



(REVIEW ARTICLE)

## A review and analysis of railway transportation system in the economic community of West African States: Towards the development of sustainable regional goal

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### Abstract

A comprehensive evaluation of the current state of the railway transport system in eleven countries of the Economic Community of West African States (ECOWAS) is presented. Four themes of the railway transportation system comprise of infrastructure, rolling stock, operational performance, telecommunication and signaling are examined in the article. The transport policy regarding the railway transport system is analyzed along with the regulation and institutional framework. The findings of this study show that the railway transportation system is characterized by deteriorated infrastructure, obsolete technologies, fragmented and old databases, scarcely accessible investments, low-quality operations regarding safety and performance, and restricted connectivity and interoperability. Based on the socio-economic context in the region and review of recent railway projects, a series of strategies are proposed to meet future regional visions. These strategies are envisaged to contribute to the development of an efficient and interoperable railway transportation system in the Economic Community of the West African States which in turn will improve the interconnectivity and enhance the economic growth and trade in West Africa.

**Keywords:** Railway transport system; Economic Community of West African States (ECOWAS); Sustainable railway; Regional goal; Strategy.

### 1. Introduction

Railway transportation has recently shown a global revival through the extension of its network that becomes the vision of the African Union to meet the second aspiration of the Agenda 2063 [1]. This revitalization of the railway is due to the significant socio-economic and environmental spatial relations generated by the transport. While road contributes to over three-quarters of global greenhouse gas emissions of the transport sector [2], the railway is considered to have considerable potential advantages than its counterpart regarding traffic safety, energy consumption, lower costs, and environmental protection [3, 4].

While significant return on investment has been noticed worldwide during the last thirty years, there is low freight railway market development and a decline in passenger transport in West Africa [3]. Road network has the exclusive dominant transportation role in West Africa [5], however, its network stays poor quality with insufficient density and extent. As a result, an exclusive partnership for railways is a prerequisite for transportation operation services.

According to Seba Minsili, Kisito, Gilbert, Jean, Gadam and Christian [6], huge investment is needed for the construction and maintenance of railway, which gave the feeling of its expensiveness to challenge road. Yet rail is much cheaper through feasible economies of scale [3]. Notwithstanding the limited financial resources, the West African countries have begun to put the railway transport system into a new phase of modernization at international standard for the next decades [7], because of its crucial role in the industrial revolution in Europe and the remarkable economic developments in North America, India, Russia, China, Japan, Hong Kong and Australia [8-10].

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The current timing seems to be suitable, as rapid economic growth than the standard has been perceptible in the region directing to favorable forthcoming [11]. The opportune possibility to develop railway is comprehensible when putting together this growth along with unused resources and arisen middle class [11]. In conformity with this, the extension of the railway network become the eyesight of the African Union to meet the second aspiration of its Agenda by 2063 [1] and solve the mobility difficulties of its increasing population [12].

There is consequently an important discontinuity between the existing condition of rail infrastructure, the recurrent perception of regional integration development and temporary projects in execution [13]. While sustainable development goals cannot be achieved without financing rail infrastructure, there should have certain caution in the implementation of the project, particularly in countries with limited financial resources [14].

The objective of this paper is to point out specific areas for capacity development in order to strengthen access to more reliable, safe and secure railway transportation within the countries of ECOWAS. That is to say, the goals of each component of the railway were to diagnose the current state of the railway transportation system in ECOWAS to pinpoint ways regarding interconnectivity targets. The study eventually selected the lacunas in the regional perspectives with the current potentiality for developing strategies for the development of the regional railway transportation system.

