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URBAN MOBILITY AND TRANSPORTATION STRATEGIES FOR SUSTAINABLE CITIES: A CASE STUDY IN KABUL, AFGHANISTAN

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Abstract— In recent decades, the rates of urbanization, motorization, population growth, and population density have increased. Congestion has detrimental effects on the efficiency of transportation, as well as on travel times, air pollution levels, and fuel consumption. Kabul is the most crowded city in Afghanistan. Unrestrained urbanization and motorization often lead to a socially, economically, and ecologically unsustainable urban land use and transportation system. In developing nations, urban mobility systems are quite diverse, taking into consideration their components in terms of transport modes and the development path associated with urban expansion. As a case study, this article examines Kabul, the most populated and economically significant city in Afghanistan. This study starts by doing a literature review on sustainable transportation systems to help the reader comprehend the link between sustainable development and transportation. The article then assesses the present transportation and infrastructure system, national transportation regulations, and urban transportation initiatives to see whether the current paradigm is shifting toward or away from sustainable mobility. Furthermore, the principles for sustainable urban transportation are designed to determine the importance that national transportation policies have given to urban transportation from the standpoint of sustainable transportation. Finally, I proposed several public transportation alternatives and strategies for Kabul city, the implementation of which may result in a more sustainable urban development and transportation system in the future.

Keywords— Urbanization, Motorization, Sustainable Mobility, Urban Transportation.

I. INTRODUCTION

Kabul became the capital of Afghanistan in the 18th century when the city had a population of 10,000 people. After Afghanistan gained independence in 1919, the population was roughly 90,000, and the city area grew to 450 hectares in 1925. Kabul city spans 1,023 square kilometers (395 square miles) and has a population density of 4,500 people per square kilometer (12,000 per square mile). This city is marked by an increasing trend of suburbanization. As indicated in Figure 1, its growth rate has been tremendous. In the 1950s, the urban movement began in Kabul, resulting in the construction of the Kabul university, Maiwand Hospital, and Jaday-e- Maywand Road. Since the beginning of urbanization in Kabul, four master plans have been developed [1].

The first was from 1962 to 1987 and encompassed 238,8 square kilometers with an intended population of 0.8 million. The second was in 1970, with a population of 1.4 million and a land size of 299 square kilometers. It was expected to be completed by 1995. The third was in 1978, up to the intended year of 2002, with a population of 2.0 million and an area of 323.3 square kilometers. The most current one, created in 32008, is intended for 4,2 million individuals and is still in use by government agencies. Urban transportation is a critical issue in large cities all over the globe. These cities' accelerated urbanization and motorization directly affect sustainable development. It is expected that the transportation industry will double its energy consumption and greenhouse gas emissions in the next few years [1].

Adopting the principles of sustainable transportation has become more important in Kabul, where a lack of public transit and rising incomes have increased the need for personal mobility, as seen by a rise in automobile ownership and use. Inadequate land use and transport planning, poorly maintained vehicle stock, and rising rates of motorization have all contributed to a severe increase in traffic congestion, which in

turn has increased travel times, fuel consumption, pollution, and the deterioration of urban environments, all of which hurt the possibility of achieving sustainable development.

This article is based on a case study of Kabul, Afghanistan's economic and administrative capital and a megacity with a population of over 4 million people. The research assesses the city's urban development, transportation and infrastructure systems, public transportation alternatives, and traffic characteristics, control, and management in Kabul city [2]. This assessment tries to determine if the existing paradigm is bringing the city toward or away from sustainable transportation. Based on the assessment, certain methods are offered.

Population growth and sub-urban spatial expansion have resulted in a dramatic rise in demand for urban transport infrastructure and services, despite the absence of development planning for densification and spatial expansion. Since 1975, several development plans for Kabul have been drafted but never executed [8]. As a result, the city suffers from a chronic lack of essential amenities like housing, water, electricity, and public transportation. The scarcity of housing units is partly to blame for the formation of squatter communities. Approximately 20% of the population now dwells in these squatter communities [6].

II. BACKGROUND

In the 1950s, Buses, vans, lorries, and automobiles conducted long-distance road travel in Kabul. Even though bus service was accessible statewide from Kabul, flying was safer, particularly for foreigners. In the 1960s, the city's public bus service (Millie Bus / "National Bus") was formed to transport people to several places every day. There were around 800 buses in operation [3].

