

# Sustainability of Rail Transport in Africa: A Case Study of Kenya's Standard Gauge Railway

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**Abstract:** Rail transport has a crucial role in shaping the transportation system in a country. For instance, rail transport has played a significant role in movement of goods and people in Kenya and in Africa as whole for almost a century. By 1990, however, the industry started to decline due to competition from more reliable and efficient means of transportation (buses and trucks). Passenger services had almost disappeared (accounting for less than 1% of total traffic). Against this background, this research paper analyses consideration factors for sustainability of the SGR (Standard Gauge Railway) infrastructure in Kenya. A case study method was selected and mainly used the desk top research approach to collect secondary data that were drawn from railway institution records, railway journals, railway magazines, internet and other secondary sources from projects, contract documents and government reports. The research results were used to formulate a roadmap for sustainable railway infrastructure projects. The research also discusses the outcomes and makes some recommendations for railway transportation infrastructure projects sustainability.

**Keywords:** SGR, case study, sustainability, railway infrastructure.

## 1. Introduction

Rail transport is one of the most important and cost-effective modes of commuting and goods carriage over long, as well as, short distances [1]. Rail transportation has been the product of the industrial era, playing a major role in the economic development. It is least affected by usual weather turbulences like rain or fog, compared to other transport mechanisms. Its services are more certain, uniform and regular compared to other modes of transport. Since this system runs on metal (usually steel) rails and wheels, it has an inherent benefit of lesser frictional resistance which helps attach more load in terms of wagons or carriages [2, 3].

In recent years, the world has turned to rail to answer some of the problems threatening our global transport network [4].

The desire to have trains that are fast, efficient, transnational, energy efficient and able to cope with the increasing demand on infrastructure has led to countries to invest in rail transport.

Rail transportation has a strong economic rationale, making it a competitive modal option for the mobility of passengers and goods. The ability of trains to haul large quantities of goods and significant numbers of people over long distances is the mode's primary asset. Overall, rail transportation is more efficient than road transportation, although its main drawback is flexibility as traffic must follow fixed routes and transshipment must be done at terminals [5, 6]. It was this feature that led to rail's role in opening the interior of the continents in the 19th century.

Africa's first network of railways was started in Alexandria, Egypt in 1852. By 1860, South Africa had launched its first steam train, running from Central Durban to the Point, and by 1897 a railway line between Cape Town and Bulawayo in Zimbabwe was completed [7].

In the early part of the 20th century rail lines were being constructed across the continent, connecting cities and countries in North, East, West and Southern Africa [8]. In many countries, poor rail infrastructure and outdated technology contribute to extensive delays in passenger rail networks, with disastrous

consequences for productivity (among passengers) and profitability (for the rail operator) [2].

Today, fast-growing economies across the continent are upgrading antiquated rail infrastructure to support improved regional trade and mass local transit. However, the poor condition of rail infrastructure and rolling stock in many African countries is undermining the potential of rail systems to contribute to economic development [5].

Railway administration in developed nations like Japan, France and Canada, has become more rational with time. New strategies, such as public-private partnership, and BOT (Build Operate-Transfer) arrangements, as well as old strategies such as privatization, are being adopted to enhance railway safety, punctuality, reliability and sustainability. Furthermore there is increasing interest worldwide in development of transport by expanding high-speed rail networks such as the Shinkansen in Japan and the *Train à Grande Vitesse* (TGV)—a high-speed passenger train in France. New non-rail technologies such as the magnetic levitation trains are being investigated in China and Japan. The priority for these changes have environmental undertones, and railways are increasingly being seen as environmentally friendly [9].

In developed countries, transport policy is dynamic and changes responsively according to technological trends in the transport sector. Government policy in respect of rail transport innovation and development are fairly consistent and largely limited to policy making and execution [10].

Meanwhile, countries all over the universe are now being challenged with issues that have to do with sustainable infrastructure project delivery. Therefore, railway infrastructure sustainability problem remains active all the time and one of the critical challenges that cut across various transportation infrastructures in Kenya and East African Countries as a whole.

The East Africa Community (EAC) acknowledges the need to rationalise rail development within the

region and to harmonise road and rail transport operations along the main corridors and has therefore, prepared an East African Railways Master Plan to guide the future development of the railway services in the region [8].

This study assessed issues and problems that form obstacle to successful delivery of sustainable railway infrastructure projects in Kenya. It uses Kenya's SGR (Standard Gauge Railway) as a case study with a focus on railway transport projects in Kenya. The research paper discusses the results which include: sustainability issues for rail transportation projects and a road map on the vital sustainability issues identified in the study. The study then makes recommendations for successful delivery of sustainable railway transportation infrastructure projects in Kenya.