## 2. Methodology

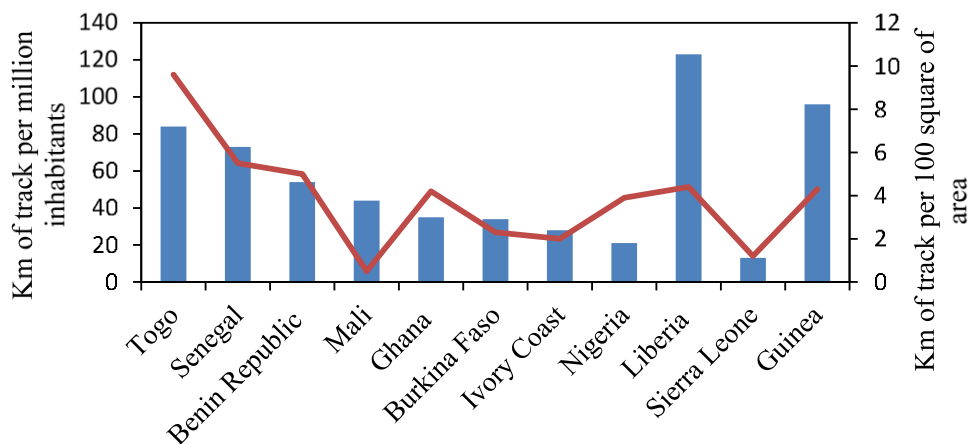
The methodology of the study includes the use of major sources from a practical survey, analysis of evidence from the experimental study as well as analysis of data from different published sources. The list of selected countries consists of four English speaking countries (Ghana, Liberia, Nigeria, and Sierra Leone) and seven French-speaking countries (Benin Republic, Burkina Faso, Guinea, Ivory Coast, Mali, Senegal, and Togo).

## 3. State of the existing railway transportation system

In this section, we evolve an examination of various elements of the railway transport system of the region, with a special focus on the infrastructure, rolling stock, operational performance, and telecommunication and signaling.

### 3.1. Infrastructure

The railway network of the ECOWAS as a whole is around 10,188 km of which only half out of 12 of the national networks are for sub-regional purposes. Freight is principally being transported on the railway infrastructure (Figure 1). This is due to the fact that the region is characterized by innumerable natural and mineral resources. The majority of railways are connected to mining zones and ports because of the dominance of the regional importation and exportation traffic by sea.



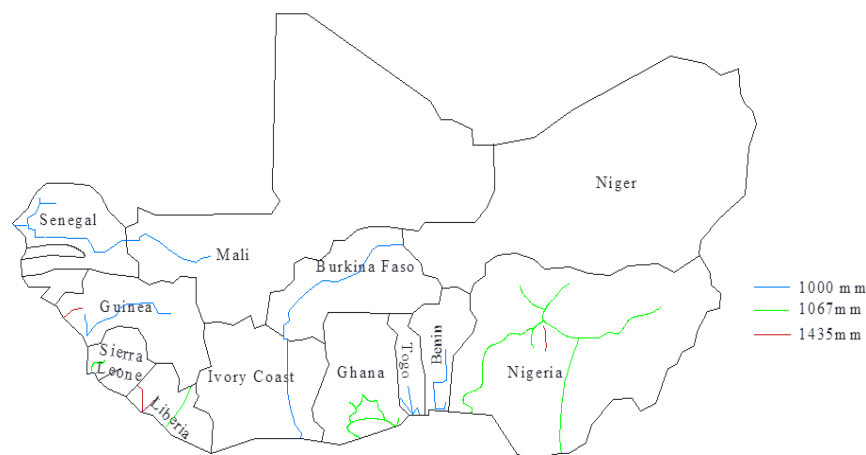
**Figure 1** Track density in the selected countries of ECOWAS

Restricted size and quality of the railway network have characterized the region which results in the decline in traffic volumes that line should bear, influencing severely efficiency and productivity. Only a smaller number of lines traverse borders, for instance, Sitarail between Burkina Faso and Ivory Coast, and Transrail between Mali and Senegal. The deficient length of rail routes indicates that there is a transfer of freight to road transport in order to get the final destinations. For instance, in the Benin Republic, the railway provides inland railheads in Parakou city from which goods can be transported to Niger by roads, which raises the costs compared to road-only transport.

A variety of track gauges ranging from narrow (600mm) to standard (1435mm) contribute to the hindrance of a balance traffic flow on the railway networks within the countries of the ECOWAS [15]. This explains the highest transportation costs internationally noticed in West Africa in comparison to other developing countries of other regions [16]. While the meter gauge is mostly used in all French-speaking countries, the Cape gauge can be found in English speaking countries [5]. Except for Guinea and Liberia where there is the existence of the standard gauge, it is also found in the newly constructed railway lines of the Port Harcourt-Onne, Itakpe-Ajaokuta-Warri and Kaduna-Abuja in Nigeria [17]. The operated track gauges are elucidated in Figure 2. It can be seen that no significant efforts have been done until now to improve the limited connectivity and interoperation of railway infrastructure in the ECOWAS zone.

