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The Role of Transport, ICT and Power Infrastructure in the Ethiopian Economy[1]

Abstract. Infrastructure development plays an important role in reducing poverty, assuring food security and sustainable development of a country. One of the key challenges hindering the economic growth of developing countries is the lack of proper transport, Information and Communication Technology (ICT), and energy sector infrastructures. This research aims to examine the importance of transport, ICT and power sector in Ethiopia's economic growth and identify the main challenges these sectors have been facing based on data obtained from different secondary sources such as websites of the World Bank and Trading Economics, official reports, and published works. Descriptive statistical analysis was implemented to describe the secondary data obtained, while graphs, tables, and charts were used to visualise the results. Despite the difficulties in establishing and sustaining necessary infrastructure, research indicates that the growth of Ethiopia's economy is largely attributed to infrastructure development. Furthermore, year after year, progress has been made in each sector of development, though there are still obstacles to overcome. Poor quality of road, transport and ICT infrastructure have been key factors of poor development in the country. There is an imbalance between the power needed and the available power. Given Ethiopia's abundance of resources, the country must continue to prioritise infrastructure development.

Keywords: road infrastructure, air infrastructure, transport, electricity, power, economic growth, Ethiopia, regional development, ICT, economic development

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

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Роль транспорта, информационно-коммуникационных технологий и энергетической инфраструктуры в экономике Эфиопии

Аннотация. Создание инфраструктуры способствует снижению уровня бедности, а также обеспечению продовольственной безопасности и устойчивого развития. Одна из ключевых проблем, сдерживающих экономический рост развивающихся стран, — отсутствие необходимой транспортной и энергетической инфраструктуры, информационных и коммуникационных технологий. В статье проанализировано влияние транспорта, ИКТ и энергетического сектора на экономический рост Эфиопии, а также представлены основные проблемы, с которыми сталкиваются эти отрасли. С этой целью проанализированы данные из различных источников, таких как Всемирный банк, веб-сайт Trading Economics, официальные отчеты и опубликованные исследовательские работы. Для объяснения данных использован метод описательного статистического анализа; полученные результаты визуализированы в виде графиков, таблиц и диаграмм. Результаты показали, что экономика Эфиопии растет во многом благодаря развитию необходимой инфраструктуры, несмотря на трудности ее создания и обслуживания, которые еще предстоит преодолеть. Прогресс наблюдается в каждом исследуемом секторе. На данный момент низкое качество дорожной и ИКТ-инфраструктуры, а также дисбаланс между необходимой и доступной энергией являются определяющими факторами недостаточного развития страны. Учитывая обилие природных ресурсов в Эфиопии, правительству страны необходимо уделить приоритетное внимание развитию инфраструктуры.

Ключевые слова: дорожная инфраструктура, инфраструктура воздушного транспорта, транспорт, электричество, энергетика, экономический рост, Эфиопия, региональное развитие, ИКТ, экономическое развитие

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Introduction

According to the International Monetary Fund's Government Finance Statistics Manual (GFSM)[1] and the Classification of Functions of Government (COFOG)[2], infrastructure refers to the extensive network of systems that support and facilitate economic and social activities. These systems comprise various components such as transportation, water supply, sanitation, power supply, and information and communication technologies. The transportation infrastructure, for instance, includes roads, railways, maritime, and air transport. In the present study we concentrate on infrastructure elements that are crucial for economic development, specifically transport (particularly road and air), information and communication technology (ICT), and power supply. By doing so, the study aims to gain a more comprehensive understanding of how these critical infrastructure components impact economic growth and development. Hence, transport, ICT, and power infrastructure play critical roles in shaping the country's economy.

Efficient transport networks facilitate the movement of goods and people, supporting trade and economic growth. By connecting various regions, transport infrastructure enhances accessibility, reduces transportation costs, fosters economic integration, and contributes to regional development. Moreover, it plays a critical role in enabling businesses to access resources and markets, thus driving economic growth. Overall, transport infrastructure not only eases the movement of goods and individuals but also serves as a fundamental enabler of economic activity and development.

Furthermore, a well-developed Information and Communication Technology (ICT) framework empowers businesses, facilitates e-commerce, and promotes communication and innovation, all of which are instrumental in driving productivity and competitiveness.

[1] GFSM is a portal under the monetary fund which helps describe specialised macroeconomic statistical framework which can be accessed at

[2] COFOG was developed in its current version in 1999 by the Organisation for Economic Co-operation and Development and published by the United Nations Statistical Division as a standard classifying the purposes of government activities. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Classification_of_the_functions_of_government_(COFOG)

Additionally, reliable power infrastructure is pivotal for industrial and commercial activities, enabling businesses to operate smoothly and efficiently. Access to electricity is essential for manufacturing, healthcare, education, and numerous other sectors, thereby underpinning economic development. Therefore, investing in and maintaining robust transport, ICT, and power infrastructure is crucial for boosting economic activity, improving living standards, and positioning Ethiopia for sustained growth and development.

Theory

The expression "infrastructure" is primarily a technical term, yet it is one of the most commonly used and mostly debated terms of modern economic development. Its logical meaning covers the prerequisite, the basis, or the antecedent of the creation or development of something. The term "infrastructure" occurred in the common language in the 60s, though the use of infrastructure dates back to the beginning of the history of human beings.