## 2. Development of the Railway Network in East Africa

The origin of the modern transport system in Kenya was the port in Mombasa and the railway line built during the 1890s and the first years of the 20th century, linking the port to Nairobi and further on to Kisumu with a ferry connection to Port Bell (near Kampala) and Jinja in Uganda and to Mwanza, Bukoba and Musoma in Tanzania.

Kenya, a transit country in the East African region is endowed with a coastal line that has a natural harbour serving the land-locked countries of Uganda, Burundi, Rwanda and DRC (Democratic Republic of Congo). Kenya serves the Northern Corridor, after the 1985 NCTA (Northern Corridor Transit Agreement) on trade was established. The port of Mombasa has gained the status as the gateway to the northern corridor countries providing shipping activities and has extended its services to the customers by the opening up of the Inland Clearance Depots in Nairobi, Naivasha, Kisumu and Eldoret towns.

The Kenya-Uganda railways were built a hundred years ago with the aim of opening up the East African hinterlands for trade.

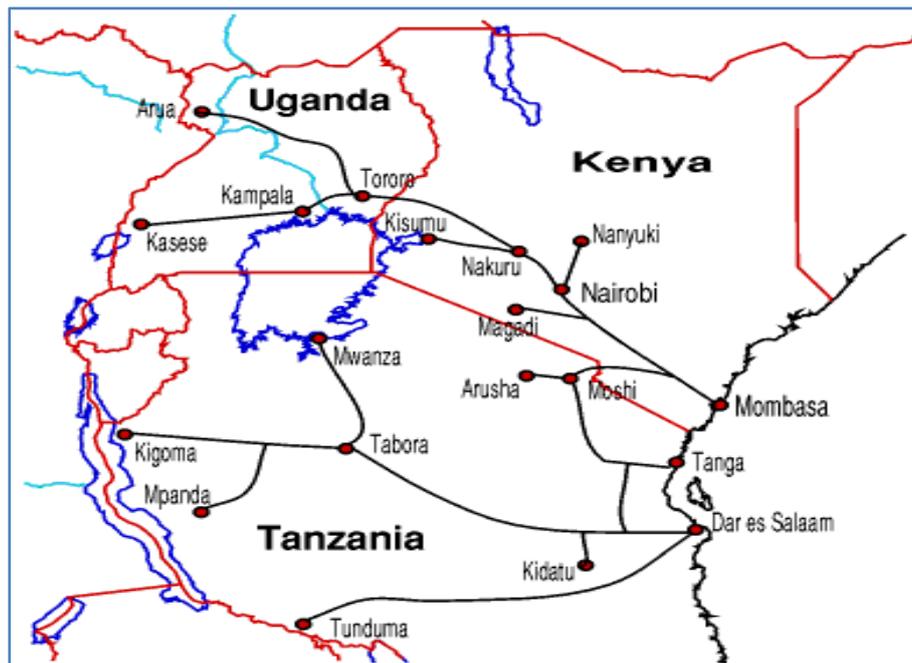


Fig. 1 Map of the major railway networks existing in East Africa [11].

Today, the rail network, together with road transport has turned out to be the major modes of transport in the region. They (road and rail) account for about 70% of the total cargo transported within the region and 94% of the passengers ferried, while 30% of cargo is carried either by air, pipeline or sea [12].

It is through these systems that inter networking patterns of the movement of cargo have emerged within the region which depends on road and rail to meet the needs of the business community. The most important routes for the transport of cargo are the Kenya-Uganda railways that link Kenya to Uganda. Mombasa road runs alongside the railways serving a wide area extending to Uganda, Rwanda, Burundi, Northern Tanzania and the DRC. Refer to Fig. 1 [11].

### 3. Problem Statement

The fast developments in industry and technology in the countries of the northern corridor have outgrown the capacity of the Kenyan infrastructure. This has led to violation of the maximum load limit and hence the collapse of the roads and this in turn has contributed to a strain on the budget allocation and extra costs are passed to vehicle owners through road

and petrol levies. Over-dependence on road and old rail transport infrastructure has exposed traders to losses due to the climatic (El Nino) changes that set in and destroyed the infrastructure. There are slow but on-going rehabilitation projects to improve the infrastructures. Seaports have been developed with the hope that they will be able to generate income and become sustainable. There are many problems associated with how these infrastructures are run and these have in turn affected shipping activities.

