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Developing, Enhancing, and Solving Problems of Transportation System in Addis Ababa

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ABSTRACT

There is a strong reciprocal relationship between the development of transport networks and economic development in cities. This can be achieved by developing transport patterns in the city separately and linking them all to form an integrated transport system, attracting investments and driving development, thus upgrading or improving the quality of life in urban areas. The current study has dealt with the development and problems of the transport system in Addis Ababa. It tackled the development of the transport sector in the streets of Addis Ababa, improving the connection between the network nodes and the development of the light rail transport sector as well as the future of transport in Addis Ababa, through an energy-saving transport system and connectivity. The current study also found that the Addis Ababa region has the potential for development and problem-solving if it follows the proposals and development steps for the street network in the ten sub-cities of the capital.

1. Introduction

There is a strong reciprocal relationship between the development of transport networks and economic growth in cities. This can be achieved by developing transport patterns in the city separately and linking them all to form an integrated transport system, attracting investments, advancing development, and thus upgrading or improving the quality of life in urban areas [1].

2. Material and Method

2. 1. Location

The site is an important point addressed by the geographer. It is the center of geography and its axis [2]. Addis Ababa is one of the cities of the eleventh State of Ethiopia, and it is the capital. It is located in the center of Ethiopia. The city is characterized by deep valleys, hills formed by rivers, and small streams that flow through the town. The city extends with Ethiopian territory on an area of 526-592 square kilometers [3].

It is located astronomically between latitudes 50′ 8° to 5′ 9° North and 38′ 38° to 54′ 38° East. It is clear from that the city is located within the subtropical climate region of mountainous lands. As a result of the city's height, the highland areas have become one of the best areas for the settlement of the population due to their moderate climate. Geographically, the town is in the heart of the Oromia region, the largest area in Addis Ababa. According to the Ethiopian Federal Land Transport Authority for the year 2019, it has ten districts called sub-cities.

2. 2. Study Sources

2. 2. 1. Statistical Sources

This study depended on data collected from various official government bodies in Ethiopia, such as censuses and population surveys, as well as data on vital statistics collected from multiple sources, such as the Ethiopian Central Statistical Organization and/or the United Nations websites. Additionally, the study also relied on some data taken from the Internet, and statistical data posted on the website of the Ethiopian Ministry of Transport.

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2. 2. 2. Spatial Data

It is represented in the maps of the administrative division of the study area, which are available in previous studies, the maps of the State of Ethiopia available on the internet, and the spatial data Shapefile for the road network.

2. 2. 3. References

It includes articles and books published in English and French as we as MA theses and PhD dissertations in some different disciplines. In addition, much research published in periodicals and conferences proceedings have been consulted.

3. Study Problems and Objectives

The study tries to highlight the importance of the role of transport in Addis Ababa through an analytical study of the transport network in the country. The analysis of transport networks has become one of the modern trends in geographical studies. This study aims to identify the most critical problems facing road transport in Addis Ababa, and to analyze the phenomenon of transport geographically and show its impact on development, whether urban or rural. Transport problems in Addis Ababa are represented in the diversity of classification of roads in the city as well as nodal and severe concentration in the town, which led to confusion and even stopped movement.

Therefore, this study classifies the road network in Addis Ababa, identifies the roads and the problems they are exposed to, mainly in quantity and quality, studies the movement and its directions and tries to link them to the efficiency of roads in the capital and geographically analyze the structure of transport networks in Addis Ababa so as to exploit the strengths and improve the weaknesses.

4. Results and Discussion

4. 1. Development of the Street Transport Sector

4. 1. 1. Improving Communication between Network Nodes

Improving communication between road network nodes helps to save the time required to carry out the journey between them better. However, many urban nodes need better access to them, as some nodes need more connection to other nodes in the network. The unequal distribution of social and economic services is necessary to achieve communication between nodes. Therefore, there is no node, whether urban or rural, that does not need to connect to neighboring nodes to accomplish any purpose of the trips, whether for work, Education, Shopping, visiting relatives, or treatment. To overcome accessibility issues between contracts, it is necessary to:

- provide a road (paved or codified) linking remote urban centers to the city belonging to them or linking them to the region's main road.
- provide a paved road linking the main satellite cities.
- provide a road linking small towns with their major cities.
- Connect small towns with paved main roads, facilitating access to various services, such as transferring students to their schools, transferring patients to hospitals, and the movement of stay-at-home parents to markets, all of which are primarily concentrated in major cities.

