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# ECONOMIC JUSTIFICATION FOR DEVELOPMENT AND OPERATIONALIZATION OF RAIL-FREIGHT-CORRIDORS BETWEEN HUB-SEAPORTS AND INLAND CONTAINER DEPOTS IN NIGERIA

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***Abstract***

The study provided economic justification for private sector investment in developing, revitalizing and making operable, the rail-freight-corridors between hub-seaports and inland container depots in Nigeria. It estimated the operator-benefits and profitability potentials of investment in each of the ten rail-freight-corridors consisting of existing but inoperable and proposed rail routes from the major seaports to the Inland container depots in different geopolitical regions of Nigeria. Secondary data on the import and export (cargo generation) capacities of each of the ICD regions to and from the respectively connected hub-seaport were obtained from the Nigerian ports authority statistical report covering a period of two years (2018 – 2019) based upon which the annual expected revenue earnings of the operators were estimated. The cost of investment was also obtained. Benefit-Cost-Ratio (BCR) and Net Present Value (NPV) were used to estimate the operator-benefits and profitability potentials of each rail route. It was found that six of the rail routes have BCR > 1; and NPV>0; implying higher operator-benefits over costs within the period while four of the rail-routes have BCR <1; and NPV <0; implying higher operator-costs over benefits.

**Keywords: Economic-justification, rail-freight-corridors, developing, seaports, inland-container-depots**

## 1. INTRODUCTION

It is the constitutional role and duty of Government to drive the sustainable development of the state through programs and policies aimed at optimizing public social welfare, economic growth and living standard within

the state. The theories of transport development emphasize transport as the forerunner of human, economic and sustainable development and as such, transport infrastructure investment policies and programs of government aimed at providing mobility to the people, economic goods and services, and improving utility derivable from social and economic transactions in goods and services must be based on expected benefits to the public, and/or profitability potentials to the private operators with interest in investment in the given transport infrastructure. The lack, absence of and/or inadequacy in investment in these infrastructures in any mode of transport be it road, maritime, aviation, rail, pipeline etc, results in transport infrastructure deficit and under supply situation which presents the society with accessibility problems, such that a section of the society in need of transport which is an essential public good cannot adequately access it (Alstadt, 2012). The resultant negative effect is multiple but manifest via immobility of society, economic goods and services etc, leading social deprivation, economic recession, non sustainability of earlier achieved growth, economic blight and underdevelopment. The continuous conscious drive by governments to ensure adequate investment in transport infrastructure is motivated by the above facts.

The railway transport system in Nigeria over the years faced serious infrastructure decay problems occasioned by government neglect, lack of new investment in rail infrastructure by successive governments such that over a long period of time, the only rail infrastructure available were the colonial era investments in the system, which currently are inoperable in many regions where they exist. The Nigeria railway corporation almost went moribund. Accessibility to railway transport in different parts of the Country for both passenger and freight services were impossible as a result of the nonexistent infrastructure (Ndikom, 2008). The decay in the national rail infrastructure and railway transport system caused a diversion of freight and passenger traffic formally handled by the mode to the road transport system; a situation which led to serious traffic congestion challenges in major Nigeria cities and highways as road trucks handling all classes of freight had to compete for road space with cars and passengers vehicles. The loss in output occasioned by the travel time delay associated with such traffic congestion particularly in Lagos (Apapa gridlock) motivated a government committee on Port decongestion to recommend the development of Inland Container Depots (ICDs) and Container Freight Stations (CFS) in identified container freight origin and destination cities in the six geopolitical zones of Nigeria and in Lagos. The port decongestion strategy made case for the development of rail-freight- corridors between the

hub seaports and the ICD Cities and the operationalization of existing but moribund routes such that railway could serve for laden and empty container freighting to and from the destination ICDs and hubs ports respectively, thereby eliminating congestions caused by the long distance trucking of laden and empty container freight.

It was until the year 2013 that the Federal Government of Nigeria commenced a serious commendable attempt at reinvestment in the rehabilitation of the already dilapidated railway routes including Kano-Kaduna-Abuja rail-line, Lagos-Ibadan rail routes and Lagos- kano rail route among others with a view to replacing the old tracks with modern rail tracks and gauges. The Government also proposed to link Lagos to Benin-Cotonou axis through an obvious formidable rail lines with modern tracks and gauges from Orile-Mile 2-Badagry axis to Cotonou ports (Ndikom, 2019). The current level of investment in revitalizing the railway system is justifiable and commendable. However, it has not addressed holistically, the series of traffic congestion and port congestion challenges occasioned by long-distant trucking of container freight and other cargo types that ought to be transported by rail to the ICDs as recommended. It is obvious that this reinvestment approach has not considered the recommendations for the development of rail-freight-corridors between the ICDs and the hub seaports and operationalization of existing routes. It seems incapable of meeting the yearning for rail freight services to supplement the poor road haulage services provided to shippers across the major trade centers and cargo/freight generation and destination corridors in Nigeria. Though government has cited funding as a major challenge to developing and making operable rail routes to connect the major seaports to the ICDs in the various regions; the recent approach to overcoming the funding challenge in developed Countries is the use of private sector investment via public private partnership arrangement (Banister & Berechman, 2000; Cambridge Systematic, 2008). But the operator-benefits to such private sector investors must be guaranteed in order to elicit private sector investment.

Recognizing the need serious need to developing functional and optimal rail-freight-corridors between the hub seaports and ICDs since the scarce nature of economic resources may limit Government from investing to link all such ICDs and hub seaports; Ndikom et al (2019) carried a study on “Developing optimal rail freight transport corridors between hub seaports and inland container depots (ICDs) in Nigeria”; with the aim of providing empirically backed evidences to guide government in investing to develop rail infrastructure to link only ICDs and hub port rail-freight-corridors that are optimal and offer

greater economic benefits to the development of the nation. Such routes must equally be profitably to any interested private sector investor that may be engaged to provide infrastructure and/or revitalize existing infrastructure on a public private partnership (PPP) arrangement of build operate and transfer (BOT), Rehabilitate, Operate and Transfer (ROT) and/or other forms of PPP.