Due to the existing challenges in the transport corridor in Kenya and East Africa the government has deemed it necessary to construct an SGR connecting all East Africa Countries.

On 31st May 2017, Kenya became the first country to launch the 472 kilometre stretch of SGR. According to Nkirote [13], this saw the largest, most ambitious and costly infrastructure project in Kenya since independence from the British Colonial Government 55 years earlier [13]. The operational section of the SGR in Kenya has redefined and modernized railway transport in Kenya and East Africa.

The East African governments expect the SGR to bring a turn around to the economy through integration

and boost the respective country's GDP (Gross Domestic Product) [14].

The intention of this study therefore is to attempt to analyze how the SGR will harmonize the East African countries and be a sustainable means of transport in the long run.

#### 4. Study Objectives

The main objective of this study was to determine the strategic factors affecting sustainability of rail transport infrastructure projects in Kenya and the region.

For the purpose of this study, the exploratory approach of the case was used to assess specific problems and seek for answers to the following questions.

1. What are the problems that hinder achieving sustainability infrastructure projects (railway) in Kenya?
2. How those problems addressed and what procedures or methods are needed in order to achieve sustainability in railway transportation infrastructure projects in Kenya?

#### 5. Conceptual Framework

The construction and development of the standard Gauge transport infrastructure in the East African region is a major element of the regional economy integration and modernization and aims at a further national economy growth and improvement of the social sphere. The SGR in East Africa has provided over 60,000 jobs collectively for both locals and expatriates.

The integrative role of transport infrastructure will strengthen the domestic economic environment on the basis of the regional integration of the EAC.

The SGR will provide economic and strategic unity of the East African member states and will play a major role in the integration of the constituent sectors and will also be a stabilizing factor of the region's economy. The tourism sector which is a major foreign

income earner for East Africa stands to gain from the SGR because the tourism destinations in the region will be open to both local and foreign tourists. The SGR once fully operational in East Africa will boost the tourism sectors by virtue of being able to move tourists in masses closer to their destinations faster and at affordable rates. This will greatly impact on the EAC GDP. The environment will greatly improve the effects of climate change which will see a reduction as trains are more ecologically friendly. The upcoming scheduled upgrades of the SGR to the electric propelled version will further reduce cost and will be more sustainable towards reducing the impacts of carbon emission.

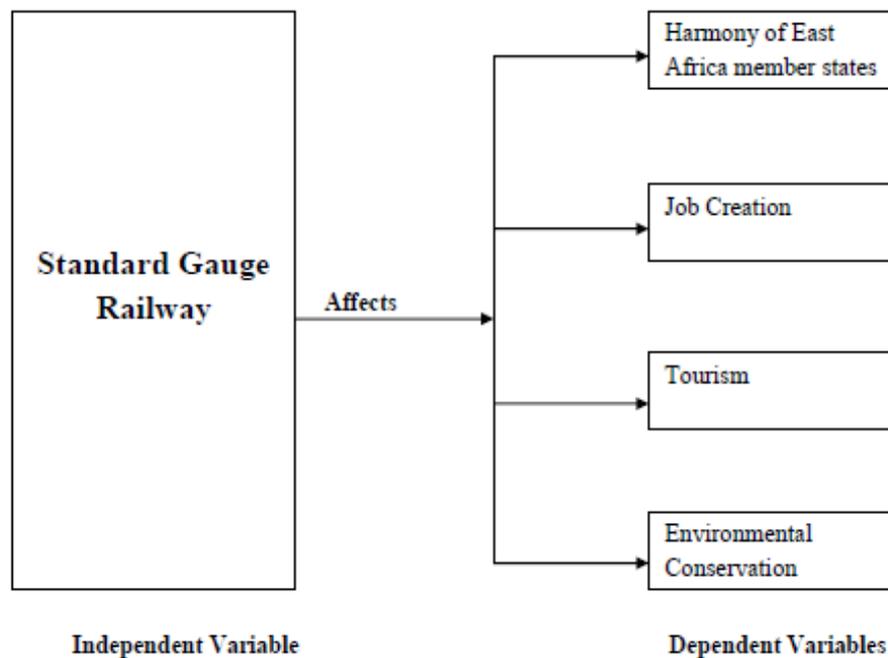
In the study, the conceptual framework will look at the factors affecting sustainability of rail transport infrastructure in Kenya.

