DEVELOPING A FRAMEWORK OF SUSTAINABLE RAIL PERFORMANCE MEASUREMENT: IN REFERENCE TO THE EGYPTIAN RAILWAYS

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Abstract

Over the years, different terms were developed such as multimodal transport, combined transport and co-modality. These terms refer to integration between different modes of transport. The target is to achieve a more efficient use of the transport system. In the transport sector, railways are recognised as an environmentally friendly transport mode with a significant potential for sustainable development. Hence, the railway industry is facing potential growth. Setting a sustainable strategy and identifying how a sustainable rail Programme can be developed are the main purposes in this paper.

Purpose

This paper aims to examine the current state of sustainability efforts within the Egyptian railways, to identify the opportunities for enhancing the sustainable operations and to develop a sustainable rail strategy.

Research Approach

In order to discuss the above purposes, the researcher has set the following questions to be answered, including: what is the rail sustainability strategy? What are the sustainable development principles? How can a sustainable railway system be enhanced? What are the potential growth opportunities for developing the railway services? An exploratory approach is applied in this paper as it helps defining the rail sustainable issues, areas for potential growth, alternatives, and prioritising areas of development that are required. An Empirical Study has applied in reference to the Egyptian railway as a case study. A SWOT analysis has been developed regarding the three sustainability pillars; economic, environmental and social. The paper starts with discussing the importance of implementing sustainability into rail logistics operations, followed by the extant literature, and then it turns to explain the rail industry sustainable development principles with application to the Egyptian railway, and finally it ends with SWOT analysis for Egyptian railway sustainable pillars.

Findings and Originality

There has been little work done to understand how a sustainable rail strategy can be developed. Developing such a framework for the rail sustainability strategy will help to improve the efficiency of the transport systems in Egypt, including rail transport.

Research Impact

This paper aims to identify the sustainable practices, principles and constraints that should be considered in order to understand the overall rail sustainable operations.

Practical Impact

Top managers and operators of the Egyptian railways need to be able to visualize and map out the rail industry sustainable strategy, and benchmark their sustainability efforts with other rail networks.

Key Words

Sustainable strategy, Egyptian railways, railway SWOT analysis

Introduction

In the transport sector, railways are recognised as an environmentally friendly transport mode with a significant potential for sustainable development (Marinov and Ricci, 2012). Lean logistics principles can be applied, for example, to provide a more efficient railway system. Hence, the railway industry is facing potential growth. Reis et al. (2013) appealed that the performance of an intermodal transport services, including rail services, can be determined by freight forwarders (FF).

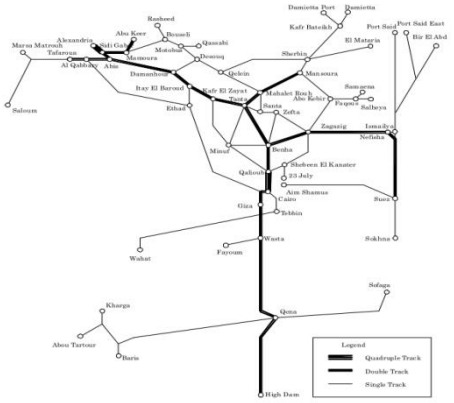

Figure 1: Railway Network in Egypt
Source: JICA, 2012

Egyptian National Railways (ENR)

Egypt is one of the oldest countries in the world in the use of the railway where the first railway line was built in 1851 in Africa and the Middle East, and it was between Alexandria and Kafr El-Zayat. Egypt was the second country in the World to introduce railway service after England. The Egyptian National Railways (ENR) has the responsibility for rail systems and services in Egypt. The rail network extends over some 5,100 kilometers, or about 9,600 track kilometers. Almost 30 percent are double tracked, and the remainder is single tracked. The entire system is standard gauge and not electrified. There exist some 705 stations, and almost 1,300 level crossings, only about one fourth of which are provided with electrical warning devices.

The ENR is divided into 10 sectors, including (1) long-haul, (2) short-haul, (3) cargo transportation, (4) infrastructure, (5) maintenance and technical support, (6) services, (7) safety and quality assurance, (8) finance, (9) human resources, and (10) engineering projects and the Authority Management Center. The number of workers at the ENR is about 57 thousand workers in 2015.