The study by Ndikom, et al (2019) investigated the cost optimality of the development and use of all such rail routes from various seaports to ICD regions considering factors such as distance of the ICD regions to and from hub ports, cargo destination and origination capacity (import and export capacities of the ICD regions), operability, service cost and investment cost considerations, the need to develop new rail routes to service the rail-freight service needs of many of the emerging market hubs, centers and sub-centers particularly those market centers that depend much of the major hub seaports of Lagos, Port-Harcourt, Calabar and Warri to have access to and from international markets; and which are currently underserved by the road haulage system. The findings of the study led to the recommendation for investment the development and operationalization of optimal rail-freight-corridors between hub seaport and inland container depots as shown in figure 1 - 3 below:

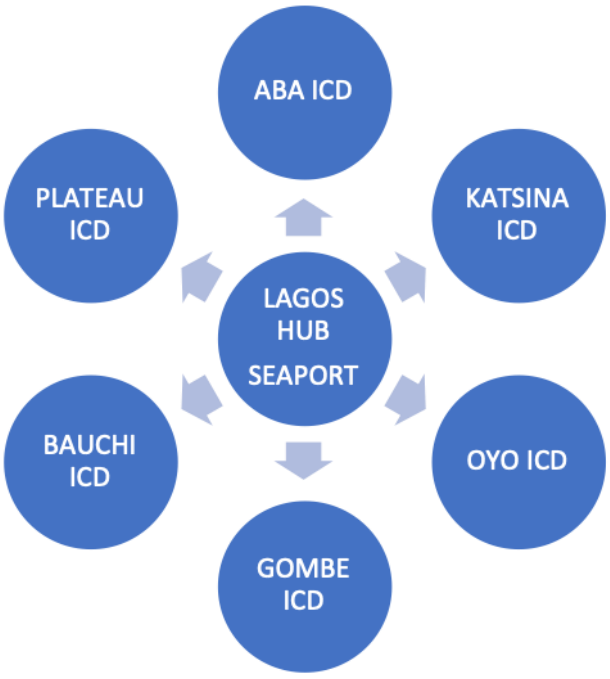


**Figure 1:** Optimal Lagos seaport to ICDs Rail Freight Corridors Recommended for Development and Making Operable.

Source: Modified based on research study outcome of Ndikom et al (2019)

As aforementioned, the need to develop and make operable rail infrastructure to link the seaports in Lagos to each of the inland container depots (ICD) Cities in the various regions in a hub and scope concept is illustrated as shown above (Ndikom, et al, 2019). Each of the marked rail-freight-routes offers optimal cost of rail freight services to shippers. The optimized annual costs of container freight transportation from the Lagos seaport to the ICDs in Aba, Plateau, Katsina, Oyo, Gombe and Bauchi were determined to ₦3,997,786,000, ₦1,527,459,000, ₦1,780,269,000, ₦7,643,044,330, ₦871,791,976, and ₦1,000,750,725 respectively. Similarly, the Warri hub seaport offers optimal container freight transport cost to two inland container depots in two geographical regions in North-West and South-East Nigeria while Rivers (Port-Harcourt Onne and Calabar) hub seaports offers optimal container freight transport cost to Aba (South-East) and Kano (North-West) regions respectively as shown in the figure below:

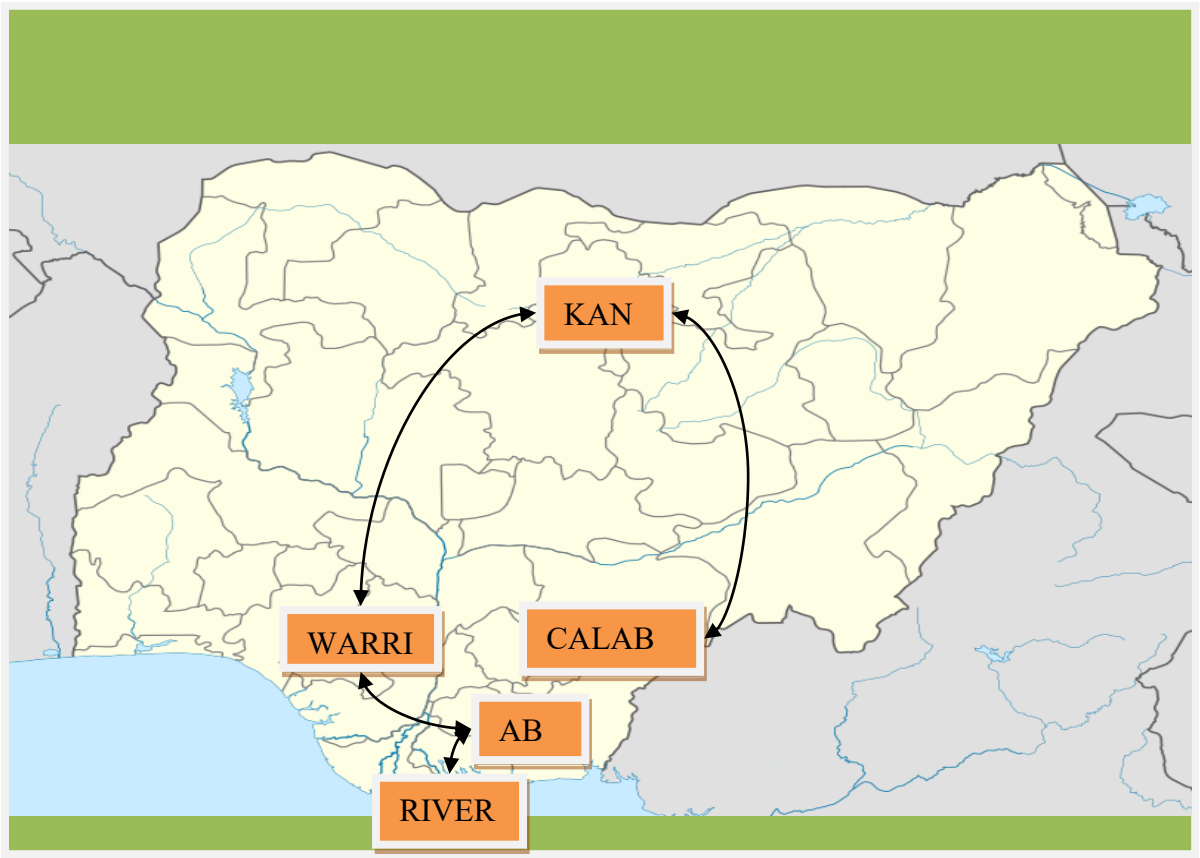


**Figure 2:** Warri, Calabar and Rivers hub seaport to ICDs Rail Freight Corridors that offer optimal TEU Transportation Cost Recommended for Development.
Source: Prepared by the author(s).

Investment in rail infrastructure development between the Warri-seaport and Kano-ICD freight corridor on one hand; and between the Warri-seaport and Aba- freight corridor on the other hand will offer optimal annual container freight transportation costs of ₦1, 906,713,000 and ₦138, 908,260 respectively to shippers. The study also developed optimal rail-freight-corridors between the seaports in Port-Harcourt consisting of the Onne seaport and Port-Harcourt seaport and major inland container depots that offer best possible TEU (container) transportation costs to the shippers in the various regions as shown in figure2 above. The rail-freight-corridor between Port-Harcourt seaports and Aba ICD in the South-East offers optimized annual container freight transportation cost of ₦612,695,740 while that between the Calabar seaport and Kano ICD (North-West) recommended for development offers optimized annual container freight transportation cost of ₦2,545,539,744.

