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Article

Trans-Regional railway corridor implications on urbanization

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Abstract: Recently, the government of Ethiopia has been engaged in modernizing the trans-regional Ethio-Djibouti railway infrastructure using the Belt and Road Initiative. This railway corridor has been serving as the main get way for the landlocked Ethiopia to the port. This article creates an insight about the implications of the Ethio-Djibouti railway corridor by exploring the question: what kinds of urban form and morphological changes evolved due to the railway corridor? To examine the impact of this railway corridor, the article employed stratified sampling and multiple criteria intermediate cities selection method. Accordingly, four (Bishoftu, Mojo, Adama, and Dire Dawa) intermediate cities were selected as case study. The article points out that the railway corridor conceived different kinds of linear urban centers around stations. The identified four intermediate cities attract industries and logistic centers. Those industries, logistic centers, and new railway stations often established at the periphery of intermediate cities resulted labour influx from rural and nearby small urban centers and urban expansion that caused a rural-urban continuum of ribbon settlement and strengthen trade gate way for the landlocked Ethiopia that caused trans-regional integration.

Keywords: industrialization; intermediate cities; urbanization; railway station; railway corridor; regional integration

1. Introduction

Urban centers are an engine of economic growth that serves as a nucleus for agglomeration of people and firms for the flow of goods, services, ideas, innovation and technology (Ofori-Amoah, 2022). Urban development is highly path-dependent usually, it evolved on river banks, coastal lines, and terrestrial transportation lines (Woodlief, 1998; Salm, 2005). The provision and improvement of transport infrastructure can give rise to growth in productivity through the reinforcement of agglomerations of people and resource benefits (Chen and Abreu, 2011; Rietveld, 1992). Transport infrastructure improvement in return could accelerate travel time and cost interaction. The travel time-cost interaction also had an impact on land use in terms of accessibility and connectivity. Accessibility from urban or regional vantage point refers to the ease of access opportunities within a given spatial distribution using transportation infrastructure and services (Pulido et al., 2018; Rodrigue, 2020). It is one of the crucial components in the transportation networks. On the other hand, connectivity refers to the functional relationship of different activities (firms, services, facilities, etc.) with in an urban or regional area (Kindlmann and Burel, 2008; Molaei, 2021). Of the different terrestrial transport infrastructure, the railway transport corridor

is the most prominent one that has a direct impact on land use dynamics and development in urban and regional areas (Navalkar, 2023; Sang, 2022). With the advancement of railway transport technology, it has recently become more preferable than other terrestrial modes of transport due to its energy efficiency, low greenhouse gas emissions, and increasingly important role in the conveyance of freight over long distances (Marson, 2021; UIC, 2019). Apart from these, railway infrastructure has centripetal power that serves as nuclei for the accumulation of people and firms for the flourishing of urban centers around stations (UIC, 2019). This created two major railway corridor-based station development approaches: modernizing the old inner city railway stations or the construction of new stations on the periphery of the urban centers (Bharti, 2023; Marson, 2021).

Stations on the railway line often play a significant role in designing sustainability strategies for the corridor in general and urban centers in particular. Modern railway stations often trigger holistic (social, economic, and environmental) development within the courtyard and its integration with the urban center (UIC, 2019). Railway stations are increasingly the focus of integrated transport and land use development efforts using different modalities. These are: node-place development (NPD), transit-oriented development (TOD), compact or integrated development (CD/ID), and corridor-oriented development (COD) frameworks (Bertolini, 1998; Bolton, 2014; Paaswell, 2008; Schwander, 2007). To plan an urban area or neighborhood for sustainable mobility, two major streams of thoughts are identified: TOD and CD/ID (Paaswell, 2008; Pulido et al., 2018; UIC, 2019). Often 'TOD, practiced in North America; 'Node-Place' development/redevelopment around railway stations in the form of CD/ID in Europe and elsewhere (Bertolini, 1998; Navalkar, 2023).

In Ethiopia, modern railway transport was introduced during the reign of Emperor Menelik II (1888–1913) (Bahru, 2002; Pankurust, 1967). The advent of the railway infrastructure caused the flourishing of the eastern economic corridor. This railway-corridor development results in flourishing urban centers ranging from small towns to intermediate cities; the establishment of industrial plants in the vicinity of railway stations; the inflow of people from rural to newly flourishing railway station-based monocentric urban centers; inter- and intra-trade linkages among regional states, etc.

Although the Ethio-Djibouti railway corridor has existed for more than a century and has an indispensable role in urbanization and regional development, it is often overlooked by researchers and policymakers. However, there are few studies that address the historical development and economic benefit of the railway line (Bharti, 2023; Chen, 2021; Kozicki, 2015; Pankurust, 1967), but none of them addressed the railway corridor prospects or potential impacts on urban and/or regional development using TOD or CD/ID planning option. This triggers the researchers contribute to the academic world about the old railway corridor and its impact on the then-time urban development paradigm of station-based urbanization as well as the current periphery-oriented station development prospects for urbanization and regional integration.

Therefore, the purpose of this article is to examine the role of railway infrastructure corridor development for city formation that evolves from monocentric station towns to intermediate cities; industrialization through special economic zone

development in the form of industrial parks; and regional integration as urban-rural linkages as well as regional linkages.

2. Review of literature

2.1. Railway corridor

The word corridor refers to a passageway, or 'route', or 'an area or stretch of land identified by a specific common characteristic or purpose' (Merriam-Webster, 2023). Epistemologically, the term 'corridor' is derived from the Latin word 'currere' meaning to run (Furundzic, 2013). Whebell (1969) explains corridor as 'a linear system of urban places together with the linking surface transport media' (Whebell, 1969). From a physical or spatial planning perspective, corridors are bundles of transport and logistics infrastructure that connect two or more urban centers (Priemus, 2003).

As one of the major terrestrial infrastructures, railway corridors have significant roles in urbanization, which results in industrialization and rural-urban integration. Railways transport represents an essential aspect of socio-economic urban life, and railway transportation systems, consisting of networks and nodes, or growth poles, have distinct urban and regional functions (Furundzic, 2013). The railway transport system has a spatial structure of infrastructure corridors and stations. Often, stations serve as nodes for access to transport networks. The provision and improvement of railway transport infrastructure can give rise to growth in productivity through the reinforcement of agglomerations of people and resource benefits (Chen and Abreu, 2011). An ideal infrastructure corridor and station design and development with advanced materials will create a more sustainable urban and regional environment (Furundzic, 2013).

2.2. Railway corridor verses urban formation and urbanization

Corridor oriented urbanization is directly related to the linear or ribbon pattern urban form concept. As a planning concept, linear or ribbon urban development was introduced in the late 19th century by the Spanish urban planner Soria y Mata (1844–1920), who developed the idea of the Ciudad Lineal, a linear garden city (Aggarwal, 2020; Hall and Tewdwr-Jones, 2020). Following him planners like Hilberseimer (1955) gave special attention to 'a linear system of urban growth with strong connecting links', through producing maps that depicted this fact, and the architectural historian George R. Collins (1960s) theorized the notion of linearly oriented urbanization (Aggarwal, 2020). "...linear growth is the natural pattern of growth in urban regions. Cities develop along a linear passage called a corridor which is usually its artery of transport for people, goods, and services: Roads, rails, pipes, and wires" (Collins, 1968).