4. 1. 2. Raising the Efficiency of Roads in the City

Many paved roads need to be re-paved, whether by re-paving them to facilitate and achieve the prescribed speeds or by expanding to accommodate more traffic volumes. Table 1 shows some roads that need to be re-paved in Addis Ababa.

Table 1: Some roads that need maintenance in Addis Ababa in 2021

ROAD NAME	ROUTE LENGTH (KM)	ROAD CONDITION
SEMPU – KISSEM	85	UNPAVED
CHANGZHOU – DARBA	23	UNPAVED
AZZU – GORGORA	52	UNPAVED
TIA – AMOTI	12	UNPAVED
BUNGA – SHIDA	115	UNPAVED
ADOLA – SHAKESU	17	UNPAVED

Source: Asnake Adraro Angelo (31 May 2023): Safety Integrated Network Level Pavement Maintenance Decision Support Framework as a Practical Solution in Developing Countries: The Case of Addis Ababa, Ethiopia, https://doi. org/10. 3390/su15118884.

Carrying out the required maintenance operations achieves many positive steps, such as:

- Rapid transport of raw materials and agricultural products to consumer markets and factories in different regions.
- Reducing journey time, as most roads connect cities and villages or between many cities.
- Reducing the gap between rural and urban regions, as the migration of rural people to cities is only in pursuit of the abundance of various services, including roads.
- Facilitating the dispatch of means of protection and rescue to those remote urban areas.

4. 1. 3. Providing Alternatives

Many paved roads in Addis Ababa need alternatives, as increasing traffic on them leads to their lack of efficiency in transportation, frequent accidents, and economic and human losses, not to mention the high impact of these roads on the surrounding environment which pollutes and impacts human health. Therefore, it is necessary to search for an alternative.

5. 6. Providing Safety and Security on the Roads

Safety and security are essential elements of movement that must be available on any type of network, whether paved or dirt. They help to reduce the percentage of accidents and thus the losses resulting from them, as well as acts of bullying, robbery, vehicle looting, and passenger property theft.

4. 1. 4. Development of Means of Transportation in the State

The means of transporting passengers and goods can be developed. It helps to increase the mobility of the population, and also increases the ease of access to services, as the abundance of roads alone is not enough to reduce access between the population, economic and social services. Therefore, paths and roads are useless unless vehicles are working on them, Blazey et al [4]. Transportation issues pose a significant barrier to development in Addis Ababa's rural areas. While some regions completely lack any means of transport, others struggle with a different problem: the abundance of pickup trucks, primarily for carrying goods, being used to transport passengers. These vehicles are uncomfortable and slow, especially since they lack proper seating. This lack of suitable transportation options makes accessing essential services and facilities a major challenge. Traveling long distances for basic needs consumes a significant amount of time and effort, leaving little room for other productive activities. Farmers, for instance, lose valuable harvest time due to these transportation difficulties. Similarly, workers in various sectors might struggle to reach their jobs on time, ultimately impacting overall production [5].

Since the early 2000s, the National Institute of Physical Planning (NUPI), regional works, and urban development offices have prepared several urban plans; however, their attention to road and transport planning was mainly focused on the city rather than the urban and local level.

In the 1990s, the government of Ethiopia focused more on transportation and road networks to achieve its development goals. To implement these strategies, the government has developed a 10-year road and transport sector development program (2007-2027).

Fig. 1. The Evolution of Passenger Transport Vehicles from the Tractor to the Bus in Addis Ababa

source: Belew Dagnew Bogale (2016): socioeconomic impacts of road development in Ethiopia: case studies of gen gendewuha – gelato, Mile – weldiya and Ginchi - Kachisi roads, Doctor of Philosophy in Geography College of Agriculture and Environmental Sciences Department of Geography at the university of south Africa, P120.

