

KARADENIZ TECHNICAL UNIVERSITY
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

URBAN AND REGIONAL PLANNING

**COMPLETE STREET MODEL AS AN ALTERNATIVE APPROACH TO
ENHANCE SUSTAINABLE MOBILITY IN A DEVELOPING CITY: KABUL,
AFGHANISTAN CASE**

MASTER'S THESIS

Sumaya MAIHAN

NOVEMBER 2025
TRABZON



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**This thesis is accepted to give the degree of
“MASTER OF SCIENCE”
By The Graduate School of Natural and Applied Sciences at
Karadeniz Technical University**

The Date of Submission : 02 / 09 / 2025

The Date of Examination : 24 / 11 / 2025

Supervisor : Dr. Öğr. Üyesi Gökhan Hüseyin ERKAN

Trabzon 2025

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THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

Department of Urban and Regional Planning
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Has been accepted as a thesis of
MASTER OF SCIENCE
after the Examination by the Jury Assigned by the Administrative Board of
the Graduate School of Natural and Applied Sciences with the Decision Number 2119 dated
11 / 09 / 2025

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ACKNOWLEDGE

The thesis entitled “Complete Street model as an Alternative Approach to Enhance Sustainable Mobility in a Developing City: Kabul, Afghanistan Case” has been formulated as part of the master’s program in Urban and Regional Planning at the Graduate School of Natural and Applied Sciences, Karadeniz Technical University.

During the preparation of this research, I significantly benefited from the important academic supervision and experience of my distinguished adviser, Assistant Professor Dr. Gökhan Hüseyin Erkan. His steadfast support and committed mentorship have been important in guiding the trajectory and improving the quality of this thesis. I wish to convey my profound gratitude and genuine appreciation for his unwavering support and academic contributions.

I deem it my obligation to convey my profound gratitude and appreciation to the officials and workers of the Kabul Municipality, who provided me with their earnest collaboration and support throughout the many phases of data gathering and field investigations.

I extend my sincere gratitude to my esteemed parents, my mother Nafisa Maihan and my father Miraqa Maihna, who have steadfastly supported me throughout my life with their unwavering love, selfless sacrifices, and both financial and spiritual assistance, especially during this scientific endeavor. I express my heartfelt gratitude to my elder brothers, Mir Mazhar Maihan and Mir Zafar Maihan, and my elder sisters, Robina Maihan and Rohina Maihan, for their unwavering encouragement and support.

I express profound gratitude to Regina Maihan, my life mentor and guiding light, my compassionate sister, whose indispensable direction and support have been pivotal to my accomplishments. Achieving this milestone would have been unattainable without her help.

In conclusion, I aspire for this thesis to contribute modestly to the advancement of knowledge and the proliferation of future research in urban planning, serving as a resource for scholars and practitioners alike.

Sumaya MAIHAN

Trabzon 2025

THESIS RESEARCH ETHICS STATEMENT

I certify that I have completed the thesis entitled “Complete Street Model as an Alternative Approach to Enhance Sustainable Mobility in a Developing City: Kabul, Afghanistan Case,” which I prepared and presented as a requirement for the Master's degree in Urban and Regional Planning, under the direct guidance and supervision of Assistant Professor Dr. Gökhan Hüseyin Erkan from inception to conclusion.

All data and material utilized in this research were obtained by me, and the analyses were completed in accordance with scientific norms, employing reliable sources and pertinent academic contexts. I have disclosed the information and resources from external sources honestly and accurately, ensuring precise citations in the main text and bibliography.

During this study endeavor, I have consistently upheld research ethics, scientific integrity, and the norms established by academic and scientific institutions. In the event of a breach of scientific and ethical norms and principles, I unequivocally take responsibility for all legal and administrative repercussions. 24/11/2025

Sumaya MAIHAN

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Master's Thesis

SUMMARY

COMPLETE STREET MODEL AS AN ALTERNATIVE APPROACH TO ENHANCE SUSTAINABLE MOBILITY IN A DEVELOPING CITY: KABUL, AFGHANISTAN CASE

Sumaya MAIHAN

Karadeniz Technical University
The Graduate School of Natural and Applied Sciences
Urban and Regional Planning Program
Supervisor: Assist. Prof. Gökhan Hüseyin ERKAN
2025, 93 Pages

Currently, the “Complete Street” model is articulated as a holistic and sustainable strategy in urban planning, designed to establish safe, accessible, and efficient environments for all users, including walkers, cyclists, motorists, and those with disabilities. In rapidly growing cities with unregulated expansion, such as Kabul, there is a pressing necessity to reevaluate Complete Street model. This research evaluates the feasibility of implementing the Complete Street model in Kabul, taking into account numerous physical, social, institutional, and economic factors. The study first looked at the basic ideas and global examples of Complete Street, then assessed Kabul's current infrastructure, urban policies, public opinions, and the capacity of local management, using field data, direct observation, and, document analysis. Research shows that even though there are some strengths, major problems like the lack of clear laws, budget issues, poor teamwork among responsible groups, and low public awareness are the main obstacles to putting this approach into action in Kabul. The research findings suggest that reforming urban policies, enhancing social participation, improving street design, and promoting public education can render the implementation of the Complete Street model in Kabul as an effective measure for sustainable urban development and elevating citizens' quality of life.

Keywords: Complete Street , Sustainable Mobility, Urban Planning, Kabul Afghanistan

Yüksek Lisans Tezi

ÖZET

SÜRDÜRÜLEBİLİR ULAŞIMI ARTIRMAK İÇİN ALTERNATİF BİR YAKLAŞIM
OLARAK TAM SOKAK MODELİ: GELİŞEN BİR ŞEHİR ÖRNEĞİ, KABIL,
AFGANISTAN
Sumaya MAIHAN

Karadeniz Teknik Üniversitesi
Fen Bilimleri Enstitüsü
Şehir ve Bölge Planlama Anabilim Dalı
Danışman: Dr. Öğr. Üyesi Gökhan Hüseyin ERKAN
2025, 93 Sayfa

Günümüzde “Tam Sokak” modeli yaya, bisikletli, motorlu sürücü ve engelliler de dahil olmak üzere tüm kullanıcılar için güvenli, erişilebilir ve verimli ortamlar oluşturmayı amaçlayan bütünsel ve sürdürülebilir bir strateji olarak ifade edilmektedir. Kabul gibi hızla büyüyen ve düzensiz bir şekilde genişleyen şehirlerde, geleneksel sokak tasarım modelalarının yeniden değerlendirilmesi acil bir gereklilik haline gelmiştir. Bu araştırma, birçok fiziksel, sosyal, kurumsal ve ekonomik faktörü dikkate alarak, Kabil’de Tam Sokak modelinin uygulanabilirliğini değerlendirmektedir. Çalışma, önce Tam Sokak modelinin temel fikirlerini ve dünya genelindeki örneklerini incelemektedir, ardından saha verileri, doğrudan gözlem, belge analizi ve kullanılarak Kabil’in mevcut altyapısı, kentsel politikalar, kamuoyu ve yerel yönetimin yetenekler değerlendirilmiştir. Araştırma, bazı güçlü yönler olmasına rağmen, açık yasaların eksikliği, bütçe sorunları, sorumlu gruplar arasındaki zayıf işbirliği ve düşük kamu bilinci gibi büyük sorunların, bu yaklaşımın Kabil’de hayata geçirilmesinin önündeki başlıca engeller olduğunu göstermektedir. Araştırma bulguları, kentsel politikaların reformu, sosyal katılımın artırılması, sokak tasarımının iyileştirilmesi ve kamu eğitiminin teşvik edilmesiyle, Kabil’de Tam Sokak modelinin şehirde uygulanmasını sürdürülebilir kentsel gelişim ve vatandaşların yaşam kalitesini artırmak için etkili bir önlem haline getirebileceğini önermektedir.

Anahtar Kelimeler: Tam Sokaklar, Sürdürülebilir Hareketlilik, Kentsel Planlama, Kabil
Afganistan

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SYMBOLS AND ABBREVIATIONS

AARP	: American Association of Retired Persons
ADA	: American with Disabilities Act
ADB	: Asian Development Bank
ANPDF	: Afghanistan National Peace and Development Framework
BCS	: Benefits of Complete Streets
BRT	: Bus Rapid Transit
CSDG	: Complete Street Design Guidelines
CSC	: Complete Street Concepts
CST	: Complete Street Typology
CSP	: Complete Street Policy
JICA	: Japan International Cooperation Agency
HOV	: High Occupancy Vehicle
KM	: Kabul Municipality
KUDF	: Kabul Urban Design Framework
LCA	: Life Cycle Analysis
MOPW	: Ministry of Public Works
MOT	: Ministry of Transport
MRRD	: Ministry of Rural Rehabilitation and Development
MUDH	: Ministry of Urban Development and Housing
TOD	: Transit-Oriented Development

1. GENERAL INFORMATION

As the thread that ties people, communities, and economic activity together, transportation is a vital component of urban systems. Its impact on social justice, environmental sustainability, economic productivity, and the general standard of living in cities goes beyond simple mobility. In addition to promoting urban resilience and vibrancy, a well-functioning transportation infrastructure guarantees that residents can effectively access jobs, healthcare, education, and recreational activities.

In the past, the automobile has shaped urban streetscapes with concrete and asphalt designed for private vehicle transportation. But as people around the world have become more conscious of sustainable development and high-quality urban living, cities are reassessing the function of streets, seeing them as vital public areas that support social interactions, business, and cultural life in addition to being routes for automobiles (Bain et al., 2012; Istrate et al., 2022). This renewed attention underlines the need to alter streets to support many activities beyond automotive throughput, encouraging environments suitable to walking, cycling, and public interaction (Montella et al., 2022).

The Complete Street model has become a strategic paradigm for enhancing urban transportation networks in this environment. Complete Streets places a strong emphasis on designing streets that can serve various users and modes of transportation, in addition to complementary urban planning techniques including Transit-Oriented Development (TOD), the 15-Minute City, Living Streets, Woonerf, and Radburn principles. Although examples from throughout the world show how flexible these tactics may be, choosing the best course of action depends on the particular features and limitations of each city. In resource-rich cities, extensive interventions and large-scale urban redesigns may be viable. On the other hand, cities with limited financial resources, highly populated areas, or historic cities with preservation restrictions need adaptable techniques that can improve mobility without requiring significant structural changes.

The Complete Street model is especially suitable in these situations since it adapts to the current urban fabric while striking a balance between safety, inclusivity, and operational effectiveness.

Afghanistan's main political, economic, and cultural hub, Kabul, is a prime example of the pressing need for such a strategy. Kabul has seen fast and mostly uncontrolled

urbanization during the last 20 years. The current roadway network, which is primarily built for motorcars, finds it difficult to handle the complicated transportation demands created by population development, expansion into outlying areas, and concentrated employment and service hubs in the city core. Chronic traffic jams, erratic and inadequate public transportation, damaged or blocked sidewalks, inadequate bicycle infrastructure, and increased risks for vulnerable groups such as pedestrians, women, children, the elderly, and individuals with disabilities are all examples of how this imbalance has materialized. These issues are made worse by institutional fragmentation, uneven upkeep, and financial constraints, which compromise the possibility of well-maintained, useful roadways.

The Complete Street model provides a comprehensive, context-sensitive method for rearranging Kabul's right-of-way to effectively and safely serve all users. Complete Streets are defined as roadways that provide equitable access to all modes of transportation without privileging a single mode (Calloway et al., 2020). The concept places a high priority on balance and seeks to accommodate the needs of freight, private vehicles, cyclists, pedestrians, and users of public transportation. A wide range of interventions are used in implementation, such as:

Infrastructure for pedestrians includes raised crossroads for visibility, regular and secure crossings, and continuous, accessible sidewalks.

Bicycle facilities include secure parking, buffered or protected bike lanes, and access to transit hubs.

Transit-priority solutions include signal prioritization, level boarding, bus bulbs, and dedicated lanes.

Roadway design and traffic control: curb extensions, raised crossings, tight curb radii, and speed-calming features.

Public realm enhancements: structured on-street parking, street trees, shading, microclimate mitigation, and wayfinding signage.

Importantly, Complete Streets model adapt to local street typologies, land-use settings, and operational restrictions by acting as a flexible design philosophy rather than a strict blueprint (URL-1). Three main perspectives can be used to assess the importance of Complete Streets in Kabul:

Safety improvement: The approach directly targets recurring safety risks by minimizing conflicts across modes, controlling vehicle speeds suitable for congested cities, and establishing predictable spaces for non-motorized users.

Inclusive mobility: Walking, bicycling, and public transportation modes that a sizable section of Kabul's population depends on become more dependable and appealing thanks to Complete Streets, which also enable egalitarian travel options.

Complete Street model can help reduce traffic, lower environmental impact, and make city systems stronger by allowing more people to move through, making travel times more predictable, and promoting space-saving options.

Complete Street model create a connected plan that ties street design to broader city and transportation goals, like making roads safer, improving public transit, connecting the first and last parts of a journey, and enhancing public spaces. While maintaining flexibility to accommodate various street types, including commercial high streets, mixed-use collectors, and residential streets, Complete Street model can be integrated into local design rules and project pipelines to standardize cross-sections, treatments, and performance measures. By switching from discrete interventions to network-based tactics that concentrate on high-activity corridors, scalability is improved, quantifiable results are made possible, and the foundation for a phased citywide rollout is laid.

Inadequate data for evidence-based decision-making, conflicting requests for right-of-way, financial limitations, and the requirement for collaboration between several agencies, including planning, transportation, public works, and law enforcement, are some of the significant obstacles to implementation in Kabul. A phased, practical approach is needed to address these issues; low-cost, high-impact interventions (such as tactical curb extensions, modular refuge islands, and pavement markings) must be incorporated; local design and operational capacities must be improved; and quantifiable performance indicators like pedestrian safety, transit service reliability, accessibility, and person throughput must be established.

In conclusion, implementing a Complete Street model in Kabul is a practical, timely, and context-sensitive way to change the city's car-centric roadways into inclusive, secure, and effective multimodal corridors. Kabul may progress toward a pedestrian-oriented roadway network that promotes fair mobility, sustainable urban growth, and an enhanced quality of life for all citizens by coordinating design solutions with local conditions, urban morphology, and institutional capacities. To provide a systematic approach for trial implementation and ultimate citywide extension, this study presents Complete Street model as a strategic framework that directs corridor selection, context-sensitive cross-sections, roadway changes, and transit-priority measures.

1.1. Problem Statement

Kabul city, despite its significant reliance on walking and public transit, has not adequately prioritized the improvement of pedestrian and public transportation infrastructure. The prevalence of car-centric constructions negatively impacts the infrastructure of streets and sidewalks, impeding their ability to support walkers, bicycles, and public transport users. As a result, there is insufficient room for individuals to participate in diverse activities and traverse streets safely.

Therefore, it is necessary to investigate the possibility of developing environments based on the Complete Street model in Kabul to determine how effective they can be in improving safety, health, and accessibility for all users, including pedestrians, cyclists, children, the elderly, and people with disabilities.

1.2. The Scope of Study

This study focuses on a critical analysis of three relevant methodologies and policies in Complete Street planning, ultimately identifying the most appropriate strategy for the specific setting of Kabul. The criteria for selecting target streets in Kabul were based on the synthesis attributes of successfully converted streets identified in the analyzed overseas case studies.

Kabul was chosen as the empirical case for multiple persuasive reasons. Kabul, as the capital and principal socio-economic, political, and cultural hub of Afghanistan, plays a pivotal role in influencing national urban development pathways. The selected streets are situated in high-traffic corridors characterized by significant pedestrian and vehicular movement, essential commercial and administrative functions, and opportunities for multi-modal access.

This case study focuses on the built environment, specifically street design features, irrespective of the current level of service provision. The analysis evaluates the degree to which the physical design characteristics of the selected streets align with the concepts and criteria inherent in the chosen Complete Street planning methodology. This research did not utilize questionnaires or survey instruments, unlike some urban studies that incorporate perception-based data. Importantly, no field visits were conducted during the study. Instead, the analysis relied on systematic virtual observations, accurate spatial measurements using high-resolution satellite imagery from Google Earth Pro, and comparative benchmarking

against recognized international street design standards. Although the researcher possessed previous on-site knowledge of the chosen streets, the present assessment depended entirely on contemporary geospatial data to ensure the precision and reliability of the measurements.

1.3. Research Objectives & Questions

This thesis aims to evaluate the applicability of the Complete Street model in a developing city where there are financial and structural limitations to solving transportation problems.

This thesis was conducted to evaluate the feasibility of the Complete Street model in a developing city facing financial and structural limitations in addressing transportation problems. Kabul, Afghanistan, was chosen as a case study to examine the feasibility and practical challenges of implementing this model.

Research Objectives:

This study has two main objectives:

First Goal: The first goal of this study is to identify and examine a suitable Complete Street model that can effectively address mobility, accessibility, and safety issues in Kabul's streets. Additionally, this objective includes evaluating the practical feasibility and potential impacts of the proposed model in specific sections of Kabul's streets.

Secondary Objectives:

1. Examining existing gaps and limitations in Kabul Street guidelines and planning with a Complete Street model approach.
2. Determining and proposing specific criteria for selecting the most suitable streets for implementing the Complete Street model in Kabul city.

Research Questions:

We design research questions to directly align with the objectives.

How can the Complete Street model be implemented in selected streets of Kabul to improve accessibility, safety, and multimodal transportation?

1. Which streets in Kabul are most suitable for implementing the Complete Street model, considering traffic volume, pedestrian activity, and land use?
2. How can street improvements based on the Complete Street model contribute to sustainable urban development and environmental benefits in Kabul?

This question is also related to the main objective of the research, and it examines the potential effects of the proposed model on sustainable development and the urban environment.



2. STUDIES CARRIED OUT

A street is the basic unit of urban space through which people experience a city. It is often misconceived as the two-dimensional surface that vehicles drive on when moving from one place to another. Streets are, in fact, multidimensional spaces consisting of many surfaces and structures (Global Street Design Guide, 2016, p.4)

The Global Street Design Guide (2016) states that by 2050, around 75% of the global population is expected to live in cities, necessitating urban streets to reconcile the growing demand for personal mobility with the requirement for effective access to urban economic activities. The perspectives articulated in GSDG (2016) indicate that the low-density, automobile-dependent development models prevalent in the 20th century no longer satisfy contemporary requirements and have often proven inadequate. This book asserts that dense, compact communities with multimodal transportation systems are optimal for attaining sustainable development, equitable economic opportunity, and enhanced quality of life. According to GSDG (2016), walkable neighborhoods, appropriate bike routes, and effective public transit networks represent the fundamental demands and preferences of modern urban inhabitants (Global Street Design Guide, 2016).

A Green street is a street that uses natural processes to manage stormwater runoff at its source (Im, 2019, p.3).

A livable street serves not just as a transit route for automobiles but also as a vibrant public place for pedestrian activities such as strolling, shopping, socializing, and interacting; thus, it boosts urban quality of life through improved air quality, health, and economic development (Dumbaugh & Gattis, 2005).

Woonerfs are a specific type of road design that encourages multimodal transportation and blends pedestrian and vehicle space. They originated in Delft, Netherlands in the 1960s as a reaction to mid-20th century, auto-dominated urban planning (URL-2).

A woonerf is a human-centered residential street that unifies sidewalks and roadways, severely restricts vehicle speeds, and prioritizes pedestrians. This design transforms the street into a social, safe, and livable space for daily activities (Collarte, 2012).

The 15-Minute City concept stipulates that every resident should be able to fulfill all daily needs within a 15-minute walk or bicycle ride from their residence. This concept prioritizes closeness above simple accessibility, indicating that services, activities, and urban

areas ought to be centralized within neighborhoods to obviate the necessity for extensive travel (Pozoukidou & Chatziyiannaki, 2021).

Living streets, like Complete Streets, are designed to be shared safely by pedestrians, cyclists, and low speed motor vehicles. However, they tend to center around the mobility of the people, not the vehicles that frequent the street (URL-1).

The first of its kind in the United States, the Bicycle Bill foreshadowed the national Complete Street movement that began to take hold three decades later to encourage the adoption of policies aimed at providing safe access to the streets for all users (Oregon Encyclopedia, n.d., P.1).

Officially introduced to the lexicon in 2003 by Barbara McCann, a staff member of the advocacy organization America Bikes, Complete Street was proposed as an alternative to the term “routine accommodation,” which was being used to convey the need to include bicycles in transportation planning (Zavestoski & Agyeman, 2015). As McCann recounts, Right away, we knew that we had a concept that was bigger than bicycles (McCann & Rynne, 2010). The coalition concept devised by McCann between America Bikes and the League of American Bicyclists rapidly broadened to encompass AARP, the American Planning Association, and the American Public Transportation Association, American Society of Landscape Architects and American Heart Association, advocates and transportation planners convened and ultimately formulated the subsequent concept of a Complete Street policy:

“ A Complete Street policy ensures that the entire right-of-way is routinely designed and operated to enable safe access for all users. Pedestrians, bicyclists, motorists, and transit riders of all ages and abilities must be able to safely move along and across a Complete Street” (McCann & Rynne, 2010, p.3).

LaPlante and McCann (2008), A Complete Street is a road that is designed to be safe for drivers, bicyclists, transit vehicles, users, and pedestrians of all ages and abilities. “The Complete Street concept focuses not just on individual roads but on changing the decision-making and design process so that all users are routinely considered during the planning, designing, building, and operating of all roadways” (LaPlante & McCann, 2008, p.24).