#### 6. Empirical Review

Among other sectors in the modern society, the roles of transportation cannot be overemphasized. Transportation is mainly demanded to execute the objectives of each of other sectors in the economy. An efficient transport system covering rail, waterways, air, and road, is a catalyst for economic growth and development.

The study could form a base for the solid foundation in the wider context of sustainability assessment and organizational knowledge management in railway infrastructure projects.

For the development of an efficient, effective and productive railway sector support of Kenya's anticipation as a transportation hub in the East Africa, the country needs to position itself to develop a robust manufacturing industry that turns out the components for the construction and maintenance of an extensive rail infrastructure network [15]. It should seek and develop criteria for modally and geographically equitable development of infrastructure in the country. It also needs to commission a technical feasibility study on the rehabilitation of the existing system.



**Fig.3** Conceptual framework.

Such an investigation should also map the spatial aspects of the realisation of the expansionary system across the country and the provision of the appropriate links to the neighbouring countries in the sub-region [16, 17].

A sustainable transport system combines the strengths of all transport modes in one integrated system. Policies and funding strategies should follow a set of key sustainability indicators for transport. Rail now faces a huge opportunity to consolidate its position and continue to grow; but to do so it will need to move to the next level of maturity as an industry, developing its commercialism, capabilities, culture and confidence.

## 7. Research Gap

Much literature focuses on the efficiency of railway transport in transportation of mass cargo, which often starts with a market metaphor that is rationalized. Studies on the influence of railway transport in the country are numerous. Most of the studies conducted by Scholl and Klischewski [18] and Min and Galle [19] etc. were based on developed economies. Locally,

there is no study in Kenya that has looked at the factors affecting adoption of rail transport for mass cargo in Kenya from the point of view of technology, government policies, staff competency and operational costs. This study therefore, will seek to fill the knowledge gap by establishing the overall objective of this study which is to determine the strategic factors affecting sustainability of rail transport infrastructure projects in Kenya and the region.

## 8. Study Methodology

The research design in this context was defined as the conceptual structure within which the study was conducted. The research study used the explanatory research design and predictive analysis. Sources were derived from the internet, newspaper articles, academic books, academic documentaries and scholarly and railway journals.

The study mainly used the desk top research approach to collect secondary data that were drawn from railway institution records, railway journals, railway magazines, internet and other secondary sources from projects, contract documents and government reports.

## 9. Results

The SGR involves acquiring huge chunks of land by the respective EAC governments. Not all land in East Africa is government owned as the case is with Tanzania and Ethiopia.

In Kenya, challenges that come with this include just and prompt compensation, smooth relocation of displaced communities, land ownership concerns which include procedures for acquiring the already scarce and inaccessible land for the displaced populations. Relocation of these populations to neighborhoods far away from their ancestral settlement areas has interfered with the communities' moral and cultural principles and in the long run this may bring about human rights issues. Trans-boundary disputes are likely to arise in cases where communities feel that the newly relocated occupants were infringing on their property and basic space especially water and grazing land.

Further to this, the SGR construction has brought about a loss of farmland and agricultural throughput. The SGR has so far taken up a substantial chunk of arable farmland and therefore has reduced the agricultural sector contribution to the East African economy.

This study has revealed that the SGR driving spirit was founded upon the idea of integrating East African member states and fostering economic development, to include stimulating mineral exports from the hinterlands of the EAC, DRC and elsewhere.

Without the SGR in place, both the Mombasa and Dar es Salaam ports would remain a non-investment as they are the key port gateway to East Africa. Thus far, the Mombasa-Nairobi section of the SGR has been completed and is fully operational.

China has taken credit for promoting the SGR in East Africa which is a mega infrastructure development project set to bolster modernization and to integrate transportation systems in the East African countries of Uganda, Rwanda, Burundi, Congo and South Sudan. The SGR will also link East Africa to

China and help enhance trade.

The SGR is set to contribute greatly to East Africa's harmonization through economic and social development as well as improving people's livelihoods and stirring the country to heights of prosperity. According to Atanas Maina, the managing director at Kenya Railway Corporation (KRC), the Kenyan project will raise Kenya's gross domestic growth by 1.5 percent when fully in operation.

A 2013 report by the Economics of Rail Gauge in the East Africa Community from the World Bank argued that in order to service the China loan, the railroad must attract additional freight in the order to reach 20 to 55 million tons per year if a bit of the SGR in Kenya is to stay economically viable [20].

The SGR train has revolutionized movement of people, goods and services in the country since its operations commenced in 2017. This achievement has been attained by lowering the cost of transport thereby making the SGR more affordable, convenient and reliable for Kenyans to travel for business and for leisure [21].