It is obvious that the investment in rail transport infrastructure is a capital intensive and lump sum investment. As a result, the Government given the scarce nature of economic resources as aforementioned may not have adequate capital to revitalize dilapidated existing corridors and develop all the newly recommended optimal rail-freight-corridors at the same time. It would be favorable to use the private public partnership approach in which private sector operators are required to make investment in revitalization, development and operationalization of the optimal rail-freight-corridors on a build operate and transfer basis and/or other PPP terms peculiar to such investments. This requires estimation and understanding of the operator-benefits and profitability potentials of each optimal rail-freight-corridor as well as comparing the economic benefits offered by the development of each rail routes against the cost of provision and use of the infrastructure for service delivery. To the private investor whose major interest is profit and maybe not social welfare maximization, benefit-to-cost ratio and net present value approaches will offer empirical evidences and/or support to the choice of which optimal rail freight-corridor becomes first major investment priority over others (Gibbons & Overman, 2009; Barnerjeey et al, 2012). While investment in the optimal rail-corridors that offer greatest benefits are made a priority, those that offer less benefits over costs can be bargained to have longer contract periods and payback periods. This is true because the major motivation for private sector investment in the projects is the profit potentials of the projects. Thus, providing empirical evidence in support of the profitability of the hub seaports to ICDs rail-freight-corridors becomes necessary. For choice of investment among alternate hub-

seaport to ICD rail-freight-corridors, the rail-freight-corridor that offers the most profitability potential and operator-benefits over costs is preferred.

The current study is therefore aimed at providing empirical evidences on the operator-benefits and profitability potentials of investments in developing, revitalizing and making operable, rail transport infrastructure between the ICDs and hub-seaports in Lagos, Port-Harcourt, Warri and Calabar as recommended by various studies. The hub-seaport to ICD rail-freight-corridors considered in the study which we seek understanding of the economic justification for investing in consist of ten (10) rail-freight corridors as summarized in table1 below:

**Table1: Hub-seaport to ICD rail-freight-corridors considered in the study**

**(A) LAGOS HUB-SEAPORTS ROUTES**

(i) Lagos ⟺ Aba (South-East) Rail-Freight-Corridor

(ii) Lagos ⟺ Bauchi (North-West) Rail-Freight-Corridor

(iii) Lagos ⟺ Gombe (North-East) Rail-Freight Corridor

(iv) Lagos ⟺ Oyo (South-West) Rail-Freight-Corridor

(v) Lagos ⟺ Plateau (North-Central) Rail-Freight-Corridor

(vi) Lagos ⟺ Katsina (North-East) Rail-Freight-Corridor

**(B) WARRI HUB-SEAPORT ROUTES**

(i) Warri ⟺ Kano (North-West)Rail-Freight Corridor

(ii) Warri ⟺ South-East (Aba) Rail-Freight-Corridor

**(C) PORT-HARCOURT HUB-SEAPORT ROUTE (S)**

(i) Port-Harcourt/Onne ⟺ Aba Rail-Freight-Corridor

**(D) CALABAR HUB-SEAPORT ROUTE(S)**

(i) Calabar ⟺ Kano Rail-Freight-Corridor

## 2. BRIEF REVIEW OF LITERATURE

The use of econometric tools for project and investment appraisal for purposes providing economic evidence that justifies the benefits of such investment projects to the society and its profitability potentials to private sector investors is not new. The very capital intensive and lump sum investment nature of transport projects, coupled with the scarcity of economic resources, demands that every such project is appraised with a view to justifying the amount of resources committed in setting it up. The overall aim of appraisal is to provide empirical evidences to support and/or provide empirically based advice for transport infrastructure provision and improvement.

A study by Venables, Laird and Overman (2014) provides that transport is an important input in production, consumption, income generation and domestic living. As a result, deficit in the supply of transport infrastructure causes decline and negatively affects production, consumption, income, and wider domestic living. Venables, Laird and Overman (2014) notes that should all other drivers of economic growth be increased by 10% while transport infrastructure remain unchanged and/or constant, income would only grow by 9%, showing a decline of 1% less than it ought to be. Thus several studies on impacts of transport infrastructure provision and improvement indicate positive impacts on almost all known economic indices; this however is not enough motivation for public and private organizations to invest in transport infrastructural position without recourse to investigating first the viability, benefits and profitability of specific transport projects to the society and/or organization. While the revitalization and operationalization of the few already existing rail routes is ongoing in Nigeria, the recommended development of heavy rail infrastructure between the hub-seaports and ICDs for transportation of laden and light container TEU to the regional ICDs has not seen the light of the day and available research literature has not documented the operator-benefits of these projects in the recourse to use private capital for the development of the projects, nor has documentary evidences on the profitability potentials of the proposed rail freight corridors been provided to the attention of private investors for possible investment options.

Cambridge Systematic (2008) and Venables et al (2014) agree that improvement in already existing and/or development of a new transport infrastructure offers numerous economic gains ranging from user-benefits, productivity effects, to investment and employment effects, among others. User-

benefits is viewed as the most direct impacts comprising of transport cost savings to users, travel/journey time savings, vehicle operating cost savings, etc. Venables et al (2014) notes that while cost saving is best measured by its impact on users; the market economy transfers much of the benefit to others in the economic system. Wider varieties of literature in this area are in harmony that the user-benefits do not capture in totality all the impacts of major transport infrastructure projects (Venables et al (2014). Productivity effects represent benefits offered by investment in developing and/or improving transport infrastructure in improving productivity gains accruing to industries and workers including external parties who are neither direct users nor operators of the transport infrastructure. These third parties however benefit from the multiplier effects of the increased output and productivity engineered by the new and/or improved infrastructure (Cambridge, 2008, Weisbrod, 2016). The third major gain is the impact on economic performance by changing the patterns of private sector investment and consequent employment. Transport infrastructure development and improvement generally reposition a place and/or region to attract more investment, thereby enabling more employment opportunities. This is the reason availability of transport infrastructure and its adequacy is viewed as one of the most important factors that influences location decisions of firms (Venables et al 2014). Leung (2006) using a pictograph summarized the effects of a transport infrastructure development and/or improvement project as shown below:

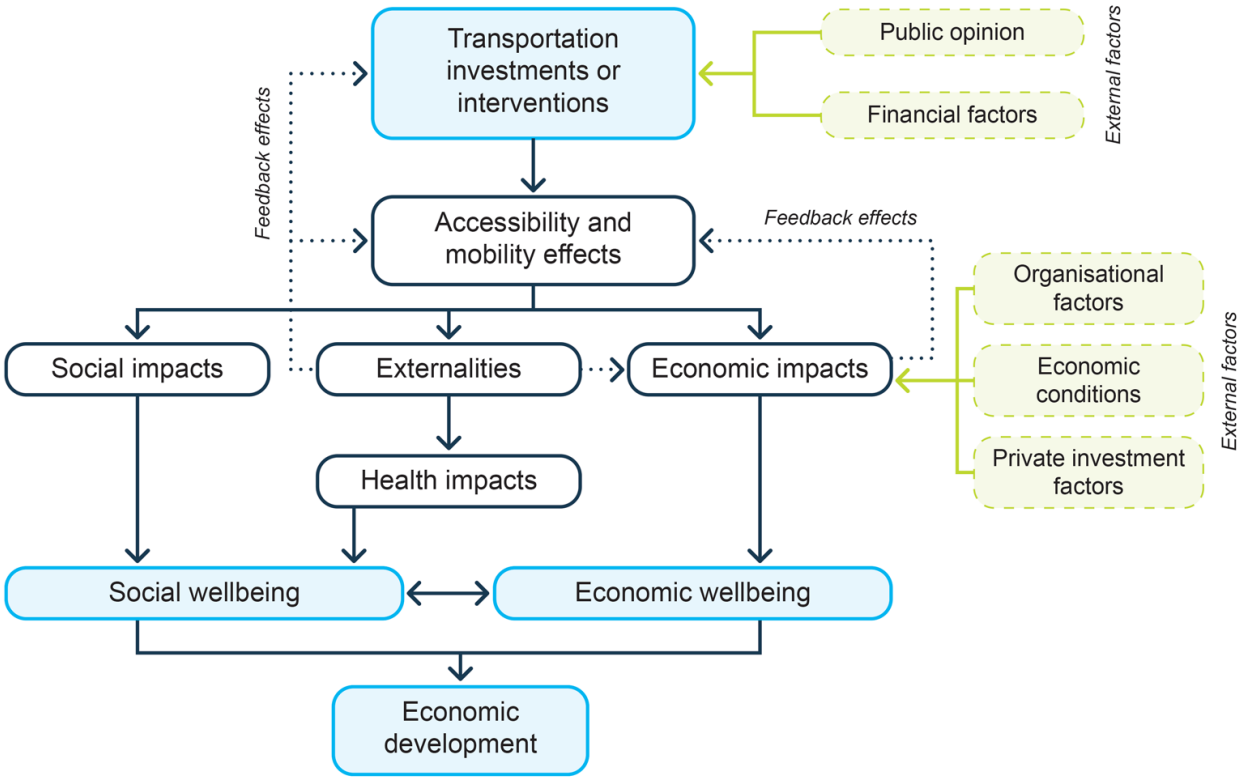


**Figure: 4:** Impacts Interventions in Transport Infrastructure Provision.
Source: Adapted from Leung (2006). This is also available in variety of existing literature.

As expected, Leung (2006) itemized a direct link between transport investments and accessibility and mobility effects as well as externalities effects. The study also notes that accessibility and mobility effects interfaces with and affects and/or causes social impacts, health effects on externalities and economic impacts leading to social wellbeing cum economic wellbeing and finally economic development (Leung, 2006; etc). While the intervention decision is made by Government (public) considering financial factors, the gains of the intervention that drives economic growth and the externalities effects are borne by individual organizations, persons, and private investments (Leung, 2006; Faber, 2013 ).

Study by the Ministry of Transport of New Zealand (2014) classified the effects of transport infrastructure intervention programs to have an overlap and/or intersection between the two major groups. The report classified the effects into Welfare effects and GDP effects as shown in the figure5 below:

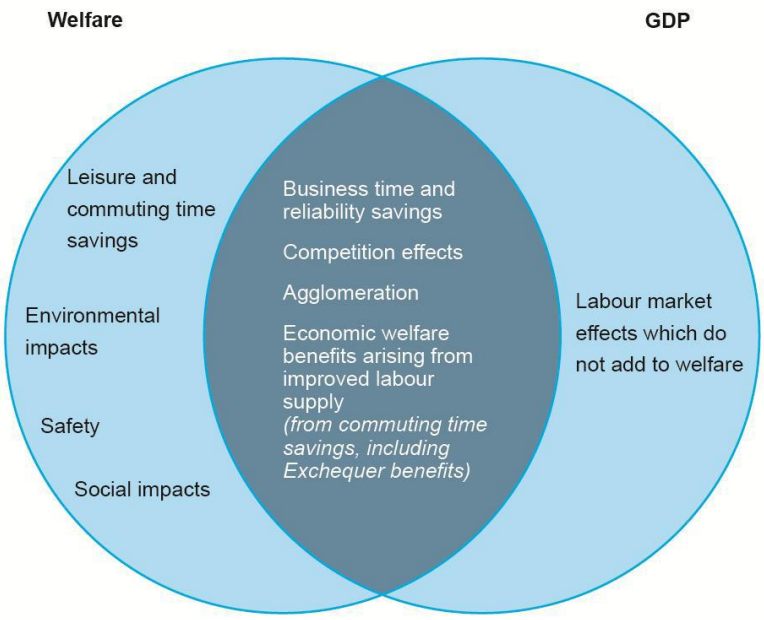


**Figure 5:** Further classification of Transport infrastructure intervention effects
Source: Adapted from New Zealand Ministry of Transport Report (NZMT, 2014)

While the study identified social impacts, safety, environmental impacts, leisure and travel time savings as majors effects of transport infrastructure intervention that may improve public welfare, it identified labour market effects due to improvements in investment and employment as drivers of gross domestic product (GDP) and identified business time savings, competition effects, improved labour supply, etc. as intersect and/or joint drivers of both welfare and GDP benefits.

Going further, the New Zealand Ministry of Transport (2014) opines that for purposes of appraisal and comparative analysis between benefits and costs of transport infrastructure intervention projects, benefits of transport projects are further classified into direct-user-benefits (conventional benefits) and wider economic benefits. This is in harmony with the classification of benefits in Venables et al (2014) as aforementioned. See figure6 below for typology of direct-user benefits and wider economic benefits as presented in the study.

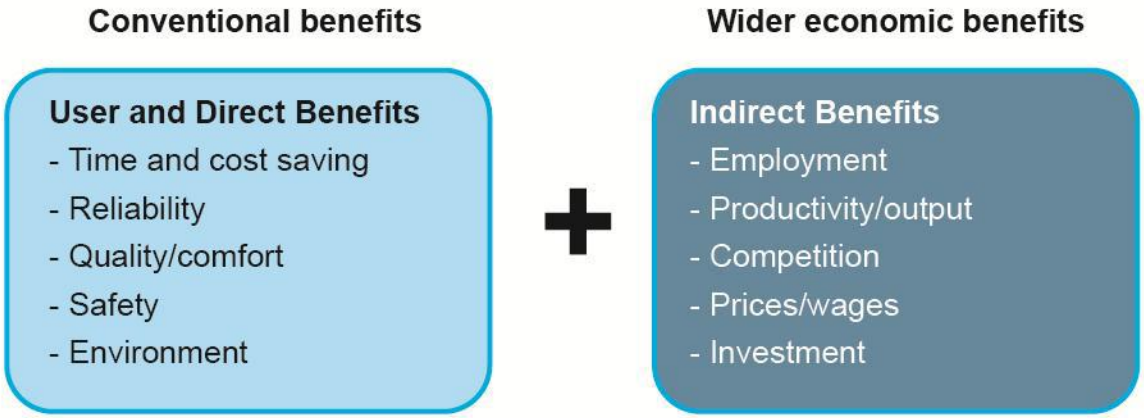


**Figure 6:** Components/Typology of User-benefits and Wider Economic Benefits.

Source: Adapted from NZ Transport Agency Economic Evaluation of Transport intervention projects (2014)

Weisborg (2016) and Venables et al are in agreement that that the benefits offered by any transport investment project can best be ascertained and the project economically justified by the use of transport investment appraisal techniques. By transport appraisal, the user-benefits, operator-benefits, as well as the overall/wider economic benefits can be measured and compared against the associated costs in order to form a formidable opinion on the economic justification of the project based on empiricism. Though several techniques of appraisal have been identified in many literatures, they can be broadly categorized into traditional techniques and the discounted cash flow techniques (DCF). The DCF which employs the concepts of time value of money into consideration are favorably recommended for use in conjunction with the traditional techniques for better evidence based decisions on the viability, profitability and benefit potentials of transport projects (Gibbons et al 2012; Glaeser and Gottlieb, 2009).