The railway tracks in terms of density and quality are significantly poorer and still operated at low standards in the region in comparison to the international ones. Their track consists of light rails that are not adequate with modern requirements. The railway networks are more than a century old, which characterized the obsolescence state of their track materials. All the original railway track of the selected countries in the region are ballasted tracked, however, they are not adequately or frequently maintained. The operational performance of ECOWAS railways has been seriously influenced due to the combined effect of aging infrastructure, tamping and deficient maintenance. First of all, the maximum axle load that the railway structure can bear is roughly 17 tonnes in countries such as the Benin Republic [18], Burkina Faso [19], Ivory Coast [19], Mali [19], Ghana [20] and Senegal [19]; while in Nigeria, it is 20 tonnes [21]. In contrast to European countries, a standard axle load greater than 25 tonnes is seen as standard [22]. The maximum speed achieved in these networks is thus influenced by the poor condition of the track. By 2010, an average speed reached by the freight transport is 36 km/h in Benin Republic [18], 31.8 km/h in Burkina Faso and Ivory Coast [23, 24], 20 to 50km/h in Mali and Senegal [23], 45km/h in Ghana [20], and 65 km/h in Nigeria [25]. There is no available data about the axle load and speed in Guinea, Liberia, and Sierra Leone.

All the networks are almost single track with the exception of the first 30.6 km of the Western line (Takoradi-Manso) in Ghana, and 70 km double track of Dakar-Thies line in Senegal. None of the existing networks of the selected countries are electrified which explained the use of diesel locomotives [26].



**Figure 2** Track gauges operated in the selected countries of ECOWAS

### 3.2. Rolling stock

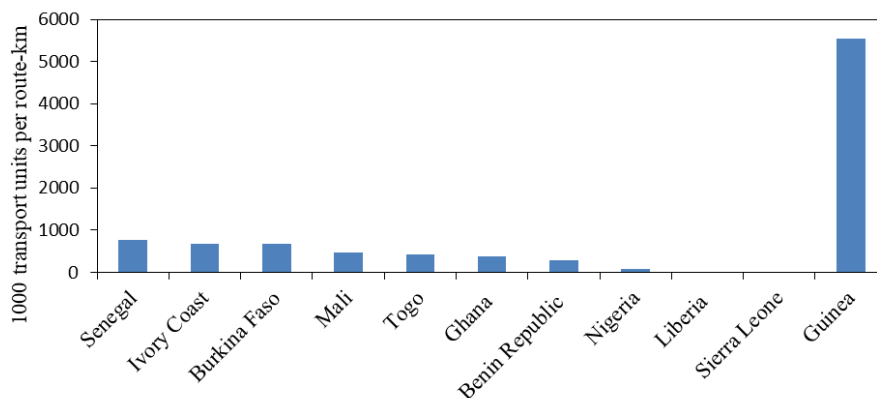
In West Africa, the current condition of rolling stock has resulted in a decrease in the operational performance of the railway. In the Benin Republic, the stability and availability of rolling stock at less than 50% characterized the current scarce and poor condition [27]. When 50.18% of wagons were considered to be functioning, 35% of passenger

coaches were fit for use [28]. As for locomotives, all of them were more than 30 years old with 10.52% having a reduction in their capacity` and the other percentage needing urgent repairs [27]. A field investigation by the Japan International Cooperation Agency JICA [23] in Ivory Coast, Burkina Faso, Mali, and Senegal showed that the rolling stock is equipped with facilities that are in poor condition and far from what is required for efficient maintenance.

The fleet of locomotives in Ghana is aging with 42.8 percent between 11 and 13 years old, 16.3 percent between 20 and 24 years old, 36 percent between 28 and 31 years old and 4.9 percent over 40 years old [20]. There is no standardization in the current locomotive fleet, of which only 63.9 percent can be used. Fifty percent of wagons are available and fit for the transport of mineral resources, while in the case of passenger coaches, most of them were purchased in the late 1980s, with 44 percent that has been rehabilitated in the last 15 years [20]. In Nigeria, a look at the current capacity of infrastructure showed a severe dearth as it is not extremely sufficient. The locomotives, rolling stock and other facilities have become obsolete and extremely unbalanced with the increase of population [17]. For now, the corporation had just 50% of locomotives, 40% of freight wagons, and 47% of passenger vehicles operating for a total population of 177 million. This poor level of locomotives and rolling stock explains the poor-quality services provided by the Nigerian Railway Corporation, which led to the loss of patronage of both passengers and freight to road transport. As for Togo, many problems occur in the development of its railway since the rolling stock has deteriorated and insufficient. Additionally, the maintenance facilities of the depot/workshop are old type and deteriorated [29]. No specific data has been found regarding the current rolling stock in Guinea, Liberia and Sierra Leone.