The National Complete Street Coalition, launched in 2005 by Smart Growth America, aims to advocate for sustainable road design, efficient transit networks, and pedestrian-friendly laws. Within this coalition, the concept of Complete Street occupies a significant position as an interdisciplinary approach. According to Perk et al (2015, p.2), the Complete

Street transcends physical architecture, representing “a humanistic vision for rethinking the way urban spaces are designed”. This perspective posits that the Complete Street model prioritize safe and accessible infrastructure for all, including the elderly and individuals with disabilities, while enhancing urban living quality through the promotion of multimodal transportation (Perk et al., 2015).

A Complete Street is secure and conveys a sense of safety for all users. Defined Complete Street standards or policies as those which “ensure the safe and adequate accommodation of all users of the transportation system, including pedestrians, bicyclists, public transportation users, children, older individuals with disabilities, motorists, and freight vehicles” (FHWA, 2022, p.5).

In academic literature, “proponents of citizen science (CS) emphasize the alleged ancillary advantages of Complete Street initiatives related to enhanced public health, less pollution, and social equity, among other benefits” (Jordan, 2020, p.28).

According to Burden & Litman (2011), recounts that Complete Street can contribute to the improvement of traffic performance and provide a number of social, economic, environmental, and health benefits to communities. “They respond to and support other efforts to increase transportation system efficiency, including transportation demand management, parking management, improvements to alternative modes, transit-oriented development, and smart growth land use policies” (Burden & Litman, 2011, p.38).

The Complete Street Coalition defines a Complete Street as “designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities. Complete Street make it easy to cross the street, walk to shops, and bicycle to work.” (Babb & Watkins, 2016, p.14). The American Planning Association defined them as streets that “accommodate pedestrians, bicyclists, transit, and cars, creating multimodal transportation networks” (Babb & Watkins, 2016, p.15).

Gregg and Hess (2019) elucidates the network concept by defining Complete Street in the following manner: “Complete Street” describes a comprehensive, integrated transportation network with infrastructure and design that allows safe and convenient travel along and across streets for all users, including pedestrians, bicyclists, motor vehicle drivers, public transportation riders and drivers, and people of all ages and abilities, including children, youth, families, older adults, and individuals with disabilities (Gregg & Hess, 2019).

Litman (2015) characterizes cities as areas where varied populations and activities are densely aggregated. Litman (2015) asserting that this concentration inherently results in

enhanced accessibility and diminished transit expenses. He also underscores that the efficacy and livability of metropolitan areas can only be assured when transportation systems prioritize more economical and sustainable modes of travel. According to Litman (2015), walking, cycling, and public transportation are not merely alternatives but vital components for establishing an efficient and habitable city :

Complete Street planning recognizes that roadways serve multiple purposes, such as mobility, commerce, recreation, and community engagement, and that the range of road users includes everyone from freight vehicles to pedestrians with disabilities (Litman, 2015).

The inaugural state policy for Complete Streets in the United States originated in 1971, when Oregon enacted the "Bicycle Bill." This law requires that newly constructed or renovated roads provide access for bicycles and pedestrians. Burlacu & Cimpeanu (2012) assert that this legislation mandated state and local governments to allocate requisite resources for the establishment of walking and cycling infrastructure in the public domain.

2.1. Methodology

This research is a qualitative case study enhanced by spatial analysis, intended to examine the obstacles and prospects associated with the implementation of the Complete Street model in Kabul city. The primary highlighted problem was the structural inefficiency of Kabul's road system, resulting from uncontrolled urban development, rapid population increase, and inadequate urban infrastructure.

We examined worldwide standards, guidelines, and manuals pertaining to Complete Street model during the initial phase to ascertain technical and planning concepts and requirements. The subsequent phase involved analyzing successful international case studies from cities including like Second Street Corridor (US 60), Danforth Avenue, Toronto, Ontario, Canada, Pennsylvania Avenue NW, Washington, D.C., USA and St. Marks Road, Bengaluru, India investigating the practical application of these ideas in diverse urban settings.

The data analysis began at this step. The qualitative content of case studies and design guidelines was analyzed to discern patterns, difficulties, and effective solutions. A comparison was conducted between international standards and examples to discern commonalities and significant disparities. This analysis examines the distinctions between a

Complete Street and a conventional street to underscore the advantages and necessity of adopting the Complete Street model in the urban environment of Kabul.

The subsequent phase of the research's theoretical framework was founded on three primary pillars: enhanced public access. This pillar focuses on the theoretical framework for creating fair and convenient access to urban spaces, services, and facilities for all citizens. Its main goal is to improve urban mobility and reduce geographical or physical limitations in the use of streets and public spaces. In research, the criteria and results related to this section include the width of sidewalks, access to public transportation, and the possibility of safe movement for pedestrians and cyclists. spatial justice, The second pillar of the theoretical framework is spatial justice, which addresses the fair distribution of urban resources, services, and amenities among different regions and social groups. This model advocates for the design of streets and public spaces to ensure that no social or regional group lacks access to urban services. In this research, the criteria and evaluations include equal access to green spaces, walking facilities, parking, and public transportation. And sustainable urban development, the third pillar of the theoretical framework emphasizes the preservation of resources, the environment, and quality of life in the long term. Its goal is to create a city that meets current needs without diminishing the ability of future generations to enjoy urban amenities. Indicators related to this section in the research include reducing fuel consumption and pollutants, encouraging the use of non-motorized and public transportation, and improving the quality of the urban environment.

Official papers, maps, and spatial data, including Google Earth images, OpenStreetMap data, the Kabul Master Plan (JICA), and the Kabul Urban Development Framework (KUDF), were utilized to analyze the local environment. This investigation resulted in the identification of problems, including inadequate safety, inefficient public transit, and insufficient infrastructure for walkers and bikers.

Ultimately, the Kabul Complete Street model was developed in AutoCAD using the received data. This design was created based on the actual conditions in Kabul and is feasible from both a technical and execution standpoint.

This study offers a definitive, accurate, and reproducible framework that can aid in the establishment of a secure, accessible, and sustainable urban transportation system in Kabul. Figure 1 defines the framework of the research stages, encompassing problem identification, goal formulation, data collection, analysis, comparison, and conclusion, while succinctly illustrating the logical progression of the research.

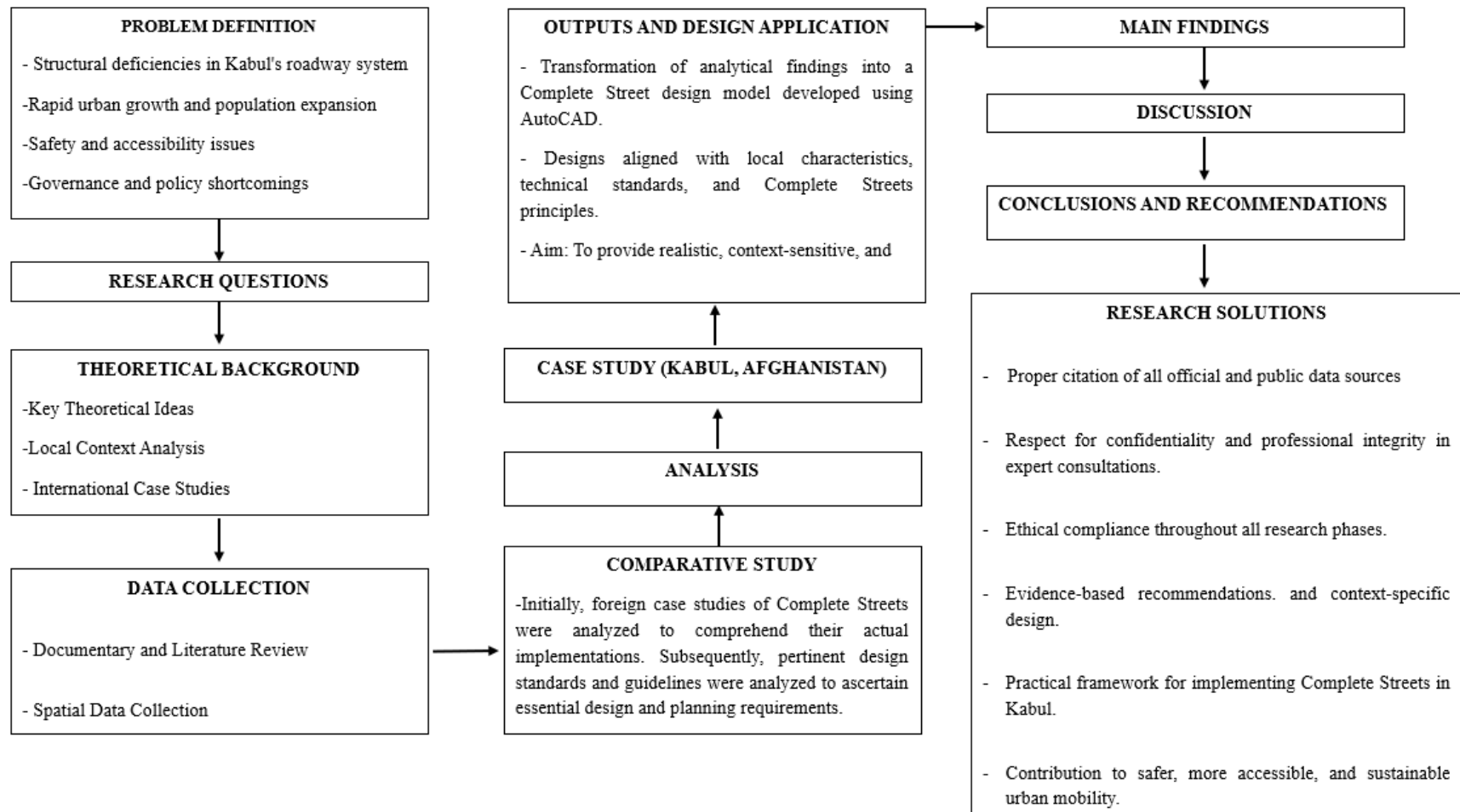


Figure 1. Research design

2.2. Complete Street Concepts (CSC)

Historically, a city would adopt standard cross sections for each street functional class. While it was recognized that the cross sections were “typical” and each street had unique context and constraints, the general purpose was to define consistent characteristics for streets (URL-3, p.2).

The concept of Complete Street gives pedestrians, bicyclists, and transit modes the same priorities in street design that automobiles have traditionally had, so that the street can routinely support safe and convenient uses for all modes of transportation within an integrated multimodal system (URL-3, p.2).

The “Complete Street” concept was implemented first in North America, where streets are designed and operated to enable safe, attractive and comfortable access and travel for all users, including pedestrians, bicyclists, motorists and public transport users of all ages and abilities (Burlacu & Cîmpeanu, 2012, p.1).

The Complete Street concept is defined as streets design that can safely accommodate all transport modes for all segments of the society (Al-Mosaind, 2018).

2.2.1. Complete Street Typology (CST)

Typology, the examination of classifications, is employed by transportation experts to categorize streets and their environments based on type or analogous qualities. They assist in the selection of treatments that optimally align with the surrounding environment, accommodate all modes effectively, adhere to regulatory constraints, and achieve the desired outcomes: complete streets. While defining typologies, one may consider historical, existing, planned, and aspirational situations (CDOT, 2013, p. 27). The policies and procedures will utilize four sets of typologies (CDOT, 2013).

1. Building Form & Function delineates the attributes of adjacent land uses, edifices, legal frameworks, as well as environmental and economic factors.
2. Roadway Form & Function delineates the characteristics of the roadway and its applications and roles within the modal systems. Characteristics encompass right-of-way, design/target speeds, lane count, parking demand, traffic operations, and modal volumes.
3. Intersections and Crossings delineates how streets converge.

4. Overlays refer to the diverse regulatory, operational, and planning categories, including snow routes, truck routes, modal plans, and jurisdictions, that influence design decisions.

The four sets of typologies- Building Form & Function, Roadway Form & Function, Intersections and Crossings, and Overlays are illustrated in Figure 2. This figure provides a visual representation of how typologies categorize streets and guide design decisions when creating a Complete Street.

Building Form and Function	Roadway Form and Function	Intersections and Crossings	Overlays
R – Residential	TH – Thoroughfare	SIG – Signal	SRT – State Route
M – Mixed-use	MS – Main Street	RBT – Roundabout, Traffic Circle	BRT – Transit Priority Street
C – Commercial Center	NS – Neighborhood Street	AWS – All-way Stop	HBS – Historic Boulevard System
D – Downtown	SW – Service Way	STY – Stop, Yield	TOD – Transit-Oriented District
IC – Institutional or Campus	PW – Pedestrian Way	UNC – Uncontrolled	HZ – Home Zone
IN – Industrial		MID – Midblock Pedestrian Crossing	BIK – Bicycle Priority Street
P – Parks		DW – Driveway	CTY – County Route
			MOB – Mobility Priority Street

Figure 2. Complete Street typologies cover street form, classification, and intersection design (Sources: CSCDOT, 2013)

Table 1 presents a comprehensive summary of Complete Street typologies, encompassing building form and function, roadway form and function, and intersection and crossing. This table systematically delineates the characteristics and classification that guide urban street design, demonstrating how each typology informs design decisions to achieve the principles of Complete Street, including multimodal accessibility, safety, and contextual integration.

Table 1. Complete Street Typologies: Building Form and Function, Roadway Form and Function, Intersections and Crossings (Source: CSCDOT, 2013)

Building Form and Function			
Typology coda	Typology Name	Characteristics	Typical Buildings
R	Residential	houses-low-density multi-family buildings, and non-residential sites such as	Height is 1-3 stories, with a front yard
M	Mixed-use	buildings with service and commercial uses on the ground floor that serve surrounding neighborhoods, residential or office uses above the ground floor	Height is 2 or more stories, and buildings are typically about the sidewalk
C	Commercial center	concentration of commercial uses that draw from a large area, may be stand-alone commercial buildings, or may be part of mixed-use buildings	Height varies considerably from one-story commercial buildings to high-rise mixed-use, residential, and office buildings. Buildings on the sidewalk. Surface parking lots and parking structures are common
D	Downtown	high-rise mixed-use, residential, or office buildings centrally located within the city.	Buildings are tall and dense. The sidewalks are wide, and the buildings are on the sidewalk
IC	Institutional or Campus	extensive construction (exceeding 2 acres) under centralized management and structured, akin to a campus, generally enclosed by gates and regulated access	Diverse architectural styles are predominantly oriented around an interior courtyard rather than the street.
IN	Industrial	Manufacturing, wholesale, and industrial applications may be structured within a campus or industrial corridor and necessitate provisions for large vehicles.	The height ranges from 1 to 4 stories. Structures may adjoin the sidewalk, although entrances are directed away from the streets, facilitating internal access.
P	Parks	Deliberate open areas include parks, forest reserves, and aquatic environments; streets wholly situated within or adjacent to a park; and park-like central reservations.	These places are characterized not by their internal structures but by distinct boundaries.
Roadway Form and Function			
Typology coda	Typology Name	Definition	Characteristics

Table 1 continued

TH	Thoroughfare	Broadest right-of-way; elevated medians; potential side medians, green spaces, and expansive walkways; accommodates both through and local functions. Not typically commercial.	Lanes Speed Blocks ADT Flow	4+ 25-30mph 6601320 ft 20k and higher 2 ways
MS	Main Street	The system primarily accommodates local traffic, links neighborhoods and business zones, and potentially expands to commercial areas.	Lanes Speed Blocks ADT Flow	1 to 3 15-20 mph 150-300 ft 3-15k 1 or 2 ways
NS	Neighborhood Street	Nearly all local transportation options serve residential areas. No centerline or lane striping is necessary.	Lanes Speed Blocks ADT Flow	1 10-20 mph <300 ft <6k 1 or 2 ways
SW	Service Way	A constricted thoroughfare, lacking pedestrian pathways, provides brief connectivity between two streets.	Lanes Speed Blocks ADT Flow	1 5-10 mph NA NA 1 or 2 ways
PW	Pedestrian Way	Pedestrian access between buildings is facilitated by a pedestrian corridor or walkway that is not necessarily adjacent to a conventional roadway.	Lanes Speed Blocks ADT Flow	NA NA NA NA NA
Intersections and Crossings				
Typology coda	Typology Name	Definition	Characteristics	

Table 1 continued

SIG	Signal (including 6-way intersections)	A traffic signal regulates intersections.	Complete signals encompass all modalities and adhere to ADA standards.
RBT	Roundabout, traffic circle.	The intersection features a circular aisle for traffic. The area could potentially have unsignalized splitter islands.	Roundabouts must align with the modal hierarchy, accommodate all transportation modes, and comply with ADA standards.
AWS	All-way stop	Intersections where all approaches are regulated by stop signs.	Stop and yield signs are often installed to regulate vehicular traffic; however, the locations must be assessed to ensure the accommodation of other forms of transport.
STY	Stop, yield	Intersections where the primary route is uncontrolled, while the secondary street is regulated by a stop or yield sign.	These locations require analysis to assure the accommodation of non-motorized modes, as referenced in Pedestrian Crossings, Sections 3.4.3, and CDOT's Bicycle Section.
UNC	Uncontrolled	Intersections devoid of traffic control devices (stop signs, signals).	These typically occur in areas with low car volume; yet, they require analysis for pedestrian and bicycle accessibility, particularly at crossings.
MID	Midblock pedestrian crossing	There is a pedestrian crossing between designated intersections. The pedestrian may or may not have marked crossing facilities or traffic control equipment.	Refer to Pedestrian Crossings, Section 3.4.3.
DW	Driveway	You are entering private property. It is considered a junction where vehicular traffic converges with the pedestrian walkway.	Refer to Driveways, Section 3.4.4
Overlays			
Typology coda	Typology Name	Discussion	
SRT	IDOT	Approximately 37% of Chicago's principal thoroughfares are governed by governmental authority. This constrains the city's capacity to regulate and sustain its street infrastructure. A directive from several agencies offers instructions on the appropriate circumstances and methods for implementing jurisdictional transfer for certain streets.	
BRT	Transit Priority Street	The CDOT and CTA will designate specific routes where transit will take precedence over other modes, impacting the modal hierarchy and subsequent design.	
HBS	Historic Boulevard System	Chicago's historic boulevards are cataloged on the National Register of Historic Places and serve as a distinctive feature of the city's roadway system.	

Table 1 continued

TOD	Transit-Oriented District (El stops)	These regions need particular attention for individuals arriving on foot, by bicycle, bus, or taxi. The City has established a working committee to officially designate these zones.
HZ	Home Zone (shared street)	Home Zone is an innovative roadway concept to be implemented by CDOT. It is a residential thoroughfare, maybe incorporating some commercial elements, that employs physical traffic calming measures to reduce vehicle speed to that of pedestrian pace. It is generally a communal area without division between modalities.
BIK	Bicycle Priority Street (bicycle spoke route, signal timing for bikes)	CDOT will designate certain routes where cycling will take precedence over other transportation modes, hence affecting the modal hierarchy and subsequent design.
CTY	County Route	The majority of county roadways inside the city are classified into two categories: 1) those under county control but maintained by the city, and 2) municipal extensions of county highways that come under city jurisdiction. CDOT exercises effective authority over these roadways; collaboration with the County is frequently a mere formality.
MOB	Mobility Priority Streets	Link commuter train stations to the central business district. Section 17-4-0600 of the Chicago Zoning Ordinance defines Mobility Streets and mandates 14-foot sidewalks to facilitate certain pedestrian mobility requirements.

Table 1 delineates the comprehensive street typologies encompassing Building Form and Function, Roadway Form and Function, Intersections and Crossings, and Overlays. This table offers a detailed overview of the characteristics and classifications that inform urban street design, demonstrating how each typology influences design decisions to realize the principles of Complete Street, such as multimodal accessibility, safety, and contextual integration, ensuring that the categories are correct and consistent with accepted urban planning frameworks.

2.2.2. Complete Street Policies (CSP)

Complete Street policies aim to promote the development of road networks by cities and counties that are safer, more habitable, and inclusive for all individuals. Planners consider all users while designing urban environments using this concept. Users include bikers, drivers, pedestrians, public transport passengers, and riders of various ages and capabilities. They will facilitate the safe movement of individuals along and across urban roadways (Villela, 2011).

Complete Street regulations mandate that transportation authorities and planners modify development focused exclusively on motor vehicles. Current trends increasingly emphasize environmental sustainability, and Complete Street to promote healthy lifestyles associated with walking, cycling, and safety. According to NCSC (2011), over 55% of Americans would rather walk than drive.

In a (2008) paper in ITE Journal, John LaPlante and Barbara McCann elucidated that Complete Street should prioritize policy. “A Complete Street is a road that is designed to be safe for drivers, bicyclists, transit vehicles and users, and pedestrians of all ages and abilities” (LaPlante & Barbara McCann, 2008, p.24). The Complete Street model focuses not just on individual roads but on changing the decision-making and design process so that all users are routinely considered during the planning, designing, building, and operating of all roadways. It is about policy and institutional change (Burden & Litman, 2011).

As individuals increasingly acknowledge the necessity for improved transportation practices, they are turning to Complete Street policies to ensure safe mobility. In the last four years, the number of towns implementing Complete Street rules has more than doubled, exceeding 200 policies by 2010 (Villela, 2011).

2.2.3. Complete Street Elements

The Complete Street model encompasses essential design components such as walkways, bicycle pathways, public transit, and vehicular lanes. Each aspect contributes distinctly to improving safety, accessibility, and urban living quality, and its design must ensure that all users may concurrently and securely utilize urban areas, with appropriate prioritization (URL-4). The subsequent discussion will elucidate the characteristics and significance of each of these parts.