Since most of the routes considered in the study only needs revitalization and the original costs associated with externalities factors like community costs among others have the borne in the earlier face of the project, while few needs a totally fresh investment in rail infrastructure, there is need to analyze from operator-benefits for investment in the hub-seaport to ICDs rail-freight-corridors. This is borne from the fact that Government seems to have favoured the use of Private investors in the provision and operation of these new infrastructures. Available literatures have dwelt on measuring user-benefits and

wider-benefits, but the private investor and operators needs to understand the operators-benefits and routes viability as economic justification for investing in the projects. For the hub-seaport to ICDs rail freight corridors and from the public sector approach to appraisal of the benefits of transport infrastructure development, adopting a fairly narrow view of benefits from operators perspective, may indicate benefit-cost- ratios greater than two particularly for routes such as the Lagos seaport to South-East (Aba-ICD), Calaber-seaport to North-West (Kano ICD), Lagos-Seaport to Jos ICD (North-Central), Lagos-seaport to Ibadan ICD (Oyo-Southwest), among others which show fairly high container traffic flow rates daily. The current study is thus aimed at bridging the gap is literature by targeting to measure the operators-benefits from the investing in the projects as empirical evidences and guide for the development of rail infrastructure to link the hub-seaport to ICDs rail-freight-corridors in Nigeria.

## 3. MATERIALS AND METHODS

The regional inland container depots (ICDs) as identified above are marked to be connected to the hub-seaports by rail while the existing rail-routes from the ICD regions to the hub-seaports are to be revitalized and made operable for container TEU freighting by rail. The cargo traffic and/or container traffic flow capacity between each identified hub-seaport and the to be connected and/or connected ICD region, representing the cargo origination and destination (import and export) capacity of the ICD region handled via the connected hub-seaport is obtained from the Nigeria Ports Authority annual statistical reports covering a period of 2 years. The NPA annual reports provide the annual shipment of TEUs of cargo from each seaport to the various ICD Cities and regions in Nigeria. The optimal rail freight rate to be charged by the railway corporation / operator for carriage and delivery of per TEU of container from each identified ICD region to and from the hub-seaport (hub-port-ICD rail-freight-corridor) as determined by Ndikom et al (2019) is used as the price to be paid by shippers using each ICD-hub-seaport rail freight corridor for shipping per TEU of cargo. The operator's revenue earnings per annum from the shipment of TEU's is thus the product of the total TEU shipped from and to each ICD regions via the seaports by rail. This represent the annual earnings and benefits to the operators for rail freight services provided through each Hub-seaport to ICD rail-freight-corridor and when aggregated over the two years covered in the study, represent the total benefits/earnings over the same period.

The estimated cost of investment in developing and making operable each rail-freight-corridor which represents the cost of capital and operation cost of investment in building the rail infrastructure to link each proposed hub-seaport and ICD was obtained from the studies by Ndikom et al (2018). It is important to however state that the capital cost is inclusive of the estimated annual operating and/or service cost estimated based on current operation cost of the Nigerian Railway Corporation (NRC). It is however exclusive of the externalities cost as the externalities cost of most already existing routes that needs only revitalization having already been originally settled by the government. The benefits considered as aforementioned are operator-benefits. Bonzanigo and Karla (2014) argues that the World Bank provides the social rediscount rate for development projects in developing as ranging from 10 to 12 percent. Using the lower limit social discount rate (interest rate, r) of 10% for development projects in Nigeria, the discounted appraisal techniques of benefit cost-ratio and net present value methods were used to assess the projects for economic justification from operator's perspective. The decision to use the lower limit interest rate of 10% was to limit errors that might arise from excess profits/benefit estimation that may be occasioned by the use of a higher interest rate. Note that the construction cost used by Ndikom et al (2019) was based on the Nigeria average per kilometer rail construction cost of 3.04million dollars.

## 3.1 Benefit-Cost Analysis

The benefit/cost analysis (BCA) or benefit-cost- ratio (BCR) is an econometric instrument used for the appraisal of economic viability of public projects (Gibbons et al 2012).

Using the method, we used the estimated cost of developing each of the ICD-hub-Seaport rail-freight-corridor as well the estimated revenue earnings (benefits) by the operators from the use of each rail-freight-corridor for service delivery as discussed above over a two years period. The annual benefits and/or earnings is the product of the total annual TEU moved between each ICD region (annual import and export TEU cargo capacity of the region) and the hub-seaport as obtained from the NPA annual report and the rail freight rates(prices) for shipping per TEU from and to the ICDs and hub-seaports. This benefit is determined for each and aggregated over the two years period used.

We denote the benefits as aggregated discounted benefits over the period as: $B_n$ and the associated capital cost with $C_n$ , We will then compute the present values (PV) of benefits and costs using the prevailing discount rate (r) .

Then the benefit-cost ratio of each hub-seaport to ICD rail freight corridor project X is given as:

Generally, $BCR_i = \frac{\sum_{i=n}^{i}\left(\frac{B_i}{(1+r)i}\right)}{\left(\frac{C_i}{(1+r)i}\right)}$ ---------- (1)

The present value of the benefits is given as : $B_{pv} = \sum_{i=n}^{i}\left(\frac{B_i}{(1+r)i}\right)$

Thus the present value aggregate benefit over the n period of assessment is:

$$B_{pvt} = \sum_{i=n}^{i}\left(\frac{B_1}{(1+r)n-4}\right) + \left(\frac{B_2}{(1+r)n-3}\right) + \left(\frac{B_3}{(1+r)n-2}\right) + \left(\frac{B_4}{(1+r)n-1}\right) + ----\left(\frac{B_5}{(1+r)n-0}\right)$$

Where $B_i$ = project benefit in year i and i ranges from 1 ,2, 3, ---n, and n = 2 years for the present study.

$C_i$ = project cost in year i,

$r$ = discount rate

$n$ = 5 years.

Thus, the benefit-cost-ratio of the Project over the period is:

$$BCR_p = \frac{\sum_{i=n}^{i}\left(\frac{B_i}{(1+r)i}\right)}{\sum_{i=n}^{i}\left(\frac{C_i}{(1+r)i}\right)}$$ ---------- (2)

When the $BCR_p \geq 1$; the project is viable and acceptable.