After decades of debates, experts agree that infrastructure is an essential precondition of economic activities, services, and the life and development of settlements and regions. Infrastructure is considered to play a key role in the development of the living conditions, the employment structure as well as — in broader terms — the lifestyle of the population. Therefore, it contributes to economic and social development, being one of the most determinant elements of structural transformation. However, outdated or underdeveloped infrastructure does not only interfere with the speed of economic development, but it may lead to the sharpening of social problems as well as the creation of tension. Thus, infrastructure is a key element of poverty alleviation. Based on the abovementioned, infrastructure development must always be on the agenda, regardless of the size or the development level of a country. Indeed, infrastructure investment, as a proven method of successfully stimulating growth in the aftermath of an economic shock, must play a key role globally, especially during these times caused by the COVID-19 pandemic.

While pioneer efforts in the research on the topic suggest a positive relationship between infrastructure development and economic growth and report robust positive coefficients (Ratner, 1983; Aschauer, 1989; Mitsui & Inoue, 1997), a sizable number of subsequent studies have reported less than attractive results, thus suggesting a weak link between infrastructure development and economic growth (Munnell, 1992; Gramlich, 1994; Romp & de Haan, 2007). We support the first group of scientists and are convinced that infrastructure has a strong positive link with economic and social development, especially in our research area. Moreover, problems occur also concerning its measurement. While infrastructure is a multidimensional concept, empirical studies typically take a single-sector approach because it is difficult to capture multiple dimensions of infrastructure in a simple way.

Kessides (1993) also states that infrastructure affects profitability, levels of output, income, and employment, particularly for small-medium scale enterprises. Infrastructure also has an impact on the costs and service quality in international trade (trade logistics), which determines competitiveness in export/import markets. It also has an impact on domestic transaction costs and access to market information.

Moreover, infrastructure contributes to the diversification of the economy in rural areas, for example, by facilitating the growth of alternative employment and consumption possibilities. Infrastructure (especially telecommunications) provides access to applications of modern technology in many sectors. It is also key to the economy's ability to adjust the structure of demand and production in response to changing price signals. However, we agree that infrastructure investments cannot create economic potential, only develop it.

The economic growth of African countries can be greatly facilitated by their infrastructure, which plays a crucial role in reducing poverty, ensuring food security, and promoting sustainable development. According to Srinivasu and Srinivasa (2013), infrastructure is considered a prerequisite for any development, as it is difficult to achieve sustainable growth without adequate infrastructure. According to Calderón and Servén (2008), in most dimensions of infrastructure performance, Sub-Saharan Africa ranks at the bottom of all developing regions, so the strategic emphasis on infrastructure is hardly surprising. The literature suggests that some intrinsic features of Africa's economies may enhance the potential role of infrastructure for the region's economic development — in particular, the large number of Africa's landlocked countries, home to a major proportion (about 40 %) of the region's overall population, and the remoteness of most of the region's economies from global market centres. According to the research done by Foster and Morella (2011), the cost of Africa's infrastructure is high while the quality is poor. The writer also explained that the coverage of infrastructure in Sub-Saharan Africa is low compared to some similar developing coun-

tries with service prices as high as double compared to the other developing countries. Bloom et al. (1998) in their study mentioned poor infrastructure and high cost as the key determinant bottlenecks for the economic development of developing countries.

In general, it can be said that the African road and railway infrastructure is nation-based, as there are only a few big-capacity cross-border connections between the neighbouring countries. Moreover, in terms of international flights, there are still more international flights connecting African cities with destinations in Europe or the Middle East, than between two Sub-Saharan African cities. However, domestic flights are densely operated in many countries. For example, in Nigeria, the most populous country of the Sub-Saharan region, there are hourly flights between the old and new capitals (Lagos and Abuja) and also a dozen other domestic destinations operated by several companies.

The reason for the relative scarcity of international transportation corridors can be the fact that most Sub-Saharan countries do much higher trade with the biggest economic hubs (including the former colonizer in Europe) than with each other. Definitely a brighter future can be imagined by increasing regional trade and integration among African countries, however, it needs robust international infrastructure development. As for international railway connections, it can be said that during colonial times there were impressive ambitions to interconnect North Africa with the South, as the railway project of Cape Town — Cairo was initiated in 1874 (Ball, 2015), but the project has never been finished and there is no railway connection even between Egypt and Sudan.

Much later, in 1967 China initiated and successfully implemented an international railway project TanZam, connecting the landlocked country Zambia to the coast of the Indian Ocean in Tanzania (Bailey, 1995). Another China-initiated cross-continent infrastructural project can be mentioned, the Addis Ababa-Adama Expressway of Ethiopia and the Kribi Deep-water Port of Cameroon (Erdei-Késmárki-Gally & Neszmélyi, 2017).

It is a challenging task to simultaneously construct and establish the required infrastructures. However, prioritising the most crucial types of infrastructure is an intelligent approach to attain the desired outcome. Generally, countries prioritise their infrastructural needs based on their economic foundation. For instance, Ethiopia, with more than 79 % of rural inhabitants engaged in agriculture and being landlocked, focuses on enhancing its transport and power infrastructure to boost its economy. While it is beneficial to concentrate on the economic activity, where the majority are involved, it is also imperative to recognise the sectors that can meet the current requirements of the country.

Since 1993/94, the Ethiopian government has been implementing various reforms that have involved the processes of structural adjustment programmes along with the commercialisation of agriculture, private sector development, and several related poverty alleviation programmes. Successful implementation of the programmes requires an efficient infrastructural system. In particular, road transport is supposed to create a network over a wide array of infrastructural facilities. In addition, the road transport sector is essential for developing countries since advanced means of transportation may not be affordable for everyone. Fan and Rao (2003), based on several studies, indicated that public spending on rural infrastructure is one of the most powerful instruments that governments can use to promote economic growth and poverty reduction and among these services road transport sector is considered the crucial one.