A) Pedestrian

According to Cannon et al. (2011), pedestrian-friendly communities confer substantial advantages to urban areas. He articulates that enhancing access to local enterprises can expedite economic development and contribute to the revitalization of the urban landscape. Cannon et al. (2011) observes that in these societies, streets function not merely as conduits for transportation but also as primary avenues for social contact, infusing the urban environment with increased vitality and activity. He indicates that approximately 15% of the population experiences permanent mobility impairments, while an additional 20% encounter transitory limits resulting from injuries or the utilization of assistive devices such as wheelchairs. These findings indicate that creating urban places to prioritize walking is not merely a design decision but an imperative for ensuring equitable access and enhancing the quality of life in the city (Cannon et al., 2011).

B) Cyclists

According to Pucher & Buehler (2012), cycling has been integrated into the daily routines of individuals for several reasons. Individuals may utilize bicycles exclusively for transportation or integrate them with alternative forms of transit, such as bus travel. Bicycles serve several uses, including daily errands, personal appointments, transporting children to school, engaging in sports activities, and recreational use. Urban experiences demonstrate that the closeness of cycling infrastructure to retail centers, educational establishments, and recreational areas markedly enhances the efficacy and appeal of the bicycle transit network.

“A civilization that facilitates safe and efficient cycling will yield economic advantages, social improvements, and enhanced public health metrics” (Pucher & Buehler, 2012, p.22).

C) Transit

A meticulously constructed street adhering to universal design principles facilitates the utilization of a dependable and efficient public transit system as an alternative to urban commuting. This method not only reduces traffic accidents and pollutant emissions but also boosts residents' physical activity, improves mental health, and fosters equitable access to medical care. Consequently, by addressing the requirements of all users throughout the design phase, public transportation would effectively enhance mobility, improve connections, and augment safety in these urban corridors (Official Gazette, 2025, p.13).

D) Cars

Conventional Streets are predominantly engineered to accommodate private automobiles, which profoundly influences the configuration and utility of roadways. Conversely, the Complete Street model prioritizes the integration of various transportation modalities to guarantee the safety of all users, irrespective of ability or condition (URL-3, p.15). Thorough and inclusive road design can mitigate traffic issues and enhance the safety of all vehicles while simultaneously raising driver awareness of the presence and rights of alternative road users, such as pedestrians, cyclists, and public transport patrons. Considering the preeminent presence of private automobiles on roadways, these vehicles can present considerable hazards to other users; hence, prioritizing safe and cohesive design is not merely a traffic imperative but also a crucial societal requirement (URL-3).

The Washington Complete Street & Main Street Highways Program Case Studies & Practice Resource emphasizes a fundamental yet significant concept: our roadways must accommodate all users, including substantial vehicles such as freight trucks and agricultural machinery. In Washington State, where trucks transporting logs, agricultural products, horses, and substantial freight are commonplace, ensuring their safe and efficient movement is imperative. While Complete Streets are designed to accommodate all users equitably, freight trucks possess distinct requirements. They are larger, more substantial, and occupy increased areas so urban architecture must evolve accordingly. This signifies broader lanes, increased space for turning, and more robust road surfaces. Through these modifications, communities can establish thoroughfares that facilitate the safe and efficient coexistence of trucks, pedestrians, cyclists, and motorists, thereby enhancing both daily activities and the local economy (CSCDOT, 2013).

2.2.4. Benefits of Complete Street (BCS)

According to Burden & Litman (2011), Complete Street enhances traffic efficiency and offers various social, economic, environmental, and health advantages for communities. This approach also complements and enhances other initiatives aimed at improving transportation system efficiency, such as travel demand management, parking management, the promotion of alternative modes, transit-oriented development, and smart growth land use regulations (Burden & Litman, 2011).

Public health and safety are integral to the development of Complete Street legislation. By advocating for many transportation modes, including cycling and walking, Complete Street enhances physical activity and promote the health of both individuals and the broader community (Jackson, 2011).

This approach demonstrated efficacy in decreasing vehicular traffic crashes and injuries via safety enhancements and interventions. A safety assessment of lane width for arterial road segments revealed no evidence, save in rare instances, that smaller lanes elevate crash rates (Potts et al., 2007). The review identified that walkways, elevated medians, optimal bus stop placement, traffic calming strategies, and accommodations for those with disabilities can enhance pedestrian safety (Campbell et al., 2003).

Complete Street have the capacity to economically invigorate a town. Improving accessibility, augmenting safety, integrating sustainable practices, and elevating the aesthetic appeal of a town can attract visitors, foster business development, and enrich the community's character and identity (Cannon, 2011).

It also ensures users have vital access to the transportation network, irrespective of their mode of travel. Access, or connectedness, dictates the ease with which individuals navigate the transportation system. At its most fundamental level, network connectivity pertains to the safe and efficient movement of people between locations (FHWA, 2022). And it is closely linked to safety outcomes Complete Street improve safety by mitigating accidents via safety enhancements. Research revealed that implementing raised medians and reconfiguring crossings and walkways for pedestrian mobility decreased pedestrian risk by 28% (NCSC, n.d).

2.2.5. Complete Street Design Features

Complete Street design features denote a collection of design aspects and principles intended to establish streets that are secure, accessible, efficient, and multifunctional for all users. These features encompass conventional and secure walkways, designated bicycle lanes, public transportation stops and routes, specialized pathways for those with disabilities, green areas and street furnishings, enough illumination, and acceptable geometric design for motor vehicles (URL-3).

The objective of these elements is to enhance safety, elevate the quality of urban life, diminish pollution, and promote sustainable mobility options, like walking, cycling, and public transit, which will be elaborated upon below.

A) Pedestrian Amenities and Infrastructure

Pedestrian infrastructure and amenities are regarded as essential components of sustainable urban planning. This section of urban areas must be built to ensure safe, comfortable, and autonomous access for all societal groups, including the elderly, children, and those with disabilities. Pedestrian-friendly streets often feature conventional sidewalks, secure crosswalks, accessibility ramps, green spaces, seating, adequate illumination, and appropriate signage (FHWA, 2022)

B) Bicyclists' Treatments and Facilities

A bicyclist is a significant road user who runs a vehicle and warrants respect and accommodation in all facets of transportation planning. Complete Street must guarantee that cyclists experience safe, accessible, and comfortable conditions when utilizing the highway. To achieve this objective, roadway design must have suitable infrastructure that accommodates all categories of bicycle users, irrespective of age or capability (FHWA, 2022).

C) Transit Treatments and Facilities

Public transit is a fundamental component of the Complete Street model. User volume and street classification typically dictate the degree of focus on public transportation components. This system, being compatible with various transportation modalities, ought to occupy a significant position in urban street design. The services provided are contingent upon the type of transport line, be it local, regional, or express bus routes (FHWA, 2022). Hara & Kuwahara emphasize in this context, cooperation between the municipality and local bus operators is crucial for formulating an effective strategy that addresses the community's

requirements. Moreover, public-private partnerships can effectively contribute to the establishment and implementation of transportation stations and shelters, especially in commercial zones located in suburban municipalities (Hara & Kuwahara, 2015).

2.3. Comparative Analysis of the Complete Street Model in International Case Studies

This research involved a comprehensive examination of multiple case studies from different cities globally to assess the practical implementation and efficacy of the Complete Street model in varied urban settings. Prominent examples include cities like Second Street Corridor (US 60), Danforth Avenue, Toronto, Ontario, Canada, Pennsylvania Avenue NW, Washington, D.C., USA and St. Marks Road, Bengaluru, India each providing significant insights into the design and execution of Complete Street model, influenced by their distinct cultural, infrastructural, and policy contexts.

2.3.1. Second Street Corridor (US 60)

Second Street in Frankfort, the capital of Kentucky, is located south of the city center and runs from east to west. The Kentucky River separates this street from the city center, which is only connected by two bridges (URL-5). Prior to the implementation of the Complete Street and Road Diet project on Second Street Corridor, this corridor faced numerous challenges, including high vehicle speeds, wide streets, narrow and unsafe sidewalks, and a lack of sufficient facilities for cyclists and people with disabilities. The main objectives of this project include increasing safety for all users (pedestrians, cyclists, vehicles, and public transportation), improving accessibility for the elderly and people with disabilities, reducing vehicle speeds and the width of pedestrian crossings, enhancing the urban landscape and physically revitalizing low-income neighborhoods, and improving the urban drainage system to reduce pollution in the Kentucky River (URL-6).

According to demographic data, approximately 25% of the region's residents lived in poverty, 20% had disabilities, and 15% did not own personal vehicles; therefore, this project was not only about physical and traffic aspects but also held special significance from an environmental justice perspective (URL-5, p.2).

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Preliminary studies for this project began in 2012 under the Greeing America Capitals program, followed by securing the necessary funding and finalizing the design in 2018. The official implementation of the project began in 2019 and was completed in 2022. The project included the reconstruction of three main thoroughfares: Second Street (from Taylor Ave to Capital Ave), Capital Avenue (from Second Street to the Capital Bridge), and Main Street (from High Street to Broadway Street) (URL-5).

The design modifications implemented in this project include reducing the street width from four traffic lanes to two lanes for both directions, along with a dedicated center turning lane (Road Diet), creating a safe two-way bike lane on the north side of Second Street, and widening sidewalks to a width between 1.8 and 4 meters with standard paving according to Americans with Disabilities Act requirements. Additionally, new LED (Light Emitting Diode) lights and safety signs were installed, street trees and rain gardens were planted to control runoff and beautify the environment, and access to public transportation stations was improved. Additionally, by creating Curb Extensions, the pedestrian crossing distance across the street was shortened, and by modifying the intersection geometry, some intersections were converted into All-way Stop intersections. The results of this project included a noticeable increase in the safety of pedestrians and cyclists, especially near schools, a reduction in vehicle speeds, and a decrease in the average annual number of accidents from 17 to less than 8 (URL-5,p.17).

In addition, the project improved access for low-income groups and people with physical disabilities, enhanced the quality of the urban landscape, increased the value of adjacent properties, reduced air and water pollution through green design, and created spaces for urban art, including murals and street-level art installations. This project is a prime example of the successful implementation of the Complete Street model in a diverse urban historical and social context.

The general length of the Complete Street road project along this axis is roughly 4 km, with an average width of the road segment being 16 meters. Sidewalks of 4 meters in width have been constructed on both sides of the roadway, adjacent to each sidewalk, a green area or a 2-meter-wide flowerbed strip has been proposed to enhance the urban landscape,

effectively manage surface runoff, and improve the quality of the urban environment. Dedicated 1.5-meter-width of the bicycle lane routes have been created on both sides of the roadway, enhancing the safety and connectedness of the non-motorized transportation network. A dedicated bus lane has not been proposed on this axis; however, bus stops are not located at regular intervals and do not provide adequate access for different customers. The street traffic segment comprises four lanes: two lanes for inbound traffic and two for outgoing traffic. Prior to the implementation of this project, there were just four lanes in a single direction, resulting in congestion and diminished traffic safety. The mean distance between two junctions, including minor intersections, is 132 meters, with around 5 intersections every km of the route. The turning radius of cars at junctions is established at 7 meters, in line with urban planning geometric requirements. The distance between two pedestrian crosswalks in the central portion of the street is 157 meters, whereas the distance between the two cross ramps is around 8 meters. These ramps are constructed at the entrances of alleyways and side streets to ensure safe access for pedestrians, particularly individuals with mobility disabilities.

All measures and dimensions cited were precisely obtained using the measuring tool in Google Earths to guarantee an accurate evaluation of the real street conditions and their adherence to comprehensive street design guidelines. This route features many land uses, including residential zones, public parking facilities, a hospital, a university, and a cemetery, underscoring its multifunctional and essential role within the urban framework. This amalgamation of functions underscores the necessity for a comprehensive, secure, and versatile street design one that accommodates the requirements of all users while adhering to the ideals of urban sustainability and spatial equity. Figure 3 shows a view of the area for implementing the Complete Street project.

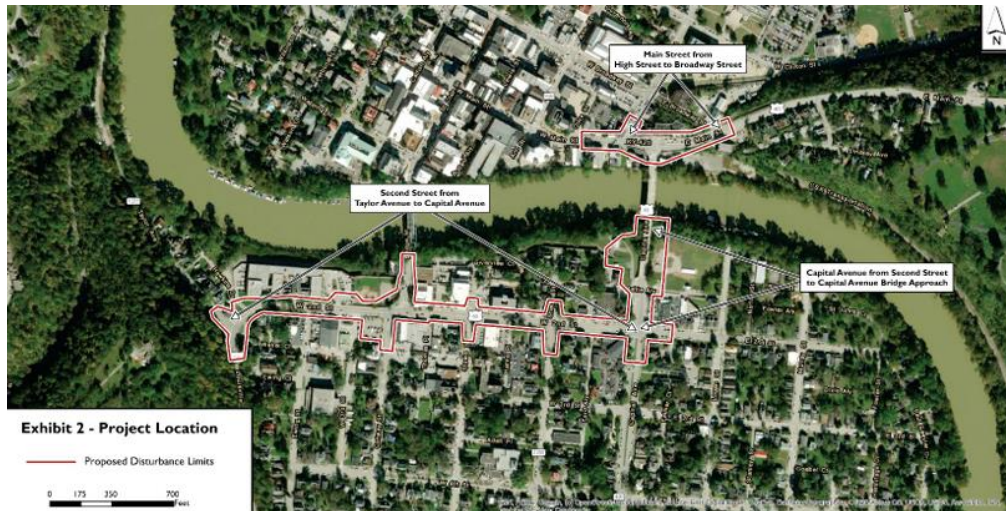


Figure 3. Second Street Corridor (US 60), (Source: URL-6, p.8)

2.3.2. Danforth Avenue, Toronto, Ontario, Canada

In 2019, the City of Toronto commenced an extensive examination of Danforth Avenue, a collaborative endeavor including urban planning, transportation services, and economic development, encompassing a thorough street study, urban planning, economic analysis, and retail assessment. This research aimed to address the requirements of all users, including pedestrians, cyclists, motorists, and public transit users, with particular emphasis on elderly people, those with mobility challenges, and local enterprises (URL-7, p.1).

The Destination Danforth Complete Street Pilot project encompassed a pilot segment, conceived and executed as part of the Active to initiative for developing a temporary cycling network from early 2020 through 2021. Danforth Avenue is designated as a street in the city's official plan and categorized as a major thoroughfare in the road classification system, featuring a right-of-way width of 26 to 27 meters and a consistent sidewalk width of 16.4 to 16.8 meters between Broadview Avenue and Dawes Road, which expands to approximately 100 meters in the Coxwell section (URL-7, p.2).

The primary objectives of the comprehensive street research were to prioritize the safety of vulnerable users, such as pedestrians, schoolchildren, elders, and bikers, and to guarantee inclusive street design for all users. The research sought advantages including enhanced safety, the creation of an aesthetically pleasing cityscape, greater transportation alternatives, local social and economic benefits, and environmental gains. In reaction to the pandemic, the pilot project also addressed supplementary objectives, such as bolstering local

enterprises, providing outdoor seating options, enabling physical distancing for active transportation, presenting sustainable alternatives to public transit, and expanding areas for enhancing public spaces and bicycle parking (URL-7).

The general length of the road is 5.4 kilometers, and its general width is 16 meters. Sidewalks with a width of 5 meters are situated on both sides of the roadway, with green spaces in the shape of planters along the pedestrian zones. The pedestrian crossing spans 16 meters, while separate bicycle lanes, each 1.5 meters wide, total 3 meters, facilitating secure cycling travel. Each bicycle parking facility has the capacity to hold up to 10 bicycles. The bus lane is 3.5 meters in width, while the bus stop bays stretch 22 meters in length. The thoroughfare comprises four vehicular lanes, with an average interval of 300 meters between bus stations. The distance between two intersections is around 159 meters, so there are an average of 13 junctions per kilometer (one direction). The turning radius for automobiles, which also impacts pedestrian safety, is 7 meters.

Street facilities consist of seats, benches every 1.5 meters, and trees situated at intervals of 0.5 meters. The height variation along the street is negligible, with a gradient of 0.5 per 100 meters. The roadway is designated as a collector route, traversing mixed land-use districts that include residential zones, parks, shopping malls, public parking facilities, hospitals, government and administrative offices, restaurants, cafés, retail establishments, and educational institutions. The speed limit on the road is set at 40 km/h.

Regarding transportation and accessibility, there are two bicycle routes, and the street offers complete accessibility for individuals with disabilities. Traffic-calming interventions, such as speed bumps, road constriction, and elevated pedestrian crossings, have been instituted to improve safety. Illumination is provided along the whole path. Additionally, intelligent street components like digital signs and smart lighting systems are included in the design. The mean separation between pedestrian crosswalks is 159 meters, but accessible ramps for individuals with disabilities are positioned every 11 meters, facilitating inclusive and secure movement for all users.

All measurements and spatial calculations were performed using the Google Earth measuring tool. This platform enabled the precise measurement of distances, street widths, and spatial interactions among diverse urban components, including sidewalks, traffic lanes, bus stops, crossroads, and public amenities. The utilization of Google Earth guaranteed uniformity and accuracy in the data-collecting procedure, facilitating a dependable examination of the street's geometric and functional attributes within the research region.

The Destination Danforth Complete Street Pilot project initiative was executed in July 2020. The final design incorporated various urban enhancements, including the installation of over 500 planters with indigenous flora, aesthetically painting sidewalk edges to minimize pedestrian crossing distances, establishing three public seating areas (parklets), and allowing cafes and restaurants to extend onto sidewalks with a straightforward, complimentary permit. Parking and loading were instituted on both sides of the street around the clock, with less than 10% of parking spaces diminished to accommodate new street features (URL-6).

Furthermore, the bike route was constructed in two distinct directions to improve rider safety and promote sustainable transportation alternatives. The route features two traffic lanes (eastbound and westbound), designated pedestrian areas, and artistic elements like 12 embellished traffic boxes and 5 murals to enhance the thoroughfare's aesthetic appeal. Furthermore, high-capacity bike parking provided more parking (1260 bike parking stalls) along Danforth Avenue to serve additional cycling demand (URL-6, p.9).

Figure 4. It shows the pilot cycling path and the artistic expansion of the sidewalk edge in the Destination Danforth Complete Street Pilot project. In this figure, one can observe the creative design combination of urban spaces, the use of bright colors on the edges of the sidewalks to increase pedestrian safety, and the separate bicycle path, which has contributed to enhancing safety, visual aesthetics, and the dynamism of the street.



Figure 4. Destination Danforth pilot bike lane and artistic curb extension, (Source: URL-7, p.10)

Figure 5 presents the cycling test track and the curbside patio seating area in the Destination Danforth Complete Street Pilot project. In this image, the combination of a separate bike path, green space, and seating areas alongside the street is visible, designed with the aim of creating a safer, more vibrant, and friendlier environment for pedestrians and street users.



Figure 5. Destination Danforth pilot bike lane and curb side patio, (Source: URL-7, p.11)

2.3.3. Pennsylvania Avenue NW, Washington, D.C., USA

Washington, D.C., is considered one of the relatively walkable cities for those who live near their destination, although it may present various challenges for mobility. According to Walk Score's ranking, this city was named the seventh most walkable city in the United States in 2017 (URL-8). This success is partly the result of changes and improvements made in the last decade, some of which stem from the implementation of the "Complete Street" policy. This policy was adopted in 2010 by the Washington D.C. Department of Transportation (DOT) and aims to design streets in a way that ensures the safety and comfort of all road users—from drivers and cyclists to pedestrians.

“Complete Street” are streets and roadways designed for the safety and convenience of drivers, cyclists, and pedestrians alike” (URL-8, p.1).

A Complete Street model does not mean every thoroughfare will have a cycling lane, sidewalk, or crosswalks, but in D.C. it means that all DOT projects “shall accommodate the

safety and convenience of all users”. In other words, its a directive not of how to design a street, but for whom to design it (URL-8).

Based on measurements taken through Google Maps, the physical and functional characteristics of the street studied are as follows:

The total length of the street is about 6 km, and its general width is 34 meters. The width of the sidewalk on both sides of the street is 3 meters on average. The width of the pedestrian crossing is approximately 24 meters. The 3-meter-wide bicycle lane is only located on one side of the street, and there are no bicycle parking facilities along the route.

The bus lane width is 3.5 meters, and the bus stop bay length is approximately 22 meters. In total, the street has 8 traffic lanes, and the median width varies from 2 to 6 meters. The distance between two bus stops is approximately 300 meters, and the distance between two consecutive intersections is measured to be about 119 meters. The distance between the two fields is also 119 meters. Based on these data, the number of intersections per kilometer (in one direction of travel) is estimated to be 6.

The turning radius of vehicles, which has a direct impact on pedestrian safety, is 9 meters. The distance of street furniture from the pedestrian path, including benches, is on average 2.5 meters, and for trees, it is about 0.5 meters. The rate of change in elevation, or the slope of the path, for every 100 meters was measured at 0.5 meters.

In terms of street type, this route is classified as Collector Boulevard and is located adjacent to various land uses such as residential areas, parks, shopping centers, public parking, government and administrative offices, restaurants, cafes, shops, and public transportation stations. The maximum speed limit on this street is 50-60km/h.