Linear urbanization is mainly a modernist concept and can be regarded as an urban/spatial expression of the modernist (Fordist) approach, inspired by mass production and the development of the train, highway, and interrelated lines (Sap, 2007).

The technical term 'corridor' was used in urban and regional planning in the late 1950s (Aggarwal, 2020). Then the corridor development concept becomes an explicit

part of urban and regional spatial planning (Sap, 2005). Corridor based linear or ribbon urbanization can be observed as an evolutionary and long-term concept for urban or regional development that is shaped through technological advancements and location threats (Sap, 2007). The corridor urban center, as part of a historical urban pattern, is regarded as a spatial expression of postmodern flexible production and the decline of spatial fixation (Sap, 2007).

2.3. The implication of railway corridor based urbanization

2.3.1. Industrialization

The development of railway corridor is tantamount to the flourishing of urban centers around stations. Railway stations, particularly freight stations, attracts firms, which leads to industrialization in station based urban centers. Industrialization is the process of sectoral transformation in which industry is dominated (Britannica, 2023). The transport infrastructure corridor, particularly the railway corridor, has had an indispensable impact on industrial development and industrialization process. Industrialization is the key to economic development (Fundan SIRPA, 2017). Modern industrial sectors improve productivity, foster innovation, facilitate technology diffusion, and have other positive spillover effects (Fundan SIRPA, 2017). Nations used different policy options for the realization of industrialization in their countries. The prominent policy options are: Import substitution, export-oriented industrialization, special economic zones, and agro-industrial parks (Fundan SIRPA, 2017).

Scholars argued on the direct correlation between station-based urbanization and industrialization. Often, urban centers on railway corridors and industrial parks have a direct nexus that accelerates urban dynamics and transforms the area into an 'intermediate city' (UCLG, 2016).

2.3.2. Urban dynamics

An urban center is comprising of both natural and built environment and whose endogenous dynamics, external interactions (Bolay, 2020). Recently urban centers usually expand in industrial areas with diversification of land use, new infrastructure, regional reconfiguration of rural-urban interface, modes of investment and governance (Bolay, 2020). Lefebvre (1970) identified that urban dynamics evolved on urban dwellers, infrastructures and economic activities (Bolay, 2020). Therefore, these three an anthropogenic forces of population, infrastructure and economy that shape and reshape the morphology of cities over time considered as urban dynamics (Bolay, 2020; Latitude Geography, n.d.).

Urban dynamics perceive the city as a complex social and economic system formed by the interactions of different parties ranging from individuals to government agencies and firms' efforts to achieve their respective goals (Alfeld, 2009). Urban dynamics, will serve as urban management tool for urban policy analysis that embraces a conceptual understanding of the city as a whole (Alfeld, 2009). It can facilitate analyzing the city's various activities as interrelated functions (Alfeld, 2009). Often, urban dynamics try to evaluate the main components initiating or being affected by changes within a given urban territory (Rodrigue, 2020). Of the different factors impacting urban dynamics, transportation is the prominent one (Rodrigue, 2020).

Transport infrastructure development is expected to improve the mobility of passengers and freight, which in turn will improve the overall performance of an urban and/or regional economy (Rodrigue, 2020).

2.3.3. Intermediate city

The word 'intermediary' was first introduced in the academic world in the mid-1980s, which resembles a medium-sized city' (Torne and de Duque, 2016). There are many different viewpoints about intermediate cities. Some countries interchangeably use intermediate or middle-size cities and secondary cities, as categories of intermediate cities (Cities Alliance, 2022). Roberts et al. (2014). propagate contextual definition of intermediate city using population size, administrative area, political, economic, and historical significance of a system of cities below the primary order of cities within a country or geographic region (Bolay and Kern, 2019; Roberts and Hohmann, 2014). Usually, the population of intermediate cities ranges between 10-50% of the country's primate city (Roberts and Hohmann, 2014). Intermediate cities often constitute a sub-national second-tier acting as administration hub, education or knowledge hub, referral hospitals, industrial or development growth pole, new national or sub-national capital, a large city making up a cluster of smaller cities in a large metropolitan region (Bolay and Kern, 2019; Roberts and Hohmann, 2014; UN-HABITAT, 2016). United Cities and Local Governments (UCLG), define an 'intermediary city' using the elements of a specific demographic size of more than 50,000 and the functions they perform, such as their role in mediating flows of goods, information, innovations, administration, etc. between rural and urban areas, within the respective areas of influence, and with respect to other urban centers or regions, which may be close to them or more distant (Torne and de Duque, 2016). UN-Habitat recognize population size variations among states; it labels ranging from 20,000/50,000 to 500,000 up to 1 million inhabitants depending on the countries and regional contexts (UN-HABITAT, 2016). There are different types of intermediate cities, and these can be broadly categorized into: regional, clustered, and corridor intermediate cities (Bolay and Kern, 2019; UCLG, 2016).

Ethiopia has used the terms intermediate city and secondary city interchangeably since 2005, with the approval of national urban policy (Cities Alliance, 2022). The Ministry of Urban Infrastructure (MoUI), which is an authorized government organ for making urban-related regulatory frameworks, considered urban agglomerations having greater than 20,000 inhabitants and/or sites of regional states and/or economically vibrant as intermediate, secondary, or major cities (MoUDH, 2016).

Currently the MoUI, has been in the process of revising the National Urban Policy, the 2016 Urban Plan Preparation and Implementation Strategy and developing regulatory document that will serve in determining hierarchy of cities. Ln these draft regulatory legal documents, the minimum population threshold criteria of intermediate city increased to >50,000 inhabitants (MoUI, 2020, 2023).

2.3.4. Regional integration

Regional integration is a means to "achieve sustained, equitable, and inclusive economic growth in least developed countries […] and overcome their marginalization through their effective integration into the global economy" (Söderbaum, 2006). It also emphasizes facilitating development in least-developed countries through improved

productive capacity, infrastructure, and trade.

Regional integration is crucial for sustainable and inclusive development (AU et al., 2019). It cannot happen without adequate infrastructure. Of the different territorial transport infrastructure, railway has inter-regional effect on the region and/or urban centers that lays along the railway corridor (Liu, 2022). These effects can be broadly categorized as internal and external to the urban centers. Internally it has a catalyst and industrial agglomeration effect. On the other hand, the external effect of railway infrastructure on the structure of an urban centers are mainly: integration, industrial diffusion, siphon and gradient effects (Liu, 2022).

Integration effect refers to the development pattern of an area and interaction between urban centers in adjacent areas due to economic and population density as the administrative boundaries of individual cities tend to blur with the convenience of inner-city transportation and the continuous shortening space time distance (Liu, 2022). The standard gauge railway with all-weather running capability greatly improves the efficacy of commenting between neighboring cities.

Industrial diffusion effect refers to the gradual radiate and spread of industrial development economic effect to the surrounding area (Liu, 2022). The impact of standard gauge railway infrastructure on industrial diffusion effect is mainly focused on: the flow of factors driven by the railway and agglomeration resulted in confusion and rising costs. Due to the industrial diffusion effect, large cities' production and economic factors are more likely to flow to nearby small and medium-sized towns, spurring the development of the central towns. In general, big cities have advantages in the fields of technology, capital, talents, and information. Small and medium-sized cities' development must be complemented by these factors.