The main aim of this research is to analyse the status of the transport, power, and Information and Communication Technology (ICT) infrastructures in Ethiopia. In addition, this research will discuss the role of these infrastructures in the economy of the examined country and the challenges that have been observed with possible solutions.

Data and Methods

To accomplish the research objectives, a thorough analysis of both quantitative and qualitative data is necessary. The data were sourced from several reputable sources such as the World Bank[1], Ethiopian Roads Authority[2], Trading Economics[3], National Bank of Ethiopia[4], published research works, and reports. This comprehensive analysis will provide valuable insights into the research subject matter.

Results

Scholars have presented various perspectives on transport and its characteristics. According

[1] World Bank is an international financial institution that provides loans and grants. https://www.worldbank.org

[2] ERA is one of the government organs of Ethiopia and is given the task of administrating the federal road network system of the country.

[3] Trading Economics is a website that provides information of 196 countries on different economic indicators. https://tradingeconomics.com/

[4] NBE is the central bank of Ethiopia. https://nbe.gov.et/

to Hoyle and Knowles (1999), it is a fundamental aspect of geography that acts as an intermediary between regions where communication is reliant on the status of transportation infrastructure. Robinson and Bamford (1978) define it as a means of secure travel from one location to another, such as from work to home, or from the marketplace to home and back. Similarly, the World Bank Project Appraisal Document (2003) views it as a factor that contributes to overall development, as transportation infrastructure promotes the production and distribution of goods and services, reducing regional inequalities and preventing shortages. In contrast, if transportation facilities and systems are limited, it can result in remoteness that negatively impacts economic development across regions, which in turn will create regional inequalities (Taaffe & Gauthier, 1973). In this study, we would like to focus on the road, air, and rail transport infrastructures in Ethiopia.

Road Transportation

The construction and upkeep of road transportation systems is what road transportation infrastructure deals with. There have been various advancements in Africa, not just in constructing roads but also in improving the institutions that manage and maintain them. The cost of logistics associated with road transportation in East Africa is higher than in any other region globally. Compared to other African sub-regions, the East African road corridors are in relatively good condition. Indeed, there has been a marked improvement over the last five years, with an increase in the proportion of paved sections. Improving road accessibility has been a major focus in African countries such as Ethiopia, however, the roads' coverage and quality remain a significant challenge.

A well-developed road transport sector in developing countries is assumed to fuel up the growth process through a variety of activities of the development endeavours of a nation. Among these, the creation of market access opportunities for agricultural products is the major one. The issue of market access is more relevant for a country like Ethiopia where the rural population accounts for about 79 % of the national population who are engaged in production for both the domestic and international markets. Moreover, road transport facilities play a role in both the production and consumption decisions of every household in their day-to-day activities. Besides, road transport facilities are essential for expanding education, health service provision, trade facilitation — both within the country and the export market, and better public as well as private service provisions, including banking and insurance services, to the destitute and marginalised rural dwellers. Likewise, roads serve as key infrastructural units, which provide linkages to other modes of transportation like railways, shipping, and airways. Shiferaw et al. (2013) found out that towns with good quality roads are more attractive to people and can draw companies to positively impact job creation, increase income, and decrease poverty. According to Hallaert et al. (2011), improving transport infrastructure in developing countries can increase exports by up to 10 %. Nagy et al. (2019) recommended improving transport access as a solution to enhance the livelihood of rural Ethiopian communities. We fully agree with Stoyanov and Sakharova (2023) saying that in modern realities, access to sustainable infrastructure is a basic good and a political right of every inhabitant. Furthermore, the availability of good quality transportation access and other infrastructures can attract tourists to a country, which can be a source of foreign currency earnings.

Oyesiku et al. (2013), who investigated the impact of public sector investment in transport on economic growth in Nigeria, concluded that transportation has a pivotal role in achieving sustainable economic growth. Alemnew (2015) also highlights the importance of investing in public infrastructure. He concluded that it has a significant impact on boosting output growth.

The extent to which public infrastructure affects a country depends on the level of quality and quantity desired. Ethiopia's government has invested significant funds in a variety of infrastructure projects since the downfall of the Dergue regime, including those relating to mining and energy, road transportation, information and communication, as well as health and education. In the meantime, the government of Ethiopia through its infrastructure development projects has prioritised the transport infrastructure over developing other infrastructure as the country has been landlocked after the secession of Eritrea 29 years ago by initiating the so-called Road Sector Development Project that was implemented between 1997 and 2010 (Shiferaw et al., 2015).

As per the Handbook on Infrastructure Statistics (2011), only one out of three rural Africans can access roads throughout the year, and the remaining half share is found in developing regions. Africa has made several improvements, not only in constructing road infrastructure but also in enhancing the implementing institutions' systems. Figure 1 illustrates that the road network distribution is lagging in the Benshangul and Gambella regions, despite having a favourable environment for in-

