The Effects of The Tanzanian Railway Network in the Performance of the Rail Freight Operations. A Case of Dar es Salaam to Isaka

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Abstract

The railway is the fundamental means of transport, especially for freight. It has a substantial contribution to the sustainable economy of the country and the region at large. However, some factors have been affecting the performance of rail operations; especially for freight, to the extent of reducing the modal share from rail to roads. This has been resulting in high road maintenance costs and underutilization of the available capacity in the railway. This research has studied the factors affecting the Tanzanian railway network in the performance of rail freight operations. The focus was on the corridor from Dar es Salaam to Isaka because it serves most of the landlocked countries such as Uganda, Burundi, Rwanda, and Eastern DRC. The study used the Performance Measurement theory with the Balanced Scorecard model. Data analysis was done by the Linear Regression statistical method with the aid of SPSS version 20. The results of the study show that derailments, washouts, and rail freight wagons maintenance capacity directly affect the performance of rail freight operations. TRC, therefore, needs to strategize measures for ensuring that derailments and washouts are very much reduced. A plan for quick recovery must be in place in case a derailment or washout happens. Also, TRC should enhance its capacity for maintaining the rail freight wagons to ensure its optimal availability. Railway should be viewed as a potential area for investment because it supports the growth of other sectors as well. If constraints are minimized in the railway system; the performance of rail freight operation will be high and many customers will be attracted to use the railway as a preferred mode of transport, hence, the modal share to the railway will increase.

Keywords: Railway, Transport, Performance, Rail Freight;

1.0 Introduction

Tanzania has four main railway corridors for transport. One corridor is on the northern part and it starts

from Tanga port and the second one is on the southern part starting from Mtwara port. Chelsea Markowitz, 2017 stated that these two corridors mostly transport local people and goods. The two other major corridors are the central and the Dar es Salaam corridors which extend from Dar es Salaam port to various parts of the countries; and therefore, greatly facilitate trade operations in the country (Chelsea Markowitz, 2017).

The central corridor links the Dar es Salaam port to Uganda, Burundi, Rwanda, and the Eastern Democratic Republic of Congo (DRC). Its railway operated by Tanzania Railways Corporation runs from Dar es Salaam to Kigoma and branches to Mwanza through Isaka. This railway is badly in need of maintenance and cannot effectively serve Tanzania's trades or neighboring countries. Therefore, the transportation of goods in the Central Corridor primarily occurs on the road network (Chelsea Markowitz, 2017).

Dar es Salaam host one of the largest hub ports in the East Africa Region that handled a lot of cargos in the region. In 2011 it handled about 1.4 million tons, 13.1 million tons in 2013, and 15 million tons in 2015 (Limi, et.al, 2017). As for Isaka, there is a dry port facility where landlocked countries such as Uganda, Burundi, and the Democratic Republic of Congo can pick their goods by road transport since this dry port is also connected with major roads that go to neighboring countries.

Tanzania Railways Corporation (TRC) was established following the railway's act of October 2017 which also described the objectives and functions of the Corporation (URT, Railway act, 2017). This was the result of the merging of two companies, Reli Assets Holding Company (RAHCO) that was mandated to manage the infrastructure, and Tanzania Railways Limited (TRL) was dealing with railway operations.

According to the Tanzania railway act of 2017, the functions of TRC include the provision of rail transport and manage rail infrastructure, protection of railway reserve, the maintenance of rail infrastructure and rolling stock, acquiring and operate trains as well as repairing anything that belongs to the corporation.

At the beginning of the 20th century, most surface freight was moved by using rail transport. Recently, a small fraction of all freight in most countries is moved by rail. The road has become the preferred mode of transportation for many customers, particularly in developing countries (Aritua, 2019).

Association of American Railroads identified that in 1930, rail freight count was more than 70 percent of the intercity ton-miles, by 1960 the share had fallen to under 45 percent and by 1980 it was under 40 percent. A similar falling trend of the modal share was evident in Europe where the share dropped from 40 percent in 1960 to less than 13 percent in 2000 (Aritua, 2019). A similar modal share falling trend has been experienced in Tanzania Railways where the rail traffic records by TRL suddenly dropped from over 1000 million ton-km to less than 300 million ton-km between 2000 and 2010 and continued to drop further to less than 200 million ton-km in 2013 (Limi, et. al, 2017).

Aritua (2019) states that most railways failed to provide services that meet their customer's needs. Aritua (ibid) further states that this failure has caused many traditional customers to shift to road transport and new customers do not opt for rail transport even for long-distance bulky freight. Limi, et Al. (2017) also state that fewer and fewer shippers are using rail transport because service reliability is deteriorating.

