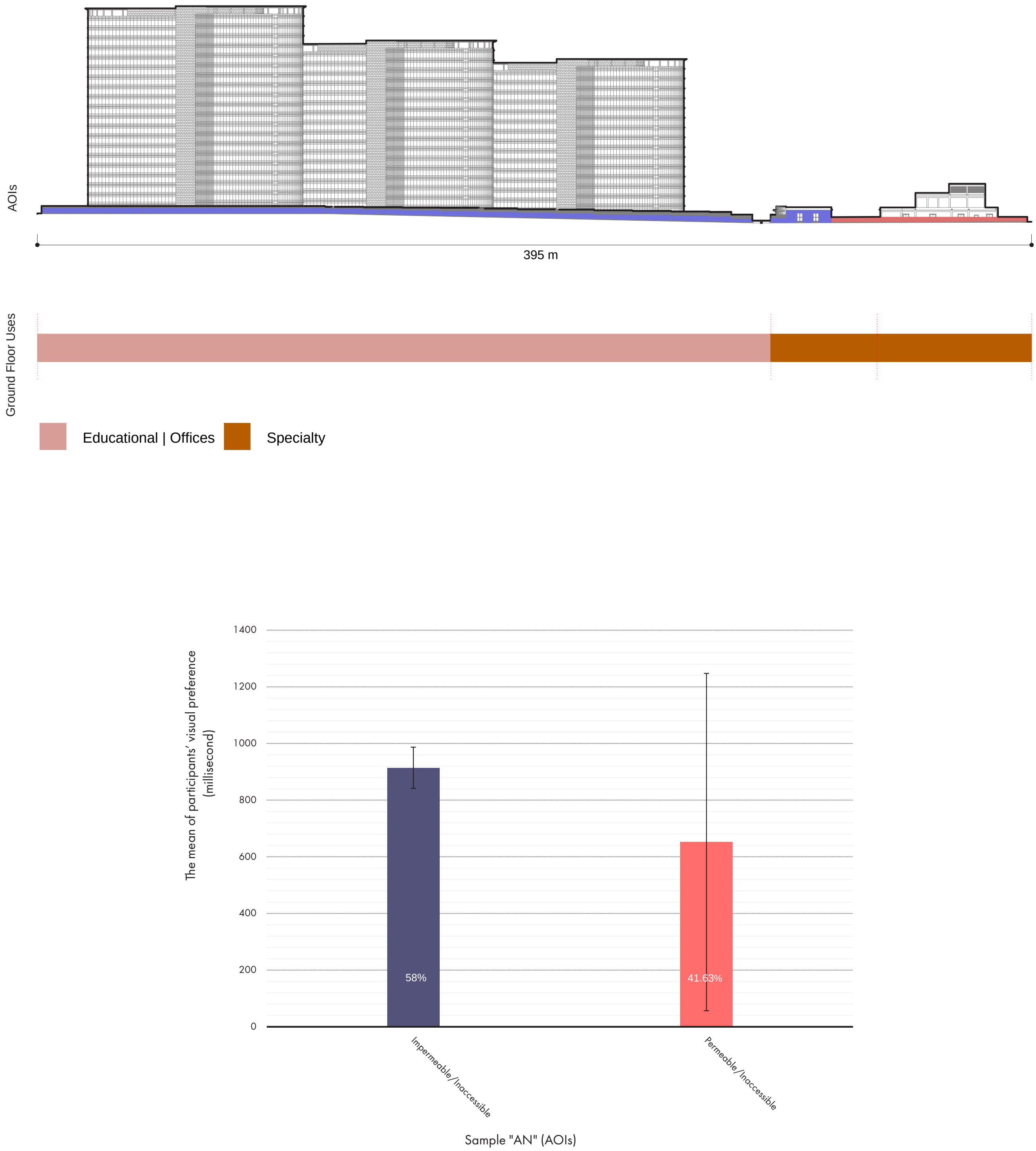


Figure 9.2-33 The percentage of participants' visual preference for street areas of interest (AOIs) in Abi Jafar Al Mansour, sample "A."
a) Sample "AS." (Source: Author's Edition).



b) Sample "AN." (Source: Author's Edition).

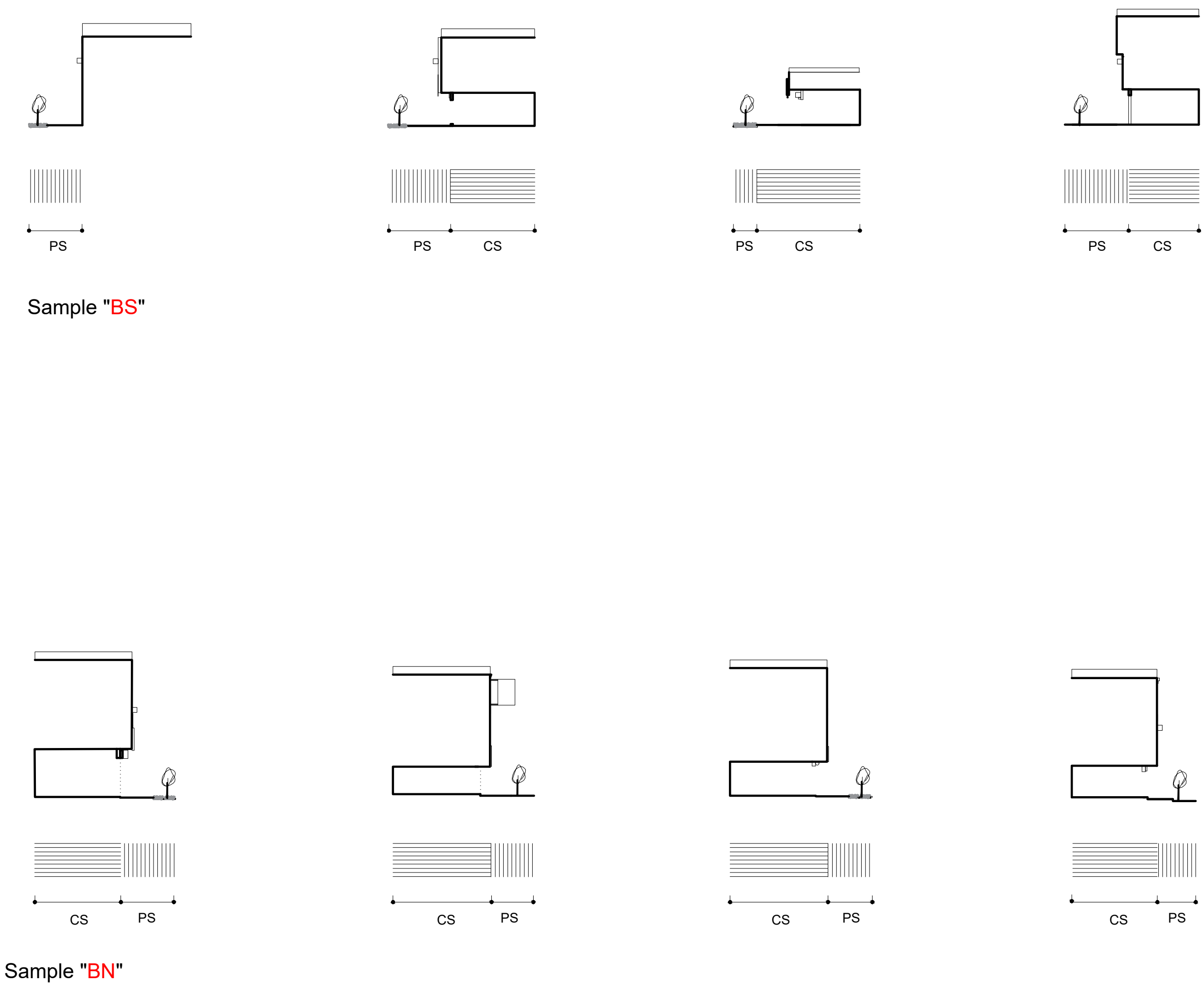
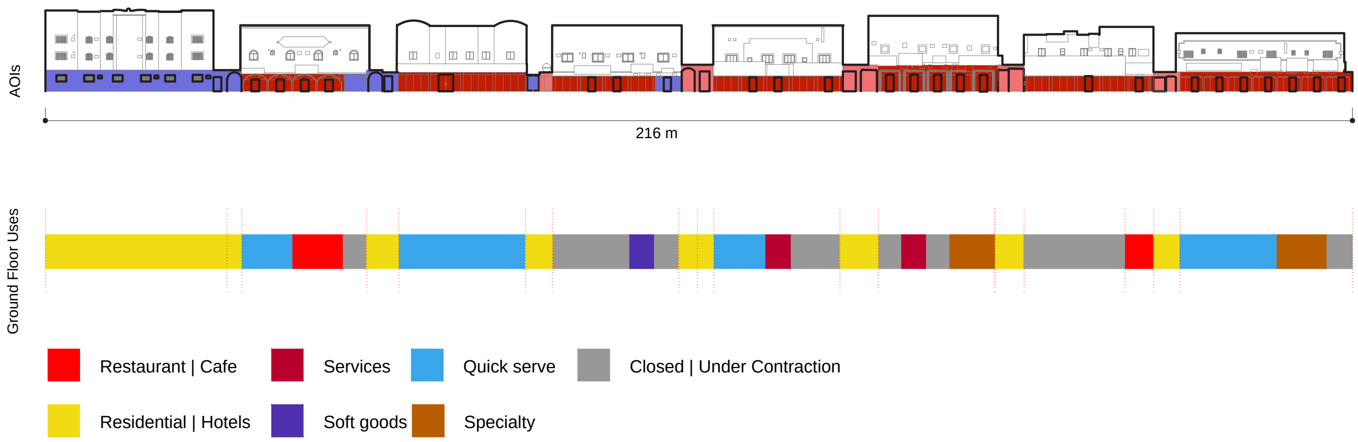


Figure 9.2-34 Cross-sections of sample "B" of Abi Jafar Al Mansour Street show the visual and physical permeability of the street interfaces. (Source: Author's Edition).



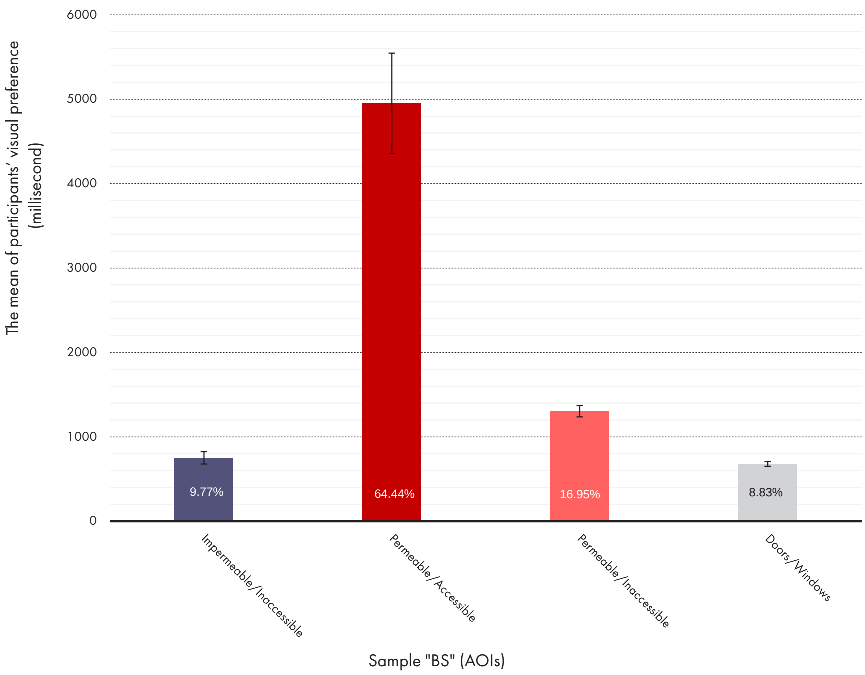
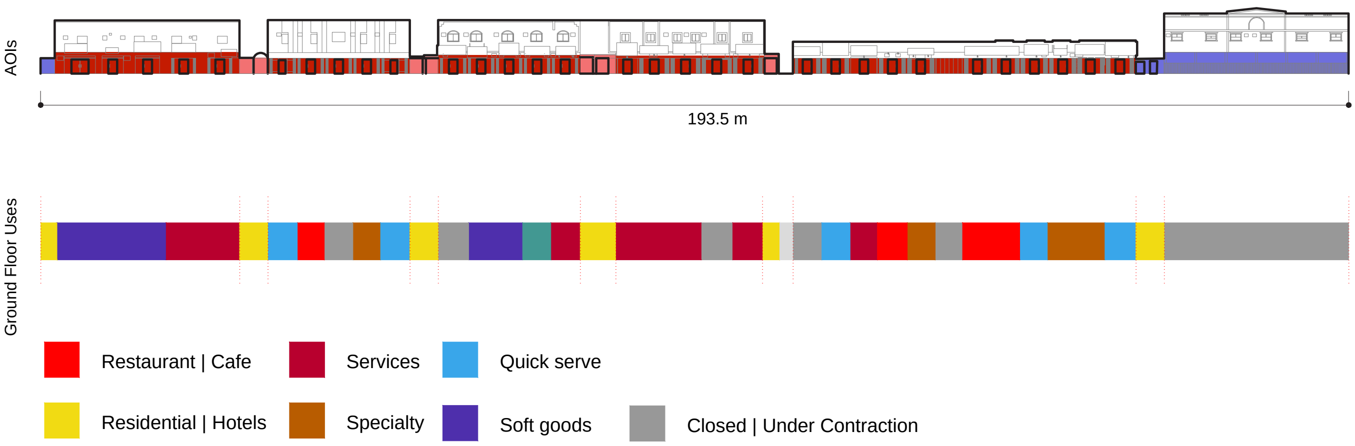
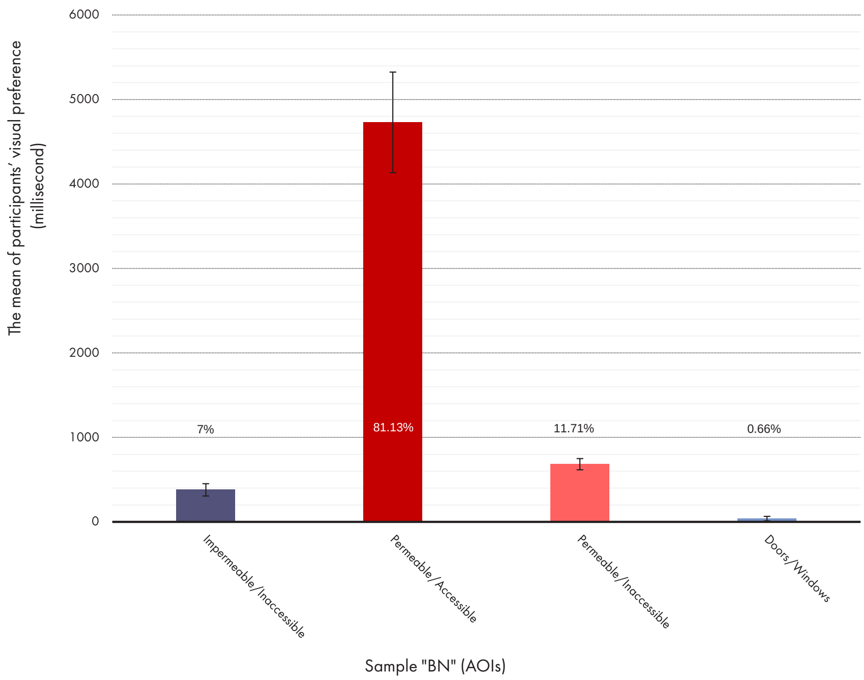


Figure 9.2-35 The percentage of participants' visual preference for street areas of interest (AOIs) in Abi Jafar Al Mansour, sample "B."
a) Sample "BS." (Source: Author's Edition).





b) Sample "BN." (Source: Author's Edition).

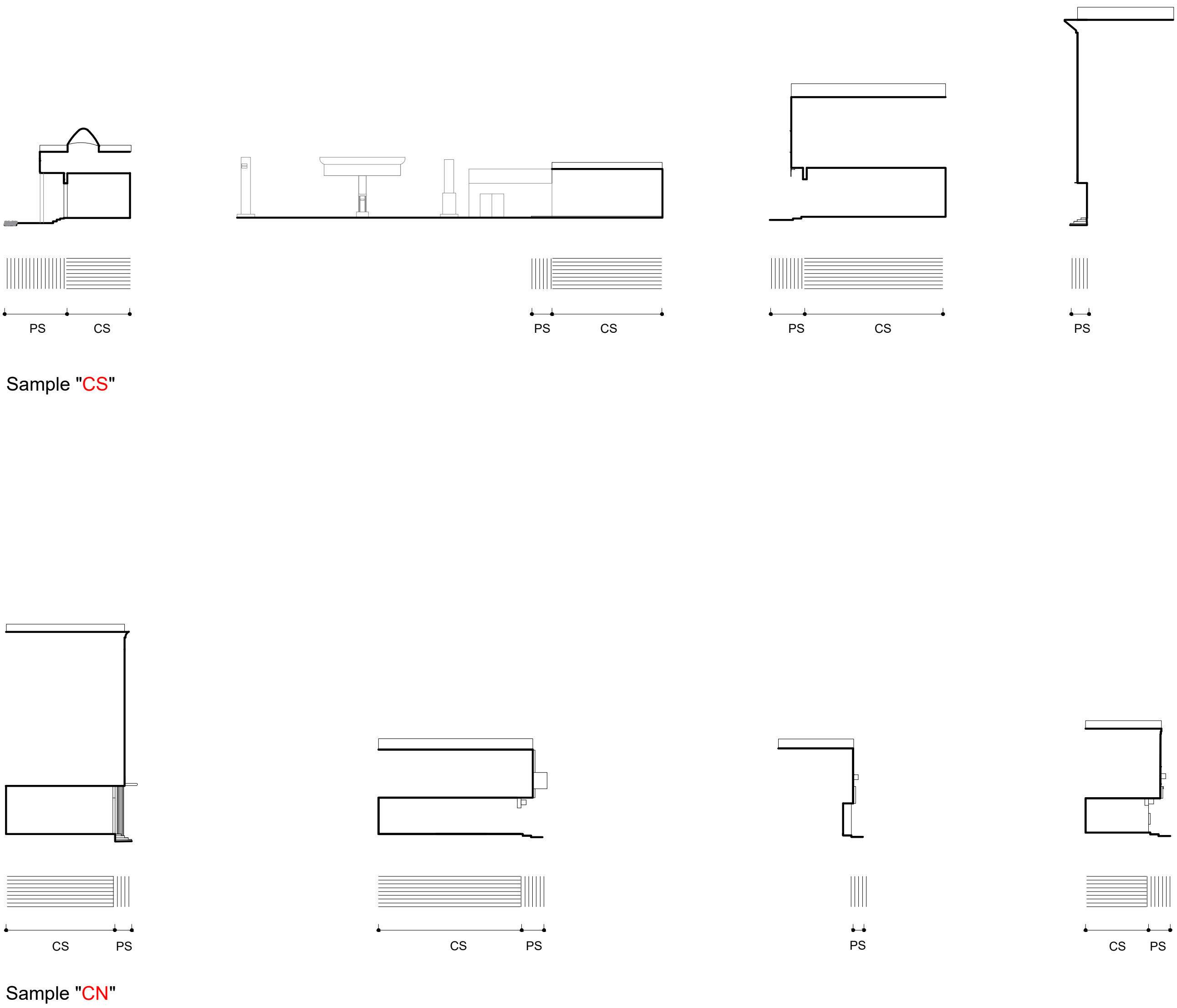
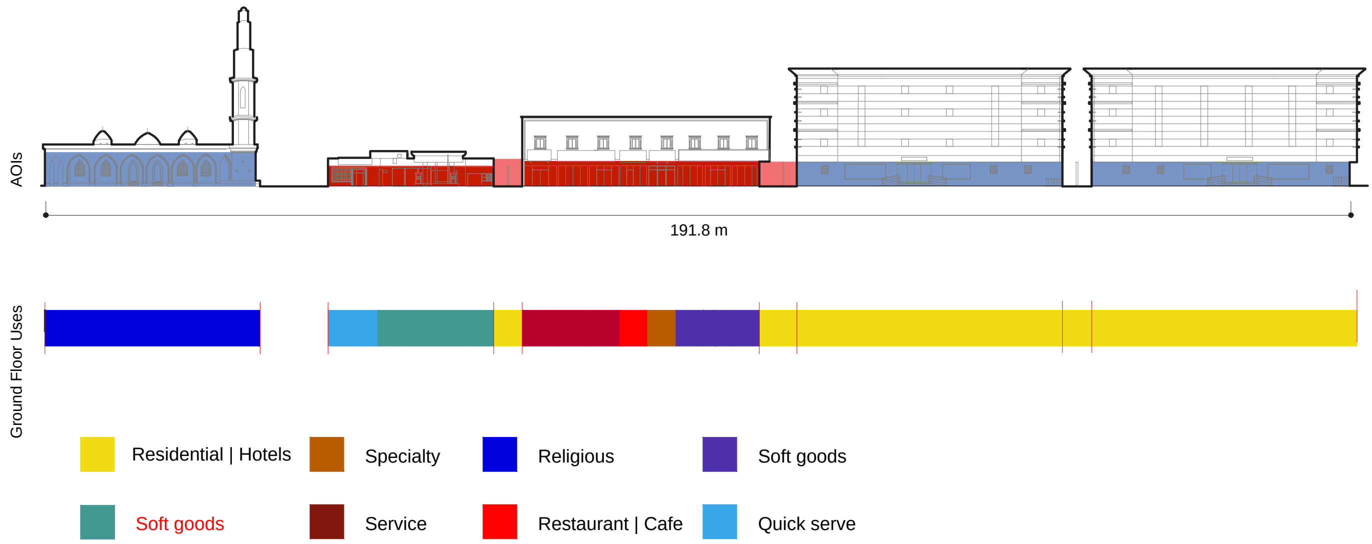


Figure 9.2-36 Cross-sections of sample "C" of Abi Jafar Al Mansour Street show the visual and physical perme-ability of the street interfaces. (Source: Author's Edition).



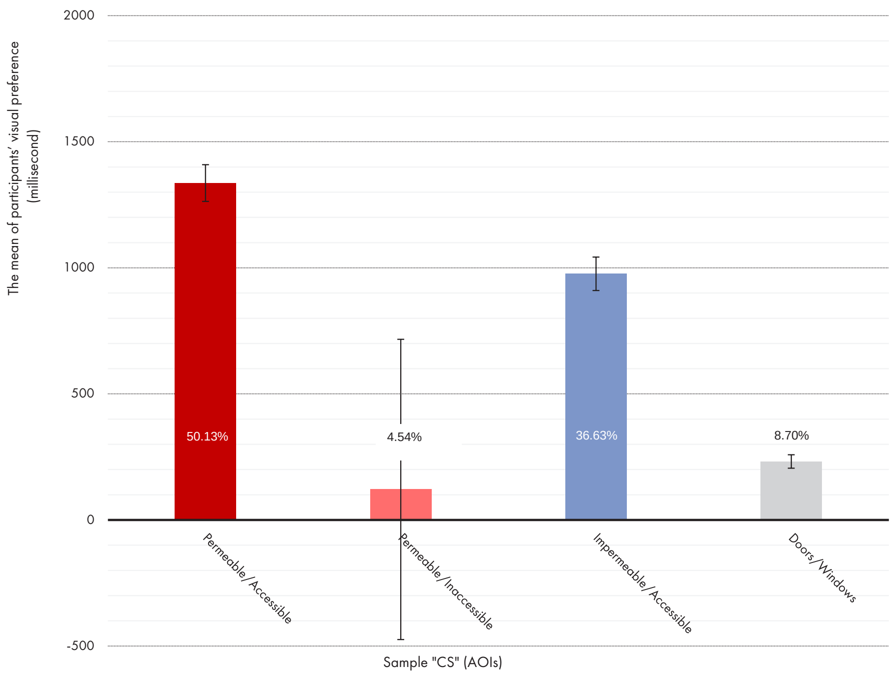
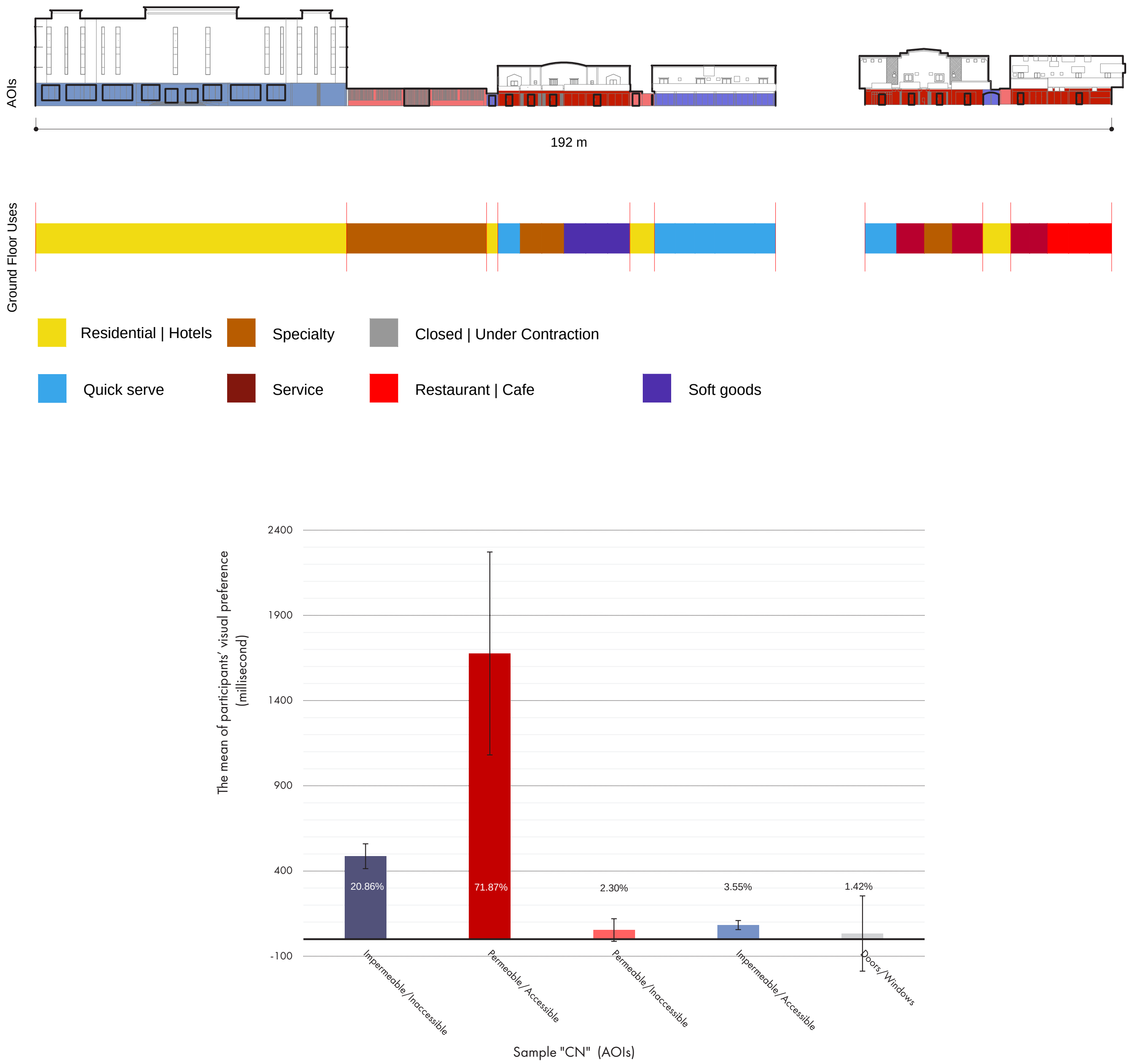
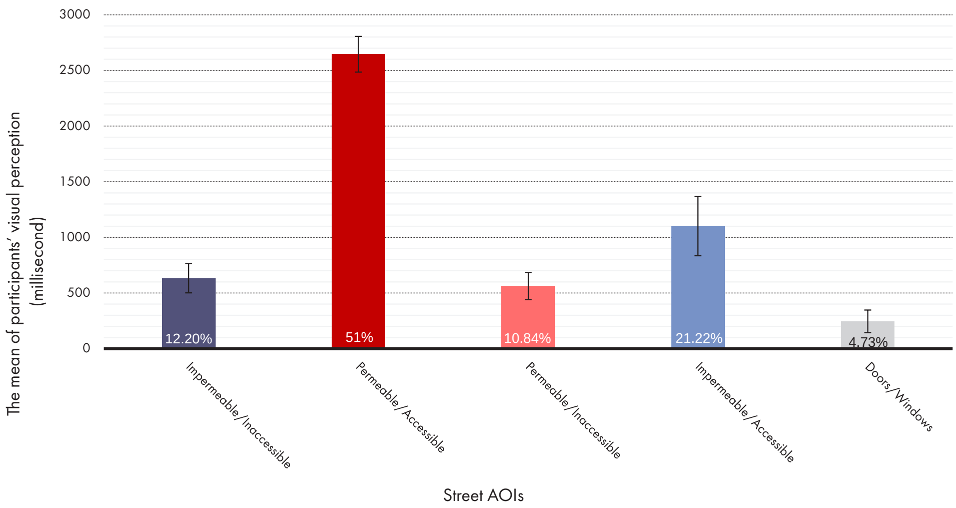


Figure 9.2-37 The percentage of participants' visual preference for street areas of interest (AOIs) in Abi Jafar Al Mansour, sample "C."
a) Sample "CS." (Source: Author's Edition).



b) Sample "CN." (Source: Author's Edition).



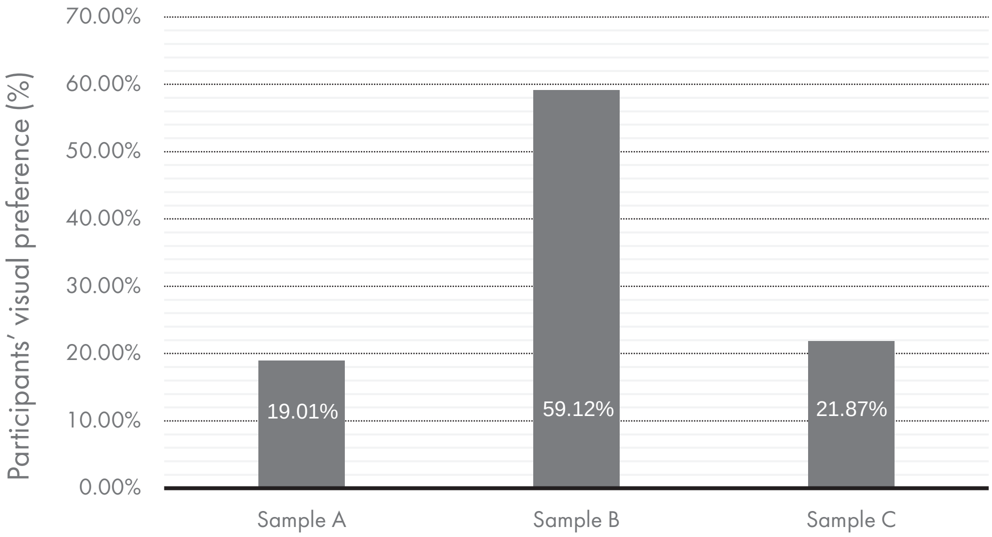


Figure 9.2-38 The percentage of participants' visual preference for Abi Jafar Al Mansour Street areas of interest (AOIs).
Figure 9.2-39 The percentage of participants' visual preference with the three samples "A", "B", and "C" of Abi Jafar Al Mansour.

9.2.4. Local case studies' public life

The study of public life was conducted during the summer and winter seasons in order to compare pedestrians' flow and activity patterns under different weather conditions. The observation study also took into account different times of day during the day and night, from August 8 to 14, 2021, and from December 5 to 11, 2021. The study was based on personal observation of pedestrians' flows and activities in relation to urban structure and street partition compositions.

The original purpose of reforming and redesigning the local case studies was to enhance walkability and improve the quality of the streets in parallel with the introduction of the public transportation system. However, despite the transformation of the streets' profile and the widening of some sections of both streets' sidewalks with new paving materials, they have not acquired the intended sense of public life and social activities.

The observation and study of pedestrians' flow and activities showed that both streets failed to invite pedestrians and cyclists or to accommodate pedestrians' activities. Regardless of the temperature or different seasons, the study found that both streets did not provide places that attract optional or social activities, where the only observed activities were necessary activities, for the most part. This fact might come as no surprise; it is, indeed, a consequence of the absence of the streets' physical considerations on three scales, which affected visual richness, pedestrian activities, and the streets' flows.

Khalid bin Al-Waleed and Abi Jafar Al Mansour streets failed to integrate the pedestrian network with the surrounding urban area, as the pedestrian flows were significantly absent. The lack of permeability due to the long blocks, the low frequency of street intersections, the low density, and the dependence on automobiles affected pedestrians' access to the streets. As observed, pedestrian flow on both streets was notably lacking during the day and night, except at praying times, as most workers were found walking from their shops toward the mosques (Figure 9.2-40).

Furthermore, this study revealed undiversified street partition compositions, as automobile space dominates the majority of both streets' cross-sections. This, in fact, resulted in narrow pedestrian sidewalks that lack the minimum comfort conditions and physical features that might provide a pleasant experience and create opportunities for pedestrians' various activities. The public life observation demonstrated that pedestrians walk toward oncoming traffic due to the narrowness of sidewalks (or their absence) in some sections of the streets. For example, during the visual experiments, participants were recorded walking in the automobile space due to the lack of proper sidewalks (Figure 9.2-41)

Additionally, both streets presented unbalanced cross-sections with empty or undeveloped plots, affecting the streets' enclosure. The streets failed to provide vertical elements such as trees and other functional elements that, besides providing a sense of enclosure, provide shaded and more appealing streets. For instance, in Samples A and B of Abi Jafar Al Mansour Street, the few existing trees are relatively low in height, which weakens their effectiveness in providing protection from rain, wind, and sun. As observed, some pedestrians were walking under the shaded metro viaduct because of the lack of trees along the sidewalks (Figure 9.2-42). The fact that users choose a nonprogrammed shaded path clearly underlines the need for shade in the street in this specific context, which should have been taken into consideration.

In this regard, the most observed pedestrian activities on both streets were vendors standing in front of their stores waiting for customers. This, in fact, can be related to the ground-floor uses, which affected not only the form and use of the street but also the types of users on both streets. Instead of creating mixed and diverse ground floor uses, including restaurants, cafés, leisure, and other retail amenities, the dominant uses were mostly services and retailers of construction materials. Thus, the study found that similar use patterns were reflected in the notable absence of diverse users along both arteries. For example, Sample B on Khalid bin Al-Waleed Street is mainly composed of building materials stores, which attract groups of migrant day laborers, who congregate in front of stores to solicit temporary daily work.

Figure 9.2-40 Series of photographs capturing street public life of the local case studies.
a) Khalid bin Al-Waleed Street, 2022. (Source: Author's Edition).

b) Abi Jafar Al Mansour Street, 2021. (Source: Author's Edition).

Figure 9.2-41 Screenshots from eye-tracker analysis software showing participants walking in the automobile space due to the lack of sidewalks. (Source: Author's Edition).

Figure 9.2-42 Pedestrians seeking shade under the metro viaduct due to the lack of shaded trees along side-walks, highlighting the need for alternative sources: Abi Jafar Al Mansour Street, 2021. (Source: Author's Edition).

"To distinguish the other cities' qualities, I must speak of a first city that remains implicit."

Calvino, 1997

10. Between International influence and local adaptation

Cities have always been in continuous comparison with other cities in all aspects, including planning and quality of life. Thinking about a city often leads to implicit comparisons to other cities. This comparative process is a source of knowledge from which we can learn and base our architectural and urban practices. In this regard, we find, in between international influence and local adaptation, a field that is driven toward comparative thinking. This comparative thinking has a rather instrumental role in learning and inspiration.

Although the international case studies have different geographical and cultural contexts from the local case studies, this comparative study explores morphological and urban life similarities and differences as a means of learning that can inform the composition of the urban code. Robinson (2006, p. 62) poses a thought-provoking question: "Must we wait for social or spatial phenomena to become the same before we can learn from experiences in different kinds of places?" This inquiry underscores the need to critically examine the conventional notion that similarities across places are a prerequisite for knowledge transfer. By raising this question, Robinson's query invites us to consider the potential of cross-contextual learning and the merits of embracing diverse perspectives, even when faced with disparate circumstances. This question is particularly relevant to the comparative study at hand, which aims to transcend geographical and cultural boundaries to extract valuable knowledge that can inform the formulation of an inclusive urban code.

International influence can be a source of inspiration in urban studies to be adapted to the local context. For example, Haussmann's Parisian urban renewal plan inspired the great avenues that cross major cities, from Moscow to Chicago and from Vienna to Buenos Aires. Lisbon is no exception; during the second half of the nineteenth century, Haussmann's avenues were a source of inspiration for developing Lisbon's new avenues (Rodrigues, 2017).

Moreover, Cerdà's plan for Barcelona was inspired by the urban history of Spanish colonial cities in America. The international influence of several urban models, such as New York, London, Buenos Aires, and Portobelo, among others, contributes to the idea of the urban grid as a solution for Barcelona's urban extensions. One of the examples studied that inspired Cerdà and the plan for Barcelona was Philadelphia, which was planned in 1683 by William Penn and Thomas Holme. After extensive consideration of the type of block used in these cities (rectangular, quadrangular, etc.), Cerdà concluded that the square "Manzana" best fit his idea of an egalitarian city (Creíxell and Parés, 1977).

Furthermore, as found in studying Riyadh, the local case study, the city was planned first based on Doxiadis's planning principles as a hallmark of his works elsewhere, such as Baghdad. Doxiadis's plan for Riyadh was inspired by his previous experiences, such as the planning for the capital of Pakistan, Islamabad. Although there is a staggering difference between the two cities in terms of scale and context, Doxiadis employed similar design elements in Riyadh, such as the same two-by-two-square-kilometer urban unit (Middleton, 2009).

Ideas travel through distinct geographical contexts and also emerge at different moments in time. Therefore, as hypothesized in Chapter 01, the complexity of arterial streets, as cities' fundamental urban element, requires learning from different experiences to formulate new lines of inquiry that lead to knowledge creation. Thus, there is an implicit suggestion for recognizing and comparing international experiences in parallel with local case studies. This comparative study allows learning from different experiences, successes, and mistakes, thus morphologically influencing our understanding.

Our interest in the physical form of arterial streets offers new opportunities to learn from differences as a tool representing international influence. However, seeking local adaptation requires incorporating international influence and local needs. From this perspective, it is helpful to interpret and adapt the international influence to favor the local context of Riyadh's vision and the quality of life program goals, together with the results of this comparative study.

Therefore, Chapter 10 unfolds the concept of international influence and local adaptation through two key subchapters. Subchapter 10.1 introduces a comparative study that considers the international and local case studies, thus adding new meanings and conceiving different realities with regard to the process of decoding arterial street livability. Subchapter 10.2 frames lessons learned from international influence and the local vision and goals. It aims at local adaptation as a step toward establishing an urban code for livability based on the three selected scales: micro, meso, and macro.

10.1. The comparative study

For the development of this research, a comparative study based on the results of the international and local case studies was carried out. The comparative reading of the three scales allows for an understanding of the differences in the morphological features that enhanced public life in the international case studies compared to the local ones. Thus, the study answers the question related to the impact of street morphology on public life through the three selected scales to be compared internationally and locally, starting from the microscale and moving up to the macroscale, as follows:

2.1 The street interface: What are the most important variables of street interface configurations that influence pedestrians' visual perception?

2.2 The street partition: How do street partition compositions influence pedestrians' activities?

2.3 The urban structure: What physical characteristics of the street's permeability with regard to the urban context contribute to facilitating pedestrians' flow at the arterial street level?

10.1.1 The street interface

The current study shows that the quantitative measurement of visual perception using mobile eye-tracking glasses contributes to studying the form of the street interface. An interdisciplinary methodology has been applied and tested in the main international and local case studies in this scale of decoding arterial streets. The current study addresses the differences between the main case studies regarding the street interface as a physical entity related to visual perception, involving pedestrians as the center of creating visually engaging streets that contribute to composing a spatial framework for livability. This theme connects street livability on a micro-morphological scale to how people visually perceive a street by addressing the main question: What are the most important variables of street interface configurations that influence pedestrians' visual perception?

As hypothesized, the findings demonstrate that pedestrians interacted visually with the permeable/accessible (PA) interfaces more than other configurations of street interfaces. This can be observed in all the main case studies, showing that pedestrians spent more time visually interacting with the permeable and accessible interfaces than in other areas of interest (AOIs). These interfaces present a dialogue that transfers activities from private to public, from buildings to streets. In this regard, the participants' high visual preference for this type of interface is due to the street interface's configurations, ground-floor uses, and the sidewalks' widths and partitions.