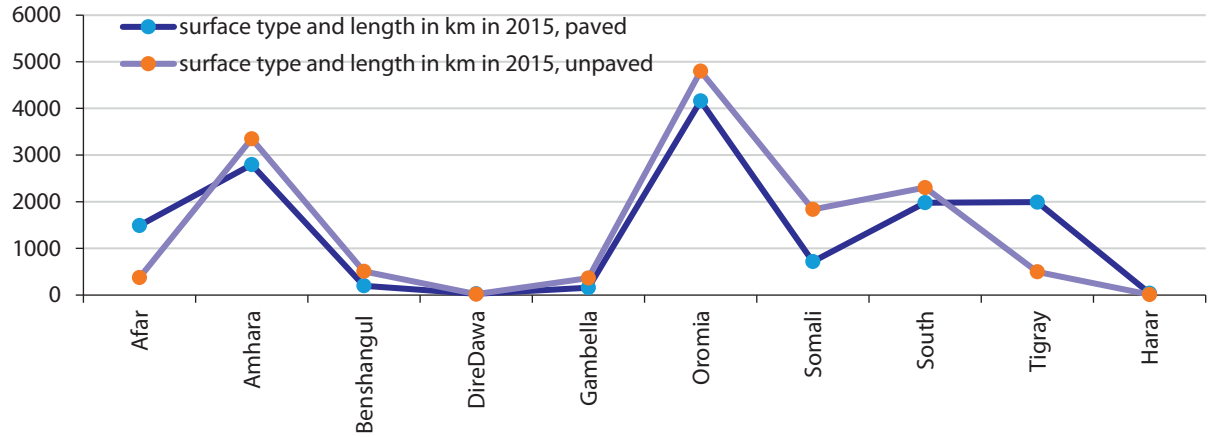

Fig. 1. *Distribution of federal road networks in Ethiopian regions, 2015 (source: Ethiopian Roads Authority, 2015)*

vestment opportunities. The chart indicates that the paved road coverage is slightly higher in all regions except for the Afar regional state, which is the major pastoral area. The paved roads' size depicted in the graph for the Afar region is limited to the main roads connecting the region to other areas, implying that the paved ways shown are probably similar to other regions in Ethiopia and indicating poor road infrastructure quality.

On the other hand, the majority of the Ethiopian road network is unpaved which is unsuitable for both cars and travellers. Table 1 shows that the trunk road network has the highest share of road networks.

As it can be seen from the map in Figure 2, the main road networks connecting Ethiopia with neighbouring African countries are Ethio-Djibouti, Ethio-Eritrea, Ethiopia-Somali, and Ethiopia with Kenya. Seeing the quality of these roads where more than 2,000 trucks per day use this main road, it is very difficult to easily transport goods from there, especially as a landlocked country benefiting from the port of Djibouti and other neighbouring countries. Even though Ethiopia has an option to use the renewed rail to Djibouti, which will improve trade logistics and reduce the transportation cost of moving goods in and out of the country, the balance of the imported goods which need to be transported and trains is not achieved. So, the main road to and from Djibouti remains key to transporting goods.

Table 2 indicates that there are 44,359 km of road networks in Ethiopia and the density of the road is 4 per square kilometre. There are about 5 vehicles per kilometre of road transporting 2,456 tonnes of goods and services and a total of 219,113 million passengers. This is an indication that Ethiopian road transport has a significant role in transporting goods and services and passengers.

Ethiopia has made progress in infrastructure development, but there are still challenges that need to be addressed. According to Foster and Morella (2011), infrastructure only contributed 0.6 % to Ethiopia's GDP per capita growth over the last decade. Bogale (2012) revealed that rural areas have insufficient infrastructure. He highlighted that only 10 % of the rural population lives within two kilometres of all-sided road directions. This means that the remaining percentage has to travel more than 2 km to reach roads, making it difficult to transport goods to marketplaces. As an agrarian country, Ethiopia needs better road access to connect rural farmers and enable them to reach marketplaces. Improving transport access is crucial for improving the livelihood of the rural community. The majority of Ethiopia's rural community is composed of agrarians, and better access to road transport facilities will allow them to engage

Table 1

Road network types and their nature in km

Road networks	Paved	Unpaved	Total Roads
Trunk	1343	—	1343
Link	335	374	709
Main access	237	611	848
Collector	—	385	385
Feeder	396	—	396
Total			

Source: The World Bank, IBRD, IDA. https://tradingeconomics.com/

Table 2

Total road networks, road density, vehicles per road, and roles of road transport in Ethiopia

Countries	Roads total network	Road density km of road/km2 land area	Vehicles per km of road	Goods transported in million ton-km	Passengers carried (million passenger-km)
Ethiopia	44,359	4	5	2,456	219,113