Siphon effect describes the occurrence when a particular region, because of its advantageous position, draws production elements from other surrounding regions to congregate in itself, diminishing the development base of other regions (Liu, 2022). Usually, urban siphon effect is a phenomenon that refers to the continuous expansion of urban areas at the expense of rural lands (Song et al., 2023). The urban siphon effect has several underlying factors that differ depending on the location (Song et al., 2023). Population increase, economic expansion, and infrastructural development are a few of the main forces behind urbanization (Song et al., 2023). Large cities' dominant position is further cemented by the development of railways, which have improved inter-city and inter-regional mobility and made it easier for production factors to flow to areas with stronger levels of economic development and better development environments (Liu, 2022). This has increased large cities' appeal and generated stronger development momentum (Liu, 2022).

Gradient effect changes in the regional development pattern along the railway lines will result from the different weak attenuation of distance caused by standard gauge railway, which will encourage the allocation of resource factors on a broader regional scale (Liu, 2022). Specifically, over time, standard gauge railway tends to amplify the components' siphoning effect in certain cities along the railway corridor, whilst in other locations, the centrifugal effect would manifest to differing degrees (Liu, 2022). This is mostly because cities around the railway lines have developed largely as a result of the railway infrastructure particularly the railway station (Liu, 2022). This is mostly because the cities along the railway corridor differ in terms of

economic scope, degree of development, urban functions, and inventive capacity (Liu, 2022). This gradient difference, which indicates that cities on the higher gradient will have access to greater factor resources while cities on the lower gradient are at risk of factor outflow, sums up the differences in the roles played by railway in various cities (Liu, 2022). Low-gradient cities are primarily small and medium-sized cities with small scale and less specialized functions; high-gradient cities are typically center cities with great overall potential, cities with specialized functions, etc. (Liu, 2022).

Due to this, regional integration offers opportunities for leveraging urbanization for industrial demand, including across borders. Railway transportation corridors, are critical for linking regional cities and zones of industrial production.

3. Methodology

3.1. Description of the study area

Ethiopia is a least developed landlocked sovereign country that lays in the Horn of Africa, neighboring Eretria in the north, Djibouti in the northeast, Somalia in the east and south, Kenya in the south, South Sudan in the west, and Sudan in the north-west. The total land mass of Ethiopia is 1.14 million Sq. Km. With a population of greater than 126 million, Ethiopia is the second most populated nation in Africa next to Nigeria (UN, 2023). The existing functional railway corridor being examined is located in the eastern direction of Ethiopia. The eastern railway corridor stretched from the central part of Ethiopia to the port of Djibouti (See **Figure 1**).

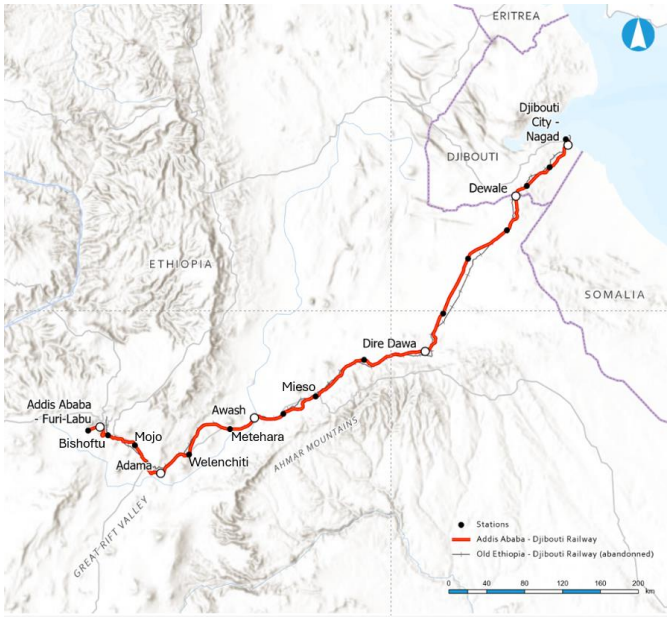


Figure 1. The old and new Ethio-Djibouti railway line (GIH, 2020).

3.2. Method

The article mainly employed exploratory research methods to search the literature and talk with experts on the historical development of the railway corridor its role for urbanization, industrialization, and regional integration (Gray, 2004). To gather primary data about old and new railway infrastructure, open-source satellite images,

field observation, and key informant interviews were conducted.

Secondary data were also used to support the primary data and describe the railway corridor development and its urban and regional impacts in the study area. The study mainly focused on the state of affairs as it exists in the past and at present, as well as the potential impact of the railway corridor on urbanization, industrialization, and regional integration (Kothari, 2004). The article critically analyzes population data of the years 1984, 1994, and 2007 census results as well as five years intervals population projection of 2012, 2017 and 2022 obtained from CSA/ESS.

The outbreaks of COVID-19 and continuous internal instability might be considered limitations to the evaluation of the actual impacts of the corridor. On the other hand, the new standard gauge railway line started operation very recently, i.e., in 2018; making it difficult to find comprehensive data from responsible government organs like the ERC. This limitation was addressed by analyzing and comparing a variety of works written by scholars and journalists in order to minimize some level of possible bias.

The other limitation of this article emanates from the applicability of the analysis to another similar trans-regional railway corridor that will be developed in Ethiopia, such as the Awash-Kombolcha railway corridor. Hence, to avoid the 'one feat for all' approach, the article argues for the need to follow a case-by-case examination. Therefore, this article employed a case study as an adequate research method for scrutinizing the corridor's impact on urbanization, which resulted in industrialization and regional integration.

3.3. Case study

The article specifically examines intermediate urban centers from the vantage points of railway corridor impacts on urban dynamics. In order to select intermediate cities, the article followed a two-stage analysis. First, using stratified sampling techniques, those railway station-based urban centers are listed and categorized based on their regions, zones and weredas. Although, the Ministry of Urban Infrastructure is in the processes of amending relevant regulatory frameworks that determine the minimum population threshold (MPT) of intermediate cities, this article used the prevailing 2016 Urban Plan Preparation and Implementation Strategy population threshold of 20,000 inhabitants. Accordingly, urban centers with a population of greater than 20,000 based on the June 2023 Ethiopian Statistical Service (ESS) population projection were selected.

Table 1 indicates that eight urban centers fulfill the minimum population threshold (MPT) set by the MoUI, i.e., >20,000 inhabitants (MoUDH, 2016). These are: Bishoftu/Debre Zeyit, Mojo, Adama/Nazret, Welenchiti, Awash Sebat Kilo, Mieso, and Dire Dawa.

Following to the this the article reviews the 'functionality parameters of intermediate cities' from an international perspective, and then customized them with enforceable national regulatory frameworks. Accordingly, administration hubs, economic hubs, and mediating flow of goods are functional parameters and selection criteria for railway corridor-based intermediate cities. Accordingly, the article employed functionality parameters such as administration status, the availability of

logistic hub and industrial park. In Ethiopia, administrative hierarchy starts with the top federal capital, followed by the regional capital, the zonal capital, and the woreda capital.

Table 1. The distribution of station based urban centers on the Ethio-Djibouti railway corridor.