## 10. Discussion

Garmendia, et al. [22] suggest that in tandem with supplementary financial and economic policies, transport infrastructure including railways and ports used as a means of facilitating the movement of freight and passengers has long been acknowledged as a crucial element in supporting the background for economic growth [22].

A latest study by the World Bank revealed that an emphasis by the development community in fostering productivity and economic development, affordable and reliable transport is crucial in reducing dearth levels and contributes to achieving the MDGs (Millennium Development Goals).

The development of a modernized railway transport infrastructure in a great degree contributes to growth and development through several channels including reducing transaction costs, reducing tear and wear of

vehicles and roads, adding to the durability of capital goods, fostering national and international trade and investment, expansion of demand and diversifying supply and attaining economies of scale and scope [23].

There seems to be adequate evidence to support this in developed countries; however, supporting research with regards to the effect of railway infrastructure on developing nations in Africa and East Africa to be precise, is severely lacking.

Barrow [24] points out that poor connectivity or the lack of it thereof among East African countries is a fundamental cause for intra-African trade and economic imbalance. The African Economic Outlook 2017, compiled by the AfDB (African Development Bank), The Organisation for Economic Co-operation and Development (OECD) Development Centre and the United Nations Development Programme, reveal that the transport and communication infrastructure needed to speed up economic development is less developed than those that link the continent to the rest of the world and recommends that increasing transportation links, improving rails that connect internal growth centers is a priority in reducing time and cost of doing business not just in East Africa but in Africa as a whole [25], the lack of which would presents a major setback where impacts of regional integration on trade and development are concerned [24].

Statistics indicate that railway infrastructure in developing countries is generally either in poor condition or is nonexistent. A considerable investment is required to return it to an optimal functional state. This rings particularly true for SSA (Sub-Saharan Africa) where railways lag behind those of other regions both in quality and quantity [26]. To actualize this goal, the East African Governments are constructing an SGR that will connect the port cities with the hinterlands. In the long run, this railway line is projected to continue onward to neighboring Rwanda and South Sudan. The end goal would be to

reduce travel costs and simplify transport operations across borders as well as provide massive social and economic harmonization benefits to all the East African member states. According to the United Nations economic and social council, the SGR mode of transport that has thus been far proven to be cost-effective as far as moving bulk cargo over long distances efficiently is concerned [27].

The World Bank has indicated that there are massive benefits that an efficient railway network could offer to boost economic growth, social growth and trade integration in the EAC region.

### *10.1 Trends and Developments*

To meet the numerous challenges (demographic development, climate change, etc.) the rail sector in Kenya must increase its innovations so as to deliver smart solutions as regards to safety, security, punctuality, availability, accessibility, seamless operation, capacity, connectivity, sustainability and other performances. The greatest challenge, however, is to meet all the goals while remaining economically affordable [6].

In order to achieve economies of scale and seamlessness of operation, there has to be a continued effort to bring national and regional specificities of the rail system closer together—where such specificities are unavoidable—to optimise their inclusion into a coherent and interoperable network.

The demand for long distance journeys is already growing and this growth is expected to increase with further development of SGR [30]. For instance, according to KRC, more and more passengers have preference for the SGR over road transport when travelling between the towns where the SGR cuts through. For one, the SGR fares are competitive and the SGR comes with a travel in style comfort. Since inception of the SGR in Kenya, there has been a recorded increase in capacity from 5 million passengers to 15 million passengers initially then to 60 million passengers per year in Phase 1 [31].

Transporters are taking advantage of technology in cost reduction. With the SGR, it will cost less to move a ton of cargo not to mention the substantial savings that will be made such as a reduction in fuel consumption. In SGR, fuel efficiency ranges between 35 and 50 per cent. Maintenance costs will be brought down because of the nature of infrastructure. The expected substitution of road transport with SGR, usage of tires by trucks and vehicles will go down. Tire replacement is one of the major costs in transport, and this reduction in replacement cost may result in substantial savings to the larger economy.

Diversification of labour markets and differences in prosperity between the countries will lead to more differentiation in pricing policies, with a strong growth in yield management systems and low-cost carriers.

From a technological point of view, innovations are expected to operate towards more energy and resource efficient systems for rolling stock and infrastructure and to converge towards a "digital railway". Integrated services for ticketing and traveller information and guidance, also in case of disruption, are expected to be further improved towards real time level [30, 31].