Source: https://tradingeconomics.com/

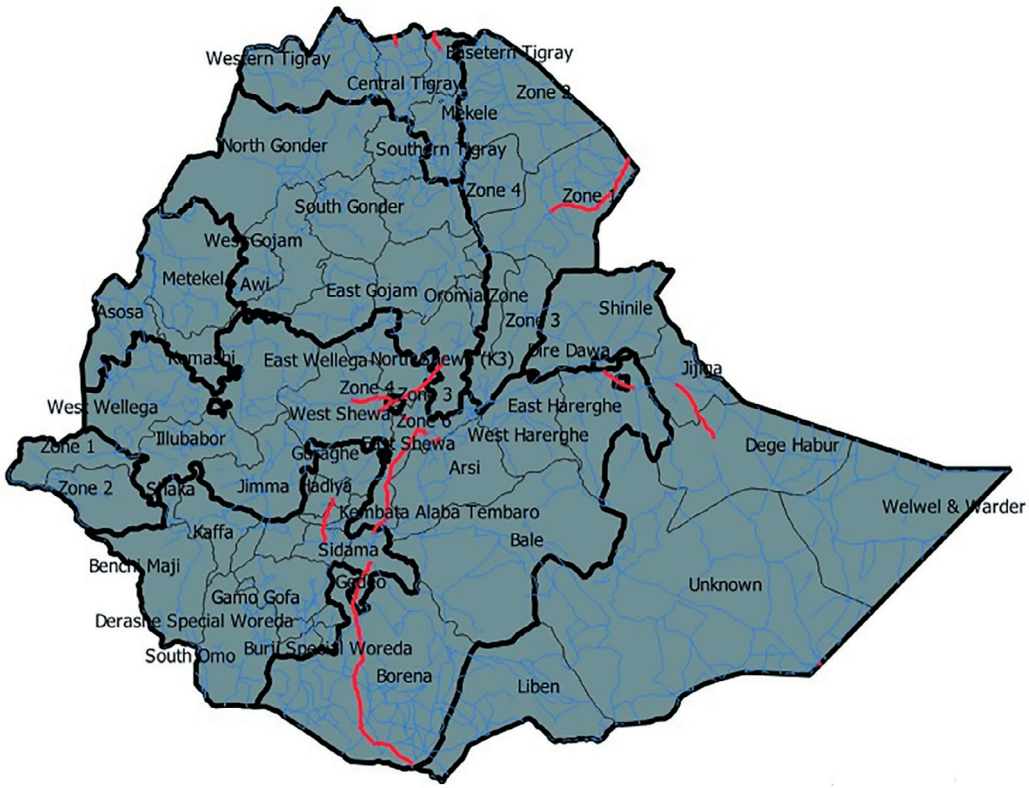

Fig. 2. *Road networks of Ethiopia (source: map from QGIS)*

in the market more easily. Improving the quality and access of transport is the primary challenge for Ethiopia. The financial constraints are a bottleneck in the process of increasing access to transport and improving its maintenance. Given the enormous investment required to construct road access, prioritising the construction of rural roads based on their return to national income is crucial.

Air transport

Another mode of transport that plays an important role in boosting an economy is the air transportation. Nowadays, air transport is one of the key determinant factors of economic growth. This sector includes the construction and maintenance of airports and all the systems linked to them. It is one of the world's most important and technologically advanced modes of transportation with a significant contribution to the country's economic growth. It eases the flow of goods, services and people by providing very speedy connections between regions, countries, and cities. Several studies (Brueckner, 2003; Green, 2007; Hu et al., 2015; Mehmood & Shahid, 2014) remarked that the role of air transportation in boosting economic growth is high.

These days the need for air transport has been increasing because business activities are time-sensitive as the competition among the business industries is growing. This mode of transport has a better advantage over other modes of transportation for the transportation of imported or exported intermediate goods and services. It is also the best mode of transportation for regions surrounded by mountains. Moreover, it enables countries to specialise in the production of goods and services and participate in global trade where they can benefit more, which in turn improves the quality of life of the inhabitants. This mode of transportation is not only important for transporting people but also plays a significant role in transporting goods via a cargo system. A study conducted by Shepherd et al., (2016) indicated that an increase in cargo development by one percent is likely to increase the total trade by 6.3 percent.

Considering the needs of Africans to use air flight, the current infrastructure seems adequate to serve the connectivity. These days, one of the primary difficulties that African airlines encounter is their poor safety records. According to Oyesiku et al., (2013), in Sub-Saharan Africa, 4.3 aircraft are lost per 1 million departures, compared with 0.7 elsewhere where the main reason for the accidents was the use of old aircraft. African countries such as Ethiopia and South Africa have developed well-recognised air transport systems relative to others.

The graph in Figure 3 shows the quality of air transport according to the World Bank data. As indicated, the Ethiopian airline's quality is be-

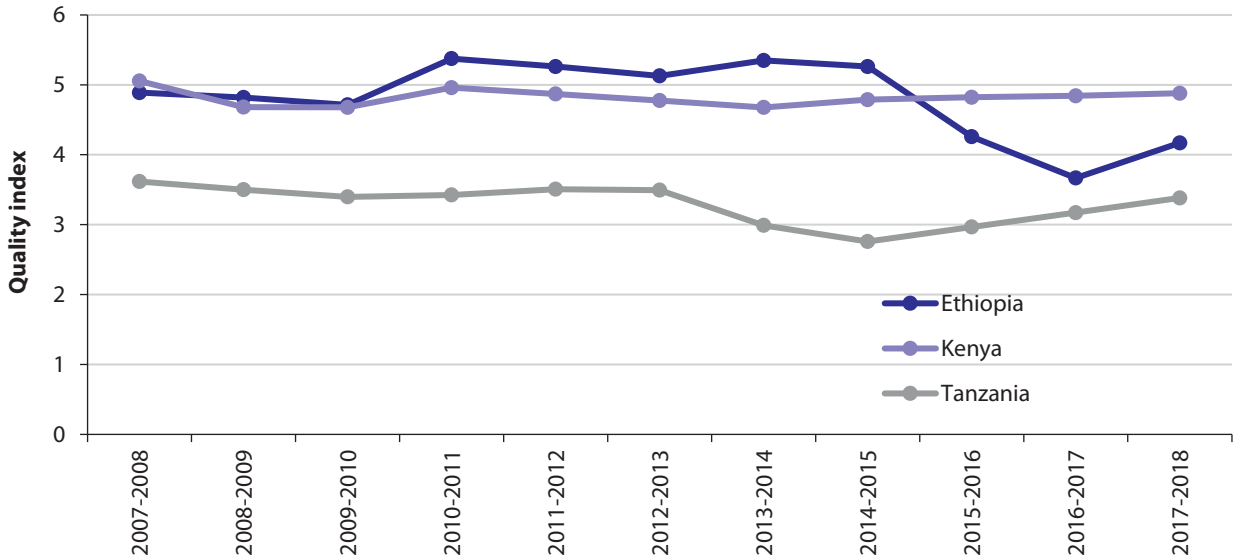

Fig. 3. *Quality of air transport infrastructure, East Africa (source: World Bank. https://tcdata360.worldbank.org/indicators/he8d17867?country=ETH&indicator=543&countries=KEN,TZA&viz=line_chart&years=2007,2017)*

low, but approximate to the Kenian quality of air transport.