The ENR fleet consists of more than 800 locomotives and some 3,800 passenger coaches as well as 11,900 freight wagons. The maximum operable train length is 16 units or 640 meters. Signaling is, in general, performed manually with exception of the high-use Cairo-Alexandria corridor, where signaling is automatic. Daily demand exceeds 150 trains on the busiest network sections. All operation is via diesel propulsion. Figure 1 shows the railway network in Egypt. Wheat, Cement, Oil, Iron Ore, Coal and Coke and Containers are supposed to be the main commodities that are carried by the ENR.

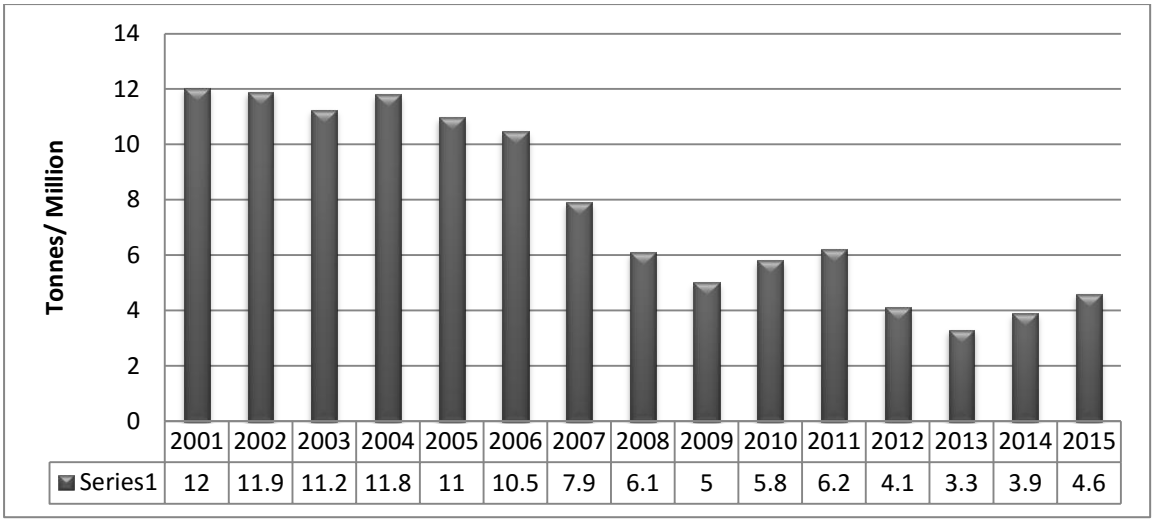

Figure 2: Railway Network in Egypt
Source: MOT, 2016

However, the ENR is suffering the lack of sufficient funds resulting in a deteriorated state of equipment, maintenance service and untrained personnel. The recurring train accidents and delays, deteriorated state of locomotives, trains and signalling system, lack of qualified labor, solid safety and security systems, and insufficient budget, are major reasons behind ENR's losses which are estimated at $1 billion annually. Figure 2 indicates freight volume transported by ENR. It shows that the Freight transportation volume by railway had been holding at the level of about 12 million tons until the year 2003. However, since then it has been rapidly declining down to only 4.6 million tons in 2015. These are the main challenges facing the ENR.

Literature Review

Sustainable development is a widely used term, which has been increasingly influential on countries' planning, housing and urban policy in recent years. Debates about sustainability no longer consider sustainability solely as an environmental concern, but also incorporate economic and social dimensions (Dempsey et al., 2011). Transportation and mobility are central to the sustainable development of developing countries. Sustainable transportation can enhance economic growth, promote trade opportunities and improve accessibility. Sustainable, reliable and safe transportation achieves better integration of the economy while respecting the environment (UN, 2014). Consequently, the term Sustainable Transportation (ST) came into use as a logical follow-on from sustainable development, and is used to describe modes of transport, and systems of transport planning, which are consistent with wider concerns of sustainability (Sakty and Tarek, 2015). The concept of sustainable transportation has three major dimensions (Rodrigue, 2013); environment where a reduction of the environmental impacts of transportation is a likely strategy for sustainability, Economy where transportation is a factor of economic growth and development, and social where sustainable transportation should benefit the society.