### 3.3. Operational performance

Low density has characterized the traffic in ECOWAS. The freight services are the main dominant traffic and represent 90 percent of the movement in the economic community. This situation can be explained by the fact that the costs through passenger operations with poor track conditions and lack of subsidies are difficult to recuperate. The lower volume of traffic in the region is due to the emerging effect of low axle load and restricted speed on most of the deteriorated existing lines.



**Figure 3** Rail traffic density in the selected countries of ECOWAS

In fact, many sections have been dilapidated or closed because of poor maintenance, civil wars, or natural disasters. In the Benin Republic, the lines of Cotonou-Ouidah, Pahou-Sègbohoulè, Cotonou-Pobè, viz Porto-Novo and Abomey-Zagnanado via Bohicon are out of service [27]. Meanwhile, passenger traffic has been stopped since 2007. In Burkina Faso, the 104-kilometer section between Ouagadougou and Kaya are out of service since 2003 [19, 30]. As for Ghana, only Accra to Tema, Accra to Kotoku, Awaso to Dunkwa and south to Takoradi lines are still operating out of the total railway network [20]. In Mali, the Bamako-koulikoro section, which is 53 km long, is no longer used because of the state of dilapidated infrastructure [19]. The trains are currently out of service in the sections between Thies-Saint-Louis, Guinguineo-Kaolack, and Diourbel-Touba in Senegal [31]. In the case of Togo, some sections of the railway have been stopped since 1987; the Lomé-Kpalimé line (117km) has not been used since 1996; Lomé-Blitta (281km) and Lomé-Aného lines (45 km) have not been in service since February 2012 [29]. The passenger transport has been stopped for more than fifteen years in Togo [32]. In Liberia, most sections of the rail network were disconnected during the civil wars. By 2010, the Bong mine railway is the only operational line, while the Lamco Railway was put back into service in 2011 after partially rebuilt. In Sierra Leone, the Makeni branch and the Kenema- Pendembu

section were successively closed in 1968 and 1971. Additional shutdowns prior to Bo happened in 1973, and the railway eventually closed totally in 1974.

A tolerable and reasonable operational railway is weighted through the measurement of traffic volume, which shows the utilization of infrastructure. The competitiveness between railway transports with its counterpart transport modes depends on the large volume of traffic carried, which will generate huge funds for the maintenance and upgrade of its infrastructure. A study on the railway traffic in the selected countries in ECOWAS (Figure 3) showed that all countries have a density below 1 million traffic units (passenger-km plus tonne-km) per route-km, except Guinea where the railway lines are considerably used by the private mining companies. The data was not available in the case of Liberia and Sierra Leone.

Labour productivity is considerably lower in most countries in ECOWAS because of the low volumes reached (Figure 4). Under these situations, little traffic units are covered by fixed costs, which are expensive in contrast to other transportation modes. This leads in reciprocity to a violent cycle where lower demand results on higher unit costs, which impacts the unit costs and return. While an average employee in Burkina Faso produces approximately 481, 000 traffic units per year, Nigeria produces the lowest traffic units at 37, 200. No data was found for Togo, Ivory Coast, Guinea, Liberia, and Sierra Leone.

The safety on railways tracks in selected countries of the ECOWAS has been a subject of considerable concern. According to Bullock [4], there is the availability of little data regarding safety records in addition to uncertain standards and compliance. The safety of the railways is the most revealed feature during most of the workshops in ECOWAS because of the main issues such as derailments and thievery of infrastructure encountered in the region.



**Figure 4** Labour productivity in the selected countries of ECOWAS

Based on the statistics of the international union of railways (UIC), the safety records in the selected countries of ECOWAS are considerably disagreeable in comparison to other countries [14]. Representative safety records of Ivory Coast and Nigeria in 2002 and 2003 show that they have a higher rate of accident in comparison to developed countries such as Great Britain (see Table 1). With 0.402 accidents for every million traffic units, the accident rate of Nigeria is 402 times greater than Great Britain (0.001 accidents per million traffic units), and almost twice than Ivory Coast.