Regarding the street interface configurations, this study established that different interface typologies produce various patterns for public life and induced the participants to spend different amounts of time looking at them. These variables attracted participants' visual attention, as pedestrians are visually attracted to interfaces that offer a connection between public and private spaces. Permeability and accessibility comprise the relationship between a street and buildings, giving a new extension to the sidewalk space for different public uses, such as outdoor seating. Thus, the street interface acquires value when it becomes a catalyst for public life, allowing interaction between buildings and the street. It can be said that these variables are socio-spatial entities, useful for multiple activities through which people live their everyday lives.

This is an important finding in understanding the way in which the interface between the public and private plays a critical role in public life by allowing interaction and communication with the surroundings. As such, permeable and accessible interfaces are not only the most visually stimulating configuration but also produce a variety of shared spaces accommodating various activities. Thus, the main international case studies showed different types of permeable and accessible interfaces that attracted the participants' visual attention and created different patterns of public life.

These types, found in the international case studies, arise from the complex relationship between public and private realms, resulting in transitional spaces that possess various spatial depths. As observed, the more variation there is in these in-between spaces, the more vibrant social and public activities they tend to foster. Consequently, it can be argued that some types of permeable and accessible configurations, like the colonnades or arches found in locations such as Avinguda Diagonal or Ringstrasse, where public and private domains overlap, offer shade and shelter to pedestrians and provide the potential for the development of urbanity. Moreover, interfaces with alcoves, such as those in Avenida da República or Avenue des Champs-Elysées, which construct a distance between the sidewalk and the building line, provide a small spatial and visual extension of the public space and a sitting place for pedestrians, enriching social life in different ways.

The importance of street interfaces' configurations and forms has been discussed in the fields of psychology and neuroscience. Based on psychological principles, William James stated that "stimulation is the indispensable requisite for pleasure in an experience" (James, 1890, p. 626). This perspective outlines the fundamental role of stimulation in enhancing an individual's experience. In this regard, street interface configurations can be prime stimulators of human behavior that may either enrich pedestrians' experiences or create an experience of boredom. Colin Ellard (2015) conducted an experimental study in environmental psychology and neuroscience to assess pedestrians' emotional states in relation to different street façades. The study showed that the designs of façades influence the psychological states of pedestrians, whereby blank façades create a sense of tedium compared to active façades. It has thus been demonstrated that the general design of the street interface influences pedestrians' psychological and emotional states.

The decoded international case studies presented a variety of permeable and accessible interfaces with transitional spaces, where two realms overlap, conferring value to the street space. The decoded permeable and accessible interfaces are characterized by some ambiguity, making them favorable to the appropriation and use by pedestrians, where they often become places for optional and social activities. These livable arterial streets show interface configurations that can provide not only visual interactions but also create potential spaces for social interaction, as stated by various authors (Alexander, Ishikawa and Silverstein, 1977; Brown, Burton and Sweaney, 1998; Gehl, Kaefer and Reigstad, 2005; Hess, 2008; Glaser et al., 2012).

The interpretations in Subchapter 8.3 on the main international case studies, Avenida da República in Lisbon and Avinguda Diagonal in Barcelona, revealed that participants' visual preferences were also related to ground-floor uses. The study shows that permeable and accessible interfaces, as in Samples AE, AW, and BW in Avenida da República and AS, AN, BS, and BN in Avinguda Diagonal, constitute the commercial and social core. Restaurants and social activities were observed, linking permeability and accessibility and immediately attracting participants' eyes. Permeable and accessible interfaces promoted the connection between the ground floor and the street, whereby stores opened their doors to the public and demarcated the territory facing the street through elements such as advertisements, tables, and seats, which offered different sensory information and social stimuli, including the visual.

Further, the comparisons reveal that the width and partitions of the sidewalk correlated with the participants' visual preferences. As demonstrated, the amount of time that participants spent visually with Samples A and B in Avenida da República and Avinguda Diagonal was greater than that of other samples. This suggests that the sidewalk width in these samples, between 7 and 19 m, offered an extension of the ground floor, which created contact points between the two realms. The sidewalk width provided a space that buffered pedestrians from opening doors and structural elements and created more space for sidewalk cafés, store entrances, retail displays, and waiting. This feature was absent in Sample CE, Avenida da República, and CS, Avinguda Diagonal, where the sidewalks were narrow, between 3 and 5 m. They were also adjacent to the roadway area, creating a sense of a lack of safety. Additionally, the sidewalks contained several physical barriers that obstructed participants' visual perception and movement, which manifested in the eye-tracking results as less visual attractiveness than in Samples A and B in Avenida da República and Avinguda Diagonal.

In contrast, in the local case studies, Khalid Ibn Al Walid and Abi Jafar Al Mansour Streets, although the findings demonstrate that pedestrians interacted visually with the permeable/accessible (PA) interfaces more than other configurations of street interfaces, both streets interface configurations lacked interactional relationships between public and private spaces, with minimal pedestrian activities and social interactions. In fact, the street interface is not only a means to access public and private spaces but also a place of social and collective life, which was absent in both local arteries.

The street interface, as found in the international cases, is considered the space that serves and supports interactions through which the social dynamics of the street occur. In this context, the inefficiency of the street interface as a collective space on Khalid Ibn Al Walid and Abi Jafar Al Mansour can be attributed to the lack of the same factors that enriched the main international case studies, including the street interface's configurations, ground-floor uses, and the sidewalks' widths and partitions.

In light of this close examination of the configurations of street interfaces in the local case studies, it is clear that the permeable/accessible (PA) interfaces of local streets lack an important component that was observed in the international case studies. Specifically, the element missing is the dialogue between public and private spaces. In the international examples, these interfaces were configured to provide additional space, either on the sidewalk or within the building, to foster social interactions and public activities. However, in the local context, such enhancements were found to be absent. As a result, the interfaces in the local streets do not facilitate meaningful engagement and exchange between people in public spaces and the private spaces they connect to. This observation implies that permeable and accessible interfaces should not be solely defined by their glass finishing. Instead, their physical configuration and in-between space play a vital role in establishing a strong connection between the public and private realms, thereby promoting urbanity and enriching social life with varied meanings.

When comparing the configurations of street interfaces in international and local case studies (Figure 10.1-1), it is apparent that the local cases contain various types of permeable and accessible interfaces that do not facilitate a relationship between the street and the buildings. These interfaces are predominantly composed of flush-glazed aluminum systems or curtain walling, which offer little connection between the ground floor and the sidewalk and do not provide additional space for collective use. Therefore, most enclosed buildings can be described as lacking in architectural complexity or elements such as colonnades, alcoves, exhibits, or awnings, among others, rendering them uninspiring or, in some cases, outright monotonous. These elements have an impact on the domestication of public spaces, as stated by Bobić (2004), and have a great impact on providing additional attention and spontaneity, as observed in the international case studies. This, in turn, affects the rate at which opportunities for the vibrancy of public life and sensory complexity arise, as also stated by other researchers (Gehl, Kaefer and Reigstad, 2005; Simpson, Thwaites and Freeth, 2019).

The absence of rich detail, architectural complexity, and features of street interfaces along both local case studies reduced the value of the street interface. Thus, the street interface gains less value when it becomes less connected and integrated with public space, decreasing the interaction between the buildings and the street.

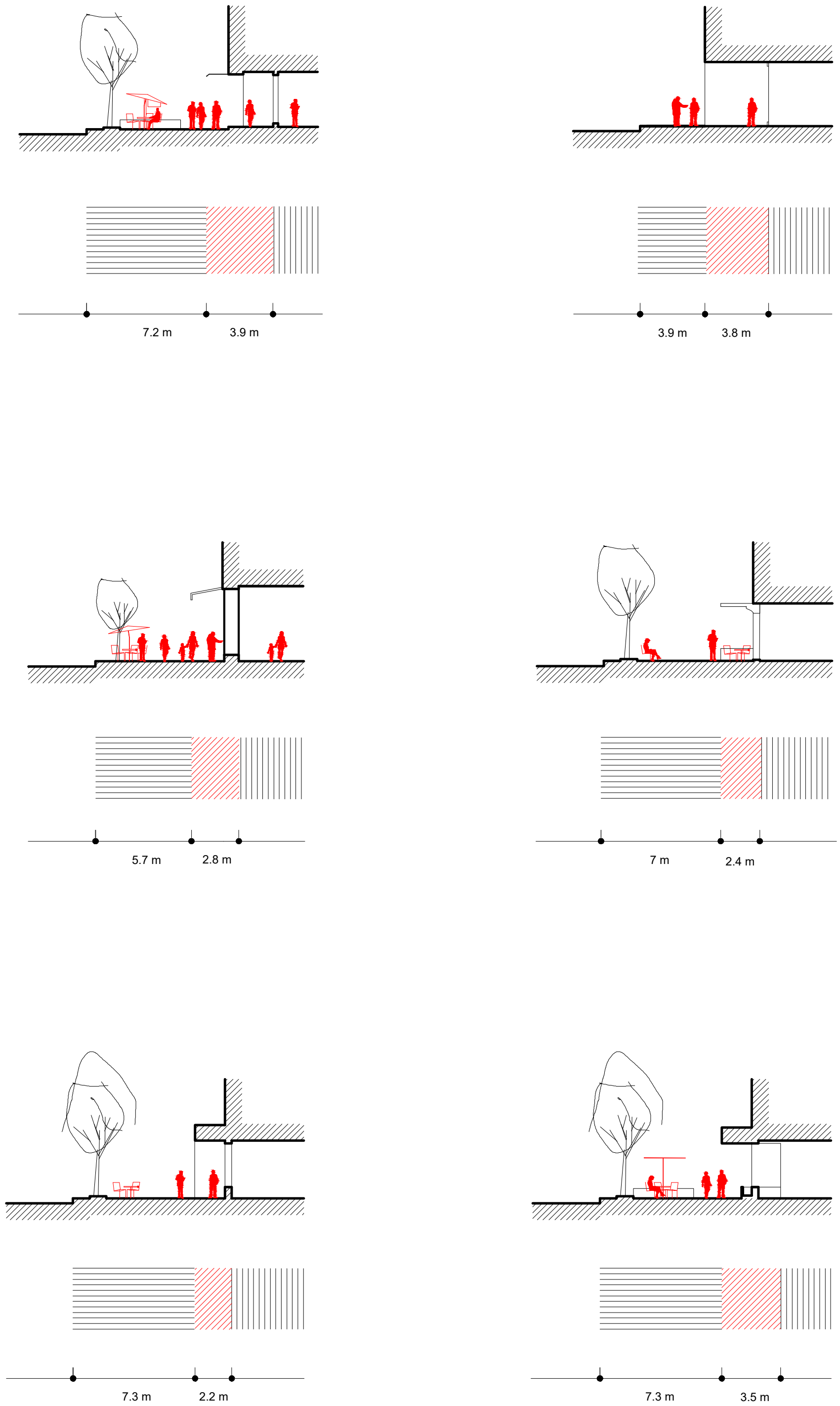
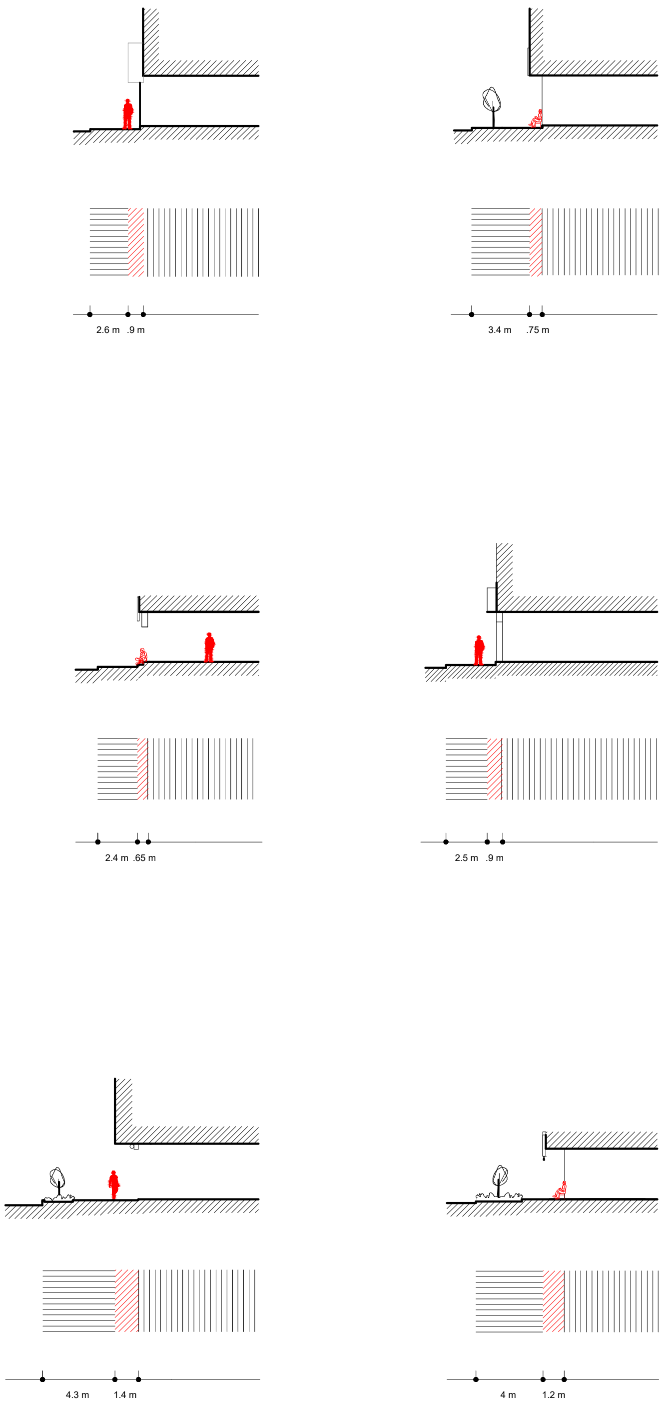


Figure 10.1-1 Cross-sections highlight different types of permeable and accessible interfaces internationally and locally.
a) The main international case studies. (Source: Author's Edition).



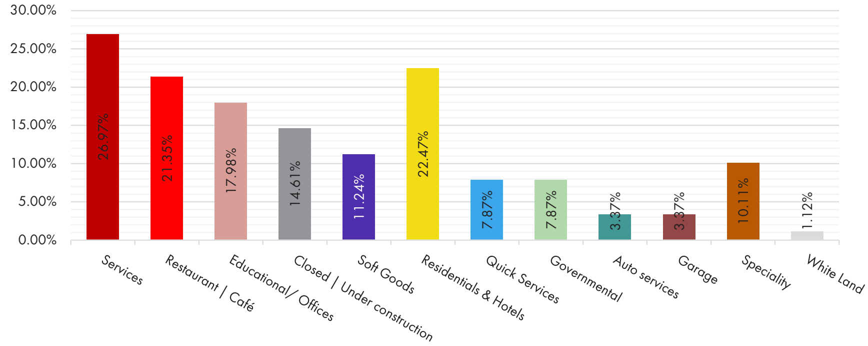
b) The local case studies. (Source: Author's Edition).

Moreover, several scholars have stated the role of ground-floor uses in enhancing social and public life (Jacobs, 1961; Montgomery, 1997). The results obtained showed that, in contrast with the international livable arterial streets, the local case studies presented less variety and diversity of uses along the ground floor on both arteries, which in turn targeted specific users (Figure 10.1-2). As found, both local streets provided mostly single-use ground floors with a dearth of basic amenities, such as corner stores, local cafés, and restaurants, which would generate more attractive interfaces, promote social activities, and lower the pedestrians' walking speed.

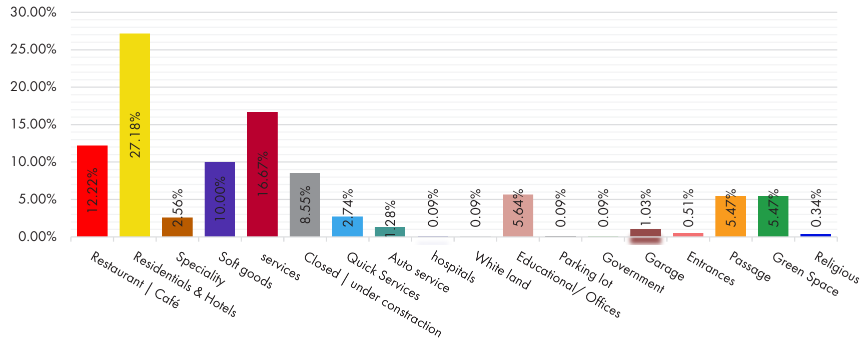
Regarding the width and partitions of the sidewalk, it was observed that there were many clear differences between the international and local case studies in shaping and forming the sidewalk. Unlike the international examples, the results showed that the local streets did not have sufficient sidewalk width to encourage an extension of indoor activities to the public realm or give extra space from the sidewalk to the ground floor. Although Sample A in Abi Jafar Al Mansour Street has relatively wider sidewalks than other samples, this sample also presented spaces only as a transition point to pass through for entry or exit buildings, with fewer visual interactions and social activities.

Furthermore, the results cast new light on the significance of doors and windows in pedestrians' visual preferences, where they welcomed participants' visual attention. As found, the continuity of doors and windows along the main international arterial streets provides a rich visual and sensory experience. The results show that pedestrians were visually attracted to doors and windows, in contrast with the local case studies, which were less complex and closed to the public realm (Figure 10.1-3).

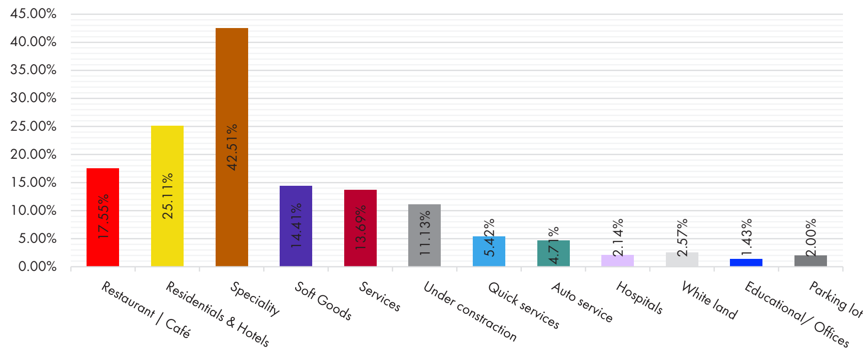
In summary, in terms of the street interface configurations, ground-floor use, and sidewalk width and partition in the local case studies compared to the international cases, it was found that local arterial streets failed to provide quality street interfaces that encourage pedestrians' visual engagement. This comparative study thus showed the significant role of the street interface and its configurations, ground-floor uses, and the sidewalk's widths and partitions as qualities that relate to each other and support or create pedestrians' visual engagement and public life. Thus, in line with previous studies, the current investigation provides evidence for the importance of the configurations of the street interface in shaping active street frontages (Bobić, 2004; Gehl, Kaefer and Reigstad, 2005; Heffernan, Heffernan and Pan, 2014; Palaiologou and Vaughan, 2014).



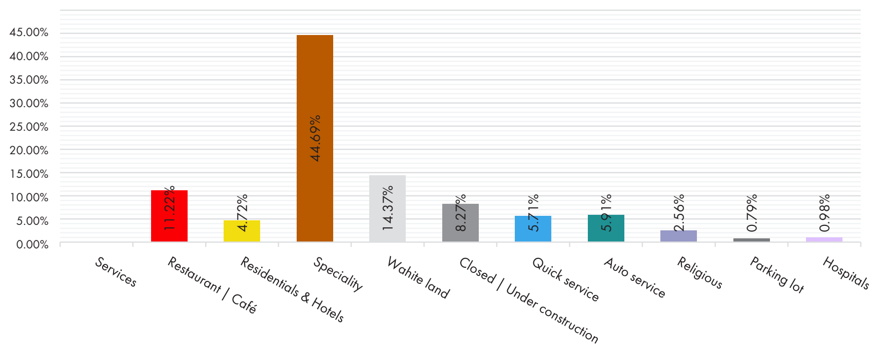
Avenida da República



Avenida Diagonal

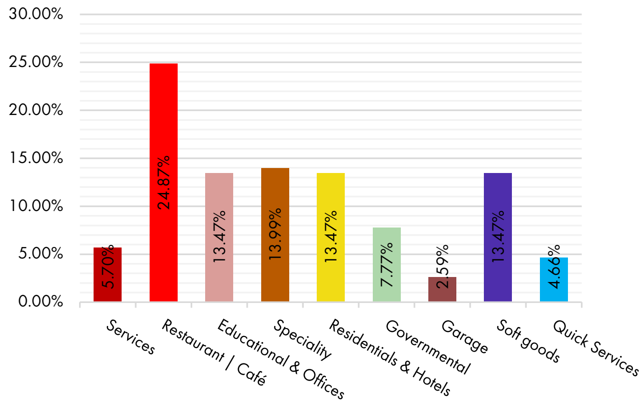


Khalid bin Al-Waleed Street

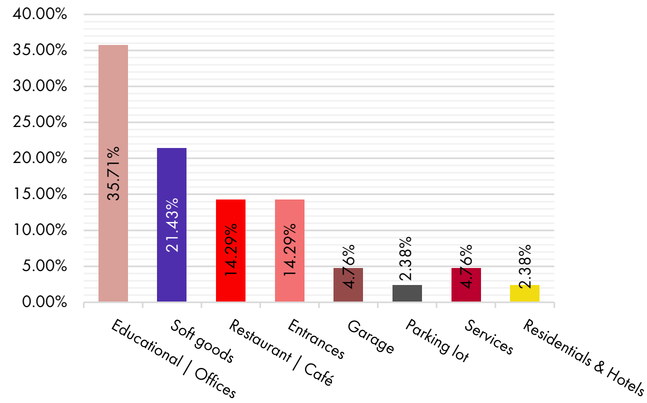


Abi Jafar Al-Mansour Street

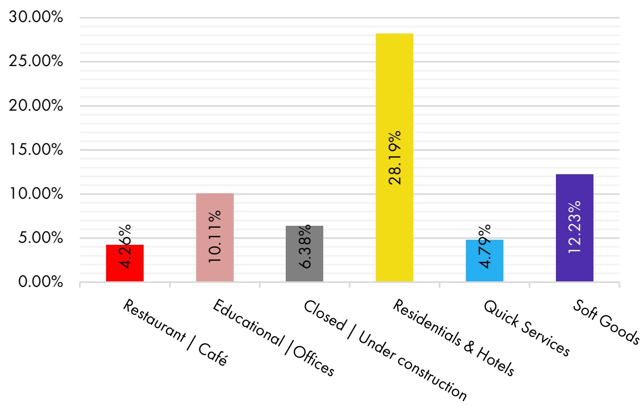
Figure 10.1-2 Comparative analysis of ground-floor uses of the main international and local case studies.
a) The percentages of the ground-floor uses along Avenida da República and Avinguda Diagonal compared to Khalid bin Al-Waleed and Abi Jafar Al Mansour streets.



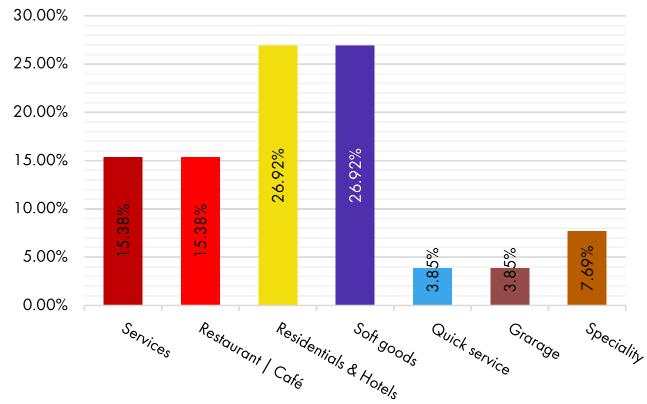
Avenida da República - Sample A



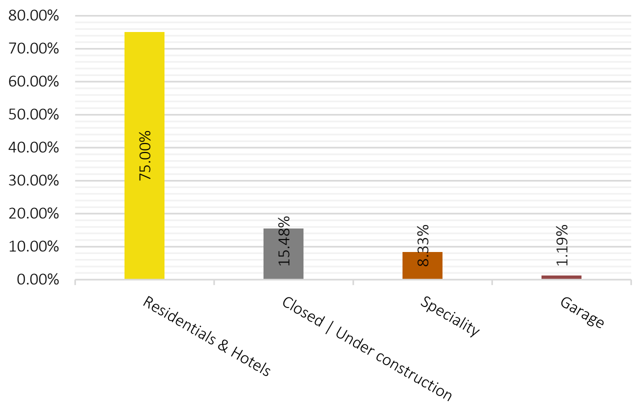
Avinguda Diagonal- Sample A



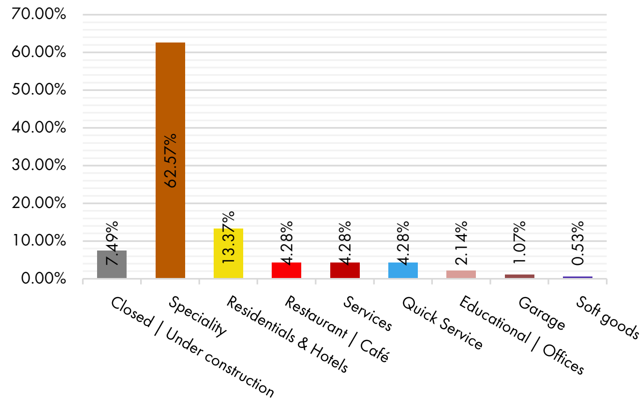
Avenida da República - Sample B



Avinguda Diagonal- Sample B

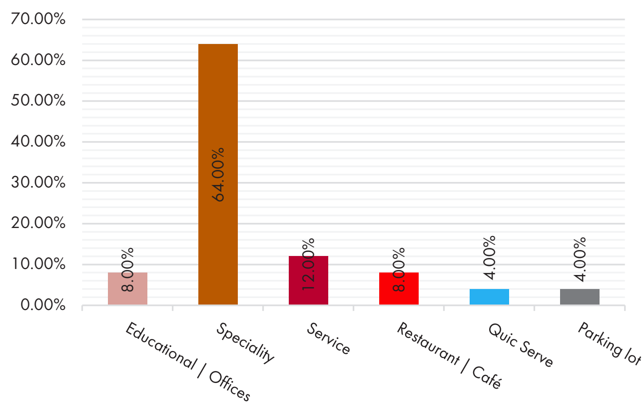


Avenida da República - Sample C

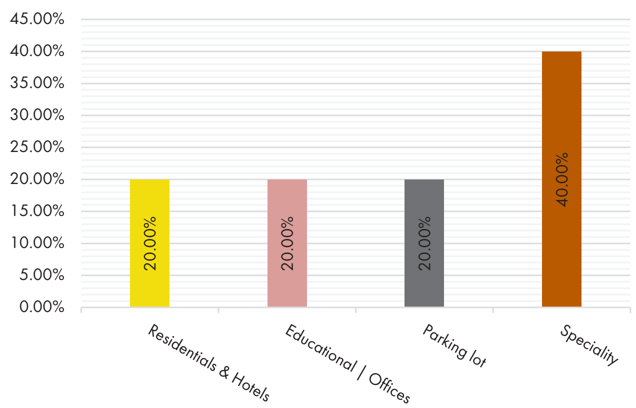


Avinguda Diagonal- Sample C

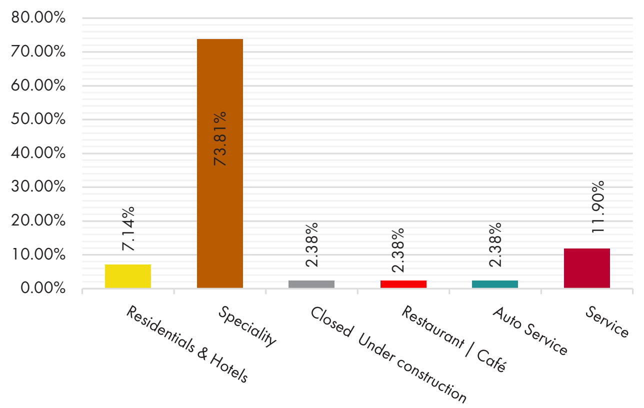
b) The percentage of the ground-floor uses of each selected sample of Avenida da República and Avinguda Diagonal.



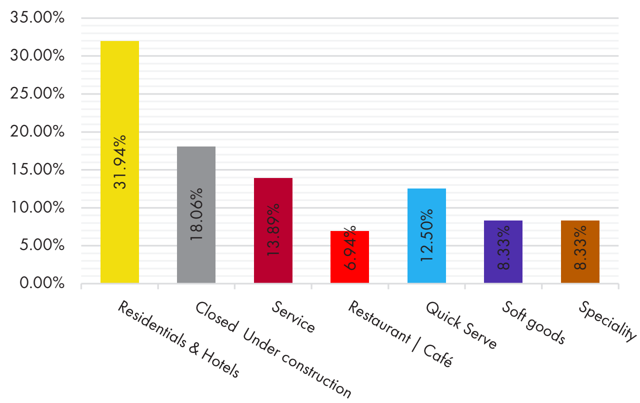
Khalid bin Al-Waleed Street - Sample C



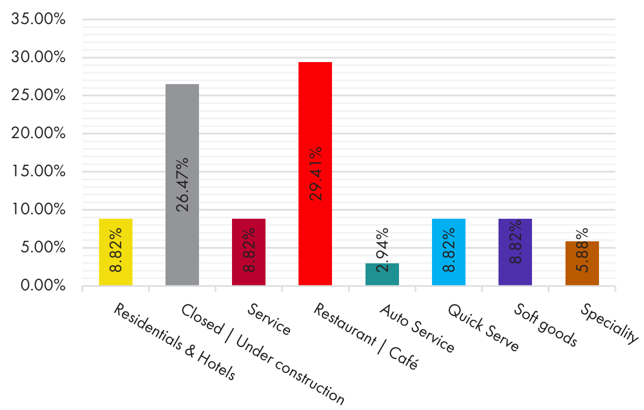
Abi Jafar Al-Mansour Street - Sample A



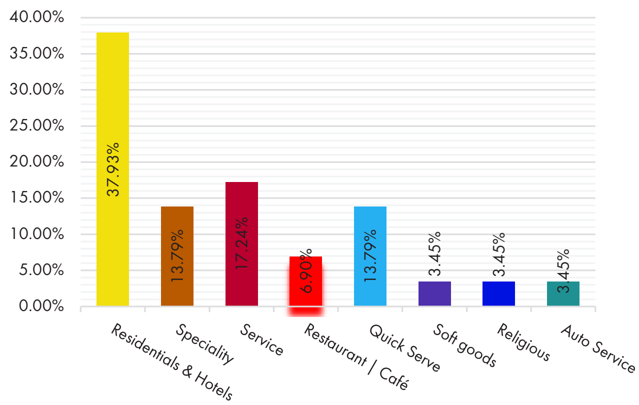
Khalid bin Al-Waleed Street - Sample B



Abi Jafar Al-Mansour Street - Sample B



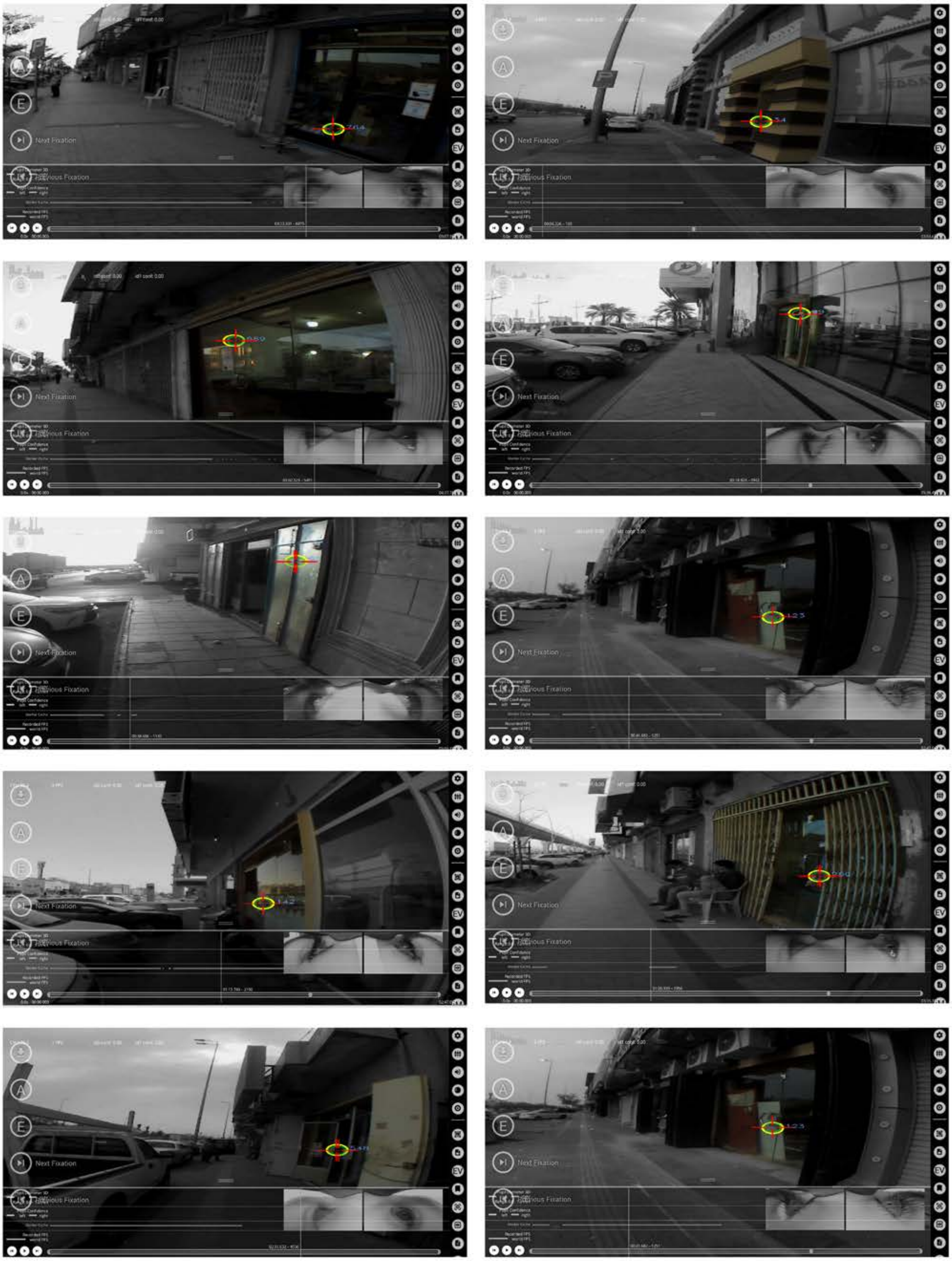
Khakid bin Walid Street - Sample A



Abi Jafar Al-Mansour Street - Sample C

c) The percentage of the ground-floor uses of each selected sample of Khalid bin Al-Waleed and Abi Jafar Al Mansour streets.

Figure 10.1-3 Screenshots from eye-tracker analysis software showcasing participants' fixation with doors and windows.
a) The main international case studies. (Source: Author's Edition).



b) The local case studies. (Source: Author's Edition).

10.1.3. The street partition

The current scale studies arterial street partition in relation to pedestrian activities using morphological interpretation and public life studies. The study reveals correlations between street partition compositions and human activities. The interdisciplinary methodology addresses the differences between the international and local case studies regarding street partition compositions, which allows us to decode the morphological features that have an impact on the use of the street space and promote different types of activities. In essence, the question is this: How do street partition compositions influence pedestrians' activities?

The findings support the hypothesis that pedestrian activities occur when street partition is organized around people and their daily activities. The analysis of international and local case studies showed that pedestrian activities were associated with streets that offer space for pedestrians' daily needs and activities. Such streets have physical characteristics that facilitate different types of activities, including necessary, optional, and social activities. The study also revealed that pedestrian activities are influenced by street partition compositions, the balance between pedestrians and automobiles, and the street enclosure ratio.

The results from the international case studies revealed that street partition compositions reflect the dynamic and permanent character of streets and their capability to respond to public life rhythms and users' needs. The results showcase the diversity of street partition compositions, which serve diverse roles in response to the arterial street's characteristics, strategic and urban location, mobility logic, and regulations interconnected with the inhabitants' needs. These spatial compositions are organized in different orders with different materials, elements, levels, furniture, size, and uses, all of which define the spatial configuration of the street layout. These findings emphasize the notion of street partition compositions as a formal reference from which to study street quality.

The variety of daily pedestrian activities—including necessary, optional, and social activities—that occurred in the international case studies, particularly in Avenida da República and Avinguda Diagonal, embodied the partition compositions' role not only in organizing the street space but also in inviting and attracting many people of different ages and genders. As found, the complexity of partition compositions in Samples A and B on both avenues produced spaces for meeting and socialization, where varied activities took place, allowing people to feel that they were an integral part of that social diversity.

The findings highlight that the partition compositions of the livable international arteries could be grouped into two broad types of street functions: "route" and "place." These functions balance the ratio between pedestrians and automobiles, as such (1:1) or (2:1), allowing the street space to offer room for public life and resulting in a more balanced accommodation of street mobility and social life. The findings show that these avenues are composed of main partitions, the roadway and the walkways, and sub-partitions, cycling way, the pedestrian zone, the frontage zone, and the amenity zone, both characterized by well-balanced ratios that serve the diverse functions of this type of street as multi-functional public spaces. The results strongly imply that livable arteries are composed not only from the perspective of circulation but also from the perspective of public life use for a wide range of urban activities that enhance street livability.

For example, the main international case studies demonstrated that pedestrians' optional and social activities were concentrated along the samples that were formed for pedestrians' use, which were characterized by wide sidewalks with approximately 50% of the total width of the street, diverse sidewalk partition compositions, and active edges. Interestingly, the pedestrians' realm in these samples became an urban living room that reflected the city's identity and generated vibrant public life. The wide sidewalks on these samples were composed of different sub-partitions that organized pedestrian activities and provided room for different purposes with amenities, street furniture, trees, and paving techniques, such as the Portuguese pavement "Calçada Portuguesa" in Avenida da República and the pattern of the leaf of the trees that grow along Avinguda Diagonal (Figure 10.1-4).

Moreover, the ratio between the street width and building height also plays a crucial role in influencing pedestrians' activities and creating a sense of place in the street. The W:H ratio principle in both main international case studies was proper, providing a sense of enclosure. Nevertheless, the enclosure was not only due to the street width to building height ratio but also due to the vertical elements—as in the central pedestrian spaces of the Diagonal, for example. These vertical elements, including trees, provided a sense of enclosure, where pedestrians' activities were found to be more diverse, such as in Samples A and C in Barcelona, where the pedestrians' central space became a room for different activities.

In comparison, the morphological characteristics of the two local arteries in relation to pedestrian activities revealed two different sections: One presented the streets' previous form, and the other presented the new transformation due to the introduction of the public transportation project. However, both sections suffer from a significant deficiency in terms of accommodating necessary, social, and optional pedestrian activities throughout the day and night and during different seasons. Although these streets witnessed a recent transformation in their profile, including widening the sidewalk and adding new street furniture, they showed less diversity in the partition compositions dedicated to pedestrians' and cyclists' uses, and the streets were dominated by automobile spaces. The presence of diverse street partitions on arterial streets allows for a wide range of activities and different modes of mobility. For instance, the central tree-shaded area of the Diagonal provides a designated pedestrian zone, fostering the emergence of more optional activities compared to other sections of the street that lack such designated spaces.

One of the main factors contributing to the absence of pedestrian activities on Khalid Ibn Al Walid and Abi Jafar Al Mansour streets at the mesoscale can be attributed to the composition of the street partitions, which prioritize the needs of automobiles. The roadway sections occupy most of the street space, while the sidewalks are predominantly utilized for accessing surrounding buildings, leading to a lack of pedestrian activity on the sidewalks. The configuration of street partitions on these local streets appears to have been designed with an emphasis on accommodating automobiles, rather than pedestrians, as evidenced by the limited space and functionality allocated to sidewalks.

Unlike the selected international case studies, the pedestrians' social and optional activities in the local case studies occurred only among the sellers in front of their shops. The local case studies show a lack of public life and pedestrian activities where these arteries formed as routes that serve automobile needs. The wide, automobile-oriented streets blocked the pedestrians' natural walking routes and created a sense of danger (Figure 10.1-5).