The stated goals of implementing the Complete Streets model on Pennsylvania Avenue NW include meeting the diverse transportation needs of the area's population, providing safe, affordable, and convenient ways for people and goods to move without harming environmental and cultural resources, and improving residents' quality of life so that their reliance on single-occupancy vehicles is reduced. Additionally, this project was designed to enhance economic activities, improve the movement of goods, increase the quality of the urban environment, and expand the transportation network for all modes of travel. Figure 6 shows the total length of the Complete Street on Pennsylvania Avenue.

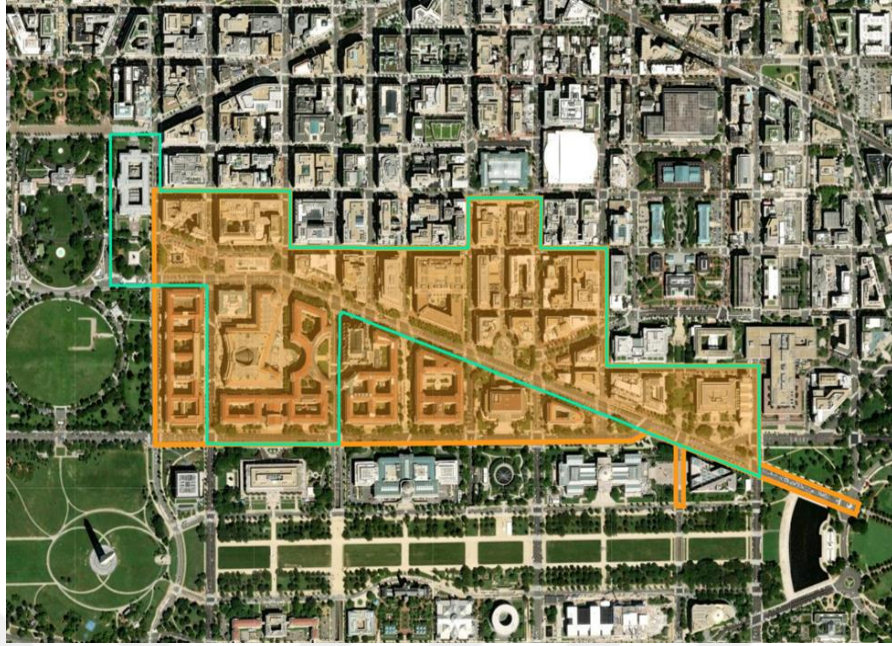


Figure 6. Pennsylvania Avenue Street, (Source: Virginia Tech School of Architecture, 2024)

2.3.4. St. Marks Road, Bengaluru, India

St. Mark's Road named after the oldest Anglican Church in Bangalore, is a landmark street of the city synonymous with established eateries. The 0.90 km road is a part of the Central Business District, linking MG Road at Anil Kumble Circle in the north with Residency Road at Cash Pharmacy Junction in the south (URL-9).

This project took four years to complete. The initial plan was presented in 2011, and the project was completed in 2015 for 20 million US dollars in the first phase (URL-9).

Total length of St. Mark's Road in Bangalore, India, is approximately 0.90 kilometers long and has a general width varying between 18 and 20 meters. The sidewalks on both sides of the street are about 3 meters wide, and the pedestrian crossings are approximately 18 meters long. The bicycle lane is designed on one side of the street with a width of 1.4 meters. More bicycle parking facilities are provided for motorcycles, with a capacity of approximately 49.

There is no bus lane on this street, and buses share the road with other vehicles. The length of the bus bay is approximately 22 meters, and the distance between two bus stops is approximately 300 meters. The number of traffic lanes for vehicles is two in most areas, but

in some places, it increases to three lanes. Green spaces and trees have been added to the sidewalks to improve the street's environmental quality.

The distance between the two intersections is approximately 100 meters, and the distance between the two squares is approximately 400 meters. There are approximately 11 intersections per kilometer of road. The turning radius of vehicles at intersections is approximately 7 meters, which has a direct impact on pedestrian safety. There are no public benches along the path, but trees are planted about 0.5 meters apart. The longitudinal slope of the street is very low, with a change in elevation of about 0.5 percent for every 100 meters. According to the urban network classification, this street falls into the category of collector roads.

The land used along the street includes residential areas, shopping centers, public parking lots, government and administrative offices, restaurants and cafes, shops, and educational institutions. This street also has good access to public transportation, and the maximum speed limit is set at 40 kilometers per hour.

Additional features of the street include accessibility for people with disabilities, traffic calming measures such as speed bumps, lane narrowing, and raised crossings, as well as a modern lighting system including digital signs and smart lighting. The distance between the two pedestrian crossings is approximately 100 meters, and the distance between the two access ramps (for wheelchairs or people with disabilities) is approximately 8 meters. All the above measurements and data were obtained and verified using Google Earth map.

Figure 7 illustrates the physical and geometric evolution of the street from its existing condition before redesigning to achieving its final dimensions and features after project implementation, a change that demonstrates the successful implementation of the Complete Street approach within the Tender SURE program.



Figure 7. St. Marks Road, Bengaluru, (Source: URL-8)

Geometric features, mobility and land use accessibility, and safety and accessibility are the primary criteria that are included in Table 2. The sub-criteria that fall under these categories include a variety of physical and functional indications, including, but not limited to, the overall length and width of the road, the width of the sidewalk, the width of the bicycle lane, the distances between junctions, bus stops, and accessible ramps, and many others.

All the values that correspond to the sub-criteria (A, B, C, and D) were acquired through measurements that were carried out with the implementation of Google Earth Map measuring tools. Within the context of the Complete Street model, these metrics serve as the foundation for evaluating the physical and functional qualities of the streets that have been chosen.

Table 2. Evaluation criteria for Complete Street model based on international case studies

Criterion	Sub criterion	A	B	C	D	Min	Max	Average
Geometric Features	The general length of the road (km)	4	5.4	6	0.90	0.90	6	4
	The general width of the road (m)	16	16	34	18-20	16	34	21
	sidewalk width (m)	4	5	3	3	3	5	3.75
	Pedestrian crossing length (m)	16	16	24	18	16	24	18.5
	Width of the bicycle lane (m)	1.5	1.5	3	1.4	1.4	3	1.85
	Bicycle parking facilities (Availability and capacity of bicycle parking spaces)	8	10	-	10-15	8	15	8
	Motorcycle parking facilities	-	-	-	49			
	Bus line width(m)	-	3.5	3.5	3.5	3.5	3.5	3.5
	Bus stop bay length (m)	-	22	22	22	22	22	22
	Car traffic lane	4	4	8	2	2	8	4
	Median (m)	2	-	2-6	-	2	6	3
	Distance between two bus stops (m)	-	300	300	300	300	300	300
	Distance between two junctions (m)	132	159	119	100	100	159	127
	The distance between the squares (m)	132	159	119	400	119	400	202
	How many junctions per km (one direction)	5	13	6	11	5	13	8
	Turning radius (Corner radius for vehicles, impacts pedestrian safety)	7	7	9	7	7	9	7.5
Mobility and Land Use Accessibility	Street furniture setback (Distance of furniture benches, trees, and signs from the pedestrian path)							
	Benches(m)	-	1.5	2.5	-	1.5	2.5	2
	Trees(m)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Elevation changes slope per 100m	0.3	0.5	0.5	0.5	0.3	0.5	0.45
	Street Type (Arterial, collector, boulevard, promenade, and local)							
	Arterial	-	-	-	-			0/4
	Collector	+	+	+	+			4/4
	Boulevard	-	-	+	-			1/4
	Local	-	-	-	-			0/4
	Access to land uses							
	Residential Area	+	+	+	+			4/4
	Park	+	+	+	-			3/4
	Shopping mall	+	+	+	+			4/4
	Public parking	+	+	+	+			4/4
	Hospital	+	+	-	-			
	Government and Administrative Offices	-	+	+	+			3/4
	Restaurant and Cafes, Shops	+	+	+	+			4/4
	Cemetery	+	-	-	-			
	Educational	+	+	-	+			+
	Public Transport Accessibility	-	+	+	+			+
	Speed limit km/h	50-60	40	50-60	40	40	50-60	47
	Bike path /side	2	2	2	1	1	2	4/4
	Accessibility for the Disabled	+	+	+	+			4/4
	Traffic Calming Measures(Speed bumps, narrowing, raised crossings)	+	+	+	+			
	Lighting	+	+	+	+			4/4
Safety and accessibility	Smart Street Elements (Smart lighting, digital signage, solar benches, charging stations)							
	Digital signage	+	+	+	+			4/4
	Smart lighting	-	+	+	+			3/4
	Distance between two pedestrian crosswalks(m)	157	159	108	100	100	159	131
	Distance between two accessible ramps(m)	8	11	18	8	8	18	11

In Table 2, four options are presented for studying and comparing Complete Street projects:

- A. Second Street Corridor (US 60)
- B. Danforth Avenue, Toronto, Ontario, Canada
- C. Pennsylvania Avenue NW, Washington, D.C., USA
- D. St. Mark's Road, Bengaluru, India

In the table descriptions, comprehensive and detailed information is provided for each street, including physical and geometric characteristics, surrounding land uses, pedestrian and cycling facilities, traffic calming measures, accessibility for people with disabilities, smart lighting and signage systems, and other indicators related to Complete Street models.

2.4. Developing and Structuring Criteria for Complete Street Models

This part identifies and examines the criteria and subcriteria pertinent to the Complete Street model, design upon standards, specialized literature, and esteemed international examples to establish a scientific and complete analytical framework. Subsequently, chosen case studies were scrutinized, and the criteria identified in the design and execution of Complete Street model in those instances were retrieved and analyzed. This table includes just those criteria that are reiterated and validated in both scientific literature and case studies, excluding those found in standard sources. Table 3 presents these criteria and sub criteria.

Table 3. Evaluation criteria for Complete Street model based on design guidelines

Criterion	Sub criterion	(URL-10)	(URL-11)	CSDG City of Los Angeles (2018)	(URL-12)	(URL-13)	(URL-14)	Average
Geometric Features	The general length of the road (km)	-	-	-	-	3-8	-	3-8
	The general width of the road (m)	-	9-45	9-42	12-30	6-60	-	24
	sidewalk width (m)	1.5-3	1-5	1-5	1-5	2-6	4-8	3.5
	Pedestrian crossing length (m)	8-34	8-40	8-40	10-28	5-50	10-40	20
	Width of the bicycle lane (m)	1.5-3	1.5-3	1.5-3	1.5-3	1.5-3	1.5-3	1.5
	Bicycle parking facilities (Availability and capacity of bicycle parking spaces)	4-8	6-10	6-10	6-10	4-10	6-10	7
	Bus line width(m)	3-3.5	3-3.5	3-3.5	3-3.5	3-3.5	3-3.5	3-3.5
	Bus stop bay length (m)	25-30	20-30	20-30	20-30	18-28	18-30	24
	Car traffic lane	4-8	4-8	4-8	4-8	2-8	4-8	3-8
	Median (m)	0.5-3	0.5-1	3-6	0.5-1	0.5-1	0.5-3	1.5
	Distance between two bus stops (m)	200-400	300-600	200-400	200-400	150-300	200-400	300
	Distance between two junctions (m)	-	200-400	150-400	150-300	80-300	-	250
	The distance between the squares (m)	61	-	-	-	250	-	155
	How many junctions per km (one direction)	-	-	-	-	-	-	-
	Turning radius (Corner radius for vehicles, impacts pedestrian safety)(m)	15	10-20	10-20	6-20	6-15	8-15	14
	Street furniture setback (Distance of furniture benches, trees, and signs from the pedestrian path)							
	Benches(m)	2.5	2.5-4.5	2.5-4.5	2.5-4.5	1.5-5.5	3.5-7.5	3.5
	Trees(m)	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Table 3 continued

	Elevation changes slope	2.5-4%	2.5-5%	2.5-5%	2.5-5%	2.5-5%	2.5-8%	2-5%
Mobility and Land Use Accessibility	Street Type (Arterial, collector, boulevard, promenade, and local)							
	Arterial	+	+	+	+	+	+	+
	Collector	+	+	+	+	+	+	+
	Boulevard	+	+	+	+	+	+	+
	Local	-	+	+	-	+	-	+
	Public parking	+	+	+	+	+	+	+
	Access to land uses, residential area, hospital, government and administrative offices, educational, restaurant and cafe shops, shopping mall, park, cemetery .	+	+	+	+	+	+	+
	Public Transport Accessibility ,	+	+	+	+	+	+	+
	Speed limit km/h	50-60	30-60	40-60	50-60	10-50	10-45	43
	Bike path /side	1-2	1-2	1-2	1-2	1-2	1-2	1-2
	Accessibility for the Disabled	+	+	+	+	+	+	+
	Traffic Calming Measures(Speed bumps, narrowing, raised crossings)	+	+	+	+	+	+	+
	Lighting	+	+	+	+	+	+	+
Safety and accessibility	Smart Street Elements (Smart lighting, digital signage, solar benches, charging stations)							
	Digital signage	+	+	+	+	+	+	+
	Smart lighting	+	+	+	+	+	+	+
	Solar benches	+	+	+	+	+	+	+
	Distance between two pedestrian crosswalks(m)	50-100	80-200	100-250	80-250	150-250	50-200	125
	Distance between two accessible ramps(m)	8-12	10-12	8-12	10-12	8-10	8-12	8-12

Table 3 analyzes the sub criterion pertaining to the overall length of the ro. None of the five comprehensive sources for street design guidelines specify a particular length for streets. In (URL-13), its length is specified as ranging from 3 to 8 km. The primary rationale for establishing this range is the street's function as a conduit connecting various urban zones, facilitating an efficient pathway for public transit, pedestrian movement, and cycling. Furthermore, choosing this length range makes projects feasible for cost, implementation, oversight, and maintenance, while substantially enhancing the urban transportation network (URL-13).

Within the sub-criterion of general road width, four out of the six comprehensive street design standards examined stipulate a specified road width. No precise dimensions are indicated in (URL-10) and (URL-14). The street width in (URL-11) ranges from 9 to 45 meters; in CSDG City of Los Angeles (2018), it ranges from 9 to 42 meters; in (URL-12), it ranges from 12 to 30 meters; and in (URL-13), it ranges from 6 to 60 meters. The variation in ranges illustrates the disparities in urban networks, population density, land use classifications, and roadway design methodologies across different nations. The width of a street is often dictated by its functional purpose, traffic volume, and the inclusion of comprehensive street features such as bicycle lanes, walkways, green areas, and public transit facilities.

All Complete Street design guidelines specify precise dimensions and sizes for sub criteria related to design elements, including sidewalk width, pedestrian crossing length, bicycle lane width, bicycle parking facilities, bus lane width, bus stop bay length, car traffic lane width, median width, and the distance between adjacent bus stops. The proportions were set based on standards for urban design, levels of transportation service, street function classification, and user safety. The precise quantities of each of these elements are detailed in Table 3.

No exact measurement for the distance between two intersections is available on the (URL-10) and (URL-14) resources. Other guidelines articulate this distance numerically; for instance, (URL-11) specifies 200 to 400 meters between two intersections, Complete Street Design Guidelines City of Los Angeles (2018) indicates a range of 150 to 400 meters, (URL-12) delineates 150 to 300 meters, and (URL-13) states a range of 80 to 300 meters. The disparity in the numbers shown underscores the significance of choosing the optimal distance between crossings to mitigate traffic congestion, enhance safety, and promote multimodal transportation efficiency.

Only two sources reference the specific size within the street design rules, specifically under the sub-criterion of distance between squares. According to (URL-10), the distance is specified as 61 meters, whereas (URL-13) indicates it as 250 meters. No exact size was indicated for this sub-criterion in the other sources examined. The notable disparity between these two numbers signifies a variation in urban patterns, fabric density, and the function of squares within the spatial configuration of cities.

According to the sub criteria of the number of intersections per km (How many junctions per km-one direction), no specific size or value is provided in any of the Complete Street design guidelines. This suggests that the number of intersections is typically decided individually for each situation, considering factors such as the characteristics of the urban network, whether the street is a main or secondary road, land use density, and the traffic requirements of each area; there is no established international standard.

According to the sub criteria of vehicle turning radius, street furniture setback, and elevation changes slope, specific dimensions are provided in all Complete Street design guidelines. However, the sub-criterion "Elevation changes slope" is only mentioned in the (URL-14) source, which states that in exceptional circumstances, the slope of the path can range from 2.5 to 8%, while other references list this range as 2.5–5%.

According to the sub criterion of Street Type, which includes classifications such as Arterial, Collector, Boulevard, and Local streets, it is specifically mentioned in all Complete Street design guidelines. These classifications indicate the functional role of each street in the urban transportation network and are the main basis for determining design elements such as lane width, speed limits, and space distribution among different street users. Details regarding these classifications, including which source considers which type of street is suitable for implementing the Complete Street model, are shown in Table 3.

According to the sub criterion, access to land uses encompasses residential areas, parks, shopping centers, public parking facilities, hospitals, government and administrative offices, educational institutions, industrial zones, factories, restaurants, cafes, shops, cemetery and public transportation systems. Across cities and along each street where the Complete Street model applies, the type and diversity of these uses vary. This disparity arises from the location, urban development patterns, and the role of the street within the urban framework. All Complete Street design guidelines assert that this model must be executed to benefit a substantial segment of the city's populace, since the principal objective of Complete Street is to facilitate convenience, safety, and equitable access for all urban

users. No particular reference to Emergency Accessibility (access for emergency vehicles and unimpeded pedestrian routes) was identified in any of the examined sources.

The sub criteria's of speed limit (km/h), bike path/side, vehicular traffic volume, accessibility for the disabled, traffic calming measures (speed bumps, narrowing, raised crossings), lighting, smart street elements (smart lighting, digital signage, solar benches, charging stations), distance between two pedestrian crosswalks (m), and distance between two accessible ramps (m) are explicitly detailed in all reviewed sources. Table 3 also presents each element separately.

2.5. Comparison between Conventional Street and Complete Street

This step involved an examination of the primary distinctions between conventional street and Complete Street to elucidate the objectives and design principles of complete street. Conventional Streets are predominantly engineered to accommodate motor vehicle traffic, with minimal consideration for pedestrians, bicycles, and other users. Conversely, Complete Street adopts a more comprehensive approach to urban planning, aiming to prioritize all users in its design considerations.

Table 4 delineates the primary distinctions between Conventional Street and Complete Street, highlighting the transition from a solely traffic-centric design to a holistic and equitable design approach.

Table 4. Comparative analysis of Conventional Street and Complete Street

Criterion	Conventional street	Complete street
The general length of the road (km)	-Unlimited, urban infrastructure and traffic circulation route	-Limited, quite planning and design
The general width of the road (m)	-Limited width, vehicle focused	-Limited flexible width, all users
sidewalk width (m)	-Limited, narrow sidewalks	-Limited, optimized sidewalks
Pedestrian crossing length (m)	-Limited, short crossing	-Limited, safe crossing
Width of the bicycle lane (m)	-No lane	-Limited, protected lane 1-2 said
Bicycle parking facilities (Availability and capacity of bicycle parking spaces)	-No parking	-Limited parking (6-10)
Bus line width (m)	-No bus line	-Limited bus line width (3.5m)

Table 4 continued

Bus stop bay length (m)	-limited ,short bus stop length	-limited , extended bus stop length
Car traffic lane	-limited	-limited
Median (m)	-limited ,optional median	-limited , required median
Distance between two bus stops (m)	-Variable spacing	-Optimized spacing
Distance between two junctions (m)	-Irregular spacing	-Standardized spacing
The distance between the squares (m)	-Variable distance	- Planned distance
How many junctions per km (one direction)	-Irregular junction	- Controlled junction
Turning radius (Corner radius for vehicles, impacts pedestrian safety)	-Large radius	-Reduced radius
Benches(m)	-Few benches	-Provided benches
Trees(m)	-	-Its existence is required
Elevation changes slope	2-8%	2-5%
Street type	-Arterial,collector,boulevard,local	-Arterial,collector,local
Access to land uses like (Residential area, park ,shopping mall, public parking , hospital, government and administrative offices , cemetery , educational)	-Limited and fragmented access	-Optimized and safe access
Public Transport Accessibility	-Limited access	-Mandatory access
Speed limit km/h	20-60km/h	40km/h
Bike path /side	-	1-2 bike path
Accessibility for the Disabled	-Limited access	-Fully accessible
Traffic Calming Measures(speed bumps, narrowing, raised crossings)	-Rarely applied	-Actively implemented
Lighting , smart lighting	-Basic lighting	-Smart lighting
Digital signage	-Limited access	-Fully accessible
Pedestrian crosswalks	-Limited access	-Fully accessible
Accessible ramps	-Limited access	-Fully accessible

The criteria included in this table were derived from an analysis of case studies. It is essential to acknowledge that, alongside these requirements, additional design indications and principles are incorporated in the design standards and must be considered while executing the Complete Street model. The case studies were executed utilizing reports published post-project completion, with measurements obtained from Google Earth maps. Table exclusively contrasts the attributes of Complete Street with those of Conventional Street, omitting other street types.

2.5.1. Standard Dimensions and Characteristics Conventional Street and Complete Street

Road dimensions fluctuate based on traffic composition and travel objectives. Primary highways with elevated design speeds are often constructed with additional lanes, broader lane widths, and an increased overall road width, whereas subsidiary or local roads may include fewer lanes, narrower lane widths, and a reduced overall road width.

In the Complete Street model, user safety and the appropriate road type for implementation are of paramount significance, alongside dimensions. The goal of adopting Complete Street is to make sure that pedestrians, cyclists, and various vehicles can safely use the roads.

