A situational Analysis of Transport Usage in Zambia: A Modal Perspective of Railway Freight Services from 1960's to 2018

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Abstract

Zambia's transportation policy highlights gaps in the transportation sector. This review focuses on analysing railway freight services and provides a departure from other similar reviews through a critical review of the Zambia railway sector gaps. The study sought to review existing literature, reports, and online information sources on Zambia railway freight services by grouping challenges into thematic groups. Causal loop analysis is used to identify cause and effect relationships among challenges specific to Zambia. Findings indicate that Zambia's railroad infrastructure quality score (2.4) benchmarks below the average mean score (3.5) of all countries in 2017 and further benchmarks below the income group 'eight-year average' mean scores on infrastructure quality and train efficiency. Zambia has been recording declining railway volumes in terms of ton-km over a 37-years period. Five main thematic areas are identified as the main challenges for the railway sector in Zambia. These include infrastructure/ equipment gaps, quality gaps, human resource gaps, investment gaps, policy/political will/regional coordination gaps, and business viability gaps. The study recommends the need to improve investments in the railway sector and strengthen government commitment to resolve the majority of challenges currently associated with Zambia's railway sector.

Keywords

Modal perspective, Railway Freight Services, Situational Analysis, Transport Usage, Zambia

1. Introduction

Transportation plays a central role in economic growth (Zorina, et al., 2018; Berg, et al., 2017; Eftestol-Wilhelmsson, et al., 2014; Hong, et al., 2011) and has become an important aspect of the modern day activity (Sawadogo, et al., 2012). There are arguments by both academic and policy experts for a "big push" for Africa to narrow its infrastructure gap with the rest of world in light of reducing poverty and narrowing the gap in income per capita (Calderón, et al., 2018). Freight transportation globally has increased by 1,000 times and the resultant effect of increasing flows and

distances between firms has increased the demand for intermodal services (Sawadogo, et al., 2012). Among world regions, Sub-Saharan Africa has recorded declined in road infrastructure over the past 20 years and with railroad network similarly continuing to decline as indicated in 2014 (<0.002 km per square km of surface area) (Calderón, et al., 2018). Intermodal transportation imply the "multimodal chains or networks involving at least two transportation modes, freight being packed into a "container" and not being handled at intermodal-transfer terminals on its trip from its origin to its destination" (Crainic, et al., 2018).

Literature has shown evidence strong linkages between transport infrastructure and economic growth such as Hong, et al. (2011) who reviewed evidence from 31 provinces in China which indicated a strong linkage between transport infrastructure and economic growth and Cigu, et al. (2019) who reviewed evidence from 28 EU countries and concluded that transport infrastructure status had a significant impact on economic development. Literature further shows that in developing countries, transport infrastructure development has a positive feedback on economic activity (Fisch-Romito & Guivarch, 2019). Bröcker & Rietveld (2009) states that secondary to education, infrastructure investments as a component of government expenditure yield favourable results on national productivity value outcomes.

Among the challenges highlighted in Zambia's transportation policy of the absence of research in the area of transportation according to the Ministry of Transport and Communication (MTC) (2019). This paper builds on the goal of Zambia National Transport Policy of 2019 to improve transportation infrastructure by providing a situational analysis of transport usage in Zambia through the lens of Railway Freight Services from 1960's to 2018. Despite the targeted transition slated for the year 2028, Zambia still has gaps in its transportation sector as highlighted in Zambia intends to transition to become a regional hub for transportation services in the SADC region by 2028 (MTC, 2019). Infrastructure development in Africa is rated as poor on average despite country government efforts to improve it (Calderón, et al., 2018). Additionally, a lack of infrastructure maintenance also leads to high risk of fatalities, injuries and accidents on the users (Mwanaumo & Mambwe, 2019) and hence, affecting the entire railway grid. In Zambia, the transportation sector accounts for an estimated 7.9% of gross domestic product (GDP) (MTC, 2019).

The departure of this paper from other similar reviews on the railway sector in Zambia is that it develops a critical review of Zambia railway sector gaps, and further reviewing Zambia's railway sector performance by including railway freight service comparison with Zambia's regional and income group counterparts in the railway sector. Zambia's transportation sector is sub-divided into five modes, that is Air, Road, Rail, Water, and Pipeline Transportation (MTC, 2019). This paper is limited to the review of railway sector and in particular railway freight services only. The paper is part of a full-length research

2. Literature Review

Despite road transport being the dominant mode of moving goods since the mid-1900s, globally railways are increasing their market share (Blumenfeld, et al., 2019). Countries in sub-Saharan Africa have a common interest in improving their railway infrastructure despite the economic challenges they are facing (Blumenfeld, et al., 2019). Use of railway services is argued to have lower external costs related compared to road transport. A study by African Development Bank (ADB) reviews that railway freight services provide up to 86.9percent reduction on external costs per 1000tkm using road transport as a benchmark for comparison (African Development Bank, 2015). Table 1 outlines the major savings as per African Development Bank (2015).