A recent report by W. T Consult PLC (2014) indicates that improvements in the road and transportation sector have helped increase access to rural areas and integrate them into the mainstream economy (Fig. 1). They have also improved local mobility and transportation opportunities and access to services, including health, education, and other essential services.

Table 2: Value of Imports of Motor Vehicles during the Period (2000-2022)

year	Number of vehicles (in thousand Bir)	Percentage increase from the previous year	Increase in 5 years
2000	135. 789	-	-
2001	165. 328	22%	-
2002	259. 372	57%	-
2003	164. 765	-36%	-
2004	210. 621	28%	-
2005	179. 589	-15%	32%
2006	287. 134	60%	-
2007	339. 324	18%	-
2008	369. 944	9%	-
2009	279. 22	-25%	-
2010	189. 288	-32%	5%
2011	249. 844	32%	-
2012	177. 203	-29%	-
2013	402. 403	127%	-
2014	825. 89	105%	-
2015	1. 015. 951	23%	4. 37
2016	1. 393. 422	37%	-
2017	1. 117. 480	-20%	-
2018	795. 978	-29%	-
2019	1. 390. 946	75%	-
2020	1. 548. 459	11%	0. 52
2021	1. 456. 285	-6%	-
2022	1. 737. 245	-1%	-

Adapted from National Bank of Ethiopia, Annual Report, 2022/2023.

4. 1. 5. Appropriate means of transportation can be provided through the following:

- Equipping pickup means to suit the transport of passengers so that they are provided with a box to protect passengers from the sun, cold, dust, and wind during the trip, as well as comfortable and appropriate seats inside.
- Impose penalties and fines on those who fail to equip pickups to accommodate passengers.
- Preventing rickety cars, as their use threatens passengers' lives.
- Encouraging investments and facilitating procedures for operators to purchase vehicles and operate them in city transport services.
- Providing transportation to areas suffering from a lack of transport services.

Fig. 2. Pickups are not Suitable for Passengers. Source: World Bank Data (2014): Enhancing Urban Resilience, Ethiopia. https://www. worldbank. org/en/topic /addis-ababa-ethiopia-enhancing-urban-resilience.

Many areas, especially remote ones, suffer from the problem of deprivation of public transport services, as in the case of two informal settlements, the sub-city of Addis Ketima Wereda 07 (inner-city slums) and the sub-town of Kolfe kerana Wereda 03 (semi-urban) because the low population density in those areas makes the provision of public transport services somewhat expensive. Moreover, it increases competition with other cars, and

the scattering demand for that service in remote areas, reducing the commercial operation of those services, yet these communities have the right to obtain such services which raise the quality of life and reduce poverty, Sloman & Hendy [6]. www.cfit.gov.uk. Well-organized public transport in marginal areas can promote economic growth by improving social integration between rural and urban areas, achieving easy access to services, and facilitating movement between communities [7]. Providing public transport services in remote and marginal areas leads to the following:

1- Providing support by local authorities to units operating in lines or areas where economic operation is not achieved.

2- Bus service schedules that are commensurate with peak times, thus making the most of passenger gathering and maximizing capacity, Petersen. [8]

3- Supporting and encouraging the private sector to invest in passenger transport projects and encouraging civil and charitable associations to operate their transport vehicles to benefit from their revenue. This already exists in the Menagesha area where the Charitable Society for Orphans Sponsorship purchased two buses and operated them to transport passengers to the city. Relying on buses with a small capacity of 24 passengers facilitates the achievement of the economic capacity of these means.

Distributing these means with an average of (1-3) buses on the passenger transport lines increases alternative opportunities for passengers in remote and rural areas, and reduces the exploitation of taxi drivers. When public transport buses are distributed on the roads where the most significant number of urban shops are located, the scattering of demand for those means can be overcome, achieving economic capacity as well as the maximum rate of service frequency during the day, which increases the return. Moreover, this provides support by local authorities to units operating in lines or areas where economic operation is not achieved.

Bus service schedules, that are commensurate with peak times, makes the most of passenger gathering and maximizing capacity, Petersen [8]. Medium transportation operates on a large scale in the city, but under random operating conditions. There are no licenses, cost limitations, or commitments to certain itineraries or specific scopes. Still, in general, these means play an excellent role in improving access to isolated areas, as they break the isolation that many urban shops in the region were experiencing due to the lack of transportation, which was affecting the development of those peripheral areas, The scarcity or lack of means of transport is reflected in the high costs of transport, Miracle [9]. This hinders the ability of families in remote and peripheral areas to access the market, forcing them to continue to cultivate subsistence.