Region	Zone	Woreda	Urban center	Population projection of 2023
Oromia	East Shewa	Akaki	Dukem	14,546
		Bishoftu	Bishoftu/Debre Zeyit	217,964
		Lomme	Mojo	64,439
	Adama special	Adama	Adama/Nazret	480,175
	East Shewa	Boset	Welenchiti	33,108
		Fentale	Metehara	20,582
Afar	Zone 3	Awash Fentale	Awash Sebat Kilo	38,447
Oromia	West Hararge	Mieso	Boridede	4835
			Kora	4326
			Asebot	17,102
			Mieso	29,081
Somali	Shinile	Mulo	Mulo	1459
		Afdem	Afdem	2520
			Bike	10,064
		Erer	Erer	6678
			Hurso	6106
Dire Dawa city administration			Dire Dawa	355,000
Somali	Shinile	Shinile	Shinile	13,445
			Harewa	6240
			Milo	2993
			Adigala	9467
		Ayesha	Ayesha	10,587
			Dewel	7393

Source: Computed by authors.

As **Table 2** depicts administration status, availability of a logistic hub and industrial park were used as an additional functionality criterion to select intermediate cities. Of the pre-selected eight urban centers Dire Dawa, Bishoftu, and Adama fulfilled all three criteria. Mojo also fulfilled the two criteria of having a logistic hub and industrial parks.

Therefore, this article selects Adama, Bishoftu, Dire Dawa, and Mojo as case study; because, they fulfil even the international criteria of UCLG i.e., demographic criteria of > 50,000 population and functionality criteria of serving as administrative and/or service and/or industrial hubs.

Table 2. List of potential intermediate cities on the Ethio-Djibouti railway corridor.

Name of Intermediate city	Administration status	Availability of logistic hub	Availability of industrial park
Bishoftu	Zonal capital	√	√
Mojo	Woreda capital	√	√
Adama	Zonal capital	√	√
Welenchiti	Woreda capital	×	×
Awash Sebat Killo	Woreda capital	√	×
Mieso	Woreda capital	×	×
Dire Dawa*	Federal city	√	√

Source: Computed by authors. * Dire Dawa is charter based self-administrative city.

4. Findings

4.1. Historical incites on railway corridor development in Ethiopia

4.1.1. Genesis of the railway corridor

In the beginning of the 20th century, terrestrial transport was introduced in Ethiopia. Emperor Menelik II is well known for his effort to modernize Ethiopia (Bahru, 2002). Of the different modernization activities, the introduction of the modern communication system was the most prominent. As a communication system, the railway transport, with its intrinsic element of the telegram, started construction and installation during the Emperor Menelik II reign period (Pankurust, 1967). Unlike other African countries, the concept of railway line construction was conceived by an indigenous African leader, i.e., the emperor, and followed an innovative management strategy using a public-private partnership (PPP) approach to design, built, and administer the railway transport corridor.

The mission to undertake the railway project was given to Ilg on February 11, 1893 (Pankurust, 1967). Accordingly, Igl and his friend the Frenchman Leon Chefneux, who had been active in the country since 1882, went to Europe in search of the necessary capital and to establish a company. Then the Imperial Railway Company of Ethiopia, or 'Compagnie Imperiale des Chemins de fer d'Ethioie' was established in 1894. After the necessary preparation, the railway construction started in 1897 with the French standard. This old trans-regional Ethio-Djibouti Railway was a single metric gauge (950 mm) with a length of 781 km that stretched from the Ethiopian capital Addis Ababa to the port of Djibouti. The construction of the railway line was accompanied by the installation of telegraph and the construction of stations.

The first commercial service was started from the port of Djibouti to the border town of Dewele, Ethiopia in 1901. Then the railway reached Dire Dawa in 1903. After a number of ups and downs, the railway line reached Addis Ababa in 1917. This railway corridor had been serving as the main economic corridor for landlocked Ethiopia until the 1950s, when it began facing competition from road transport and the federation of Eritrea with the Assab and Massawa ports. Following this period, the railway corridor has declined from time to time due to a lack of maintenance and management.

Then, after the independence of Eritrea (1993), particularly after the border

conflict between Ethiopia and Eritrea (1998), the government was forced to revitalize the old Ethio-Djibouti railway corridor, which deteriorated and was partially destroyed due to old age and civil wars. Since then, the government has used the port of Djibouti as the main gateway for landlocked Ethiopia. Specifically, in 2007, the government of Ethiopia established a technical advisory group under the Ministry of Transport to undertake a framework for the revitalization and development of the railway corridor. The study emphasized the importance of modernization and expansion of the existing 950 m gauge railway to a standard gauge (1435 mm) line to provide faster access to the Port of Djibouti from inland Ethiopia.

4.1.2. The new standard Guage railway corridor

As the major infrastructure development plan, the national railway lines revitalization and development project is crucial to meeting the infrastructure demand of the country, boosting the national economy, and bringing urban development and land use dynamics. For the realization of this railway infrastructure, the country has designed the National Railway Network of Ethiopia (NRNE) project and established the Ethiopian Railway Corporation (ERC) to administer it (ERC, 2012; FDRE-COM, 2007; MoUDH, 2016).

As **Figure 2** indicates, there are two railway corridors, i.e., Sebeta to Dewele and Awash Sebat Kilo to Weldia that are completed. Of these, the Sebeta-Dewele corridor is operational. This new standard-gauge railway line is constructed adjacent to the old railway line. The new railway standard gauge brings considerable advantages for long-distance freight transport by reducing travel times from up to 50 hours down to 10 hours.

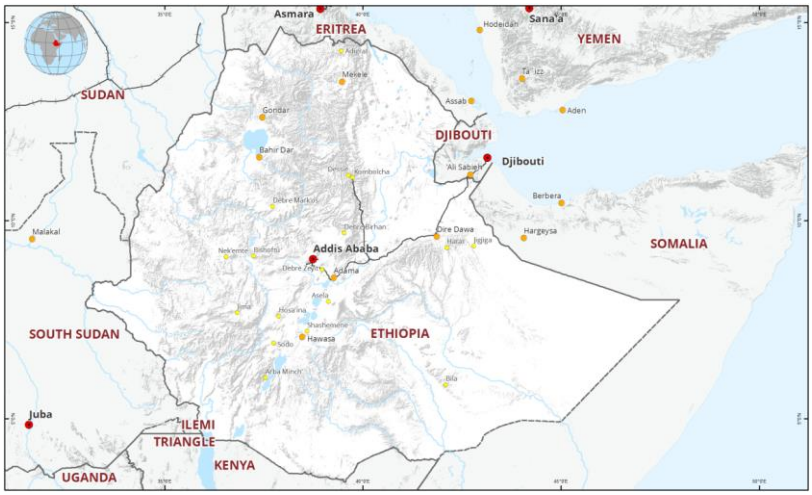


Figure 2. The new standard Guage railway corridors.

(WFP Logistics Cluster, 2022).

The newly operational standard gauge (1435 mm gauge line with 25 kv electrification) railway line is the first environmentally friendly cross-border railway corridor in Africa. It is supported by the Belt and Road Initiative. The railway corridor has a total length of 743.44 km, with Sebeta to Adama 115 km of double track and the remaining length being single track (GIH, 2020). From the total length of the railway line, 645.44 (86.81%) is located in Ethiopia.

The new railway line limits the number of stations to 20. Of these, only half (10

stations) are operational, and with the exception of two, eight (80%) of them are located in the Ethiopian jurisdiction. These stations operational in the Ethiopian jurisdiction are: Lebu, Bishoftu, Modjo, Adama, Mieso, Bike, Dire Dawa, and Dewelle; and all four selected intermediate cities have functional railway stations.