The morphological interpretation of both local streets found that the sidewalk, as a ground for sociability, was composed with less complexity in comparison to the selected international streets, thereby negatively affecting pedestrians' activities. Despite their recent transformation, sidewalks' partition compositions were found to lack physical qualities that could perform symbolic and representative functions that foster user interactions. The fixed seating, streetlamps, and rubbish bins are significant components of outdoor spaces; however, the sidewalk partition compositions are a critical factor in the perceived quality of streets, and they have been undervalued in the local case studies.

Further, the findings revealed that the street enclosure ratio played a significant role in shaping a more active pedestrian realm, which was balanced in the selected international streets compared to the local ones. Jacobs (1995) stated that vertical elements and street enclosures attract pedestrians. In this context, in the selected international case studies, vertical elements such as trees were found to encourage pedestrian activities by separating the pedestrian area from the roadway, offering pleasant and shaded places and creating a sense of enclosure. On the other hand, the local cases, despite their location in a harsh climate during the summer, offered fewer vertical elements, including trees, which represent an essential factor in shading streets for different kinds of social and optional activities, or even necessary activities (Figure 10.1-6).

Finally, comparing the street partition compositions between the international and local cases revealed significant differences in organizing the pedestrian and automobile ratio (Figure 10.1-7). The different partition compositions of the decoded international streets resulted in the coexistence of the different mobility modes, including vehicles, buses, trams, metros, and soft mobility options, as well as providing a place for social interaction, thus making these streets public spaces. This quality, in contrast, was lacking in the local streets, where urban arteries became roads only for movement functions, with a significant ratio of automobile spaces that dominated the majority of the overall width of these streets.

a)

b)

Figure 10.1-4 The paving techniques of the main international case studies. (Source: Author's Edition).
a) Avenida da República.
b) Avinguda Diagonal.

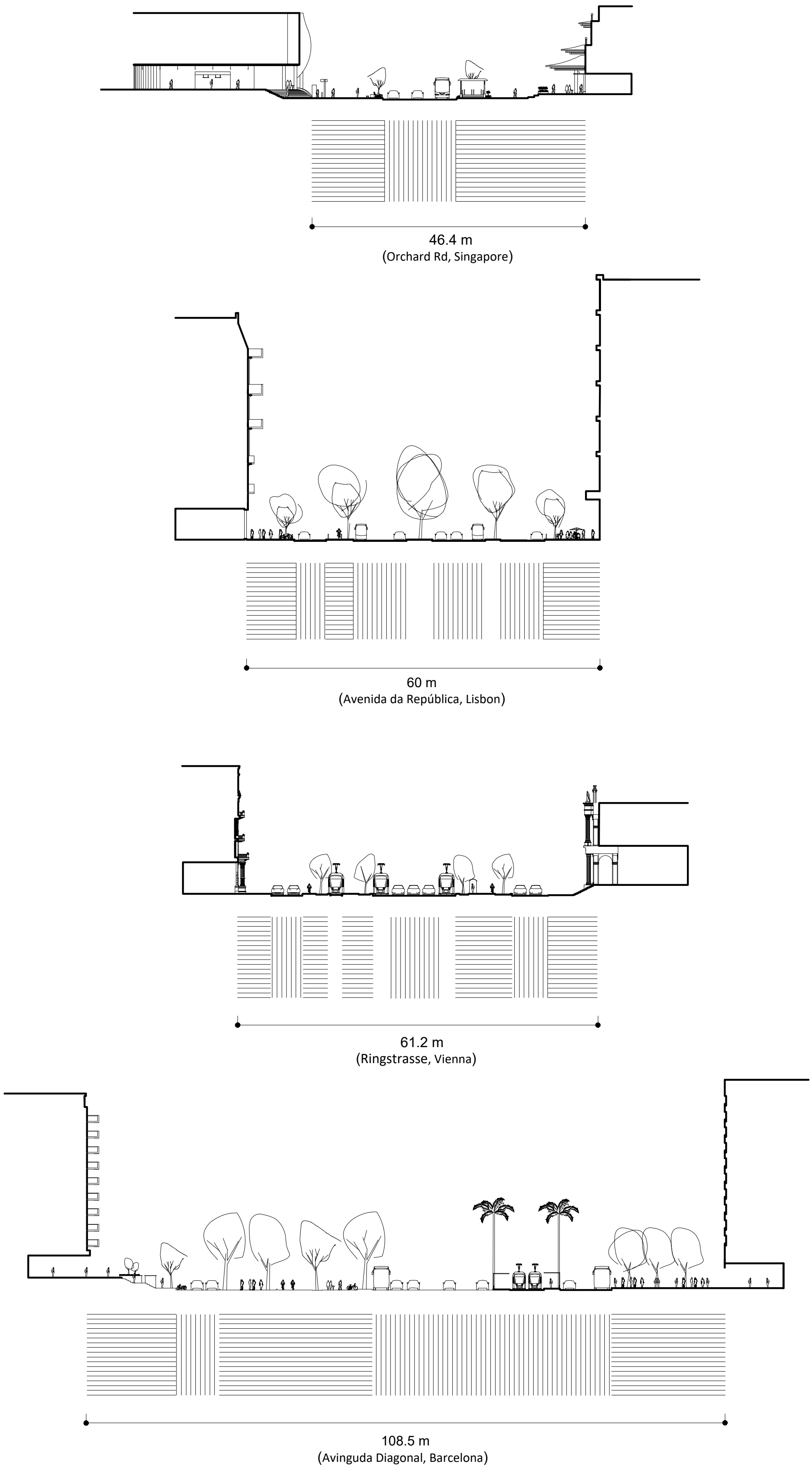
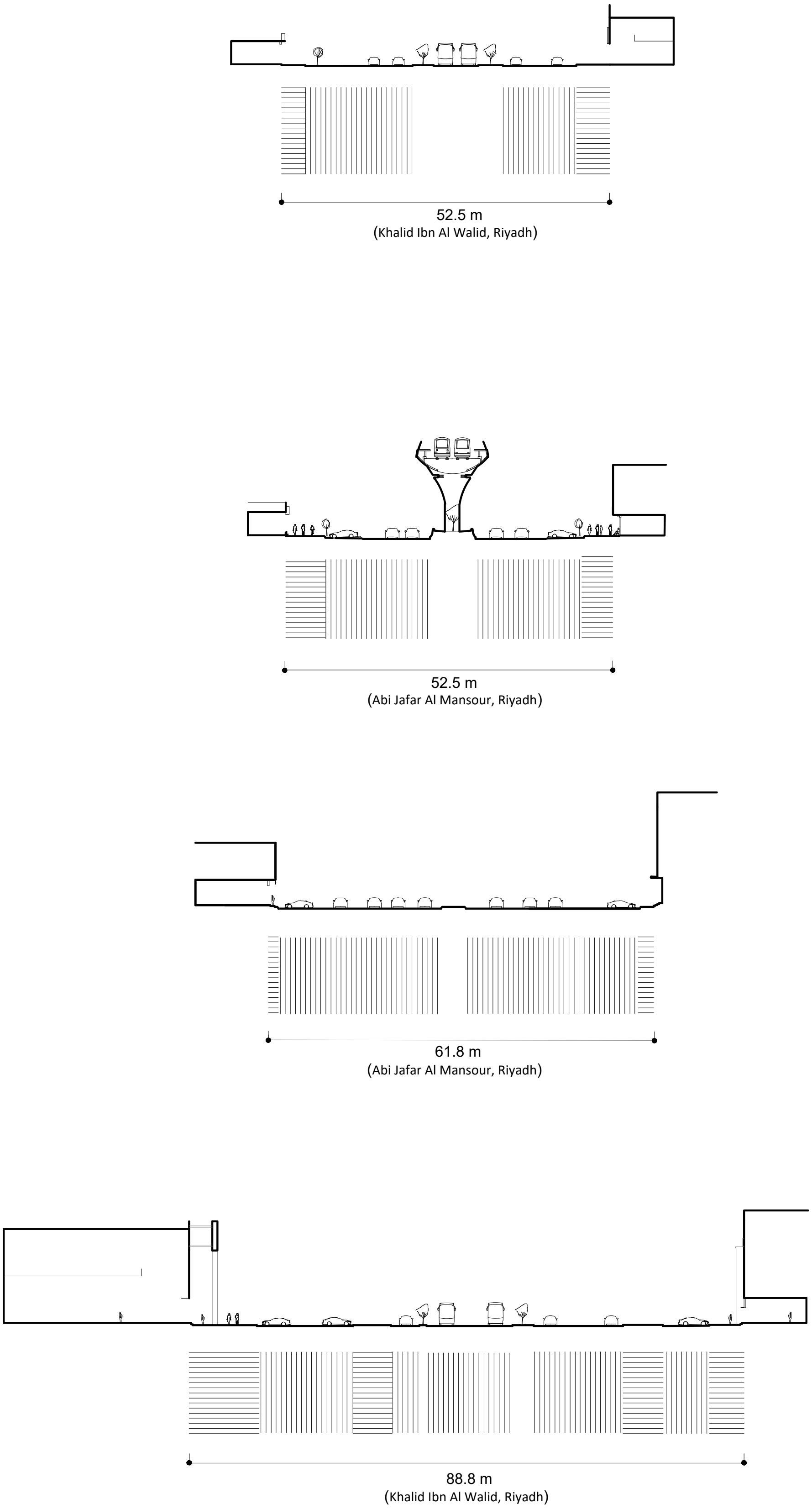


Figure 10.1-5 Cross-sections show the street partition compositions of the slected case studies.
a) The international case studies. (Source: Author's Edition).



b) The local case studies. (Source: Author's Edition).

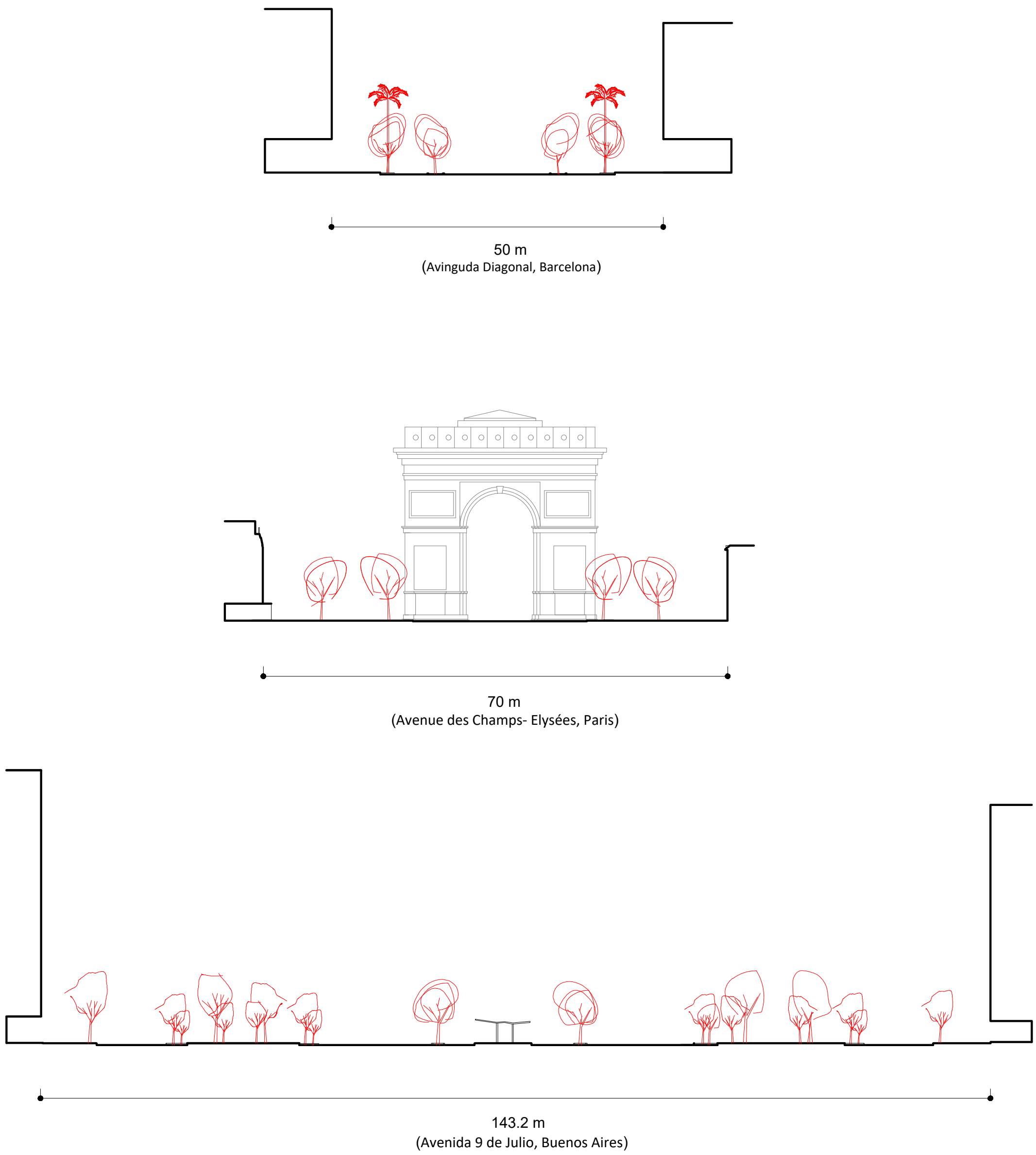
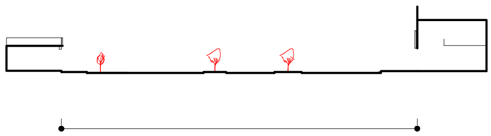
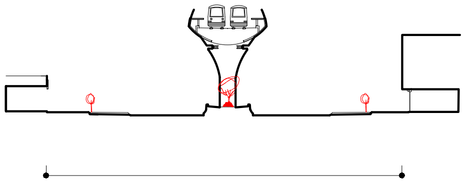


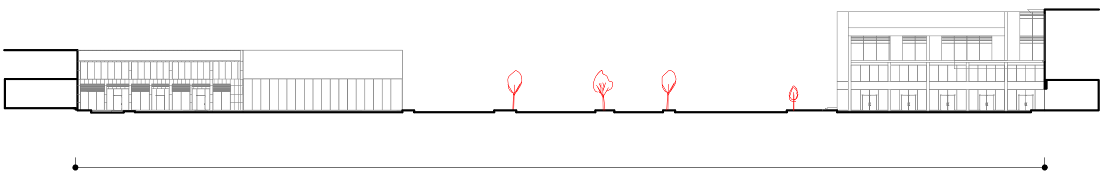
Figure 10.1-6 Cross-sections show the street trees of both the international and local case studies.
a) The international case studies. (Source: Author's Edition).



52.5 m
(Khalid Ibn Al Walid, Riyadh)



52.5 m
(Abi Jafar Al Mansour, Riyadh)



143 m
(Khalid Ibn Al Walid, Riyadh)

b) The local case studies. (Source: Author's Edition).

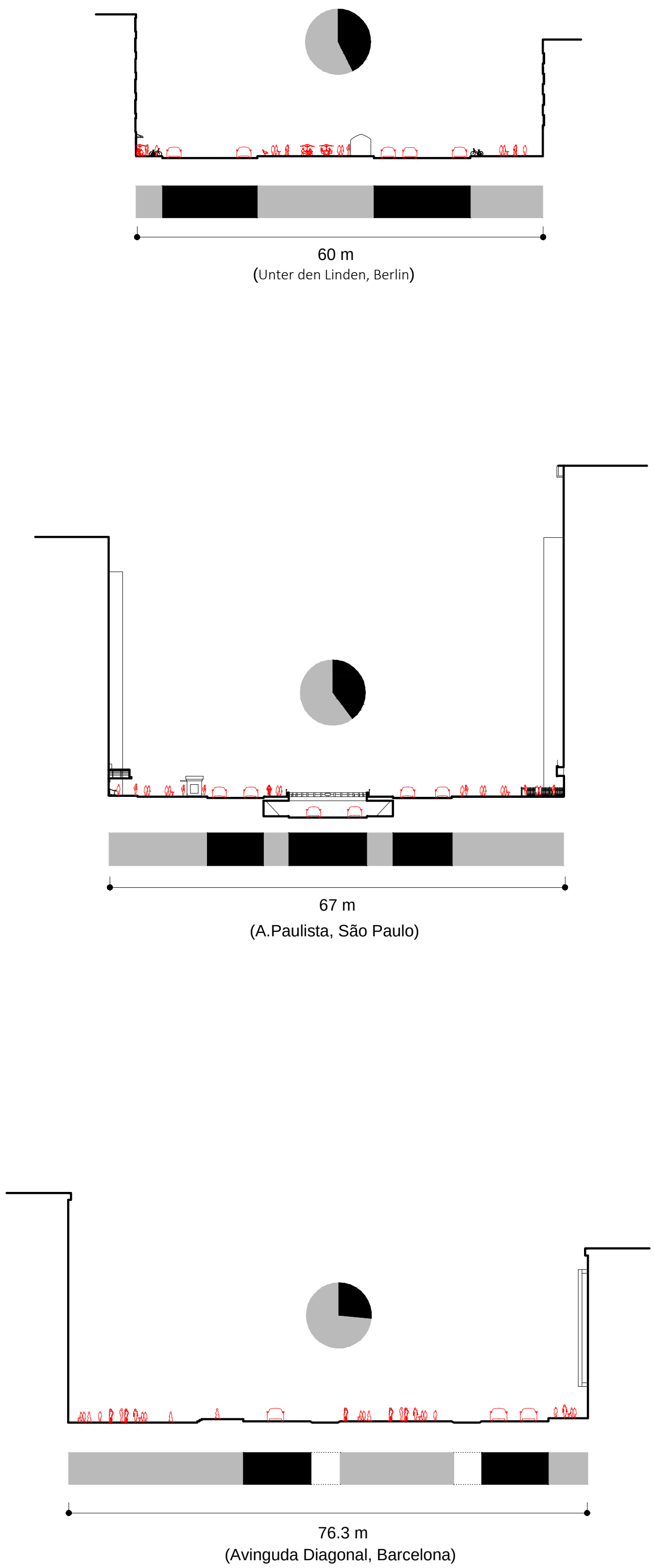
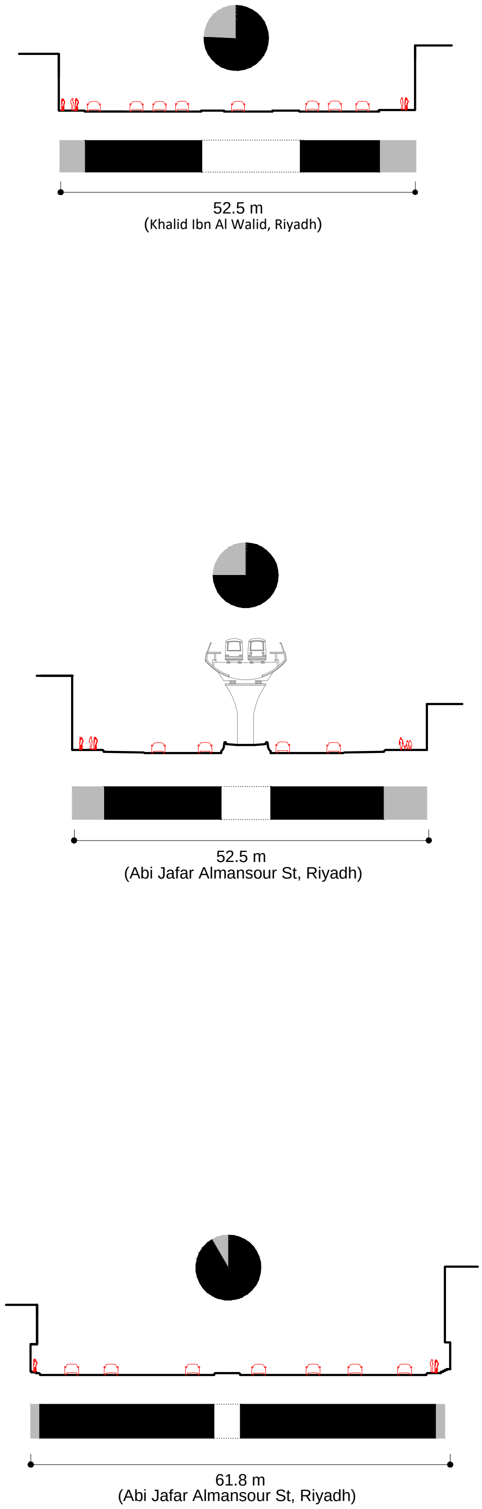


Figure 10.1-7 Cross-sections show pedestrian-to-automobile ratios of both the international and local case studies.
a) The international case studies. (Source: Author's Edition).



b) The local case studies. (Source: Author's Edition).

10.1.4 The urban structure

The study of arterial streets at the macroscale contributes to assessing pedestrian flow in relation to urban structure. The comparative study on this scale reveals the impact of the street and block patterns of the urban structure on pedestrians' flow and decodes the association between the permeability of the urban structure and arterial street livability. This study addresses this question: What physical characteristics of the street's permeability with regard to the urban context contribute to facilitating pedestrians' flow at the arterial street level?

As hypothesized, the findings demonstrated that arterial streets that incorporate high permeable qualities regarding the surrounding urban structure have higher pedestrian flows. The study of the relationship between urban permeability and pedestrian flow showed that arterial streets' high permeability creates permanent active streets, where in addition to the physical characteristics of the street interface and partition, pedestrians linger more in the highly permeable streets. In this regard, in the main international case studies, Avenida da República and Avinguda Diagonal, the pedestrians' flow is related to three common characteristics: urban block size and length, street intersection frequency, and urban porosity.

A permeable arterial street has relational characteristics that create connections between the street and the surrounding urban structure to provide physical, visual, and sensory connectivity. The result of the urban structure in the international case studies (see Subchapter 8.1) showed the impact of permeability on pedestrian flow, allowing us to decode street livability on the macroscale. The results showed that pedestrian flow can vary in the same street, with various factors increasing or decreasing pedestrian flow. Although arterial streets are sometimes seen as channels for heavy traffic movements, livable arterial streets can also allow a high degree of permeability for pedestrian and bicycle traffic flow.

The results obtained from the international arteries underscored the significance of creating a continuous, well-connected street space that is porous and permeable to its surroundings. Notably, Samples AE, AW, and BW in Avenida da República and Samples BS and AN in Avinguda Diagonal exemplified this principle by facilitating a substantial pedestrian flow. These samples were formed to maximize pedestrians' presence and flow, which is a crucial aspect of enhancing a street's livability. The significance of these design elements aligns with the observations made by Jacobs (1961), who emphasized the importance of permeability in fostering urban vitality.

Upon comparing these samples with others, it became apparent that the correlation between high pedestrian flow and certain urban characteristics played a vital role. Specifically, urban block size and length, street intersection frequency, and urban porosity contributed to the observed high pedestrian flow.

Samples with small urban block sizes and lengths were found to encourage pedestrian movement as they facilitated more walkable and accessible environments. Additionally, a higher frequency of street intersections facilitated smoother pedestrian flow and better connectivity within the urban fabric. Furthermore, the concept of urban porosity, which encompasses the openness and interconnectedness of the built environment, emerged as a significant factor in attracting pedestrians and ensuring a continuous flow of activity. Thus, the street's permeability allowed for interconnection through the street and block patterns that generated the dynamism of the street space.

Regarding block size and length, the most obvious measure of permeability, the morphological interpretations of both main avenues showed a relation between the average block dimensions and the number of pedestrians using the street space. For example, the pedestrian counts showed a considerable gap between the number of people observed in the southern section of Avenida da República compared to the northern section, which had a long-elongated block that disrupted transversal pedestrian flows. Moreover, in the case of Avinguda Diagonal, the central section with a medium-sized block and dimensions that allowed a high frequency of street intersections presented a significantly higher number of pedestrians using the street compared to the third section of the avenue.

The urban block size and length identified by several authors as critical characteristics of urban vitality, such as Jacobs (1961) and Montgomery (1998), facilitated permeability and walkable access between the avenues and their surrounding areas. It also increased the frequency of street intersections, which was found to be associated with pedestrian flow, by opening new and alternative ways for pedestrians and cyclists to access their destinations and to flow. The medium to small length of the blocks along both avenues created the capacity to penetrate the pores of the urban structure and enriched pedestrian encounters and flows. These characteristics of street and block patterns contributed to the presence of different users with different purposes during the day and night, which decreased in large and long blocks.

Another morphological characteristic that was found in the interpretation of the international case studies is urban porosity. As found in the L'illa Diagonal building that occupies the entire block in Sample B in Avinguda Diagonal, the series of passageways enhanced the integration with the surrounding urban structure, allowing pedestrian traffic flows and opening alternative connections to the street. Despite the fact that these passageways are privately owned, their porosity facilitates the flow of people where public streets meet private blocks for public and collective use, creating new ways of appropriating urban space.

The porous spaces created on the ground floor and between the buildings are crucial to the vitality of the arterial street. In the ancillary international case studies, this quality was also determined to enhance the human scale while reinforcing continuity in relation to the urban structure. For example, the São Paulo Museum of Art (MASP), a significant modern architecture project in Brazil, offers a safe pedestrian alternative with a close relationship with the city. The MASP project, designed by Lina Bo Bardi, presents a porosity through which the idea of transforming society through architecture is defended with a collective space integrated into the city.

Moreover, Conjunto Nacional is a significant building in São Paulo, Brazil, which occupies a block bounded by Avenida Paulista. The building, designed by David Libeskind in 1955, promotes unique relationships between the Avenida Paulista and the city level on the ground floor. The various entrances, passageways, and corridors along the ground floor create porosity, emphasizing the idea of continuity and featuring shops, bank offices, and restaurants (Figures 10.1-8).

Furthermore, the street and block patterns surrounding Avenida da República and Avenida Diagonal transformed their qualities as multi-functional spaces into active places that support pedestrian existence and flow from people of various ages and genders. In comparison, the study of the local examples presented streets almost empty of pedestrians and cyclists; vehicles dominated the urban scene. The morphological interpretations in the macroscale of Khalid Ibn Al Walid and Abi Jafar Al Mansour streets showed less pedestrian permeability between these arteries and their surroundings. From the street and block patterns perspective, there were differences between the international cases compared to the local ones in terms of urban block dimensions, street intersection frequency, and urban block porosity, all of which affected the pedestrians' flow.

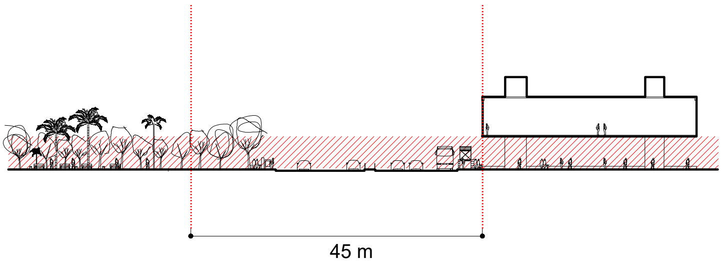
The main physical legacy of Doxiadis's planning of Riyadh was that it transformed the city from a self-contained neighborhood restricted to pedestrian interaction and flow to one that favored vehicle traffic flow. As found, the street and block patterns were not formed to support pedestrians' flow, especially the integration between the streets and the surrounding urban area. The recent interventions on both streets that aimed to create more people-friendly streets were insufficient to facilitate pedestrian access and flow. Paving, lighting, and street furniture, as the main physical aspects addressed in the streets' recent transformation, did not facilitate pedestrian existence.

As argued by Bently *et al.* (1985), permeability is a crucial indicator of environmental responsiveness. Thus, in the case of arterial streets, permeability is closely intertwined with pedestrian flow, in that permeability supports pedestrians' variety of choices to access the street space. In this manner, unlike the analysis obtained in the international case studies, the study finds in the local cases a shortfall of permeability that ensures the continuity and diversity of pedestrian access.

The length of the urban blocks, longer than 200 meters, played a significant role in the absence of the circulation of public life. This finding in in line with previous studies that have demonstrated the role of short blocks in providing permeability (Jacobs, 1961; Montgomery, 1998; Carmona et al., 2003). Thus, the comparative study of the urban block dimensions revealed that the long block size (i.e., great distances) has prevented pedestrians from easy access to the street space, especially in a car-dependent city, where distances are crucial. This, in turn, minimized the street intersection frequency and created fewer opportunities for pedestrians to flow compared to vehicles.

Along the same lines, Allan Jacobs suggests that the frequency of street intersections can improve the quality of a street (Jacobs, 1995). This quality can be found in the international case studies, where the short blocks allowed for more encounters and greater street interactions for pedestrians' flow. However, compared to the international arterial streets, the results obtained from Khalid Ibn Al Walid and Abi Jafar Al Mansour streets showed fewer pedestrian and cyclist intersections, which contributed to decreased pedestrians' potential to access the streets (Figure 10.1-9).

In this regard, the international case studies addressed the issue of long urban blocks by resorting to urban block porosity in order to achieve permeability and to allow alternative pedestrian passageways. For instance, in the case of Sample B on the Avinguda Diagonal, which featured a block length of 343 meters, the implementation of passageways at approximately 100-meter intervals effectively mitigated the challenges posed by the block's length (Figure 10.1-10). Similarly, on Avenue des Champs-Élysées, long blocks of around 230 meters showcased porosity through features such as covered passages. This quality of urban block porosity facilitating pedestrian movement can also be observed on Orchard Road in Singapore, where larger blocks provide opportunities for pedestrians to access the block through various passageways. This porosity of the urban blocks promoted the relationship between the street and the surrounding urban area, which was absent on both local streets. Furthermore, the lack of variety in spatial solutions in local streets reduced the transition between the street and the surrounding context, allowing for greater isolation between the streets and public life.



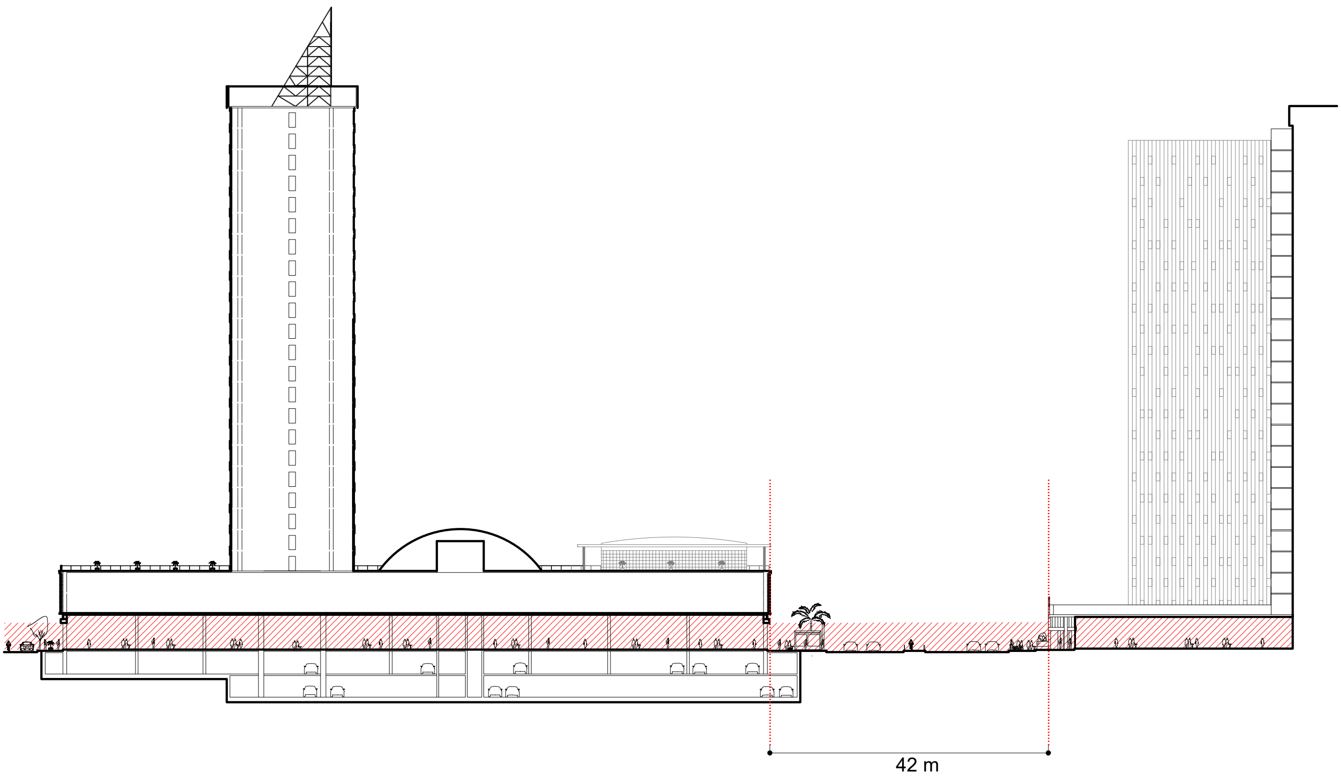


Figure 10.1-8 Cross-sections show the urban porosity of the international case studies.
a) The São Paulo Museum of Art (MASP). (Source: Author's Edition).
b) Conjunto Nacional, São Paulo. (Source: Author's Edition).

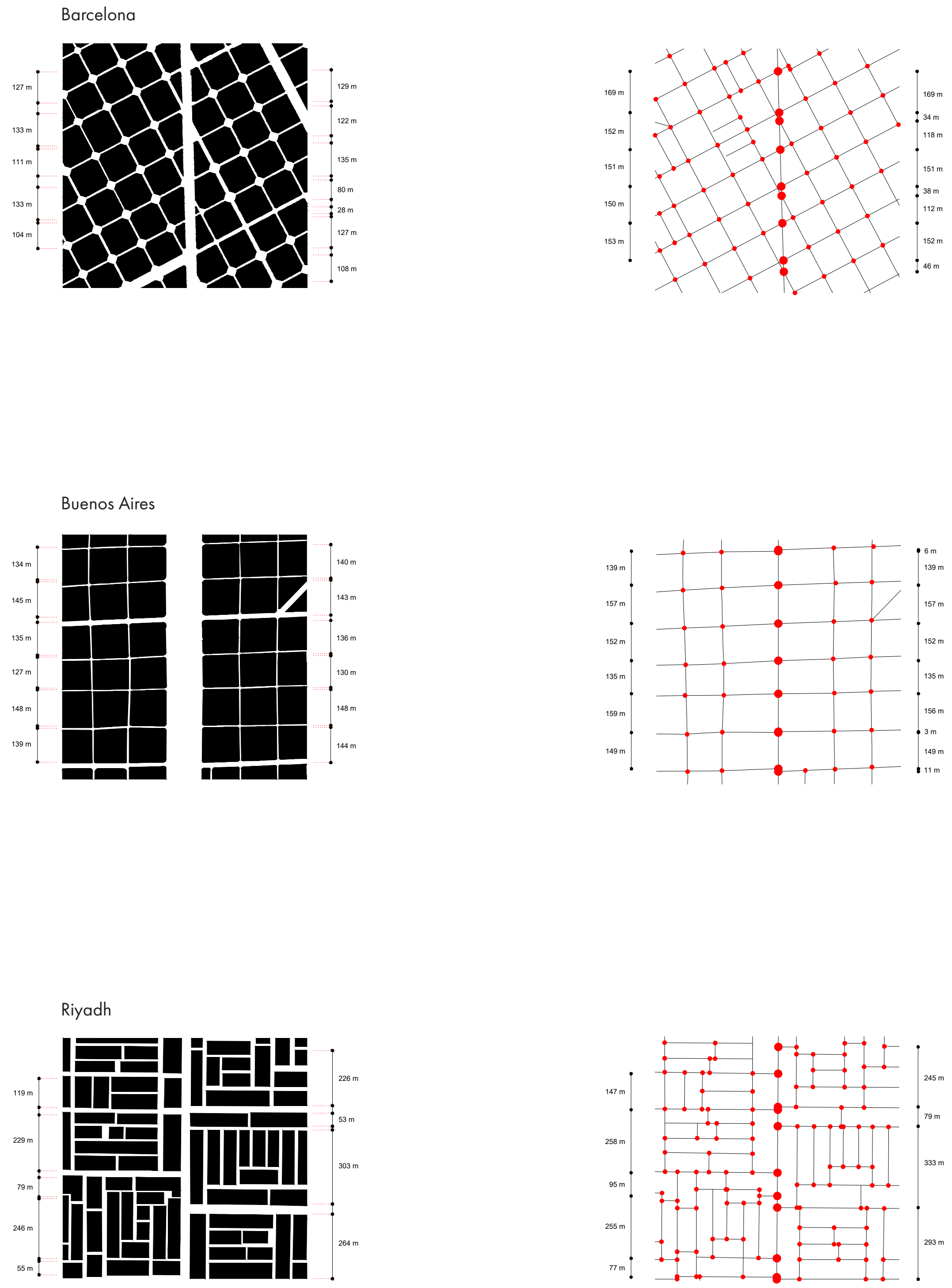


Figure 10.1-9 Comparison of 1x1 km² samples of Buenos Aires, Barcelona, and Riyadh highlighting block size and street intersection frequency. (Source: Author's Edition).

Figure 10.1-10 The urban porosity in the L'illa Diagonal shopping center, Barcelona. (Source: Author's Edition).

10.1.5. Lessons from the comparative study

The previous comparative study shed light on existing arterial streets located in different contexts and conditions in order to extract qualities and learn from different experiences, aiming to build a framework for livable arterial streets. In addition, the comparative study addressed the impact of arterial street morphology on shaping public life on three different scales. From this perspective, we found arterial streets to be complex urban elements composed of different elements that have the ability to affect the quality of public life. They are not only fixed structures but also entities that relate to and evolve according to daily, weekly, monthly, and seasonal rhythms and to events, purposes, and uses.

Lewin(1943) stated that the interaction between people and their environment influences their behavior. Similarly, Hillier and Hanson (1989) viewed the role of the environment in shaping human activities as the mechanism that affects human behavior. Thus, we can infer that street space is a physical product of society with different forms, functions, and meanings that has the ability to affect the degree of public life and social interaction.

From comparing the international and local case studies, the international case studies represent successful linear centers as they respond to most of the pedestrians' needs. This comparative study provided a clear understanding of the morphological qualities that attracted pedestrians' visual perception, enhanced pedestrian activities, and facilitated pedestrian flow, confirming the inextricable relationship between street space and public life. The decoded physical qualities on different scales, dedicated to different themes, show the interconnection and overlapping between street's different scales, where there is no quality for one without the other.

Therefore, arterial street space is a multiscale issue corresponding to the multifunctionality of a complex urban element. From this fact, it can be demonstrated that public street life is related to different scales, representing the complex diversity and overlapping between their needs and the spatial settings that reestablish the connections and coexistence of different public life rhythms.

10.2. The elements of livable arterial streets

"Certain physical qualities are required for a great street. All are required, not one or two. They are few in number and appear to be simple, but that may be deceptive."
(Jacobs, 1995, p. 270)

The current rapid transformations of cities and lifestyles show arterial streets' capability to organize and give meaning to the new urban dynamics. The current cities are no longer formed only by a single center but by multiple and multi-dimensional centralities. In this regard, livable arterial streets show their capability of being linear centers that correspond to new ways of life and constitute vibrant urban spaces. As revealed, livable arterial streets can generate vital public life and urbanity, becoming the backbone of an urban area.

Supported by theoretical references and the interpretation and decoding of existing arterial streets, various fundamental characteristics have been determined on different scales that reinforce the value of arterial streets. In this context, it has been discerned that decoded livable arterial streets, which translate their centrality, is predicated upon mixed land use, high density, and the presence of various connected means of transportation, including soft mobility. Nonetheless, it is vital to acknowledge that these factors, while pivotal, do not singularly define the quality of the street space. Instead, they are supported by distinct morphological characteristics and qualities that synergistically enhance the overall street livability.

Regarding morphological qualities, which were the focus of this research, the selected livable arterial streets showed that the main spatial characteristics are interconnected and interrelated on different scales. That is, the quality of street interface configurations, street partition compositions, and street and block patterns are related to each other, where there is no quality for one without another. The forms and configurations of these qualities can express ways of life, traditions, and public life needs in different typologies.

The analysis of these streets points to distinct morphological types that establish connections between public space and private domains, link the street to the broader urban fabric, and integrate architecture with urbanism. These decoded types are the result of a complex interplay of various factors, including spatial utilization, user requirements, urban structures, infrastructure provisions, economic dynamics, geographical considerations, weather conditions, locational influences, legislative frameworks, and urban traditions. Despite their specific origins, these morphological types hold the potential to contribute to the development of a comprehensive lexicon and reference framework that can promote the creation of livable arterial streets.

10.2.1. The street interface configurations

Regarding the microscale, the street interface is a fundamental and decisive element for the development of livable arterial streets, which can be configured with different types to produce sub-types that share the same fundamental principles. Livable arterial streets allow connection and articulation between the street space and the city, creating public and collective spaces. As revealed, the decoded international arterial streets shared physical and visual permeability as a fundamental quality that can improve street livability.