Because of this goal, the Complete Street model is better suited for Arterial, Collector, and Local streets that are close to current land uses and large populations. The significant pedestrian presence on these routes necessitates secure access for the local populace.

Conversely, expressways/freeways, highways, Arterial Street, and Major Arterial roads are inappropriate for the implementation of the Complete Street model owing to their elevated design speeds, many lanes, and minimal pedestrian traffic. On these road types, the primary emphasis is on the swift movement of intercity traffic, and the establishment of expansive pathways for walkers and bicycles is constrained by safety considerations. The following Table 5 displays the dimensions and measurements of a Comprehensive Street and a Complete Street.

Table 5. Street dimensions: Conventional Street and Complete Street (Source: Kılınçaslan & Elker, 2012)

[illegible]

Table 5 continued

Arterial Street	24-36	3.25-3.5	3	4	50	3
Collector Street	18-24	3-3.25	2-3	4	30-50	3
Local Street	9-18	2.75-3	1-2	4	15-30	1.5

The objective of analyzing the characteristics of Conventional Street and Complete Street is to discern design constraints and possibilities, as well as to evaluate the practicality of integrating Complete Street across different street kinds.

2.6. Case Study: Applicability Complete Street Model in Kabul City (Afghanistan)

Afghanistan is a landlocked, mountainous nation in South-Central Asia, encompassing an area of 652,000 square kilometers (249,900 square miles), and ranks 42nd globally by total area. The nation borders six countries: Pakistan (2,670 km), Tajikistan (1,357 km), Turkmenistan (804 km), Iran (921 km), China (91 km), and Uzbekistan (144 km). Afghanistan holds significant importance due to its strategic position at the intersection of key trade routes (KM, 2011).

“Afghanistan's capital city of Kabul is one of the more complex phenomena in the country today, to which complexity its immense size, fluid borders, and links with national politics and dynamics all contribute” (Foschini, 2017, p.5).

The capital of the Islamic Republic of Afghanistan is Kabul, located in the eastern region of the country and recognized as the most populous city. Kabul, with a history spanning 3,500 years, holds significant importance due to its strategic location in Asia, facilitating links between the east and west, as well as the north and south of the continent. Kabul is the fifth fastest-growing metropolis and the 75th largest city globally, with a population of 3.28 million in 2012 (Ahadi, 2020).

The table below displays the estimated population of Kabul throughout the years. From 2000 to 2024, Kabul's population rose from around 2.40 million to about 4.88 million, reflecting a total increase of over 2.48 million individuals (nearly 103% overall), as reported by Population Stat (2025). The mean yearly growth rate over this interval was around 2.6%. The UN Population Division reports (2025) that Kabul's population has consistently increased over the past twenty years, primarily due to internal migration, the repatriation of

refugees, a comparatively high birth rate, and a youthful demographic, with a substantial percentage of the population under 15 years of age. Figure 8 depicts the population increase in Kabul during the past 24 years. The data indicates a consistent and substantial rise in population, which has been significant in influencing urban growth, infrastructure requirements, and transportation demands. This growing tendency underscores the necessity of sustainable urban planning solutions to tackle the issues posed by rapid urbanization.

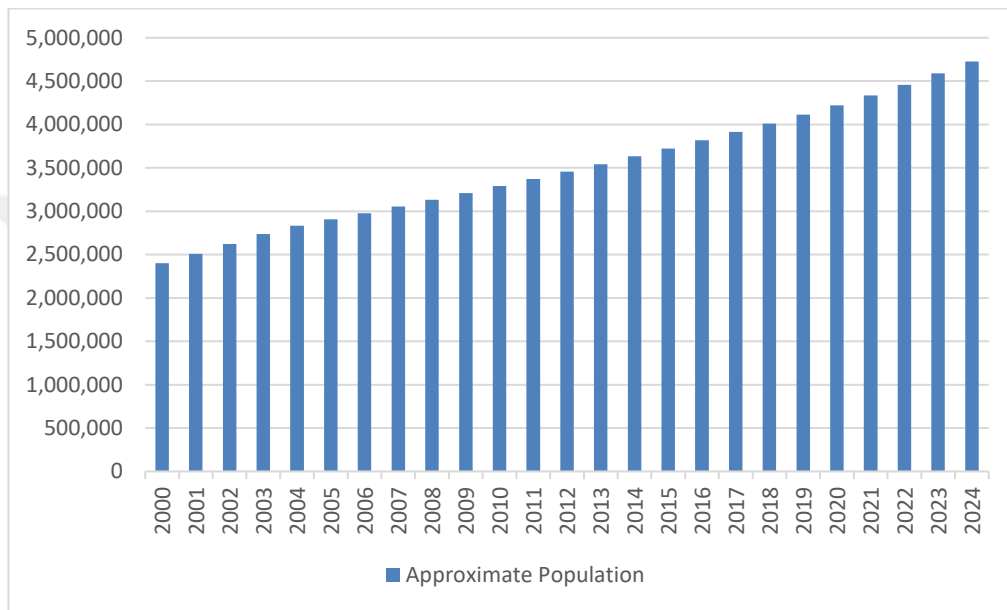


Figure 8. Population of Kabul City (2000-2024), (Source:URL-15)

Kabul became the capital of Afghanistan in 1773 during the rule of Timur Shah, the son of Ahmad Shah Abdali. The urban movement commenced in the 1950s in Kabul, marked by the construction of Kabul University, Maiwand Hospital, and Jaday-e-Maywand Road. Kabul has established four master plans since the inception of urbanization. The initial phase occurred from 1962 to 1987, including an area of 237.8 square kilometers, with a projected population of 0.8 million. With a population of 1.4 million and an area of 299.00 square kilometers, the second one took place in 1970 and was expected to last until 1995. With a population of 2.0 million and an area of 323.3 square kilometers, the third took place in 1978 and was predicted to last until 2002. The latest version, published in 2008, is designed for 4.2 million individuals and remains applicable within governmental organizations (Ahadi, 2020). Figure 9 depicts the geographical position of Afghanistan. These graphic highlights the location of Kabul City, its administrative districts, and the general framework of the city's

master plan. The map offers a lucid depiction of Kabul's physical arrangement and functional zones, facilitating a deeper comprehension of its urban structure and planned growth.

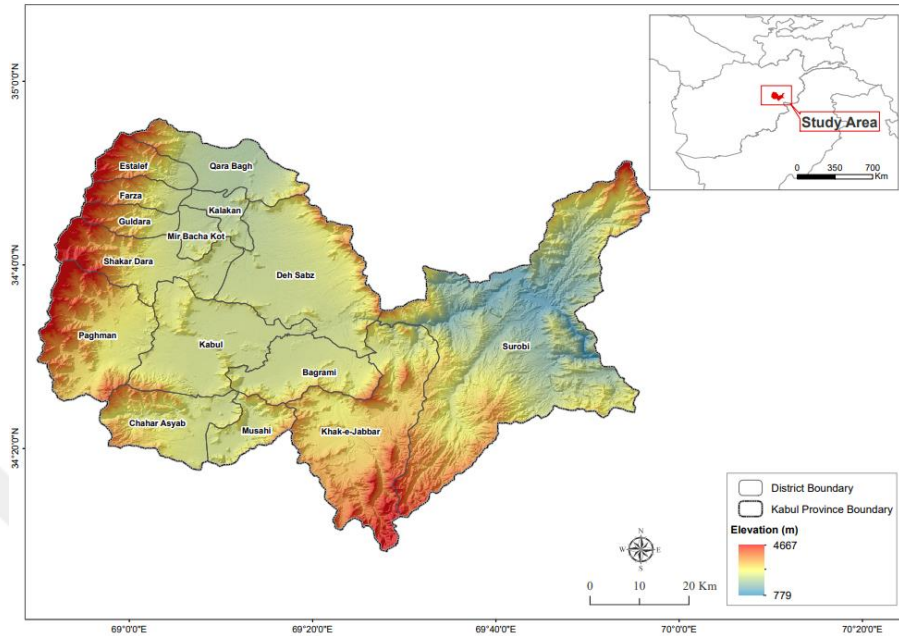


Figure 9. Map of the study area

2.6.1. Road and Transport Overview in Kabul City

Afghanistan is a landlocked, mountainous nation characterized by intricate and challenging topography, lacking direct access to maritime trade routes. This lack of connectivity has significantly affected Afghanistan's sluggish economic development and rendered the nation reliant on neighboring countries (Pakistan and Iran) for commerce, thus obstructing the expansion of its exports. Consequently, the transport network and its advancement have been pivotal components and indicators of social and economic growth in Afghanistan. Transport is vital for socio-economic development, economic growth, poverty alleviation, sustainable agricultural intensification, the distribution of agricultural and industrial products to national consumers, regional and international markets, and the movement of passengers to and from national and international destinations (World Bank ,2019).

As a landlocked nation with an estimated population of over 40 million, distributed throughout a predominantly hilly area of 652,000 square kilometers, and without numerous

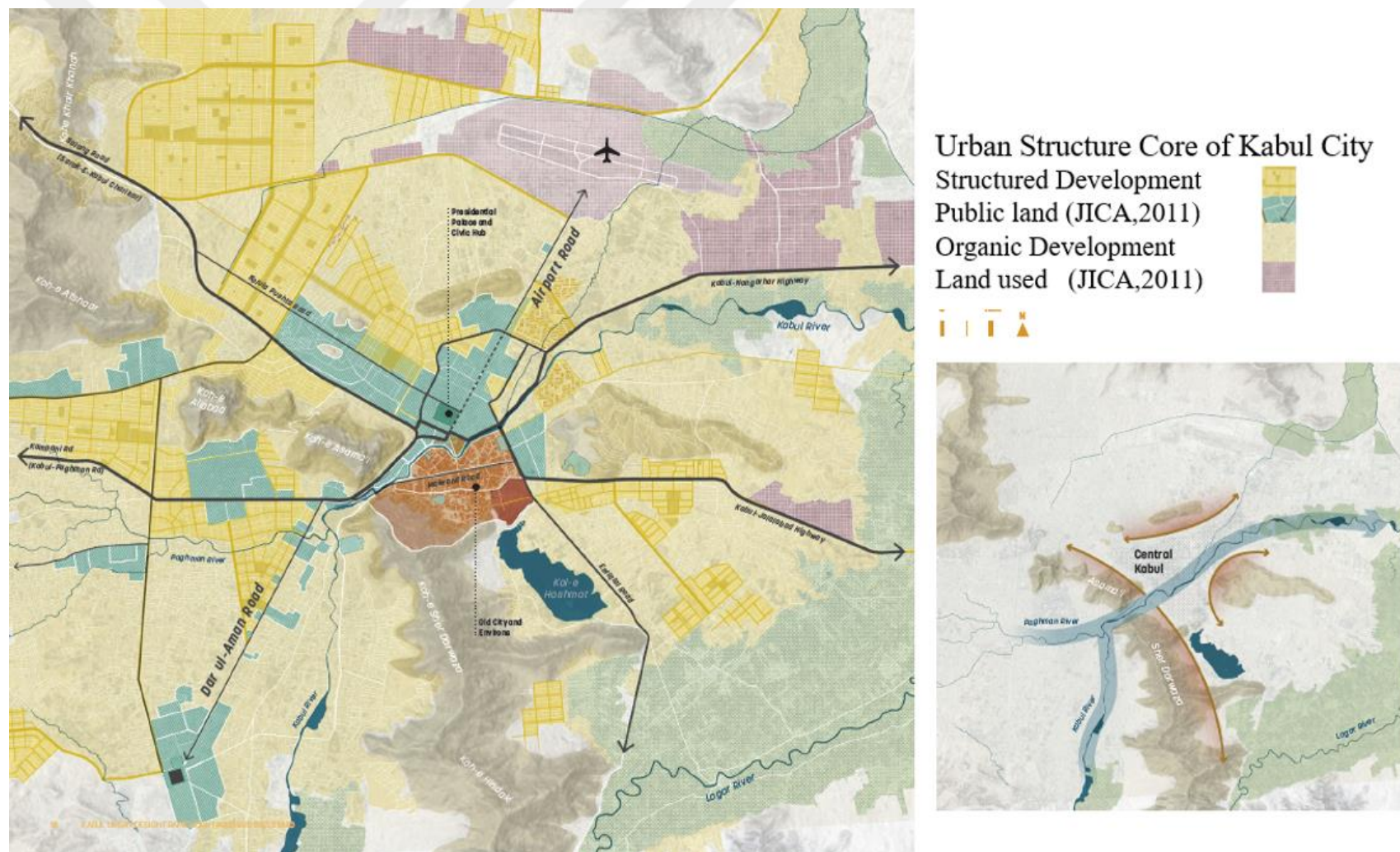
viable alternative transportation options, highways serve as the primary form of travel (World Bank, 2018).

Conversely, Afghanistan's topography, along with its distinctive geopolitical significance as the sole conduit between Central and South Asia, presents a prospective transportation platform capable of transforming existing obstacles into exceptional prospects (World Bank, 2019).

Furthermore, Afghanistan is a resource-rich nation with natural resources valued at over USD 3 trillion. The development, extraction, and distribution of these resources to both domestic and international markets necessitate a dependable and efficient transportation system to enhance government revenue while simultaneously facilitating resource extraction and transit. The advancement of the transport industry is a crucial element for sustainable development in Afghanistan (Asian Development Bank, 2021).

Afghanistan's transportation infrastructure comprises air routes, railways, road transport, and limited inland waterways, restricted to the Amu Darya and its tributaries, with the sole operational inland port located at Shirkhan Bandar. The nation's road infrastructure consists of around 3,300 km of regional highways, 4,900 km of national highways, 9,700 km of provincial roads, 17,000–23,000 km of rural roads, and 3,000 km of urban roads, which includes 1,060 km in Kabul. The Ministry of Public Works (MOPW) manages highways and provincial roads, while the Ministry of Rural Rehabilitation and Development (MRRD) supervises rural road infrastructure. The Ministry of Transport (MOT) is responsible for transport legislation, regulations, and guidelines about transport services for trucks, buses, aircraft, and other vehicles (Asian Development Bank, 2021).

Figure 18 illustrates the road infrastructure of Kabul City. This picture depicts the city's primary, secondary, and tertiary road networks, highlighting the principal transportation arteries and their interconnections throughout various metropolitan sectors. It is a summary of how the road infrastructure facilitates mobility, accessibility, and connection in Kabul.



2.7. Modes of Urban Public Transportation and Their Challenges in Kabul City

Public transportation services have employed a variety of vehicles since 2001, including regular buses, minibuses, minivans, shared private cars, taxis, and motor-rickshaws. The conditions are predominantly deplorable due to the presence of antiquated fleets and inadequate upkeep (Asian Development Bank, 2017).

The public transport system in Kabul comprises mostly two categories: formal and informal public transport. The term refers to a government-managed and regulated public transportation service. The Milli Bus Enterprise is the sole government-operated transportation service in the city, whereas informal public transit is mostly administered by local private businesses or people and may not comply with official standards. The Milli Bus Enterprise constitutes around 10% of the city's public transportation journeys overall (JICA, 2011).

In many areas of the city where formal public transportation is lacking, informal public transport has been providing on-demand services that significantly enhance mobility options for citizens and account for over 90% of mass transportation services in Kabul. These services are prevalent in areas where traditional bus service is unavailable, unreliable, inconsistent, or nonexistent. Informal public transportation is prevalent in Kabul, providing passengers with a cost-effective and efficient way of transportation. The subsequent sections address the information and present status of both formal and informal types of public transit (JICA, 2011).

The amalgamation of public transportation services is crucial for the execution of Complete Street with a human-centric methodology. Streets constructed according to the Complete Street model emphasize safety, accessibility, and mobility for all users, encompassing walkers, bikers, and public transit riders. The dependence on informal transit and the restricted reach of the Milli Bus Enterprise in Kabul underscore the necessity for multimodal solutions that can integrate various transportation methods. Enhancing infrastructure for buses, shared taxis, and other transport modalities can improve equal access, alleviate congestion, and promote sustainable urban mobility. Well-designed streets, including designated bus lanes, secure pedestrian crossings, and accommodations for informal transport vehicles, may guarantee that the complete transportation network operates harmoniously, advancing the human-centered objectives of Complete Street model.

2.7.1. Milli Buses

In Afghanistan, urban public transport services have been operating for sixty years, provided by both the government and the private sector, in a rudimentary, non-standard, and inconsistent manner, primarily concentrated on Kabul city. The urban bus service in Kabul comprises 54 routes originating from 10 terminals across the city. The bus lines predominantly originate from the city center and expand into the suburbs. The cumulative length of these bus services is 473 km, resulting in an average service length of around 8.8 km per route. The density of served lengths is 160 m/ha, approximating the average density of arterial roadways inside the city (Asian Development Bank, 2017). The inaugural public transportation service was started in 1960. Following 14 years of inadequate services under the Ministry of Finance, the company was reassigned to the Ministry of Transportation and rebranded as Tasadi Milli Bus (Milli Bus Enterprise) (JICA, 2011). In the 1980s, Milli Bus Enterprise partially fulfilled the public transportation demands of Kabul's people. At that time, Enterprise operated over 1,000 conventional buses and around 80 operating trolleybuses, primarily in Kabul city and 19 other provinces (JICA, 2011). The protracted civil war led to the scrapping of most public transport buses and trolleybuses, severely damaging the organization, resulting in the loss of experienced personnel, and since then, insufficient attention has been devoted to the urban public transport system and its restoration. Figure 11 depicts the existing bus network of Kabul City. The picture illustrates the primary bus lines and their links to significant destinations across the city. This network is essential for daily urban travel and underpins the future advancement of more sophisticated public transportation systems.



Figure 11. Current bus network, (Source: URL-19, p.37)

Reports indicate that following the conclusion of the Taliban's previous administration in 2001, merely 50 buses were operational in Kabul. Following the establishment of the new government, the rehabilitation and reconstruction of the urban transport sector were accelerated, moving towards corporatization. In 2003, India initially supplied 269 buses, committing to provide a total of 1,000 over a decade. JICA facilitated the acquisition of 115 buses and the building of 252 bus stations along Kabul's urban routes and at the airport from 2003 to 2004. In 2005, Pakistan contributed 35 buses, whereas Uzbekistan provided 25 buses to Milli-bus. In 2007, Milli Bus Enterprise possessed a total of 1,050 buses, reflecting a significant expansion in their fleet since 2001. In 2014, it was claimed that numerous buses were non-operational due to disrepair, and as most were imported, the absence of replacement parts and an adequate maintenance system impeded their repair effort (JICA, 2018).

As part of the National Institution Building Project of the United Nations Development Fund, a maintenance department was created within Milli Bus Enterprise, where officers and engineers received training in bus maintenance and other areas, including driver training, provided by the Indian automotive company Tata Motors. In 2018, the Indian government committed financial aid of USD 2.87 million to Afghanistan's transport infrastructure for the construction of an effective maintenance system, the repair of 350 public buses, and the donation of additional new buses. In 2018, the Milli Bus firm possessed a total of 1,380 buses, marking the highest figure since 2001; nevertheless because of inadequate

maintenance, fewer than 40 percent were operational. By the conclusion of 2020, it was shown that over 800 buses provided in previous decades have remained predominantly unused due to maintenance complications. The Milli Bus enterprise's inadequate performance, poor coordination, mismanagement, and the absence of effective operational policies and procedures, coupled with a deficient maintenance system, have hindered improvements in Kabul's transportation situation (JICA, 2018). Figure 12 illustrates the total quantity of buses in Kabul City over a two-decade span, differentiating between the overall number of buses and their functional distribution. The orange bars denote the overall count of buses, whereas the blue bars signify the quantity of operational buses, spanning from the year 2000 to 2020.

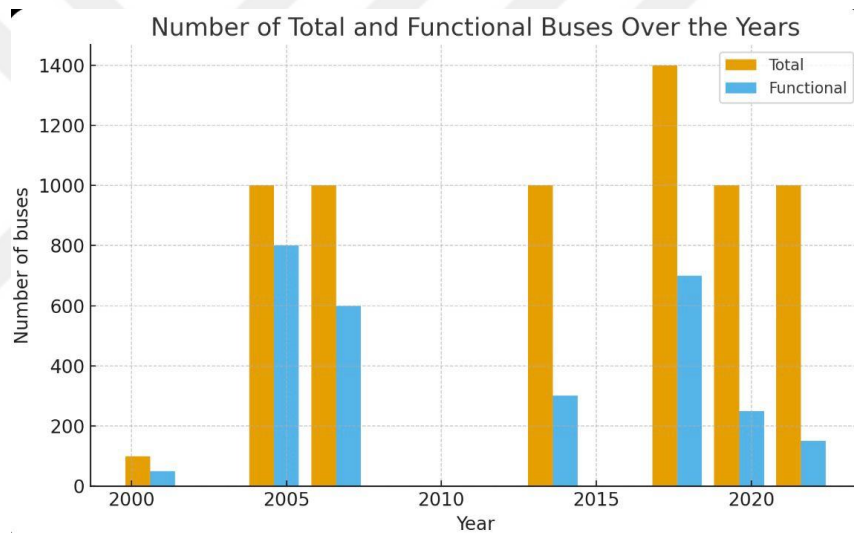


Figure 12. Total and Function Buses Number over 20 years

Figure 12 shows the comprehensive expansion and functional allocation of buses in Kabul city. The orange columns represent the entire bus fleet, while the blue columns depict the buses that have been active in the past twenty years. This graphic image highlights the patterns of public transport growth and capacity improvements over the past twenty years.