Ethiopia owns one of the leading airlines in Africa, among the top three international transporters in Africa (Foster and Morella, 2011), with more than one hundred direct flights across the world, and a main flight connecting centre. The flight safety record of Ethiopian Airlines is globally recognised. The airline has more than 90 international destinations, where majority are African countries. For most Africans, the Addis Ababa Bole International Airport is a connecting hub to fly to other parts of the world. The Airline, as part of the service sector, plays an important role contributing more than 60 % of the service sector contribution (Ethiopia Economic Update). Including other transport services, the service account was 2,228.6 in 2015/16, 2,304.0 in 2016/17, and 2,919.6 in 2017/18 in Millions of USD (National Bank of Ethiopia, 2018).

Table 3 presents the freight and passengers carried by Ethiopian Airlines in the last 10 years. As is shown, the freight carried by Ethiopian Airlines for both exports and imports has been increasing over the specified period. Besides, with the increase in destination countries of the airline and the safety records, the number of passengers who flew via Ethiopian Airlines has been increasing. This indicates that the national gross domestic product (GDP) share that comes from this service has been increasing.

Furthermore, in addition to transporting human beings, Ethiopian Airlines plays a significant role in transporting goods and services through its cargo services. Accordingly, the freight carried in millions of tonnes and number of passengers transported by Ethiopian Airlines from 2010 to 2017 is shown in Table 3. Accordingly, freight carried has significantly changed from 407.062 million tonnes in 2010 to 2,089.278 million tonnes in 2018. This significant increment indicates that the contribution of the airline is improving dramatically. On the other hand, the total number of passengers transported has improved from 3,347,022 to approximately 8,154,244 (about 243 %) implying the preference of passengers. The number of international departures per year has also increased by 127 %, making 110,971 departures in 2018 compared to the 48,783 departures in 2010.

Besides the international flights, Ethiopian Airlines has at least one destination in every regional state. In some regions such as Tigray, Amhara, Southern Nations and Nationalities and Peoples, and Oromia, there are more than 4 lo-

Table 3

Freight carried (in millions of tonne-km), number of passengers carried and registered carrier departures of Ethiopian Airlines, 2010–2018

year	Freight carried	Number of passengers carried	Registered carrier departures
2010	407.062	3,347,022	48,783
2011	505.565	4,440,917	57,728
2012	703.644	5,001,121	62,136
2013	790.743	5,671,501	68,131
2014	950.157	6,274,582	71,166
2015	1,228.738	7,074,779	83,940
2016	1,500.148	8,242,114	94,330
2017	2,076.185	9,566,378	99,263
2018	2,089.278	11,501,244	110,971

Source: World Bank.

cal international standard destinations. In all these local destinations, there are at least two daily flight. Although the cost of traveling is high, its importance in connecting traders and easing the transportation of perishable goods is highly invaluable.

Railway Transport

Railways have played a significant role in the growth of Sub-Saharan countries where significant economic growth has been registered by dominating the role of transport of both public and good at low costs. According to the Railway Handbook 2015 (2015), railway transportation contributes to over 8 % of the global movements of passengers and goods. Furthermore, it carries about 6.3 % of passengers and 9 % of the freight of the world (Iimi et al., 2017). A good performance of the railway in terms of financial earnings can be measured for average shipping of more than 500–600 km (Liano et al., 2017; Olievschi, 2013). The railway can move heavy freights for a longer distance and is characterised as fast, reliable, convenient, economical, safe, fuel-efficient, and environmentally friendly.

In general, the railway is a less environmentally harmful mode of transportation compared to others (Joumard, 1995). According to the Railway Handbook 2015 (2015), compared to the emission of other modes of transportation, the railway sector contributes only 3.6 %; it is 50 % greener than road transportation. In Africa, particularly in East Africa, although this mode of transportation is more economical and environmentally friendly, it has not overtaken the role of road transportation yet. This is mainly due to a lack of infrastructure maintenance, and the ageing of rail lines (Gwilliam, 2011).

As indicated in Table 4, compared to East African countries, the Ethiopian railway is one of the least developed and its coverage is only limited to 781 km from Addis Ababa to Djibouti. The rail has transported 50 million tonnes of goods and 157 million passengers. In recent years, Ethiopia has been investing in railways connecting administration regions basically to transport goods from a connecting point of the Ethio-Djibouti railway line. Besides, the Addis Ababa train public transport system has been transporting the community. This is an indication that the importance of this mode of transport for transporting goods and people has been understood and got the government's attention.

Table 4

Railroad line in km, goods and passengers transported, Ethiopian railway

Railroad lines (total route-km)	Railway goods transported (million tonne-km)	Railway passengers carried (million passenger-km)
781	50	157

Source: https://tradingeconomics.com/

Electricity

According to the Classification of Functions of Government (COFOG) in the Government Finance Statistics Manual (GFSM) of the International Monetary Fund (IMF), electricity (power) covers both traditional and modern sources of electricity. Among the traditional, thermal or hydropower supplies and the modern sources such as wind or solar are the main ones. Besides, the power infrastructure deals with the system employed in the construction and distribution of electricity.

With the pace African countries are moving, they will be challenged to achieve the universal power needs of their country by 2050. The power access of Sub-Saharan African countries except North African countries and South Africa is minimal.