When the $BCR_p < 1$, the project cannot recover the cost outlay within the period as the cost is greater than the benefits. For the current study, the number of years covered is far less than the life of the project and the number of years of Public Private Partnership (PPP) term which ranges for more than 10 years. The short period used however enables the investors to understand the nature of operator-benefits in the early life of the projects.

Using equation (2) we estimated the benefit-cost-ratio of each of the proposed hub-seaport to ICD rail-freight-corridors to understand the relationship between the operator-benefits to the cost outlay as basis for making investment decision and choice.

## 3.2 Net Present Value (NPV) Method

The estimated cost of developing and operating the railway services between each hub-seaport and ICD rail-freight-corridor over the period is subtracted from the discounted revenue estimates (streams of returns) from each

route over the same period. The NPV method was thus used to determine the profitability of service delivery using each ICD-Seaport rail link, using a discount rate/ interest rate r = 10%. Also note that the two years period used for the study is far less than the life of the project but enables private investors to understand the nature of operator-benefits in the early life of the projects.

The NPV is mathematically expressed as:

$$NPV = B_{pvi} - C_{pvi}$$

Where $\boldsymbol{B_{pvi}}$ = discounted /present value of benefits over period i, i ranges between 0 to n, and n =2.

$C_{pvi}$ = present value of Costs.

Thus the discounted value of the aggregate benefits over the period i become:

$$B_{pv} = \sum_{i=n}^{i} \left(\frac{B_i}{(1+r)i}\right) \text{; and;}$$

$$C_{pv} = \sum_{i=n}^{i} \left(\frac{C_i}{(1+r)i}\right)$$

Therefore $$NPV = \sum_{i=n}^{i} \left(\frac{B_i}{(1+r)i}\right) - \sum_{i=n}^{i} \left(\frac{C_i}{(1+r)i}\right) \quad (4)$$

When NPV≥0, the project is profitable and acceptable for investment. However, when NPV = 0, that is the minimum condition for the acceptance of the project and it indicates that the project initial cost will be recovered at the expiration of n periods on which the computation of the NPV was based. NPV>0 indicates that the projects yielded profit over the review period. Using these methods, the research assessed the operator-benefits and profitability of each identified rail-freight-corridor as basis for justifying private sector investment in the development of rail infrastructure to connect the hub seaports and the inland container depots.

Note: The aggregate of the estimated capital and running cost of making the identified rail freight corridors operational, determined in Ndikom and Nwokedi (2019), were used as cost data and input for estimating the BCR and NPV of each optimal rail freight corridor.

# 4. RESULTS AND DISCUSSION

**Table 2: Operator benefits-cost- ratio (BCR) for development and operationalization of rail-freight-corridors between Lagos-seaport to connected ICDs**

| Rail-freight ICD Corridors From Lagos Seaport to | Aba South East | OYO ICD | Katsina ICD | Plateau ICD | Gombe ICD | Bauchi ICD |
|---|---|---|---|---|---|---|
| BCR | 5.99 | 13.02 | 3.76 | 4.23 | 0.19 | 0.24 |
| Remarks | 5.99 > 1 | 13.02 >1 | 3.76 > 1 | 4.23 > 1 | 0.19 <1 | 0.24 <1 |
| Sig: Accept If: BCR≥ 1 | **significant** | **significant** | **significant** | **significant** | Non significant | Non significant |

Source: Authors computation

The result of the study showed in the table above indicate BCRs of 5.99, 13.02, 3.76, 4.23, 0.19 and 0.24 for rail-freight-corridors between Lagos seaports and each of Aba ICD (South-East), Oyo ICD (South-West), Katsina ICD (North-West), Plateau ICD (North_central), Gombe ICD(North-East) and Bauchi (North-West) ICD respectively. The implication is that while the rail-freight-corridors from Lagos seaport to Aba ICD, Oyo ICD, Katsina ICD and Plateau ICD each offers higher benefits/earnings than the cost of development and operation of the rail infrastructure, the rail freight-corridors from Lagos seaports to Gombe ICD in the North-East and Bauchi ICD in the North-West have less benefits/earnings than cost over the period covered in the study with both having BCR<1 .By implication, it will take more than 5-year operational period for the rail infrastructure along the two routes with BCR <1 to payback and or yield returns equivalent to the initial cost of development and operation. While cost outlay by a private developer, investor and/or operator committed to the development and operation of the rail-freight corridors from Lagos seaports to Aba (South-East) ICD, Oyo ICD (South-West), Katsina ICD (North-West) and Plateau ICD (North-central) zones will be recovered with huge profits/returns in less than five years of commitment of the resources, similar capital committed to invest in developing the rail-freight-corridors from Lagos seaport to Gombe ICD (North-East) and Bauchi ICD (North-West) cannot be recovered within the same period. Based on the BCR project acceptance criteria

identified above, we recommend private operator's investment in the significant rail-freight-corridors which include routes from Lagos seaport to Aba ICD, Oyo ICD, Katsina ICD and Plateau ICD.

Also given the locations in proximity to the Plateau and Katsina ICDs, the plateau and Katsina ICDs can be positioned as intermediate load/cargo centers between the Lagos seaports and both Gombe and Bauchi ICDs, accepting freight from Gombe and Bauchi ICDs as feeder depots and subsequently feeding the Lagos seaports with all such cargoes received from the non-significant routes. It is however important to note that if investment must be committed to connecting the non-significant routes, operator-benefits will need a higher payback period in order to begin to accrue. This can be achieved by the operator negotiating to win a longer term PPP and/or Build, operate and transfer (BOT) agreement. See figure 8 for a pyramidal arrangement of the rail-freight-corridors from the Lagos seaports to the different ICDs in order of decreasing operator BCR values.