In recent years, promoting the development of rail transport at world level became an indispensable mechanism in order to meet challenges of mobility and sustainable development (Schwarz, 2011). As a low carbon transport mode, the railways have created environmental challenges in global mobility. Rail is prepared to be the backbone of such sustainable transport systems. Cruceanu (2011) claimed that railways certainly have a crucial role in a sustainable, safer and greener evolution of the transport system. Grabowska and Strzelczyk (2014) emphasised that a rail transport is characterized by low costs of transport

at medium and longer distances and higher load capacity of means of transport. It is also characterised by fast deliveries, regularity and improved reliability. From the regulatory perspective, Erdos (2011) applied the macro and micro environment analysis and introduced the regulatory impact on the railway market supply while concentrating on intra-modal competition. The focus was on how railway liberalization has changed the shrinking railway market in order to define a strategic policy intervention, with the express purpose of increasing the competitiveness of railway transport and solving efficiency problems. Erdos (2011) introduced the rate of railway market attractiveness (RAMATE rate) in order to compare the attractiveness of the different railway markets of the European Union for new entrants and the degree of deregulation. A set of variables of the passenger and freight railway market attractiveness were identified.

Sustainable ENR Challenges

This paper has set the following challenges/problems that can be displayed in three pillars:
- Hardware challenge: Operational efficiency and available capacity of railway transport is low, and the freight shipped by rail has declined from some six to less than one percent of domestic freight shipments. Containers are not a priority for the rail sector due to a lack of infrastructure both for handling and transporting of this growing cargo potential.
– Software challenge: Commercial utilization of the inland waterway and railway modes is predominantly for low value bulk cargoes transported between dedicated destinations. Cargo consolidation is hindered not only by the lack of available infrastructure and equipment, but also by the absence of management and operational know-how.
– Humanware challenge: the sector suffers from a severe shortage of qualified staff. There is a lack of training programmes and human resources development, in particular related to the introduction of modern technologies in this sector.

ENR and Sustainable strategy plan

The ENR authority has prepared the sustainable development strategy plan for the future freight rail. The plan has been set for ten years starting from the year 2013 to the year 2023 with the total amount of 157 billion pounds. The plan relies on the development of the current situation of the fleet of the Authority and the infrastructure. Hence, the ENR has started to develop the infrastructure, including:

- The renewal of 275 km railway at a cost of $ 84 million
- Replace mechanical signals systems Email link systems talk (EIS) on the following lines: Cairo / Alexandria - Beni Suef / Assiut -Binha / Port Said - conf / Nag Hammadi (a total cost of about 600 million US dollars
- Replace the current automated control system (ZUB) to a modern control system (ETCS-Level 1)

Table 1 shows that the ENR has set the future projects in order to overcome the hardware, software and Humanware challenges.

Project	Purpose	Estimated costs
Construction of a link 35 km connect Sokhna Port to 3 cement plants in Suez	Transfer cement products to domestic market using ENR networks	350 Million EGP
Establishment of intermodal terminal	Enhancing the flow of domestic freight using an intermodal system	N/A
Establishment a logistics center for containers	Connecting the industrial zones with ENR network	N/A

transfer		
Developing ENR network	Renewal of 2,000 km railway on all lines	N/A
Developing ENR network	Replace the mechanical systems by the modern systems (EIS)	N/A

Table 1: BOT Future Projects
Source: MOT, 2016

Sustainable Railway Principles

The rail industry requires applying the Sustainable Development Principles in order to meet the challenges discussed above. A Sustainable Development Steering Group should be launched to ensure the implementation of the principles. Different Principles have been developed to reflect the knowledge and understanding of the challenges and opportunities of sustainable development for the rail industry. Those principles cover social, economic and environmental issues. Some of those principles are as follows (Rail Safety and Standards Board, 2009):

1. Customer-driven; which refers to the rail capacity to meet customers' expectations.
2. Putting rail in reach of people; which refers to the physical and information accessibilities to both freight and passenger services.
3. Providing an end to end journey; which refers to the integration of the rail system with other modes of transport?
4. Being an employer of choice; which refers to the level of skills and competency of employers at rail industry in order to achieve the sustainability vision?
5. Reducing our environmental impact; which refers to reducing the environmental impacts?
6. Carbon smart; which refers to a lower carbon services through shifting passengers and freight from more carbon intense mode to rail.
7. Energy wise; which refers to lowering the cost of power sources.
8. Supporting the economy; which refers to the support for the key industrial sectors through providing efficient distribution and operations?
9. Optimising the railway; which refers to increasing the existing rail network capability?
10. Being transparent; which refers to corporate responsibility and environmental performance? This can be achieved by developing the industry's sustainable rail programme as shown in Figure 3, involving passengers, cargo owners, shippers, government and regulators and researchers.