The decoded arterial streets presented a variety of street interface configurations as classified by many authors (Bobić, 2004; Gehl, Kaefer and Reigstad, 2005; Gehl, 2010; Dovey and Wood, 2015). However, the findings demonstrated that permeable and accessible interfaces constitute visual and social interactions, which makes them the core focus of the study of street interface configurations. The permeable and accessible street interface, as a fundamental quality, can be formed in different configurations. Thus, the transition spaces can be formulated with different constructive elements, such as slabs, pillars, beams, and canopies.

The decoded types of permeable and accessible street interface configurations function as complementary spaces, where they can give extra space, either for the sidewalk or the building, to support social and public activities. These types shape various places, with varying degrees of function and form. In this regard, permeable and accessible interface configurations can be divided into three types.

The first type is configured as an extension of the sidewalk, meaning the interface penetrates the building line to reach the private space. This type of permeable and accessible interface provides extra space for the public realm; in turn, various public and social activities may appear. The configuration of this type provides shelter for pedestrians during severe weather seasons through the inner extension. The decoded livable arterial streets have sub-types of the extended-out interfaces, with different forms and shapes. The various sub-types, for example, include various forms of extension that can be fixed structural additions or temporary attachments, such as a gallery, outdoor café, overhang, canopy, awning, porte-cochere, and balcony.

On the other hand, the second type is configured as an extension from the private space to the public space. In this case, the interface penetrates the public space, giving extra space for collective use and enhancing the dialogue between public and private. The second type of permeable and accessible interface can be shaped into sub-types with different structural additions, such as arcades that function as covered streets providing shade for pedestrians.

Finally, the third type is mediated between the two realms, where it is configured without penetrating either the street space or the building. This type is the most common configuration of the permeable and accessible interface. However, there can also be sub-types of this category that delineate the boundary between public and private spaces.

These different types of permeable and accessible interface configurations are also relative to the sidewalk width, partitions, and ground-floor uses, which can be organized and composed in many ways that generate an overlap between the buildings and the street space. The visual and physical permeability on a microscale is also related to ground-floor uses, which contribute to inviting diverse users with different needs. Thus, the mixed uses of the ground-floor also act as "links," which include cafes, bookstores, art galleries, kiosks, and restaurants, among others, that diversify the activities of the street.

10.2.2. The street partition compositions

The international livable arterial streets revealed models for the coexistence of unlimited uses and functions. Behind their morphological qualities, many connotations are hidden. On the mesoscale, which connects the street's different levels, a livable arterial street shows complex partitions that correspond to the multifunctionality of the street. The decoded arterial streets are characterized by shared fundamental qualities of partition compositions that balance the pedestrian and automobile spaces with sufficient flexibility, capable of adapting to the changes that time and society demand without ever losing the livability that constitutes their essence.

However, these compositions can be organized in various shapes, levels, materials, and widths, from which different types of street partitions can be composed in order to enhance street livability. The street in a cross-section is mainly formed by the roadway and the sidewalks, which are the areas of vehicular traffic and pedestrian space. Therefore, the roadway and the sidewalks constitute the predominant composition of the street layout, each with sub-partitions.

The central movement canal, or roadway, is a fundamental area of the street layout and a primary element that embodies the arterial street function as a route that connects different parts of the city. The primary purpose of the central movement canal, or roadway, is vehicle mobility, including segregated space for public transport. A roadway provides dedicated space for vehicle use separate from the sidewalk and stationary activities. The livable arterial streets emphasized the importance of the roadway in forming arterial street centrality. It is a dominant and influencing element of a street's overall elements.

The arterial street, as the lifeblood of an urban area, presents a variety of forms and characteristics of the roadway area, which can include a central roadway for non-local traffic separated from local traffic lanes on either side by tree-lined medians of various widths. It may also include one or two lanes for on-street parking. The roadway is found to be configured as multi-functional to accommodate different types of traffic: fast, slow, public transport, and separated bicycle lanes. In this context, the composition of these spaces—the number of lanes, parking, and width—all play a significant role in the street's spatial structures and function, which can produce sub-types that share the same primary qualities.

On the other hand, the sidewalk space, as a platform for public life and social interaction, is a primary element of the street layout that embodies the concept of the street as a place. The sidewalks contain social life, including pedestrian movements and activities. Despite having many more potential conflict points between pedestrians and automobiles on such major streets, livable arterial streets present a substantial and extended pedestrian space that is clearly separated from the roadway with width and partitions that are balanced and that provide for the needs of diverse users. Therefore, understanding the sidewalks' composition is key to enhancing public life.

When it comes to physical characteristics, one of the main shared qualities of livable streets' sidewalks is width that is equal to the space allocated for automobiles, that accommodates various partitions, and that facilitates contact and communication without disturbing other functions of the street. Livable arterial streets require proper sizing—that is, enough space to satisfactorily cope with the role and centrality of arterial streets. Thus, in livable arterial streets, sidewalks or pedestrian spaces are used not only as a circulation space, but also as a place in its own right, capable of accommodating various pedestrian activities.

Livable arterial streets introduce a variety of sidewalk partition compositions that adhere to the same principles that ensure their functions as routes and places are met. Livable arterial streets offer zones that can be organized in different orders, including the frontage zone, the pedestrian zone, and the amenity zone. These partitions can have different widths, materials, and levels that are never composed randomly, where each partition fulfills its function.

Livable arterial streets separate pedestrians and cyclists from vehicles by certain types of partitions or vertical elements. For example, the on-street parking lane between the sidewalk and the non-local roadway creates a partition and separates pedestrians from the fast traffic flow. Livable arterial streets also have trees as vertical elements to separate pedestrians from vehicles and to provide a sense of safety. Vertical elements such as trees are the most common way to create a safe, shaded pedestrian realm. As pedestrians understand and respond to comfort, the best streets are comfortable, depending on the climate. Trees provide shade on hot, sunny days and protection from rain, making the street delightful.

Eventually, livable arterial streets will have an enclosure that is defined by the width of the street in relation to the height of buildings or trees along the street. Enclosure in livable streets is a matter of proportion, as wider streets necessitate a higher vertical element height to create spatial definition. All livable arterial streets provide a sense of enclosure, even significantly wide ones. In this regard, trees provide the needed strength and provide a proper street enclosure.

10.2.3. The urban structure permeability

Since the arterial street is a major route and an essential urban element on the scale of an urban area, decoding its livability should not be assessed only at the micro and mesoscales but also at the macroscale. From this perspective, the view at the urban structure level becomes an essential lens for connecting different street levels. Thus, having identified the livability of arterial streets on the micro- and mesoscales, we find that livable arterial streets at the macroscale level share physical qualities that correspond to their primary role in the urban area.

Although it is understood that cities have different urban patterns and that each embodies a unique identity of an urban area, the analysis of the physical and designable qualities of the livable arterial streets revealed common qualities that connect the various components of an urban area. Thus, decoding arterial streets' livability on the macroscale provided a panoramic view, aiming for possible physical qualities that strengthen the arterial streets' urban image and centrality.

The livable arterial street's physical and symbolic characteristics have urban permeability that enriches the street space and maintains its centrality. The permeability and porosity of the urban structure are critical qualities of livable arterial streets on the macro scale, as it is not only a principle that is related to the street layout but also to the surrounding street and block patterns. Urban permeability, as a morphological quality on the macroscale, supports a multiplicity of choices due to the diversity of pedestrian and cyclist options. At the macroscale, livable arterial streets share the urban permeability that advocates integration and overlapping instead of fragmentation, ensuring the continuity and diversity of accessibility for pedestrians and cyclists.

Permeability is a feature that livable arterial streets possess, ensuring their spatial centrality and allowing pedestrians choices of access. In light of these findings, permeability has a positive impact on the street's qualities, making it legible with an understandable distribution of the street spaces. Nevertheless, urban permeability can be acquired through types of different spatial solutions of great diversity through which accessibility and porosity allow for easy, effective orientation; navigation; and dialogue between the street and the surrounding urban area.

From a physical point of view, the decoded livable arteries show small-to-medium block dimensions, ranging between 90 and 180 meters in length, allowing accessibility as the prerequisite of permeability. Livable arterial streets also have a high frequency of street intersections, 130 meters on average, maximizing the number of alternative routes to the surrounding environment. This most obvious characteristic can generate a series of pedestrian access points and attractive nodes for social and commercial activities. It also leads to pedestrian flow possibilities and strengthens the formal identity of the street. Thus, livable arterial streets also share active block corners, creating a sequence of public spaces and allowing new connections in the urban area.

Moreover, livable arterial streets have urban porosity and spatial continuity through transition spaces. These ambiguous transition spaces—between the public and private and between architecture and urbanism—stimulate the street's role as a linear center that connects the street space with the surrounding area. These spaces allow a meeting between the street and the block's interior or between two streets, which introduces urban porosity, diversity, and spatial richness.

Although buildings that generate urban porosity are exceptional in a city's fabric compared with the majority of other buildings, they nevertheless have a relevant role in enhancing arterial street livability and adding spatial quality. This understanding is due to the fact that the form underlying these buildings makes it possible to open the interior of a block or to connect parts of the urban fabric, including patios, passages, pathways, and porticos, as transitional spaces between the buildings and the street space.

When framing the types of urban porosity and transition spaces, we can reveal different types that share urban porosity, which can be identified from the level of permeability they generate. Thus, the interpretation of the case studies resulted in the identification of various types of urban porosity, such as patios and passageways.

However, the above types are not the only typology of permeability; other types can be revealed. Thus, the permeability of all its types is an added value to the arterial streets because it facilitates the streets' roles as routes and places. These urban qualities have an essential role beyond the form-function relationship—namely, to attribute symbolic value and to accentuate the three-dimensional aspect of the street.

"the street has always been the scene of this conflict, between resident and traveler, between street life and the threat of traffic."

Appleyard, 1981

11. Between decoding and coding

From an urban, multiscale approach, the livable arterial street is a socially constructed urban element that is constantly developing and changing based on a set of complex and interrelated relationships, giving the street space its specific function and meaning. These complex multi-scalar and multi-dimensional relationships compose not only forms, spaces, and objects but also diverse social practices and activities. In this regard, this study decoded the arterial street qualities based on the relationship between spatial and social forms, where arterial street qualities can influence public life and enhance street livability and quality of life.

Although the livable arterial streets decoded in this study shared several fundamental principles at different levels of resolution, they were articulated by different types of spatial characteristics, from which the street gains its quality and vitality. Decoding arterial street livability demonstrated different types of interface configurations, street partition compositions, and street and block patterns, within which the livability of the arterial street can be determined. In this sense, it is evident that the generic idea of a livable arterial street is precisely associated with fundamental physical principles and social needs.

The specific conditions in which the relationships between spatial and social forms are established are constantly transforming, and each society has a particular pattern of occupying street space. Thus, the different types of spatial characteristics take different configurations, compositions, and patterns that continuously form according to the particularities of the social needs that correspond to different societies and moments.

International arterial streets, with their variations in forms, contexts, and cultures, show a clear capability of accommodating the coexistence of various transportation modes and pedestrians' activities and needs as a clear expression of their complexity. The livable arterial streets decoded in this study displayed characteristics that are not self-contained but are linked by fundamental spatial principles that reveal their synergies.

From the case studies, types were extracted based on their shared morphological characteristics. The types refer, first and foremost, to the spatial organizing principle that defines arterial street livability. The decoding process indicated that the aspirations and interests of any street always have to relate to local interests. Within this fact, between decoding and coding, there are "types" that seek the optimal solution that fulfills the needs of their users and those of the local urban community. As a result, types are required to correlate the complex morphological and social realities.

Therefore, Chapter 11 unfolds the concept between decoding and coding as the quintessence of the dissertation, from which we can create an urban code for livability and answer the study's main question. The coding of the decoded qualities is based on types that were generated from the international livable arterial streets located in different contexts. These types share the same fundamental formal quality but differ in the forms, scales, and circumstances of their contexts. In this regard, subchapter 11.1 introduces the typomorphological approach, while subchapter 11.2 refines and elaborates on the urban code based on the three selected scales: micro, meso, and macro.

11.1. Typomorphological approach

In this research, "type" acts as an outcome of the decoding process and as an approach to formulating an urban code for livability. As such, between decoding and coding is the concept of "type," which lends itself as an effective approach to describe morphological commonalities.

The concept of type interests us not only as a cognitive or classification category of what has been decoded but also as a way in which we can establish an urban code that can be adapted in different contexts based on local needs. As mentioned in Chapter 04, according to Moudon (1994), typomorphology is the study between morphology and typology. It is characterized by combining morphology and typology, as stated by Bobić (2004, p.70): "Typo-morphology reflects the fact that morphology and type cannot be separated, nor can one term be dominant over the other." It is a fundamental approach that follows the process of decoding streets' physical qualities in order to recompose the arterial streets' morphological qualities that enhance livability.

In fact, the theme of type and typology is commonly used and discussed in the fields of architecture, urbanism, and history (Rossi, 1966; Steadman, 1979; Caniggia and Maffei, 2001; Cataldi, 2003; Panerai *et al.*, 2004; Proença, 2014). However, in architectural theory, type and typology began to gain relevance at the end of the eighteenth century. The first to theoretically formulate the concept of type into architecture, relating it to artistic production and establishing its differences in relation to the model, was Antoine Chrysostome Quatremère de Quincy (1755–1849), through a rational and scientific method (Madrazo, 1995).

For Quatremère de Quincy, "The word 'type' represents not so much the image of a thing to be copied or perfectly imitated as the idea of an element that must itself serve as a rule for the model. . . . The model, understood in terms of the practical execution of art, is an object that must be repeated as it is; type, on the contrary, is an object, according to which one can conceive works that do not resemble one another at all. Everything is precise and given in the model; everything is more or less vague in the type. Thus we see that the imitation of types involves nothing that feelings or spirit cannot recognize." (Quatremere de Quincy quoted in Rossi, 1966, p.40)

Quatremere's definition and perspective of conflating architecture with sociality through the heuristics of type were discussed by historians and architects such as Aldo Rossi (1931 – 1997), who defines "type" as the very essence of architecture (Rossi, 1966). It has also been used many times as a starting point for the theorization necessary for the study of types. Moneo (1978, p. 23) defined type "as a concept which describes a group of objects characterized by the same formal structure". That is, it implies the presence of certain shared structural characteristics among various objects. As the level of specificity within a group increases, additional levels of categorization emerge, leading to the formation of new categories of types.

Thus, the type contains symbolic meanings for something else with established common characteristics, which a phenomenological process can manipulate; that is, it corresponds to an element that can be invoked but does not imply the reproduction or repetition of existing forms. On the other hand, typology is the study of types, or rather, the study that proceeds to a classification by types based on an investigation built on observation and description (Moneo, 1978). Typology, therefore, is generally a cognitive system, as it allows a vast set of phenomena to be grouped and ordered by categories, classes, or scales. According to Bobić (2004), typology is related to the fundamental physical and functional scales.

Relatedly, as mentioned above, the first works of typological analysis linked to urban morphology, which established relationships between urban morphology and built typology, were based on the works of the Italian School, developed by Saverio Muratori in the 1950s. Muratori founded the Italian school of typology by developing a study on the urban fabric of Venice and proposing a typomorphological method of analysis for understanding the structure of cities (Moudon, 1997).

In various writings and works in architecture and urbanism, since the mid-twentieth century, the typomorphological approach has assumed a critical role in interpreting the urban fabric's dynamics and decoding the urban physical and spatial elements based on systematic classification processes (Moudon, 1998). Thus, type and typology can be an approach to conceiving, interpreting, and constructing the city and its elements. Concerning this research, typomorphology is used to describe the final types found within the study, from which the urban code can be formulated. In other words, after the morphological characterization and interpretation, the typomorphological framework consists of the elaboration of the types that compose livable arterial streets.

11.2. The typomorphological urban code

Urban coding, as a tool for regulating the built environment, has a long history and has made contributions to shaping better cities and enhancing overall place quality (Carmona, 2009; Adams, Croudace and Tiesdell, 2011). Urban coding has always been historically interwoven with the history of planning to create more livable urban environments, such as Seaside, a Florida development, which defines standards for plot size, public space location, building heights, and parking (Marshall, 2011). However, the term "urban code" embraces a diversity of practices and can be understood in many ways in urban studies, as Marshall (2011) stated that any code used in the urban context, such as a building code, design code, or zoning code, can be represented as an urban code.

In the context of this thesis, the typomorphological approach is used to categorize the final types of livable arterial streets that have already been acknowledged for their quality based on the dominant types identified in each case study. Although these types have emerged from a specific set of cultural, climatic, and economic factors, the typological principles underlying them have the potential to be transferred and adapted to different contexts to be an explicit and implicit reference point. As stated by Christ *et al.* (2015), the concept of typology is characterized by its abstract and general nature, allowing it to transcend specific geographical locations.

The approach introduces a diversity of types, sharing the same principles but using different variables. The approach, as a heuristic and didactic instrument, answers the question of how to build an urban code for livability by reinterpreting the livable streets' morphological qualities that influence public life.

In this regard, the urban code takes the form of "types" that allow for adaptation to particular cultural conditions expressed through abstract representations, reducing the street elements to their fundamental form and allowing space for additional variations within the type. Therefore, urban arterial streets can be created or improved through a continual process of decoding and coding toward desired cultural ends. In this context, the urban code in this research differs from the idea of a model, which is associated with copying and imitation; instead, it aims to create a typology of physical qualities that can be developed and adapted to different contexts. From this perspective, the urban code does not stipulate a model or design solution; rather, it is a part of the design process and a means to ground urban design in urban morphology.

The following urban code seeks to formulate ground rules or recommendations for the arterial streets based on the extracted morphological qualities decoded from the referential case studies. As the morphological characteristics of arterial streets were interpreted and decoded on different scales of resolution, coding the extracted qualities is also based on the same level of reading the streets, where each level categorizes a different set of properties that determine livability. From these criteria, we can proceed to the first property on each scale, which can group together elements that have common characteristics and share the same fundamental property. The scale of resolution holds the potential to organize and classify the extracted qualities through rational abstraction, reducing them to their simplest expression and allowing for the structuring of the urban code. The coding of each of the three scales is classified following the bottom-up approach, starting from the microscale, as follows:

11.2.1. The microscale

The microscale describes the smallest level of resolution that focuses on the quality, which is related to the relationship between the street interface and pedestrians' visual perception. Although a variety of interface configurations can create permeability and accessibility, not all of them can be considered as an urbanity interface. Therefore, the main principle of this scale is the permeability and accessibility of the street interface configurations that are able to generate street public life.

(A.1) *The street interface configurations*

The permeable and accessible street interface configurations, according to their relation to public and private spaces for public use, can be categorized into three types (see Figure 11.2-1). However, these three types can have sub-types through additional fixed or temporary structures or attachments (e.g., balconies, overhangs, canopies, awnings, etc.), as follows:

(A.1.1) is a permeable and accessible interface type, where the interface at the ground floor penetrates the building line, creating an inward extension and providing extra space for the sidewalk.

In terms of form, the (A.1.1) interface can manifest in diverse architectural expressions that are contingent upon various factors, such as context, regulations, and design intentions. It may encompass a recessed entrance that beckons pedestrians inward or a continuous canopy-like structure that extends from the building facade, serving as both a shelter and a delineator of a distinct spatial zone. The form may incorporate architectural elements such as columns, arches, or ornamental motifs, thereby enhancing visual interest and bestowing a sense of architectural character upon the interface.

The dimensions of this interface type constitute a pivotal aspect, as they directly influence its functional efficacy and occupations. The width of this interface type can vary based on several factors; however, a range between 1 and 6 meters in width may provide a generous spatial allocation that accommodates a range of pedestrian activities with utmost comfort. Within this expansive width, various occupations can be fostered, cultivating a vibrant pedestrian environment. For instance, the provision of strategically placed seating areas, comprising fixed benches or flexible seating elements, offers pedestrians respite and opportunities for social engagement.

Moreover, the inward extension facilitated by this interface type presents an array of possibilities for use. In addition, it can serve as an incubator for small-scale pop-up shops, boutiques, or street vendors, invigorating street life and fostering local economic activity. It may also invite the incorporation of art installations, sculptures, or interactive displays, thereby transforming it into an engaging public space that invites passersby and enriches street life (Figure 11.2-2).

(A.1.2) is a permeable and accessible interface type where the interface at the ground floor penetrates the sidewalk, creating an outward extension and providing extra space for collective uses.

In terms of form, the (A.1.2) interface type can be realized through various forms, including canopies or arcades. Canopies comprise elevated structures that extend horizontally from the building facade, providing shelter and protection to pedestrians below. Arcades, on the other hand, are characterized by a series of arches or columns supporting a roof structure, creating a covered walkway. Both forms contribute to enhancing pedestrians' comfort and convenience, serving as protective elements against inclement weather conditions.

The extension's width, which can vary from 1 meter to 10 meters, is contingent upon multiple factors, including the width of the sidewalk and applicable regulations. This variation in width allows for flexibility in accommodating different urban contexts and user requirements. The ample space provided by the extended interface fosters diverse collective uses, further enriching the street space.

This interface type generates various potential occupations that contribute to the vitality and functionality of the street. First, the outward extension can serve as an exhibition area, where objects are displayed on the pavement. Moreover, this extended interface effectively lends itself to being utilized as a sidewalk café, offering a temporary or seasonal extension of the building's amenities. By integrating seating areas and tables within the extended space, the interface fosters opportunities for social gatherings (Figure 11.2-3).

(A.1.3) is a permeable and accessible interface type where the interface at the ground floor mediates the building and the sidewalk without penetrating either public or private space, creating an equilibrium between public and private space.

This interface type represents the strictest division between public and private areas, where the two domains meet directly and confront each other without ambiguity. This interface type is characterized by a small width, which can extend up to 0.9 meters. This limited width is determined by the form and function of the interface. It allows for the inclusion of elements such as a colonnade, which consists of evenly spaced columns supporting a building above. These columns serve as an integral part of the public space, providing a sense of protection and creating a place for social gatherings (Figure 11.2-4).

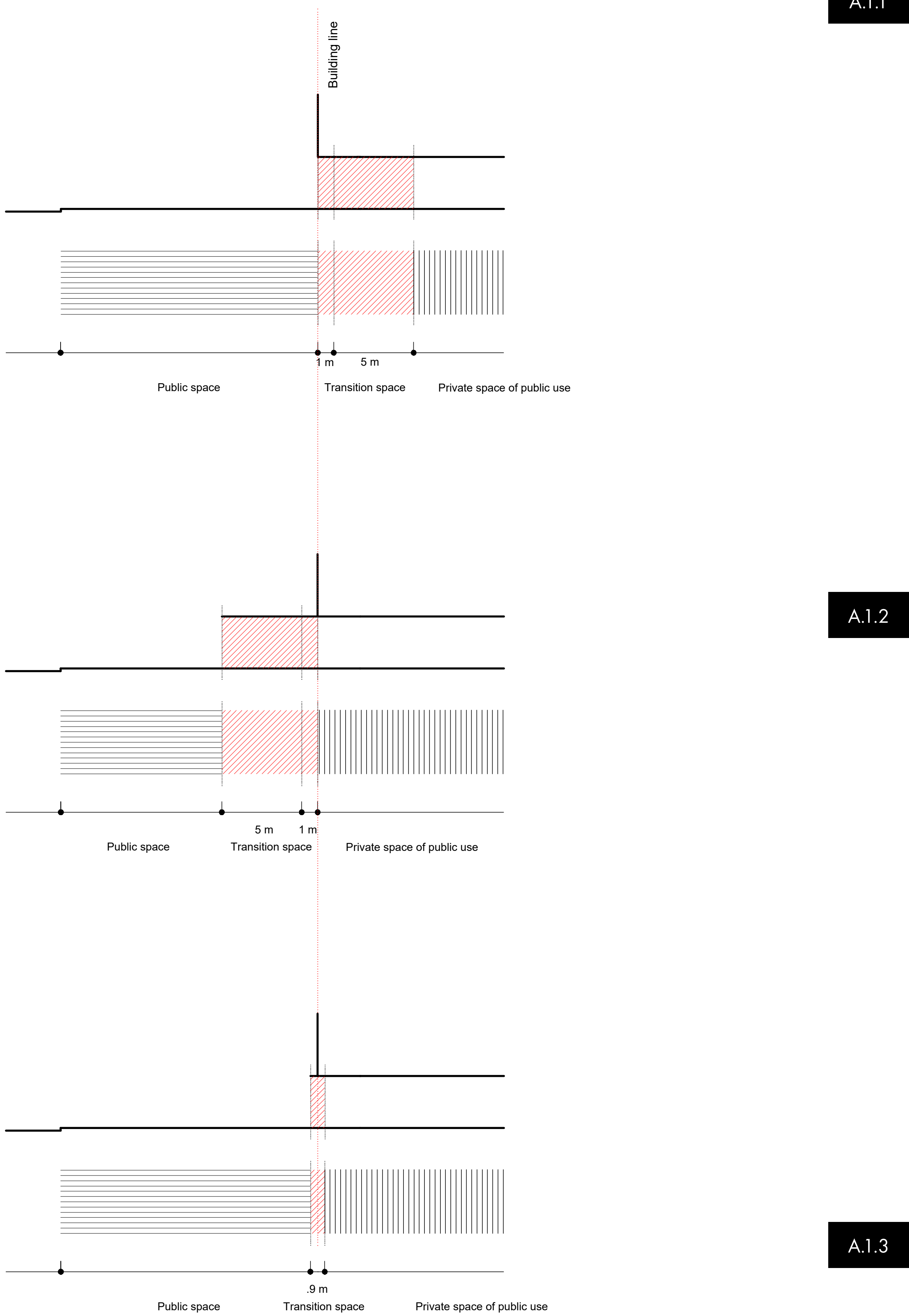


Figure 11.2-1 Cross-section of the three main types of the permeable and accessible street interface configurations (Source: Author's Edition).

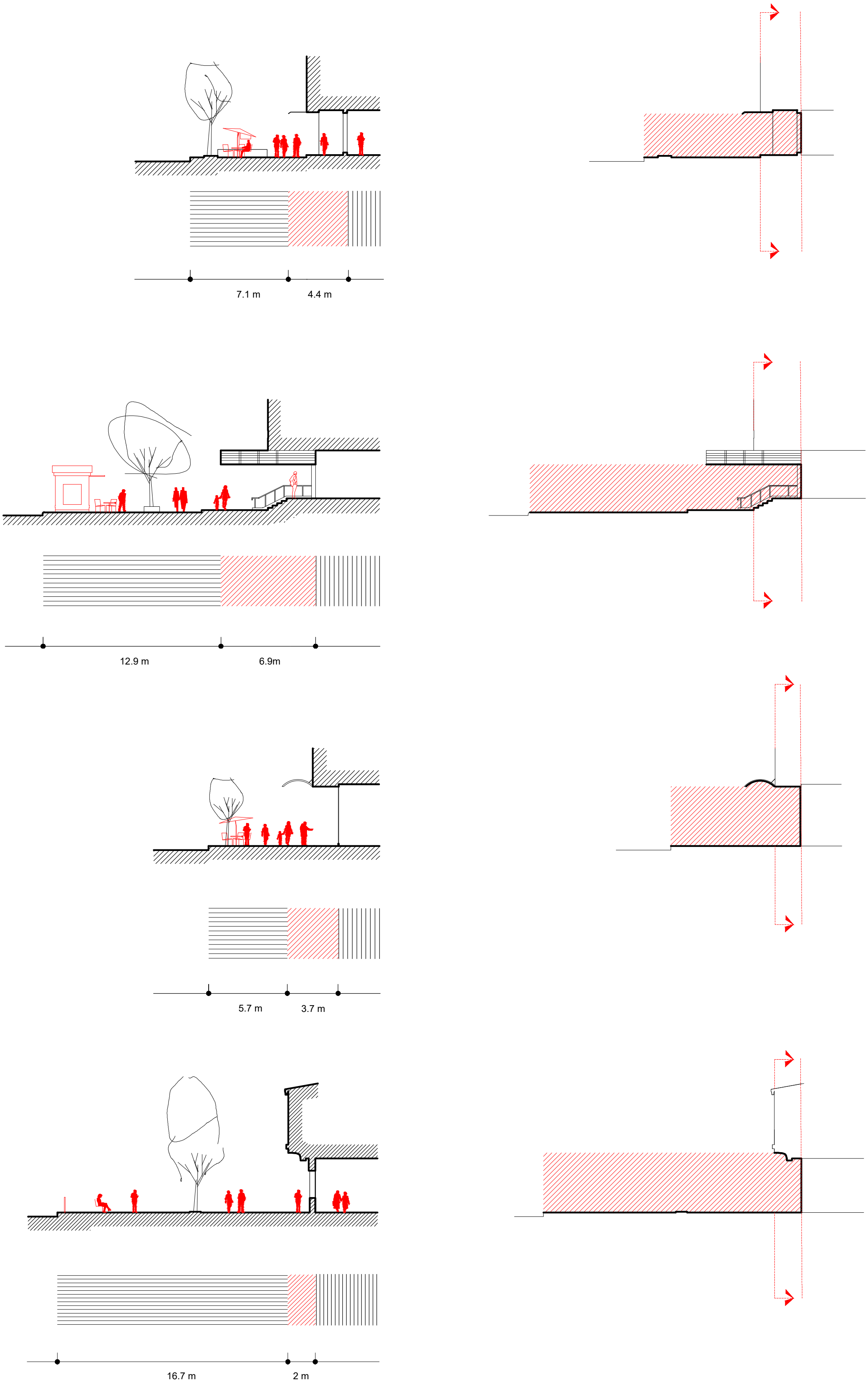


Figure 11.2-2 Cross-sections of the microscale (A.1.1). (Source: Author's Edition).

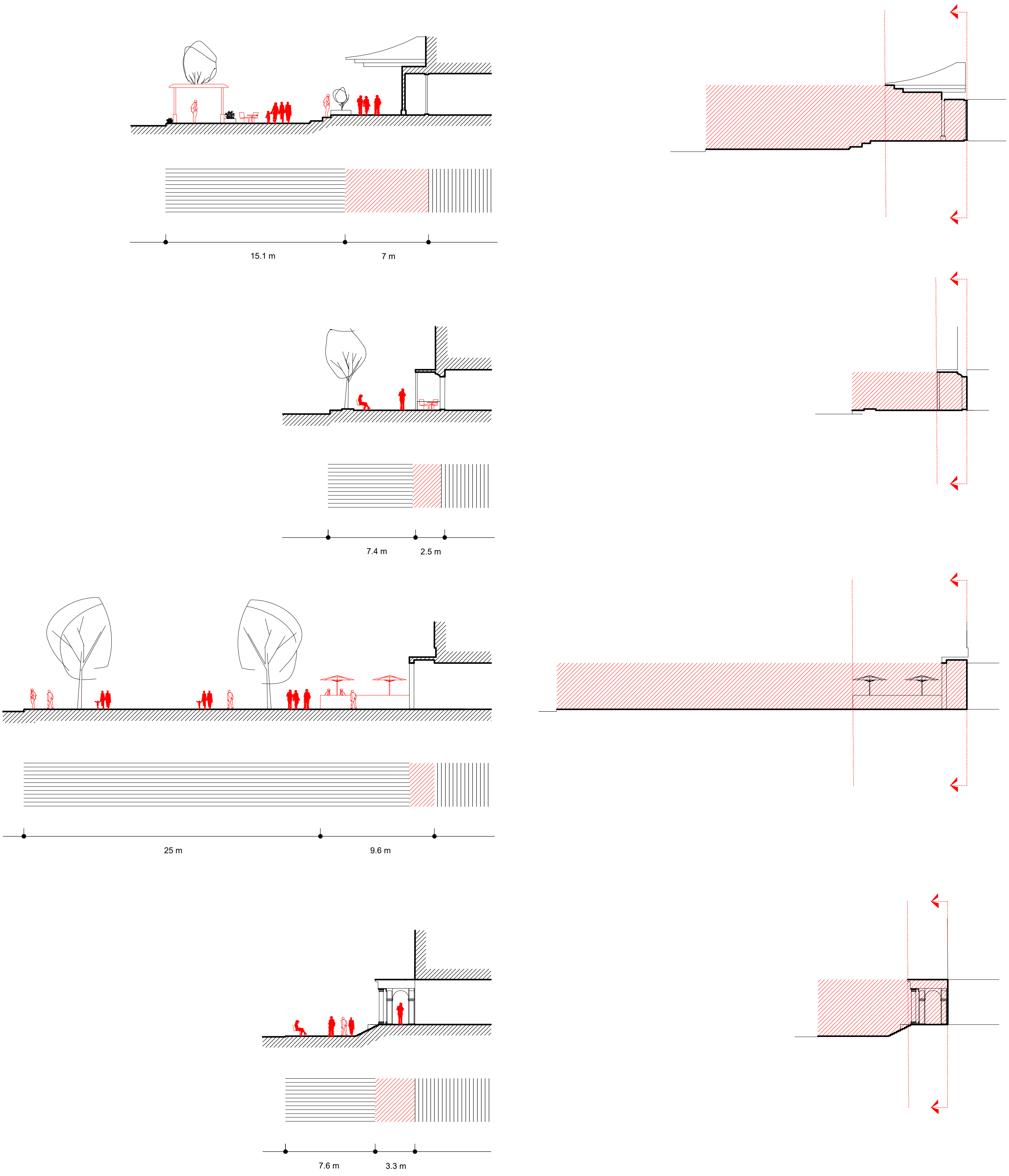


Figure 11.2-3 Cross-sections of the microscale (A.1.2). (Source: Author's Edition).

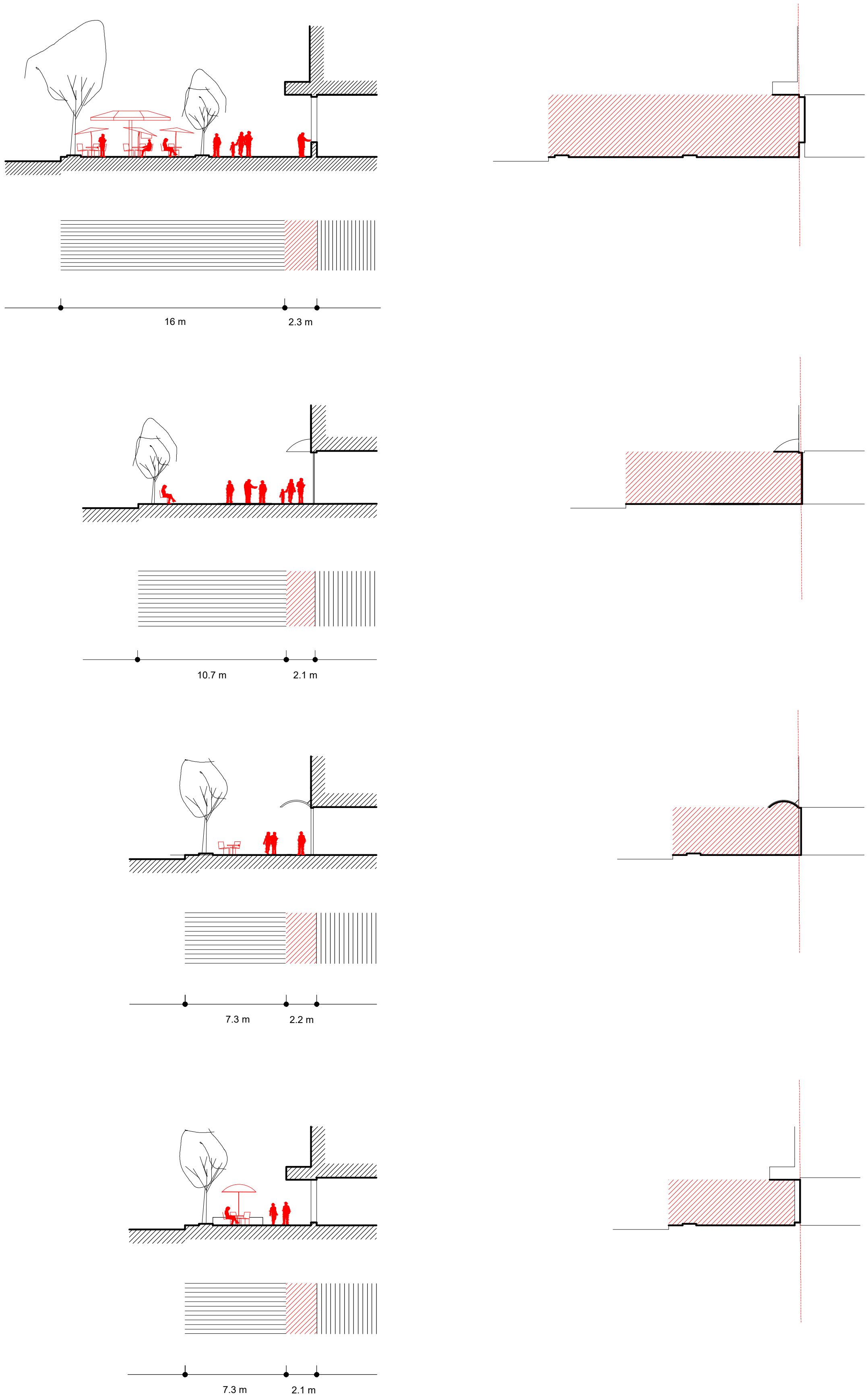


Figure 11.2-4 Cross-sections of the microscale (A.1.3). (Source: Author's Edition).

11.2.2. The mesoscale

The mesoscale represents the intermediate lens that links the different scales for reading the street. The main property of this scale is the street partition compositions' complexity and diversity, which allow the street to function as a route and a place and which can have various composition arrangement types.

(B.1) *The street partition compositions*

The street partition compositions can never be formed randomly; they must fulfill the arterial street's function as a route and a place, balance pedestrian and automobile needs, and create a sense of enclosure. This complexity and diversity of street partition compositions can be formed in different types of arrangements, ratios, and relations. Thus, based on the two realms of the street, the pedestrian and roadway realms, three main types can be categorized. These types can share some of the principle qualities of livable arterial streets.

The roadway is located in the central area of the street space, with at least two and often three lanes in each direction, or multiple lanes in one direction only. This roadway is devoted to relatively fast through-going traffic. The overall width of the center realm is determined by balancing considerations of the available right-of-way (maximum of about 50 percent of the street width), the traffic capacity desired, and the need for pedestrians to cross the street safely. Public transit is best accommodated in the lane adjacent to the roadway to ensure speed and accommodate large vehicles.

The pedestrian realms are on the sides of this roadway, separating it from the abutting buildings. These can include the sidewalk, a narrow access street with at least one parking lane and one moving lane, and a continuous tree-lined median. Movement in these realms is slow and mainly intended to serve as access to the buildings and uses along the street, and for slow local traffic.

Establishing a pedestrian realm in all the area that extends from the edge of the right-of-way to the edge of the median along the central roadway is vital to a successful and safe arterial. However, the pedestrian realms on both sides, or in the center area, should be at least 50 percent of the overall width of the right-of-way.

The pedestrian realm should be defined strongly by a continuous median, planted with at least one uninterrupted, densely spaced line of trees, that marks the boundary with the central, through-traffic realm. The canopy of trees and the buildings facing the street create a defined enclosed space at a pedestrian scale.

The median can accommodate many amenities for pedestrians, such as transit stops and subway entrances, kiosks, benches, or fountains, all of which encourage many crossings between the sidewalk and the median, thereby increasing the domination of all the space by pedestrians.

On arterial streets, continuous medians bound the center roadway and the pedestrian realms on each side, separating them and joining them simultaneously. Medians are the most flexible part of the design of an artery, and their form and character determine a great extent, the form and character of the street. The primary function of the medians is to define and protect the pedestrian realm from the speed and noise of traffic on the center roadway. The medians create a more tranquil and slow-paced realm between them and the buildings facing the street. The width of the medians depends largely on the width of the overall right-of-way. However, as an absolute minimum, the medians must be wide enough to accommodate a line of closely spaced relatively large trees.

Therefore three main types can be categorized as follows, which can be extended to include a variety of other sub-types (Figure 11.2-5). The first type comprises a wide central roadway, occupying approximately 1/3 of the total street width, primarily intended for through traffic and other transportation modes. Optionally, a tree-lined median may be included. The sides of the street are dedicated to pedestrian spaces, which incorporate bicycle paths along their outer edges. These pedestrian areas, encompassing about 2/3 of the total street width, are separated from the roadway by rows of street trees.

In the second type, the central space accommodates a roadway for through traffic and a wide pedestrian area, which constitutes approximately 2/3 of the total pedestrian space width. This central pedestrian space can be entirely designated as a pedestrian promenade or configured to include cyclist lanes. Public transportation systems act as separators between the pedestrian space and the roadway. In this type, the sides of the street are narrower and primarily serve as access points for pedestrians to adjacent properties.