1.1 Problem Statement

Limi et al, (2017) stated that on average road transport in Tanzania costs13.5 US$ per ton-km compare to rail transport which costs4.3 US$ per ton-km. The study done by Limi et al. revealed that road transport cost is nearly 4 times higher than the railway transport cost. But due to the low reliability of rail transport

in the country, many shippers seem not to be attracted to use the rail mode of transport (Limi et.al, 2017). Limi, *et al.* (ibid) stated that the Government spends approximately US$ 310 million on road development and maintenance every year. There is a developed problem of many shippers to use roads as a preferable mode of transportation even though the railway is cheaper as a transportation mode than the road(Aritua, 2019). The result is therefore an increase in road traffic congestions, accidents as well as road damage. It also causes very high traffic on roads and less on the railway.

It was, therefore, important to look at the effects of the Tanzanian railway network in the performance of rail freight operation to find out the challenges which if addressed would lead to a substantial increase in rail freight modal share. Limi, et. al, (2017) explained that globally, the railway carries more percentages of freight demand (9 percent) than passenger demand (6.3 percent). This research has focused on rail freight because of its demand globally in transporting surface freight. For passenger movements, road transportation is the dominant mode in many countries with an exception of some countries such as China, India, Japan, and the Russian Federation where railway transport demand is about 15-30 percent of total passenger transport (Limi, et.al, 2017)

1.2 Main Objective of the Study

The main objective of the study was to assess the effects of the Tanzanian railway network in the performance of rail freight operations.

1.2.1 Specific Objectives

Specifically, the study dealt with the following objectives;

i. To assess the effect of derailments on the performance of rail freight operations.
ii. To assess the effect of washouts on the performance of rail freight operations.
iii. To assess the effect of rail freight wagons maintenance capacity on the performance of rail freight operations.

1.3 Significance of the Study

Tanzanian railway has lost competitiveness against trunk road traffic resulting in having a very low market share. This study contributes toward understanding and identifying more areas that cause railway transport operations, especially for freights, not to perform properly and attract more customers. It was imperative to conduct this study because it can assist the corporation to know potential areas for improving rail freight operations. It should be noted that the railway corporations lose much revenue due to the underperformance of rail freight operations.

On the knowledge gap, the study contributes to the application of the performance measurement theory in measuring the performance of organizations, especially railroad companies. The study is useful to the government on how to prioritize investment in the transportation sector to get more returns and minimize maintenance costs on transport infrastructure (rail and roads). It furthermore helps the projects funding institutions like the World Bank, for example, to understand potential areas of fund allocation to boost the economy of the borrowing countries.

2.0 Literature Review

The key concepts as applied in this study are railway network, performance, rail freight, and operations. A Railway network refers to the system of intersecting rail routes (Collins English dictionary. 1994). These rail routes are composed of a line of parallel metal rails fixed to sleepers and they are used for the transportation of passengers and goods in trains. In this study, the railway network can be explained as the system of intersecting rail routes used for transportation of goods and passengers by using rail vehicles or rolling stock (constructed from the review).

Grüning (2002) defined Performance as the ability of a company to achieve goals, meet expectations, and is therefore influenced by results in a. wider sense, but also by the corresponding goal setting. Wettstein (2002) also said Performance can be understood as the degree of stakeholder satisfaction. Performance can also be referred to as the accomplishment of duty or mission accurately to the satisfaction of the stakeholders (constructed from the review).

Rail freight refers to goods that are transported by trains moving on a railway network(Cambridge international dictionary of English, 1995). These goods are carried by rail freight wagons of different types. This study has adopted this definition because it is relevant as applied in the problem statement. Galloway (1998) defines operations as all activities concerned with the transformation of materials, information, or customers. Operations refer to all activities required to create and deliver a product or service (constructed from the review).

2.1 Theoretical Analysis

This study used performance measurement theory. Performance measurement has the role mainly of assessing the position of the organization and also helping managers to create and implement a better strategy (IonutIvaov, et al, 2013). More than twenty years ago, organizations have invested many resources in the design, implementation, and use of Performance Measurement Systems (PMS) such as the Balanced Scorecard; following a similar principle that measurement is a necessary activity for organizations to be successful. On the contrary, Micheli and Mari (2013) criticized this standpoint and proposes an alternative position according to which measurement should aim to produce ‘adequate to purpose’ rather than ‘true’ results.

Federico and Cavenaghi (2017) revealed that there have been no proposals to measure the railroad companies. The study also revealed a lack of comprehensive, strategic, and cause-and-effect Performance Measurement System (PMS). Through their study, they developed the PMS framework for both researchers and practitioners interested in railroad companies’ performance measurement. They used PMS based on Balanced Scorecard by considering a case study of a large railroad company in Brazil.