4.2. The impact of the railway corridor in Ethiopia

In the beginning of the 20th century, modern type of railway transport was introduced in Ethiopia. The advent of this modern terrestrial railway infrastructure caused the flourishing of the eastern economic corridor. This eastern railway corridor was one of the major causes for the flourishing of urban centers that evolved on the major morphological tissues of railway line and stations.

This single-gauge (950 mm) railway had more than 34 stations, and the number of railway stations varies from time to time depending on the advancements in railway locomotives: steam engines, diesel engines, and electric-power engines.

Initially, these station courtyards had a few buildings that served for limited railway service-related functions such as ticket selling, passenger waiting, administration, residential for staff, and warehouse.

Those stations, which had a residential house in the courtyard, attracted different kinds of urban service providers and traders to live a sedentary life in the vicinity of the stations. Then station areas gradually evolved into urban villages and urban centers.

In this sub-section, the article examines the population dynamics (population size and growth rate over a time horizon) and Morphological traits (station location and station yard function) of station based urban centers, with special emphasis on station-based intermediate cities.

4.2.1. Population dynamics

Population size: To compute the population dynamics of station-based intermediate cities, the article used the 1984, 1994, and 2007 census results and taking the last census result, i.e., 2007, a five years' time intervals of ESS projections of the 2012, 2017, and 2022. ESS is a responsible government organ for producing statistical data on demographic and socio-economic conditions (FDRE-HoPR, 2021). The article intentionally used a five years interval of ESS projection, which aligns with the 2007 (renovating the old railway line was conducted), 2011 (the new railway line development was started), and 2016 (the new railway line development was finished) historical events of the railway corridor.

As **Figure 3** indicates, during the 1984 census, with the exception of Mojo, all intermediate cities had more than 50,000 inhabitants. In the 2022 ESS projection, Adama showed significant population growth, followed by Dire Dawa and Bishoftu.

Population growth: With regards to the population growth rate, initially between the two-census period, of 1884–1994, Dire Dawa (7.65) and Bishoftu (4.35) showed the largest and the least growth rates, respectively. With the exception of Adama, all three intermediate cities had experienced nosediving declining growth rate between the second and third census periods (1994–2007). From the last census to the first five year projection (2007–2012) all the other intermediate cities showed a significant growth rate, except Dire Dawa. During this five-year period the Ethi-Djibouti railway corridor development was revived and got government attention. The next five year

i.e., 2012–2017 is well known as the new standard gauge railway line construction period. In this period Mojo showed the highest growth rate followed by Bishoftu and Adama. As compared with the previous period (2007–2012) all show a slight decline except Mojo. With regards to the last period which is well known as the standard gauge railway operation period (2017–2022), Bishoftu demonstrated high growth rate followed by Adama. In comparison with the previous (2012–2017) or standard gauge railway line construction period, all the intermediate cities experienced a significant growth rate, except Mojo. All in all, during the first two census years, the Dire Dawa and Bishoftu growth rates were very high and low, respectively; however, in the last the last two consecutive five-year period, Dire Dawa had the least growth rate and Bishoftu the highest. Pertaining to the overall period (1984–2022) Adama showed the highest growth rate followed by Mojo. Dire Dawa still showed the least growth rate from all the intermediate cities (See **Figure 4**).

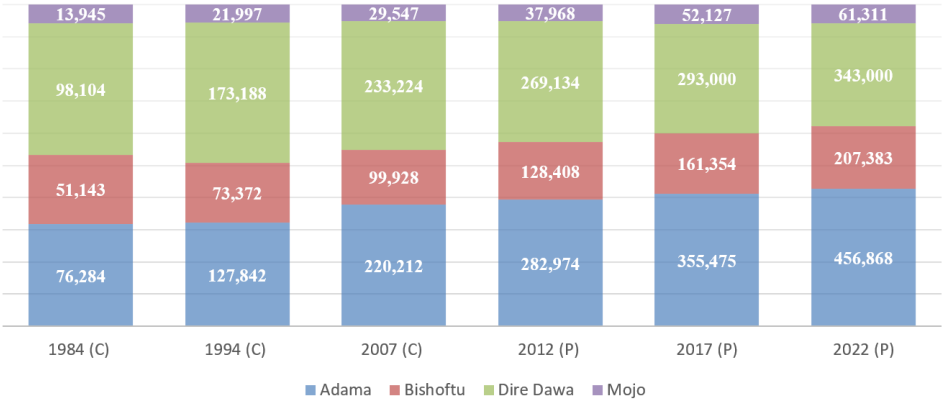
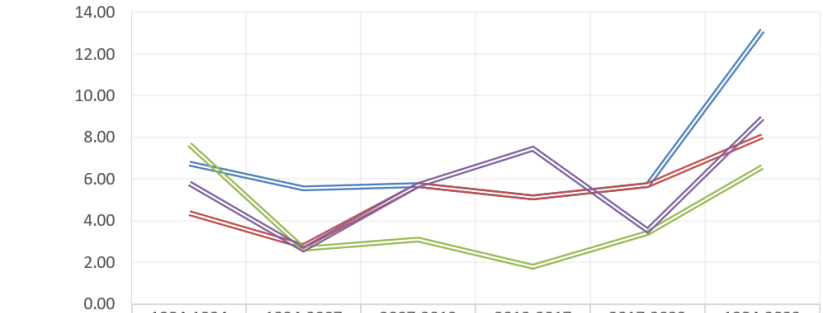


Figure 3. Population size of Ethio-Djibouti railway corridor based intermediate cities.

Source: Computed by Authors from CSA/CSS 1984, 1994, 2007, 2012, 2017, and 2022 reports.



	1984-1994	1994-2007	2007-2012	2012-2017	2017-2022	1984-2022
Adama	6.76	5.56	5.70	5.12	5.70	13.13
Bishoftu	4.35	2.78	5.70	5.13	5.71	8.04
Dire Dawa	7.65	2.67	3.08	1.77	3.41	6.57
Mojo	5.77	2.64	5.70	7.46	3.52	8.94

Figure 4. Population growth rate for station based intermediate cities.

Source: Computed by Authors from CSA/CSS 1984, 1994, 2007, 2012, 2017, and 2022 reports.

4.2.2. Morphological traits of station in the intermediate cities

Railway station is an area that regularly provides railway facilities or stops to load or unload passengers, or freights, or both. It generally consists of at least one trackside platform and a station building, which provides auxiliary services like ticket

sales, waiting rooms, and baggage/freight services.

Stations might exist at ground-level, underground, and elevated level. All the Ethio-Djibouti railway stations are located at ground level. There are different determinant factors for the selection of convenient sites for railway location. The following are the prominent ones:

- Affordability: The distance between station and localities should be affordable for users;
- Connectivity: The station should be linked with the nearby areas with proper road;
- Safety: The existence of fairly level ground;
- Availability: There should be sufficient land for future expansion and development.

The article analyzed station location, types of stations, station yards and function, and station area land use within 1200 m radios, which has a direct impact on station-based urban centers morphology.

Station location: In this part station location is analyzed from the railway engineering, nature of locomotives, and city perspective point of views.

1) From railway engineering perspective

From the engineering perspective, station locations can be categorized into three categories based on the position of stations in line with the railway line infrastructure. There are:

- Way-side station: Way-side station is located on running lines. This allows a faster train to overtake a slower train. For this loop lines and siding are provided.
- Junction station: Junction station railway lines from three or more directions meet at the junction, which has a minimum of one main line and one branch line.
- Terminal station: Terminal station refers to the dead end of an incoming track or the station at which a railway line ends or terminates.