The third type involves an alternating allocation of space between pedestrians and automobiles along the street with different widths. The central roadway in this type occupies approximately 2/3 of the total automobile space width, while the remaining 1/3 is dedicated to local traffic along the sides of the street. A grassy median or cyclist lane separates the local traffic and through traffic. The pedestrian realms of this type are divided between the central pedestrian spaces and the sides of the street.

Thus, the complexity and diversity of street partition compositions arise from the various possibilities that different street widths offer. Depending on the width of the street, different arrangements, ratios, and relations can be employed to create an effective street partition. Figures 11.2-6, 11.2-7, and 11.2-8 present the possible types found in existing livable arterial streets where each type includes the following:

(B.1.1) The street partition compositions' diversity and complexity.

(B.1.2) Pedestrian-to-automobile ratio.

(B.1.3) Street trees and enclosure.

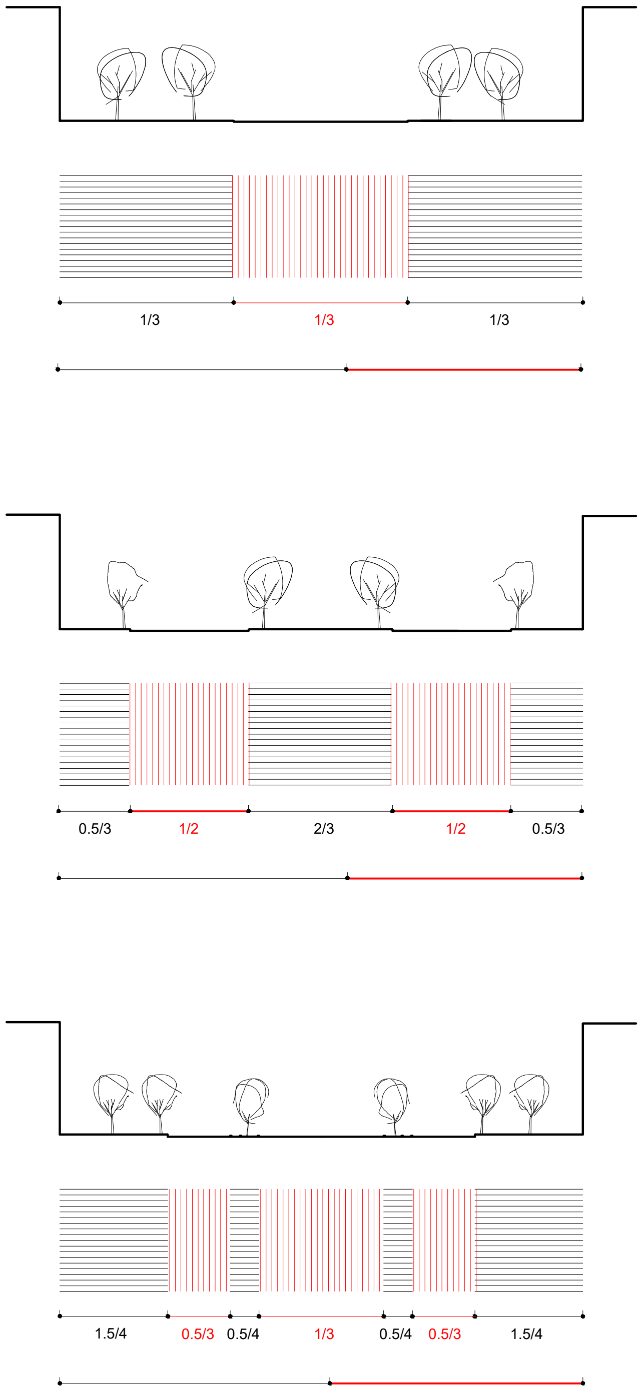
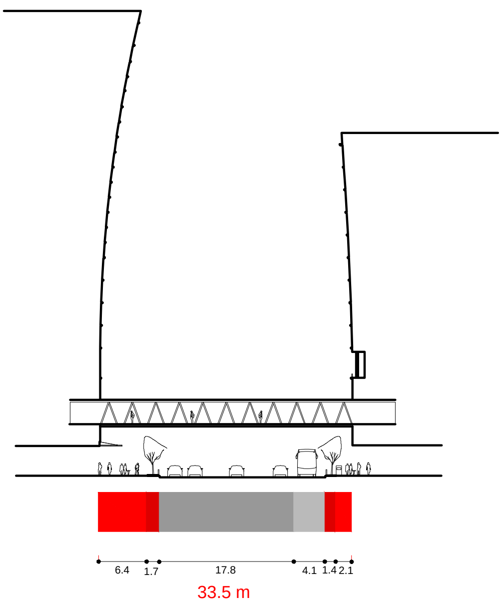
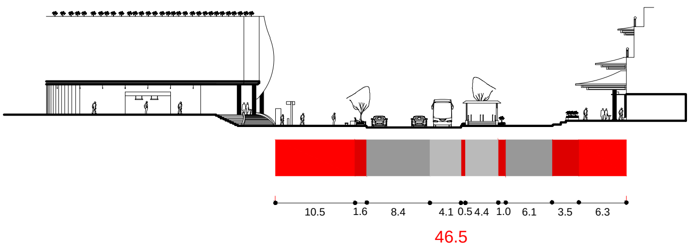


Figure 11.2-5 Cross-sections of the three types of street partition compositions. (Source: Author's Edition).





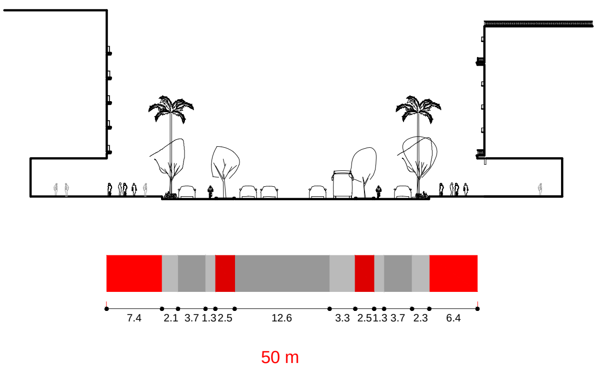
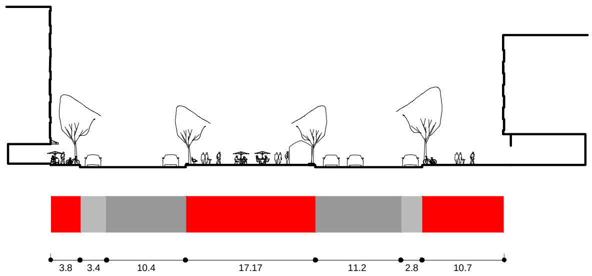
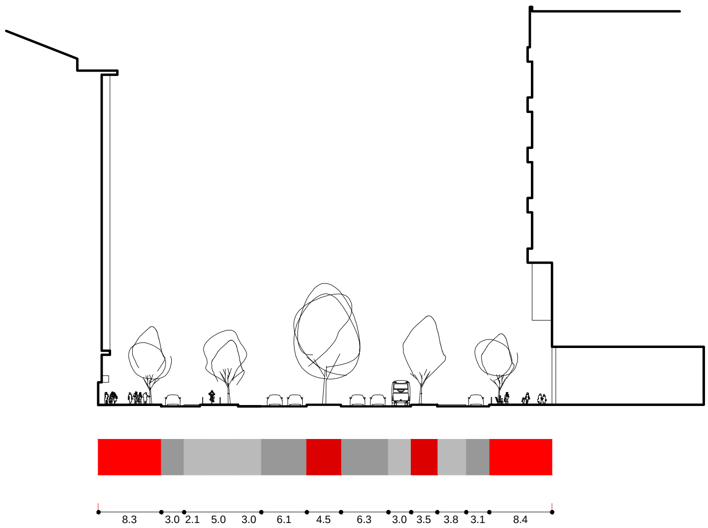
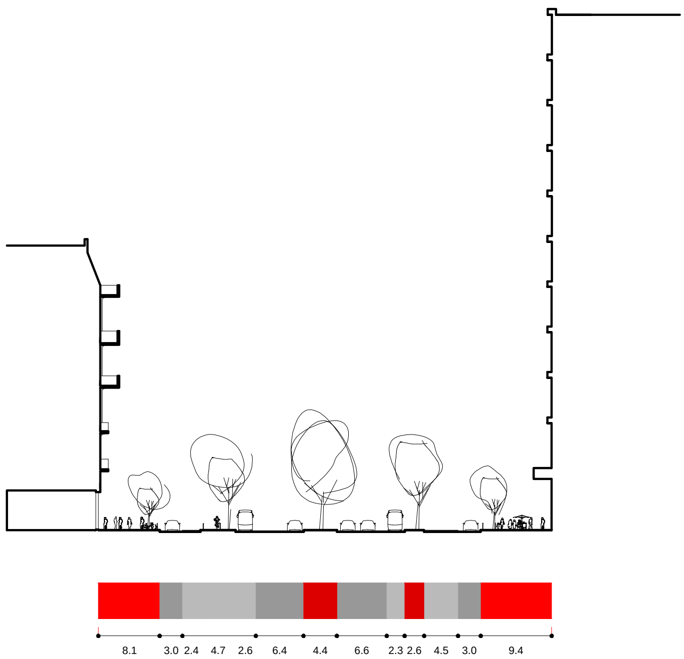


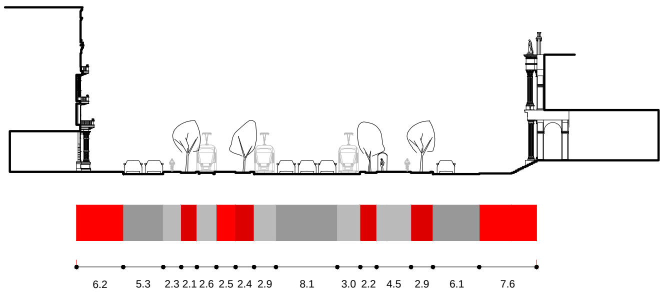
Figure 11.2-6 Cross-sections of the mesoscale (B.1.1). (Source: Author's Edition).
a) Orchard Road, Singapore (B.1.1).
b) Orchard Road, Singapore (B.1.1).
c) Avinguda Diagonal, Barcelona (B.1.1).



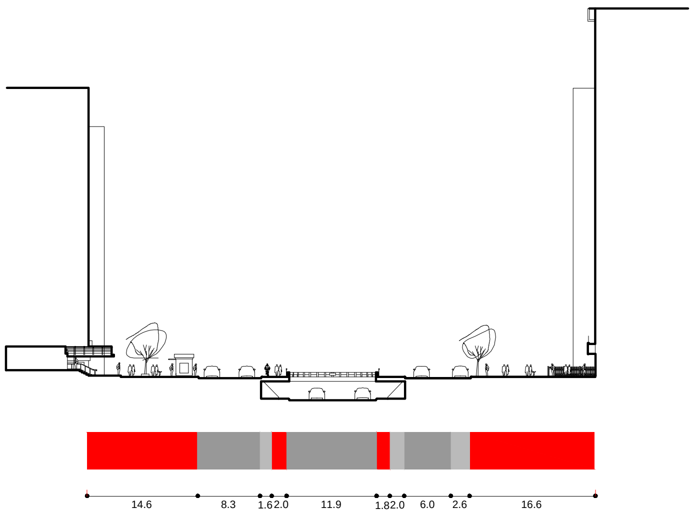




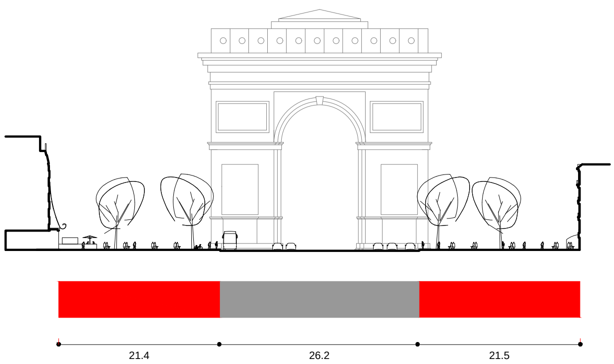
d) Unter den Linden, Berlin (B.1.1).
e) Av. da República, Lisbon (B.1.1).
f) Av. da República, Lisbon (B.1.1).



61.2 m
(Ringstrasse , Vienna)

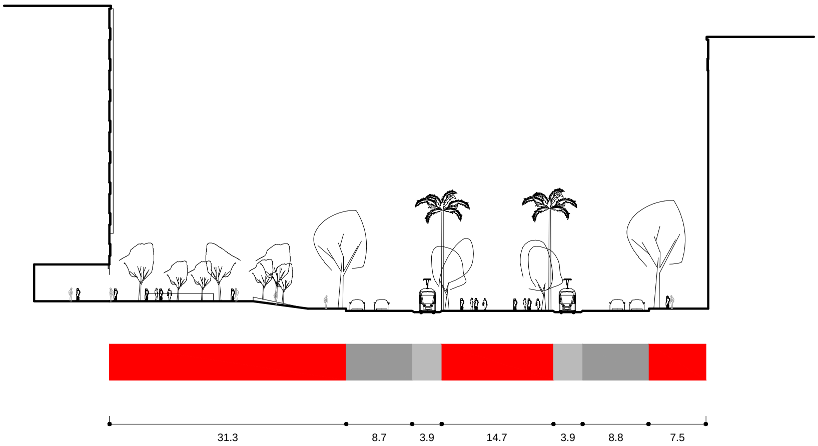


67 m
(A.Paulista, São Paulo)

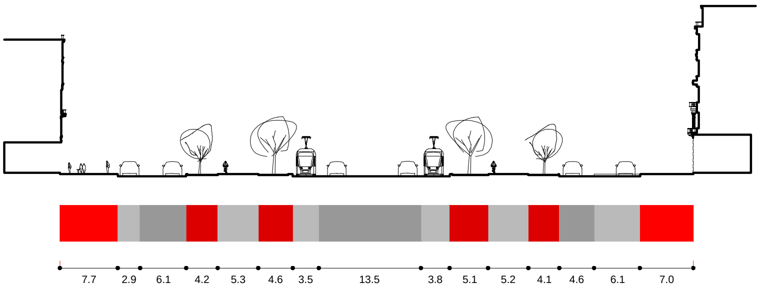


70 m
(Avenue des Champs-Elysées, Paris)

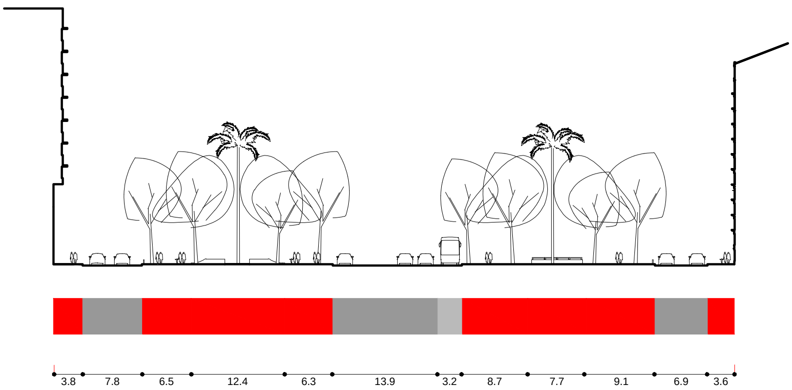
g) Ringstrasse , Vienna (B.1.1).
h) Av.Paulista, São Paulo (B.1.1).
i) Avenue des Champs-Elysées, Paris (B.1.1).



78.8 m
(Avinguda Diagonal, Barcelona)

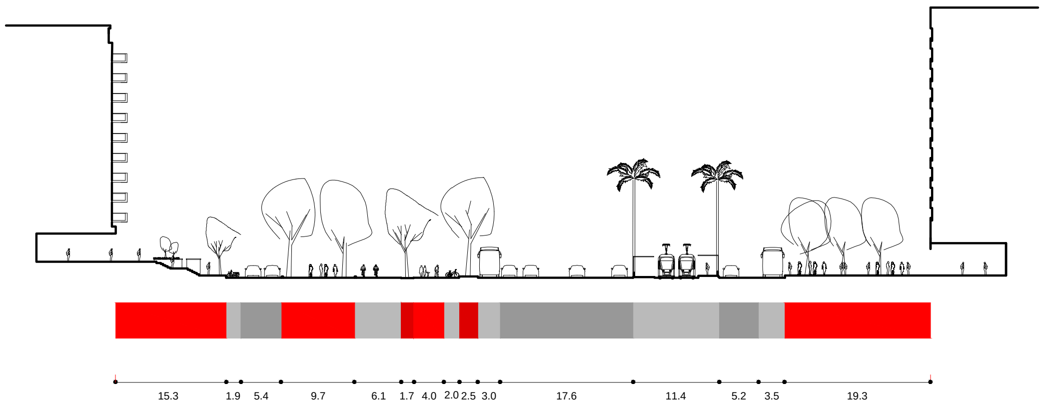


83.8 m
(Ringstrasse , Vienna)

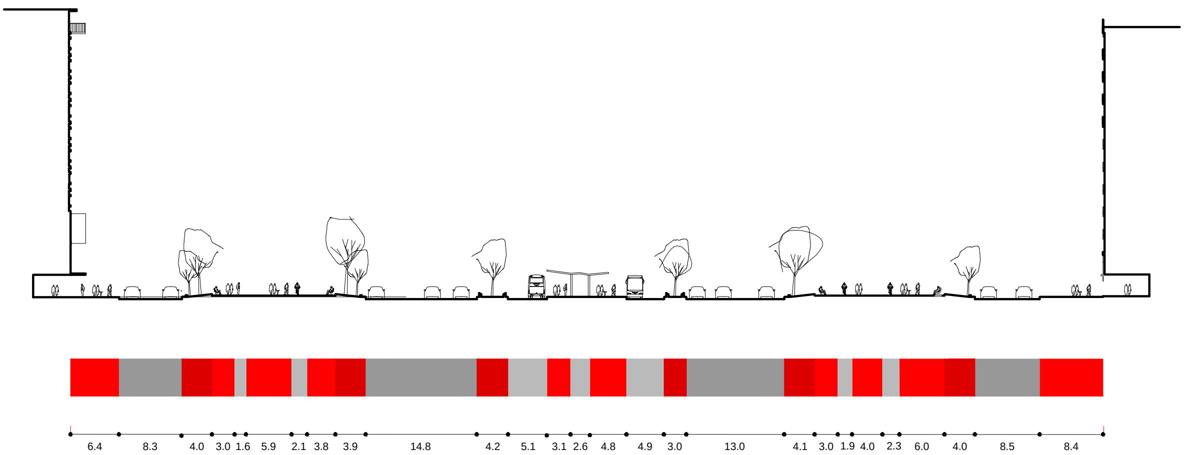


90 m
(Av. da Liberdade, Lisbon)

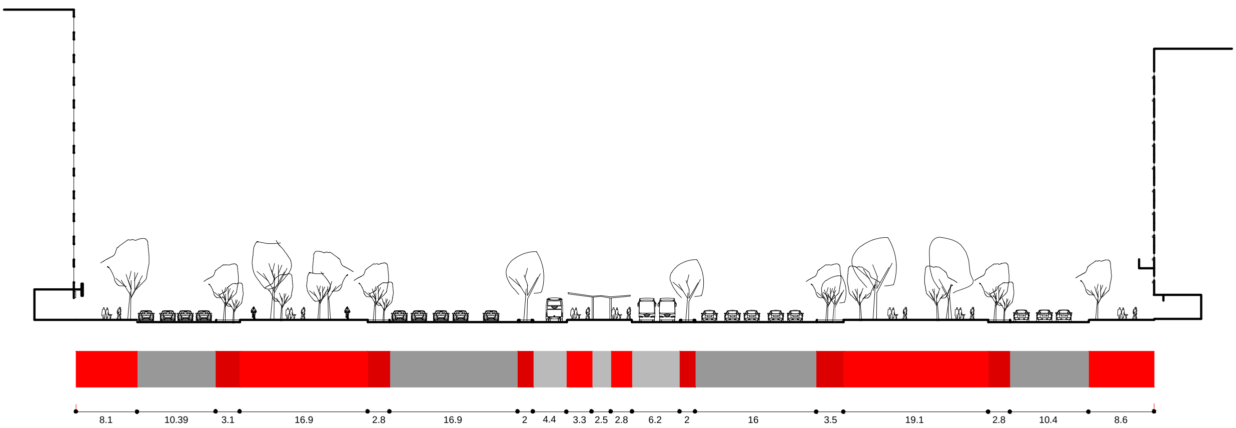
j) Avinguda Diagonal, Barcelona (B.1.1).
k) Ringstrasse , Vienna (B.1.1).
l) Av. da Liberdade, Lisbon (B.1.1).



108.5 m
(Avinguda Diagonal, Barcelona)

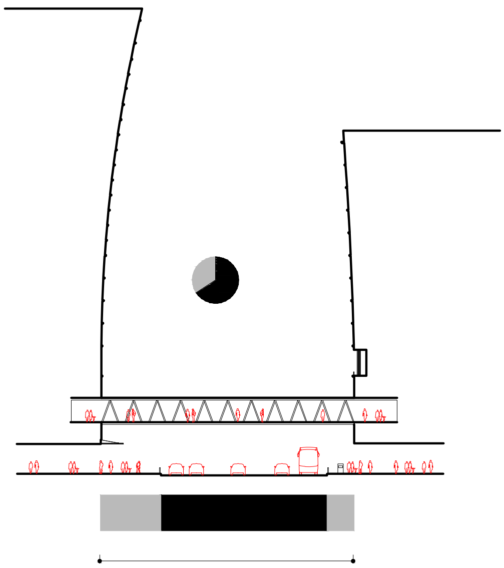


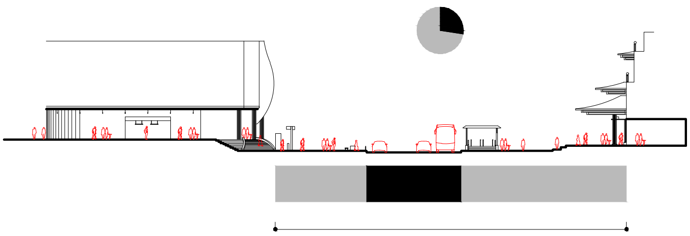
136.7 m
(9 de Julio Avenue , Buenos Aires)



143.2 m
(9 de Julio Avenue , Buenos Aires)

m) Avinguda Diagonal, Barcelona (B.1.1).
n) 9 de Julio Avenue , Buenos Aires (B.1.1).
o) 9 de Julio Avenue , Buenos Aires (B.1.1).





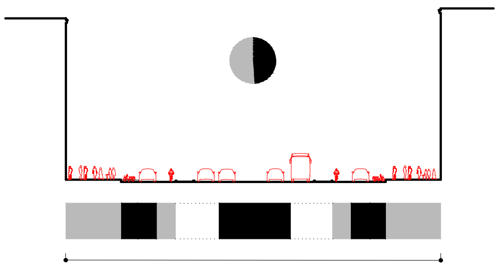
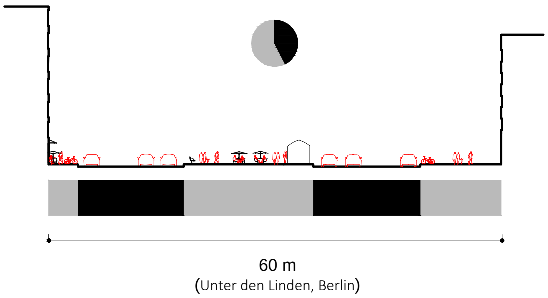
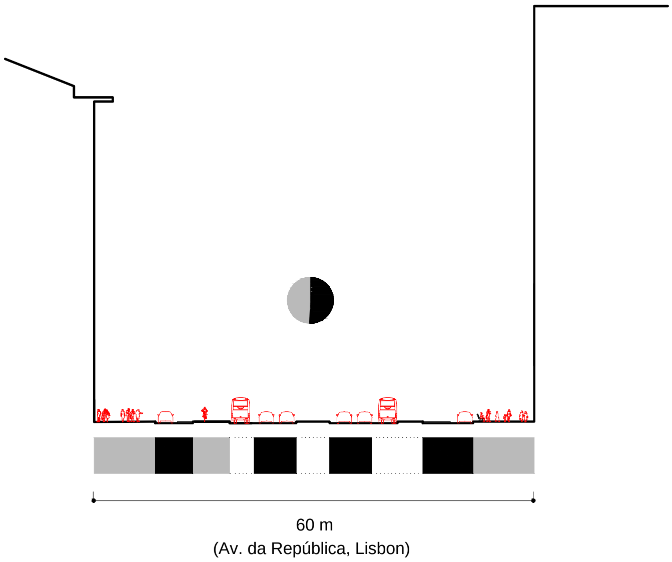
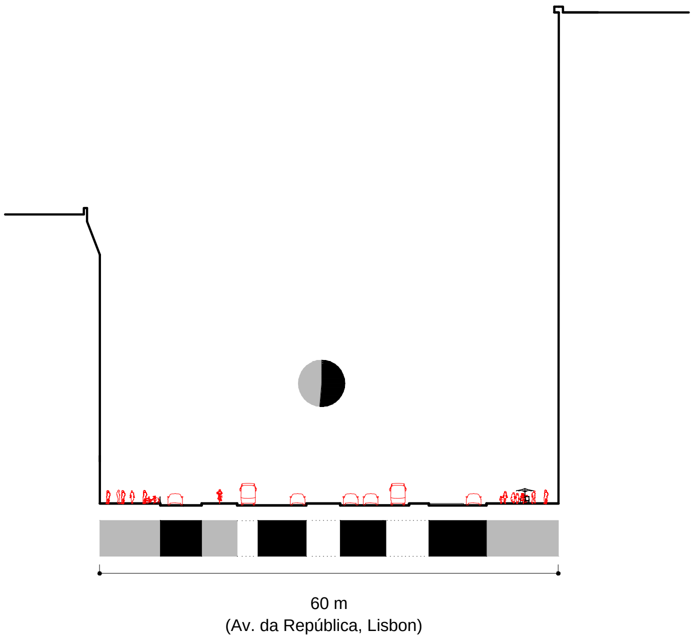


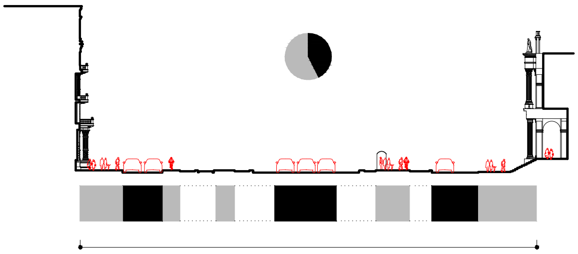
Figure 11.2-7 Cross-sections of the mesoscale (B.1.2). (Source: Author's Edition).
a) Orchard Road, Singapore (B.1.2).
b) Orchard Road, Singapore (B.1.2).
c) Avinguda Diagonal, Barcelona (B.1.2).



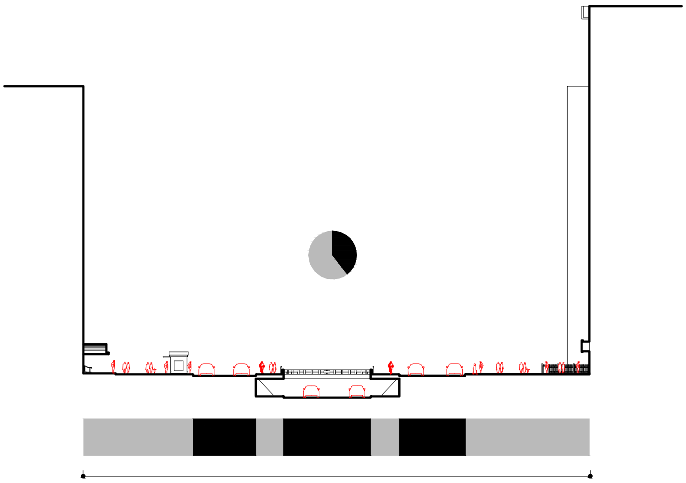




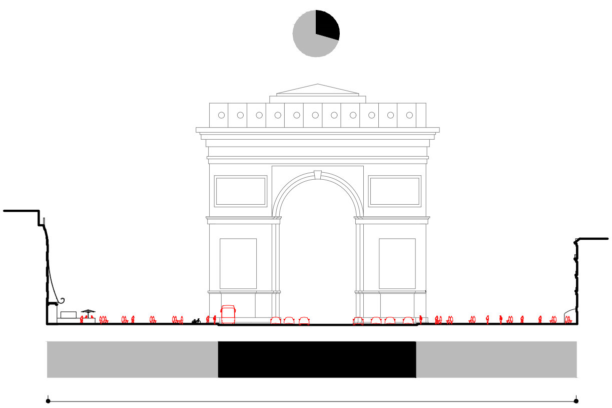
d) Unter den Linden, Berlin (B.1.2).
e) Av. da República, Lisbon (B.1.2).
f) Av. da República, Lisbon (B.1.2).



61.2 m
(Ringstrasse , Vienna)

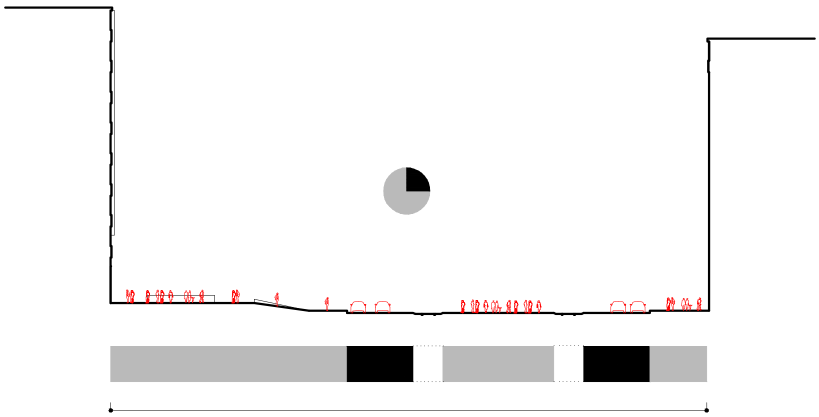


67 m
(A.Paulista, São Paulo)

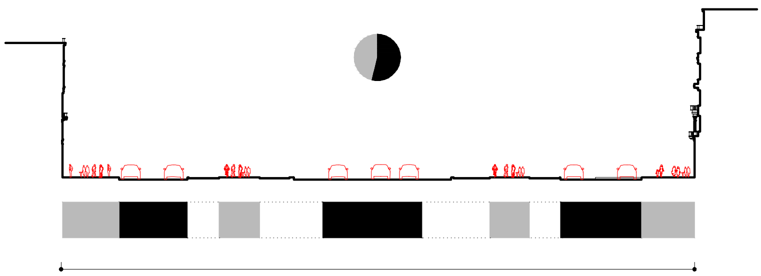


70 m
(Avenue des Champs-Elysées, Paris)

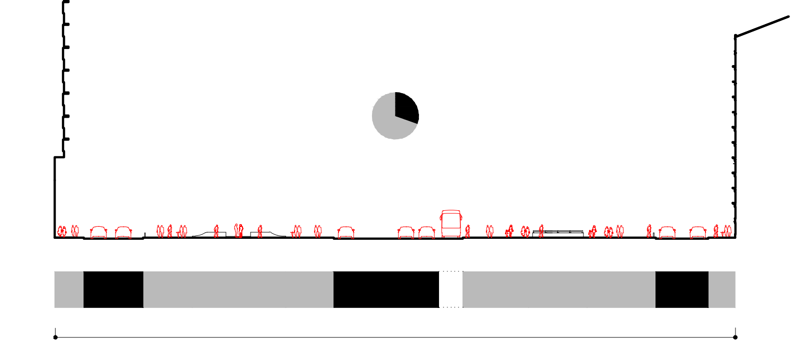
g) Ringstrasse , Vienna (B.1.2).
h) Av.Paulista, São Paulo (B.1.2).
i) Avenue des Champs-Elysées, Paris (B.1.2).



78.8 m
(Avinguda Diagonal, Barcelona)

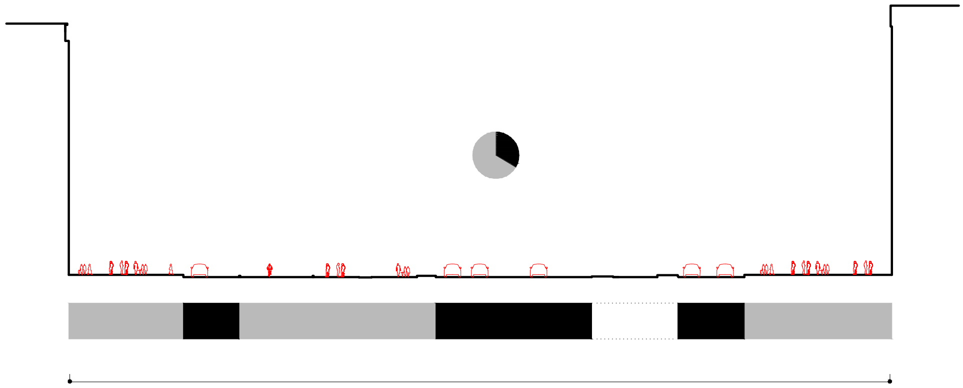


83.8 m
(Ringstrasse , Vienna)

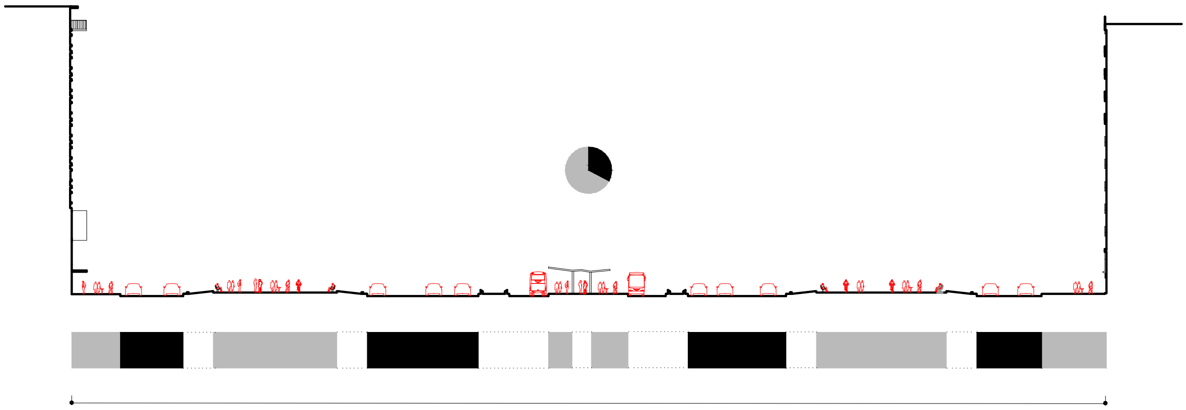


90 m
(Av. da Liberdade, Lisbon)

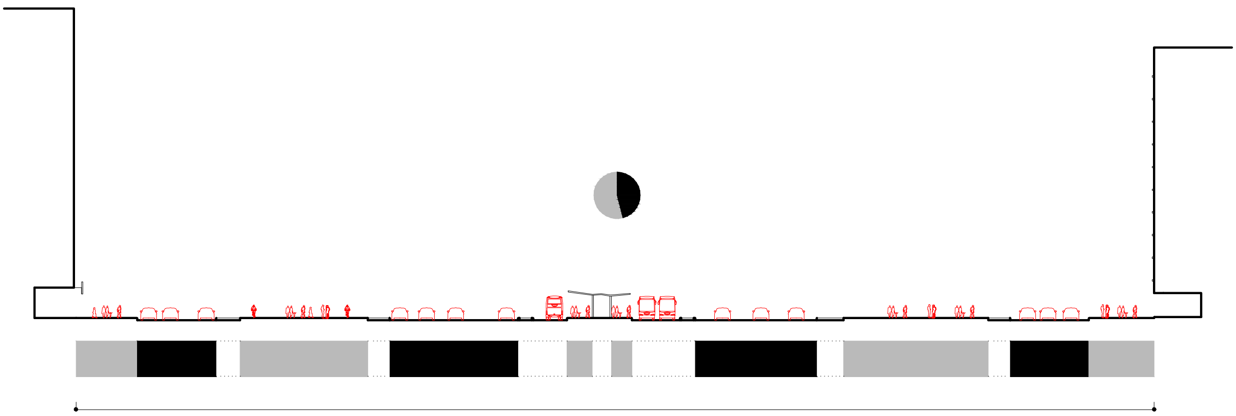
j) Avinguda Diagonal, Barcelona (B.1.2).
k) Ringstrasse , Vienna (B.1.2).
l) Av. da Liberdade, Lisbon (B.1.2).



108.5 m
(Avinguda Diagonal, Barcelona)

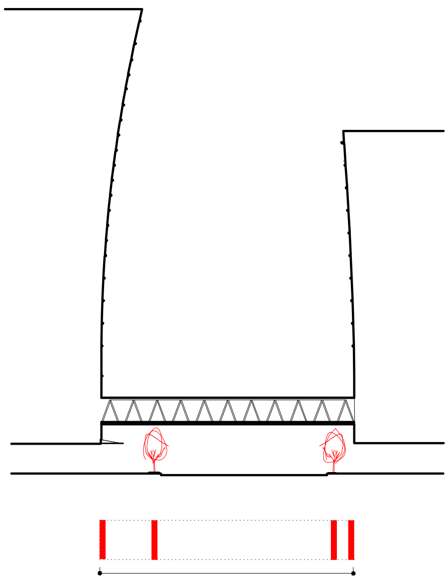


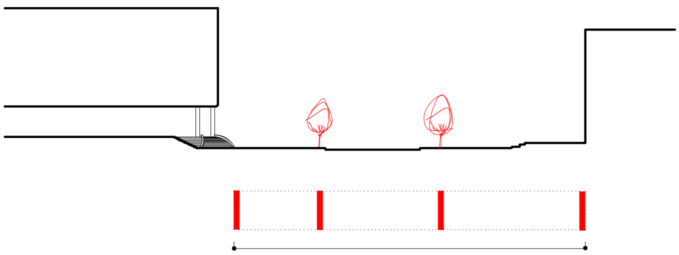
136.7 m
(9 de Julio Avenue , Buenos Aires)



143.2 m
(9 de Julio Avenue , Buenos Aires)

m) Avinguda Diagonal, Barcelona (B.1.2).
n) 9 de Julio Avenue , Buenos Aires (B.1.2).
o) 9 de Julio Avenue , Buenos Aires (B.1.2).