Table 1: Estimates in the Reduction of External Costs by Mode [Rail and Road Comparison]

Transport Mode	Estimated Reduction in External Costs (percentage)
Rail Freight (Diesel)	75.4
Rail Freight (Electric)	86.9
Road Freight (comparison benchmark)	0

Source: African Development Bank (2015)

In reviewing compound annual growth rate (CAGR) for railway services for the period 1996 to 2005, ADB showed strong positive growth pattern for freight in East Asia (4.5% CAGR), Europe and Central Asia (4.7% CARG), South

Asia (4.3% CAGR), Latin America (6.9% CAGR); while railway service in East and North Africa (2.4% CAGR) and Sub-Saharan Africa (1.1% CAGR) (African Development Bank, 2015).

2.1 The Zambian Transportation Industry

From the perspective of external cost structure, it has been argued that transportation is among the fastest greenhouse gas (GHG) emitting sectors since 1970 and transportation infrastructure outlay influences resulting emissions (Fisch-Romito & Guivarch, 2019). Similar to global increase in CO^2 emissions related to the transportation sector, Zambia has experienced continuous growth in CO^2 emission with an estimate of 19% in 1971 to 35% 2014 as depicted in Figure 1. A review of a 41year period of performance transport services in relation to CO2 covering the period 1970 – 2012 shows an increase in the CO2 emissions in Zambia. A linear trend line in figure 1 indicates a continuous increase in carbon emissions. In terms of freight transportation, Zambia's railway services are responsible for 8% of freight while the road sector freight accounts for over 90% (MTC, 2019; PMRC, 2019; Mwila & Mwanaumo, 2016). With this outlay of the freight market in Zambia, it can be argued that the external costs are higher based on the argument presented in Table 1.

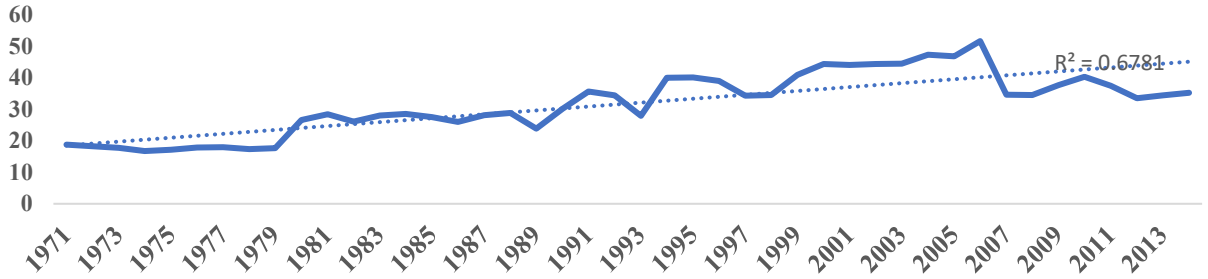

Figure 1. CO2 emission from Transport as Percent of Fuel combustion - 41yr Period (The World Bank, 2020)

In Zambia, a review of transportation services as a percentage of the balance of payment over a performance period of 40years indicates a departure in the 1990's between exports and imports with the former consistently indicating a reduced performance averaging below 10% while the latter is ranging between 50% and 60% over the last 10 years up until 2018 as depicted in Figure 2.

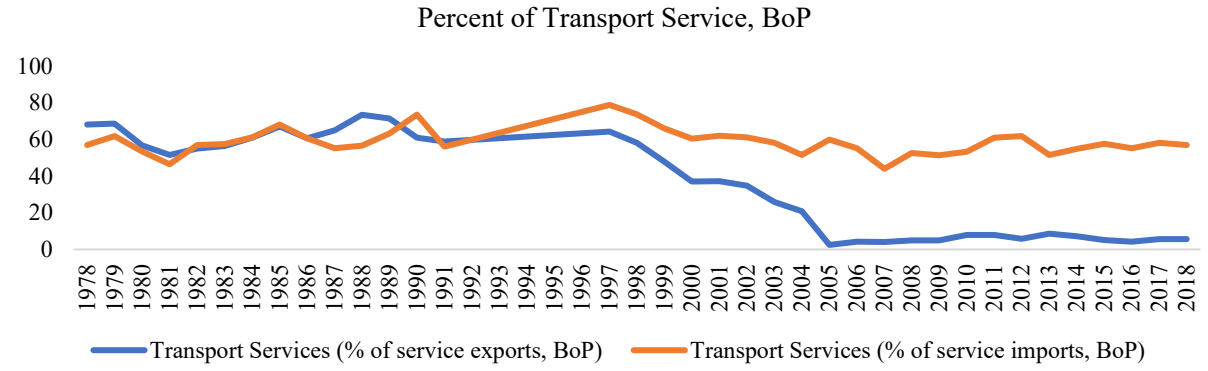

Figure 2. Performance of Transport Services over 40year Period (Percent of BoP) (The World Bank, 2020)

In spite of some of these gains, the Ministry of Transport and Communication of Zambia reports a need to improve the overall transportation infrastructure of the country in order to transform Zambia into a regional transport hub (MTC, 2019). Logistical performance indicator (LPI) indicates that in comparison to the global leader, income group leader, and regional leader, Zambia's has continued to underperform on both the overall LPI score and the infrastructure score (The World Bank, 2020). Table 2 shows the overall performance of Zambia in terms of the overall

LPI score and infrastructure score. Over a period of 10 years, Zambia has improved its global infrastructure standing relative to LPI from 2014 to 2018 as indicated in Table 2.