In 2020, KM (Kabul Municipality) leadership initiated the refurbishment and deployment of former military buses as a mode of public transportation for the citizens of Kabul. KM commenced operations with merely 6 buses, with a projection to ultimately deploy 200 buses across 16 routes throughout the city. This proposal was ineffective, as the

military buses were too antiquated to be restored and utilized as public transit in the city (Islam, 2023).

2.7.2. Private Buses

The private sector undoubtedly plays a significant and essential role in delivering public transit services. According to the 2018 MOT data, 17 private enterprises and transportation associations registered 2,475 vehicles, while 7 private taxi companies registered 4,123 cabs. Nevertheless, the number of vehicles actively running in the city was significantly lower than the number registered with the MOT (JICA, 2018). No statistical data exists regarding the precise number of private buses currently operating in Kabul out of the 44,924 that were registered in 2020. In addition to these private and irregular public buses, other private urban transportation businesses were also established. In 2008, the Yusuf City Transportation Company, an individually owned bus enterprise, established itself in Kabul. The company engaged in a contract with German Mercedes-Benz to import 200 buses to Kabul city, of which a total of 80 vehicles arrived in Kabul during 2008–2009 (Islam, 2023).

2.7.3. Minibus

A substantial number of private vans operate independently on nearly all routes, functioning as minibuses with a maximum capacity of 15 people. We expect the Kabul police department to oversee them, but they currently lack an adequate system and sufficient facilities. Their mobility is unrestricted throughout the city, except for central or VIP areas, often referred to as the green zone. The fare is similarly economical, ranging from 10 to 20 Afs for each passenger (JICA, 2018). Despite being classified as public transit vehicles, the majority operate independently or are controlled by a firm without oversight from the traffic department. There are “small vans” with a capacity of 10 passengers that possess private license plates and transport passengers unlawfully. These small vans serve as a primary mode of public transportation throughout Kabul city, operating without restriction or designated routes established by traffic or other pertinent authorities (JICA, 2018).

2.7.4. Taxis and Private Small Cars

In 2020, the total number of registered taxis nationwide was 192,400, according to the Afghan Statistical Yearbook 2020. Furthermore, the National Statistics and Information Authority (NSIA) reports that approximately 1,183,748 privately owned compact vehicles are registered throughout Afghanistan, with over 600,000 registered alone in Kabul as of 2020. While precise data on the number of private illegal or informal passenger vehicles and official taxis in Kabul City is unavailable, estimates suggest the figure exceeds 100,000. The nationwide registered total of such cabs reached 29,131 in 2002. Consequently, a significant increase has occurred, resulting in an annual growth rate of 16–20% (JICA, 2018).

2.7.5. Online Taxi Services

Taxi services an acronym derived from a Persian term meaning “Carry,” commenced operations as a ride-hailing online taxi service in 2018. The primary objective was to link drivers with passengers via a mobile application. BBR functioned as an online, user-friendly, and dependable e-commerce platform. BBR's online taxi once provided a 24-hour taxi service in Kabul, employing over 500 active drivers. People in the city regarded it as the safest transit alternative. Furthermore, BBR provides daily and hourly automobile rentals with three distinct categories: Economy, Comfort, and Business (JICA, 2018). 24/7 Cab Services: Afghan Logistic and Transportation Company has offered basic cab and airport drop-off/pick-up services in Kabul since 2008. It provided 24-hour services with both standard and armored cabs, accessible by telephone or mobile application. Other comparable companies and mobile applications, such as Faxe, Zood, and Echo, operated similarly to BBR (JICA, 2018). The BBR and other online cab services ceased operations due to the overall decline in the country's economic conditions, rendering them less effective and profitable. The second reason was that private automobiles, used as public transit, were readily accessible, allowing passengers to hail them at various locations throughout the streets without waiting for 10–15 minutes. The third factor was the public's limited smartphone usage, unfamiliarity with online cab services and applications, and insufficient internet availability on smartphones (JICA, 2018). Figure 13 delineates the distinct forms of public transit functioning in Kabul City. The graphic presents a comprehensive overview of the many service types offered, encompassing buses, minibuses, and other shared

transportation modes, thus emphasizing the diversity and organization of urban public transit in Kabul.



Figure 13. Categories of public transit in the city of Kabul (Source: URL-16)

2.7.6. Public transportation uses and preferences in Kabul

In 2022, the Kabul Transport Company (KM) executed a study entitled "Understanding Public Transport Usage and Preferences in Kabul" to evaluate the existing condition of public transport and pinpoint critical areas for enhancement. This survey encompassed 7,314 people, both in-person and online, to guarantee a substantial and representative sample. The study results elucidated Kabul's public transportation scenario, revealing that 62.8% of respondents predominantly utilized the bus for their daily commutes to work. Fewer than 15% of the population utilized shared vans or minibuses, while just 8.5% employed taxis as their principal means of transportation. 10.3% of travelers in Kabul utilized private automobiles, reflecting their considerable reliance on public transit (Almatar,2023).

This survey also investigated the challenges encountered by public transport users in Kabul. A notable 52.6% of participants saw congestion as a primary concern that renders travel unpleasant and occasionally hazardous. Furthermore, 47.9% of participants indicated apprehension regarding the dependability and punctuality of bus services, frequently resulting in delays and interruptions to their daily routines. 38.2% of respondents expressed concerns about theft and harassment (Almatar,2023).

Additional issues were insufficient real-time data on bus timetables and routes, inadequate infrastructure at bus stops, and a deficiency in connectivity across various transit modes. 68.4% of respondents endorsed the addition of extra buses as a recommended measure to alleviate congestion and enhance service frequency. 54.3% of respondents proposed a key recommendation: establishing bus routes particularly intended to expedite travel and minimize delays. Increased security measures on public transportation, including the addition of more security personnel and surveillance cameras, were a significant worry for 45.7% of respondents. Furthermore, 42.1% of respondents indicated the necessity for more seamless integration across various public transit modalities, encompassing the establishment of a unified ticketing system (Al- Malki, 2021).

The public transit capacity in Kabul is inadequate to accommodate the expanding urban population. Many transportation networks depend on private automobiles and tiny minibuses, which are inadequate for everyday transit and exacerbate congestion and delays owing to a lack of systematic planning. Transportation rates are sometimes established irregularly and without stringent oversight, resulting in public discontent and a deficiency in service coordination. Nonetheless, there exists a pressing necessity to establish sustainable public transportation systems, encompassing frequent buses, exclusive lanes, and intelligent payment mechanisms, to enhance affordability, safety, and accessibility for individuals. Table 6 illustrates the capacities of various modes of transportation.

Table 6. Capacity and fare price of transportation modes in Kabul City

Transportation mode	Available seats	Used Seats	Fare price per passenger in AFG.2004	Fare price per passenger in AFG.2009	Fare price per passenger in AFG.2024
Millie Bus/ Private Bus	52	70	2	5	10
Millie Bus Small Bus/ Private Bus	32	50	5	5	10
Taxi share	5	8	10	20	25
Minibus	8	14	7	10	10
Rickshaw	4	7		5	10
Taxi	5	2	10km-70Afg	10km -120Afg	10km-150Afg

(Source: JICA,2011; KM,2024)

2.8. Current and Future Mobility Demand (Trip Generation)

The frequency of daily trips in Kabul will increase significantly in line with population growth. Given the growing demand for mobility, creating extensive and efficient transportation infrastructure is a fundamental necessity. Additionally, as socio-economic conditions improve, the number of daily trips taken by each person increases. As a result, more citizens will commute daily between different parts of the city for employment, education, recreation, and other activities.

Since Kabul has 22 urban districts, predicting the population of these districts in the coming years has been the basis for analyzing travel demand. Region 1, as one of the analytical regions, includes parts of the eastern areas of the city. The purpose of examining this region is to analyze the effects of eastern expansion and its rapid population growth on the increase in travel production. Currently, the rate of trip generation in this area has increased compared to the past, indicating greater pressure on the existing transportation network.

The eastern expansion of the city and the increasing population are considered among the most important factors influencing the projected increase in travel. Table 7 shows the projected travel growth trend based on population increases in the coming years. These projections were initially prepared by the Kabul Urban Development Framework (KUDF) in 2018 and reflect the city's medium- and long-term growth and travel demand in different areas.

It is necessary to point out that the reason for mentioning this table is to demonstrate the importance of the population in the selected areas for implementing the complete streets model. The streets examined in this study are in districts 3, 4, and 5 of Kabul city. Therefore, knowing the current and projected population of these areas is of great importance.

Implementing the complete streets model is only effective and justified when a significant portion of residents can benefit from its advantages and services. For this reason, providing this table helps to show that regions 3, 4, and 5 have high and growing populations, and implementing this model in these areas could have the greatest impact.

Table 7. Population-based trip generation estimates

Current Planning Scenario				Medium-Term Planning Scenario			Long-Term Planning Scenario		
	Estimated Total Population	Trip Gen Rate Trips/day/person	Estimated Trips/day	Estimated Total Population	Trip Gen Rate Trips/day/person	Estimated Trips/day	Estimated Total Population	Trip Gen Rate Trips/day/person	Estimated Trips/day
1	57,000	4.7	271,000	144,000	4-5	720,000	154,000	4-5	770,000
2	74,000	3.1	230,000	242,000	3-4	793,000	252,000	3-4	820,000
3	297,000	1.7	513,000	617,000	2-3	1,600,000	624,000	2-3	1,620,000
4	348,000	1.5	257,000	446,000	2-3	1,015,000	462,000	2-3	1,160,000
5	419,000	1.3	556,000	560,000	1-2	1,116,000	569,000	1-2	1,130,000
6	317,000	0.6	187,000	488,000	0.5-1	433,000	500,000	1-2	600,000
7	49,000	0.5	24,000	65,000	0.5-1	48,000	67,000	1-2	60,000
8	125,000	0.6	78,000	165,000	0.5-1	155,000	170,000	1-2	187,000
9	81,000	1.1	86,000	106,000	1-2	169,000	110,000	1-2	174,000
10	205,000	1.5	302,000	385,000	2-3	852,000	396,000	2-3	912,000
11	235,000	0.9	220,000	573,000	1-2	806,000	581,000	1-2	930,000
12	237,000	0.5	137,000	397,000	1-2	489,000	403,000	1-2	726,000
13	193,000	0.2	44,000	258,000	0.5-1	89,000	261,000	1-2	157,000
14	221,000	0.8	173,000	258,000	1-2	309,000	266,000	1-2	312,000
15	42,000	1.6	367,000	263,000	2-3	557,000	783,000	2-3	1,957,000
16	173,000	0.4	65,000	239,000	0.5-1	227,000	379,000	1-2	492,000
17	255,000	0.3	66,000	373,000	0.5-1	163,000	412,000	1-2	329,000
18	290,000	0.2	53,000	418,000	0.5-1	92,000	341,000	1-2	273,000
19	262,000	3.8	998,000	334,000	4-1	2,592,000	654,000	4-5	2,750,000

Tabel 7 continued

20	21,000	0.9	19,000	647,000	1-2	151,000	144,000	1-2	216,000
21	75,000	0.5	36,000	107,000	1-2	274,000	166,000	2-3	365,000
22	30,000	0.3	10,000	564,000	0.5-1	292,000	1,119,000	1-2	671,000
Total	4,074,000		4,660,000	7,550,000		12,940,000	8,810,000		13-18,000,000

*Based on potential population growth to 7.5 million people

** Based on potential population growth to 8.8 million people

Estimated 2017 Total Daily Trips = 4,660,000 trips /d

Estimated Long-Term Scenario Total Dailly Trips = 13-18,000,000 trip/d

Current Low-Range Trip- Gen Rate 0.2 trips/ person

Current High- Range Trip-Gen Rate 4.8 trips/ person

Based on JICA 2011

Long - Term Scenario 1.0-3.0 trips/ person

Long - Range Trip- Gen Rate

Long- Term Scenario 3.0-5.0 trips/ person

High- Range Trip- Gen Rate

Source:(KUDF, 2018, p.41)

2.9. Selection of a Potential “ Complete Street Model ” Pilot Project Road

Seven example streets have been chosen for the research and implementation of the Complete Street model in Kabul city for the following reasons: The streets exhibit a diverse array of land uses, encompassing residential, commercial, public services, educational, recreational, and green areas, enabling a thorough analysis of accessibility and interaction among various users. The differing traffic densities (high, medium, and low) on these streets present an exceptional chance to assess the efficacy of the Complete Street model in practice. The existence of safety concerns for pedestrians and cyclists on certain streets presents an opportunity for redesign and enhancement of safety conditions, while the current infrastructure, including pedestrian and bicycle pathways, public parking, and street furniture, or the potential for their inclusion, renders the model viable and executable. Furthermore, the availability of public transit and the closeness of streets to bus stops present a chance to enhance public accessibility, while population density and real users create favorable conditions for examining traffic behavior and human interactions. These streets are analogous to successful worldwide benchmarks for construction and dimensions, and their urban landscape and aesthetic allure foster a conducive atmosphere for pedestrian activities and social interactions. The selection of these seven streets was primarily based on technical and economic viability, swift enhancement, and the coverage of various city districts, including the center, suburbs, and both business and residential zones. Figure 14 depicts the seven designated streets recommended for the execution of the Complete Street model in Kabul City.

Afghanistan - Kabul City Road

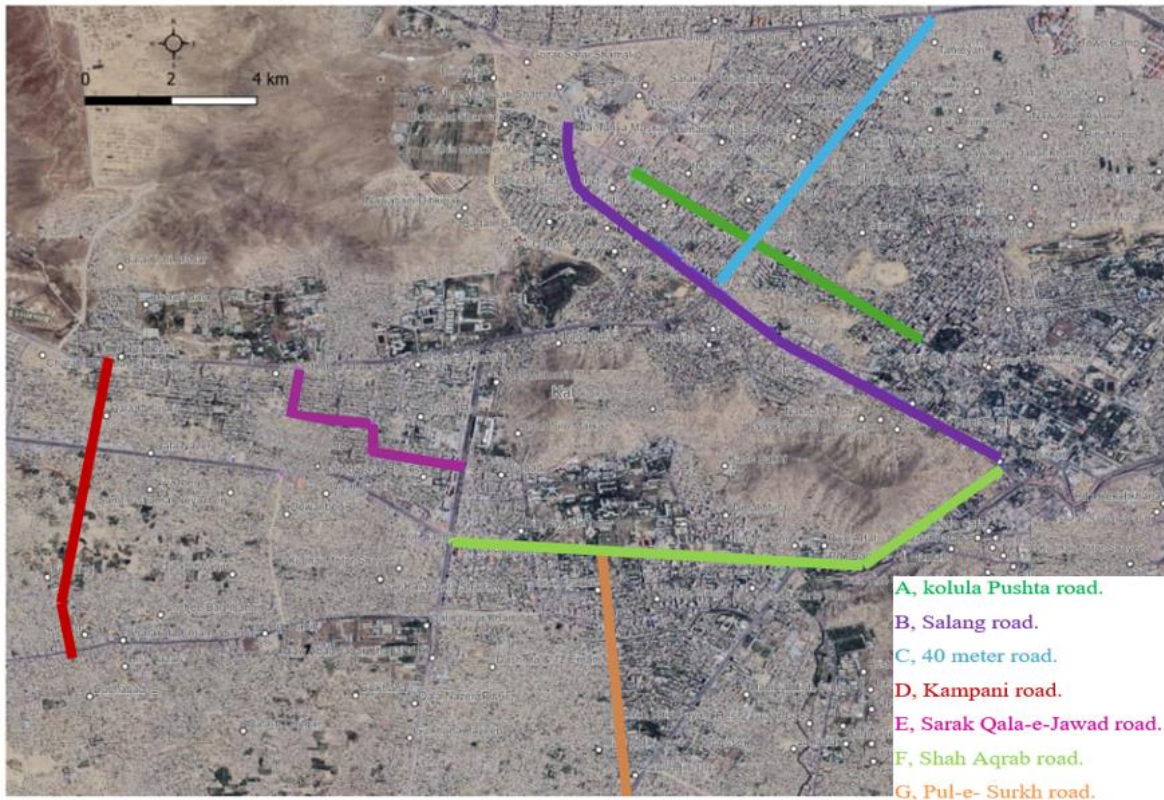


Figure 14. Seven selected streets in Kabul city, (Source: Google Earth Pro imagery, 2025)

The streets depicted in Figure 14 are succinctly introduced in the subsequent section in spatial order sequence.

Street A (Kolula Pushta Road), starting from Torabaz Khan and ending at Market Square, measures roughly 4 kilometers in length and has an average width of 28 meters. The width of sidewalks measures around 4 meters, although pedestrian crossings span the full 28-meter width of the road. The distance between two crossroads is roughly 210 meters, whereas the distance between two significant squares along the corridor is around 150 meters, yielding an average of four junctions per kilometer in one direction. The turning radius for automobiles is approximately 6 meters, facilitating sufficient vehicular maneuverability but presenting certain safety risks for pedestrians. Trees are typically situated 0.5 meters from the pedestrian pathway, although benches and other street furnishings exhibit inconsistent placement. The elevation change reflects a gradient of 0.4% every 100 meters, indicating mostly level terrain appropriate for walking and cycling activities.

Spatial studies and measurements using Google Earth map indicate that Torabaz Khan Street serves mostly as an arterial route linking essential metropolitan districts. Due to the current situation in Afghanistan, all measurements were done online using Google Earth Pro measuring tools. Access to significant land uses, like parks, retail malls, hospitals, and public parking facilities, is restricted, but access to restaurants, cafés, and small commercial establishments is moderate. Adjacent roadways host most of the government and administrative offices, as well as educational institutions. The speed limit varies from 30 to 50 km/h, and the volume of motor traffic is notably high due to the area's mixed-use nature. No designated bicycle lanes or bus facilities exist, and traffic calming measures, such as elevated crossings or speed bumps, are lacking. Street lighting comprises traditional systems, lacking any indications of intelligent street components such as digital signs, smart lighting, or solar benches. The mean distance between two pedestrian crosswalks is around 120 meters, and the provision of accessible ramps is variable, leading to insufficient accessibility for those with disabilities and restricted access to public transit. Figure 15 depicts Street A, showcasing its existing physical and geographical attributes.

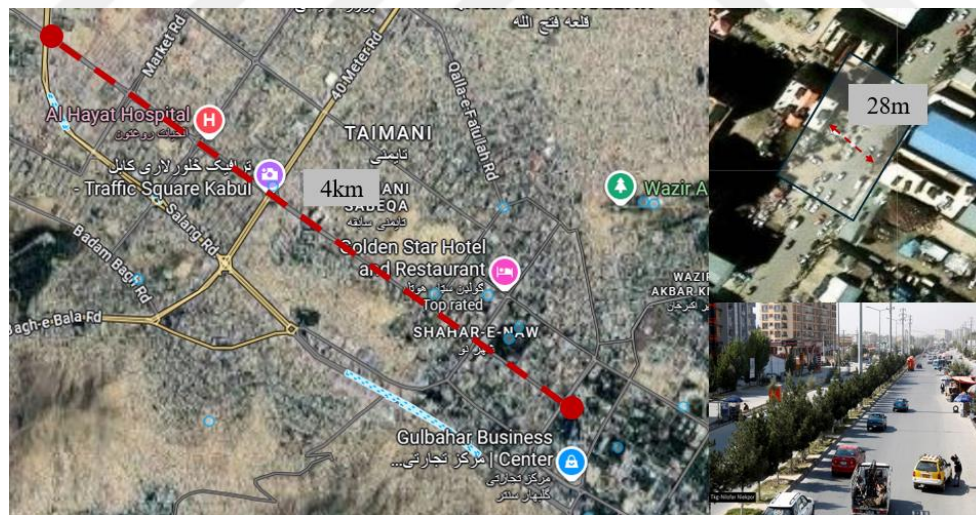


Figure 15. Street A, (Source: Google Earth Pro imagery, 2025)

Street B (Salang Road), the thoroughfare between Zarnegar Park and Parwan 3, measures roughly 4 kilometers in length and has an average width of 34 meters. The sidewalks are approximately 3 meters wide, and the pedestrian crossings extend around 30 meters, aligning with the whole width of the road. The distance between two intersections is

around 400 meters, whereas the distance between two significant squares along the corridor is about 66 meters, yielding an average of two junctions per kilometer in one direction. The turning radius for automobiles is 5 meters, facilitating easy maneuvers but somewhat compromising pedestrian safety. Benches are situated around 2.5 meters from the pedestrian pathway, but trees are often planted 0.5 meters apart, resulting in a balanced, although suboptimal, pedestrian environment. The gradient along the roadway is around 0.5% every 100 meters, signifying a gentle incline conducive to walking and cycling.

Measurements and spatial analyses performed using Google Earth Pro indicate that this corridor serves as a vital thoroughfare connecting key commercial and administrative regions of Kabul, given the prevailing circumstances in Afghanistan. The route comprises six vehicular traffic lanes and features a 3-meter-wide median, facilitating improved traffic flow and enhanced directional separation. Nonetheless, the roadway is devoid of designated bicycle lanes and official bicycle parking facilities, thus constraining its multimodal capacity. The bus stop bay is roughly 20 meters in length, whereas the average separation between two bus stops is about 257 meters, somewhat surpassing international norms that advocate for shorter distances to improve accessibility. There are no designated facilities for handicapped individuals, and the absence of traffic calming measures, such as speed bumps or elevated crossings, diminishes overall pedestrian safety.