**Table 1** Safety records of sample ECOWAS countries compared to Great Britain [14]

Country	Traffic Units (million)	Accidents	Accidents per Million Traffic Units
Ivory Coast	436	91	0.209
Nigeria	268	108	0.402
Great Britain	68, 912	71	0.001

### 3.4. Telecommunication and signaling

Manual systems mostly depend on telecommunication and signaling networks through manual train's orders or mechanical signals [4]. The use of manual systems is proved to be sufficient because of the lower traffic volume on existing networks. However, safety problems occur through human error.

In the Benin Republic, most of the existing telecommunication network dates back to 1960/70s and is completely outdated and cannot be rehabilitated, which results in bad communication within yards and stations. The management of the trains dependent on external services and does not allow a rigorous application of all the safety rules due to the use of grouped GSM for station-to-station calls in certain areas [18, 33]. In Burkina Faso and Ivory Coast, the railway system is non-electrified with no interlocking system between turnouts and traffic lights. The safety of the railway is uncertain due to the manual operation of turnouts, and obsolete signaling and telecommunications resulting in speed restriction over long sections [23, 34]. The mechanical and color light are the main train control signals in Ghana. Communication is done through telephone radio and microwave systems [20]. However, they did not provide adequate communication capabilities for the train. All radios systems have been defective due to problems of frequency allocation and interference with third-party frequencies. In addition, the equipment for the signaling department is out of date and necessitates spare parts which have been very difficult to procure or very expensive in terms of foreign exchange [35]. As for Nigeria, the functioned mechanical semaphore signals and electric signals are installed on the telecommunications lines. However, the signaling system is not being used at all and radio is often used for communication, despite the old state of the facilities [36]. In Mali, the telecommunications system is obsolete, and the starting signals are probably operated with wires and may not be perceptible at night. The coverage of private operators of GSM telephony is not sufficient and does not allow to ensure regular traffic in safety [37]. The manual quartering system is employed as a means of controlling train movements within the railway system. The communications are ensured by the exchange of telephone dispatches from the station to the station [38]. The circulation of the trains is ensured by exchanges of dispatches via the fixed and GSM telephony of the public operator SONATEL-ORANGE in Senegal [19]. The BAL light signaling, which is installed on the heavy traffic section between Dakar and Thies is no longer in operation [23]. There was not any system for train operation in Togo. Drivers, station staff and security guards used dedicated mobile phones (green line) at level crossings for safety instead [29]. In countries such as Guinea, Liberia, and Sierra Leone, the manual systems are mostly through manual trains' orders or mechanical signals [4].

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### 4. Transport policy

Governments of the region are still grappling with the old policies decided by the colonial powers rather than having a break [39]. In the Benin Republic, the texts of the OCBN have seen to be obsolete and do not allow effective and modern management. The national transport sector plan has favour road transport mode over its rail counterpart. This undoubtedly explained why more funds are given to road transport instead of the railway because of its sustainability and immediate operation [40]. In Burkina Faso, Mali, Guinea, Liberia, and Sierra Leone, the main lines drawn in the national policy are more related to the road sector over rail transportation. This is felt through the number of pages devoted to road transport. In Ivory Coast, the authorities have resolutely oriented their efforts towards the construction of the standard gauge track for all new constructions. However, the question of the renewal of railway equipment which is in a state of advanced degradation is ignored. In Ghana, the irrelevant policies and strategies generate inactivity in the execution of sub-regional and regional agreements which impede the sustainable development of the railway transport sector. Additionally, the public-private partnership (PPP) was not encouraged by the political leaders in the development and operation of the transport infrastructure. These explain the fact that the liberalization and privatization in rail sector are still in its earlier stage [35]. In Nigeria, the failures to rescue the railway system were more related to faulty policy design and government lack of self-determination rather than scarcity of funds [21]. While Odeleye [41] accused the government of its complete holding, Aderamo [42] and Oye Abioye [17] identified the decreased capacity and profitability of the railway to be related to discontinuity and incoherence in policy implementation. In 2009, an institutional study in Senegal showed a relatively large number of diverse actors with diffuse and poor skills. This situation has weakened the supervision of the state and reduces the effectiveness of the management and control mechanisms of the public rail transport service. In Togo, with the lines to increase considerably the railway traffic by 2020, the government has planned in its railway development policy, the rehabilitation and construction of the Lomé-Cinkassé line and the rehabilitation of the existing network by 2014 [29]. However, the execution of these projects is not yet materialized. Above all, there is a weak coordination of policies and regulations applicable to cross border transport, as many West African countries have not fully enacting consensus at promoting cross border movement by rail from which each country could take advantage. Additionally, the accessibility of master plans at the national level and the lack of digitalization of all documents for basic access were accentuated.