Table 2. Summary of Zambia's LPI performance - 10years Period

Category	2007	2010	2014	2016	2018
LPI Score	2.37	2.28	2.46	2.43	2.53
LPI Rank	100	138	123	114	111
Infrastructure Score	2	1.83	2.31	2.26	2.3
Infrastructure Rank (by country)	119	140	115	113	108

Source: (The World Bank, 2020)

2.2 Evolution of the Zambian Railway System

In the majority of African countries, rail systems have their origins in the colonial era (African Development Bank, 2015). Railway services in Zambia traces its beginning during the colonial era in 1903 through the work of the British South Africa Company (BSA) which initiated construction at Victoria falls, and concluded construction in 1909 in present Ndola (ZRL, 2018). This puts some of Zambia's rail infrastructure over a 100-years since their construction to date. Zambia's rail tracks were constructed at cape gauge 1,067mm/ 3ft 6in (PMRC, 2019; ZRL, 2018) challenging Zambia from transporting higher tonnages and achieving greater train speed (PMRC, 2019). Railway development in Zambia, like many other countries in Africa resulted from mining operations and political interests (due to the earlier arrangements where mineral and railway concessions were awarded more often to the same financial interest); in Zambia (then Rhodesia), this was the BSA (Doganis, 1967).

In Zambia, railway services ownership has changed hands starting with: i) Federation of Rhodesia and Nyasaland 1903 – 1963 which came to an end after the dissolution of the Federation in 1963; ii) followed by the Zambia-South Rhodesia ownership 1963 – 1967 which ended with the introduction of the Zambia Railways Act of 1967 paving way for new ownership; iii) under the Zambia Railways Board from 1967 to 1979 which transferred ownership through the Zambia Railways Act of 1979 to; iv) Zambia Railways Limited (ZRL), a company under ZIMCO (ZRL, 2018). Added to the timeline of ZRL, Zambia, Tanzania, and China signed an agreement to construct a railway connecting Zambia and Tanzania and the Sea in 1967 (Briggs, 1992). During its 60 year tenure, Rhodesia Railways in 1936 signed a twenty-year agreement with copper companies that were in Zambia (then Northern Rhodesia) to route all their copper using the Rhodesia system which resulted in the flow of copper to Beria (Doganis, 1967). Copper revenues began increasing £900,000 in 1939 to £23,000,000 by 1952 (McKee, 1952). In 1949, post British government assuming administrative authority over Rhodesia in 1924, Rhodesia Railways was nationalised as part of other major assets in transportation.

Between 1963 to 1967 was the reign of Unitary Railway System in supporting railway services in Zambia and Southern Rhodesia (ZRL, 2018) which was fostered through the signing of a corporative agreement in 1963 (prior to Zambia's independence) that restricted either country from using divergent routes aside the Unitary Railways through a punitive compensation. In 1967, another key milestone was achieved in the area of developing alternative railway routes given the dissolution of the agreement that fostered the Unitary Railway System usage. Zambia, Tanzania, and China signed an agreement for the development a railway system that would interlink Zambia to Tanzania, with Zambia linking to the Indian ocean (TZR, 2020; Briggs, 1992). Railway line construction began in Dar es Salaam (Tanzania) in 1970 and construction works were concluded in Kapiri-Mposhi (Zambia) in 1975 (TZR, 2020) totalling 1,860km in total (Briggs, 1992). In 1975, a co-ownership between Tanzania and Zambia was formed through the formation of Tanzania-Zambia Railway Authority (TAZARA) which was made possible through the enactment of TAZARA act of 1975.

Moving to 2003, Zambia railways was placed under a concessionaire, Railways Services of Zambia, which had ownership up until 2012 when the concession was cancelled due to dilapidation of infrastructure as a result of concessionaire not meeting their end of the deal of investing in railway infrastructure and paving way for Zambia Railways Limited ownership again (ZIPAR, 2016; African Development Bank, 2015). The ownership of railway infrastructure in Zambia has predominantly being under the hands of the Zambian government except the 11year

period (2002 – 2013) when it was under a concession. Railway services in Zambia development has predominant dependence on public sector funding to grow. According to ZRL (2018) railway infrastructure, in terms of rail line, accounts for approximately 1,248km of rail which are comprised of Mainline from Victoria Falls Bridge to Kitwe (848 km); Branch Lines (214 km); The Mulobezi Line (162 km); and The Chipata- Mchinji Line (24 km) and own 20 functional locomotives as stock. Based on railway services investment timeline that starts in 1903, some of Zambia's railway infrastructure is just over 100-years old. Further Zambia has a single rail track structure (ZRL, 2018). Most of this infrastructure is in a dilapidated state (MTC, 2019; ZIPAR, 2016). In 2012, the railway concession cancelled by Zambian government on account of degrading infrastructure and non-compliance and the Zambia Railways limited takes over. In 2018, the Statutory instrument No. 7 of 2018 was passed that required 3% of bulk cargo be moved by railway services (PMRC, 2019).