This study tested the application of cause-and-effect PMS based on a Balanced Scorecard (BSC) by considering a case study of a relatively small railroad company, the TRC in Tanzania. The TRC is considered a small railway company because it is operating a railway network with a rail network of 2,722 km; ranked number 60 in the list of countries by rail transport network size. The Brazil network which was studied by Federico and Cavenaghi (2017) is ranked number 6 with a rail network of 38,743 km (Wikipedia contributors, 2020, October 1). Also, this study contributes to the theory in terms of PMS applications.

Performance Measurement System refers to a brief and precise set of measures (financial or non-financial) that supports the decision-making of an organization by collecting, processing, and analyzing qualified data of performance information (Gimbert et al. 2010). This system helps in measuring the performance of organizations so that areas for improvement can be identified. Kaplan (2009; p. 1253) stated that when one can measure what he/she can speak about and express it in numbers, he/she knows something about it; but when he/she cannot measure it, when he/she cannot express it in numbers, his/her knowledge is a meager and unsatisfactory kind. If he/she cannot measure it, he/she cannot improve it.

Fried (2010) stated that Performance Measurement Systems are characterized as strategic expert systems by which organizations observe and measure their intangible performance elements in the form of qualitative and quantitative assessment. Balanced Scorecard (BSC) was developed in 1990 from a workgroup of Nolan Norton Institute, that assisted KPMG in research and establishment of management models (Federico and Cavenaghi, 2017).

Niven (2002) defines a Balanced Scorecard as a careful set of measurements resulting from the strategy of the organization. It is also referred to as a tool that organizations use to manage the implementation of corporate strategies.

Kaplan and Norton (1996) stated that the Balanced Scorecard measures operational performance through four financial perspectives, customers, processes and learning, and growth.

2.2 Empirical Analysis of Relevant Studies in General

Federico and Cavenaghi (2017) studied measuring performance in Rail Freight Transportation Companies – Brazil. The study was done by using the theory of Performance Measurement System (PMS) by Balanced Scorecard (BSC). It was found in the study that the PMS has a very important role in the performance management of railroad companies. The study further showed that the cause and effect of PMSs were not considered by many proposals.

Ahi and Yildiz (2018) studied the performance criteria of the railway market classified a case study of railway companies by analyzing the competitive performance criteria with the innovation capability of the industries using different models. 130 Turkish railway industries were used as the source of data. Methods applied in this study were Porter's Industries Life Cycle Evolution, Diamond, Five Forces Models, and SWOT Analysis. The findings showed that although the applied models have different dimensions, they give the same results. The study concluded that models were consistent and can be used as strategic decision-making tools for improvement of performance. The study did not use PMS to determine the performance criteria of the railway companies.

Sharma et al (2016) benchmarked rail transport service performance for the Indian railway. The study reported that the performance of rail transport services was including the service delivery perspective of railways. The quality of service parameters used were punctuality, level of consequential train accidents (safety), and level of public complaint (customer satisfaction). The method used as a benchmarking tool to evaluate the relative efficiency was Data Envelopment Analysis (DEA). The evaluation was done in 16 zones of Indian railways. The finding in this study was that Indian Railways can use DEA to assess the performance of various zones and in the improvement monitoring as a transportation service provider. The study did not use PMS to assess the performance of rail transport.

Rajeev. et, al., (2016) evaluated the performance of sixteen Indian railway zones to propose a decision-making tool for performance evaluation of Indian railway zones. they suggested the use of a combined multi-criteria decision-making approach that employs the Decision-Making Trial and Evaluation Laboratory (DEMATEL) and Vise Kriterijumska OptimizacijaI Kaompromisno Resenja (VIKOR). The finding was that the application of the integrated methodology could serve as a systematic approach for the measurement of the operational performance of Indian railway zones. The study did not propose PMS as a decision-making tool for performance evaluation.

2.3 Empirical study in African countries

Madubanya (2015) evaluated the operational efficiency of rail freight operations in South Africa. The study aimed at improving the understanding of the value of moving freight on rail than the road. It mainly addressed how the freight rail can manage and improve the operations efficiencies to satisfy the customer's needs by rendering a good service at the same time managing the cost of doing business. The study used the method of Failure Mode and Effect Analysis (FMEA) for analyzing the data. However, this study did not assess the effects of the railway network on the performance of rail freight operations. Lack of continuous performance in railway transportation contributes much to the loss in modal share.

2.4 Empirical studies in Tanzania

Nkya (2015) studied the Role of the Tanzania Central Railway line in Promoting cargo Transportation. The study revealed that the central railway line can transport only 45 percent of cargo compared to its full capacity. This indicates that the central railway line had not fully utilized its capacity in the transportation of cargo. The study identified the challenges facing railway transportation in Tanzania as tear and wear off of the railway line, old engines, and factors associated with railway line width. However, the study did not assess other factors like the frequent interruption of railway operations due to washouts as among the factors which cause the railway transportation in Tanzania not to perform properly and hence resulting in the huge loss of modal share.