Ethiopia, a country with the most underdeveloped power system among Sub-Saharan African countries, has the potential to be the source of power to its neighbours and beyond. Ethiopia is endowed with vast hydropower potential. Electricity is almost a luxury for the Ethiopian rural community, although there have been improvements in access. The imbalance between the power needed in the country and the available power is a key challenge to the economic growth of Ethiopia. The distribution system is another bottleneck for the power sector where the poles used are old and need replacement. In some of the regions where there is high wind, the poles usually fall and cause several damages besides the slowing down of economic activities.

Figure 4 indicates that, although there have been improvements in accessing electricity, there is a huge gap between the urban and the rural community's access. Several reasons might be attributed to the low accessibility of electricity in rural areas. The main one is the cost of construction of electricity distribution. The cost of imported transformers is high. The other reason is the loss of power in distribution due to the ageing of distribution poles.

Electric power consumption in Ethiopia has been increasing as the country's development policy is towards industrialisation. As it is shown in Figure 5, the per capita power consumption has been increasing in the past two decades. With the increase in population size and the introduction

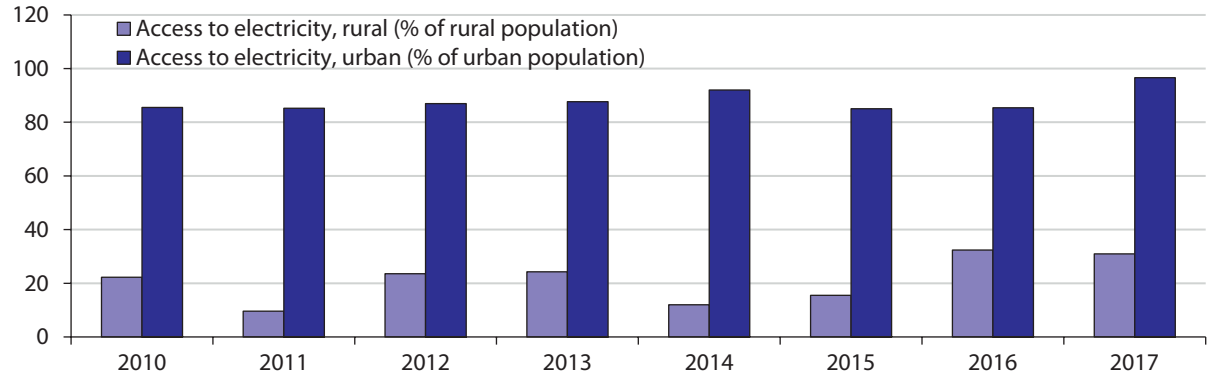

Fig. 4. *Access to electricity, rural and urban inhabitants of Ethiopia, 2010–2017 (source: World Bank data, own computation)*

of modern technological household materials, the utility need is expected to increase.

Since 2012, Ethiopia has been working on a major electric power dam that is expected to generate 6000 megawatts annually. Additionally, numerous small-scale dams have been constructed across the country over the past decade, contributing to economic growth. The completion of the Ethiopian Grand Electric Power Renaissance Dam will address the country's power shortages and increase access to electricity for rural Ethiopians. Furthermore, Ethiopia plans to export some of this power to neighbouring countries, which will generate foreign currency and create job opportunities through increased investment. Moreover, the dam would enable Ethiopia to implement a significant agricultural development programme which means 3.7 million hectares of land for irrigation-based agriculture with the view of the elimination of starvation concerning nearly 3 million human beings (Glied, 2008).

Information and Communication Technology (ICT)

Information and Communication Technology (ICT) refers to the implementation of services, construction of physical infrastructure, and maintenance of communication systems. The coverage of ICT services in Ethiopia is one of the lowest in the continent, with only a small fraction of the population being able to access them. Based on Foster and Morella (2011), only 10 % of Ethiopians have access to GSM signals and the subscription rate for GSM is only 1.6 % of the population, which is significantly lower than the benchmark for low-income countries at 48 % and 15.1 %, respectively. Foster and Morella (2011) also suggest that internet access is among the lowest in Ethiopia, with a speed of only 0.3 megabits per second per capita, while the benchmark for similar low-income countries is 5.8 megabits. Additionally, they note that Ethiopia has invested less in the ICT sector compared to other African countries, preferring to focus on power and transport infrastructure.

Recently, there has been a noticeable change in policy under the leadership of the Prime Minister Abiy Ahmed (PhD) in Ethiopia's government. The concept of privatisation which was not implemented in the past has been a key part of the developmental strategy of ICT especially about the network. Internet access was managed by government-owned telecommunication which is now under study on how to involve private sectors. Privatisation of these telecom services will create an opportunity for foreign companies and