3. Research Methodology

The study applies qualitative thematic analysis approach to review documents and articles on railway industry in Zambia. Primary focus on detailing the evolution of the railway sector in Zambia. The study proceeds in reviewing and documenting Zambia's railway industry performance from historical perspective to-date; and providing comparison within specified groupings as described by the World Bank including regional grouping (Sub-Saharan Africa) and income grouping (low-middle income). The study further identifies gaps in the railway industry in Zambia from various pieces of literature and existing reports and other document; and analyses these gaps using a causal loop analysis to ascertain causality.

4. Results and Discussion

4.1 Review of Railway Performance

Railroad infrastructure in sub-Saharan Africa is low with a representation of and continues to decline. A review of the current ranking from the World Economic Forum (WEF) indicates that Zambia's average score on railway infrastructure quality was at 2.4 out of 7 where a score of 1 represents the extremely underdeveloped among the worst in the world; and 7 represents extensive and efficient among the best in the world (WEF, 2017). During the period 2010 onwards, despite being below the 50percentile score of 3.5 out of 7, Zambia's performance in terms of railroad infrastructure ranking was below the global mean performance. This is illustrated in table 3. In 2017, based on the data presented by WEF (2017) on railroad infrastructure quality, the mean score for railroad quality infrastructure ranking derived by the study for all countries assessed was 3.5.

Table 3: Zambia's Performance on Railroad Quality Relative to Global Mean

Year	Mean Score (Global)	Zambia's actual Score	Zambia Performance relative to Global mean
2010	3.2	2	-1.2
2011	3.1	2.2	-0.9
2012	3.1	2.3	-0.8
2013	3.2	2.1	-1.1
2014	3.3	2	-1.3

Ranking score as WEF (*1= extremely underdeveloped; 7 = extensive and efficient). Data obtained from (WEF, 2014; WEF, 2013; WEF, 2012; WEF, 2011; WEF, 2010)

Performance in relation to the Sub-Saharan Region

A review of Sub-Saharan Africa by World Bank (World Bank (b), n.d.) regional classification and income grouping compared against countries assessed by the World Economic Forum (WEF) in 2017 (WEF, 2017) for railroad infrastructure quality provide a list of twenty one (21) countries. The countries compare Zambia for regional and income group performance for Railroad quality (2010 – 2017) and Train efficiency (2018 – 2019). By 2010-2017, Zambia is compared to other countries as low-middle income country. The review indicates that little progress has been achieved in railroad infrastructure quality in sub-Saharan Africa as a whole with minimal changes.

Zambia's 2017 indicated improvement remained below the railroad infrastructure quality of all countries mean score of 3.5. This illustration further collaborates with arguments presented by Calderón, et al. (2018) regarding the state of railroad infrastructure in Sub-Saharan Africa. A comparative review of Zambia's performance in the Sub-Saharan

African region indicates that Zambia's performance, in terms of WEF ranking, seemingly remains below the quality ranking of railroad infrastructure of the top 5 performers in 2017, with South Africa and Eswatini (Swaziland) scoring at fifty percentile mark (3.5) and the rest of the Sub-Saharan Africa region scoring below the mean.

4.2 Infrastructure Quality and Efficiency of the Railroad

Zambia's rating of railroad infrastructure, despite being below the global average score of 3.5 in 2017, was above the mode score and at par for the median score for both railroad infrastructure average and train efficiency average. Zambia scored below the mean score. A further review of the WEF railroad infrastructure quality (2010 -2017) using an 8-year average and WEF train efficiency (2018-2019) 2-year average rating show that there is minimal change in train efficiency rating and quality of railroad infrastructure with exception of Kenya, Ethiopia, and Tanzania that scored higher. Compared to infrastructure quality for Sub-Saharan Africa, the Low-middle income group of countries, of which Zambia is a member, provided that fewer more countries surpass the infrastructure quality mean. A comparison of railway infrastructure quality within the income group classification low-middle income group (as per World Bank classification) reviews that Zambia's railway infrastructure ranking still lags behind the majority of countries within the income group.

Zambia's train efficiency average score over a two-year period was at 2.2 similar to the average score for railroad infrastructure quality over an 8-year period. This review further collaborates with arguments that due to Zambia poor state of railroad infrastructure, rail services experience poor outcomes including long transit times and low speeds (Foster & Dominiguez, 2011; SADC, 2012; ZIPAR, 2016; Mwila & Mwanaumo, 2016; MOF 2016; MNDP, 2017; ZRL, 2018; MTC, 2019; PMRC, 2019; Kamanga et al., 2019). A more comprehensive discussion on the quality related challenges to railway sector in Zambia are discussed under the section discussing railway gaps and challenges.