Mwakibete (2015) examined the role of rail transport in improving the performance of port as regards Dar es Salaam port. The study used was exploratory and survey techniques to collect data. The study revealed that rail transport plays a great role in port performance for reducing port congestion, improve cargo handling, and increase port and government revenue. Also, rail transport increases the average cargo traffic, improves customer satisfaction, and lowers the logistic cost.

The study further added that, despite the significant contribution of rail transport to the port performance, the situation of the rail was in a poor state. The point was made that more investment has been made on road infrastructure improvement without equal reflection on railway infrastructure. So, the recommendation was for the Government to promote more the railway sector to improve port performance and increase more revenue. It was suggested that in the promotion and improvement, the private sector and other stakeholders must be involved.

2.5 Conceptual Framework

PMS framework developed by Federico and Cavenaghi (2017) for railroad companies by using BSC described four perspectives which are learning and growth, process, customers, and financial. In this study, the dependent variables have been obtained from the performance of rail freight operations. Two of the dependent variables are wagons availability and transit time of trains which are from the operational processes perspective's indicators whereas the other dependent variable, infrastructure maintenance cost is from the financial perspective indicator which is the index of reduction of costs.

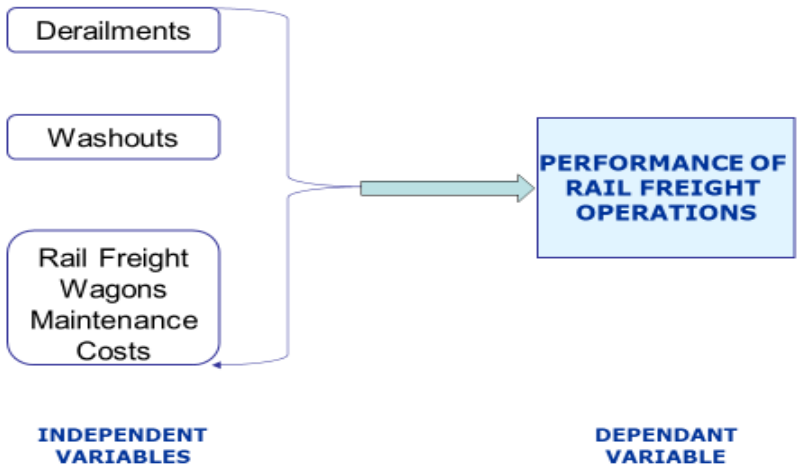

Figure 1.1: Conceptual Framework of the study

Source: Own Creation from Study literature (2020)

2.6 Theoretical Framework

This study used the Performance Measurement theory. The application of this theory can be described by different models. Ionut Ivaov et al. (2013) studied different models used to describe the application of performance measurement which are Balanced Scorecard, Malcolm Baldrige, Performance Prism, and European Foundation for Quality Management (EFQM). This study particularly used the Balanced Scorecard model. This model translates the mission and the organizational strategy into a set of performance indicators that offers a model for the Performance Measurement System (IonutIvaov et al, 2013). IonutIvaov (ibid) further described the model that it assesses the organization's performance through four perspectives which are financial, customer, learning and growth, and internal processes (operational) perspective.

The variables that will be measured in this study are as follows;

Table 2.1: Variables of the Study

S/N	Independent variable	Dependent variable (performance of rail freight operations)
1	Derailments	Transit time
2	Washouts	Infrastructure maintenance cost
3	Rail freight wagons maintenance capacity	Rail freight wagons availability

Source: researcher, (2020)

The table above clearly shows the variables used in this study.

2.6.1. Derailment:

This occurs when a rail vehicle such as a train runs off its rails (Wikipedia contributors. 2020, August 13). It also refers to the loss of contact between the wheel and the rail that may generally be caused by fault on the railway track or rail vehicle (rolling stock) or other causes related to humans.

Railway derailment causes different types of loss and damages to infrastructure, rolling stock, and operations of freight and passenger services. The derailments of rail freight can be severe and consequently may result in different forms of costs that include infrastructure costs, rolling stock costs, interruptions, fatalities, legal and litigations, damage to the third party, environmental costs, damage/delay of cargo, and loss of freight customers (Islam et al 2014).

2.6.2. Transit time:

Transit time is the interval needed for a consignment to be delivered once it has been picked up from the point of departure. it refers to the amount of time spent when moving goods from one point to another (Wikipedia contributors, 2018, April 18).

Federico and Cavenaghi (2017) stated that this variable is measured in hours by using the following formula.

$$\sum_{I=1}^{N}\left(\sum_{i=1}^{n}\frac{\left[\left(Time\ between\ Origin\ and\ Destiny\frac{i}{n}\right)\right]I}{N}\right]$$

Where, N = Days accumulated on month, n = number of trains

The frequency of measuring this variable is Month/Daily

2.6.3. Washouts

These in railroad transport refer to the result of a natural disaster where the railroad bed is eroded by flowing water normally because of the flood (Wikipedia contributors, 2019, August 16). In railways, washouts destroy the embarkment and sometimes bridges and make the rail track unstable. Rainfall records can help to indicate the possibility of washouts in a certain railway section.