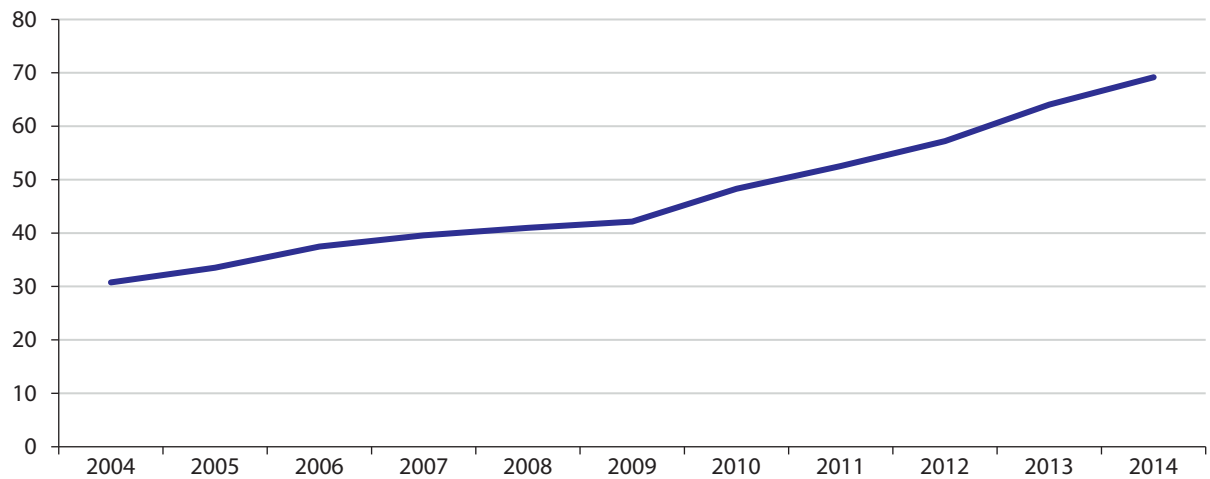

Fig. 5. *Electric power consumption (kWh per capita), Ethiopia, 2004–2014 (source: World Bank data, own computation)*

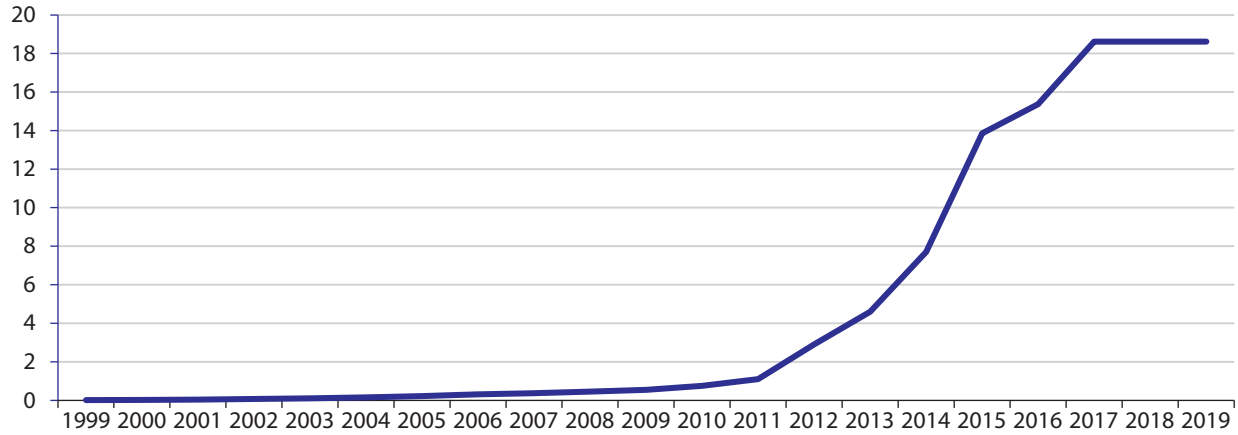

Fig. 6. *Internet service, Ethiopia, 1999–2017 (source: World Bank, own computation)*

will open a room for competition that in turn will increase the efficiency and accessibility of both broadband and mobile networks. According to the World Bank data indicated in Figure 6, the proportion of the population using internet access has been increasing, although the network signal and the cost are somewhat to be questioned.

With globalisation affecting every single household nowadays, farmers are using their mobiles to check the market situation and the global environment. Thus, ICT can play an important role in boosting the livelihood of individuals and the growth of the country.

Conclusion

Infrastructure plays an invaluable role in facilitating the economic activities of a country. Without proper infrastructure development, it is unimaginable to have a developed country. The main elements of infrastructure development included in this study are transport, power, and information and communication technology. Ethiopia is one of the richest countries in the world in tourism, livestock population, and other agricultural commodities such as coffee, oilseeds, etc., which are exported. Road transportation is an important infrastructure that creates market access for rural farmers and allows tourists to move from place to place at cheaper prices. The road transportation quality in Ethiopia is among the poorest in the region where the major part is still either unconnected or unpaved. Especially in some of the emerging regions such as Gambella and Benshangule, the length of paved roads is limited. The system of road transport is also one of the key challenges that need to be addressed.

But, even though there are impressive developments that can be witnessed inside Ethiopia and in other African countries as well, the cross-border interconnection is a bottleneck. Increasing trade and cooperation between neighbouring African countries might hopefully develop to a more intensive extent in the future which may accelerate the establishment of more cross-border and cross-continent railway and motorway connections.

Ethiopian Airlines has been a significant contributor to the country's economy by providing a major share of services to GDP. However, the cost of domestic flights is high, making it unaffordable for many Ethiopians. The contribution of the power sector and ICT towards economic growth also is pivotal. The great challenge that Ethiopia has is the power where the majority of the rural areas still need electricity access and the industrialisation process requires a lot of electric power to function. To overcome this bottleneck, the Ethiopian government with Ethiopian population self-financed the Grand Ethiopian Renaissance Dam on the Blue Nile River. This will not only solve the power scarcity of the country but also will positively affect the country's economic growth by becoming a source of foreign currency that Ethiopia has been challenged. Through the privatisation of government-owned infrastructures such as power and telecommunication, the government should enhance both the accessibility and strength of network signals and proper electric power distribution by reducing the losses. Furthermore, focus should be given to the improvement of quality of roads and maintenance of the available roads.

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