Opening the door to licensing these means and imposing penalties and fines on those who violate helps limit these means to achieve sustainability, as the lack of interest in licensing them leads to an undesirable increase that puts pressure on the quantities of fuel consumed, and increases environmental pollution as these means have become urban and rural at the same time. In addition to that, Licensing is useful for setting rules and defining fines in case of infringements. These means are responsible for many traffic accidents, theft, kidnapping and bullying in the city. Licensing helps determine the tariff for their use, which reduces transportation costs in the country. It is important to distribute these means to areas away from the main roads; they are only concentrated in certain areas. Preventing these means in urban areas, as these areas absorb such means, reduces their operation in peripheral areas of the city, distorts the urban environment, and leads to congestion. Preventing these means in urban areas, as these areas absorb such means, reduces their operation in marginal areas of the city, distorts the urban environment, and leads to congestion. The government, and local councils should join hands to assist the operators of these means by facilitating their licensing, supporting their spare parts, and establishing technical workshops for maintenance [10].

4. 1. 6. Supporting and Operating the Use of Traditional Means of Transport

Despite the development and diversity of means of transportation in the country, a large part of the implementation of trips in isolated and marginal areas falls on the responsibility of traditional means of transportation, as these means play a significant role in agricultural operations from the transfer of farm and animal production inputs and outputs. Other operations include grinding grain, obtaining fuel, and accessing services. These means are the most environmentally friendly, as they contribute the least to polluting the environment. They do not need fuel. Their use can be encouraged by the use of bicycles in city transport as a means of access to schools, shops, and workshops.

5. 10. Development of Vehicle Movement Systems and Transport Fees

Roads represent a theater on which vehicles move; thus, the movement of vehicles on the road is an integral part of the transport system. If it is disturbed and worsened, the impact of this on the rest of the system is disturbed. The movement of vehicles on the city's road network suffers from many problems that have been covered previously, as well as the case for transport fees. The movement of vehicles on the roads of the state can be developed and regulated through the following:

1) Determining the range of movement of different means.

Each mean differs in range. In many communities, trucks transport large quantities of inputs and outputs over long distances and at a relatively high speed on roads linking sub-cities in the region. At the same time, pickups are faster and more maneuverable, but their load is less [4]. While the tricycle load is much reduced, its range of movement decreases. The primary and secondary roads between traditional, medium, and advanced means of transportation, the consequent traffic problems that lead to many losses and determining the scope of movement lead to the division of the burdens of making trips on all means in the city, achieving the most significant benefit from them, and reducing the monopoly of specific means of trips, as is the case in the monopoly of microbuses to carry out most of the commuters, or the monopolization of tuk-tuks or pickups with specific lines, etc.

2) Controlling the routes of taxis.

These vehicles operate in routes commensurate with the sizes of those lines and the importance of the urban centers that connect them. Therefore, some lines suffer from the lack of vehicles operating on them, which affects the journey time, as the lack of vehicles means an increase in the waiting period for passengers in vehicles, which increases the journey time. Consequently, the routes of taxis can be adjusted through re-planning routes, and securing night taxis.

Routes, that cover all areas of the region and link them to their sub-cities, increases ease of access to sub-cities, which are the main markets for the disposal of products, especially peripheral ones, as well as the labor market and the service center. Distributing cars on the lines should be more organized by studying the volumes of trips generated by the parties to those lines to determine what is sufficient to transport those trips between the source and the target. Preventing unlicensed cars from working in passenger transport until they are licensed and providing them on their route ensures that vehicle owners adhere to the prescribed routes, which helps to increase opportunities for rural residents in different villages. Determining the minimum and maximum capacity of each line of operating cars helps avoid the concentration of vehicles in certain lines.

Securing night taxis, even if there are two cars per line, ensures service availability at all times. Emergency cases often require moving to hospitals quickly, forcing many families to rent taxis or other services to transport the patients at very high costs.