2.6.4. Infrastructure maintenance cost:

This refers to the cost that is incurred to ensure that certain infrastructure is kept in good operating condition. In railway, this refers to the cost that a railroad company incurs to ensure that the railway line is in a good and safe condition for operation (Rietveld et.al, 2007).

2.6.5. Rail freight wagons maintenance capacity:

Maintenance capacity refers to the quantitative measure of maintenance capability expressed as direct labor hours that can be applied during a normal workweek (BusinessDictionary.com-Online Business Dictionary, 2016). Rail freight wagons refer to those wagons which are used to transport rail freight from one point to

another. Rail freight wagons maintenance capacity, therefore, is the measure of maintenance capability that is articulated in labor hours.

2.6.6. Rail freight wagons availability:

Wagon availability refers to the state of the wagon being able to be obtained. Federico and Cavenaghi-(2017) identified as an indicator of an operational process perspective that is measured by using the following formula.

$$\sum_{i=1}^{N}\left(Wagon.\frac{h}{Total\ wagons.h}\right)X\frac{100}{N}$$

Where N = Days accumulated in a month.

2.7 Statement of Hypotheses

The hypotheses of the study are therefore formulated as below;

i. Derailments have a direct impact on the transit time of trains.

ii. Washouts have a direct impact on infrastructure maintenance costs.

iii. Rail freight wagons maintenance capacity has a direct impact on rail freight wagons availability.

3.0 Methodology of the Study

Several research strategies can be used in research. These include experiment, survey, case study, action research, grounded theory, ethnography, and archival research (Saunders, et.al 2009). This study has used the strategy of studying a particular objective intensively. The strategy for doing research that involves an empirical investigation for a particular contemporary phenomenon within its real-life context using multiple sources of evidence is referred to as a case study (Robson, 2002). This study has therefore used the case study research strategy because it is based on studying what happens in the real-life context of the railway operations industry.

3.1 Research Approach

This research intends to use the existing theory as an approach to measure the performance of the railroad company. The approach that researchers typically associate with the scientific investigation by studying what others have done, reads existing theories of whatever phenomenon, and then tests hypotheses that emerge from those theories is called a deductive approach (Kothari, C. 2004). This study has therefore used the deductive approach. The advantage of using the deductive approach is that the researcher can use the available theory and he/she is independent of what is being researched. The limitation of this research approach is that the researcher cannot develop a theory from this type of study.

3.2 Research Design and timeline

A research design is the procedures for collecting, analyzing, interpreting, and reporting data in research studies' (Boru, 2018). As explained by Robson (2002), there are three possible forms of research design:

exploratory, descriptive, and explanatory. His base of classification relies on the purpose of the research area as each design serves a different end purpose. For instance, the purpose of a descriptive study is to provide a picture of a situation, person, or event or show how things are related to each other and as it naturally occurs (Boru, 2018).

Explanatory research looks for causes and reasons and provides evidence to support or refute an explanation or prediction. It is conducted to discover and report some relationships among different aspects of the phenomenon under study (Boru, 2018).

Saunders, et.al (2009) stated that studies that establish causal relationships between variables are termed explanatory research. The purpose of this study was to assess the effects of the railway network on the performance of the rail freight operations by assessing the cause-and-effect relationship of variables. The study will assess the relationship in terms of the effect, of one variable on the other. This is therefore explanatory research. This research design responds to both the how and why of the research objective.

In research, there are two types of time horizons depending on the research question. These are cross-sectional which is snapshot research taken at a particular time and longitudinal which is a diary or series of snapshots (Saunders, et.al 2009). So long as this study used secondary data collected for a long period, its time horizon is longitudinal.

3.3 Methods of Data Collection

This research uses secondary data, so it is referred to as secondary research. These refer to the type of data that has already been collected for some other purposes (Kothari, C. 2004). They also include both unpublished and published summaries (Saunders, et al., 2009). This research used the unpublished data which were internally collected in the organization for some other purposes. The data were obtained through consulting the Operation directorate and the supporting directorates and units which are the Rolling Stock directorate, Civil Engineering Infrastructure directorate, Finance directorate, and Rail Safety and Security Unit.

The use of secondary data has the advantage of using fewer resources and is easy to apply longitudinal study. However, there are some limitations in using this type of data including a lack of control over the data quality and that the aggregations may not match the expectations. For quality control and reliability, the collected data were checked to ensure that they pass six assumptions that are required for linear regression. The assumptions are that the two variables should be measured at the continuous level, there should be a linear relationship between the two variables, there should be no significant outliers, there should be the independency of observation, the data should show homoscedasticity, and residuals (errors) of the regression line should be approximately normally distributed. The tool which was used for this analysis was SPSS software version 20.