## 5. Regulation and institutional framework

The setting of a fundamental basis for railway development is depending on a strong regulatory and institutional framework that preserves its investment. The formulation and implementation of more appropriate policies and regulations depending on the degree of closeness government participants have in the structure of the railway industry. Regulation and legal system were set in some countries to observe safety concerns, corruption, and market performance. The Act 1955 which established the Nigerian Railway Corporation is an example. But, it needed to be revoked in order to allow sufficient competent and robust system, market participation, and competition development. In Ghana, the Railway Act 2008, which was ratified by the President's Office on January 6, 2009, has established the Ghana Railway Development Authority as a statutory body in charge of the development of the railway and promotion of railway services, management and operation of railway assets as well as construction and improvement of urban railways. In other countries like the Benin Republic where railways are public enterprises, no regulatory body exists.

In spite of the theoretical role played by the Ministry of Transport (MOT) on supervising railways, the responsibility of examining has been assigned by some governments to concessionaire (as in the case of Senegal, Mali, Ivory Coast, Burkina Faso, and Togo). The representatives from the government in the concessionaire board are so often from the Ministry of Finance rather than from MOT as they mostly agonize from appropriate financial aid. The participants of the government involved in railways have so often lacked sufficient knowledge while well informed of the sector have limited power to make any decisions. Additionally, the participants were familiar with the heritage of the public enterprises instead of modern railway management, which leads to their resistance to dynamic change. There is no specific data on the regulation and institutional framework regarding Liberia, Sierra Leone, and Guinea.

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## 6. The socio-economic context of ECOWAS

The West Africa sub-region has been widely recognized for having commercial potential. The region has a market of more than 300 million consumers that projected to be half a billion within the next 35 years, contributing directly to the dynamics of the global economy [43]. In addition, its geographic area is characterized by immeasurable potentials minerals and agricultural crops [44-46].

The member countries of the Economic Community of West African States (ECOWAS) have proved to have unequal distribution of natural resources. Prior to the attainment of their independence in the region, numerous countries were endowed with one or other forms of mineral resources. While Ghana and Nigeria are well known for gold and crude oil respectively, Ivory Coast, Liberia, and Sierra Leone are known for being rich in the diamond. Iron ore and bauxite are also contributing considerably in countries like Liberia, Guinea, and Sierra Leone. Other ECOWAS members including Senegal, Mali, and Togo are rich in phosphate. With the exception of Nigeria which produces crude oil since the 1960s, it's finding in West Africa is of latter development, with Ghana, Ivory Coast, Liberia, and Sierra Leone lately appearing as oil-rich economies.

Most of the countries are known to be largely dependent on rich agricultural potential for the income of their population before the discovery of mineral resources in the region. West African countries are major producers of cocoa, rubber, cotton, and timber. For instance, while Ghana; Nigeria and Ivory Coast have great potentials for coffee and cocoa plantations, Liberia is known for its large rubber plantation. Also, while Mali is noted for cotton, livestock, millet and rice, Senegal and Burkina Faso have great potential for groundnut, cotton and sorghum production. In Burkina Faso, peanuts and she nut total 80 percent while in the Benin Republic, the same percentage is attributed to oil palm products. Most of the countries along the coast of West Africa, including Senegal, Ivory Coast, Guinea, Sierra Leone, Liberia, Ghana, Togo, Benin, and Nigeria are known to have fishing as a major activity.

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## 7. Recent railway projects

Many projects have been recently planned in different countries with China, to build new lines or upgrade existing deteriorated infrastructures [16]. However, the sustainability of these projects showed some considerable apprehension in terms of the economic and technical point of view.

From an economic standpoint, worries have been intensified about the huge loans resulting in the dependence of the developing countries with foreign governments. A reduction of Sri-Lanka debt through the supervision of its deep seaports by China and the high cost-effectiveness of the Mombasa-Nairobi line project in Kenya are such examples of this concern [47, 48].