Railway Road Density

In terms of railway road density (kilometre per 1000km^2), compared to 21 countries, Zambia ranked number 14, indicating a lower density. Zambia continues to underperform in terms of good transported in ton-km against the majority of the member countries in the Sub-Saharan African region. Zambia's declining railway sector performance from 1980 to 2017 was during periods of government ownership and railway concession. The concession resulted in failure with the Zambian government cancelling it siting failure of the concessionaire to make gainful investments in railway infrastructure and the continued decline in railway performance of the period of the concession (African Development Bank, 2015) with was also in conformance with the study by Kamanga et al. (2019).

4.3 Review of Railway Sector Challenges in Zambia

Zambian railway sector has faced somewhat some unresolved challenges over a sustained period as illustrated in table 4 and 5. Over the past 10 years, poor state of railway infrastructure, poor quality in railway services, challenges in operations, and non-viability of railway business have been highlighted in various reports and development plans as an impediment towards railway services in Zambia among other challenges. Key factors attributed to each of the main challenge were identified and grouped in thematic areas using thematic analysis technique. A total of seven (7) thematic areas representing challenges were developed and these included; i) Infrastructure/ Equipment Gaps; ii) Quality Gaps; iii) Human Resource Gaps; iv) Operational Gaps; v) Investment Gaps; vi) Policy/Political Will/ Regional Coordination Gaps; and vii) Business Viability Gaps as illustrated in table 4. In building the thematic areas, factors were identified and grouped under broader thematic areas based on their similarities. Table 4 provides broad thematic areas and corresponding challenges (factors).

Table 4: Challenges faced by Railway Sector in Zambia

Thematic area	Corresponding challenges
Infrastructure/ Equipment Gaps	• Poor state of permanent ways (MOF,2008; MOF, 2009; MOF, 2010; MNDP,2013; MOF,2015; ZIPAR, 2016; MNDP,2017; ZRL, 2018; MTC, 2019), • Railway track configuration *with Zambia having a single- track system* (ZIPAR, 2016; MTC, 2019) • Current railway gauge below standard (MTC, 2019) • Vandalism of railway infrastructure (MOF, 2010; MOF, 2015b; ZRL, 2018),

Thematic area	Corresponding challenges
	• None-compatible railway tracks (ZIPAR, 2016) • Rundown locomotives and rolling stocks (MOF,2008; MTC (2019) • Limited railway geographical reach (MTC, 2019; Mwila & Mwanaumo, 2016) • Insufficient equipment compared to international standards (MTC, 2019; ZIPAR, 2016) • Old/ defunct telecom/ control equipment and buildings (ZRL, 2018) • Inadequate ICT and outdated railway technology (ZIPAR, 2016; ZRL, 2018, MTC, 2019)
Quality Gaps	• High transit time for rail services compared to road/ low rail speed (Foster and Dominiguez, 2011; SADC, 2012; ZIPAR, 2016; Mwila & Mwanaumo, 2016; MOF 2016; MNDP, 2017; ZRL, 2018; MTC, 2019; PMRC, 2019) • Lack of frequent maintenance (MOF, 2010; ZIPAR, 2016; ZRL, 2018; MOF,2018; MTC, 2019; PMRC, 2019) • Frequent breakdowns (ZIPAR, 2016; ZRL, 2018; Kamanga et al., 2019) • Services below international Standards (ZIPAR, 2016; ZRL, 2018) • Inadequate security for cargo (transit)/ Premises/ theft (Mwila & Mwanaumo, 2016; ZRL, 2018; PMRC, 2019) • Low quality infrastructure (MNDP, 2017; Mwanaumo & Mambwe, 2919) • Derailments (MNDP, 2017; ZRL, 2018)
Human Resource Gaps	• Labour disputes/ labour withdrawal (ZIPAR, 2016) • Insufficient management structures (Foster & Dominiguez, 2011; ZIPAR, 2016) • Overstaffing compared to optimal requirements (ZIPAR, 2016) • Unskilled personnel (ZIPAR, 2016; ZRL, 2018) • Lack of a local railway training school (MTC, 2019) • Staffing compliment top heavy (ZRL, 2018)
Operational Gaps	• Lack of local vendor to support rehabilitation works (MOF, 2015b) • Inadequate operational cost/ operational challenges (SADC, 2012; ZIPAR, 2016; MOF, 2016; ZRL, 2018) • Low availability of locomotives (MOF, 2010; MNDP, 2013; MOF, 2015b; ZRL,2018)
Investment Gaps	• Lack of investment/ recapitalisation of railway industry (MOF,2010; SADC, 2012; ZIPAR, 2016, MTC, 2019) • Unsuccessful private public partnership (Foster& Dominiguez, 2011; ZIPAR, 2016; ZRL, 2018) • Lack of Strategic plan for investment (ZIPAR, 2016)
Policy/ Political Will/ Regional Coordination Gaps	• Weak/ unclear policies/ outdated legal framework (Foster & Dominiguex, 2010; SADC, 2012; MNDP, 2013; ZIPAR, 2016; MTC, 2019) • Poor coordination between regional railway companies (Foster & Dominiguez, 2011; PMRC, 2019) • Geopolitical challenges/ lack of influence on neighbouring railway companies (MOF, 2010; MOF, 2014)
Business Viability Gaps	• Sub-optimal traffic/ lack of capacity to meet traffic demands (MOF, 2009; Foster & Dominiguez, 2011; ZRL, 2018) • Declining volumes of cargo transported via rail (MOF, 2008; MOF, 2009; MNDP, 2013; MOF, 2015b; MOF, 2015; MOF, 2016; MNDP, 2017; MOF, 2018; MTC, 2019) • Challenges in meeting debt obligation (ZRL, 2018) • Poor revenue realisation (Foster & Dominiguez, 2011; SADC, 2012; ZIPAR, 2016; ZRL, 2018) • Costs per ton-km higher than road transport (Foster & Dominiguez, 2011; SADC, 2012; ZIPAR, 2016; Mwila & Mwanaumo, 2016) • Poor cargo market share (Mwila & Mwanaumo, 2016; MTC, 2019) • High operational costs (MTC; 2019) • Uncompetitive (MOF, 2015; ZRL, 2018; MTC, 2019)