3.4 Data Processing and Analysis

Data analysis in this study was focus on the causal relationship of the variables. The aim was to establish how one variable affects the other. The statistical method that is suitable for this type of analysis is regression analysis. It is referred to as the process of calculating the coefficient of determination and regression equation by using one independent variable (Saunders, et.al 2009). There are several types of

regression techniques that include linear, polynomial, logistic, and many others. In this study, the regression technique that was used is linear regression because the focus was on assessing the effect of one variable on the other.

4.0 Research Findings and Discussion

Hypothesis testing in this study followed the five steps which started with the formulation of the null and alternative hypothesis, collection of data, performing the statistical test (linear regression), deciding whether the null hypothesis was supported or refuted, and presenting the findings. The finding of this study was related and interpreted while referring to the theories and gaps in the literature reviewed.
For the first hypothesis, the results can be summarized as below

Table 4.1: Model Summary (Derailments Vs Transit Time)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.902[a]	.813	.801	8.62829

a. Predictors: (Constant), Derailments

b. Dependent Variable: Transit Time

The above model summary table shows that R=0.902 or 90.2%, meaning that there is a high degree of correlation. R square = 0.813, meaning 81.3% of the dependent variable (Transit time) can be explained by the independent variable (Derailment), which is very high.

Table 4.2: ANOVA Table (Derailments Vs Transit Time)

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4865.053	1	4865.053	65.349	.000[b]
	Residual	1116.711	15	74.447		
	Total	5981.765	16			

a. Dependent Variable: Transit Time

b. Predictors: (Constant), Derailments

Table 4.3: Coefficient Table (Derailments Vs Transit Time)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.013	10.128		.791	.441
	Derailments	.735	.091	.902	8.084	.000

a. Dependent Variable: Transit Time

The ANOVA test and the Coefficient tables show the statistical significance of the regression model that was run. From the tables above, the P-value is less than 0.0001, which is less than 0.05. The Coefficient table below also shows the relationship between the study variables as P-value is also less than 0.05, implying that the null hypothesis is refuted.

For the second hypothesis, the results can be summarized as below.

Table 4.4: Model Summary (Washouts Vs Infrastructure Maintenance Costs)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.950[a]	.903	.879	2.38007

a. Predictors: (Constant), Washouts

b. Dependent Variable: Infrastructure Maintenance Costs

The above model summary table shows that R=0.950 or 95.5%, meaning that there is a high degree of correlation. R square = 0.903, meaning 90.3% of the dependent variable (Infrastructure Maintenance Costs) can be explained by the independent variable (Washouts), which is very high.

Table 4.5: ANOVA Table (Washouts Vs Infrastructure Maintenance Costs)

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	211.696	1	211.696	37.371	.004[b]
	Residual	22.659	4	5.665		
	Total	234.355	5			

a. Dependent Variable: Infrastructure Maintenance Costs

b. Predictors: (Constant), Washouts

Table 4.6: Coefficient Table (Washouts Vs Infrastructure Maintenance Costs)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	19.430	1.351		14.386	.000
	Washouts	2.870	.469	.950	6.113	.004

a. Dependent Variable: Infrastructure Maintenance Costs

The ANOVA test and the Coefficient tables show the statistical significance of the regression model that was run. From the tables above, the p-value is 0.004, which is less than 0.05. The Coefficient table below

also shows the relationship between the study variables as P-value is also less than 0.05, implying that the null hypothesis is refuted.

For the third hypothesis, the results can be summarized as in Table 4.10.

Table 4.7: Model Summary (Rail Freight Wagons Maintenance Capacity VS Rail Freight Wagons Availability)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.920[a]	.847	.835	3.21551

a. Predictors: (Constant), Rail Freight Wagons Maintenance Capacity

b. Dependent Variable: Rail Freight Wagons Availability

The above model summary table shows that R=0.920 or 92.0%, meaning that there is a high degree of correlation. R square = 0.847, meaning 84.7% of the dependent variable (Rail Freight Wagons Availability) can be explained by the independent variable (Rail Freight Wagons Maintenance Capacity), which is very high.

Table 4.8: ANOVA Table (Rail Freight Wagons Maintenance Capacity Vs Rail Freight Wagons Availability)

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	743.223	1	743.223	71.882	.000[b]
	Residual	134.414	13	10.340		
	Total	877.637	14			

a. Dependent Variable: Rail Freight Wagons Availability

b. Predictors: (Constant), Rail Freight Wagons Maintenance Capacity

Table 4.9: Coefficient Table (Rail Freight Wagons Maintenance Capacity Vs Rail Freight Wagons Availability)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	17.142	3.303		5.190	.000

	Rail Freight Wagons Maintenance Capacity	.447	.053	.920	8.478	.000

a. Dependent Variable: Rail Freight Wagons Availability

The ANOVA test and the Coefficient tables show the statistical significance of the regression model that was run. From the tables above, P is less than 0.0001, which is less than 0.05. The Coefficient table below also shows the relationship between the study variables as P-value is also less than 0.05, implying that the null hypothesis is refuted.