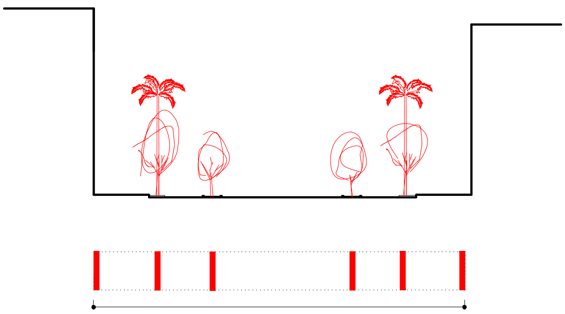
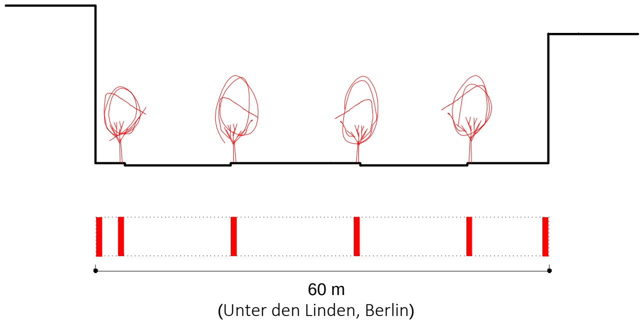
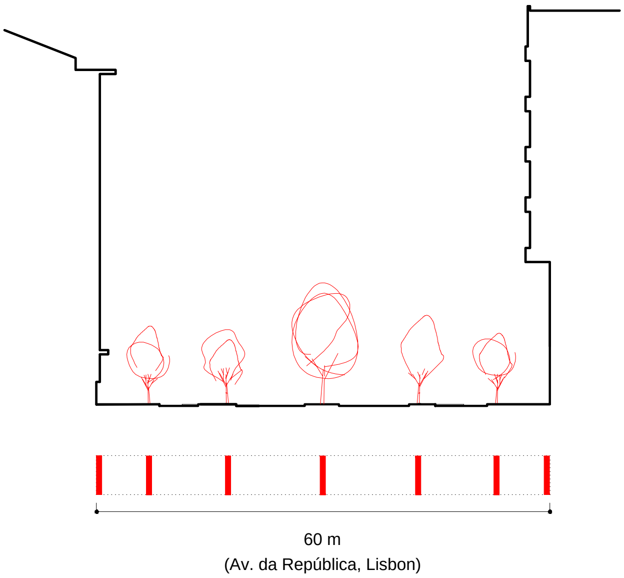
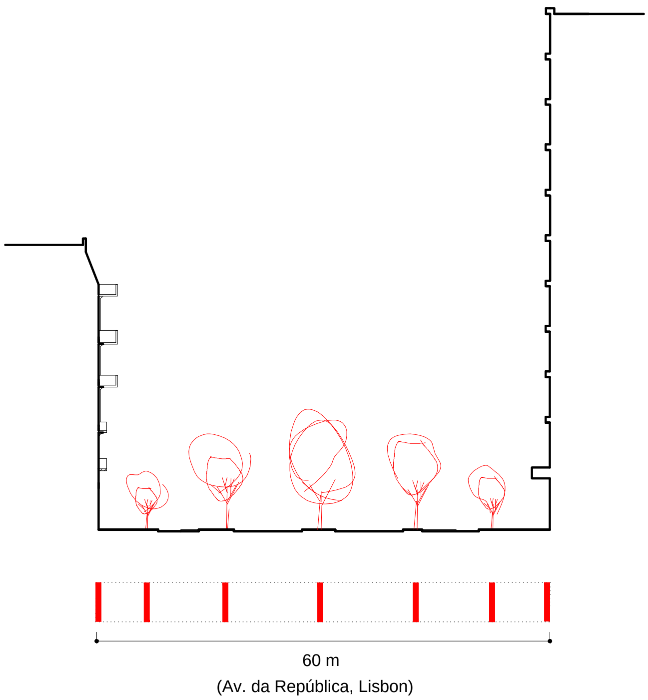


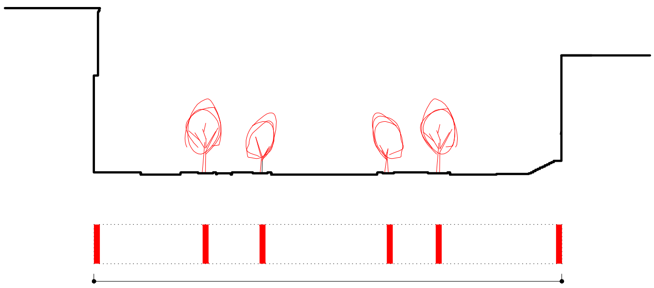
Figure 11.2-8 Cross-sections of the mesoscale (B.1.3). (Source: Author's Edition).
a) Orchard Road, Singapore (B.1.3).
b) Orchard Road, Singapore (B.1.3).
c) Avinguda Diagonal, Barcelona (B.1.3).

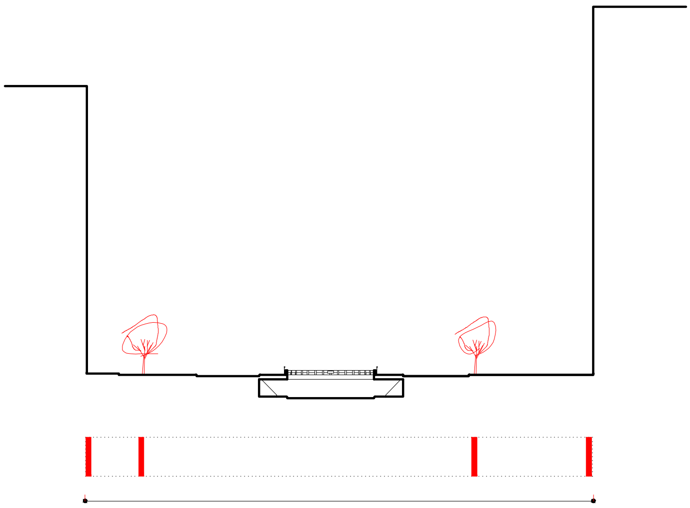


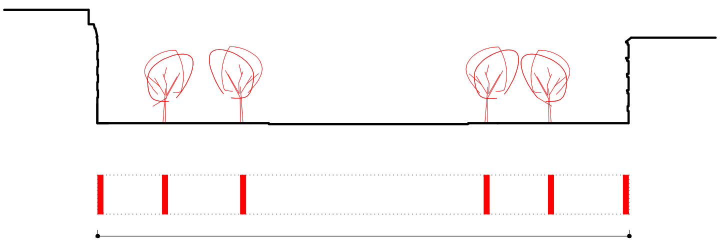




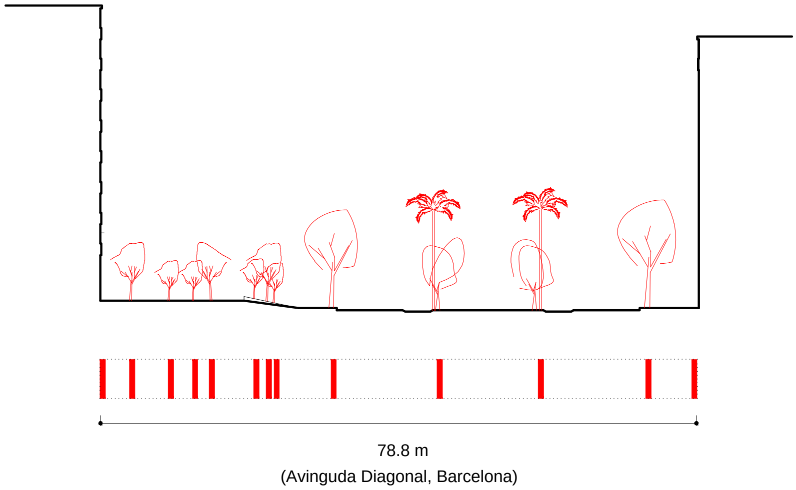
d) Unter den Linden, Berlin (B.1.3).
e) Av. da República, Lisbon (B.1.3).
f) Av. da República, Lisbon (B.1.3).

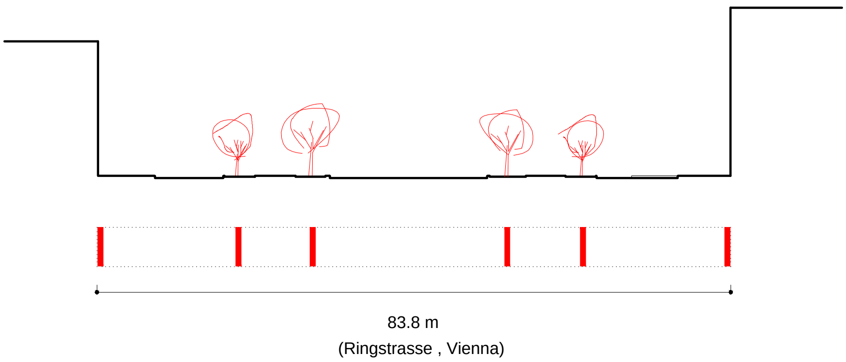


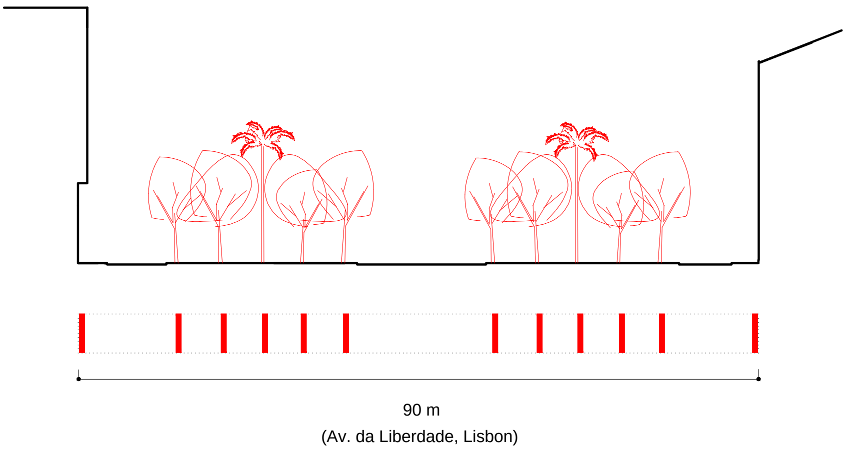




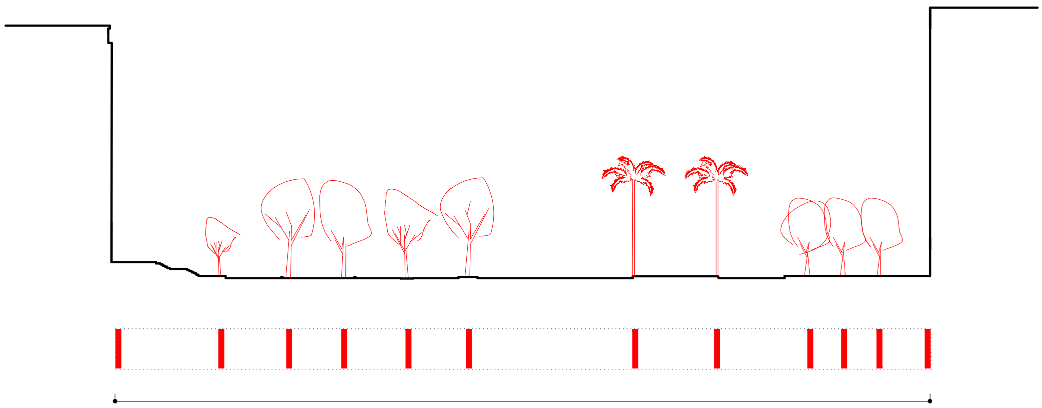
g) Ringstrasse , Vienna (B.1.3).
h) Av.Paulista, São Paulo (B.1.3).
i) Avenue des Champs-Elysées, Paris (B.1.3).



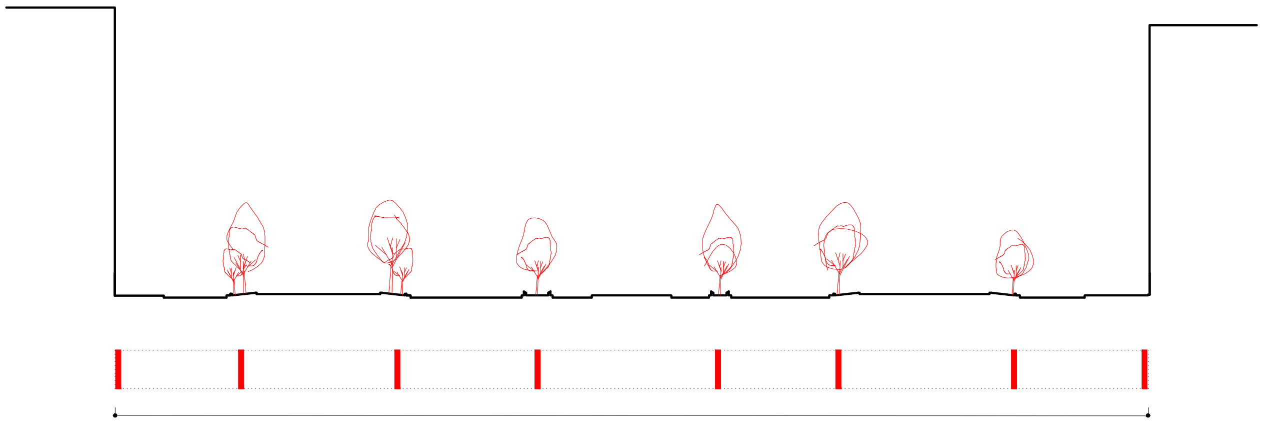




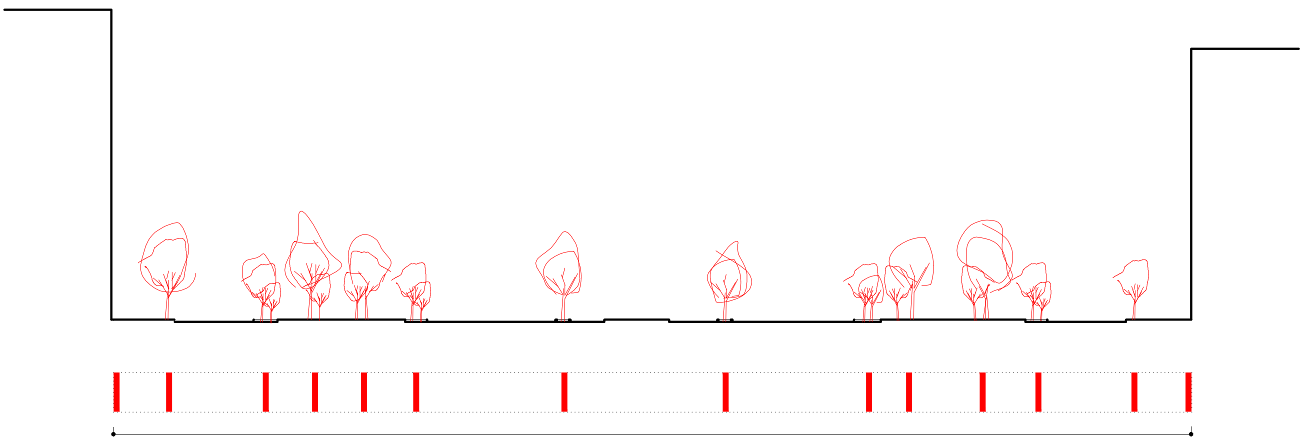
j) Avinguda Diagonal, Barcelona (B.1.3).
k) Ringstrasse , Vienna (B.1.3).
l) Av. da Liberdade, Lisbon (B.1.3).



108.5 m
(Avinguda Diagonal, Barcelona)



136.7 m
(9 de Julio Avenue , Buenos Aires)



143.2 m
(9 de Julio Avenue , Buenos Aires)

m) Avinguda Diagonal, Barcelona (B.1.3).
n) 9 de Julio Avenue , Buenos Aires (B.1.3).
o) 9 de Julio Avenue , Buenos Aires (B.1.3).

11.2.3. The macroscale

The macroscale refers to the largest scale, from which the arterial street is connected to the surrounding urban structure. The main characteristic of this scale is the permeability of the street and block patterns.

(C.1) *Urban permeability.*

Block size and length play a significant role in determining the permeability of the urban structure. Along arterial streets, urban blocks have lengths ranging from 100 to 180 meters on average. This small to medium length facilitates easy access and promotes permeability between the street and the surrounding urban structure while maintaining the continuity that characterizes arterial streets. By maintaining an optimal block length, the urban fabric can achieve harmonious integration with the arterial street, ensuring that pedestrians and cyclists can navigate through the area with convenience and efficiency.

In this regard, along arterial streets, it is desirable to have a high frequency of street intersections for pedestrians and cyclists. A range of 100 to 180 meters is often considered optimal as it ensures the necessary permeability between the arterial street and the surrounding urban fabric. Frequent intersections facilitate convenient access, encourage pedestrian and cyclist movement, and foster a sense of connectivity and integration within the urban structure.

In cases where block sizes exceed 180 meters in length, urban porosity becomes crucial to mitigate the challenges posed by such extensive blocks. Urban porosity refers to the intentional creation of alternative access points and the construction of spatial ambiguities to alleviate the impact of long block lengths. By incorporating elements such as passageways, squares under buildings, or arcades, a continuity of flowing space within the urban structure can be achieved. Moreover, urban porosity introduces a dynamic and varied spatial experience, adding richness and complexity to the urban environment.

The following presents the different layers that compose the horizontal plane based on 1000-by-1000-meter extracts of eight selected international case studies.

(C.1.1) Block size and length.

(C.1.2) Street intersection frequency.

(C.1.3) Urban porosity.

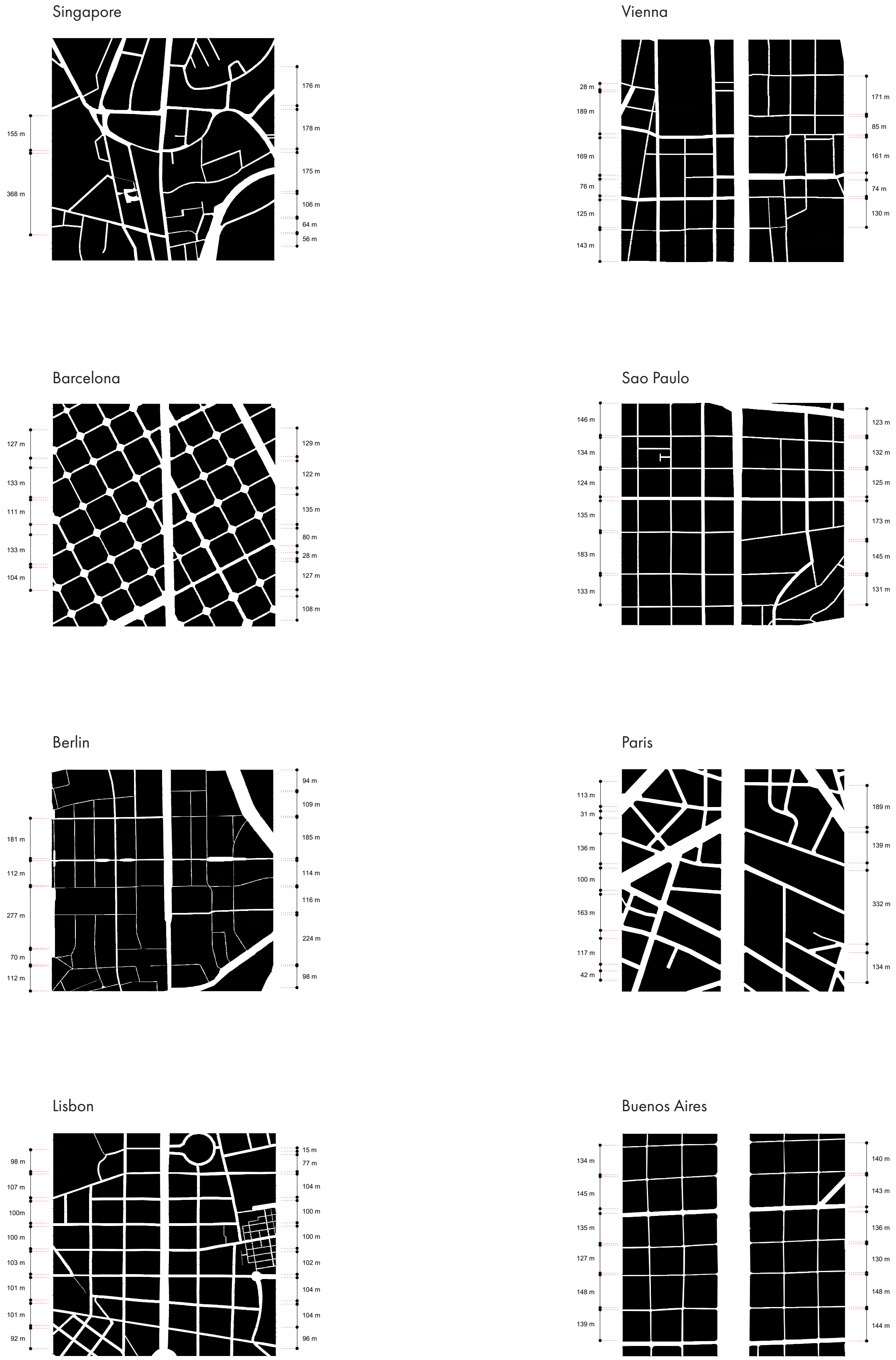


Figure 11.2-9 The macroscale (C.1.1): Block size and length. (Source: Author's Edition).

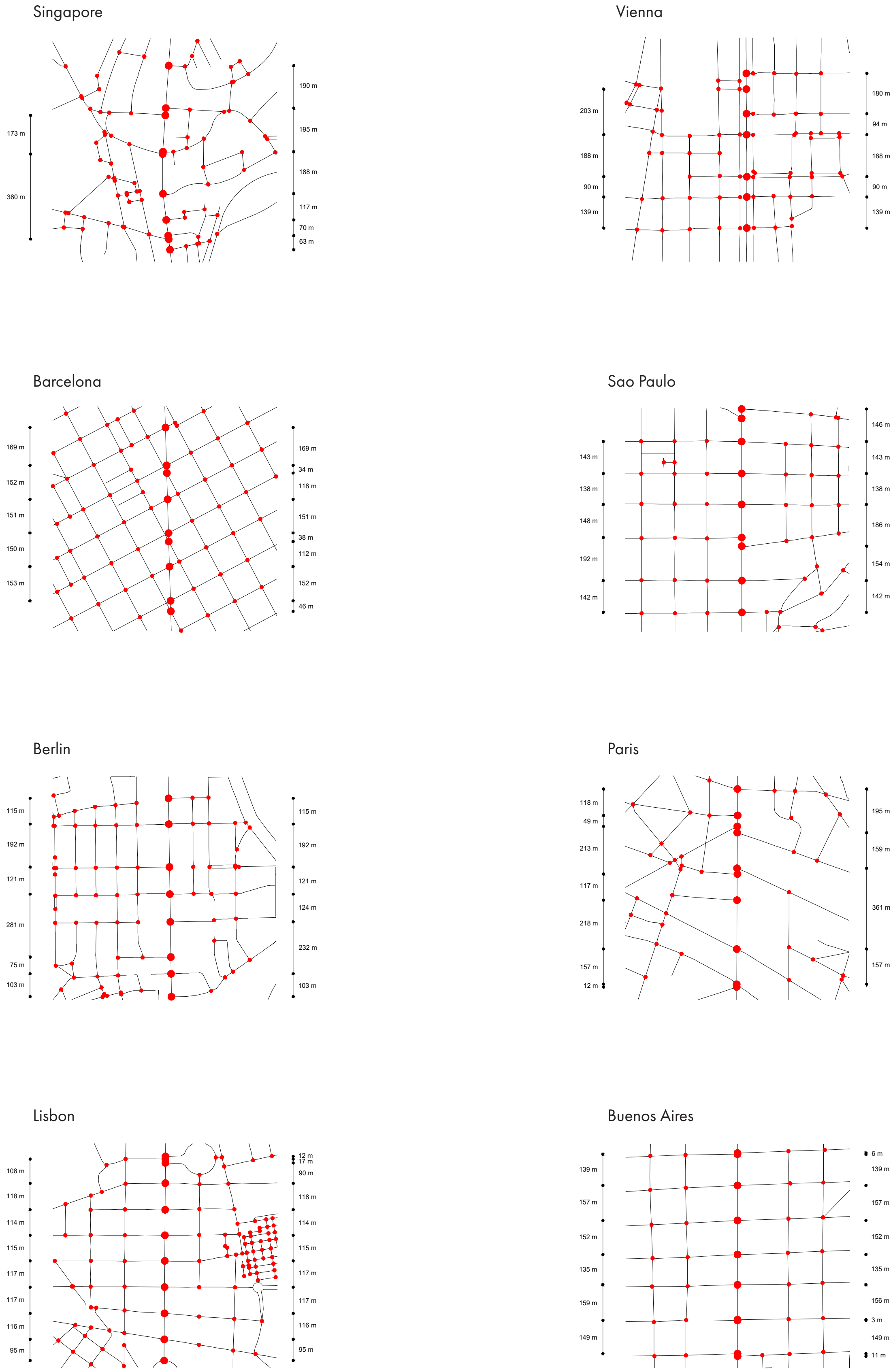


Figure 11.2-10 The macroscale (C.1.2): Street intersection frequency. (Source: Author's Edition).

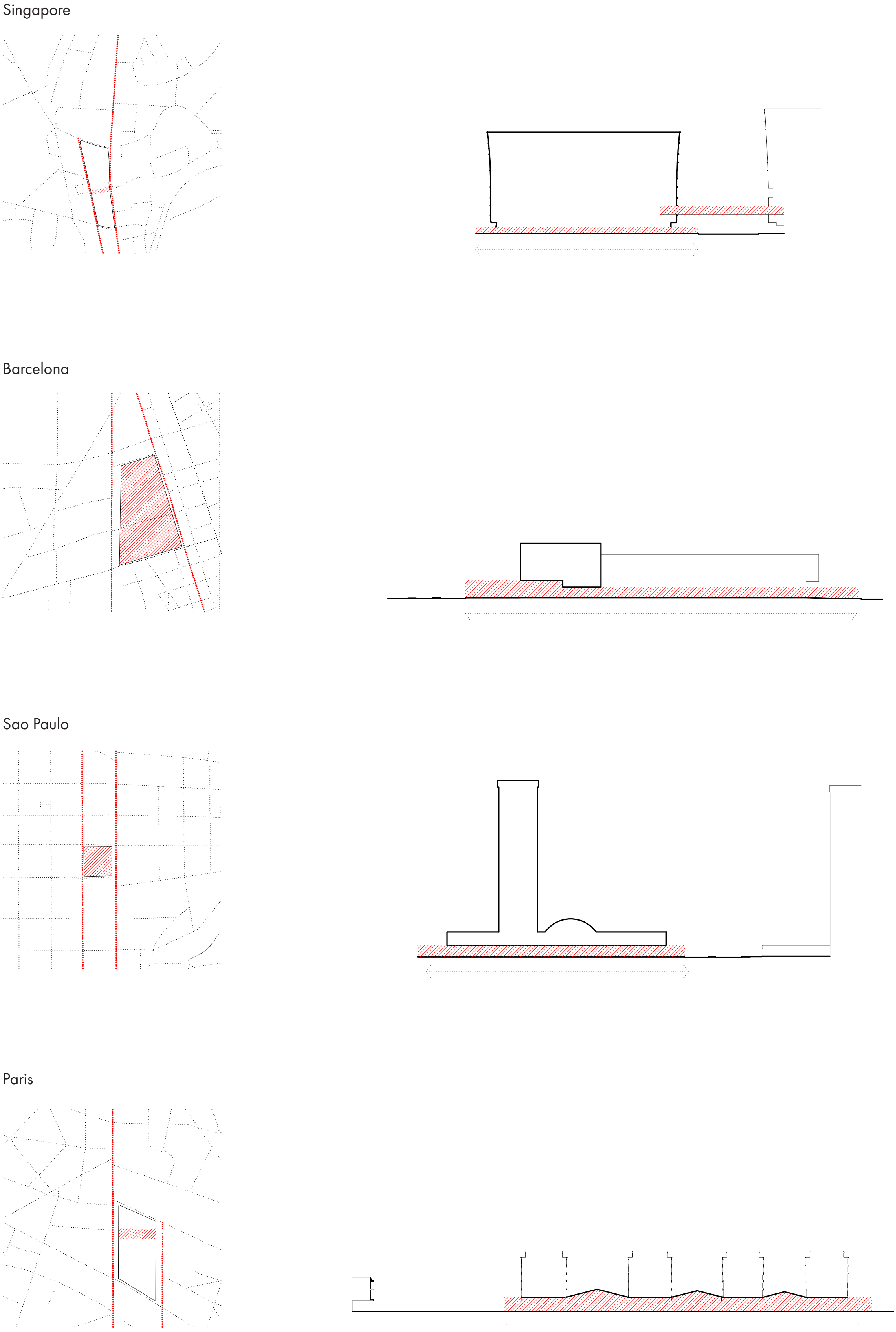


Figure 11.2-11 The macroscale (C.1.3): Urban porosity. (Source: Author's Edition).

References

ADA (2003) المخطط الاستراتيجي الشامل لمدينة الرياض *[Riyadh's Comprehensive Strategic Plan]*. Riyadh, Saudi Arabia. Available at: https://www.rcrc.gov.sa/idc/groups/public/documents/Ar_ADA_StrategicPlan/001863.pd.

Adams, D., Croudace, R. and Tiesdell, S. (2011) 'Design codes, opportunity space, and the marketability of new housing', *Environment and Planning B: Planning and Design*, 38(2), pp. 289–306. doi: 10.1068/b36055.

Al-Hathloul, S. (2017) 'Riyadh Development Plans in the Past Fifty Years (1967-2016)', *Current Urban Studies*, 05(01), pp. 97–120. doi: 10.4236/cus.2017.51007.

Al-Hathloul, S. A. (1981) *Tradition, continuity and change in the physical environment: the Arab-Muslim city*. Massachusetts Institute of Technology. Available at: http://dspace.mit.edu/handle/1721.1/46401.

Al-Hathloul, S. and Mughal, M. A. (2004) 'Urban growth management-the Saudi experience', *Habitat International*, 28(4), pp. 609–623. doi: 10.1016/j.habitatint.2003.10.009.

Al-Hemaidi, W. K. (2001) 'The metamorphosis of the urban fabric in Arab-Muslim City: Riyadh, Saudi Arabia.', *Journal of Housing and the Built Environment*, 16(2), pp. 179–201.

Al Hosain, N. and Alhussaini, A. (2021) *Evaluating Access to Riyadh's Planned Public Transport System Using Geospatial Analysis, Kapsarc*. Riyadh, Saudi Arabia. doi: 10.30573/KS--2021-DP10.

Al-Mogren, F. B. A. (2022) 'Operational Planning: An alternative view of Doxiadis' project in Riyadh', in Fabbri, R. and Al-Qassemi, S. S. (eds) *Urban Modernity in the Contemporary Gulf: Obsolescence and Opportunities*. Abingdon: Routledge, pp. 156–171. doi: 10.4324/9781003156529-11.

Al-Mosaind, M. (2018) 'Applying complete streets concept in Riyadh, Saudi Arabia: opportunities and challenges', *Urban, Planning and Transport Research*. Routledge, 6(1), pp. 129–147. doi: 10.1080/21650020.2018.1547124.

Al-Naim, M. A. (2008) *The Evolving Arab City, The Evolving Arab City: Tradition, Modernity and Urban Development.* Edited by Y. Elsheshtawy. London: Routledge. doi: 10.4324/9780203696798.

Al Naim, M. A. (2013) 'Urban transformation in the city of riyadh: A study of plural urban identity', *Open House International*, 38(4), pp. 70–79. doi: 10.1108/ohi-04-2013-b0008.

Al-Said, F. (2003) 'The pattern of structural transformation of the Saudi contemporary neighbourhood: The case of Al-Malaz, Riyadh, Saudi Arabia', in *39th ISoCaRP Congress*. Cairo, Egypt, pp. 1–10. Available at: http://www.isocarp.net/Data/case_studies/347.pdf.

Alexander, C., Ishikawa, S. and Silverstein, M. (1977) *A pattern language*. Oxford, UK: Oxford University Press.

Alotaibi, O. and Potoglou, D. (2018) 'Introducing public transport and relevant strategies in Riyadh City, Saudi Arabia: a stakeholders' perspective', *Urban, Planning and Transport Research*. Routledge, 6(1), pp. 35–53. doi: 10.1080/21650020.2018.1463867.

Appleyard, D. (1981) *Livable Streets*. Berkeley, CA, USA: University of California Press.

Bently, I. *et al.* (1985) *Responsive environments: A manual for designers*. London, UK: Architectural Press.

Bobić, M. (2004) *Between the Edges: Street-building Transition as Urbanity Interface*. Bussum, The Netherlands: Thoth Publishers.

Bonnenfant, P. (2014) 'Real estate and political power in 1970s Riyadh', *City*, 18(6), pp. 708–722. doi: 10.1080/13604813.2014.965890.

Brown, B. B., Burton, J. R. and Sweaney, A. L. (1998) 'Neighbors, Households, and Front Porches', *Environment and Behavior*, 30(5), pp. 579–600. doi: 10.1177/001391659803000501.

Calvino, I. (1997) *Invisible Cities*. London, UK: Vintage.

Caniggia, G. and Maffei, G. L. (2001) *Architectural Composition and Building Typology: Interpreting Basic Building*. Florence, Italy: Alinea Editrice.

Carmona, M. *et al.* (2003) *Urban spaces-public places: The dimensions of urban design*. Oxford, UK: Architectural Press.

Carmona, M. (2009) 'Design coding and the creative, market and regulatory tyrannies of practice', *Urban Studies*, 46(12), pp. 2643–2667. doi: 10.1177/0042098009344226.

Cataldi, G. (2003) 'From Muratori to Caniggia: the origins and development of the Italian school of design typology', *Urban Morphology*, 7(1), pp. 19–34. doi: 10.51347/jum.v7i1.3904.

Christ, E. *et al.* (2015) *Typology: Paris, Delhi, São Paulo, Athens.* Vol. 3. Zurich, Switzerland: Park Books.

Creíxell, S. P. and Parés, S. V. (1977) 'El modelo teorico del plan Cerdà', *2C Construcción De La Ciudad*, (6–7), pp. 46–55. Available at: https://upcommons.upc.edu/handle/2099/5091.

Dovey, K. and Wood, S. (2015) 'Public/private urban interfaces: type, adaptation, assemblage', *Journal of Urbanism*, 8(1), pp. 1–16. doi: 10.1080/17549175.2014.891151.

Ellard, C. (2015) *Places of the Heart: The Psychogeography of Everyday Life*. New York, NY, USA: Bellevue Literature Press.

Elsheshtawy, Y. (2021) *Riyadh: Transforming a Desert City*. London, UK: Taylor & Francis.

Garba, S. B. (2004) 'Managing urban growth and development in the Riyadh metropolitan area, Saudi Arabia', *Habitat International*, 28(4), pp. 593–608. doi: 10.1016/j.habitatint.2003.10.008.

Gehl, J. (2010) *Cities for people*. London, UK: Island Press.

Gehl, J., Kaefer, L. J. and Reigstad, S. (2005) 'Close encounters with buildings', *Urbanistika ir architektūra*, 29(2), pp. 70–80.

Glaser, M. *et al.* (2012) *The City at Eye Level: Lessons for Street Plinths*. Delft, The Netherlands: Eburon Uitgeverij BV.

Heffernan, E., Heffernan, T. and Pan, W. (2014) 'The relationship between the quality of active frontages and public perceptions of public spaces', *Urban Design International*, 19(1), pp. 92–102. doi: 10.1057/udi.2013.16.

Hess, P. M. (2008) 'Fronts and Backs', *Journal of Planning Education and Research*, 28(2), pp. 196–212. doi: 10.1177/0739456X08321799.

Hillier, B. and Hanson, J. (1989) *The social logic of space*. Cambridge, UK: Cambridge University Pres.

Jacobs, A. (1995) *Great Streets*. Cambridge, MA, USA: The MIT Press.

Jacobs, J. (1961) *The Death and Life of Great American Cities.* New York, NY, USA: Vintage Books.

James, W. (1890) *The Principles of Psychology*. Henry Holt and Company.

Lewin, K. (1943) 'Defining the "field at a given time."', *Psychological Review*, 50(3), pp. 292–310. doi: 10.1037/h0062738.

Madrazo, L. (1995) *The concept of type in architecture: An inquiry into the nature of architectural form*. ETH Zurich. Available at: https://www.research-collection.ethz.ch/bitstream/handle/20.500.11850/142221/eth-39939-02.pdf?sequence=2&isAllowed=y.

Maki, F. (1964) *Investigations in Collective Form*. A Special. St. Louis, MO, USA: School of Architecture, Washington University.

Marshall, S. (ed.) (2011) *Urban Coding and Planning.* New York, USA: Routledge. doi: 10.4324/9780203717561.

Middleton, D. A. (2009) *Growth and expansion in post-war urban design strategies: CA Doxiadis and the first strategic plan for Riyadh Saudi Arabia (1968–1972).* Georgia Institute of Technology.

Misk Art Institute (ed.) (2018) *Spaces in Between.* Misk Art Institute.

Moneo, R. (1978). On typology. *Oppositions 13.*

Montgomery, J. (1997) 'Café culture and the city: The role of pavement cafés in urban public social life', *Journal of Urban Design*, 2(1), pp. 83–102. doi: 10.1080/13574809708724397.

Montgomery, J. (1998) 'Making a city: Urbanity, vitality and urban design', *Journal of Urban Design*, 3(1), pp. 93–116. doi: 10.1080/13574809808724418.

Moudon, A. V. (1994) 'Getting to Know the Built Landscape: Typomorphology.', in Franck, K. A. and Schneekloth, L. H. (eds) *Ordering space: types in architecture and design.* New York, NY, USA: Van Nostrand Reinhold, pp. 289–314.

Moudon, A. V. (1997) 'Urban morphology as an emerging interdisciplinary field', *Urban Morphology*, 1(1), pp. 3–10.

Moudon, A. V. (1998) 'The Changing Morphology of Suburban Neighborhoods', in Petruccioli, A. (ed.) *Typological Process and Design Theory.* Cambridge, Massachusetts: Aga Khan Program for Islamic Architecture at Harvard University, pp. 141–158.

Mubarak, F. A. (2004) 'Urban growth boundary policy and residential suburbanization: Riyadh, Saudi Arabia', *Habitat International*, 28(4), pp. 567–591. doi: 10.1016/j.habitatint.2003.10.010.

Palaiologou, G. and Vaughan, L. (2014) 'The sociability of the street interface – revisiting West Village, Manhattan', in *Our Common Future in Urban Morphology*, pp. 88–102.

Panerai, P. *et al.* (2004) *Urban Forms: The Death and Life of the Urban Block*. Oxford, UK: Architectural Press.

Proença, S. dos S. B. (2014) *A Diversidade da Rua na Cidade de Lisboa: Morfologia e Morfogénese*. Universidade de Lisboa.

RCRC (2020) *Riyadh transit orinted development*. Riyadh.

Robinson, J. (2006) *Ordinary cities: between modernity and development*. London, UK: Routledge.

Rodrigues, A. D. (2017) 'Greening the city of Lisbon under the French influence of the second half of the nineteenth century.', *Garden History*, 45(2), pp. 224–250.

Rossi, A. (1966) *The Architecture of the City*. Cambridge: The MIT Press.

Simpson, J., Thwaites, K. and Freeth, M. (2019) 'Understanding Visual Engagement with Urban Street Edges along Non-Pedestrianised and Pedestrianised Streets Using Mobile Eye-Tracking', *Sustainability*, 11(15), p. 4251. doi: 10.3390/su11154251.

Steadman, P. (1979) *The evolution of designs: biological analogy in architecture and the applied arts*. Cambridge, MA: Cambridge University Pres.

UN-Habitat (2018) *Saudi Cities Report 2018*. Riyadh, Saudi Arabia. Available at: https://unhabitat.org/saudi-cities-report-2018-executive-summary.

Youssef, Z., Alshuwaikhat, H. and Reza, I. (2021) 'Modeling the modal shift towards a more sustainable transport by stated preference in Riyadh, Saudi Arabia', *Sustainability*, 13(1), p. 337. doi: 10.3390/su13010337.

"Certain physical qualities are required for a great street. All are required, not one or two. They are few in number and appear to be simple, but that may be deceptive."

Allan B. Jacobs, 1995

12. Final Considerations

This concluding chapter serves as the culminating endeavor of this study, wherein a synthesis of the principal research findings is presented and examined in light of the established research aims and questions. The chapter delves into the inherent value and contribution of these findings, thereby enriching the existing scholarly discourse. Drawing upon these insights, this chapter delineates potential avenues for future research, thus opening up new horizons for scholarly inquiry and advancement. By engaging in these comprehensive endeavors, this chapter encapsulates the study's denouement and provides a profound comprehension of its broader implications while inciting curiosity for further exploration in the academic realm.

12.1. Introduction to Chapter 12

Although the complex nature of the concept of livability and the composition of arterial streets, this research aimed at elaborating an urban code for arterial streets that can be adapted to the context of Saudi Arabia. The main research question of this thesis is as follows: **How to build an urban code for livable arterial streets that can be adapted to the Saudi Arabian context?**

This question was answered through achieving the research objectives of this study, namely: to formulate an urban morphological code that supports livability at the arterial street level (research objective I), to contribute to the quality of life program in Saudi Arabia (research objective II), and to test ways of studying and measuring the complexity of arterial street livability and determining the physical characteristics of arterial streets that influence public life (research objective III). Furthermore, in order to reach the three objectives while obtaining answers to the main research question, research sub-questions were formulated, informing the steps taken in the approach to this research. The research sub-questions were answered through a theoretical study and through the interpretation and decoding of the selected international and local case studies. Research objective III was achieved primarily by answering the research sub-questions concerning the way arterial street morphology impacts street life. Research objectives I and II were achieved through the synthesized findings. By fulfilling the research objectives and by analyzing the combined findings of the research sub-questions, the main research question was answered. In this manner, by understanding the complexity of arterial street livability at three scales, the urban code for arterial streets emerged. As a result, this study developed a three-scale typomorphological code for the design and planning of arterial streets.

12.2. Synthesized response to the research questions

The main research question of this dissertation is this: **How to build an urban code for livable arterial streets that can be adapted to the Saudi Arabian context?**

The response to this main research question primarily consists of two aspects. The first is related to the understanding of the livable arterial street as a linear urban center that has fundamental morphological principles that attract pedestrians' visual perception on the microscale, provide opportunities for various pedestrians' activities on the mesoscale, and facilitate pedestrians' transversal flow on the macroscale.