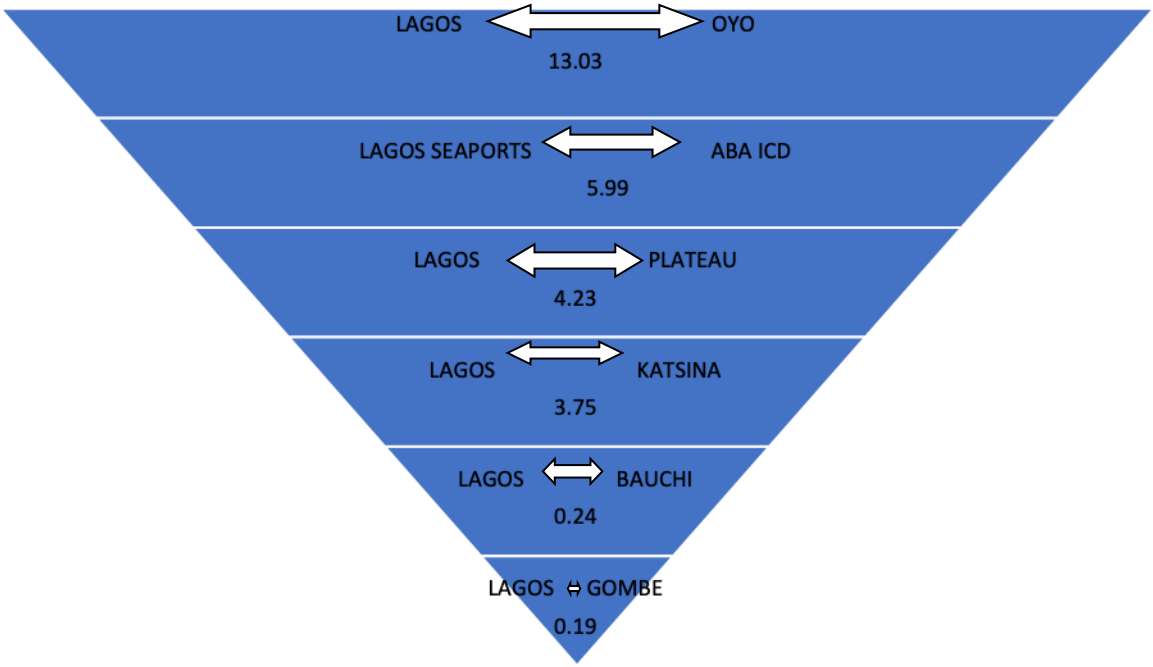


**Figure 8:** Rail-Freight-Corridors from Lagos Seaport to ICDs Ranked In Decreasing Order of BCR Values

Source: Prepared by Author

For choice of investment between and /or among alternate rail-freight routes, the routes that offers the greater BCR value are preferred over other routes and the preference continues in decreasing order of BCR value such that the routes that offers the least BCR value are least.

554 **Table 3: Operator benefits-cost- ratio (BCR) for proposed rail-freight-**
555 **corridors from Warri-seaport to connected ICDs**

| Hub-Seaport to ICD Rail-Freight-Corridor | BCR | Remarks | Significance: (Accept if BCR ≥1) |
|---|---|---|---|
| Warri ⟺ Aba ICD Rail-Freight-Corridor | 0.18 | 0.18 < 1 | Non significant |
| Warri ⟺ Kano (North-West) ICD Rail-Freight-Corridor | 6.40 | 6.40>1 | Significant |

556 Source: Authors computation
557
558 The results show BCR ratios of 0.18 and 6.40 respectively for the rail-
559 freight-corridors from Warri seaport to Aba (southeast) ICD and Kano (North-
560 west) ICD regions. While the kano ICD to Warri seaport corridor is significant
561 and offers BCR >1; the Aba ICD to Warri seaport corridor is non-significant and
562 offers less operator-benefits with BCR <1. As aforementioned, for the non-
563 significant route, operator-benefits will need a higher payback period to accrue
564 above the associated cost. This can be achieved by the operator negotiating to
565 win a longer term PPP and/or Build, operate and transfer (BOT) agreement.
566
567 **Table 4: Operator benefits-cost- ratio (BCR) for rail-freight-corridors from**
568 **Port-Harcourt and Calabar hub-seaports to connected ICDs**

| Hub-Seaport to ICD Rail-Freight-Corridor | BCR | Remarks | Significance: (Accept if BCR ≥1) |
|---|---|---|---|
| Port-Harcourt/Onne ⟺ Aba Rail-Freight-Corridor | 3.20 | 3.20 > 1 | significant |
| Calabar ⟺ Kano (North-West) Rail-Freight-Corridor | 0.5 | 0.5 < 1 | Non significant |

569
570 The table above indicated that, the benefit/cost ratio of the Port-Harcourt
571 seaports- Aba(south-east) ICD rail-freight-corridor is 3.20. By implication, the
572 route offers annual benefits per annum that are 3.20 times higher than the
573 investment cost. Though this rail link already exists, it needs to be revitalized
574 and made operable to provide TEU freight services between Port-Harcourt/Onne
575 seaports and the Aba ICD in the South-East.

Similarly, the benefit/cost ratio of the proposed rail-freight-corridor between Calabar seaport and the Kano (North West) ICD region is 0.5. Thus BCR < 1, showing a non-significant and non-profitable route within the period covered in the study. The implication of the BCR value of 0.5 is that revenue earnings from the project within the period will be half the cost of investment in the rail project. Thus, a payback period greater than the period of 2years used in the study is required to economically justify investment in this rail-freight-corridor from operator-benefits perspective.

**Table 5: Profitability potentials of each Rail-freight-corridor to the investors by the Net Present value (NPV) Method (Lagos seaports to ICDs rail-freight-corridors)**

| Hub-Seaport to ICD Rail-Freight-Corridor | NPV | Remark | Significance: (if NPV ≥0) |
|---|---|---|---|
| Lagos ⟺ Aba ICD Rail-Freight-Corridor | ₦2,665,954,632 | NPV >0 | significant |
| Lagos ⟺ OYO ICD Rail-Freight-Corridor | ₦7,056,344,330 | NPV>0 | Significant |
| Lagos ⟺ Katsina ICD Rail-freight-corridor | ₦1,177,115,320 | NPV >0 | significant |
| Lagos ⟺ Plateau ICD rail-freight corridor | ₦ 1,167,827,300 | NPV>0 | significant |
| Lagos ⟺ Gombe ICD rail-freight-corridor | -₦3641008024 | NPV<0 | Non significant |
| Lagos ⟺ Bauchi ICD rail-freight corridor | -₦3012049275 | NPV<0 | Non significant |

Source: Authors computation

The use of the Net present value method to assess the profitability potentials of each rail-freight-corridor from Lagos seaport to the ICDs shows that within the 2 years period used in the study, only the Lagos to Gombe ICD and Lagos to Bauchi ICD rail-freight-corridors show NPV values less than zero, and are as such not profitable. For Lagos-Gombe route, -₦3641008024<0, while for Lagos-Bauchi route, -₦3012049275<0. This result corroborates the previous result of BCR. The NPV values indicate the amount of profits derivable within the period covered in the study for rail routes from Lagos seaport to Aba, Oyo, Katsina, and Plateau inland container depots is ₦2,665,954,632,

₦7,056,344,330, ₦1,177,115,320 and ₦ 1,167,827,300 respectively and has NPV>0. By implication, committing funds to the development and making operable each of the routes with NPV values >0 by any private operator yields profit equivalent to the above NPV values to the operator within just two years of the operation. The implication to government negotiation team is that the PPP terms and/or life of the contract (number of years the PPP lasts) available to the private operators of the routes as contracts period for such highly profitable routes with very minimal payback periods should be less than those of less profitable routes with higher payback period. The PPP is renegotiated at the end of the period agreed originally. For choice between profitable alternate routes, the route with higher NPV value is preferred over those with less NPV values. See figure9 below for arrangement of the rail-freight routes from Lagos seaports to the ICDs in order of decreasing profitability.