4.1 Discussion of the Findings

4.2.1 Impact of Derailments on Transit Time of Trains

Derailment occurs when a train wheel and rail lose contact causing the train to come off the railway track. Sometimes derailments may result in a capsize of rolling stock. When derailment happens, it causes the railway line to be closed for some time depending on the extent of the damage. This line closure causes some trains to remain stranded in the line hence affects the performance of rail freight operations by affecting trains' transit time.

The risk of derailments in rail transportation has been a concern in the railway industry and to all stakeholders. Some approaches such as upgrading the track class have been adopted to manage and reduce the risks. The higher the track class, the more stringent are track safety standards, and thus high maximum train speed is allowed (Liu, Xiang et.al. 2011). Upgrading the track class may prevent certain track-related derailment but also increase the risk of certain types of equipment failure that may occur at higher speed and cause derailment also (Liuet, al. 2011). Also, upgraded track class may attract overspeeding by the drivers, which may lead to the risk of derailment.

TRC is implementing a railway track rehabilitation project for the section between Dar es Salaam to Isaka that is financed by the World Bank. The objective of this project is to deliver a reliable open-access infrastructure on the Dar es Salaam-Isaka rail segment (World Bank. 2014). It has significantly improved the track class and reduce track-related derailments in number (see table and graph below).

Table 4.10: Summary of Number of Derailments at TRC on the corridor of study for 2018/2019 and 2019/2020

	2018/2019		**2019/2020**	
Section	**Track Related**	**Rolling Stock Related**	**Track Related**	**Rolling Stock Related**
DSM-MOR	26	20	14	11
MOR-DOM	12	12	17	9
DOM-TBR	9	10	6	4
TBR-MZA	3	5	4	1

Source: Research Data (2020)

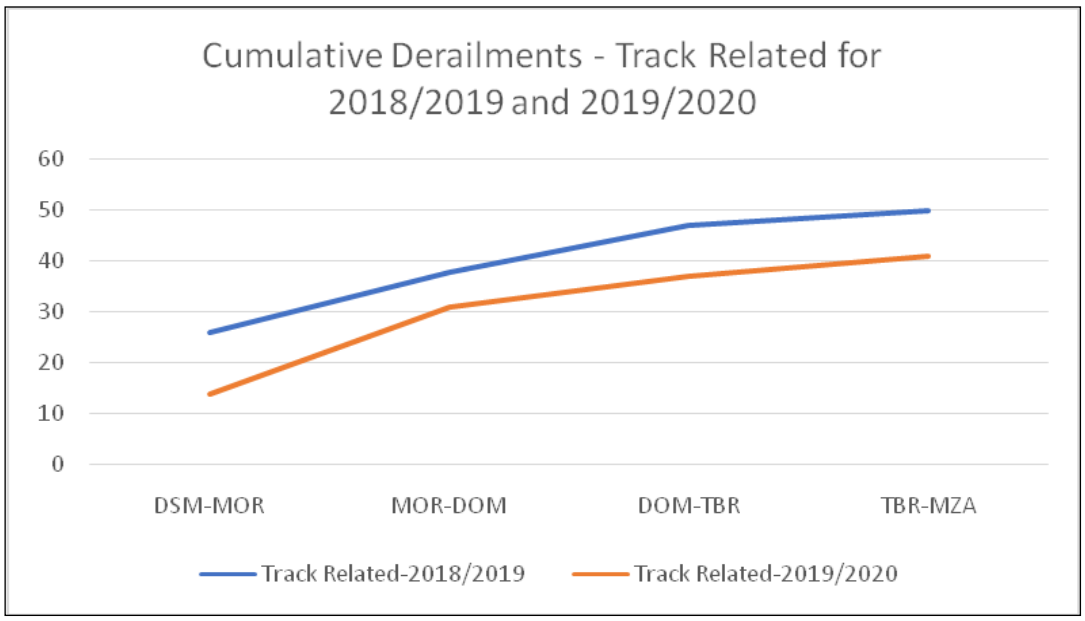

Figure 4.1: Cumulative Derailments (Track Related) 2018/2019 and 2019/2020

However, the effort of upgrading the track class needs to be complemented by the improvement of rolling stock standard and maintenance to subsequently reduce the rolling stock related derailments.