This research demonstrated that on the microscale, livable arterial streets provided permeable and accessible interface configurations, a mix of ground-floor uses, and wide sidewalks, leading to visual and social interactions. On the mesoscale, they presented complex partition compositions, a balance of pedestrian-to-automobile spaces with ratios of approximately 1:1 or 2:1, and street enclosures with ratios ranging between 1:1, 2:1, and 3:1. On the macroscale, livable arterial streets presented urban permeability with small-to-medium block dimensions, ranging between 90 and 180 meters in length, street intersection frequency of 130 meters on average, and urban porosity, enriching the street space and maintaining its centrality.

The second aspect is related to understanding the urban code as a regulatory tool that redefines the arterial street as a place and reshapes its elements to create livable arteries that fulfill human needs and foster public life. The urban code is based on abstract morphological principles extracted from the reference case studies of livable arterial streets. It is a communication instrument that conveys meaning at the convergence of theory and practice. Thus, the urban code synthesizes a diversity of types, allowing for code with flexibility in the context of Saudi Arabia.

In this manner, generating an urban code for livable arterial streets that can be adapted to the context of Saudi Arabia is based on a process of interpreting, decoding, and coding the physical characteristics that foster public street life, where the output of every phase feeds the next phase. Those processes begin with understanding the arterial street and its livability as complex concepts that are affected by physical, social, functional, and traffic attributes on different levels of resolution, including micro, meso, and macro scales. These characteristics point to morphological interpretations and public life studies as an interdisciplinary, multiscale approach to decoding the livability of streets.

The second phase is based on understanding the city and its components, including the streets, as a source of knowledge and as a valuable tool from which we can learn. Thus, creating a livable arterial street starts with decoding other existing livable arteries as a reference to understand how they are formed to foster public life. After decoding existing arterial streets that represent livable linear centers based on an interdisciplinary multiscale approach, local arteries were also decoded using the same methods and approach in order to analyze existing physical issues affecting public life and livability.

As this research understands that the content and rhythm of public life are not identical throughout societies and cultures, the next phase introduces a comparative study on the results of the international and local case studies. The comparative study extracts the morphological types that enhanced public life to build a framework for livable arterial streets. These types possess an abstract and general nature allowing for transfer and adaptation to suit different cultural, climatic, and economic conditions, and can serve as an explicit and implicit reference point. Thus, the extracted types can be adapted to the vision and needs of Saudi Arabia. Finally, in order to arrive at general principles about livable arterial streets in the local context, the urban code is formulated addressing on three morphological scales.

Response to research sub-questions: **What is the impact of arterial street morphology on public street life?**

From an interdisciplinary, multiscale perspective, the study demonstrated that arterial streets are constructed based on a set of complex, interrelated relationships that generate various types and patterns of social and public life. Therefore, arterial street morphology can impact public life on three scales, as follows:

The microscale: **What are the most important variables of street interface configurations that influence pedestrians' visual perception?**

The study demonstrated that the physical and visual permeability of the street interface configurations influenced visual and social interactions more than other variables. The permeable and accessible street interface allows connection and articulation between the public and private spheres and creates public and collective spaces for daily social life. This variable consists of different types that function as complementary spaces, where they can give extra space, either for the sidewalk or the building to support social and public activities. Moreover, the different types of permeable and accessible configurations are related to the width and partition of the sidewalk and ground-floor uses, inviting diverse users and supporting pedestrians' visual engagement and public life.

The mesoscale: **How do street partition compositions influence pedestrians' activities?**

The composition of street partitions plays a significant role in influencing pedestrians' activities. Through this study, it has been established that street partition compositions have a direct impact on the types of pedestrian activities that occur within these spaces. By creating various types of spaces, street partitions support different categories of pedestrian activities, including those that are necessary for daily functioning, optional activities, and social interactions. The dimensions and arrangement of street partitions have a critical role in shaping the behaviors and engagement of pedestrians. Achieving a harmonious balance between pedestrian and automobile spaces is crucial in creating an environment that supports diverse pedestrian activities. Ratios such as 1:1 or 2:1, where pedestrian space is equal to or larger than automobile space, contribute to the functionality of the street as both a route and a place for various activities.

The macroscale: **What physical characteristics of the street's permeability with regard to the urban context contribute to facilitating pedestrians' flow at the arterial street level?**

The study of the relationship between urban permeability and pedestrian flow demonstrated that pedestrian flow is related to urban block size and length, street intersection frequency, and urban porosity, which can increase or decrease pedestrian flow. The results revealed the contribution of these physical characteristics to pedestrian flow, as they were a catalyst for proper pedestrian environments and generated the dynamism of the street space.

12.3. The research contribution

The method and outcomes of this thesis have both theoretical and practical implications. The most important contribution is building an urban code for livable arterial streets, extracted from acknowledged examples of livable arterial streets. In addition, this typomorphological urban code can be reformulated in other contexts, as it is based on abstract types of principal physical qualities that allow flexible adaptation to diverse contexts. In this regard, the urban code, as the study's main contribution, characterizes and systematizes what is a livable arterial street.

The current study thus emphasizes the role of the arterial street as a complex, multi-functional urban element that combines route and place roles, influences public life, and improves livability. Although there is a lack of studies related to arterial streets' livability, this research combines the livable street's physical attributes (Jacobs, 1995; Ewing and Handy, 2009; Mehta, 2013); social attributes (Gehl, 1987; Lofland, 1998); functional attributes (Montgomery, 1998; Ho and Douglass, 2008; Glaser *et al.*, 2012); and traffic attributes (Appleyard, 1981; Bosselmann, Macdonald and Kronemeyer, 1999).

In light of this approach, this thesis proposes an interdisciplinary, multi-scale methodology by combining morphological interpretations with public life studies for decoding the complexity of arterial street livability on three scales, micro, meso, and macro. The methodology, therefore, integrates quantitative and qualitative data to overcome the limitations of the measurement of livability at the arterial street level.

In line with previous studies on the street interface (Bobić, 2004; Gehl, Kaefer and Reigstad, 2005; Glaser *et al.*, 2012; Dovey and Wood, 2015), the street partition (Jacobs, 1995; Proença, 2014), and the urban structure (Jacobs, 1961; Siksna, 1997; Montgomery, 1998), the current investigation provides evidence of the role of the street's physical characteristics in shaping public life. The study emphasizes the importance of the configurations of the street interface in shaping active street frontages that attract pedestrians' visual perception, the compositions of the street partitions in supporting different types of pedestrian activities, and the role of urban structure in providing permeability that facilitates pedestrian flow.

Regarding the street interface, the research connects street livability on a micromorphological scale to how people visually perceive a street. The current investigation offers empirical insight into the importance of street interface configurations in shaping public life by engaging users in real-life situations as the basis for livable and active streets. This adds value to previous studies on street interfaces' spatial, social, and cultural conditions (Bobić, 2004; Dovey and Wood, 2015; Kamalipour, 2016; Simpson, Thwaites and Freeth, 2019; Thwaites, Simpson and Simkins, 2020). As we understand cities' elements in terms of types (Stojanovski and Axelsson, 2019), the current investigation shows how different typomorphological configurations of street interfaces influence pedestrians' visual perceptions. In this regard, a typomorphological investigation, as an approach to urban morphology, not only elucidates patterns and types of morphological configurations with an intuitive understanding based on architectural or urban design but also reveals the visual perception of these configurations.

The study of public life has often been carried out through two main methods: interviews and personal observations. These methods have been proven to be an effective means of understanding public life's patterns, activities, and data regarding the numbers, ages, and genders of people in a public space (Gehl and Svarre, 2013). However, applying these methods to individuals' experiential perception would restrict the opportunity to systematically analyze their visual perception of the built environment (Duchowski, 2017). In light of this, the current study adds insight and evidence in line with previous eye-tracking experiments (Simpson, Thwaites and Freeth, 2019; Spanjar and Suurenbroek, 2020) from the pedestrians' perspective, as the street's main users, showing how different configurations influence pedestrians' visual attention in order to understand their visual preferences. The current study permits us to experiment in a highly accurate way to precisely quantify and prove that permeable and accessible interfaces influence visual and social interactions more than other variables of the street interface configurations.

On the other hand, as Jacobs (1995) has emphasized in defining the street in both vertical and horizontal terms, this study also clarifies that the way streets are formed often results from the composition of the street partition, which takes on various forms and functions (Jacobs, 1995). Despite the street partition's role in evaluating a street's public life, there is a lack of reading the street from its partition to investigate pedestrians' activities and public life. Thus, the current investigation offers essential insights into our understanding of the relationship between the street partitions and the type of pedestrian activities observed in these partitions through a morphological interpretation of the street partition compositions and the systematic observation of public life.

In line with the Quality of Life Program in Saudi Arabia, which aims to improve Saudi cities by providing better infrastructure and transport, urban design, and environmental factors with a focus on encouraging a culture of public life, it is hoped that this research will contribute to providing a comprehensive ground for planning and designing arterial streets to satisfy people's needs and to providing a variety of methods with which to achieve those needs.

12.4 Final remarks

Arterial streets possess a paradoxical nature that is both ordinary and complex, which is perhaps why they have not always been well-treated. While they are embedded in everyday life with their diverse uses, surrounding buildings, and bustling traffic, it is the amalgamation of these elements together, and the sheer space and amenities they contain, that make arterial streets livable when they work well.

The urban code that constitutes the core of this thesis can be used to design new arterial streets, renovate an existing street that was faulty designed or has deteriorated over time, or transform an existing road into a livable street. The urban code could also be used to make small incremental improvements to existing streets to improve them.

Emanuel Christ and Cristoph Gantembein proposed the idea of typology transfer applied to building types as a process that enables to migrate "a typological principle for a larger area and then examining its impact, i.e. the urban qualities that may arise at a site thanks to that principle" (Christ et al., 2015, p.7, 8). As stated, "A typological principle is abstract and not bound to one location, even though the type ensues from a highly specific constellation of cultural, climatic, and economic factors and provisions under building law." (Christ et al., 2015, p.7)

Considering types may also be extracted from urban elements of the public space, such as streets, based on typological principles, the urban code proposes a minimal and abstract nature that is easily comprehensible, transferable, and adaptable across different contexts based on specific intervention needs. Thus, it serves as a repository of formal principles extracted from successful livable arterial streets, which can be referenced and applied within the context of Saudi Arabia. Through abstraction, the urban code becomes flexible and applicable while also fostering opportunities for designers to exercise their creativity. Thus, the urban code is not intended to replace the role of urban designers and architects, but rather to inform or provide a ground for the creative work that can be derived from the intersection between types and places.

Although the urban code is composed mainly to include the street interface configurations, the street partition compositions, and the urban structure, further development of the urban code, beyond the scope of this research, may include other qualities on different scales, which may be vital to the assessment of street livability. To name a few, these other qualities may include an investigation of land uses and density on the macro-scale as well as an investigation of building height, configuration, and street orientation, and their potential impact on the street's thermal comfort. Nevertheless, these are specific to a place, therefore, to the local, specific adaptation of the type to each context. Moreover, this study envisions that future, comprehensive studies on other types of public spaces and streets be conducted. Consequently, many additional potential domains of study come from or can be supported by this research and its methodology.

Furthermore, the process of the urban code can be extended to include different types of streets, such as residential ones, to build a comprehensive urban morphological code for different street types in Saudi Arabia. In this regard, it might be especially interesting to include other morphological elements on each scale, such as the effect of block structure and plot dimensions on public street life.

References

Appleyard, D. (1981) *Livable Streets*. Berkeley, CA, USA: University of California Press.

Bently, I. *et al.* (1985) *Responsive environments: A manual for designers*. London, UK: Architectural Press.

Bobić, M. (2004) *Between the Edges: Street-building Transition as Urbanity Interface*. Bussum, The Netherlands: Thoth Publishers.

Bosselmann, P., Macdonald, E. and Kronemeyer, T. (1999) 'Livable Streets Revisited', *Journal of the American Planning Association*, 65(2), pp. 168–180. doi: 10.1080/01944369908976045.

Christ, E. *et al.* (2015) *Typology: Paris, Delhi, São Paulo, Athens*. Vol. 3. Zurich, Switzerland: Park Books.

Dovey, K. and Wood, S. (2015) 'Public/private urban interfaces: type, adaptation, assemblage', *Journal of Urbanism*, 8(1), pp. 1–16. doi: 10.1080/17549175.2014.891151.

Duchowski, A. T. (2017) *Eye Tracking Methodology: Theory and Practice*. 3rd ed. Cham, Switzerland: Springer International Publishing. doi: 10.1007/978-3-319-57883-5.

Ewing, R. and Handy, S. (2009) 'Measuring the unmeasurable: Urban design qualities related to walkability', *Journal of Urban Design*, 14(1), pp. 65–84. doi: 10.1080/13574800802451155.

Gehl, J. (1987) *Life Between Buildings*. New York, NY, USA: Van Nostrand-Reinhold.

Gehl, J., Kaefer, L. J. and Reigstad, S. (2005) 'Close encounters with buildings', *Urbanistika ir architektûra*, 29(2), pp. 70–80.

Gehl, J. and Svarre, B. (2013) *How To Study Public Life*. Washington, DC: Island Press/ Center for Resource Economics. doi: 10.5822/978-1-61091-525-0.

Glaser, M. *et al.* (2012) *The City at Eye Level: Lessons for Street Plinths*. Delft, The Netherlands: Eburon Uitgeverij BV.

Ho, K. and Douglass, M. (2008) 'Globalisation and liveable cities: Experiences in place-making in Pacific Asia', *International Development Planning Review*, 30(3), pp. 199–213. doi: 10.3828/idpr.30.3.1.

Jacobs, A. (1995) *Great Streets*. Cambridge, MA, USA: The MIT Press.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York, NY, USA: Vintage Books.

Kamalipour, H. (2016) 'Mapping Urban Interfaces A Typology of Public/Private Interfaces in Informal Settlements', *Spaces and Flows: An International Journal of Urban and ExtraUrban Studies*, 8(2).

Lofland, L. (1998) *The public realm: Exploring the city's quintessential social territory*. New York, USA: Aldine de Gruyter.

Mavros, P., Austwick, M. Z. and Smith, A. H. (2016) 'Geo-EEG: Towards the Use of EEG in the Study of Urban Behaviour', *Applied Spatial Analysis and Policy*. Applied Spatial Analysis and Policy, 9(2), pp. 191–212. doi: 10.1007/s12061-015-9181-z.

Mehta, V. (2013) *The street: a quintessential social public space*. New York, USA: Routledge.

Montgomery, J. (1998) 'Making a city: Urbanity, vitality and urban design', *Journal of Urban Design*, 3(1), pp. 93–116. doi: 10.1080/13574809808724418.

Proença, S. dos S. B. (2014) *A Diversidade da Rua na Cidade de Lisboa: Morfologia e Morfogénese*. Universidade de Lisboa.

Siksna, A. (1997) 'The effects of block size and form in North American and Australian city centres', *Urban Morphology*, 1(1), pp. 19–33.

Simpson, J., Thwaites, K. and Freeth, M. (2019) 'Understanding Visual Engagement with Urban Street Edges along Non-Pedestrianised and Pedestrianised Streets Using Mobile Eye-Tracking', *Sustainability*, 11(15), p. 4251. doi: 10.3390/su11154251.

Spanjar, G. and Suurenbroek, F. (2020) 'Eye-tracking the city: Matching the design of streetscapes in high-rise environments with users' visual experiences', *Journal of Digital Landscape Architecture*, 5, pp. 374–385. doi: 10.14627/537690038.

Stojanovski, T. and Axelsson, Ö. (2019) 'Typo-Morphology and Environmental Perception of Urban Space', in *Urban Morphological Theory*, pp. 822–834.

Thwaites, K., Simpson, J. and Simkins, I. (2020) 'Transitional edges: a conceptual framework for socio-spatial understanding of urban street edges', *Urban Design International*. Palgrave Macmillan UK, 25(4), pp. 295–309. doi: 10.1057/s41289-

Bibliography

A

Acebillo, J. (2006) 'Barcelona: Towards a new urban planning approach', *Spatium*, 5(13–14), pp. 55–59. doi: 10.2298/SPAT0614055A.

ADA (2001) نحو تطوير نظام نقل عام آمن وفعال في مدينة الرياض *[Toward the Development of a Safe and Efficient Public Transportation System in Riyadh city]*. Riyadh, Saudi Arabia. Available at: https://www.rcrc.gov.sa/res/ada/ar/Researches/development_of_transport_system/index.html.

ADA (2003) المخطط الاستراتيجي الشامل لمدينة الرياض *[Riyadh's Comprehensive Strategic Plan]*. Riyadh, Saudi Arabia. Available at: https://www.rcrc.gov.sa/idc/groups/public/documents/Ar_ADA_StrategicPlan/001863.pd.

Adams, D., Croudace, R. and Tiesdell, S. (2011) 'Design codes, opportunity space, and the marketability of new housing', *Environment and Planning B: Planning and Design*, 38(2), pp. 289–306. doi: 10.1068/b36055.

Ahmed, N. O., El-Halafawy, A. M. and Amin, A. M. (2019) 'A Critical Review of Urban Livability', *European Journal of Sustainable Development*, 8(1), pp. 165–182. doi: 10.14207/ejsd.2019.v8n1p165.

Ajuntament de Barcelona (1983) *Plans i Projectes per a Barcelona 1981/1982*. Barcelona, Spain: Ajuntament de Barcelona, Area d'Urbanisme.

Ajuntament de Barcelona (2010) *Cerda and the First Barcelona Metropolis, 1853-1897*. Edited by M. L. Guallar. Barcelona, Spain: MUHBA, Barcelona City Council, Institute of Culture and SECC.

Al-Fouzan, S. A. (2012) 'Using car parking requirements to promote sustainable transport development in the Kingdom of Saudi Arabia', *Cities*. Elsevier Ltd, 29(3), pp. 201–211. doi: 10.1016/j.cities.2011.08.009.

Al-Harigi, M. S., Yousef, A. J. and An-Nwisser, S. F. (2002) 'Jeddah urban growth and development process: the underlying factors', *Scientific Journal of King Faisal University (Basic and Applied Sciences)*, 3(1), pp. 111–136.

Al-Hathloul, S. (2017) 'Riyadh Development Plans in the Past Fifty Years (1967-2016)', *Current Urban Studies*, 05(01), pp. 97–120. doi: 10.4236/cus.2017.51007.

Al-Hathloul, S. A. (1981) *Tradition, continuity and change in the physical environment: the Arab-Muslim city*. Massachusetts Institute of Technology. Available at: http://dspace.mit.edu/handle/1721.1/46401.

Al-Hathloul, S. and Mughal, M. A. (2004) 'Urban growth management-the Saudi experience', *Habitat International*, 28(4), pp. 609–623. doi: 10.1016/j.habitatint.2003.10.009.

Al-Hemaidi, W. K. (2001) 'The metamorphosis of the urban fabric in Arab-Muslim City: Riyadh, Saudi Arabia.', *Journal of Housing and the Built Environment*, 16(2), pp. 179–201.

Al Hosain, N. and Alhussaini, A. (2021) *Evaluating Access to Riyadh's Planned Public Transport System Using Geospatial Analysis*, *Kapsarc*. Riyadh, Saudi Arabia. doi: 10.30573/KS--2021-DP10.

Al-Mogren, F. B. A. (2022) 'Operational Planning: An alternative view of Doxiadis' project in Riyadh', in Fabbri, R. and Al-Qassemi, S. S. (eds) *Urban Modernity in the Contemporary Gulf: Obsolescence and Opportunities*. Abingdon: Routledge, pp. 156–171. doi: 10.4324/9781003156529-11.

Al-Mosaind, M. (2018) 'Applying complete streets concept in Riyadh, Saudi Arabia: opportunities and challenges', *Urban, Planning and Transport Research*. Routledge, 6(1), pp. 129–147. doi: 10.1080/21650020.2018.1547124.

Al-Naim, M. A. (2008) *The Evolving Arab City*, *The Evolving Arab City: Tradition, Modernity and Urban Development*. Edited by Y. Elsheshtawy. London: Routledge. doi: 10.4324/9780203696798.

Al Naim, M. A. (2013) 'Urban transformation in the city of riyadh: A study of plural urban identity', *Open House International*, 38(4), pp. 70–79. doi: 10.1108/ohi-04-2013-b0008.

Al-Rashid, M. A. *et al.* (2020) 'Gender-responsive public transportation in the Dammam metropolitan region, Saudi Arabia', *Sustainability (Switzerland)*, 12(21), pp. 1–17. doi: 10.3390/su12219068.

Al-Said, F. (2003) 'The pattern of structural transformation of the Saudi contemporary neighbourhood: The case of Al-Malaz, Riyadh, Saudi Arabia', in *39th ISoCaRP Congress*. Cairo, Egypt, pp. 1–10. Available at: http://www.isocarp.net/Data/case_studies/347.pdf.

Aldalbahi, M. and Walker, G. (2016) 'Riyadh Transportation History and Developing Vision', *Procedia - Social and Behavioral Sciences*. Elsevier B.V., 216, pp. 163–171. doi:

10.1016/j.sbspro.2015.12.024.

Alexander, C. (1965) *A City is not a tree.* Sustasis Press.

Alexander, C., Ishikawa, S. and Silverstein, M. (1977) *A pattern language.* Oxford, UK: Oxford University Press.

Almahmood, M. A. M. (2017) *Re-humanising Public Urban Space: Unfolding the influence of socio-cultural norms on the use, experience, and provision of the sidewalk in Riyadh, Saudi Arabia.* University of Copenhagen.

Alnaim, M. M. (2020) 'The Hierarchical Order of Spaces in Arab Traditional Towns: The Case of Najd, Saudi Arabia', *World Journal of Engineering and Technology*, 08(03), pp. 347–366. doi: 10.4236/wjet.2020.83027.

Alotaibi, O. and Potoglou, D. (2018) 'Introducing public transport and relevant strategies in Riyadh City, Saudi Arabia: a stakeholders' perspective', *Urban, Planning and Transport Research.* Routledge, 6(1), pp. 35–53. doi: 10.1080/21650020.2018.1463867.

Anderson, S. (1991) *On Streets: Streets as Elements of Urban Structure.* Cambridge, MA, USA: MIT Press.

Andreani, S. and Sayegh, A. (2017) 'Augmented Urban Experiences: Technologically Enhanced Design Research Methods for Revealing Hidden Qualities of the Built Environment', in *the 37th Annual Conference of the Association for Computer Aided Design in Architecture.* Cambridge, MA, USA, pp. 82–91.

Andrews, C. J. (2001) 'Analyzing quality-of-place.', *Environment and Planning B: Planning and Design*, 28(2), pp. 201–217.

Appleyard, D. (1981) *Livable Streets.* Berkeley, CA, USA: University of California Press.

Appleyard, D., Lynch, K. and Myer, J. R. (1964) *The View from the Road.* Cambridge, MA, USA: The MIT Press.

Araujo, A. *et al.* (2021) 'O Plano Especial Diagonal-Poble Nou: da importância do protagonismo público na gestão e produção do espaço urbano à emergência do Urbanismo liberal (I)', *urbe. Revista Brasileira de Gestão Urbana*, 13(I), pp. 1–29. doi: 10.1590/2175-3369.013.e20190364.

Ares, Ó. (2010) 'Sert, Le Corbusier y el Plan Macià: heterodoxia y contradicciones formales', *DC. Revista de crítica arquitectónica*, (19–20), pp. 173–182. doi: 10.5821/dcpapers.v0i19-20.984.

Attia, M. K. (2014) 'Sustainability in Saudi vernacular built environment: The case of Al-Ahsa', in *Vernacular Architecture: Towards a Sustainable Future.* CRC Press, pp. 107–112. doi: 10.1201/b17393-20.

B

Bacon, E. N. (1976) *Design of cities.* Revised Ed. London, UK: Penguin book.

Banerjee, T. and Loukaitou-sideris, A. (eds) (2011) *Companion to urban design.* New York, NY, USA: Routledge.

Barker, R. G. (1968) *Ecological Psychology: Concepts and Methods for Studying the Environment of Human Behavior.* Stanford, CA, USA: Stanford University Press.

Batty, M. (2007) *Cities and complexity: understanding cities with cellular automata, agent-based models, and fractals.* Cambridge, MA, USA: The MIT Press.

Batty, M. and Marshall, S. (2017) 'Thinking organic, acting civic: The paradox of planning for Cities in Evolution', *Landscape and Urban Planning,* 166, pp. 4–14. doi: 10.1016/j.landurbplan.2016.06.002.

Ben-Joseph, E. (1995) 'Changing the Residential Street Scene: Adapting the shared street (Woonerf) Concept to the Suburban Environment', *Journal of the American Planning Association,* 61(4), pp. 504–515. doi: 10.1080/01944369508975661.

Benevolo, L. (1977) *History of Modern Architecture.* Vol. 2. Cambridge, Massachusetts: MIT Press.

Bently, I. *et al.* (1985) *Responsive environments: A manual for designers.* London, UK: Architectural Press.

Bergstrom, J. R. and Schall, A. (2014) *Eye Tracking in User Experience Design.* Waltham, MA, USA: Morgan Kaufmann.

Berman, M. (1983) *All that is Solid Melts Into Air: The Experience of Modernity.* New York: Verso.

Blomkamp, E. and Lewis, J. M. (2019) 'Marvellous Melbourne: Making the world's most liveable city', in Compton, M. and Hart, P. 't (eds) *Great policy successes.* Oxford, UK: Oxford University Press, pp. 180–200. doi: 10.22459/SPP.2019.05.

Bobić, M. (2004) *Between the Edges: Street-building Transition as Urbanity Interface.* Bussum, The Netherlands: Thoth Publishers.

Bonnenfant, P. (2014) 'Real estate and political power in 1970s Riyadh', *City,* 18(6), pp. 708–722. doi: 10.1080/13604813.2014.965890.

Bosselmann, P., Macdonald, E. and Kronemeyer, T. (1999) 'Livable Streets Revisited', *Journal of the American Planning Association,* 65(2), pp. 168–180. doi: 10.1080/01944369908976045.

Brown, B. B., Burton, J. R. and Sweaney, A. L. (1998) 'Neighbors, Households, and Front Porches', *Environment and Behavior*, 30(5), pp. 579–600. doi: 10.1177/001391659803000501.

Buchan, J. (1980) *Jeddah old and new*. London, UK: Stacy International.

Buchanan, C. (2007) *Paved with gold: The real value of good street design Design better streets*. London, United Kingdom: Commission for Architecture and the Built Environment. Available at: www.cabe.org.uk/streets.

Bullock, A., Stallybrass, O. and Trombley, S. (eds) (1988) *The Fontana dictionary of modern thought*. 2nd editio. London, UK: Fontana Press.

Bürklin, T. and Peterek, M. (2008) *Basics Urban Building Blocks*. Basel, Switzerland: Birkhäuser.

Burton, E. (2012) 'Streets ahead? The role of the built environment in healthy ageing', *Perspectives in Public Health*, 132(4), p. 161. doi: 10.1177/1757913912449.

Busquets, J. (2004) *Barcelona: la construcción urbanística de una ciudad compacta*. Baecelona: Ediciones del Serbal, S.A.

Busquets, J., Yang, D. and Keller, M. (2019) *Urban Grids: Handbook for Regular City Design*. San Francisco, CA, USA: ORO Editions.

C

Calavita, N. and Ferrer, A. (2000) 'Behind Barcelona's Success Story', *Journal of Urban History*, 26(6), pp. 793–807. doi: 10.1177/009614420002600604.

Çaliskan, O. (2013) *Pattern Formation in Urbanism. A critical reflection on Urban Morphology, Planning and Design*. Delft University of Technology. Available at: https://research.tudelft.nl/en/publications/pattern-formation-in-urbanism-a-critical-reflection-on-urban-morp.

Calvino, I. (1997) *Invisible Cities*. London, United Kingdom: Vintage.

Câmara Municipal de Lisboa (2013) *Plano de Acessibilidade Pedonal de Lisboa*. Lisboa. Available at: http://acessibilidade.cm-lisboa.pt.

Câmara Municipal de Lisboa (2015a) *Pavimentar Lisboa 2015-2020*. Available at: https://www.lisboa.pt/atualidade/noticias/detalhe/pavimentar-lisboa-2015-2020.

Câmara Municipal de Lisboa (2015b) *Uma Praça em Cada Bairro: Intervenções em Espaço Público*. Lisboa. Available at: http://www.cm-lisboa.pt/fileadmin/VIVER/Urbanismo/urbanismo/planeamento/termosaprovados/campus/apresentacao.pdf.

Caniggia, G. and Maffei, G. L. (2001) *Architectural Composition and Building Typology: Interpreting Basic Building*. Florence, Italy: Alinea Editrice.

Canter, D. (1977) *The Psychology of Place*. London, UK: The architectural Press.

Canter, D. (1991) 'Understanding, Assessing, and Acting in Places: Is an Integrative Framework Possible?', in Garling, T. and Evans, G. W. (eds) *Environment, Cognition, and Action: An Integrated Approach*. New York, NY, USA: Oxford University Press, p. 634.

Carlson, C. *et al.* (2012) 'Complexity in built environment, health, and destination walking: A neighborhood-scale analysis', *Journal of Urban Health*, 89(2), pp. 270–284. doi: 10.1007/s11524-011-9652-8.

Carmona, M. *et al.* (2003) *Urban spaces-public places: The dimensions of urban design*. Oxford, UK: Architectural Press.

Carmona, M. (2009) 'Design coding and the creative, market and regulatory tyrannies of practice', *Urban Studies*, 46(12), pp. 2643–2667. doi: 10.1177/0042098009344226.

Carmona, M., Magalhães, C. de and Hammond, L. (2008) *Public space: the management dimension*. London, United Kingdom: Routledge.

Carmona, M. and Tiesdell, S. (eds) (2007) *Urban design reader*. London, UK: Routledge.

Carr, S. *et al.* (1992) *Public space*. New York, NY, USA: Cambridge University Press.

Casas-valle, D. (2018) *Streets & Urbanisation. theory, case, tool-reflections on the intermediary scale in the Porto region*. Universidade do Porto.

Cataldi, G. (2003) 'From Muratori to Caniggia: the origins and development of the Italian school of design typology', *Urban Morphology*, 7(1), pp. 19–34. doi: 10.51347/jum.v7i1.3904.

Cataldi, G., Maffei, G. L. and Vaccaro, P. (2002) 'Saverio Muratori and the Italian school of planning typology', *Urban Morphology*, 6(1), pp. 3–14.

Cerrone, D. *et al.* (2021) 'Implementing Gehl's Theory to Study Urban Space. The Case of Monotowns', *Sustainability*, 13(9), p. 5105. doi: 10.3390/su13095105.

Cervero, R. (2009) 'Transport infrastructure and global competitiveness: Balancing mobility and livability', *The Annals of the American Academy of Political and Social Science*, 626(1), pp. 210–225. doi: 10.1177/0002716209344171.

Charles, M. (2013) *Happy City: Transforming Our Lives Through Urban Design*. Penguin Books.

Chazal, J. de (2010) 'A systems approach to livability and sustainability: Defining terms and mapping relationships to link desires with ecological opportunities and constraints', *Systems Research and Behavioral Science*, 27(5), pp. 585–597. doi: 10.1002/sres.1058.

Christ, E. *et al.* (2015) *Typology: Paris, Delhi, São Paulo, Athens.* Vol. 3. Zurich, Switzerland: Park Books.

Clifton, K. J., Livi Smith, A. D. and Rodriguez, D. (2007) 'The development and testing of an audit for the pedestrian environment', *Landscape and Urban Planning*, 80(1–2), pp. 95–110. doi: 10.1016/j.landurbplan.2006.06.008.

Collins, G. R. and Collins, C. C. (2006) *Camillo Sitte: The Birth of Modern City Planning: with a translation of the 1889 Austrian edition of his City Planning According to Artistic Principles.* New York, NY, USA: Dover Publications.

Consiglieri, C. (2005) *Dos Restauradores à Liberdade em Postal Antigo.* Lisboa, PT: Livros Horizonte.

Conzen, R. G. M. (1960) *Alnwick, Northumberland. A Study in Town-Plan Analysis.* London, UK: George Philip And Son Ltd.

Correia, N. (2018) 'The disintegration of the urban limits of Lisbon in the early 1960's.', in *La Città Altra.* CIRICE-FeDOA University Pres, pp. 77–87.

Cowan, R. (2005) *The Dictionary of Urbanism.* Tisbury, Wiltshire, UK: Streetwise Press.

Creíxell, S. P. and Parés, S. V. (1977) 'El modelo teorico del plan Cerdà', *2C Construcción De La Ciudad*, (6–7), pp. 46–55. Available at: https://upcommons.upc.edu/handle/2099/5091.

Creutzig, F., Mühlhoff, R. and Römer, J. (2012) 'Decarbonizing urban transport in European cities: four cases show possibly high co-benefits', *Environmental Research Letters*, 7(4), p. 044042. doi: 10.1088/1748-9326/7/4/044042.

Cullen, G. (1961) *Townscape.* London, UK: The architectural Press.

Curtis, C. and Tiwari, R. (2008) 'Transitioning urban arterial roads to activity corridors', *Urban Design International*, 13(2), pp. 105–120. doi: 10.1057/udi.2008.10.

D

D'Acci, L. (2019) 'On urban morphology and mathematics', in D'Acci, L. (ed.) *The mathematics of urban morphology.* Cham, Switzerland: Springer International Publishing (Modeling and Simulation in Science, Engineering and Technology). doi: 10.1007/978-3-030-12381-9.

Daghistani, A. I. (1991) 'Urban growth management in Jeddah', *Planning Outlook*, 34(1), pp. 2–9. doi: 10.1080/00320719108711883.

de Jong, M. *et al.* (2015) 'Sustainable–smart–resilient–low carbon–eco–knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization', *Journal of Cleaner Production*, 109, pp. 25–38. doi: 10.1016/j.jclepro.2015.02.004.

De Roo, G. and Rauws, W. S. (2012) 'Positioning planning in the world of order, chaos and complexity: On perspectives, behaviour and interventions in a non-linear environment', in Portugali, J. et al. (eds) *Complexity theories of cities have come of age: An overview with implications to urban planning and design*. Berlin, Heidelberg: Springer, pp. 207–220. doi: 10.1007/978-3-642-24544-2.

De Vos, J. (2020) 'The effect of COVID-19 and subsequent social distancing on travel behavior', *Transportation Research Interdisciplinary Perspectives*, 5, p. 100121. doi: 10.1016/j.trip.2020.100121.

Ding, D. and Gebel, K. (2012) 'Built environment, physical activity, and obesity: What have we learned from reviewing the literature?', *Health & Place*. Elsevier, 18(1), pp. 100–105. doi: 10.1016/j.healthplace.2011.08.021.

Dovey, K. and Wood, S. (2015) 'Public/private urban interfaces: type, adaptation, assemblage', *Journal of Urbanism*, 8(1), pp. 1–16. doi: 10.1080/17549175.2014.891151.

Downs, R. M. and Stea, D. (2011) 'Cognitive Maps and Spatial Behaviour: Process and Products', in *The Map Reader*. Chichester, UK: Wiley, pp. 312–317. doi: 10.1002/9780470979587.ch41.

Doxiadis, C. (1970) 'Ekistics, the Science of Human Settlements', *Science*, 170(3956), pp. 393–404. doi: 10.1126/science.170.3956.3.

Duany, A., Plater-Zyberk, E. and Speck, J. (2000) *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream*. New York, USA: North Point Press.

Duchowski, A. T. (2017) *Eye Tracking Methodology: Theory and Practice*. 3rd ed. Cham, Switzerland: Springer International Publishing. doi: 10.1007/978-3-319-57883-5.

Dumbaugh, E. (2005) *Safe Streets, Livable Streets: A Positive Approach to Urban Roadside Design*. Georgia Institute of Technology, USA.

Dumbaugh, E. and Rae, R. (2009) 'Safe urban form: Revisiting the relationship between community design and traffic safety', *Journal of the American Planning Association*, 75(3), pp. 309–329. doi: 10.1080/01944360902950349.

Dzebic, V., Perdue, J. S. and Ellard, C. G. (2013) 'The influence of visual perception on responses towards real-world environments and application towards design', *Intelligent Buildings International*, 5, pp. 29–47. doi: 10.1doi.org/10.1080/17508975.2013.807766080/17508975.2013.807766.

E

Ellard, C. (2015) *Places of the Heart: The Psychogeography of Everyday Life*. New York, NY, USA: Bellevue Literature Press.

Ellard, C. (2020) 'Neuroscience, wellbeing, and urban design: Our universal attraction to vitality', *Psychological Research on Urban Society*, 3(1). doi: 10.7454/proust.v3i1.81.

Elsheshtawy, Y. (2021) *Riyadh: Transforming a Desert City*. London, UK: Taylor & Francis.

Ergan, S. *et al.* (2018) 'Quantifying Human Experience in Architectural Spaces with Integrated Virtual Reality and Body Sensor Networks', *Journal of Computing in Civil Engineering*, 33(2), p. 04018062. doi: 10.1061/(ASCE)CP.1943-5487.0000812.

Evans, G. W. (2003) 'The built environment and mental health', *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 80(4), pp. 536–555. doi: 10.1093/jurban/jtg063.

Ewing, R. and Clemente, O. (2013) *Measuring urban design: Metrics for livable places*. Washington, DC: Island Press.

Ewing, R. and Handy, S. (2009) 'Measuring the unmeasurable: Urban design qualities related to walkability', *Journal of Urban Design*, 14(1), pp. 65–84. doi: 10.1080/13574800802451155.

F

Facey, W. (1992) *Riyadh, the old city: From its origins until the 1950s*. London, UK: IMMEL.

Faris, A. (1982) الرياض : وثبة إزدهار في الصحراء العربية *[Riyadh: A leap of prosperity in the Arabian desert]*. University of Paris.

Fields, G. (2012) 'Urbanization and the Transition from Agrarian to Industrial Society', *Berkeley Planning Journal*, 13(1). doi: 10.5070/BP313113032.

Figueiredo, P. (2022) *Taking Back São Paulo's Streets, One Sunday At A Time, Next City*. Available at: https://nextcity.org/urbanist-news/taking-back-saeo-paulos-streets-one-sunday-at-a-time.

Finn, D. (2020) 'Streets, Sidewalks and COVID-19: Reimaging New York City's Public Realm as a Tool for Crisis Management', *Journal of Extreme Events*, 07(04), p. 2150006. doi: 10.1142/S2345737621500068.

Forbes, G. (1999) 'Urban Roadway Classification: Before the Design Begins', in *Urban*

Street Symposium. Dallas, Texas, USA.

Fotios, S. *et al.* (2014) 'Using eye-tracking to identify pedestrians' critical visual tasks, Part 1. Dual task approach', *Lighting Research & Technology*, *47*(2), pp. 133–148. doi: 10.1177/1477153514522472.

Francis, M. (1987) 'The Making of Democratic Streets', in Moudon, A. V. (ed.) *Public Streets for Public Use*. New York, NY, USA: Van Nostrand Reinhold, pp. 23–39.

Franck, K. A. and Stevens, Q. (2006) *Loose space: possibility and diversity in urban life*. London, UK: Routledge. Available at: https://www.taylorfrancis.com/books/9781135993184.

Frank, L. D. and Engelke, P. O. (2001) 'The Built Environment and Human Activity Patterns: Exploring the Impacts of Urban Form on Public Health', *Journal of Planning Literature*, 16(2), pp. 202–218. doi: 10.1177/08854120122093339.

G

Galea, J. M. and Boon, J. J. (1981) 'The Traditional Architecture of the Asir Province, Saudi Arabia', in *Housing*. Elsevier, pp. 118–134. doi: 10.1016/B978-0-08-028066-0.50012-6.

Gandelsonas, M. (1991) *The Urban Text*. Chicago, IL, USA: MIT Press.

Garba, S. B. (2004) 'Managing urban growth and development in the Riyadh metropolitan area, Saudi Arabia', *Habitat International*, 28(4), pp. 593–608. doi: 10.1016/j.habitatint.2003.10.008.

Garcia-Ramon, M.-D. and Albet, A. (2000) 'Pre-Olympic and Post-Olympic Barcelona, a "Model" for Urban Regeneration Today?', *Environment and Planning A: Economy and Space*, 32(8), pp. 1331–1334. doi: 10.1068/a3331.

Gehl, J. (1987) *Life Between Buildings*. New York, NY, USA: Van Nostrand-Reinhold.

Gehl, J. (2010) *Cities for people*. London, UK: Island Press.

Gehl, J. (2018) 'Move to Melbourne', in Dovey, K., Adams, R., and Jones, R. (eds) *Urban Choreography: Central Melbourne, 1985–*. Melbourne, Australia: Melbourne University Publishing.