3) Tightening control over transport fees in the city of Addis Ababa.

The costs of transporting passengers and goods are subject to a lot of manipulation in many areas of the city, as the first is specified by the Traffic and Parking Department in the town, while the second is not specified, so there is an extreme need to tighten control over transport costs, this can be achieved through tightening control and following up on transportation fees in the various car parks. There should be signs showing transportation fees for each itinerary inside car parks in Addis Ababa, and fines should be tightened for violators of prescribed fees. Developing a system, that determines the costs of transporting goods (bar, Ton, Km), achieves satisfactory costs for the operator and the owner of the cargo.

4. 2. Development of the Light Rail Transport Sector

The development of the rail transport sector as part of the road network and as a means that plays its role in transporting passengers and goods inside and outside the country is significant; it can be achieved by overcoming the problems faced by this sector in the country.

4. 2. 1. Development of the Light Rail Network

The railway network needs to be developed and raised efficiently through the following:

1) Achieving connectivity between parts of the city.

All cities of the town enjoy the railway train service except the village of Jolili, the city of Culve-Kiran, and the town of Boli. Although the extension of the railway line of the sub-cities above has many benefits, the most important of which are (A) achieving connectivity between all centers of the capital with the light rail network, and (B) providing alternative opportunities for transportation between sub-cities using different means. These lines can then be completed to the rest of the neighboring nine regions with ease, leading to a network of relations represented in the transfer of goods and services from the capital to the neighboring areas or the ease of serving the neighboring areas with their water to facilitate shipping to the city of Addis Ababa, as is the case in the State of Djibouti.

2) Dual single lines.

Not all single lines need to be doubled, but some lines need to be doubled to facilitate access between stations, achieve high speed, and reduce trip time, which attracts many passengers. Among the lines that need to be doubled are Dewele line "Ali Sebieh" and Awash line Addis Ababa. Train traffic increases on these two lines, and the duplication of these two lines achieves many benefits, including the possibility of increasing the freight trains on the Addis Ababa-Djibouti railway to transport cargo loads to export ports, and reducing the delay of loads on paved roads. This, in turn, maintains prices in the markets and increases competition in foreign markets.

Reducing the pressure on the rail(s) helps them achieve sustainability, thus reducing maintenance and operating costs, which increases profits. Reducing the journey time due to short periods of waiting on the tracks to return saves time and great effort wasted by workers, who are the most passengers on the train, thus increasing working hours and production capacity, which achieves the highest productivity for workers.

3) Development of stations.

Many stations suffer from the broken parts of their old contents, such as Addis Ababa-Laga station, Ethiopia's oldest station. Therefore, it is necessary to pay attention to the development of these stations. Their contents include the box office, security and rescue services, waiting seats, and other services. The researcher proposes the establishment of some stations on the railways to link them to land transport at their intersection with the railway. For example, many passengers are heading from this point to many other areas at the junction of the Wiledia Mekele line with the Laiturikatu road, known as the sidewalk street.

4) Development of level crossings.

Level crossings represent the most dangerous components of the railways, as they are the only areas of communication between normal movement and train traffic. Therefore, railway crossings must be developed in all regions of the country without exception [11]. They appoint level crossing workers and follow up on their work periodically. They limit legal and illegal crossings to railway lines in the country and try to cancel, block, or turn them into legal crossings. Level crossings need to be converted to automated or electronic work to ensure the absence of human errors in opening and closing them. Subsequent human element training is required to deal with such systems.

4. 2. 2. Development of Trains

Trains operating on railways in the country suffer from slow movement, and inadequate equipment for passengers, which reduces the demand for people to take them. Trains can be developed through the following:

Fig. 3. Development of Ethiopian Railways in Addis Ababa, 2018

Source: The Arabic channel of China International Television Network (CGTN), available at https://arabic. cgtn. com/news/3d3d674d6642444d775133566d54/p. html.

- Periodic maintenance of current tractors and increasing efficiency ensure that trips are not excluded.
- Starting the process of replacing and renewing vehicles according to a specific time plan so that this comes in parallel with the maintenance work for the trolley equipment.