4.2.2 Impact of Washouts on Infrastructure Maintenance Costs

Washout occurs when the whole or part of the track structure is spoiled by constant or heavy rain. In the railway segment selected for this study that is from Dar es Salaam to Isaka, washouts mostly occur on Kilosa-Gulwe to Igandu, which is a section of about 120Km (from Kilometre post 283 to Kilometre post 403). This section is a flood-prone area that is affected by erosion and sometimes sand deposition (TRC 2019).

The research results show that washouts have a direct positive impact on infrastructure maintenance costs. This implies that the increase in infrastructure maintenance cost is also contributed by the cost used for railway recovery due to washouts. Apart from spending a substantial amount of money for railway line restoration due to washouts, TRC also suffers line closure for some time when such disruption happens. As a result of washouts, 90 days was reported as an average number of days of line closure per annum (TRC 2019).

This situation affects the performance of rail freight operations mainly in two ways; one is due to disruptions which cause delays and sometimes restriction of rail freight trains movements and the other aspect is on tariffs which cannot be lowered because TRC is already using much money than expected for infrastructure maintenance per annum.

4.2.3 Impact of Rail Freight Wagons Maintenance Capacity on Rail Freight Wagons Availability

Ballis et al. (2010) stated that the wagon fleet is an essential component in the performance of railway operations. The railroad company should ensure sufficient availability of wagons in the railway system. These wagons need to be well maintained to keep them running.

Rail freight wagons maintenance capacity in this study refers to the level of efficiency that is used to ensure that the rail freight wagons are kept in good and running condition. In TRC there are several stations for wagons maintenance that are active to date. There is one central mechanical workshop located in Dar es Salaam. This attends all the major wagons' faults and rehabilitation of rolling stock in general. There are also several depots for routine and spot maintenance of wagons which are Dar es Salaam (DSM), Malindi (MAI), Ilala (LAL), Morogoro (MOR), Dodoma (DOM), Tabora (TBR), Kigoma (KGM), Tanga (TAN), Mwanza (MZA), Mwanza South (MSO).

The study found that TRC has a 1486 fleet of wagons for Metre Gauge Rail out of which 627 equivalents to 42.2% are in the workshops and depots waiting for major repairs and maintenance. These wagons are not running for some time now. The remaining wagons are in running condition and they are checked several times at workshop and depots for repairs due to aging. The results of this study show that rail freight wagons' maintenance capacity has a direct impact on rail freight wagons availability. This implies that the maintenance efficiency of rail freight wagons affects their availability in the railway system. If many wagons stay in the workshops and depots waiting for maintenance, and they are not maintained on time, the system suffers wagons shortage, hence the performance of rail freight operations is affected.

5.0 Conclusion and Recommendations

5.1 Effect of Derailments on the Performance of Rail Freight Operations

In the trains' operations, the constant contact between the wheel and rail is very important. It ensures safe trains' movement. When the contact is lost, derailment occurs, which may lead to damage to the track materials and the rolling stock. Derailments also interrupt train movements and affect the trains' transit time.

5.2 Effects of washouts on the performance of rail freight operations

Washouts spoil the track structure and result in an interruption to trains movements. The damage due to washouts has to be restored at a cost that falls under the infrastructure maintenance budget. If the frequency of the occurrence of washouts is high then the cost of restoration becomes significantly high. Consequently, if the railroad company spends much money to maintain the infrastructure, automatically the total operations costs will be high and so the tariffs may not be competitive compared to other modes of transportation.

5.3 Effect of Rail Freight Wagons Maintenance Capacity on the Performance of Rail Freight Operations

A high level of efficiency of rail freight wagons maintenance implies high capacity. Because rail freight wagons are continuously in operation, they need to be maintained to keep them running. If no sufficient effort for maintenance, the rail freight wagons will stay longer in workshops and depots hence results in insufficient availability of such wagons in the railway network, which in fact, affects the performance of rail freight operations.

5.4 Recommendations

The study has used the Performance Measurement theory with the Balanced Scorecard model for measuring the performance of Tanzania Railways Corporation on rail freight operations. The method is therefore recommended for measuring the performance of railroad companies. The findings of the study indicate that derailments, washouts, and rail freight wagons maintenance capacity affect the performance of rail freight operations. Railroad companies should put forth strategies to reduce derailments. The major cause of the derailments being the track and rolling stock fault, the railroad companies should allocate more budgets on track and rolling stock maintenance.

Also, a permanent solution should be obtained for frequently occurring washouts to avoid spending more on temporary restorations. Further to that, the Government and other investors should look at the railway sector as a potential area for investment since apart from being a good source of income through rail freight operations, it also boosts the economy by supporting the growth of other sectors.

5.5 Areas for further study

It is recommended that further study on a similar subject can be conducted to assess the external factors affecting the performance of rail freight operations. The study can focus on the customer perspective. This may assess how the rail freight customers view the performance of rail freight operations and come up with more areas for improvement to increase rail modal share.

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