The Czechoslovak-built Koda fleet powered Kabul's electric trolleybus system from February 1979 until 1992. (see Trolleybuses in Kabul for more). To a large extent, the trolleybus service's success may be attributed to its cheaper pricing compared to that of Millie Bus, a regular bus service. In late 1992, owing to fighting, the final trolleybus ran, and although most of the copper overhead wires have been stolen, the steel poles and other infrastructure are still visible across Kabul [4].

As the first major metropolitan public transportation network, the Kabul Municipality revealed plans for a new bus rapid transit system in June 2017. Despite initial projections that it will open in 2018, building delays forced a later opening. In March 2021, American-made IC Bus buses were implemented in Kabul with brand-new bus stations. They started with five buses on one route, with plans to increase that to 200 vehicles on 16 routes. Sustainable transportation is a tricky subject of research with several challenges to address, which may be divided into four groups. Economic issues cover commercial activities, employment, and productivity.

Social issues include equity, public health, and inclusiveness; environmental challenges include pollution control, climate change mitigation, and habitat degradation. Sustainable transport is the transportation sector's manifestation of sustainable development. A literature review reveals a growing emphasis on developing sustainable transport systems and policy-oriented studies to address environmental preservation, social equality, and economic efficiency for present and future generations are the core pillars of sustainable development. Since 1950, the Kabul city population has grown, as has its geographical growth. Furthermore, the city is expected to have a population of 5.7 million by 2030, with an annual growth rate of more than 3.35%.

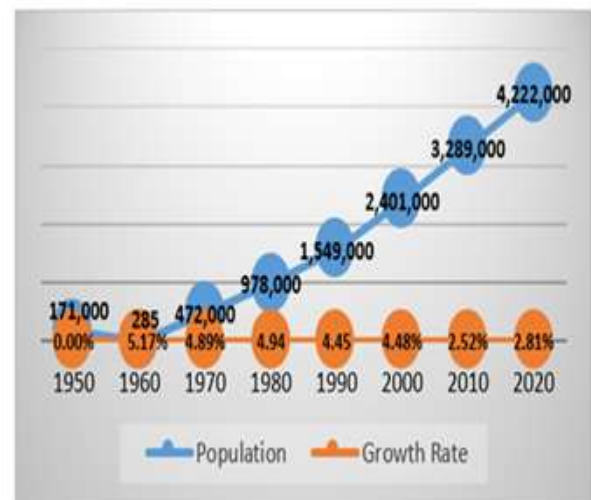


Figure 1. Kabul population and growth rate.
 Source: Kabul, Afghanistan Metro Area Population 1950-2022

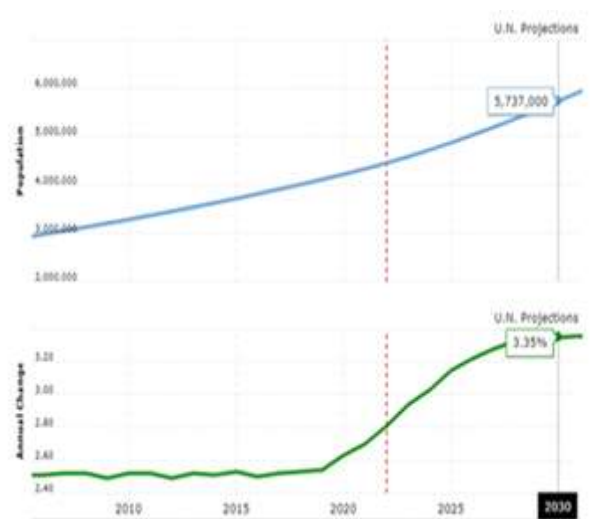


Figure 2. Kabul population and growth rate in 2030.
 Source: United Nations - World population Prospects.

A city's transportation requirements are cyclical in nature and heavily influenced by how its inhabitants travel. Three forms of urban transportation exist in Kabul: The predominant means of transportation in Kabul are two-powered wheels, which account for over two-thirds of all traffic. Four-wheeled: This category comprises private automobiles, taxis, cars,

minibuses, and buses. This group covers both personal and wheeled motorbike taxis. They represent between a quarter and a third of all traffic in Kabul's metropolitan districts; Walking and cycling make up less than one-fourth of all traffic in Kabul and are hence less significant.