- Solar energy can be utilized to light carriages by installing solar energy cells on train roofs, and this method can also be applied to all train stations, such as the Adama station in Oromia region.

4. 2. 3. Development and Organization of Train Movement

Despite all its problems, the train represents a cheap and suitable means for a large category of the country's population. Therefore, the passenger may abandon a certain level of service to implement the trip in the shortest possible time, such as business trips. Hence, the organization of train movement is vital and can be achieved through:

- Electrification of the signaling system: Signals help regulate the movement of trains on the railway; defects in their work may result in many problems. Hence, the signals should be electrified to facilitate the movement and safety of trains. This can be achieved in time stages, starting with essential lines, such as completing the electrification of the Awash-Weldiya railway line.
- Reducing the duration of trips between trains: The lack of frequency of trains has increased the weighting of cars in the competition between them, as the continuous availability of vehicles made them more attractive to passengers. Therefore, it is necessary to reduce the trickling between trains. There is a train every hour or less during the day, but it is okay to increase the periods of trains at night.
- Trains' adherence to schedules and making signs with train schedules at each railway station.
- Diversion of goods trains in the evening.
- Separation of railways and parallel streets or residential areas that penetrate them. through concrete or iron fences or barbed wire that prevent the passage/intersection of people with the movement of the train in areas not planned for this purpose, and that does not exist to reduce the cost [11].
- Allocating a trolley to transport goods inside passenger trains, such as being a carriage at the end of the train, especially on the Dire Dawa-Addis Ababa route train line, where loading goods into the carriages leads to obstruction of passengers and crowding of the train. Therefore, the provision of such a carriage increases the safety of passengers and also collects the tariff for transporting these goods, especially goods that exceed 50 kg, as there are 16% of the train passengers transporting goods during their journey, such as vegetables, fruits, animals products, etc. Their weights sometimes reach more than 150 kg, and 86% of the carriers of these goods do not pay the tariff of their transport.

4. 3. The Future of Transport and Development in Addis Ababa: Addis Ababa as a Case Study
(A Proposed Model for the Development of the Capital):

The structure of a new street and mobility model is organized in Addis Ababa, with one intense major city center and several sub-centers. In addition to these centers, some areas (usually in the suburbs) with high residential areas, industrial areas, and markets are the main hotspots of attraction. Therefore, these areas are generating areas for trekking. Government policies and strategies also influence continuous and future development, significantly impacting mobility. Last but not least, there is a need to acknowledge that Addis Ababa remains a primate city and faces serious challenges, such as a rapidly growing population. Developing the transport and road network in the city and its suburbs is based on the need for a comprehensive transport plan and system to achieve sustainability and social, economic, and environmental competitiveness. Therefore, they must:

- Ensure economic sustainability and competitiveness within the framework of affordability and efficiency.
- Allow all the fundamentals of access and development in the sector for social sustainability.
- Limit emissions to an acceptable level and use renewable resources for environmental sustainability.
- Increase the ability of the street to move people more than vehicles.
- Promote sustainable transport through mass transportation, walking, and cycling.
- Adapt safety as a fundamental concept in street design.
- Street network design with fair distribution of space between different users.
- Provide an energy-efficient transmission system.
- Provide transportation (pedestrian and bicycle transport lanes) almost throughout the city.
- Provide bicycle lanes on business streets, market areas, and streets dedicated only to non-motorized traffic.

4. 3. 1. Energy-Efficient Transportation System

For the next planning period, mass transit and non-motorized transportation will be essential modes for the city. The share of mass transit will increase. non-motorized transport (pedestrian and bicycle lanes) will be provided throughout the city within the inner ring road, especially in the main center. Therefore, wide pedestrian access and bike lanes will be provided on lively streets and market areas. Certain streets will be dedicated only to non-motorized traffic.

4. 3. 2. Connecting to the City "Addis Ababa"

The entire inner ring road will partially be converted into a highway. This core of the city is expected to ease traffic pressures. Since goods will only be allowed to be transported to the city center at limited intervals, an additional entire highway (intermediate ring road) will be constructed to facilitate this mode of transport. It is recommended that the outer ring road (III) be placed outside the city limits, Kassahun & Bishu [12]. Thus, it links the surrounding cities to Addis Ababa. The connection also concerns market and service areas with residential settlements, linking different neighborhoods. The main center is expected to be related to the sub-centers through mass transit (public) services. In addition, it is planned to connect the capital, other cities, and settlements in the region via different roads and a hierarchically organized road network system.