From these station types, all the old railway stations located in the intermediate cities were way-side station types. Similarly, in all intermediate cities, the new standard gauge railway line wayside station types are exhibited. Therefore, all the intermediate cities that are located on the trans-regional Ethio-Djibouti have wayside station types.

2) From the nature of locomotives

The number of railway stations varies from time to time depending on the advancements in railway locomotives: Steam engines, diesel engines, and electric-power engines. At the initial stages of the railway transport service, all the locomotives were steam engines; because of this, the majority of the stations were constructed near water bodies (river banks or lacks), which had a cooler purpose for the steam engines. With the advent of diesel engines, the number of stations decreased significantly. Based on this, the old railway stations can be grouped into: Stations near water bodies and stations without water bodies. From the four intermediate cities Bishoftu, Mojo, and Dire Dawa railway stations were constructed near to the water body.

3) From the city perspective

As stated above, the old railway stations served as a nucleus for the formation of urban centers. However, the new standard-gauge railway stations used a peripheral approach. The functional new standard gauge stations are located in the vicinity of

intermediate cities, with ground distances of 2.3 km, 3.74 km, 5.78 km and 11.77 km from Mojo, Bishoftu, Adama, and Dire Dawa from their respective ole railway stations.

Station yards: Station yard is a place on the track where trains stop to clear passengers and goods traffic. In general, station yards can be categorized as: Passenger bogie, goods/freight, locomotive, and marshalling yards.

On the old trans-regional Ethio-Djibouti corridor station-based intermediate cities, all stations were used for both passenger and freight services. The station of Dire Dawa also served as a locomotive yard, in which all the facilities for cooling, watering, repairing, oiling, cleaning, etc. were provided.

There were also stations that were located between intermediate cities. These stations, known as dry stations or 'derek tabiya' in the local language, served as mobile maintenance services centers. For instance, Dalota, Lemlem, Dankaka, Tedie Mariam, Soleqie, Feto, Borchota, Haro Arba, Sabu Ber, Legebenti, Eilala Sela, and Awash Eisht were dry stations located between Bishoftu and Dire Dawa.

Currently there is a functional standard gauge railway line, on this corridor there are stations constructed to provide passenger or freight or both services. From the four intermediate cities only Bishoftu station has been providing passenger services; the rest providing both passenger and freight services.

4.2.3. Industrialization

In Ethiopia, the origin of modern industrialization dates back to the early twenty-first century with the advent of the old Ethio-Djibouti railway corridor. This corridor plays an indispensable role in the agglomeration of industries and trade centers such as Akaki, Dukem, Bishoftu (Debre Zeit), Adama (Nazret), Mojo, Metehara, Awash Sebat Kilo, and Dire Dawa.

Recently, the Ethiopian government has been constructing industrial parks in different parts of the country. The government followed the SEZ policy approach with the intention of maximizing social and economic development through job creation, export generation, import substitution, and know-how and technology transfer from investors. The rate and scale of industrial park development by the Federal Government, regional states, and private developers have had an affirmative effect on urbanization processes (Mengistu et al., 2022). These industrial parks have, in turn, intensified the growth and development of already-existing urban centers or have created cluster cities (Mengistu et al., 2022).

Currently, there are a total of 25 industrial parks (IP) that are operational in Ethiopia, of which 17 are government-owned 14 by the federal government and 3 by the regional states) and 7 are privately-owned. The Chinese-owned Eastern IP covering 400 hectares was inaugurated in 2010 as the first privately developed IP. The total area allotted for IP is 20,830.47 ha; form this IP located in intermediate cities covers 7595 ha or 36.46%. (See **Table 3**).

Similar to the railway line and stations, all the industrial parks have been developed on agricultural land which have an adverse impact on agricultural production and socio-economic impact on the agricultural communities living in the fringe areas of intermediate cities.

Table 3. Industrial parks located in the intermediate cities along the railway corridor.

Ownership	Name of IP	Acquired land (in ha)	Urban center	Specialization	Status
Government	Adama IP	2000	Adama	Assembling, food processing & Garment	Operational
	Dire Dawa IP	4186	Dire Dawa	Assembling, food processing & Garment	Operational
	Bishoftu IP	189	Oromia	-	Planning stage
	Mojo Leather Industry	290	Oromia	Leather	Planning stage
Sub-Total		6665	-	-	-
Private	Eastern Industrial Zone	500	Oromia	Various	Operational
	Mojo George Shoe	50	Oromia	Leather	Operational
	CCECC	380	Dire Dawa	Various	Under Construction
Sub-Total		930	-	-	-
Grand Total		7595	-	-	-

4.2.4. Regional integration

There is no consensus on the exact definition of regional integration. However, there is an agreement that regional integration has a cross-border and multi-dimensional nature. It promotes socio-economic development by expanding markets and trade, enhancing cooperation, spreading risks, and fostering socio-cultural cooperation and regional stability benefits.

Regional integration cannot proceed without regional transport and infrastructure. It is indispensable for factor connectivity, investment flows and value creation. Connectivity is the chain link that characterizes the economy of the 21st century, which is manifested in connecting landlocked countries to ports.

As a landlocked country, the Ethio-Djibouti railway corridor plays an indispensable role in creating get way to port for trade, better physical connection with neighboring countries, free movement of people from areas of no job to areas in high demand etc.

1) Rural-Urban continuum

In the rural-urban dichotomy, there are areas with neither rural nor urban features that are located in the immediate vicinity of cities. Different scholars examine these urban fringe areas as: peri-urban, suburban, rurban, rural-urban continuum, composite settlements, gragara, and desakota settlements, depending on the region's size, scale, and settings (Brears, 2022). In the fast-urbanized world, fringe development is inevitable; however, there is seldom recognition and definition for such kinds of area (Brears, 2022).

In the trans-regional Ethio-Djibouti railway corridor station-based intermediate cities, there is urban expansion or fringe development phenomena. This fringe development phenomenon has a rural-urban continuum (RUC) feature. RUC refers to the merger of rural and urban areas, thereby eradicating the assumption of a clear-cut distinction between the two dichotomies due to siphon effect. The leapfrogging development around railway stations gradually expands its territory at the expenses of the rural land due to the economic expansion, population crowdedness and infrastructure development.

Based on the morphological settlement pattern, urban fringes can be broadly

categorized as: polycentric urban centers formed by multiple monocentric cities; ribbon development; and desakota settlements (Brears, 2022).

In Ethiopia, ribbon development urban morphology phenomena existed in the north-west parts of Bishoftu, and Dire Dawa and Southern parts of Mojo, and Adama intermediate cities. As **Figures 5** and **6** depicted, previous agricultural land on the fringes of Bishoftu, Mojo, Adama, and Dire Dawa intermediate cities were gradually converted to urban mainly due to industrial parks development. A typical siphon effect is manifested in these areas due to: infrastructure development mainly the railway line, this in turn attracts industrial parks development near to the railway stations. The prevailing industrial parks absolved large number of labour forces, which resulted in horizontal expansion towards the nearby large city.