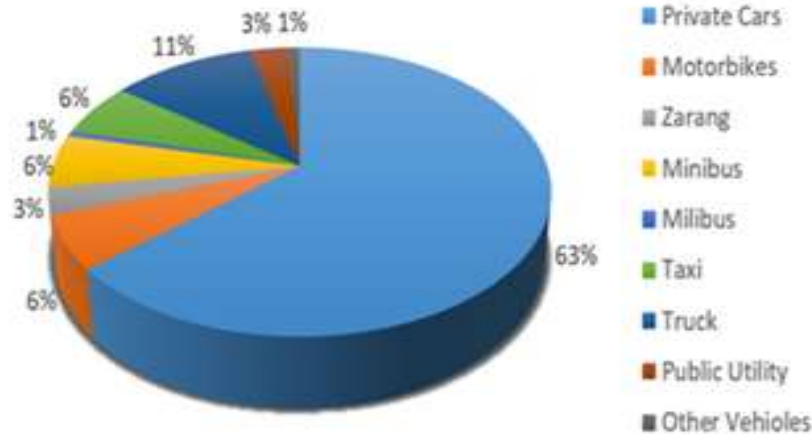


Figure 3. Transportation of vehicle fleet in Kabul,

Source: Kabul Urban Development Framework (KUDF)

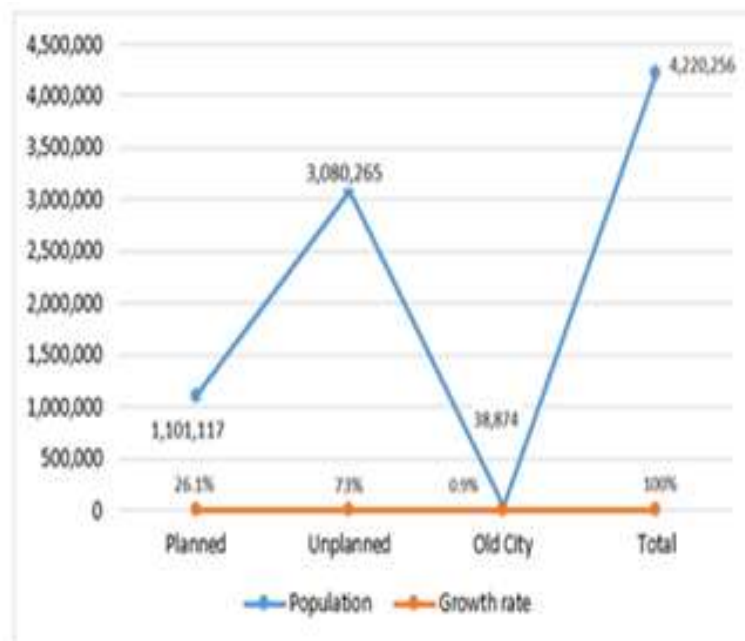


Figure 4. Assessed Population by Type of Built-up Region in Kabul City (2008).

Source: Kabul city master plan, 2011.

According to an examination of data acquired from the Kabul Municipality, Kabul's automotive fleet increased in 2008, with personal automobiles accounting for 63% of the fleet and minibuses accounting for 11% and 3% of public transportation

vehicles. The city's rapid urbanization and economic expansion have placed significant strain on travel demand. The increased need for transportation infrastructure has swiftly filled it since almost 70% of all motorized vehicles in the

nation use its roads and expressways. This fast growth in personal automobile ownership, combined with a lack of economic tools such as parking charges and road pricing, has resulted in massive congestion, particularly in the city's core, increasing the average commute travel time in Kabul. The following table details the length and density of roads in each district in Kabul.

The road density varies greatly across regions. The lowest density is less than 5.0 km/km². Districts 8 in terms of density

are districts 6, 9, 12, and 15. The density of official roadways, with the exception of "other roads," likewise varies widely. In areas 3, 4, 5, 10, 11, and 15, where medium-rise apartments predominate, the road density is very high. Except for district 18, which is considered a semi-urban zone and was established beforehand, population density is typically low in outer-range districts [5].

Table -1 Population of Kabul by District in 2008.