4. 3. 2. Reduce Traffic

Twenty-eight high buildings dedicated to parking will be constructed within the inner ring road. Park and ride-on facilities will be provided at the outlets to reduce the number of private vehicles entering the city center. These facilities will be at the maximum extension of the city's regional outlets at the points of origin/destination for mass transit services. Parking facilities for cyclists and private bikers must also be introduced around mass transit stations outside the city center. All these measures will reduce congestion and pollution in the city's heart. There are some proposals for traffic, which are as follows:

- Prepare an integrated transport plan for the city for the next 10 to 25 years [12].
- Reduce the walking distance to the nearest public transport system to 500 meters.
- Reduce travel from home to work for one hour.
- Promote healthy mobility using efficient traffic management systems, appropriate parking, and peripheral facilities.
- Reduce the waiting time for the mass transit service to 5 minutes.
- Halve the annual average of 940 traffic accidents in the city.

• Apply environmental standards to vehicle use and reduce carbon emissions by half.

4. 4. Road Network

The Ethiopian Road Network is among the main activities that the Ethiopian government is working on, as the highway development program includes 17 projects among the plan (RSDP) for the rehabilitation of the country's main roads, 26 projects to develop some roads and annex them to the main roads, the development of 32 arterial roads (roads linking main roads) and the construction of 73 combined roads, Kassahun & Bishu [12]. This is undoubtedly the most extensive infrastructure development program in the country's history and perhaps one of the largest in the region. There are some proposals for the road network as follows:

• Increase the density of existing roads from 13% to 25% in the country to weigh the density at the standard rate.
• Provide convenient road infrastructure and related facilities for older people, children, people with disabilities, cyclists, and pedestrians.
• Provide a hierarchically organized road network with the necessary infrastructure.