With regard to the technical perspective, the development of the railway transportation system has only considered the national level, with little attention to connectivity and interoperability within the region [11]. Divergence in track structure (rail, ballast, sleeper, and fasteners), track gauge (narrow, metric, and standard), and inappropriate rolling stocks are probably to be restricted the regional railway transportation [48]. Ethiopia is an example of a country where lines run on separate signaling systems because of being constructed by different companies [49]. In Kenya, identical apprehension is raised by stakeholders at the Nairobi workshop regarding the connection between new rail lines and larger development regional planning, where signaling and communications, and maximum speed and axle loads to be applied in independent lines are not standardized.

Furthermore, recent financing programs on the railway sector are appeared not to be oriented to the current gaps in potentiality. Foreign governments and international organizations are the main decision-makers on the technical part of new projects where regional plans with comprehensive viewpoints are ignored. This explained the fact that financing railway projects are incompatible with regional requirements and development.

A comprehensive inconsistency exists between present actions and future targets. Since, the development of an integrated region where the populations enjoys free mobility, access and engage in businesses while living in a secure and peaceful environment is the goal of ECOWAS, and view the fact there is concurrently a lack of strategy to guide regional development towards a common target, head of governments and states are involved in buying ready-made technology that will be too exorbitant in the projection of nearby traffic. By doing so, their route towards development is expected to only pursue the same footsteps of advanced countries over the past and stay obsolete everlasting. There is no consideration regarding the precise condition of the region and its exigency for acceptable solutions that can upsurge antecedent curvy developments and produce appropriate solutions. If no solution has been found for these problems, there will have a considerable possibility for hardy accessible financial resources to be misused, and for new infrastructure systems to less perform. Such a result is expected to reduce the development of railways in the ECOWAS community and cause problems related to efficiency and environment in the long-term. Accordingly, it is crucial to make a steady and reasonable of hardly accessible investments in order to achieve regional future goals.

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## **8. Regional strategy development for railway transport**

The perspectives of a regional-large railway network are earlier mentioned to ease interoperability as well as to cope with the mobility needs of population growth. The international union of railways has published a specified vision of the African railways by paying particular attention to the revitalization of its networks, accentuating the necessity of considering regional and continental transport networks [14].

This study recommends some strategies to be used in the development of an efficient and interoperable railway transportation system in the Economic Community of the West African States which in turn will improve the interconnectivity and enhance the economic growth and trade in West Africa.

### **8.1. Strategies for comprehensive railway transport system database**

A comprehensive data on the state of the infrastructure, rolling stock and operational performance of each country's railway is decisive for the growth of more practical strategy and structured networks. There was an absence of many indexes in the existing railway infrastructure and trains operation in many countries such as Liberia, Sierra Leone, and Guinea. Countries where there are available indicators; they dated back to more than a decade ago producing imprecision in these countries for promoting economic growth. Additionally, new projects financed by international organizations or foreign countries are lack of accessible technical data.

Although data collection is a temporary prerogative for the establishment of any strategy, its procedure should be methodical in pinpointing critical parameters that can show if potential development coincides with future perception. Accordingly, an inventory of indicators to be computed as well as the criterion to be implemented and norm assemblage operations to secure trustworthiness in the results must be undertaken within the ECOWAS. Database and technique must be set up for recording the transport services and contentment of passengers and users respectively. Information systems and databases can be initiated for the yearly checking of the services, volume, and costs of railway passengers on each trajectory.

By implementing this strategy, the level of each country will be easily identified so that countries of the region will appropriately act. Additionally, the lacuna between present-day performance and each benchmark can be specified through indexes, so that prerogative sectors for research and development (R&D) will be emphasized.



## **8.2. Strategies for capacity building and training centers**

The comparatively poor awareness of the railway sector has been one of the major issues presently hindering the railway development and influencing all the decision-makers and managers at different positions of the railway sector. Besides that, the revamping of supervisory expertise and productivity of operations is being compelled by a powerful patrimony and lifetime. The railway sector is identified by mainly an absence of constancy in railway schemes for the last three decades. This absence implies limited technical arrangements and ceasing of existing railway institutes. Therefore, establishing a regional well-known curriculum in railway technology; producing knowledge exchange and skill-building for future railway management positions and policy decisions makers; assisting technically government authorities in the planning, preparation and analysis of project; and developing training centers that produce resident labor force to employ the technologies and evolve new ones are the key drivers for promoting regional capacity building and training centers. If these strategies are implemented, they can improve the proficiency of the ECOWAS countries, and allow them not to be dependent on advanced countries for making decisions for the time ahead. Also, the railway system in the region will enlarge the attraction of private companies or investors in the sector and ameliorate lucidity in taking decisions. Finally, the regional institutional framework will thus be enhanced allowing a strong base of any additional action from either public or private enterprises.