Dist. No.	Road class					Total	Density1 (Km/Km2)	Density2 (Km/Km2)
	Main arterial	Arterial	Secondary	Community	Other			
1	0.3	3.2	3.3	2.0	67.6	76.3	16.2	2.2
2	6.9	1.8	3.6	17.4	55.1	84.8	12.5	3.3
3	5.6	1.1	9.2	39.9	61.9	117.7	12.1	1.7
4	6.9	12.3	7.0	52.3	125.1	203.6	17.6	3.0
5	18.3	0.7	1.2	97.1	231.5	348.8	12.0	1.0
6	0	19.6	10.1	49.5	322.6	401.8	8.2	0.5
7	0	15.7	5.7	27.4	343.8	392.6	12.1	0.3
8	7.5	11.6	10.4	59.8	400.4	489.7	10.1	0.9
9	10.1	7.2	3.4	23.2	195.7	239.6	9.8	1.1
10	0	14.7	7.3	78.6	121.2	221.8	17.1	1.2
11	1.4	10	2.6	57.9	226.2	298.1	17.1	1.7
12	0.0	19.3	4.8	36.2	285.1	345.4	9.9	0.8
13	0.0	7.5	19.4	58.2	442.7	527.8	11.3	0.6
14	3	24.5	3.0	55.0	239.8	325.3	2.6	0.2
15	0	25.5	5.3	128.3	89.8	248.9	7.8	0.8
16	0.4	13.4	4.2	9.8	228.1	255.9	10.2	0.8
17	9.6	0.0	8.1	12.2	245.8	275.6	4.9	0.3
18	0	14.1	18.0	54.0	38.8	124.9	3.7	0.4
19	15.5	0.0	24.1	36.2	220.1	295.8	2.1	0.3
20	17.8	0.0	7.9	81.9	148.8	256.4	1.8	0.2
21	10.9	0.0	7.0	35.8	3.4	57.1	0.9	0.03
22	0	8.8	17.6	52.8	189.4	268.6	3.4	0.00
Total	114.1	211.0	183.2	1,065.4	4,282.8	5,856.5	5.7	1.5

Source: Kabul Metropolitan Area Urban Development Master Plan, JICA, 2009

Note: Density 1: Total Road Network Density

Density 2: Core Road Network Density (except "Other Road")

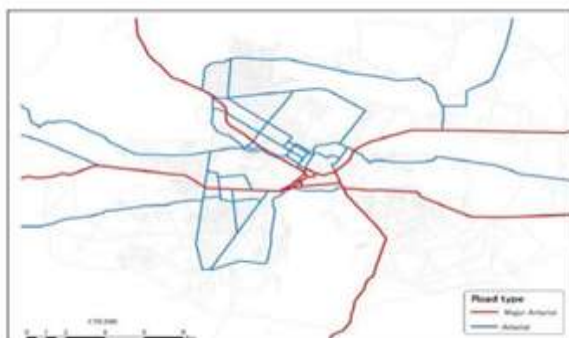


Figure 5. Road Network in Kabul

Source: Kabul Metropolitan Area Urban Development Master Plan, JICA, 2009

MAIN FOCUS OF THE CHAPTER

This study focused on urban transportation systems due to their multi-dimensional effects on urban life in aspects of economic, social, and environmental in Kabul city. By using the literature review method on population development and extension in Kabul city, evaluation of transport and infrastructure systems, road network and mobility, and non-motorized modes of transportation. A literature review reveals a growing emphasis on developing sustainable transport systems and policy-oriented studies to address environmental preservation, social equality, and economic efficiency for



present and future generations are the core pillars of sustainable development. I propose urban transportation alternatives and transportation strategies for having sustainable transportation in Kabul.

Issues, Controversies, Problems

The public transit network in Kabul city is in deplorable shape, and the absence of functioning traffic signals at the city's crossings has contributed to a rise in the number of people killed and injured in car accidents. It is vital to develop a plan in order to avoid the issues that arise from traffic, but how can this strategy be developed? And what are some of the other options for getting about Kabul's metropolitan areas?

III. SOLUTIONS AND RECOMMENDATIONS

In this article, I propose various urban transportation options and solutions for the city of Kabul in an effort to lessen the problems of transportation issues.