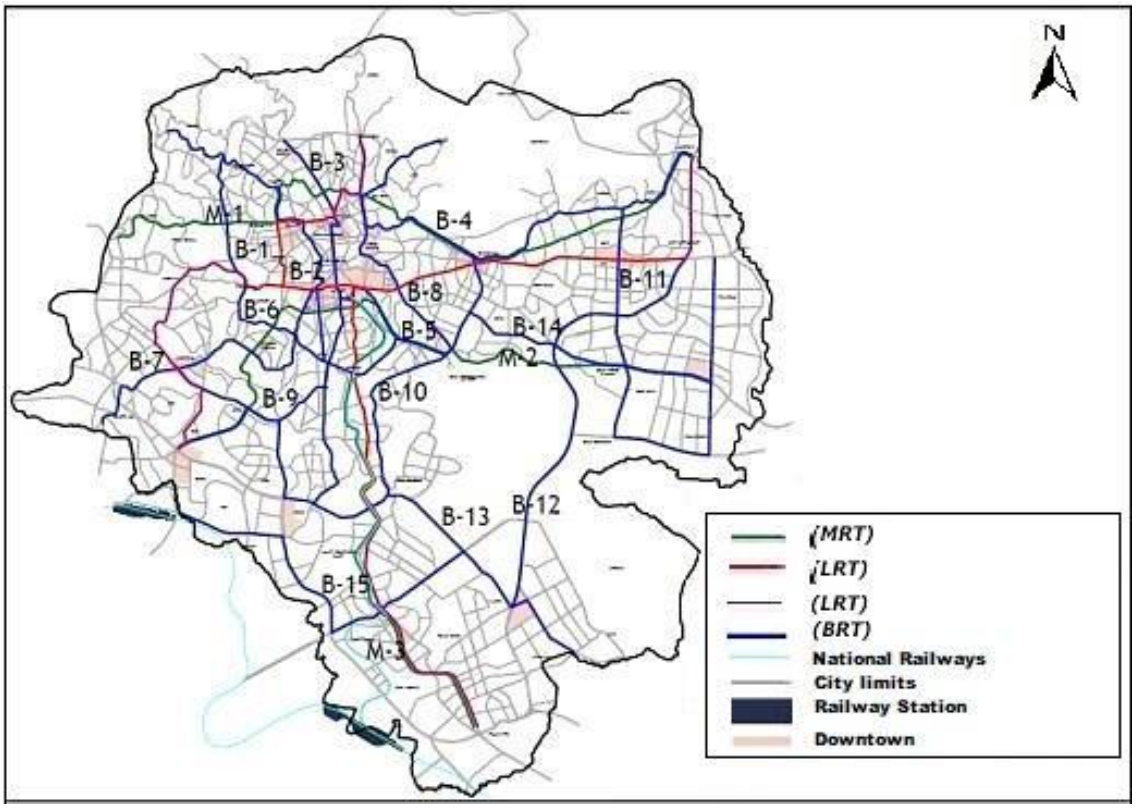

Fig. 4. Addis Ababa, City Development Proposal during the Period (2017-2027)
Source: Addis Ababa, City Structure Plan (12 September 2017): Draft Final Summer Report (2017-2027), Addis Ababa, Ethiopia, P. 91.
https://addis_ababa_structural_plan_2017_to_2027. orig nal. pdf.

4. 4. 1. Non-Mechanical Transport

Only three pedestrian lanes will be provided in certain areas within the inner ring road in vital areas and markets. These places selected for mass transit and non-mechanical transport can even be accessed. More attention must be paid to the planning and implementation of pedestrian paths that also accommodate people with disabilities. The pedestrian crossing will be built on highways. Planting trees in appropriate places will be given priority, especially on paths, islands, squares, and open spaces. Nineteen pedestrian crossings were also proposed on the city's east-west and north-south roads. In addition, 14 pedestrian crossings and four car crossings have been added to the inner ring road. Dedicated bike lanes will be introduced in areas with gentle slopes.

4. 4. 2. Mechanical Transport

The LRT line is 34.25 km long (North-South Line 16.9 km, East-West Line 17.35 km). These two lines (N-S, E-W) use a standard route of about 2.7 km, with a total passenger capacity of 60,000–80,000 passengers per hour. The passenger flow of the East-West Road in Addis Ababa (LRT) is estimated at 734.4 thousand people per day and 536.9 thousand people per day in the North-South direction [13]. The LRT project will run from Ayat Roundabout to Tafoe Roundabout, Georges to Cheromida, Torhei Lock to Jimo Lebo Center, and From Kaleti Interchange to Kaliti Center.

Fig. 5. Internal Rapid Transit System (BRT) in Addis Ababa**.** Gifti Nadi (12 April 2017): C40's Deadline 2020 report, P57, www. org/researches/deadline-2020.

15 bus rapid transit (BRT) lines were proposed to serve the city's busy corridors to feed the LRT systems from East to West and from North to South. BRT is also an urban project that will improve the entire public space along the walkway, facilitating the safe movement of pedestrians. Many BRT systems worldwide are expected to have multiple lines running along the same corridor on extensions where the need for traffic is high. The right of way will be reserved for the metro/subway. The MRT system is expected to be implemented within the next 25 years and will have an alignment ring and radial grid in the city.

4. 4. 3. National Railway

The historic national railway will serve the regional transport operation that extends back to the main city center (La Garr). The city's main center in (La garr) will be connected to the Cipita-miso railway, the national freight and passenger route, and Ume & Nwachukwu. [10] A 30-meter-wide rite of passage from Lagar to Akaki is reserved for national railways, and mass express traffic.

5. Conclusions and Recommendations

Addis Ababa has various transport systems, each suffering from different problems, whether in networks, means, movement, or transportation costs. Each issue has effects and consequences that harm the development process. Problems can be overcome by providing solutions, such as maintaining what is in place, providing alternatives, and giving control over the operation, all of which increase the sustainability of the country's transport system. Integrating the different modes of transport in the country is one of the most critical inputs to achieve sustainable development. Transport development and research in the future are the best solutions to solve problems in an ideal positive way instead of waiting for them to occur, as evidenced by the Ethiopian government's proposals in Addis Ababa for a new model for reshaping the modern city that contains different patterns in road networks and modern means of transportation.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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