## **8.3. Strategies for railway infrastructure development and transport policy**

The governments must proceed with durable strategic programs for the rehabilitation of existing networks. Necessary measures are extremely recommended to ensure the survival of all railways networks within ECOWAS by focusing on the main axes that allow clearing a good part of their accounts payable in order to be able to resume a correct supply of spare parts for locomotives, wagons and railway assets. Sections of the railway network where traffic has suffered the most should have their productivity overhaul through the revamping and restoration of the track, which will, in turn, improve the interoperability with suitable technologies and cost-effective lines. The interconnection and interoperability of railway networks require, above all, the setting of an administrative, legal, technical and financial framework capable of covering the divergent interests of users, private companies, local authorities, and nations at the regional level. Consequently, several constraints will have to be lifted in order to expect the achievement of these major objectives.

The construction and maintenance standards of railways should be harmonized. For instance, the adoption of a 60 kg rail to support at least axle loads of 22 tons is recommended. Meanwhile, the consideration of future high transportation demand must be taken into account through careful consideration of gauge (standard gauge), track density and specified geometries.

The equipment fleet along with the maintenance standards should be harmonized by governments within the region. It is obvious that a good availability and an excellent rate of reliability of the rolling stock park can compensate for the financial charges. The acquisition of railway infrastructure assets, as well as the rolling stock, should be globalized by the governments. In this respect, railway networks of the ECOWAS members must seek to use the same type of rails and locomotives to make their orders representative and attractive to the international rail industry in terms of economy of scale.

An establishment of a good environment for a workable and more reasonable railway system conforms to the development of transport policy which did not only favor road transport should be suggested. Additionally, equal funding of road and rail transport infrastructures as well as intermodal transportation systems should be taken into account in the global vision of ECOWAS countries. At the national level, governments should not only enact a policy and management strategy for the separation of the operations and infrastructure for clear transparency but also should encourage the intervention of the private sector within the framework of a public-private partnership in order to have a good environment for investments.

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## **9. Conclusion**

A review and analysis of the railway transportation system in the Economic Community of West African States, including four English speaking countries and seven French-speaking countries, is conducted in this paper. The review of the current situation of the regional railway transportation system certifies the global vision of its assets inherited from colonial powers with few restorations since then and single-track lines with light rails, low axles loads and restricted speeds.

Notwithstanding the huge investments for the construction of new railways lines as well as the rehabilitation of existing ones and the restriction of financial resources, most of the West African countries have decided to modernize their railway transportation system to meet international standards. However, their action plans appeared not to be in line with the global vision of regional-large integrated railways systems that can be able to challenge other transportation modes. As a consequence, the interoperability and interconnectivity problems still persist as it was in the case of an inherited existing infrastructure system. There is thus a necessity of additional study to propose some practical strategies as bellows.

- Develop a comprehensive information system and database on the state of railway transportation in each country of ECOWAS in order to provide a list of indexes, metrics, and norms to be measured, used and collected respectively.
- Establish a regional well-known curriculum in railway technology and produce skill-building capacity for future railway management positions and policy decision-makers
- Develop training centers for the local workforce in order to promote regional capacity building.
- Develop a stable regional master plan for the development of railway infrastructure through a durable strategic programs for the rehabilitation of existing networks, the harmonization of construction and maintenance regulations of railway, the harmonization of equipment fleet along with the maintenance standards, and the setting of administrative, legal, technical and financial framework able to cover the divergent interests of all the stakeholders.
- Provide a policy and management strategy through the separation of the operations and infrastructure of the railway transportation system for clear transparency especially in terms of accounting.
- Encourage the intervention of the private sector within the framework of a public-private partnership in order to have a good environment for investments.

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## Compliance with ethical standards

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### *Disclosure of conflict of interest*

The authors declare no conflict of interest.

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