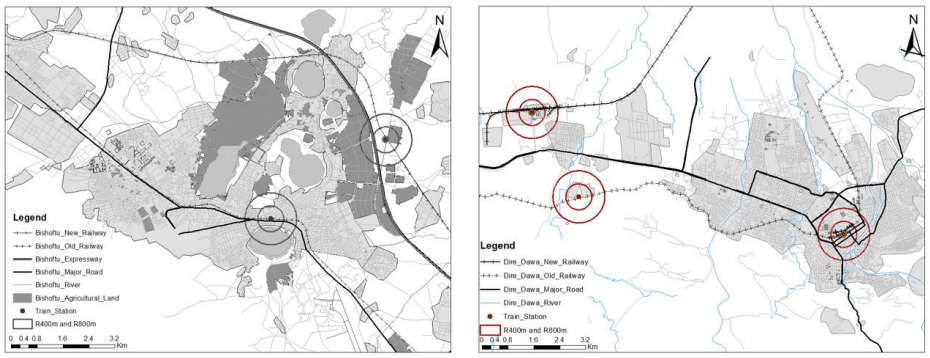


Figure 5. Bishoftu and Dire Dawa railway stations.

(Source: Authors, 2023).

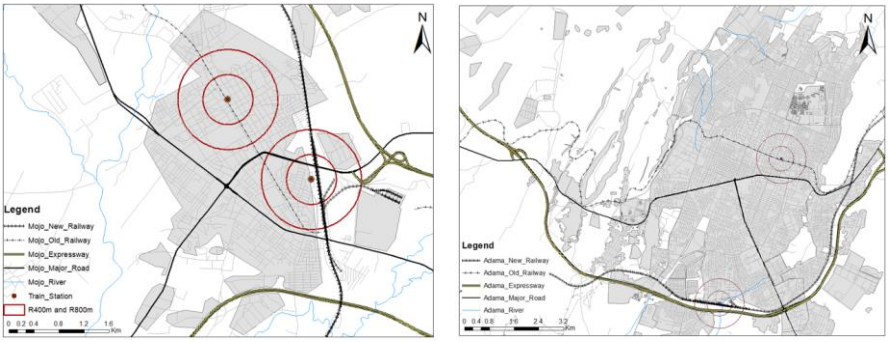


Figure 6. Mojo and Adama railway stations.

(Source: Authors, 2023).

Polycentric urban centers formed by multiple monocentric cities are also exhibited in the northern part of Bishoftu. In this area, there is a monocentric city, namely Dukem and Beshoftu, which become linked with the development. This makes the RUC morphological settlement pattern in the area. This RUC phenomenon stretches to Addis Ababa (See **Figure 7**.) For that matter, both the old and new railway stations as well as industrial parks were constructed on agricultural land. An interview with the ERC affirmed that each station of the new standard gauge railway has approximately 300 hectares of land, principally farmland.

Figure 7. Rural-Urban continuum on the south-eastern direction of Addis Ababa.

The other example exhibited in Dire Dawa is that as the figure depicts, there was a monocentric station-based urban center, i.e., Melka Jebdu, located in the north-western direction of Dire Dawa. This nearby station town has become part of the Dire Dawa city administration. This makes the intermediate city have more than one development hub and become a polycentric city (See **Figure 8**).

(a) **(b)**

Figure 8. Google Image of 1985 and 2021 of Melka Jebdu and Dire Dawa Urban Growth. **(a)** 1985; **(b)** 2021.

2) Economic/Trade integration

Regional integration is linked to competitiveness and innovation through knowledge sharing and network connections. The existing functional standard gauge railway corridor has a trans-regional nature that connects landlocked Ethiopia to international trade through the port of Djibouti. This corridor has the highest share (90%) of international trade.

As **Table 4** indicates, the performance of the Ethio-Djibouti Railway Company decreased from time to time. Specifically, after 2011, with the government's policy direction of modernizing the railway transport system, its performance become ceased.

The new standard gauge trans-regional Ethio-Djibouti railway corridor served for more than 500,000 metric tons of cargo and generated ETB 2.5 billion revenue in the past five years. According to the Ethiopia-Djibouti Railway Company, the railway corridor has a 11.2% to 15% contribution to the East African country's overall export and import trade.

Table 4. The Ethio-Djibouti old railway performance (CSA, 2000–2014).

Revenue and transport service		Year							
		2000	**2002**	**2004**	**2006**	**2008**	**2010**	**2012**	**2014**
Revenue (‘000)	Passenger	13,010	18,400	5218	6000	2450	2300	NA	5500
	Frights	50,250	37,800	37,042	27,400	7050	5700	NA	NA
Total		63,260	56,200	42,260	33,400	9500	8000	-	-
Transportation Service	Passengers travel in Km (Million)	145	254	40	24	26	5	-	15
	Freight carried (‘000 Tons)	285.3	95	204.3	123	76	2	-	-

Figure 9 depicts that the new standard gauge railway corridor will starts operation in 205/16. However, the corridor officially started commercial service in January 2018. This railway corridor has been jointly owned by the two sovereign states of Ethiopia and Djibouti. The railway company assigned a Chinese consortium to manage the corridor through a management contract.

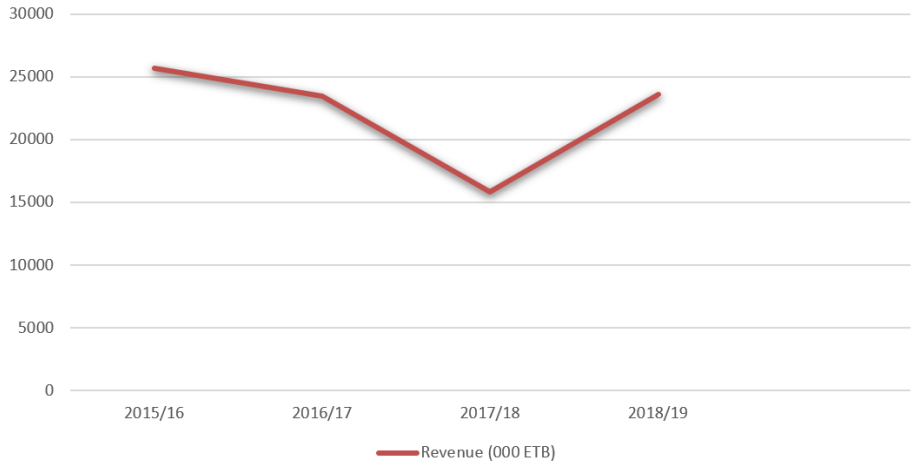


Figure 9. Revenue performance of the new standard gauge Ethio-Djibouti railway corridor.

As the ERC official indicates, initially the new standard gauge railway corridor was designed to operate with an average speed of 80 km/hr with a freight tariff of 0.046 per ton/km and 0.023 per ton/km for import and export respectively. Compared to the road corridor, trucks usually cover a 903-killomenter-long road that stretches from Addis Ababa to the port of Djibouti with an average speed of 60 km/hr and a tariff of 0.047 USD/ton/km. Due to transportation speed/time, safety, and price the modal share of railway transport shows 80% to 85% coverage than the truck transport system (See **Figure 10**).