The street offers moderate accessibility to residential zones, public parks, and local commercial establishments such as restaurants, cafés, and small shops, whereas its proximity to shopping malls, hospitals, government offices, and educational institutions is comparatively limited. The speed limit varies from 40 to 50 km/h, and the amount of vehicular traffic is often elevated, indicative of the corridor's mixed-use nature. Conventional illumination is present; however, smart street features such as digital signs, intelligent lighting systems, or solar benches have yet to be deployed. The average distance between pedestrian crosswalks is 250 meters, and the lack of systematic distribution of accessible ramps impedes inclusive mobility. Therefore, while the street exhibits robust structural integrity and urban connection, it currently fails to conform to the fundamental tenets of the Complete Street model, especially in terms of inclusion, safety, and multimodal accessibility. Figure 16 depicts Street B, showcasing its existing physical and geographical attributes.



Figure 16. Street B, (Source: Google Earth Pro imagery, 2025)

Street C (40-meter Road), commencing at Baraki Square and concluding at Shahid Square, spans roughly 3 kilometers in length and possesses an average width of 34 meters. The walkways are around 3 meters in width; however, the pedestrian crossings span 30 meters, aligning with the overall road width. The distance between two crossroads is typically 313 meters, whereas the distance between two significant squares along the corridor is around 72 meters, yielding an average of three junctions per kilometer in one direction. The turning radius for vehicles is 4 meters, facilitating sufficient maneuverability for automobiles while offering modest safety for pedestrians at intersections. Benches are positioned around 2.5 meters from the pedestrian pathway, whereas trees are situated 0.5 meters away. The elevation variation is around 0.3% every 100 meters, signifying predominantly level ground conducive to walking and cycling.

This street serves as a principal thoroughfare, linking essential metropolitan zones and enabling traffic movement along a significant corridor. It comprises six vehicular traffic lanes and a 2.5-meter-wide median, facilitating lane segregation and efficient vehicle flow. The bus stop bay measures around 25 meters in length, with a distance of about 240 meters between two bus stops, ensuring modest public transit accessibility. Despite the absence of designated bicycle lanes or parking facilities, the route facilitates overall urban mobility. Traffic calming measures, like elevated crossings and speed bumps, are absent, and conventional street lighting is utilized, lacking smart street features such as digital signs, intelligent lighting, or solar benches. The average distance between two pedestrian crosswalks is 300 meters, and the inconsistent distribution of accessible ramps leads to

restricted accessibility for those with disabilities. The speed limit on the street ranges from 40 to 60 km/h, indicative of the substantial urban traffic flow. Thus, although Street C exhibits robust structural capacity and urban connection, aspects of inclusiveness, multimodal transportation, and pedestrian safety are deficient, underscoring opportunities for enhancement in accordance with the Complete Street model. Figure 17 depicts Street C, showcasing its existing physical and geographical attributes.



Figure 17. Street C, (Source: Google Earth Pro imagery, 2025)

Street D (Kampani Road), commencing from the sixth alley of Khushal Khan and concluding at Sark Barchi, has a length of roughly 3.5 kilometers and possesses an average width of 30 meters. The walkways are around 4 meters in width, while the pedestrian crossings span 30 meters, aligning with the overall road width. The distance between two crossroads is roughly 213 meters, while the distance between two main squares along the corridor is around 200 meters, yielding an average of five junctions per kilometer in one direction. The turning radius for automobiles is 6 meters, facilitating smooth vehicular flow but potentially compromising pedestrian safety in congested places. Benches are often positioned 3 meters from the pedestrian pathway, whereas trees are situated 0.5 meters away.

The gradient along the roadway is around 0.6% every 100 meters, signifying a modest incline along the path.

Street D primarily serves as a local collection route, accommodating traffic in a largely residential zone. It comprises four automobile traffic lanes; however, there are no designated bicycle lanes or bicycle parking facilities available. Access to public transit is restricted, and the roadway does not have bus stop bays, nor are there any traffic calming measures, such as speed bumps or elevated crossings, implemented. Conventional street lighting is present; however, no intelligent street components such as digital signs, smart lighting, or solar benches have been installed. The interval between pedestrian crosswalks is around 250 meters, and accessible ramps are not uniformly available, so restricting movement for those with disabilities. The speed restriction on this roadway varies from 20 to 40 km/h, indicating its predominantly residential nature and reduced traffic volume. Although Street D possesses sufficient width and a predominantly level topography, it still lacks numerous essential components of the Complete Street model, especially in terms of multimodal transportation, inclusiveness, and pedestrian safety. Figure 18 depicts Street D, showcasing its existing physical and geographical attributes.



Figure 18. Street D, (Source: Google Earth Pro imagery, 2025)

Street E (Sarak Qala-e- Jawad), commencing from the third Khushal Khan road and concluding at University Road, spans roughly 2.5 kilometers in length and possesses an average width of 26 meters. The walkways are around 3 meters in width, while the pedestrian crossings span 24 meters, almost aligning with the overall road width. The distance between two crossroads is roughly 265 meters, whereas the distance between two main squares along the corridor is around 166 meters, yielding an average of four junctions per kilometer in one direction. The vehicle's turning radius is 4.5 meters, facilitating easy maneuverability without modestly affecting pedestrian safety. Trees are situated 0.5 meters from the pedestrian pathway, despite the absence of designated street seats. The gradient along the roadway is around 0.4% every 100 meters, indicating a predominantly level environment conducive to walking and cycling.

Street E serves mostly as a local/collector thoroughfare, linking residential neighborhoods, certain business establishments, and a university district. The roadway comprises four vehicular traffic lanes and a 2.5-meter-wide median, facilitating the separation of opposing traffic directions. The roadway is devoid of designated bicycle lanes, bicycle parking amenities, and bus stop bays, hence constraining its multimodal transportation capabilities. Access to public transit is limited, and traffic calming interventions, such as speed bumps or elevated crossings, are nonexistent. Conventional street lighting is present; however, there are no intelligent street components, such as digital signs, smart lighting, or solar benches. Accessible ramps are unevenly located, impairing mobility for those with disabilities. The speed restriction varies between 30 and 50 km/h, indicating a combination of residential and institutional use. Street E exhibits structural adequacy and urban connectedness; yet, it is deficient in inclusiveness, multimodal transit, and pedestrian safety, which are essential tenets of the Complete Street model. Figure 19 depicts Street E, showcasing its existing physical and geographical attributes.



Figure 19. Street E, (Source: Google Earth Pro imagery, 2025)

Street F (Shah Aqrab) spans roughly 5.40 kilometers in length and has an average width of 26 meters, commencing from Kote Sangi Square and terminating at the three subterranean roadways. The sidewalks are around 3 meters in width, whereas the pedestrian crossings span about 20 meters, roughly corresponding to the road width. The distance between two crossroads is typically 98 meters, while the distance between two main squares along the corridor is roughly 160 meters, yielding an average of six junctions per kilometer in one direction. The turning radius for automobiles is 6 meters, facilitating smooth vehicular circulation, while benches are located 2.5 meters from the pedestrian route and trees are situated 0.5 meters away. The gradient along the roadway is around 0.3% every 100 meters, signifying a predominantly level landscape suitable for walking and cycling.

The route comprises four vehicle traffic lanes and a 4-meter-wide median, facilitating lane separation and traffic management. Bus stop bays are around 25 meters in length, with bus stops situated roughly 250 meters apart, ensuring modest accessibility to public transit. Although essential urban infrastructure exists, the route is devoid of designated bicycle lanes, bicycle parking amenities, and intelligent street features, such as digital signs, smart

lighting, or solar benches. Traffic calming measures, such as speed bumps and elevated crossings, are lacking, and while standard street lighting is present, it lacks modern smart features. The distribution of accessible ramps is variable, hence restricting movement for those with disabilities. The speed restriction varies between 40 and 50 km/h, indicating its function as a principal arterial route. Street F has robust structural and functional capabilities for urban traffic; nonetheless, it necessitates more improvements in multimodal transit, inclusiveness, and pedestrian safety to completely conform to the Complete Street model.

Figure 20 depicts Street F, showcasing its existing physical and geographical attributes. Street F functions as a principal thoroughfare, enabling the movement of traffic between significant metropolitan districts and linking residential, commercial, and educational sectors.



Figure 20. Street F, (Source: Google Earth Pro imagery, 2025)

Street G (Pul-e-Surah Road), commencing from Aladdin's Three Ways and concluding at University Road, spans roughly 2.70 kilometers in length and possesses an average width of 18 meters. The walkways are around 3 meters in width, but the pedestrian crossings extend 18 meters, roughly aligning with the road width. The distance between two crossroads is roughly 157 meters, while the distance between two large squares is around 165 meters, yielding an average of seven junctions per kilometer in one direction. The vehicle's turning radius is 4.5 meters, ensuring modest mobility and pedestrian safety. Trees are situated 0.5 meters from the pedestrian pathway, despite the absence of formal seats or other street

furnishings. The gradient along the roadway is around 0.5% every 100 meters, indicating reasonably level ground conducive to walking and cycling.

Street G largely serves as a collector route, linking residential and restricted business zones to the university area. The route comprises four vehicular traffic lanes, although it lacks a median to delineate opposing traffic directions. The roadway is devoid of designated bicycle lanes, bicycle parking facilities, bus stop bays, and intelligent street features such as digital signs, smart lighting, or solar-powered seats. Public transit accessibility is restricted, and conventional street illumination exists but lacks contemporary technological enhancements. Traffic calming measures, such as speed bumps and elevated crossings, are lacking, and accessible ramps are not uniformly available, hence restricting mobility for impaired individuals. The speed restriction varies between 10 and 40 km/h, indicating a combination of residential and educational purposes. Street G offers fundamental urban connectedness and structural integrity; nonetheless, it requires significant enhancements in inclusivity, multimodal transit, and pedestrian safety to fully conform to the Complete Street model. Figure 21 depicts Street G, showcasing its existing physical and geographical attributes.



Figure 21. Street G, (Source: Google Earth Pro imagery, 2025)

2.10. Comparative Analysis of the Selected Streets with International Case Studies and Standards and Proposed Values for Kabul City

Table 9 offers a comparative evaluation of seven chosen streets in Kabul, Afghanistan, in relation to international case studies, design principles, and established Complete Street requirements. The research seeks to determine the degree to which each street fulfills the primary and secondary criteria of the Complete Street model, emphasizing performance disparities across the chosen alternatives.



Table 8. Selected case study streets in Kabul

Based on Kabul, Afghanistan, 7 case studie									7 example Kabul		
Criterion	Sub criterion	A	B	C	D	E	F	G	Min	Max	Average
Geometric Features	The general length of the road (km)	4	4	3	3.5	2.5	5.4	2.7	3	5	3.5
	The general width of the road (m)	28	34	34	30	26	26	18	18	34	27
	sidewalk width (m)	4	3	3	4	3	3	3	3	4	3.2
	Pedestrian crossing length (m)	28	30	30	30	24	20	18	18	30	25
	Bus stop bay length (m)	-	20	25	-	-	25	-	20	25	23.5
	Car traffic lane	4	6	6	4	4	4	4	4	8	4
	Median (m)	-	3	2.5	-	2.5	4	-	2.5	4	1.7
	Distance between two bus stops (m)	-	257	240	-	-	250	-	240	257	106
	Distance between two junctions (m)	210	400	313	213	265	98	157	98	400	236
	The distance between the squares (m)	150	66	72	200	166	160	165	66	200	139
	How many junctions per km (one direction)	4	2	3	5	4	6	7	2	7	4
Mobility and Land Use Accessibility	Turning radius (Corner radius for vehicles, impacts pedestrian safety)	6	5	4	6	4.5	6	4.5	4	6	5
	Benches(m)	-	2.5	2.5	3	-	2.5	-	2.5	3	1.5
	Trees(m)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Elevation changes slope per 100m	0.4	0.5	0.3	0.6	0.4	0.3	0.5	0.3	0.6	0.4
Safety and accessibility	Speed limit km/h	-30 50	-40 50	50- 60	-20 40	30- 50	40- 50	10- 40	20	60	40
	Distance between two pedestrian crosswalks(m)	120	250	300	250	-	180	-	120	300	157

*A, Kolula Pushta Road; B, Salang Road; C, 40 Meter Road; D, Kamani Road; E, Sarak Qala-e- Jawad; F, Shah Aqrab Road; G, Pul-e-Surkh Road

In a study of seven cases in Kabul, bike lanes, bike parking facilities, and bus lane width were not observed on any of the streets. In terms of street type, six out of seven samples were arterial streets, only G Street was a collector street, and there were no boulevard or local streets. Access to residential areas has been positive on all streets, while access to the park is only available on F Street. Shopping centers were only available on A, B, E, and F streets, and public parking was available on A and F streets. Hospitals and government offices were also only located on A, B, and F streets. Restaurants, cafes, and shops were accessible on A and F streets. Educational centers are located on B, D, and F streets, and industrial areas are only on B street. Public transportation access was available on B, C, and F streets, but the bike path and accessibility for people with disabilities were only provided on F street. Speed-calming and street safety measures such as speed bumps, lane narrowing, or raised crosswalks were seen on B, C, and F streets. Lighting was present on all streets, and digital signs and solar benches were available on streets A, B, and F, but smart lighting and accessible ramps were not seen on any street.

Table 9. Proposed standards for Kabul city based on international case studies and guidelines

Criterion	Sub criterion	7 example Kabul			4case studies	Standards and design guidelines	Proposed for Kabul city
		Min	Max	Average	Average	Average	
Geometric Features	The general length of the road (km)	3	5	3.5	4	3-8	4.75
	The general width of the road (m)	18	34	27	21	24	22.5
	sidewalk width (m)	3	4	3.2	3.75	3.5	3.6
	Pedestrian crossing length (m)	18	30	25	18.5	20	19
	Width of the bicycle lane (m)	-	-	0/7	1.85	1.5-3	1.6
	Bicycle parking facilities (Availability and capacity of bicycle parking spaces)	-	-	0/7	8	7	7
	Bus line width(m)	-	-	0/7	3.5	3-3.5	3.5
	Bus stop bay length (m)	20	25	23.5	22	24	23
	Median (m)	2.5	4	1.7	3	1.5	2.25
	Distance between two bus stops (m)	240	257	106	300	300	300
	Distance between two junctions (m)	98	400	236	127	250	188

Table 9 continued

	Distance between two junctions (m)	98	400	236	127	250	188
	The distance between the squares (m)	66	200	139	202	155	178
	How many junctions per km (one direction)	2	7	4	8	0/6	8
	Turning radius (Corner radius for vehicles, impacts pedestrian safety)	4	6	5	7.5	14	10.75
	Street furniture setback (Distance of furniture benches, trees, and signs from the pedestrian path)						
	Benches(m)	2.5	3	1.5	2	3.5	2.75
	Trees(m)	0.5	0.5	0.5	0.5	0.5	0.5
	Elevation changes slope per 100m	0.3	0.6	0.4	0.45	2-5%	2.7%
Mobility and Land Use Accessibility, Safety and accessibility	Speed limit km/h	20	60	40	47	10-50	53
	Bike path /side	1	2	0/7	4/4	1-2	1-2
	Distance between two pedestrian crosswalks(m)	120	300	157	131	125	128
	Distance between two accessible ramps(m)	-	-	0/7	11	8-10	10.5

The criteria with numerical values, for which suggestions have been presented, were established following an assessment of the current condition of Kabul city streets. These recommendations have been created based on foreign success narratives and the averages outlined in design standards, with the intention of utilizing global expertise while accommodating local circumstances.

In the proposed stage of this research, to determine the standard value for each criterion for implementing the Complete Street model in Kabul city, the average of the data obtained from seven case studies in Kabul city was first calculated, and this value is represented by the symbol K. Then the average of the international case studies was extracted, which is denoted by the letter I. In the next step, the average design guidelines related to complete streets were obtained, which are denoted by the letter G.

To achieve a suitable and implementable proposed value in Kabul city, these three values have been combined. The final proposed amount is represented by the symbol P and is calculated based on the average of the three values K, I, and G. The calculation formula is as follows:

$$K + I + G/3 = P \quad (1)$$

In this way, the proposed value (P) is the result of a combined average that simultaneously reflects both the real conditions of Kabul's streets (K), global experiences (I), and design standards (G). This method ensures that the final amount presented for the cable is reliable, realistic, and consistent with the scientific principles of urban planning.

We derived the criteria for other elements, like land use and access to urban services, from the study and selection of streets. Streets having the most accessibility to various centers, including parks, retail malls, government offices, hospitals, and schools, are prioritized in the creation of the Complete Street model. This methodology ensures the feasibility of design solutions while maximizing the enhancement of urban environmental quality and user accessibility.

2.11. Proposed Complete Street model design for Shah Aqrab

One of the most notable advantages of the F route is the high population density that it possesses, which is indicative of the primary function that the route plays in Kabul's urban transit network. This street has become one of the most important hubs for economic and social activity in the city as a result of the presence of a variety of purposes, such as residential units, Afghanistan's central university, specialized and general hospitals, government offices, commercial centers, and retail malls. In addition, the fact that this axis is situated on key metropolitan routes and provides easy access to public transit creates a significant potential for the implementation of the Complete Street model.

On the other hand, Shah Aqrab Street faces a series of serious challenges. The exacerbation of problems on this axis is exacerbated by factors such as the lack of traffic order, the occupation of sidewalks by street vendors, limited access to parking near commercial centers, and an excessive reliance on private vehicles. In addition, weaknesses in public space management, the lack of safe cycling paths, and the shortage of suitable pedestrian infrastructure such as standard ramps and safe crossing signs are considered significant obstacles to achieving the principles of complete streets on this street.

In the current situation, the width of Shah Aqrab Street is approximately 32 meters. On both sides of the street, 3 meters of sidewalk have been designated, followed by 4 meters of central green space. Additionally, 11 meters of width is allocated in each direction for vehicle passing lanes. The image shows the spatial and geometric organization of the street in its current condition.

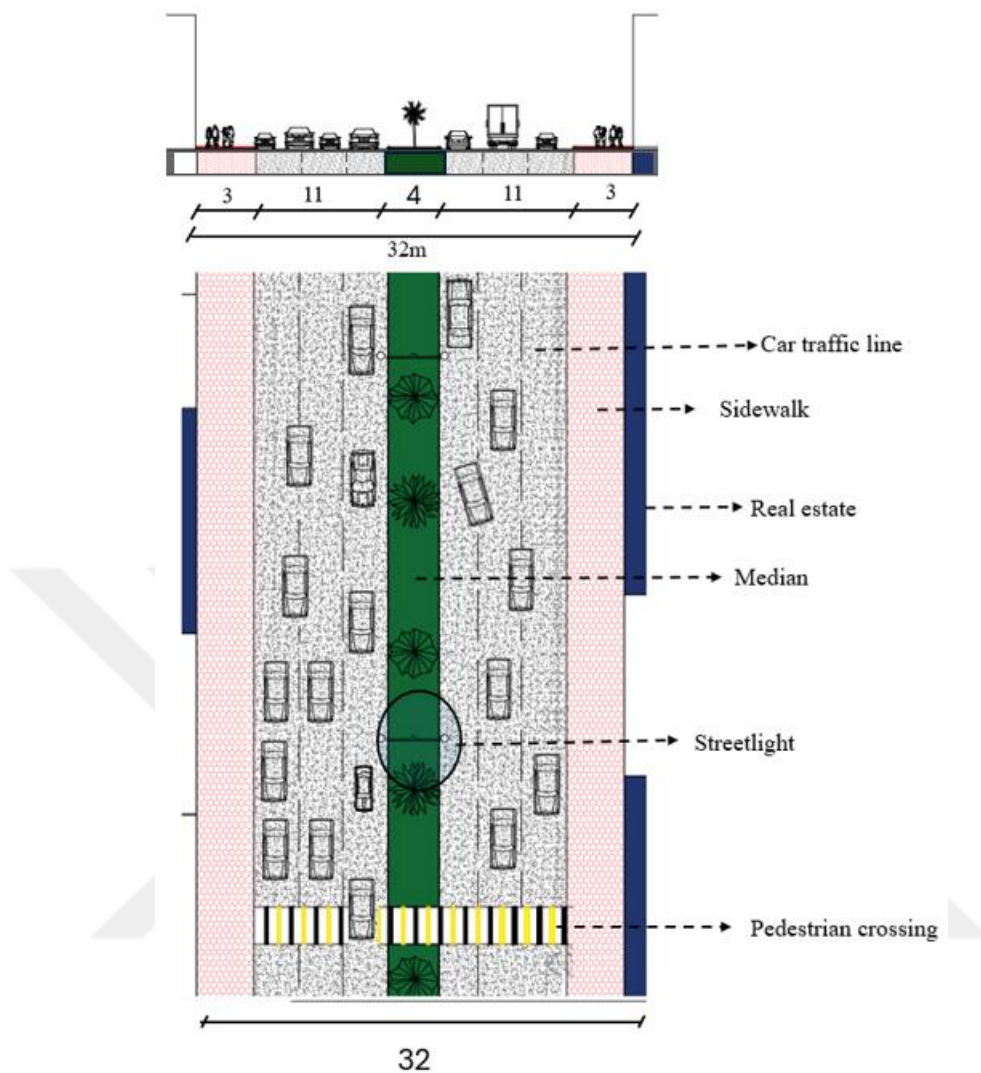


Figure 22. Existing conditions of Shah Aqrab Street

If a Complete Street model is implemented in Kabul city, it will have numerous benefits. First, the design of separate paths for pedestrians, cyclists, and motor vehicles improves traffic safety and reduces the risk of accidents. Second, pedestrian and disabled access is facilitated; standard sidewalks, ramps, and appropriate markings make it easier for all citizens to move around. Third, sustainable transportation is enhanced, and by allocating bicycle lanes and providing park facilities, citizens are encouraged to use non-motorized vehicles, which are effective in reducing air pollution. Additionally, safe and accessible streets boost the local economy and businesses, increasing customer attraction to local shops and markets. On the other hand, creating suitable stations and routes for buses and public transportation improves citizens' access to transportation services and contributes to the development of public transportation. Finally, by adding green spaces, benches, proper

lighting, and street signs, the street environment becomes more beautiful and of higher quality, and the urban experience of citizens is enhanced.