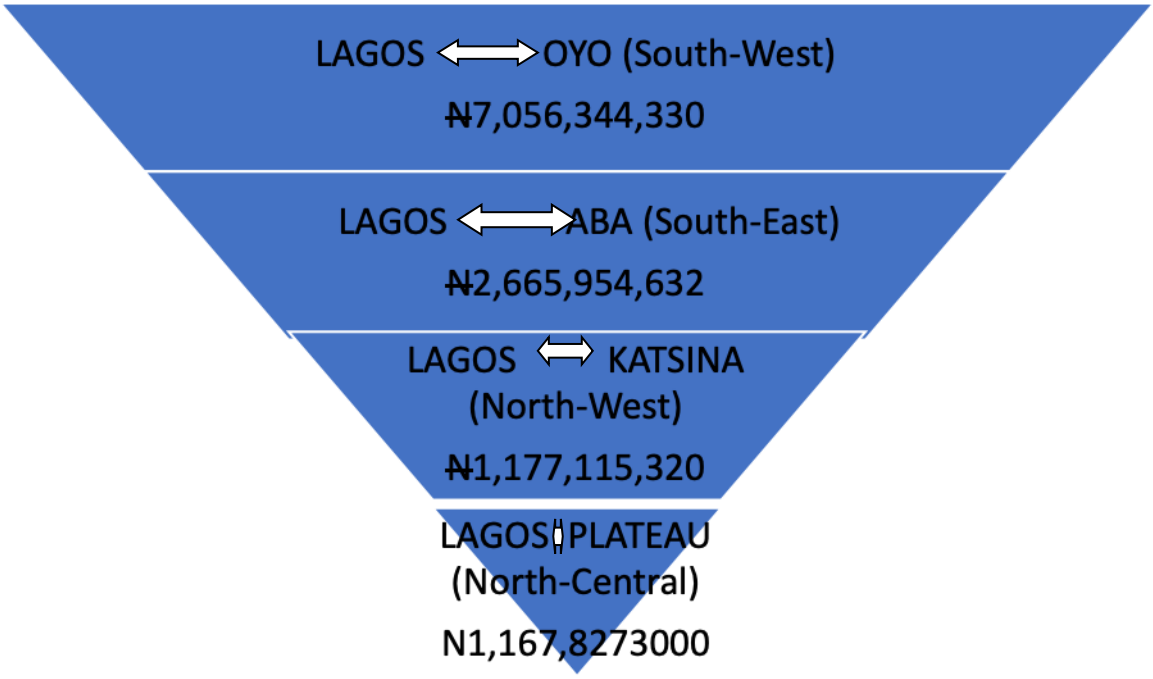


**Figure 9:** Rail-Freight-Corridors from Lagos Seaport to ICDs Ranked In Decreasing Order of NPV Values

Source: Prepared by Author.

**Table 6: profitability potentials of each Rail-freight-corridor to the investors by the Net Present value (NPV) Method (Warri seaports to ICDs rail-freight-corridors)**

| Hub-Seaport to ICD Rail-Freight-Corridor | NPV | Remarks | Significance: (if NPV ≥0) |
|---|---|---|---|
| Warri ⟺ Aba ICD Rail-Freight-Corridor | -₦1137891740 | NPV< 0 | Non significant |
| Warri ⟺ Kano (North-West) ICD Rail-Freight-Corridor | ₦1608792892898 | NPV>0 | Significant |

Source: Authors computation

The rail-freight-corridors between Warri seaport and Aba (South-East) ICD; and between Warri seaport and Kano ICD (North-West) have NPV values of -₦1137891740 and ₦1608792892898 respectively. While for Warri seaport to Kano ICD rail routes shows NPV > 0; and is profitable, Warri to Aba South-East ICD shows NPV <0 which is not significant. Thus, over the 2 years time period used in the study, the Warri-Kano rail freight corridor will make profit value equivalent to the NPV value while the Warri-Aba route will not recover the initial cost outlay. The Warri-Aba rail freight corridor requires a longer payback period than 2 years in the contract terms if it must be developed.

**Table 7: profitability potentials of each Rail-freight-corridor to the investors by the Net Present value (NPV) Method (Port-Harcourt and Calabar seaports to linked ICDs rail-freight-corridors)**

| Hub-Seaport to ICD Rail-Freight-Corridor | NPV | Remarks | Significance: (if NPV ≥0) |
|---|---|---|---|
| Port-Harcourt ⟺ Aba ICD Rail-Freight-Corridor | ₦421195740 | NPV> 0 | Significant |
| Calabar ⟺ Kano (North-West) ICD Rail-Freight-Corridor | -₦28460256 | NPV< 0 | Non Significant |

Source: Authors computation

The rail-freight-corridor from Port-Harcourt/Onne seaports to the Aba inland container depot in the south-east region has an NPV of -₦421195740. Since the NPV >0, the operator in the rail-freight corridor will make profit equivalent to the NPV value within the period covered in the study.

The rail-freight-corridor from Calabar seaport to Kano inland container depot in North-West region has NPV value of -₦28460256. Since NPV < 0, ie, -₦28460256 <0, the route cannot earn any profit for the investor within 2 years period. It requires a payback period higher than 2 years for the operator to commence earning profits from investment in making the route operable.

## 5. CONCLUSION

It is evident from the result of the study that investment in making most the rail-freight-corridors operable is economically justified. Given the import and export capacity of the ICD regions evidenced in their individual cargo generating potentials, making most of the routes operational will yield revenue earnings to the operator capable of paying back the initial cost of investment (cost of making the routes operational) and earn huge profits just within less than two years of the investment. Rail-freight-corridors such as Lagos seaport to Aba (south-east), Oyo (South-west), Katsina (North-west), Plateau (North-central) inland container depots will yield huge profits within less than one year of service delivery. Similarly, rail-freight-corridors from Warri seaport to Kano ICD, from Port-Harcourt seaport to Aba ICD will yield huge revenue profits in less than one year of service delivery via each route.

However, the rail-freight-corridors from Lagos seaport to Gombe and Bauchi inland container depots have NPVs less than zero, also and BCRs less than one. They need higher period (above two years) of service delivery in order to begin to yield profits to the operators and/or investors. Similarly, rail-freight-corridors from Calabar to Kano inland container depot and from Warri to South-East (Aba) inland container cannot yield profits to the investors within two years of the investment and as such require higher payback period and longer years (above 2 years) service delivery in order to yields economic benefits to the operators.

## 6. RECOMMENDATION

It is recommended that public and/or private investors make priority investment to develop, revitalize and make operable, the six rail-freight-corridors which have NPV values greater than zero, and equally have BCR values greater than one (1) as identified in the results and findings above. In considering the scarce nature of economic resources in the face of competing needs, investment in the four rail-freight-corridors ( Lagos to Gombe ICD,

Lagos to Bauchi ICD, Warri to Aba ICD, and Calabar to Kano ICD) with less profitability and benefit potentials to the operators, and requiring higher payback period as identified in the results and discussions may be made later.

## 7. ACKNOWLEDGEMENT

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