The railway plays an important role in contributing to an integrated national transport system, providing a sustainable transport solution that minimises environmental impacts and contributes to social inclusion and economic prosperity. The Rail Safety and Standards Board (2009) have developed the following Sustainable Rail Programme (SRP) to support the industry in reaching its full potential.

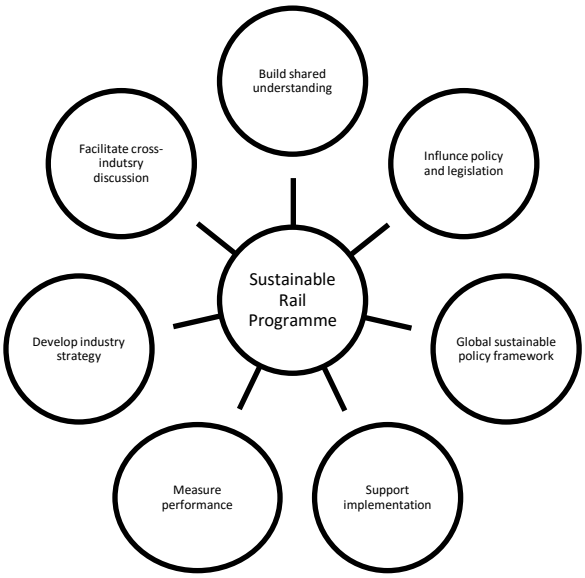

Figure 3: The Sustainable Rail Programme
Source: Rail Safety and Standards Board, 2009

Developing a Sustainable ENR Strategy

This section starts with developing an ENR freight SWOT Analysis in order to identify the current status (strength and weakness) and the future status (opportunities and threats) as shown in Table 2. Then, it turns to examine the challenges facing the ENR sustainability in term of economic (hardware challenges), environmental (software challenges) and the social (Humanware challenges).

Strength	Weakness
▪ Capability to carry high volumes ▪ Suitable for long distance transport ▪ Existing in most of main Egyptian ports	▪ Poor reliability of service ▪ Expensive compared to road transport ▪ No existence of private sector ▪ Lack of multimodal terminals ▪ Lack of locomotives and wagons to cope with demand
Opportunities	**Threats**
▪ Fuel subsidization attracting cargoes to ENR network (Model Shift) ▪ The intention of the Egyptian government to sign a multimodal transport convention.	▪ Increasing freight demand on ENR services ▪ Large road network accessible and paved covering all Egypt ▪ continuous governmental improvements for other modes of transport rather than railway, such as road transport ▪ presenting a door-to-door service by road transport

Table 2: ENR freight SWOT Analysis

First: Hardware challenges

1. Railway Tracks

Tracks along local lines are sometimes so deteriorated that it causes damage to the freight, wagons and locomotives. Only about 30% of the network is double or more tracks. Transport capacity is limited except for major trunk lines such as between Cairo and Alexandria. These defects of the railway tracks also affect the safety of the transport .

2. Rolling Stock

It seems that ENR has enough locomotives, coaches and wagons. However, the operating ratio of locomotives is around 40%. Conditions of the coaches and wagons seem to be the same. It seems that the decrease in ENR passengers and freight is caused by the lack of working rolling stock. Most of the rolling stock seems to be aged and deteriorated, although accurate ages are not clear. Railway freight might be damaged due to the deteriorated wagons. This would affect the travel/transport speed of the railway service, which is one of the characteristics of the railway service. This also would affect the safety of the railway operation.