1. Propose Public Transportation Alternatives

Transportation is a vital component of our daily life. Today, all innovations are pushing towards more mobility, and therefore pollution. Transportation has already surpassed industry as the leading producer of air pollution. It is responsible for a major portion of global greenhouse gas emissions, and therefore for global warming. However, in addition to air pollution, transportation has a negative influence on natural places, increases noise pollution, and ecosystems in Kabul. I propose several eco-friendly modes of alternative transportation in Kabul city that enable people to travel securely while having a low environmental effect.

1.1 Walking: Walking is the cheapest and greenest method to travel. Also, no petrol or other costs especially for 1 or 2 kilometers distances. People might stroll to do their shopping, go to the movie, the workplace, a restaurant, or a meeting. Walking is a great strategy to maintain overall health, minimize weight gain, and decrease automobile emissions. Daily walking benefits ourselves and the earth.

1.2 The Bike: The bicycle is a terrific green alternative transportation option and a way to boost physical activity and lower sickness risk from a rich diet and sedentary lifestyle. Reducing car use is doable. Most visits are shorter than 3 kilometers and may be made by bike. Biking minimizes pollution and greenhouse gas emissions.

1.3 The Bus: Of course, a lot of individuals have daily commutes that are so lengthy that walking or riding a bike is either not an option or not viable. Buses and other forms of public transit, as opposed to driving alone, may consume less fuel per passenger and ease traffic congestion. Considering that many regions have lanes set aside for buses or other large-capacity vehicles, using the bus might be quicker than driving oneself.

1.4 The Electronic Bus: Electric buses produce no greenhouse emissions. Its carbon footprint is not zero, but its pollution level is low. In comparison to the thermal bus, it produces relatively little noise. It might therefore if widely implemented, enhance the quality of life in cities by lowering noise pollution from public transportation vehicles [15].

1.5 The Bicycle Taxi: This new mode of travel, is growing in the world's greatest cities to solve traffic and environmental challenges. Imagine a taxi that gives nearby service without the car's downsides. Taxi bikes are sluggish, but they're quicker in traffic and produce less pollution. The bicycle taxi expresses good qualities like sustainable development, vibrancy, and dynamism.

2. Proposed Strategies

Analysis of present transport infrastructure and policy leads to sustainable development options. Urban transit (or mobility) is linked to many other areas of urban living. This comprehensive approach might help you understand the particular metrics below. New mobility, city logistics, intelligent system management, and livability may help achieve sustainable transport. Avoiding Importing ready-made designs from industrialized nations must be considered depending on city realities and specifics, using northern and southern expertise [10]

Table -2 Proposed strategies for the urban transportation system of Kabul city.

Serial	Policies	Purpose	Effects
1	Transport operator integration.	To offer an integrated transportation system with interoperability across public transportation modes based on roads and rails.	This will enhance the interaction between rail-based and road-based public transportation, capacity distribution, and passenger transfer, as well as reduce capacity waste and passenger annoyance.
2	Transport and land use	To optimize the	People's travel behavior and land use intensity are



	planning integration.	effectiveness of urban transportation systems in light of environmental and municipal resource restrictions.	affected by transportation accessibility. To allow a sustainable transportation system, integrated transportation and land use planning will enhance the efficiency of resource usage and mode options.
3	Support transit-oriented development and public transportation.	With the goals of decreasing reliance on private automobiles and increasing access to public transportation, mixed-use, walkable neighborhoods are being pushed forward.	Public transportation usage will increase and automobile ownership will decrease under a compact mixed-community plan.
4	Modify the urban structure and land use pattern.	To prevent the CBD from becoming centralized and overdeveloped.	New urban areas and urban fringe regions will decentralize urban functions and balance work and residential zones.
5	Non-motorized transportation network.	To promote non-motorized travel as a sustainable method.	Non-motorized transportation is an energy-efficient, ecologically begin method of transportation that will improve urban mobility while reducing transportation-related pollution.
6	Create and execute rules and regulations governing urban transportation.	Creating a sustainable urban transportation system through the implementation of transportation laws and regulations.	This will determine the status of transport modes, sources of transport finance, transport planning concepts, the operation and administration of transport systems, and other transport-related concerns.
7	Low-cost transportation for low-income people.	To create vertical equality for disadvantaged people.	This will assist low-income commuters with discounted rates.
8	Reduce the use of cars by using economic tools.	To reduce vehicle use and promote public transit.	This will minimize traffic and guarantee transportation for all social groups.