Table 5 provides, by way of summary, the main challenges facing the railway services industry in Zambia in terms of freight services represented by thematic grouping. Infrastructure/equipment, Business viability and quality gaps were the most sited as negatively impacting the railways industry in Zambia.

Table 5: Summary of Challenges in Railway Industry in Zambia

Author	Infrastructure/ Equipment Gaps	Quality Gaps	Human Resource Gaps	Operational Gaps	Investment Gaps	Policy/ Political Will/ Regional Coordination Gaps	Business Viability Gaps
MOF 2008	√						√
MOF 2009	√						√
Foster & Dominiguez (2011)		√	√		√	√	√
MOF 2010	√	√		√	√	√	
SADC (2012)	√	√		√	√	√	√
MNDP 2013	√			√		√	√
MOF 2014						√	
MOF 2015b (annual report on SNDP)	√			√			√
MOF 2015	√			√			√
ZIPAR (2016)	√	√	√	√	√	√	√
Mwila & Mwanaumo (2016)	√	√					√
MOF 2016		√		√			√
MNDP 2017	√	√					√
ZRL (2018)	√	√	√	√	√		√
MOF 2018		√					√
MTC (2019)	√	√	√	√	√	√	√

Factors associated to challenges listed in table 6 were then identified to facilitate the development of the Causal Loop Diagram (CLD) is a system dynamic tools that are used to understand cause and effect relationships. In this study, CLD is used to within the railway freight industry in Zambia as illustrated in figure 3. To build the CLD for railway freight services in Zambia, cause and effect relationships are identified based on factors in listing provided in table 6. Table 6provides detailed listing of the factors and challenge association under each thematic group.

Table 6: Factors associated to railway challenges in Zambia

Thematic area	Corresponding challenges	Factors
Infrastructure/ Equipment Gaps	lack of interlinkages between Railway and other modes	Interlinkages: Railway and other modes
	Railway track configuration	Railway configuration
	Current railway gauge below standard	Railway configuration
	Vandalism of railway infrastructure	Vandalism
	None-compatible railway tracks	Railway configuration
	Rundown locomotives and rolling stocks	State of railway equipment/ infrastructure
	Limited railway geographical reach	Railway Reach
	Insufficient equipment compared to international standards	State of railway equipment/ infrastructure
	Old/defunct telecom/ control equipment and buildings	State of railway equipment/ infrastructure
	Inadequate ICT and outdated railway technology	State of railway equipment/ infrastructure
	Poor state of permanent ways	State of railway equipment/ infrastructure

Thematic area	Corresponding challenges	Factors
Quality Gaps	High transit time for rail services compared to road/low rail speed	Transit time
	Lack of frequent maintenance	Maintenance activity
	Frequent breakdowns	breakdown
	Services below international Standards	Rail Standards
	Inadequate security for cargo (transit)/ Premises/ theft	Security activity
	Low quality infrastructure	Infrastructure Quality
	Derailments	Derailments
Human Resource Gaps	Labour disputes/ labour withdrawal	Labour disputes
	Insufficient management structures	Staffing complement
	Overstaffing compared to optimal requirements	Staffing complement
	Unskilled personnel	Staff skill set
	Lack of a local railway training school	Local Railway Training Institution
	Staffing compliment top heavy	Staffing complement
Operational Gaps	Lack of local vendor to support rehabilitation works	Local Capacity to Maintain infrastructure
	Inadequate operational cost/ operational challenges	Operational Costs
	Low availability of locomotives	Availability of Locomotives and rolling stock
Investment Gaps	Lack of investment/ recapitalisation of railway industry	Investment (Greenfield/ Brownfield Projects)
	Unsuccessful private public partnership	Private Public Partnership(s)
	Lack of Strategic plan for investment	Government Commitment
Policy/ Political Will/ Regional Coordination Gaps	Weak/ unclear policies/ outdated legal framework	Appropriate Regulatory Framework
	Poor coordination between regional railway companies	Intercountry railway access
	Geopolitical challenges/ lack of influence on neighbouring railway companies	Geopolitical Challenges
Business Viability Gaps	Sub-optimal traffic/ lack of capacity to meet traffic demands	Hauling Capacity
	Declining volumes of cargo transported via rail	Cargo volume
	Challenges in meeting debt obligation	Debt Obligation
	Poor revenue realisation	Revenue Generation
	Costs per ton-km higher than road transport	Hauling cost
	Poor cargo market share	Cargo Transport Market Share
	High operational costs	Operational Costs
	Uncompetitive	Hauling cost