There will also be a convergence of quality, safety and security management systems based on best practise and the vision of a global rail system with a maximum degree of inter-operability and a global railway supply market [32].

High speed rail may promote lifestyles in which long distance commuting on a daily, week-end or some days per week frequency becomes an increasingly common phenomenon.

### 10.2 Resulting Challenges

Significant improvements in cost reductions as well as reliability, availability, and maintainability of the railway system have to be achieved to make the vision described above a reality [33]. Outstanding interdependent safety and security records remain the

core feature of the rail system. Safety and security criteria should further be harmonised and rationalised, thus becoming a facilitator for shifting to rail rather than forming a barrier for inter-operability.

The rail system has to be affordable, accessible and attractive for all passengers, whatever their social and income status, their age and individual characteristics along their lifetime, and their possible physical impairment including persons with (temporally or permanently) reduced mobility [34]. Delivering reliable, affordable and attractive rail services in close coordination with other transport modes and especially public transport, is crucial in the development of a set of harmonised operating processes responding to IRSs (International Rail Standards). This level of system convergence is for the benefit of deriving harmonised technical, operating and maintenance (asset management, integration, evolution etc.) requirements for rail technology and the implementation of the railway services [3]. This is needed for reliable interworking and will foster the development of compatible components to facilitate cross-utilisation throughout the system and to reduce the cost of production and maintenance. The IRSs are "railway driven" standards, guidelines for maintenance, operation, integration, evolution, safety and security management and are expressing the corresponding functional requirements that are mobility [35].

## 11. Recommendations

### 11.1 Trainings

The purpose of training and education efforts is to contribute to the enhancement of the rail sector by fostering a better match between the human resources needs to make railways a more competitive and innovative sector and the offer of skills coming out of the various research-based education and training institutions.

#### Standardisation

A successful future railway system needs its assets

to be of high performance and meet the criteria of reliability, availability, maintainability and safety. The service to the customer has to be adapted to contemporary expected functionalities performance and sustainability.

### *11.2 Research and Innovation*

Rail should strive to create an ecosystem for innovation involving excellent research institutions, vibrant companies devoting time and energy to R&D (Research and Development) and demonstration activities [36]. The innovation chain from blue-sky research, applied engineering up to demonstration (roll-out/deployment) must be addressed at international level by bringing together critical technologies in new advanced designs, feasibility proof at concept levels as well as demonstrations and roll out efforts [37].

Research and innovation should also address new operations and assets management and engineering techniques, allowing monitoring autonomously in real time intelligent infrastructure, rolling stock and other system components, and to maintain infrastructure safely as a result of greater reliance on state-of-art automated intervention methods [38]. This will also help to maximise the effect of maintenance budgets for assets by renewing assets with optimised timing and methods.

### *11.3 Asset Management*

The discipline of asset management is now considered by all railways as a "mainstream" expectation for competent organisations. It draws from both business and financial management and also from technical, engineering, operations and maintenance management.

The longer the lifecycle of the assets in question and the higher their value (as it is typically the case in the railway business), the bigger the potential for significant benefits and added value to be gained by any organisation or business that chooses to apply

asset management properly [2]. Asset management is targeting an enhancement of the value of an asset portfolio by purchasing-selling actions.

### *11.4 Operation and Maintenance Management*

The next generation of railway operation management should produce a step change in capacity in order to enable the railway system to accommodate a substantially increased passenger and freight traffic.

### *11.5 Procurement and Quality Management*

Quality problems of the manufacturers of railway material directly concern the People's Republic of China (PROC) as the passenger or freight customer usually does not care about the cause of a delay but will put the blame on his contractual partner, the operator [22]. Therefore, it is legitimate that railway operators and infrastructure managers try to impose quality standards and quality management measures on their suppliers in order to ensure a constantly high level of product reliability.

## **12. Conclusion**

The construction and development of the standard gauge transport infrastructure in the East African region is a major element of the regional economy modernization and aims at a further national economy growth and improving the social sphere.

The integrative role of transport infrastructure will strengthen the domestic economic environment on the basis of the regional integration of the EAC. The SGR will provide economic and strategic unity of the East African member states and will play a major role in the integration of the constituent sectors and will also be a stabilizing factor of the region's economy.

The next phase of benefits requires a significantly greater alignment of incentives between all parts of the industry value-chain, to create more normal commercial relationships and greater joined-up working across the sector. If the industry can operate increasingly on the basis of transparent and

commercial arrangements, with effective aligned incentives that deliver benefits for customers, then regulation will change to reflect the different structure of the sector.

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