2.1 Transport operator integration: The coordination and integration of the many operators of road and rail transport in Kabul are necessary components of the city's overall transportation system. The lack of rail-based urban transport has already been detrimental to the city, as the railway system in Kabul has been inoperable for almost years due to budgets, the low level of service, and the absence of an integrated bus service routes to shuttle passengers between stations, their homes, and their places of employment [14].

2.2 Transport and land use planning integration: Due to the lack of integrated transportation and land use planning, development projects are carried out by multiple agencies without regard for urban ecological systems, resources, social and economic concerns [11]. Diverse city architectures (land use patterns) need different modes of transportation. The planning should attempt to maximize the efficiency of the urban transportation system while keeping environmental and municipal resource limits in mind. A dynamic interaction between the city form and urban transportation systems will aid in maximizing social benefits and long-term development.



2.3 Support transit-oriented development and public transportation: Recent efforts to alleviate traffic congestion through the construction of wider roads, flyovers and elevated expressways are unlikely to alleviate traffic congestion in the long run because these initiatives are unrelated to social and environmental land-use planning, as well as the transportation needs of the non-car-owning majority. Sustainable urban transportation development must prioritize the development of an integrated urban transportation system with public transportation at its center [16]. As a result, transit-oriented development that favors a compact mixed-use community structure with a transit station at its core will increase transit ridership and support the community's main pillars of sustainable development, namely economic growth, environmental protection, and social diversity.

2.4 Modify the urban structure and land use pattern: Kabul is essentially a monocentric city, with most activity taking place in the CBD, which causes a significant mismatch between work sites and residential areas[13]. Urban functions should be dispersed by creating new urban regions and urban fringes by building several commercial districts to prevent the CBD from being overdeveloped. Additionally, these various centers should be built by the principles of smart development, which demand that employment and residential sites be balanced and that local centers be connected by a variety of traffic modes, with large-capacity transit systems serving as the preferred means.

2.5 Non-motorized transportation network: Non-motorized travel is an energy-efficient, environmentally-friendly way of urban transit. In Kabul, safety difficulties, poorly maintained pedestrian routes, and the lack of a dedicated right of way for bikes have made this method undesirable to commuters. As most of Kabul's population is impoverished, non-motorized transport amenities like sidewalks, crosswalks, well-timed crossing signals, street lighting, and dedicated bicycle lanes might revitalize this mode for commuting and other activities.

2.6 Create and execute rules and regulations governing urban transportation: Urban transportation policies should define transport financial sources, planning concepts, road rights, system operation, and administration, and other concerns. Education and enforcement of transportation laws would boost public transit.

2.7 Low-cost transportation for low-income people: A Build-Operate-Transfer model will be used to construct Kabul's new rail-based public transport system. The lowest-income residents of Kabul will not be able to afford the fares if the government does not provide significant financial assistance in some form. As a result, it is necessary to locate a reliable source of income in order to provide subsidies to the most economically disadvantaged portion of the population.

2.8 Reduce the use of cars by using economic tools: The rapidly growing number of private cars in Kabul can be managed through the implementation of congestion pricing, area licensing schemes, cordon pricing, and high parking fees in the Central Business District [12]. This will make it possible for transportation development projects in Kabul to be successful. These plans have been carried out with great accomplishment in the cities of Singapore, Hong Kong, and London. These types of programs limit people's access to private automobiles, which in turn helps reduce gridlock and pollution, improves the quality of life, and makes better use of public transportation in the CBD.

IV. FUTURE RESEARCH DIRECTIONS

The transportation sector is the highest responsible part of harmful environmental impacts in cities and is also responsible for high generating greenhouse gas emissions, air and noise pollutions. In the future working on forming a sustainable and green urban transportation system with an integrated method is essential for policymakers and decision-makers. This system will change the path of urban transport and mobility toward a more sustainable and green future by providing an emerging affordable, economically viable, the orientation of people, and environment-friendly transport system.

V. CONCLUSIONS

The review reveals that the transportation system is now experiencing a crisis and that the current urban design and transport regulations have not offered a comprehensive approach to the development of urban transport. Urban bus development projects will enhance urban transportation in the future, but the current transportation system is not sustainable from an economic, environmental, or social perspective. These improvements will be made in the future. This study proposes a few approaches that, if implemented in Kabul, might result in the city's urban growth and transportation system being more environmentally friendly.

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