Cause and effect linkages for each of factors in table 6 were established to understand the cause and effect relation to articulate the structure of the challenge in the railway industry and induce plausible elements that would lead to solutions for improvement in the railway sector of Zambia. The causal loop diagram resulting from analysis is illustrated in figure 3.

Cargo volume factor has the most causal linkages. There is need to invest in greenfield and brownfield projects to improve performance of railway services (MOF,2010; SADC, 2012; ZIPAR, 2016, MNDP, 2018; MTC, 2019). Declining volume of cargo and inadequate revenue generation are associated to infrastructure and equipment gaps which include the poor state of permanent ways (MOF,2008; MOF, 2009; MOF, 2010; MNDP,2013; MOF,2015; ZIPAR, 2016; MNDP,2017; ZRL, 2018; MTC, 2019); railway track configuration with Zambia having a single-track system (ZIPAR, 2016; MTC, 2019); a railway gauge which is below the standard (MTC, 2019); vandalism of railway infrastructure (MOF, 2010; MOF, 2015b; ZRL, 2018), none compatible railway tracks (ZIPAR, 2016); rundown locomotives and rolling stocks (MOF,2008; MTC (2019); limited railway geographical reach of the railway tracks and services (MTC, 2019; Mwila & Mwanaumo, 2016); insufficient equipment compared to international standards (MTC, 2019; ZIPAR, 2016); old/ defunct telecom/ control equipment and buildings (ZRL, 2018); and inadequate ICT and outdated railway technology (ZIPAR, 2016; ZRL, 2018, MTC, 2019). As illustrated in figure 3, a stimulation of railway infrastructure investment in Zambia is likely to mitigate various infrastructure and equipment gaps and quality

gaps (Kamanga et al., 2019). Investments in railway infrastructure will subsequently lead to improvements in quality of railway services such as overcoming challenges associated to transit time (Foster & Dominiguez, 2011; SADC, 2012; ZIPAR, 2016; Mwila & Mwanaumo, 2016; MOF 2016; MNDP, 2017; ZRL, 2018; MTC, 2019; PMRC, 2019); frequency of breakdowns (ZIPAR, 2016; ZRL, 2018); quality of service offerings in comparison to international standards (ZIPAR, 2016; ZRL, 2018); and derailments experienced (MNDP, 2017; ZRL, 2018).

Further, investment in greenfield and brownfield railway projects (where greenfield refers to completely new railway infrastructure design and construction and brownfield refers to partial or complete renovation of railway infrastructure (African Development Bank, 2015)) will likely improve business viability of railway freight services such as increased revenue generation through increased cargo volume and provision of competitive pricing as illustrated in figure 3.

Strengthening government commitment will respond to challenges experienced by the railway sector in inadequate operational cost and operational challenges (SADC, 2012; ZIPAR, 2016; MOF, 2016; ZRL, 2018); lack of investment and or recapitalisation of railway industry (MOF,2010; SADC, 2012; ZIPAR, 2016, MTC, 2019; private public partnership challenges (Foster & Dominiguez, 2011; ZIPAR, 2016; ZRL, 2018); a lack of a strategic plan for investment (ZIPAR, 2016); weak or unclear policies and outdated legal framework (Foster & Dominiguex, 2010; SADC, 2012; MNDP, 2013; ZIPAR, 2016; MTC, 2019); challenges around labour disputes/labour withdrawal (ZIPAR, 2016); and poor coordination between regional railway companies (Foster & Dominiguez, 2011; PMRC, 2019). Figure 3 illustrates how strengthening Government commitment, on the basis of railway industry being fully own by government is likely to improve performance in the railway sector.

Geopolitical challenges and lack of influence on neighbouring railway companies (MOF, 2010; MOF, 2014) are seemingly risks worth noting and planning for in respect to managing and operating railway services in Zambia as per illustration in figure 3 as these are external to control of policy and planning and Zambia railway industry decision making.