3. Workshops and Depots

Workshops also seemed to have many problems. Machines and equipment in workshops are so old that proper maintenance and repair work would not be expected. Necessary spare parts for maintenance and repair are frequently lacking. These would affect transport capacity of course, attractiveness of railway transport service and might be one of the critical causes of railway accidents.

4. Signalling System/Train Operation

The signalling system is also aged and outdated along most of the railway network. Travel/transport speed of trains is substantially affected by the old system. Safety would be increased if a modernised signalling system is introduced. Modernisation of the system is considered urgent for efficient and safe transport.

5. Railway Terminals

Transshipment facilities such as cargo handling machines are not well provided in the railway freight terminals. The current railway terminals are not satisfactory in terms of terminal function. Freight that has arrived would not be able to reach its final destination easily.

Second: Software Challenges

1. Maintenance System

The maintenance system has a serious defect. Regarding ENR coaches, malfunctioning coaches are operated mainly on the local lines. Coaches with no window glass are operated daily. Floors of local coaches are often deteriorated badly. Comfort of passengers is totally ignored on such coaches. The maintenance system of coaches also has a serious defect . Apart from the rolling stock, track maintenance is also seemed insufficient.

2. Safe Train Operation

ENR has many accidents as reported in recent years. It is surprising that the number of accidents has been increasing despite the rapid decrease of passenger and freight transport volume.

3. Transport Planning/Database Maintenance

ENR does not own any container wagons. The transport planning of ENR does not place any importance on container transport by railway. This means that the transport planning of ENR is not functioning at all, because no one could fail to notice the current containerisation progress in not only international transport but also the domestic market of EGYPT .As a matter of fact, ENR transport containers mainly between sea ports. Containers are loaded on flat wagons and fixed by wire. It seems very time consuming and dangerous. It seems that an institutional arrangement is urgently needed to analyse and plan for the current and future transport market both for passengers and freight. Combined transport service provision would be a strategic solution, which is not independent planning of the railway but cooperative planning with other modes of transport under the principal of intermodality.

Third: Humanware Challenges

Recognition of Safety of ENR staff seems insufficient. As the railway carries a large number of passengers and freight on one train, the magnitude of a disaster becomes enormous when it happens. It would be necessary to enhance higher recognition of railway staff's recognition of the importance of safety. Considering the previous issues, capacity building of ENR staff would be necessary in the following fields .

- Railway Transport Safety ;
- Transport Planning and Data Management;

Strengths and Weaknesses of the ENR Challenges

It becomes obvious that the ENR service basically has advantages over the other modes of transport, which are shown as Strengths in Table 3. However, ENR has been failing to realize those advantages to the customers. On the other hand, ENR has also failed to deal with basic Weaknesses in the same table. Reliability is considered one of the advantages of railway service, generally. ENR has not been successful to provide this aspect of railway service as well. Enhancement of the "Strengths" and correction of the" Weaknesses" to realise the original role of the railway would be tasks to develop the sustainable ENR strategy as discussed in Table 3.

	Strengths	Weaknesses
Hardware	- environmentally friendly - large transport capacity - high speed transport - punctual transport service - it covers major parts of the country	old and obsolete system (workshops, signalling system, rolling) access is poor train speed is very slow except for main lines
Software	- systematic transport service - safe transport service	- maintenance works are not performed well safe operation train diagram

		transport planning/database maintenance
Humanware	- a large number of staff	- knowledge and experience of modern technology

Table 3: Strengths and Weaknesses of the ENR Railway Transport

Conclusion

It is concluded that the ENR must concurrently contribute to an efficient economic structure, and provide a base for market-oriented transport activity. The lack of sustainable prospects to capture new and alternative traffic further reduces the willingness to invest in innovation and modernization of railways. A sustainable long-term transport strategy needs to be supported by the government policy that can be easily adapted to changing socio-economic conditions. As discussed in this paper, the new transport strategy should pursue the realization not only of the hardware component of ENR, but should also take into consideration what is needed at the software and humanware level in order to create a sustainable. Hence, the attentions of transport planning must gradually shift from alleviation of present deficiencies to realization of a transport system founded upon sustainable evolution and integrated. Sustaining the "Strengths" and correction of the" Weaknesses" regarding the challenges facing the ENR, are highly recommended approach for developing a sustainable ENR strategy.

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