Gehl, J., Kaefer, L. J. and Reigstad, S. (2005) 'Close encounters with buildings', *Urbanistika ir architektūra*, 29(2), pp. 70–80.

Gehl, J. and Svarre, B. (2013) *How To Study Public Life*. Washington, DC: Island Press/Center for Resource Economics. doi: 10.5822/978-1-61091-525-0.

Gibson, J. J. (1986) *The Ecological Approach to Visual Perception*. New York, NY, USA: Psychology Press.

Giedion, S. (1959) *Space, Time and Architecture: The Growth of a New Tradition.* Cambridge, MA, USA: Harvard University Press.

Glaser, M. *et al.* (2012) *The City at Eye Level: Lessons for Street Plinths.* Delft, The Netherlands: Eburon Uitgeverij BV.

Gold, J. R. (1998) 'The death of the boulevard', in Fyfe, N. (ed.) *Images of the Street: Planning, Identity and Control in Public Space.* Londres/New York: Routledge, pp. 44–57.

Goldstein, J. (1999) 'Emergence as a construct: History and issues', *Emergence*, 1(1), pp. 49–72. doi: 10.1207/s15327000em0101_4.

Gorgul, E. *et al.* (2019) 'Measuring street enclosure and its influence to human physiology through wearable sensors', in *Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers.* New York, NY, USA, pp. 65–68. doi: 10.1145/3341162.3343794.

Goss, J. (1993) 'The "magic of the mall": an analysis of form, function, and meaning in the contemporary retail built environment', *Annals of the Association of American Geographers*, 83(1), pp. 18–47. doi: 10.1111/j.1467-8306.1993.tb01921.x.

Gottmann, J. (1964) 'Introduction: The Main Street of the Nation', in *Megalopolis.* The MIT Press, pp. 2–15. doi: 10.7551/mitpress/4537.003.0003.

Greenbaum, S. D. (1982) 'Bridging ties at the neighborhood level', *Social Networks*, 4(4), pp. 367–384. doi: 10.1016/0378-8733(82)90019-3.

Guardia, M., Monclús, J. and Oyón, J. L. (1995) *Atlas histórico de ciudades europeas : península ibérica.* vol. I. Barcelona, Spain: Salvat.

H

Hall, E. T. (1966) *The hidden dimension, The hidden dimension.* Garden City, N.Y: Doubleday.

Hall, P. (2014) *Cities of tomorrow: An intellectual history of urban planning and design since 1880.* Hoboken, NJ, USA: John Wiley & Sons.

Hamilton, D. and Atkins, P. (eds) (2008) *Urban and regional policies for metropolitan livability.* Armonk, New York: ME Sharpe.

Handy, S. L. *et al.* (2002) 'How the built environment affects physical activity: Views from urban planning', *American Journal of Preventive Medicine*, 23(2), pp. 64–73. doi: 10.1016/S0749-3797(02)00475-0.

Harezlak, K. and Kasprowski, P. (2017) 'Application of eye tracking in medicine: A survey, research issues and challenges', *Computerized Medical Imaging and Graphics*. Elsevier Ltd, 65, pp. 176–190. doi: 10.1016/j.compmedimag.2017.04.006.

Hass-Klau, C. (1990) *The Pedestrian and City Traffic*. London, UK: Belhaven Press.

Hebbert, M. (2005) 'Engineering, Urbanism and the Struggle for Street Design', *Journal of Urban Design*, 10(1), pp. 39–59.

Heffernan, E., Heffernan, T. and Pan, W. (2014) 'The relationship between the quality of active frontages and public perceptions of public spaces', *Urban Design International*, 19(1), pp. 92–102. doi: 10.1057/udi.2013.16.

Helbing, D. *et al.* (2001) 'Self-organizing pedestrian movement', *Environment and Planning B: Planning and Design*, 28(3), pp. 361–383. doi: 10.1068/b2697.

Hess, P. M. (2008) 'Fronts and Backs', *Journal of Planning Education and Research*, 28(2), pp. 196–212. doi: 10.1177/0739456X08321799.

Hess, P. M. (2009) 'Avenues or arterials: the struggle to change street building practices in Toronto, Canada', *Journal of Urban Design*, 14(1), pp. 1–28. doi: 10.1080/13574800802451049.

Hillier, B. *et al.* (1993) 'Natural movement: or, configuration and attraction in urban pedestrian movement', *Environment and Planning B: Planning and Design*, 20(1), pp. 29–66. doi: 10.1068/b200029.

Hillier, B. and Hanson, J. (1989) *The social logic of space*. Cambridge, UK: Cambridge University Pres.

Ho, K. and Douglass, M. (2008) 'Globalisation and liveable cities: Experiences in place-making in Pacific Asia', *International Development Planning Review*, 30(3), pp. 199–213. doi: 10.3828/idpr.30.3.1.

Hofmeister, B. (2004) 'The study of urban form in Germany', *Urban Morphology*, 8(1), pp. 3–12.

Hollander, J. B. *et al.* (2019) 'Seeing the city: using eye-tracking technology to explore cognitive responses to the built environment', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 12(2), pp. 156–171. doi: 10.1080/17549175.2018.1531908.

Holmqvist, K. *et al.* (2011) *Eye tracking A comprehensive guide to methods, paradigms, and measures*. Oxford, UK: Oxford University Press.

Horayangkura, V. (2012) 'Incorporating environment-behavior knowledge into the design process: an elusive challenge for architects in the 21st century', *Procedia - Social and Behavioral Sciences*, 50, pp. 30–41. doi: 10.1016/j.sbspro.2012.08.013.

Howard, E. (1898) *To-morrow: A peaceful path to real reform*. London, UK: Swan Sonnenschein & Co.

I

ITDP (2020) *Buenos Aires: 1985 and Today, Institute for Transportation and Development Policy*. Available at: https://www.itdp.org/2020/01/27/buenos-aires-1985-and-today/.

J

Jacobs, A. (1995) *Great Streets*. Cambridge, MA, USA: The MIT Press.

Jacobs, A. and Appleyard, D. (1987) 'Toward an urban design manifesto', *Journal of the American Planning Association*, 53(1), pp. 112–120. doi: 10.1080/01944368708976642.

Jacobs, A. B. *et al.* (1996) *The Uses and Reuses of Major Urban Arterials: A Study of Recycling, Revitalizing, and Restructuring 'Gray Area' Transportation Corridors, Faculty Research Papers*. Berkeley.

Jacobs, A. B., Macdonald, E. and Rofé, Y. (1993) *The Boulevard Book: History, Evolution, Design of Multiway Boulevards*. Cambridge, MA, USA: MIT Press.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York, NY, USA: Vintage Books.

James, W. (1890) *The Principles of Psychology*. Henry Holt and Company.

Jensen, S. U. (2004) *European Arterial Streets Historic Changes , Existing Situation and Processes*. Atkins, Denmark.

Jukes, P. (1991) *A Shout in the street: an excursion into the modern city*. Berkeley, CA, USA: University of California Press.

K

Kaakinen, J. K. (2020) 'What Can Eye Movements Tell us about Visual Perception Processes in Classroom Contexts? Commentary on a Special Issue', *Educational Psychology Review*, 33(1), pp. 169–179. doi: 10.1007/s10648-020-09573-7.

Kaal, H. (2011) 'A conceptual history of livability: Dutch scientists, politicians, policy makers and citizens and the quest for a livable city', *City*, 15(5), pp. 532–547. doi: 10.1080/13604813.2011.595094.

Kamalipour, H. (2016) 'Mapping Urban Interfaces A Typology of Public/Private Interfaces in Informal Settlements', *Spaces and Flows: An International Journal of Urban* *and ExtraUrban Studies*, 8(2).

Kane, F. (2021) *Saudi crown prince unveils plan to make Riyadh one of world's 10 largest city economies, Arab News*. Available at: https://www.arabnews.com/node/1800231/business-economy.

Karakas, T. and Yildiz, D. (2020) 'Exploring the influence of the built environment on human experience through a neuroscience approach: A systematic review', *Frontiers of Architectural Research*, 9(1), pp. 236–247. doi: 10.1016/j.foar.2019.10.005.

Kent, E. (2019) 'Leading urban change with people powered public spaces. The history, and new directions, of the Placemaking movement', *The Journal of Public Space*, (Vol. 4 N. 1 | 2019 | FULL ISSUE), pp. 127–134. doi: 10.32891/jps.v4i1.1158.

Kihl, M. *et al.* (2005) *Livable Communities: An Evaluation Guide*. Washington, DC. Available at: http://assets.aarp.org/rgcenter/il/d18311_communities.pdf.

Kim, B.-S., Park, K. and Kim, Y.-W. (2009) 'Endurance Analysis of Automotive Vehicle's Door W/H System Using Finite Element Analysis', *Journal of Software Engineering and Applications*, 02(05), pp. 375–382. doi: 10.4236/jsea.2009.25050.

Klingmann, A. (2023) 'Rescripting Riyadh: how the capital of Saudi Arabia employs urban megaprojects as catalysts to enhance the quality of life within the city's neighborhoods', *Journal of Place Management and Development*, 16(1), pp. 45–72. doi: 10.1108/jpmd-06-2021-0062.

Komossa, S. (2010) *Atlas of the Dutch Urban Block*. Nijmegen, Netherlands: Vantilt.

Koolhaas, R. (1995) 'The Generic City', in Koolhaas, R. and Mau, B. (eds) *S,M,L,XL*. New York, NY, USA: The Monacelli Press, pp. 123–178.

Kostof, S. (1992) *The City Assembled: The Elements of Urban Form Through History*. London, UK: Thames and Hudson Ltd.

Krier, R. (1979) *Urban Space*. London, UK: Academy editions.

Kropf, K. (2017) *The Handbook Of Urban Morphology*. Hoboken, New Jersey, USA: Wiley. doi: 10.1002/9781118747711.

Krstić, K. *et al.* (2018) 'All good readers are the same, but every low-skilled reader is different: an eye-tracking study using PISA data', *European Journal of Psychology of Education*, 33(3), pp. 521–541. doi: 10.1007/s10212-018-0382-0.

L

Lang, F. (2003) *Fritz Lang: Interviews*. Edited by B. K. Grant. Mississippi: University press of Mississippi.

Larkham, P. J. (1998) 'Urban morphology and typology in the United Kingdom', in Petruccioli, A. (ed.) *Typological Process and Design Theory*. Cambridge, Massachusetts, USA: Aga Khan Program for Islamic Architecture, pp. 159–170. Available at: https://archnet.org/publications/4251.

Lasala, A. (2018) *On the street: Contributions to the urban space through architectural strategies*. Pasadena, California: Typecraft Inc.

Leite, J. S. (2016) *Ruas Emergentes: Interpretação Morfológica no Contexto Urbano Português*. Universidade de Lisboa.

Leite, J. S. and Proença, S. B. (2020) 'Spatial ambiguity in singular buildings . Timeless composition principles', in Strappa, G., Carlotti, P., and Ieva, M. (eds) *5th ISUFitaly International Conference*. Rome, Italy, pp. 601–612. Available at: www.isufi taly.com/.

Lennard, S. H. C. and Lennard, H. L. (1987) *Livable Cities: People and Places : Social and Design Principles for the Future of the City*. Southampton, N.Y: Gondolier Press.

Lewin, K. (1943) 'Defining the "field at a given time."', *Psychological Review*, 50(3), pp. 292–310. doi: 10.1037/h0062738.

Lima, Z. R. M. A. (2007) 'Architecture and Public Space: Lessons From São Paulo', *Places*, 19(2), pp. 28–35.

Lisińska-Kuśnierz, M. and Krupa, M. (2020) 'Suitability of Eye Tracking in Assessing the Visual Perception of Architecture—A Case Study Concerning Selected Projects Located in Cologne', *Buildings*, 10(2), p. 20. doi: 10.3390/buildings10020020.

Llano, S. E. P. (2016) 'La reforma de la Avenida Diagonal. ¿Éxito o fracaso de un proceso participativo?', *On the W@terfront*, 46, pp. 7–84.

Lofland, L. (1998) *The public realm: Exploring the city's quintessential social territory*. New York, USA: Aldine de Gruyter.

Loukaitou-Sideris, A. and Ehrenfeucht, R. (2009) *Sidewalks: Conflict and Negotiation over Public Space*. Cambridge, MA, USA: The MIT Press. doi: 10.7551/mitpress/7423.001.0001.

Lozano, E. E. (1990) *Community design and the culture of cities: the crossroad and the wall*. Cambridge, MA, USA: Cambridge University Press.

Lynch, K. (1960) *The Image of the City*. Cambridge, MA: The MIT Press.

Lynch, K. and Hack, G. (1984) *Site Planning*. Cambridge, MA, USA: MIT Press.

M

Macdonald, E. (2002) 'Structuring a landscape, structuring a sense of place: The enduring complexity of Olmsted and Vaux's Brooklyn Parkways', *Journal of Urban Design*, 7(2), pp. 117–143. doi: 10.1080/1357480022000012203.

Macedo, A. C., Lorellay, J. and Guidoti, C. (2019) 'Paulista Avenue , São Paulo , at Ground Level', *Academic Star Publishing Company*, 5(1), pp. 24–36. doi: 10.15341/mese(2333-2581)/01.05.2019/004.

Madanipour, A. (2003) *Public and private spaces of the city*. London, UK: Routledge.

Madrazo, L. (1995) *The concept of type in architecture: An inquiry into the nature of architectural form*. ETH Zurich. Available at: https://www.research-collection.ethz.ch/bitstream/handle/20.500.11850/142221/eth-39939-02.pdf?sequence=2&isAllowed=y.

Maki, F. (1964) *Investigations in Collective Form*. A Special. St. Louis, MO, USA: School of Architecture, Washington University.

Malfroy, S. (1998) 'Urban tissue and the idea of urban morphogenesis', in *Typological Process and Design Theory*. Cambridge, Massachusetts, USA: Aga Khan Program for Islamic Architecture.

Marcus, I. (2021) *The Metamorphosis of Berlin's 'Unter den Linden' Boulevard*, *The Berlin Spectator*. Available at: https://berlinspectator.com/2021/09/07/the-metamorphosis-of-berlins-boulevard-unter-den-linden/.

Marshall, S. (2004) *Streets & Patterns*. London, UK: Routledge. doi: 10.4324/9780203589397.

Marshall, S. (ed.) (2011) *Urban Coding and Planning*. New York, USA: Routledge. doi: 10.4324/9780203717561.

Marshall, S. and Çalişkan, O. (2011) 'A joint framework for urban morphology and design', *Built Environment*, 37(4), pp. 409–426. doi: 10.2148/benv.37.4.409.

Marshall, S., Jones, P. and Plowright, I. (2004) *A Framework for Classification and Assessment of Arterial Streets*. London, UK. Available at: http://home.wmin.ac.uk/transport/download/ARTISTS_D1.pdf.

Marshall, W. E. and McAndrews, C. (2017) 'Understanding Livable Streets in the Context of the Arterials that Surround Them', *Transportation Research Record: Journal of the Transportation Research Board*, 2605(1), pp. 1–17. doi: 10.3141/2605-01.

Marshall, W., Garrick, N. and Marshall, S. (2015) 'Street networks', in Hickman, R. et al. (eds) *Handbook on Transport and Development*. Edward Elgar Publishing, pp. 208–226. doi: 10.4337/9780857937261.00020.

Martino, N., Girling, C. and Lu, Y. (2021) 'Urban form and livability: socioeconomic and built environment indicators', *Buildings and Cities*, 2(1), pp. 220–243. doi:

10.5334/bc.82.

Matin, E. (1974) 'Saccadic suppression: A review and an analysis', *Psychological Bulletin*, 81(12), pp. 899–917. doi: 10.1037/h0037368.

Mavros, P., Austwick, M. Z. and Smith, A. H. (2016) 'Geo-EEG: Towards the Use of EEG in the Study of Urban Behaviour', *Applied Spatial Analysis and Policy*. Applied Spatial Analysis and Policy, 9(2), pp. 191–212. doi: 10.1007/s12061-015-9181-z.

Mehta, V. (2008) 'Walkable streets: pedestrian behavior, perceptions and attitudes', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 1(3), pp. 217–245. doi: 10.1080/17549170802529480.

Mehta, V. (2013) *The street: a quintessential social public space*. New York, USA: Routledge.

Mehta, V. and Bosson, J. K. (2021) 'Revisiting Lively Streets: Social Interactions in Public Space', *Journal of Planning Education and Research*, 41(2), pp. 160–172. doi: 10.1177/0739456X18781453.

Menghini, A. B. (2002) 'The city as form and structure: the urban project in Italy from the 1920s to the 1980s', *Urban Morphology*, 6(2), pp. 75–86. doi: 10.51347/jum.v6i2.3902.

Middleton, D. A. (2009) *Growth and expansion in post-war urban design strategies: CA Doxiadis and the first strategic plan for Riyadh Saudi Arabia (1968–1972)*. Georgia Institute of Technology.

Milliken, P. *et al.* (2021) 'Identifying Biophilic Design Elements in Streetscapes A Study of Visual Attention and Sense of Place', in Hollander, J. B. and Sussman, A. (eds) *Urban Experience and Design: Contemporary Perspectives on Improving the Public Realm*. New York, NY, USA: Routledge. doi: 10.4324/9780367435585.

Mindell, J. S. and Karlsen, S. (2012) 'Community severance and health: What do we actually know?', *Journal of Urban Health*, 89(2), pp. 232–246. doi: 10.1007/s11524-011-9637-7.

Ministry of Municipal and Rural Affairs (2019) *Future Saudi cities program: Saudi Cities Report*. Riyadh, Saudi Arabia. Available at: https://unhabitat.org/sites/default/files/2020/05/saudi_city_report.english.pdf.

Misk Art Institute (ed.) (2018) *Spaces in Between*. Misk Art Institute.

Moneo, R. (1978) *On typology*.

Montgomery, J. (1997) 'Café culture and the city: The role of pavement cafés in urban public social life', *Journal of Urban Design*, 2(1), pp. 83–102. doi: 10.1080/13574809708724397.

Montgomery, J. (1998) 'Making a city: Urbanity, vitality and urban design', *Journal of Urban Design*, 3(1), pp. 93–116. doi: 10.1080/13574809808724418.

Moore, R. C. (1987) 'Streets as Playgrounds', in Moudon, A. V. (ed.) *Public Streets for Public Use*. New York, USA: Van Nostrand Reinhold.

Morais, J. S. and Roseta, F. (2017) *Avenida da Liberdade: Arquitectura e Cidade*. Lisbon, Portugal: Caleidoscópio.

Morris, A. E. J. (1994) *History of urban form before the industrial revolution*. Third Edit. New York, NY, USA: Routledge.

Moudon, A. V. (ed.) (1987) *Public streets for public use*. New York, USA: Van Nostrand Reinhold.

Moudon, A. V. (1994) 'Getting to Know the Built Landscape: Typomorphology.', in Franck, K. A. and Schneekloth, L. H. (eds) *Ordering space: types in architecture and design*. New York, NY, USA: Van Nostrand Reinhold, pp. 289–314.

Moudon, A. V. (1997) 'Urban morphology as an emerging interdisciplinary field', *Urban Morphology*, 1(1), pp. 3–10.

Moudon, A. V. (1998) 'The Changing Morphology of Suburban Neighborhoods', in Petruccioli, A. (ed.) *Typological Process and Design Theory*. Cambridge, Massachusetts: Aga Khan Program for Islamic Architecture at Harvard University, pp. 141–158.

Moughtin, C. (1991) 'The European city street, part 1: paths and places', *Town Planning Review*, 62(1), pp. 51–77. doi: 10.3828/tpr.62.1.j0v4j745161766r6.

Moughtin, C. (2003) *Urban design: street and square*. Third Edit. Burlington, MA, USA: Architectural Press.

Mubarak, F. A. (2004) 'Urban growth boundary policy and residential suburbanization: Riyadh, Saudi Arabia', *Habitat International*, 28(4), pp. 567–591. doi: 10.1016/j.habitatint.2003.10.010.

Mueller, N. *et al.* (2020) 'Changing the urban design of cities for health: The superblock model', *Environment International*. Elsevier, 134(May 2019), p. 105132. doi: 10.1016/j.envint.2019.105132.

Myers, D. (1988) 'Building knowledge about quality of life for urban planning', *Journal of the American Planning Association*, 54(3), pp. 347–358. doi: 10.1080/01944368808976495.

N

Neuman, M. (2011) 'Centenary paper: Ildefons Cerdà and the future of spatial planning : The network urbanism of a city planning pioneer', *Town Planning Review*, 82(2), pp. 117–144. doi: 10.3828/tpr.2011.10.

Neves, J. da R. and Pinto, P. T. (2019) 'Logradouros do Montepio Geral. Heranças e contextos na avenida alferes malheiro e na estrutura verde do bairro de alvalade (1940-1970)', *Cidades, Comunidades e Territórios*, (38), pp. 117–151. doi: 10.15847/citiescommunitiesterritories.jun2019.038.art04.

Ng, C. F. (2016) 'Behavioral Mapping and Tracking', in Gifford, R. (ed.) *Research Methods for Environmental Psychology*. Wiley, pp. 29–51. doi: 10.1002/9781119162124.ch3.

Noland, R. B. *et al.* (2017) 'Eye-tracking technology, visual preference surveys, and urban design: preliminary evidence of an effective methodology', *Journal of Urbanism*, 10(1), pp. 98–110. doi: 10.1080/17549175.2016.1187197.

O

O'Sullivan, D. and Manson, S. M. (2015) 'Do Physicists Have Geography Envy? And What Can Geographers Learn from It?', *Annals of the Association of American Geographers*, 105(4), pp. 704–722. doi: 10.1080/00045608.2015.1039105.

O'Sullivan, F. (2021) *A Green Transformation for the 'World's Most Beautiful Avenue'*, *CityLab*. Available at: https://www.bloomberg.com/news/features/2021-01-14/paris-dreams-of-a-calmer-greener-champs-elys-es.

Oliveira, V. (2013) 'Morpho: A methodology for assessing urban form', *Urban Morphology*, 17(1), pp. 21–33.

Oliveira, V. (2016) *Urban Morphology: An Introduction to the Study of the Physical Form of Cities*. Cham, Switzerland: Springer International Publishing (The Urban Book Series).

P

Pafka, E. and Dovey, K. (2017) 'Permeability and interface catchment: measuring and mapping walkable access', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 10(2), pp. 150–162. doi: 10.1080/17549175.2016.1220413.

Palaiologou, G. and Vaughan, L. (2014) 'The sociability of the street interface – revisiting West Village, Manhattan', in *Our Common Future in Urban Morphology*, pp. 88–102.

Palenzuela, S. R. (2007) *Barcelona, cuidad mediterranea, compacta y compleja. Una visión de futuro más sostenible*. Barcelona: Agència d'Ecologia Urbana de Barcelona.

Panerai, P. *et al.* (2004) *Urban Forms: The Death and Life of the Urban Block*. Oxford, UK: Architectural Press.

Pauls, J. (1984) 'The movement of people in buildings and design solutions for means of egress', *Fire Technology*, 20(1), pp. 27–47. doi: 10.1007/BF02390046.

Perovic, S. and Folic, N. K. (2012) 'Visual Perception of Public Open Spaces in Niksic', *Procedia - Social and Behavioral Sciences*. Elsevier B.V., 68(December), pp. 921–933. doi: 10.1016/j.sbspro.2012.12.277.

Philby, H. S. J. (1955) *Sa'udi Arabia*. New York, USA: Frederick A. Praeger.

Philby, H. S. J. B. (1920) 'Southern Najd', *The Geographical Journal*, *55*(3), pp. 161–185.

Pinson, D. (2004) 'Urban planning: an "undisciplined" discipline?', *Futures*, 36(4), pp. 503–513. doi: 10.1016/j.futures.2003.10.008.

Pinto, F. (2018) 'Recomposições e representações sociais das Avenidas Novas numa cidade em transformação.', in *X Congresso Português de Sociologia*. Covilhã, pp. 1–22.

Piracha, A. (2011) 'Collaborative city liveability study using Gehl methodology : pedestrian and bicycle counts and stationary activity survey in Penrith', *Journal of Town and City Management*, 2(3), pp. 287–299. Available at: http://ezproxy.uws.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=87712388&site=ehost-live&scope=site.

PlaNYC (2007) *PlaNYC: A Greater, Greener New York*. New York, USA.

Plater-Zyberk, E. *et al*. (2003) *The lexicon of New Urbanism*. Miami, FL, USA: Duany, Plater-Zyberk & Co. Available at: http://www.dpz.com/uploads/Books/Lexicon-2014.pdf.

Portugali, J. (2006) 'Complexity theory as a link between space and place', *Environment and Planning A*, 38(4), pp. 647–664. doi: 10.1068/a37260.

Proença, S. dos S. B. (2014) *A Diversidade da Rua na Cidade de Lisboa: Morfologia e Morfogénese*. Universidade de Lisboa.

Putnam, R. D. (2000) *Bowling alone: The collapse and revival of American community*. New York, NY, USA: Simon & Schuster. Available at: http://library1.nida.ac.th/termpaper6/sd/2554/19755.pdf.

Q

Quality of Life Program (2020). Available at: www.vision2030.gov.sa/v2030/vrps/qol/ (Accessed: 23 March 2022).

R

Rahal, R.-M. and Fiedler, S. (2019) 'Understanding cognitive and affective mechanisms in social psychology through eye-tracking', *Journal of Experimental Social Psychology*. Elsevier, 85, p. 103842. doi: 10.1016/j.jesp.2019.103842.

Rapoport, A. (1977) *Human Aspects of Urban Form: Towards a Man–Environment Approach to Urban Form and Design*. Oxford, UK: Pergamon Press.

RCRC (2006) *Ar-Riyadh: The City & the Life*. Riyadh, Saudi Arabia: The Royal Commission for Riyadh City.

RCRC (2020) *Riyadh transit orinted development*. Riyadh.

Robinson, J. (2006) *Ordinary cities: between modernity and development*. London, UK: Routledge.

Roca, F. (1977) *El Pla Macià*. Barcelona: Edicions La Magrana.

Rodrigues, A. D. (2017) 'Greening the city of Lisbon under the French influence of the second half of the nineteenth century.', *Garden History*, 45(2), pp. 224–250.

Rodríguez, D. A., Brisson, E. M. and Estupiñán, N. (2009) 'The relationship between segment-level built environment attributes and pedestrian activity around Bogota's BRT stations', *Transportation Research Part D: Transport and Environment*, 14(7), pp. 470–478.

Rossi, A. (1966) *The Architecture of the City*. Cambridge: The MIT Press.

Rowe, C. and Koetter, F. (1978) *Collage city*. Cambridge: MIT Press.

Rueda, S. (1995) *Ecologia urbana: Barcelona i la seva regió metropolitana com a referents*. Barcelona: Beta Editorial.

Rueda, S. (2020) *Regenerating the Cerdà Plan. From Cerdà's Block to the Ecosystemic Urbanism Superblock*. Baecelona, Spain: Agbar.

Rusnak, M. A. and Rabiega, M. (2021) 'The Potential of Using an Eye Tracker in Architectural Education: Three Perspectives for Ordinary Users, Students and Lecturers', *Buildings*, 11(6), p. 245. doi: 10.3390/buildings11060245.

Rykwert, J. (1982) *The Necessity of Artifice: Ideas in Architecture*. London : Academy Editions.

Rykwert, J. (1991) 'The Street: The Use of its History', in Anderson, S. (ed.) *On Streets*. Cambridge, Massachusetts: The MIT Press.

S

Sadeghi, G. and Li, B. (2019) 'Urban Morphology: Comparative Study of Different Schools of Thought', *Current Urban Studies*, 07(04), pp. 562–572. doi: 10.4236/cus.2019.74029.

Salagoor, J. Y. (1990) *The influence of building regulations on urban dwelling in Jeddah*. Newcastle University. Available at: https://theses.ncl.ac.uk/jspui/handle/10443/863.

Santos, R. D. O. J. dos *et al.* (2015) 'Eye Tracking in Neuromarketing: A Research Agenda for Marketing Studies', *International Journal of Psychological Studies*, 7(1), pp. 32–42. doi: 10.5539/ijps.v7n1p32.

Sauter, D. and Huettenmoser, M. (2008) 'Liveable streets and social inclusion', *URBAN DESIGN International*, 13(2), pp. 67–79. doi: 10.1057/udi.2008.15.

Schmid, H.-J. (2015) 'Morphology', in Braber, N., Cummings, L., and Morrish, L. (eds) *Exploring Language and Linguistics*. Cambridge: Cambridge University Press, pp. 77–110. doi: 10.1017/CBO9781139548922.

SCTH (2013) *Historic Jeddah, the Gate to Makkah*. Riyadh, Saudi Arabia.

Sevtsuk, A. and Davis, D. E. (2019) 'Future of Streets', in D'Acci, L. (ed.) *The Mathematics of Urban Morphology, Modeling and Simulation in Science, Engineering and Technology*. Cham, Switzerland: Birkhäuser, pp. 537–546. doi: 10.1007/978-3-030-12381-9_29.

Shakibamanesh, A. and Ebrahimi, B. (2020) 'Toward practical criteria for analyzing and designing urban blocks', in Almssad, A., Almusaed, A., and Hong, L. T.- (eds) *Sustainability in Urban Planning and Design*. IntechOpen. doi: 10.5772/intechopen.90504.

Sheikh, W. T. and van Ameijde, J. (2022) 'Promoting livability through urban planning: A comprehensive framework based on the "theory of human needs"', *Cities*, 131, p. 103972. doi: 10.1016/j.cities.2022.103972.

Sheller, M. and Urry, J. (2006) 'The New Mobilities Paradigm', *Environment and Planning A: Economy and Space*, 38(2), pp. 207–226. doi: 10.1068/a37268.

Shum, S. (1990) 'Real and Virtual Spaces: Mapping from Spatial Cognition to Hypertext', *Hypermedia*, 2(2), pp. 133–158. doi: 10.1080/09558543.1990.12031179.

Siksna, A. (1997) 'The effects of block size and form in North American and Australian city centres', *Urban Morphology*, 1(1), pp. 19–33.

Siksna, A. (1998) 'City centre blocks and their evolution: A comparative study of eight American and Australian CBDs', *Journal of Urban Design*, 3(3), pp. 253–283. doi:

10.1080/13574809808724429.

Silva, Á. F. da and Sousa, M. L. (2009) 'In search of the urban variable : Understanding the roots of urban planning in Portugal1', *Métropoles*, (6). doi: 10.4000/metropoles.4029.

Silva, R. H. da (2006) 'Das Avenidas Novas à Avenida Berna', in *Revista de História da Arte*, pp. 126–141.

Silvennoinen, H. *et al.* (2022) 'Effects of Gehl's urban design guidelines on walkability: A virtual reality experiment in Singaporean public housing estates', *Environment and Planning B: Urban Analytics and City Science*, 49(9), pp. 2409–2428. doi: 10.1177/23998083221091822.

Simpson, J. *et al.* (2019) 'Visual engagement with urban street edges: insights using mobile eye-tracking', *Journal of Urbanism*. Routledge, 12(3), pp. 259–278. doi: 10.1080/17549175.2018.1552884.

Simpson, J., Thwaites, K. and Freeth, M. (2019) 'Understanding Visual Engagement with Urban Street Edges along Non-Pedestrianised and Pedestrianised Streets Using Mobile Eye-Tracking', *Sustainability*, 11(15), p. 4251. doi: 10.3390/su11154251.

Smith, D. (2021) 'Porosity and the Transnational: Travelling Theory between Naples and Frankfurt (Walter Benjamin, Asja Lacis and Ernst Bloch)', *Forum for Modern Language Studies*, 57(2), pp. 240–259. doi: 10.1093/fmls/cqab001.

Sohn, D. W., Moudon, A. V. and Lee, J. (2012) 'The economic value of walkable neighborhoods', *URBAN DESIGN International*, 17(2), pp. 115–128. doi: 10.1057/udi.2012.1.

Soja, E. (2000) *No Postmetropolis: Critical Studies of Cities and Regions*. Oxford,London: Blackwell.

Solà-Morales, M. (2007) *Diez Lecciones Sobre Barcelona/Ten Lessons on Barcelona*. Edited by 2nd Edition. Barcelona, Spain: Collegi d'Arquitectes de Catalunya (COAC).

Southworth, M. and Ben-Joseph, E. (2013) *Streets and the Shaping of Towns and Cities*. Washington, DC: Island Press.

Spanjar, G. and Suurenbroek, F. (2020) 'Eye-tracking the city: Matching the design of streetscapes in high-rise environments with users' visual experiences', *Journal of Digital Landscape Architecture*, 5, pp. 374–385. doi: 10.14627/537690038.

Speck, J. (2012) *Walkable city: How downtown can save America, one step at a time*. New York, USA: North Point Press.

Steadman, P. (1979) *The evolution of designs: biological analogy in architecture and the applied arts*. Cambridge, MA: Cambridge University Pres.

Stevens, J. (2022) 'Urban porosity: a chronicle of spatial inclusion in Matonge, Brussels', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 15(1), pp. 61–83. doi: 10.1080/17549175.2020.1858443.

Stojanovski, T. and Axelsson, Ö. (2019) 'Typo-Morphology and Environmental Perception of Urban Space', in *Urban Morphological Theory*, pp. 822–834.

Svensson, Å. *et al.* (2004) *ARTISTS - Arterial streets for people : Guidance for planners and decision makers when reconstructing arterial streets.* Lund.

T

Talen, E. (2003) 'Measuring urbanism: Issues in smart growth research', *Journal of Urban Design*, 8(3), pp. 195–215. doi: 10.1080/1357480032000155141.

Tarbatt, J. and Tarbatt, C. S. (2020) *The Urban Block: A Guide for Urban Designers, Architects and Town Planners.* London, UK: RIBA Publishing.

Tarr, J. A. (1984) 'The Evolution of the Urban Infrastructure in the Nineteenth and Twentieth Centuries', in Hanson, R. (ed.) *Perspectives on Urban Infrastructure.* Washington, D.C.: National Academies Press, pp. 4–66. doi: 10.17226/561.

Tesoriere, G. and Errigo, M. F. (2018) 'Urban travel behavior determinants in Saudi Arabia', *Journal of Land Use, Mobility and Environment*, SP/01(01/18), pp. 3–6. doi: http://dx.doi.org/10.6092/1970-9870/5449.

The Economist Intelligence Unit (2022) *The Global Liveability Index 2022*. London, United Kingdom. Available at: https://www.eiu.com/n/campaigns/global-liveability-index-2022/#:~:text=The Global Liveability Index quantifies,liveable city in the world.

The European Commission (2020) *LISBON: European Green Capital 2020.* Luxembourg. doi: 10.2779/17846.

The Sports Boulevard (2022) *Sports Boulevard.* Available at: https://sportsboulevard.sa/en/about-us/ (Accessed: 11 April 2022).

Thwaites, K., Simpson, J. and Simkins, I. (2020) 'Transitional edges: a conceptual framework for socio-spatial understanding of urban street edges', *Urban Design International.* Palgrave Macmillan UK, 25(4), pp. 295–309. doi: 10.1057/s41289-020-00115-9.

Tillas, A. *et al.* (2017) 'Can Affordances Explain Behavior?', *Review of Philosophy and Psychology*, 8(2), pp. 295–315. doi: 10.1007/s13164-016-0310-7.

Towers, G. (2005) *At Home in the City: An Introduction to Urban Housing Design.* Oxford, UK: Architectural Press.

Trancik, R. (1991) *Finding Lost Space: Theories of Urban Design.* New York, USA: John Wiley & Sons.

Tüncalp, S. (1993) 'The Automobile Market in Saudi Arabia: Implications for Export Marketing Planning', *Marketing Intelligence & Planning*, 11(1), pp. 28–36. doi: 10.1108/02634509310024164.

U

UN-Habitat (2018) *Saudi Cities Report 2018*. Riyadh, Saudi Arabia. Available at: https://unhabitat.org/saudi-cities-report-2018-executive-summary.

Urbano, J. (2016) 'The Cerdà Plan for the Expansion of Barcelona: A Model for Modern City Planning', *Focus*, 12(1). doi: 10.15368/focus.2016v12n1.2.

Urry, J. (2006) 'Inhabiting the Car', *The Sociological Review*, 54(1_suppl), pp. 17–31. doi: 10.1111/j.1467-954X.2006.00635.x.

Uttley, J., Simpson, J. and Qasem, H. (2018) 'Eye-tracking in the real world: Insights about the urban environment', in *Handbook of Research on Perception-Driven Approaches to Urban Assessment and Design*, pp. 368–396. doi: 10.4018/978-1-5225-3637-6.ch016.

V

Vainio, T. *et al.* (2019) 'Towards Novel Urban Planning Methods -- Using Eye-tracking Systems to Understand Human Attention in Urban Environments', in *the 2019 CHI Conference on Human Factors in Computing Systems*. Glasgow, Scotland, UK, pp. 1–8.

Valcárcel-Aguiar, B., Murias, P. and Rodríguez-González, D. (2018) 'Sustainable urban liveability: A practical proposal based on a composite indicator', *Sustainability (Switzerland)*, 11(1), p. 86. doi: 10.3390/su11010086.

Vamberg, H. (2015) *Visions for Vienna's Ringstrasse*, *Gehl Architects*. Available at: https://gehlpeople.com/blog/visions-for-viennas-ringstrasse/.

van Renswoude, D. R. *et al.* (2018) 'Gazepath: An eye-tracking analysis tool that accounts for individual differences and data quality', *Behavior Research Methods*, 50(2), pp. 834–852. doi: 10.3758/s13428-017-0909-3.

Venturi, R., Izenour, S. and Brown, D. S. (1977) *Learning from Las Vegas*. Revised Ed. Cambridge, MA, USA: MIT Press.

Vernet, N. and Coste, A. (2017) 'Garden Cities of the 21st Century: A Sustainable Path to Suburban Reform', *Urban Planning*. The second. Edited by 2 edition. London, UK: Sonnenschein & Co., 2(4), pp. 181–196. doi: 10.17645/up.v2i4.1104.

Vernez Moudon, A. *et al.* (2002) 'Pedestrian Location Identification Tools: Identifying Suburban Areas with Potentially High Latent Demand for Pedestrian Travel', *Transportation Research Record: Journal of the Transportation Research Board*, 1818(1), pp. 94–101. doi: 10.3141/1818-15.

Vision2030 (2016) *National Transformation Program*. Available at: https://www.vision2030.gov.sa/ (Accessed: 11 March 2019).

W

Wen, T.-H., Chin, W.-C.-B. and Lai, P.-C. (2017) 'Understanding the topological characteristics and flow complexity of urban traffic congestion', *Physica A: Statistical Mechanics and its Applications*, 473, pp. 166–177. doi: 10.1016/j.physa.2017.01.035.

Weston, R. (2011) *100 Ideas that Changed Architecture*. London, United Kingdom: Laurence King Publishing.

Whitehand, J. W. R. (2001) 'British urban morphology: the Conzenian tradition', *Urban Morphology*, 5(2), pp. 103–109. doi: 10.51347/jum.v5i2.3896.

Whyte, W. H. (1980) *The Social Life of Small Urban Spaces*. New York, NY, USA: Project for Public Spaces.

Whyte, W. H. (1988) *City: Rediscovering the Center*. 1st edn. New York: Doubleday. Available at: papers2://publication/uuid/00B3A17A-EDF2-49D2-9B39-2821BE014E3C.

Wolfrum, S. (2018) *Porous City: From Metaphor to Urban Agenda*. Boston, MA, USA: Birkhäuser Architecture.

Wright, F. L. (1932) *The Disappearing City*. New York: W. F. Payson.

Wynn, M. (1979) 'Barcelona: Planning and Change 1854 - 1977', *Town Planning Review*, 50(2), p. 185. doi: 10.3828/tpr.50.2.w8q42x4125j70576.

Y

Yeung, H. W. and Savage, V. R. (1996) 'Urban Imagery and the Main Street of the Nation: The Legibility of Orchard Road in the Eyes of Singaporeans', (April). doi: 10.1080/00420989650011870.

Youssef, Z., Alshuwaikhat, H. and Reza, I. (2021) 'Modeling the modal shift towards a more sustainable transport by stated preference in Riyadh, Saudi Arabia', *Sustainability*, 13(1), p. 337. doi: 10.3390/su13010337.

Z

Zacharias, J. (2020) 'The contribution of a tramway to pedestrian vitality', *Tema. Journal of Land Use, Mobility and Environment*, 13(3), pp. 445–457.

Zou, Z. (2018) 'Where Do We Look? An Eye-Tracking Study of Architectural Features in Building Design', in *the 35th CIB W78 2018 Conference: IT in Design, Construction, and Management*. Chicago, IL, USA, pp. 439–446.

Zurawicki, L. (2010) *Neuromarketing: Exploring the Brain of the Consumer*. Boston, MA, USA: Springer.