If the Complete Street model is implemented in Kabul city, it will have flaws and challenges. First, lack of space and infrastructure problems are among the most significant obstacles; many of Kabul's streets are narrow, and adding bike lanes or sidewalks could make the roads even narrower for vehicles. Second, high costs are a major challenge, as designing and implementing a Complete Street standard requires a significant budget, which is difficult to secure in Kabul's current conditions. Third, public resistance can also hinder the successful implementation of the model. Changes in traffic patterns and reduced vehicle routes may be met with opposition from drivers and shopkeepers. When vehicle routes are reduced or street structures change, some drivers and business owners may be dissatisfied with these changes, as they feel their interests are being limited or their access to shops and routes is becoming more difficult. This resistance can slow down the implementation of the plan or even cause some components of the model to not function properly, as some people may feel their access or benefits are being limited. Additionally, maintaining and managing the streets is another challenge, as preserving the quality of bike paths and sidewalks and managing traffic requires continuous monitoring and specialized human resources. Social and cultural challenges are also influential in this regard; some urban habits and behaviors, such as illegal parking on sidewalks, can disrupt the proper functioning of the model. Finally, coordination with other urban projects, including water, wastewater, and electricity infrastructure projects, is essential and may slow down the Complete Street implementation process.

Given that the width of Shah Aqrab Street varies along different sections of the route, increasing near intersections and bus stops and narrowing in some places, the proposed street design model has been prepared based on a representative cross-section, which is highlighted in red in the image. This section is considered the most suitable part for demonstrating the proposed complete street pattern due to its stability and the possibility of precise measurement.

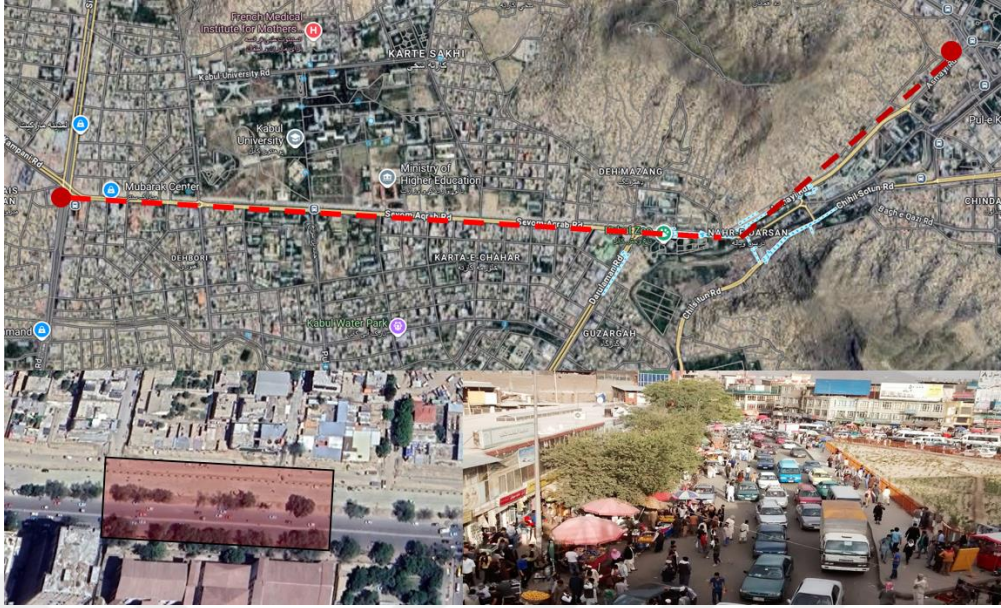


Figure 23. A selected section of Shah Aqrab Street in its current state, (Source: Google Earth Pro imagery, 2025)

The proposed Complete Street model for Shah Aqrab Street is designed so that its main components are organized according to existing conditions and the street's spatial capacity. In Table 9, proposals for Kabul city are presented based on international case studies and design standards; however, the current plan has been developed considering the specific characteristics and physical limitations of Shah Aqrab Street.

The final evaluation of the cross-section design for Shah Aqrab Street shows that the total width of the road (not including sidewalks) is 26.00 meters. A 4.00-meter-wide green strip (Median) has been established in the center of the street, computed independently of the street's width. The width of either side of the street is 11 meters, with two traffic lanes, each 3.5 meters wide (totaling 7 meters), a 2.5-meter on-street parking strip, and a 1.5-meter cycling path. Sidewalks of 3 meters in width have been constructed on both sides of the roadway, resulting in a total street width of 32.00 meters from the edge of one sidewalk to the other edge, inclusive of the middle green strip. To enhance pedestrian safety, crosswalks are designated at intervals of 300 meters. Moreover, street seats have been positioned along the sidewalks, 2.5 meters from the main street boundary, to create an appropriate setting for individuals to rest and wait. Bus stops are situated every 250 meters on each side of the roadway to comply with urban accessibility regulations. Bicycle parking is available every 300 meters, with each site capable of housing seven bicycles. The objective is to promote active transportation and enhance connections among public transit networks. Power poles

and lighting have been put at intervals of 30 meters to guarantee enough evening illumination and safety along the street. Figure 24 illustrates the conclusive design of the planned cross-section of Shah Aqrab Street, developed according to the Complete Street model created by the author. This design, taking into account the prevailing conditions and established urban design standards, incorporates several aspects such as traffic lanes, cycling routes, walkways, public transit stops, and urban furniture.

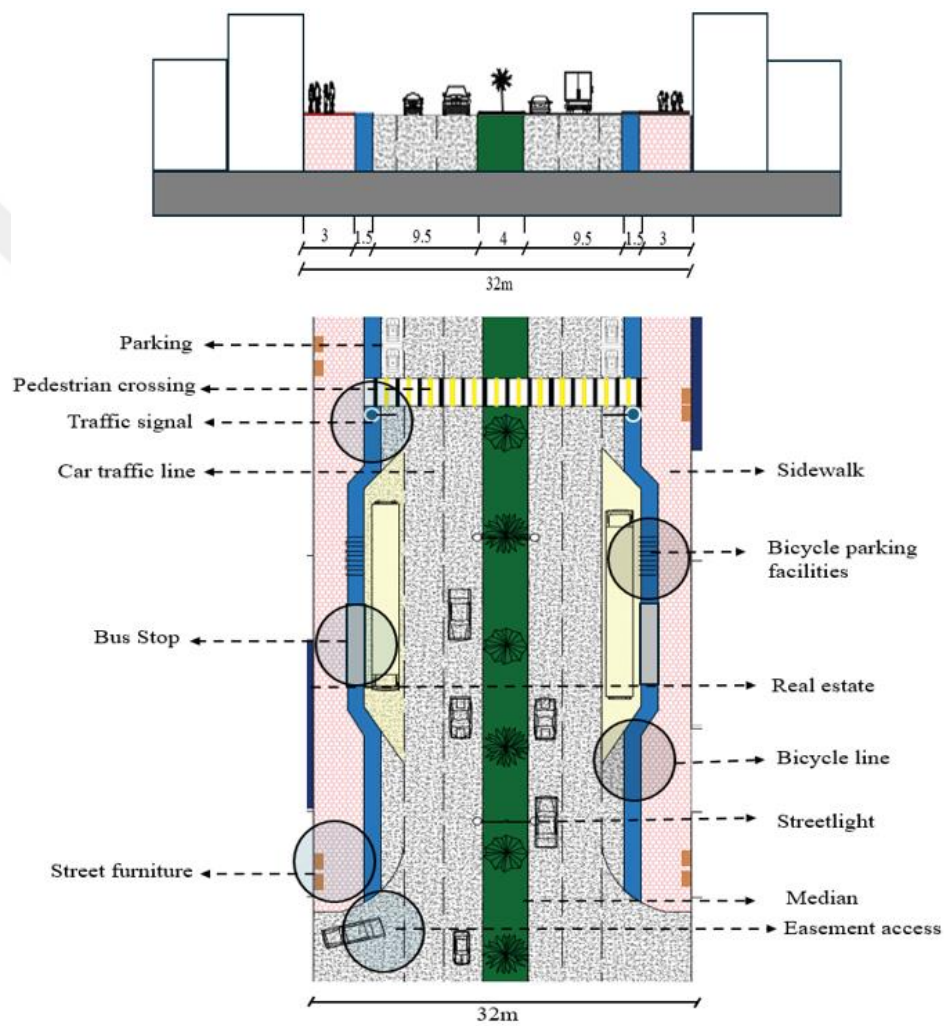


Figure 24. Author's proposed Complete Street model design for Kabul

3. FINDINGS

This research identifies substantial obstacles and simultaneous opportunities in the execution of the Complete Street model in Kabul city. The research stemmed from a comparative examination of effective worldwide design principles and standards, indicating that the Kabul transportation system has substantial structural inadequacies yet possesses tremendous capacity and opportunity for enhancement. An exhaustive examination of present circumstances indicates that the primary impediments are insufficient infrastructure, elevated traffic congestion, inadequate provisions for walkers and bicycles, and the lack of cohesive policies among pertinent agencies.

This study's findings suggest that leveraging successful international case studies and design guidelines in Complete Street, as demonstrated in both rich and developing nations, can enhance circumstances in Kabul. Implementing the Complete Street model on Shah Aqrab Street might yield significant advantages for diverse street users, including walkers, bikers, and public transit patrons. This approach promotes street functional safety by decreasing design speed and regulating traffic flow, improves service quality for non-motorized vehicles, reduces energy consumption and pollutant emissions, and fortifies the alignment between transportation performance and land use. A substantial segment of street users immediately benefits from this paradigm, which is crucial in enhancing the urban experience and facilitating access to sustainable mobility.

Despite these advantages, implementing a Complete Street model presents several obstacles. The issues encompass diminished traffic capacity on small streets, heightened investment and maintenance expenses for street designs, the necessity to recalibrate signaling and traffic control systems, and the possibility of exacerbated local congestion during peak hours. Furthermore, managerial and organizational challenges, including the absence of a definitive legislative framework for reallocating street areas, opposition from conventional transportation entities, and constrained municipal resources, might hinder the project's execution.

Conversely, substantial potential exists to adopt the Complete Street model in Kabul. These opportunities encompass the alignment with intelligent transportation policies and sustainable urban development, the enhancement of the economic appeal of urban areas and property values along the street, the improvement of the Livability Index and urban

environmental quality, and the application of innovative technologies in traffic management and safe street design. The cable's distinct attributes, including its strategic position within the transportation network, fluctuating population, and popular endorsement for urban enhancements, facilitate the effective execution of the Complete Street model street.

Furthermore, infrastructure evaluations indicate that numerous sidewalks possess critical deficiencies and fail to comply with safety regulations; unregulated commercial activities and unauthorized parking and loading operations, along with insufficient sidewalk widths, compromise the safety and comfort of at-risk populations, including the elderly, children, and individuals with disabilities. Consequently, the effective execution of a Complete Street model necessitates the redesign of sidewalks, the establishment of dedicated bike lanes, the installation of traffic control systems and safety apparatus, and the optimization of roadside areas to enhance traffic flow and safety for all users.

The combination of strengths, opportunities, limitations, and threats shows that despite challenges in structure, management, and operations, the Complete Street model has great potential to improve safety, accessibility, efficiency, and the quality of the urban environment in Kabul, which would greatly help in creating sustainable and user-friendly urban development.

4. DISCUSSION

The present study indicates that Kabul's streets, as the main urban space, are still far from meeting the standards of the Complete Street model. As mentioned in the theoretical foundations, streets should not be merely passageways for vehicles but should be multi-dimensional spaces for pedestrians, cyclists, and social activities (G.S.D.G., 2016). The findings of this research indicate that many streets lack the necessary infrastructure for walking and cycling and are also severely congested, which is incompatible with the concept of livable and safe streets for all users (Dumbaugh & Gattis, 2005).

International case studies have shown that implementing the complete streets model improves street operational safety, reduces energy consumption and pollutant emissions, enhances service quality for non-motorized users, and increases alignment between land use and transportation performance (Laplante & McCann, 2008; Perk et al., 2015). The findings of this research on Shah-Aqrah Street in Kabul indicate that, despite structural and managerial limitations, it is possible to utilize such benefits, especially if successful design principles from other countries are applied.

However, significant challenges were also identified, including the lack of a legal framework for reallocating street spaces, resistance from traditional transportation agencies, and limited municipal resources, which could hinder the implementation of Complete Street. These barriers are consistent with the theoretical limitations mentioned in GSDG (2016) and the principles of green and livable street design, which state that sustainable urban development requires coordination between infrastructure, policies, and user needs.

The opportunities available in Kabul, such as public support, the city's strategic location, and the potential to utilize new technologies in traffic management, indicate that the Complete Street model can improve the quality of the urban environment, increase economic attractiveness, and enhance the livability index (Burdin and Litman, 2011; Greg and Hess, 2019). Additionally, sidewalk improvements, the creation of dedicated bike lanes, and the installation of safety equipment align directly with the principles of complete streets and 15-minute cities and can provide safe and convenient access for all users.

This study examines three principal questions based on the findings.

1. How can the Complete Street model be implemented in selected streets of Kabul to improve accessibility, safety, and multimodal transportation?

Based on the findings of this study, an examination of selected streets in Kabul revealed that pedestrian and cycling infrastructure is inadequate, and traffic flow is primarily focused on vehicles. However, it is possible to modify sidewalks, create dedicated bike lanes, and install traffic control equipment, which can provide safe access for all users. International case studies have shown that Complete Street model, by reducing speed, regulating traffic flow, and prioritizing non-motorized users, can improve urban safety and sustainability.

Therefore, implementing the Complete Street model on selected streets in Kabul, with infrastructure improvements and the localization of successful international principles, can enhance accessibility, safety, and multimodal transportation and promote urban sustainability.

2. Which streets in Kabul are most suitable for implementing the Complete Street model, considering traffic volume, pedestrian activity, and land use?

An examination of Shah-Aqrab Street showed that, despite traffic congestion and street width limitations, significant pedestrian activity and diverse land use density make it a suitable option for implementing the Complete Street model. Streets with less traffic flow and more interaction between pedestrians and businesses have a higher priority for implementing this plan. Streets with similar conditions to Shah-Aqrab Street are the most suitable options for implementing the Complete Street model due to the possibility of creating bicycle lanes, modifying sidewalks, and aligning with land use. They can provide significant benefits faster than other streets.

3. How can street improvements based on the Complete Street model contribute to sustainable urban development and environmental benefits in Kabul?

Implementing the complete streets model reduces vehicle speeds and increases the use of non-motorized and public transportation, which in turn helps to lower fuel consumption and pollutant emissions. Creating pedestrian spaces and dedicated bicycle lanes also enhances the quality of urban life, social interactions, and economic productivity in urban areas. Aligning with sustainable urban development policies and utilizing innovative technologies in traffic management enables universal access and reduces environmental impacts.

Street improvements based on the Complete Street model not only have transportation and safety benefits, but also contribute to sustainable urban development, reduced pollution, and improved urban quality of life.

Overall, the analysis of the findings indicates that, despite practical challenges and organizational limitations, implementing the Complete Streets model in Kabul has significant potential to improve safety, accessibility, efficiency, and the quality of the urban environment and can contribute to creating a sustainable city. This result aligns with the theoretical foundations and key concepts and indicates that achieving the goals of a Complete Street in Kabul is possible, provided that structural and managerial barriers are effectively managed.



5. CONCLUSIONS

This research shows that implementing the Complete Street model in Kabul is entirely achievable, providing sufficient funding, increased public awareness, and the happiness and participation of citizens are ensured. This strategy is effective and efficient for both urban sustainability and increasing the safety of road users.

The aim of this research was to assess the feasibility of adopting the complete streets model in Kabul city. The results indicate that implementing this model in Kabul is feasible; however, its realization requires the establishment of specific technical, institutional, and social prerequisites.

Initially, technical assessments indicated that the selected roads in Kabul were compatible with the principles of the Complete Street model in terms of cross-sectional width, accessibility, and land use diversity. By aligning design requirements with local constraints and utilizing cost-effective alternatives, we can align this approach with the city's physical and economic realities. Secondly, from an institutional perspective, the effectiveness of model implementation depends on the cooperation of relevant urban institutions, particularly the municipality, the Ministry of Labor and Social Affairs, and the traffic police. We consider this process essential for creating a unified framework for decision-making and the allocation of financial resources. Third, from a social perspective, increasing public knowledge and social acceptance are vital for the project's success. Kabul's cultural framework is largely car-centric, which necessitates increasing public understanding of the benefits of adopting complete streets – such as enhanced safety, reduced congestion, improved public health, and environmental sustainability – through educational and media initiatives. In conclusion, the definitive answer to the main research question is: implementing the complete streets model in Kabul is technically and practically feasible, provided that the designs are adapted to local conditions, sufficient financial resources are secured, and public awareness and participation are increased. As a result, the findings of this research not only confirm the feasibility of the Complete Streets model in Kabul but also serve as a foundation for developing future urban policies and initiatives focused on increasing safety, spatial equity, and urban sustainability.

After technical and geographical reviews, a street in Kabul was identified as having the highest potential for implementing the Complete Streets model based on its physical,

functional, and social characteristics. This road, which is over 5.4 km long, serves as the city's main street and includes the central market, two of the country's main institutions, hospitals, ministries, public halls, and residential areas along its route. Given the diverse applications and high user density, implementing the model along this axis can significantly enhance the safety and quality of urban services.



6. RECOMMENDATIONS

This research faced several fundamental limitations that could impact on the accuracy of the analyses and the generalizability of the results. First, there was no official, accurate, and up-to-date data available in Kabul city regarding the current state of street infrastructure. Information such as the quality of road surfaces, traffic flow volume, the number of non-motorized users, and reliable accident statistics has not been systematically recorded or published. Therefore, a significant portion of the assessments have inevitably relied on satellite imagery, secondary sources, and existing reports.

Second, conducting a direct survey of street users, including pedestrians, residents, cyclists, and drivers was not feasible due to implementation and access limitations; therefore, public attitudes, needs, and reactions to the implementation of the complete streets model were not directly collected and analyzed in this study.

Third, security and logistical limitations in Kabul prevented accurate field surveys, measurement of physical details, and the preparation of complete documentation of the actual street conditions.

These limitations indicate that the research results must be interpreted considering the data and environmental conditions of Kabul, and the need for further data-driven studies in the future remains.

Based on the research findings and limitations, a set of practical recommendations is provided for responsible institutions, including Kabul Municipality, the Ministry of Urban Development, and the Traffic Department. First, the development of non-motorized transportation infrastructure should be prioritized; these goals can be achieved by constructing safe and standard paths for walking and cycling, as well as renovating sidewalks, removing physical barriers, and creating smooth and accessible surfaces for all citizens. In the next step, intelligent traffic management is essential, which includes installing timed traffic lights, standard speed bumps, and safety signs, and utilizing intelligent systems to control speed and increase safety. Also, implementing speed limits on busy roads and creating plans to reduce private vehicle use can help smooth traffic flow. On the other hand, geometric improvements to streets and the redistribution of public space, such as redesigning lane widths, creating dedicated bicycle paths, and expanding roadside green spaces, play a significant role in improving the quality of space and increasing the

efficiency of roadways. Developing official laws and regulations for the design and implementation of the Complete Street model and strengthening coordination between the traffic department, municipality, Ministry of Urban Development, and the private sector are other essential steps in this regard. Ultimately, raising public awareness through educational campaigns about the benefits of complete street, encouraging non-motorized transportation, and involving local communities and businesses in the decision-making process can contribute to the long-term success of this initiative. This set of recommendations can collectively provide the groundwork for the effective implementation of the Complete Street model and the improvement of urban quality of life in Kabul.

Considering the gaps in literature and the limitations of this research, future studies can develop along several key paths. First, a thorough examination of the coordination between street infrastructure and land use is essential; specifically, analyzing how the road network aligns with residential, commercial, and institutional land uses and evaluating the impact of street redesign on reducing congestion and improving urban accessibility. Second, spatial justice is a major focus of future studies, and subsequent research can assess the accessibility of low-income areas and informal settlements to safe and efficient infrastructure and propose inclusive planning models to reduce inequalities. Third, assessing the feasibility of non-motorized transport through an analysis of integrating pedestrian and cycling paths with the public transport system, as well as gathering user perspectives on the acceptance of the Complete Street model in Kabul, can provide a more accurate understanding of the model's practicality. Fourth, examining the policy and legal dimensions is also of high importance, including studying the experiences of countries with similar conditions to Afghanistan to develop street-related laws and identify strategies to strengthen inter-organizational cooperation and create political will. Finally, future studies could focus on urban innovations and smart technologies, evaluating Kabul's potential to utilize smart routes, traffic sensors, and sustainable infrastructure to reduce pollution, increase safety, and improve urban efficiency. These paths of research can contribute to the development of Complete Street science literature in theoretical, applied, and policy areas.

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RESUME

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