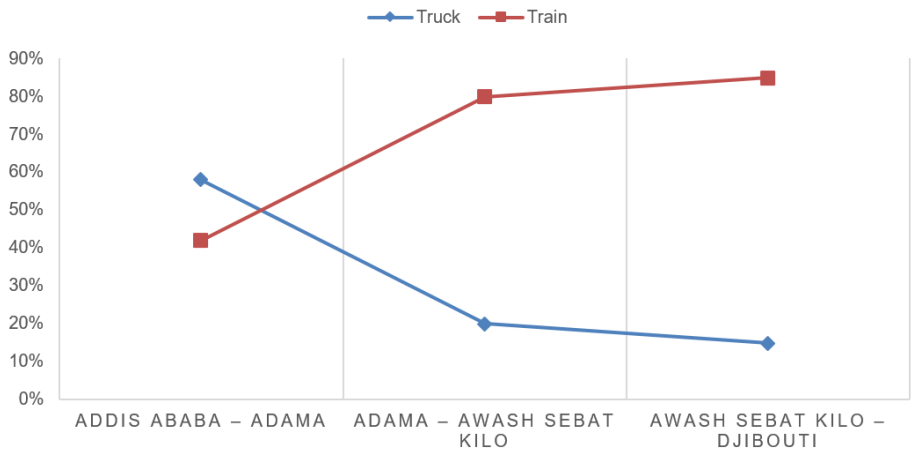


Figure 10. Modal share of truck and train on the eastern economic corridor.

3) Inter-Regional integration

Taking the current state structure, both the old and new standard gauge railway lines pass through four regional states and two city administrations. Namely: Oromia, Amhara, Afar, and Somali regional States, and Addis Ababa and Dire Dawa City administrations (See **Figure 11**).

From the intermediate cities' perspective, all except Dire Dawa are located in Oromia regional state, and they are located within a 100 km radius of the metropolitan city of Addis Ababa.

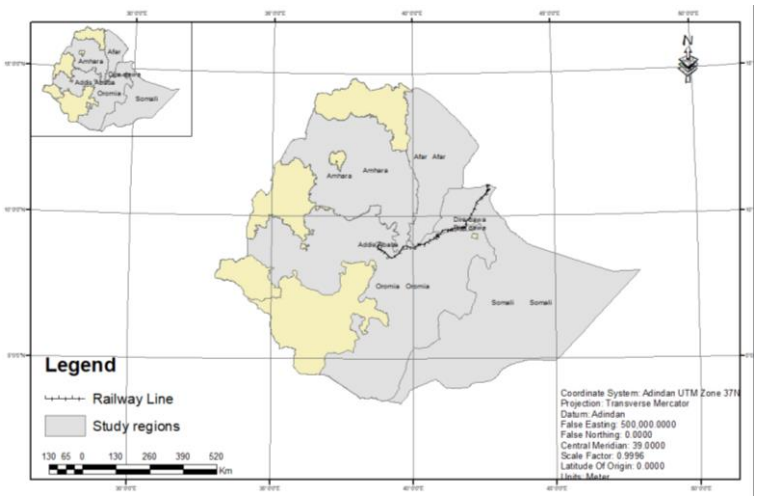


Figure 11. The eastern trans-regional railway corridor.

5. Policy measures to optimize the positive impacts of the railway corridor

In the academic world, there are different regional development theoretical paradigms, of which functional and territorial integration development approaches are the two dominant ones (Egziabher, 2000; Knickel, 2021; Kato, 2022). The former used a top-down development approach that aims at efficiency and modernization using the principles, means, and practices of national economic planning, free trade, entrepreneurship, and innovations as the driving forces for industrialization, the comparative advantage principle, and central government intervention (Egziabher,

2000). Often, functionalist employed growth center and rural service center strategies for regional development planning (Egziabher, 2000). On the other hand, territorialism followed a 'bottom-up' development approach, in which a change of development should be based on economic criteria, competitive behavior, external motivation, and large-scale redistributive mechanisms to a new model of development incorporating broader societal goals, collaborative behaviour, and endogenous motivation (Egziabher, 2000).

As Ethiopia followed a federal state structure, the power to develop, administer, and regulate railway lines linking two or more regional states is given to the Federal government (FDRE-HoPR, 1995). As the railway infrastructure is an enter-regional development, ERC designed, constructed, and administered the new electrified Ethio-Djibouti standard gauge railway line. However, this railway corridor has the following drawback:

- Inadequate normative framework, which makes institutional linkage necessary to create sound interaction among federal, regional, and city administrations. Because of this limitation, almost all of the station towns do not have functional and territorial integration with the railway station.
- Both the old and new stations had/have limited functions; most of them were/are providing limited commuter-related services like sealing tickets.
- The old railway stations were constructed in the vicinity of a water body without taking into account their potential to become future urban centers.

To overcome these problems and optimize the yield of railway corridor benefits for urbanization, industrialization, and regional integration the government should follow:

1) Hybrid regional development policy that obtains both functional and territorial integration on the corridor;
2) Sound station development approach preferably transit-oriented development (TOD); this will help planners incorporate the station and its courtyards into urban strategies; and it will reinforce its role as a mobility hub and public place for people to meet and work.
3) The government should develop a regulatory framework that promotes cooperation and collaboration in economic, social, and environmental growth dynamics between the ERC and station-based urban center authorities.
4) Work with the private sector using the PPP approach. This will help to preserve old railway station buildings as historical buildings and serve as a gallery for railway historical events as well as an economically vibrant retail area. A station courtyard with 800 m radius will also serve as a mixed-use real estate area.

6. Conclusion

In Ethiopia, the advent of railway corridor development caused for the flourishing of station based monocentric linear urban centers. Although, this eastern railway corridor has more than 34 railway stations that served for more than 100 years, only four urban centers reached the statues of intermediate cities.

Morphologically, both the old and new standard gauge railway stations are located at the ground level, using 'way-side' station approach. Originally the nature of

locomotives were steam engines, due to this all intermediate cities stations were constructed near to water bodies. The old railway stations served as a nucleus for the formation of urban centers; while, the new standard gauge railway stations used a peripheral approach, which located far from the centers or old railway stations that ranges from 2.3 km (Mojo) to 11 km (Dire Dawa).

The advent of the old railway corridor also plays an indispensable role for clustering of industries and trade centers, and the new railway corridor also attracts SEZ in the form of IPs. The railway corridor demonstrated RUC, specifically the ribbon development and polycentric urban centers formed by multiple monocentric cities. This creates siphon effect on the corridor based intermediate cities, which is manifested in horizontal expansion at the cost of the nearby rural lands and outward urban development towards the large cities.

From the regional integration vantage point, the railway corridor passes through Oromia, Amhara, Afar and Somali regional States, and Addis Ababa and Dire Dawa City Administrations. With the exception of Dire Dawa all intermediate cities are located in Oromia regional state.

The government followed functional integration, which used top-down railway corridor development approach. This makes lacuna on normative framework and institutional linkages to create sound integration among federal, regional and city administrations. The stations provide limited functions and the old railway stations were constructed without considering future potential of becoming economically vibrant, livable and integrated urban center. To overcome these problems and maximize the benefits of corridor for urbanization, the government should follow hybrid regional development policy; sound station development approach mainly TOD; promulgate regulatory framework that regulate cooperation and collaboration among main stakeholders; and work with the private sector through PPP to make the station yards well integrated, vibrant, and livable area.

Author contributions: Conceptualization, DTM and EG; methodology, DTM; software, DTM; validation, DTM, EG and XW; formal analysis, DTM; investigation, DTM; resources, XW and SZ; data curation, DTM; writing—original draft preparation, DTM; writing—review and editing, DTM and SZ; visualization, DTM; supervision, EG and XW; project administration, DTM; funding acquisition, XW and SZ. All authors have read and agreed to the published version of the manuscript.

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