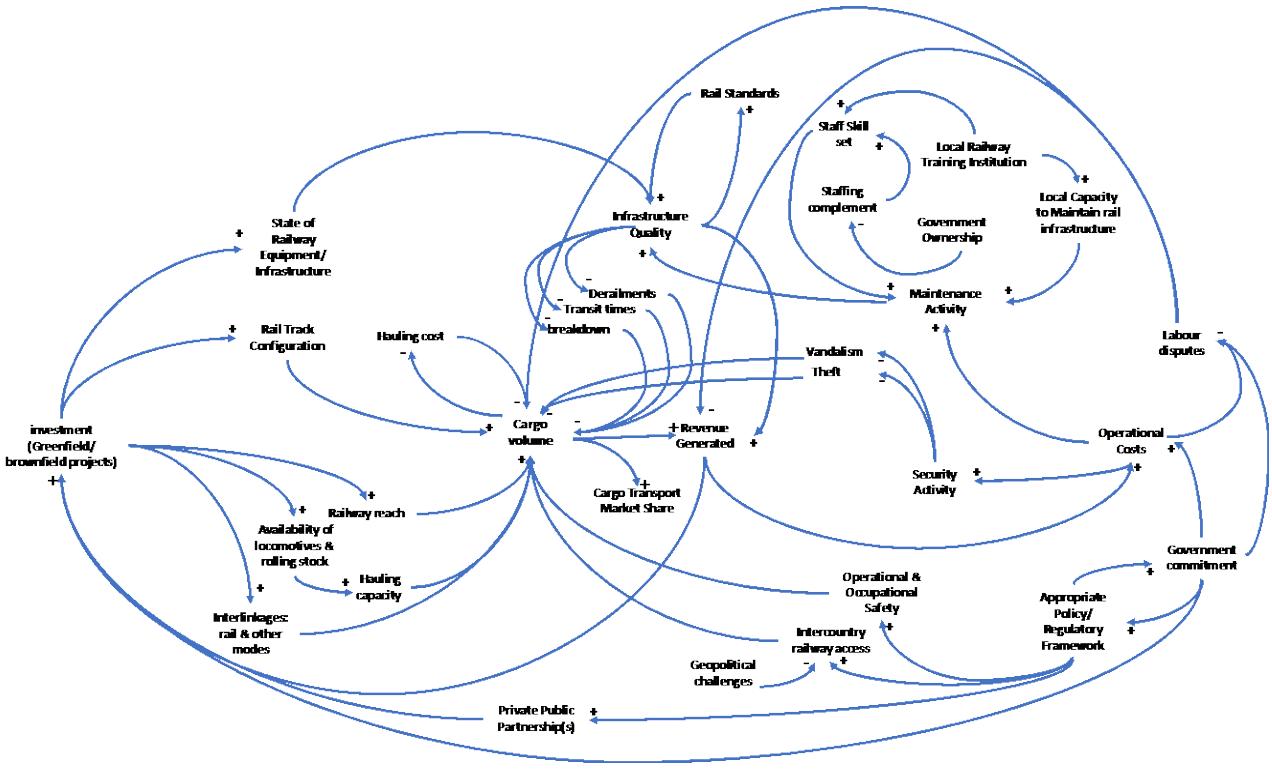

Figure 3. Causal Loop Diagram on Railway Industry for Freight Services in Zambia

Figure 3 further illustrates that government commitment and appropriate policies and regulatory frameworks are likely to form a reinforcing loop strong and appropriate policies are likely to further strengthen government commitment to the promotion of the railway sector freight agenda. Appropriate policies and regulatory framework are illustrated to positive influence intercountry railway access occupational and operational safety which further influence cargo volumes. Government commitment is further illustrated to positively influence operational costs leading to increased maintenance activities responding to both poor state of railway infrastructure and a lack of consistence maintenance. Sustainable financing for railway infrastructure is arguably achievable in Zambia through implementation of a private public partnership model (MNDP, 2018). Strengthening government commitment by instituting appropriate policies and regulatory framework for railway freight services will improve private public partnership implementation in Zambia.

5. Conclusion and Recommendation

The study undertook an analysis on the transport usage in Zambia by specifically reviewing the current railway freight services from 1960 to 2018. The review found that even though Zambia intends to revamp the railway sector through investments in the railway, its current performance is lower than most of the countries in the Sub-Saharan region. The review showed that key policy and strategic documents such as the 7th National Development Plan, National Transport Policy (MTC, 2019), National Transport Policy Implementation Plan, and Statutory instrument No 7 of 2018, all stimulate the growth of the railway freight services in the sector. The review also indicated that Zambia scored lower in the quality, efficiency, performance in relation to goods moved in the industry and other countries in the sub-Saharan region. It can be concluded that Zambia's railroad infrastructure is old, dating back to the early 1900's, and this lowers its ability to transport more cargo and achieve higher speed. Additionally, the poor performance can be attributed to a single-track system that poses challenges. A further review of the challenges highlighted in literature and reports indicates that a lack of investment in railway infrastructure in Zambia has led to the poor state of railway infrastructure. The main challenges impacting the railway sector in Zambia include infrastructure/Equipment Gaps; Quality Gaps; Human Resource Gaps; Investment Gaps; Policy/Political Will/Regional Coordination Gaps; and Business Viability Gaps.

A causal loop analysis reviewed that a clear linkage between improving investments in railway sector and strengthening government commitment to resolving the majority of the challenges currently associated to the performance of the railway sector as a whole, was significant and high recommended. In order to achieve the movement of Zambia to become a regional hub for transportation services in the SADC, the study recommends that Zambia should address the multiple challenges that have been outlined in the situation analysis of the railway sector.

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