

GRIDLOCK TO GREENWAYS: NAVIGATING NIGERIA'S ENVIRONMENTAL FUTURE WITH LESSONS FROM BELGIUM'S WATERWAY TRANSPORTATION

Motese Macarthy* and **Ikpenmosa Uhumuavbi****

Abstract

The advent of the motorized age has brought about competition between road, rail, and air transportation, which developing countries like Nigeria seem to have fully embraced, neglecting the vast potentials which lie in the improvement of water transportation. The maritime sector is critical to the social, environmental, and economic development of Nigeria. About 90% of the world's trade still moves through water and that proportion is higher in developing countries. Approximately 92% of Nigeria's imports and exports pass through Nigerian Ports. The Country boasts of over 853km of Atlantic Ocean Coastline and a vast network of navigable inland waterways from the North down to the South. Despite these advantages, the maritime sector faces numerous challenges, stemming from ineffective management, regulatory deficiencies, and outdated infrastructure. This article argues that revitalising Nigeria's transportation sector hinges on harnessing the latent potential of its waterways. Drawing insights from the successes in Belgium's waterway transportation system, we propose a multidimensional research approach to analyse the institutional framework governing waterways transportation in Nigeria. By examining Belgium's transition from gridlocks to greenways, we aim to glean valuable lessons applicable to Nigeria's context. Through systematic analysis and comparison with Belgium's experiences, we seek to identify actionable strategies for enhancing

* PhD Researcher, School of Law, Greater Manchester Business School, University of Bolton.

** Senior Lecturer, Post Graduate Research/Knowledge Exchange Coordinator and Programme Leader, School of Law, University of Bolton.

regulatory efficiency, promoting sustainable infrastructure development, and unlocking the full potential of Nigeria's water transportation sector. This paper serves as a call to action for policymakers, stakeholders, and researchers to prioritize the revitalisation of water transportation in Nigeria for sustainable development and transitioning from gridlocks to greenways.

Keywords: Waterways transportation, Law, Governance, Intermodal Units, Environment, Greenways, Sustainable development and Navigable waters.

Introduction

Water transportation is historically an important means of transportation in Nigeria. The country is crisscrossed by many rivers, and the lakes around the Niger are natural terminal stations for the otherwise isolated regions. The network of navigable waterways is over 8000km long, and there are in addition several ports spread across the nation. However, the potential of water transportation in the country has been underutilized since independence. Factors contributing to its decline include the concentration on-road transportation by policymakers, the neglect and closure of canals during the oil boom era of the 1970s, and the lack of modern infrastructure and needed investment in the sector. The result has been increasing isolation of riverine communities, a hijack of the waterways by sea pirates and other criminal elements and the worsening of the economic prospects in Nigeria.

The specific objective of this paper is to determine whether the Belgian model for water transportation can be leveraged in revitalizing Nigeria's struggling maritime transportation sector. Nigeria and Belgium have a lot in common in terms of history and governance which make this comparison interesting. Both countries were former colonies, and now members of the Commonwealth. Nigeria and Belgium are also federal states. The basis for this comparison is to provide a background of water transportation in Belgium and Nigeria and suggest how the present Belgian system may be used to develop a long-term plan for rehabilitation of the Nigerian inland waterway transportation.

There is a growing realisation that the current state of Nigerian transportation infrastructure is unsustainable and far below optimum, especially with the menace of fuel tanker explosion accidents¹ and numerous incidents of boat mishaps² claiming thousands of lives yearly.

Current modes of transportation are largely unsustainable, overstretched and environmentally hazardous. Research has shown that road transportation in Nigeria though heavily subsidised, is becoming increasingly expensive and difficult to maintain. The result is that the quality and quantity of road infrastructure in Nigeria is insufficient to meet demand. In 2023 alone, the Federal Road Safety Commission recorded a total of 10, 617 road crashes, resulting in 31,874 injuries and 5,081 deaths.³

The potential inherent in the movement of goods and persons through motorized water transportation in Nigeria cannot be overstated. The alternative of increased air transportation is also economically and socially unviable.⁴ Despite the current state of water transportation in Nigeria, a renaissance of water transport usage as road congestion and maintenance costs increase is inevitable.⁵ The current legal and institutional framework for waterways transportation has however been characterized by uncertainties due to duplication of laws and functions. These uncertainties have contributed to the current situation in this critical sector.

We employ a systematic multidimensional and doctrinal approach in analysing the legal and institutional framework for marine transportation in Nigeria. This will include a brief review of the literature, an overview of the extant legal framework for marine transportation, examining case studies, comparative analysis, and policy recommendations to provide a comprehensive understanding of the legal and institutional framework for

¹ List of tank truck explosions, Wikipedia, https://en.wikipedia.org/wiki/List_of_tank_truck_explosions. Accessed 12-04-2024.

² In Nigeria, Boat Capsize on River Niger Leaves 100 People Dead, Al Jazeera <https://www.aljazeera.com/news/2023/6/13/in-nigeria-boat-capsize-on-river-niger-leaves-100-people-dead>. Accessed 12-04-2024.

³ Gift Habib, Nigeria Recorded Over 5000 Road Crash Death in 2023, (The Punch Newspaper 22/1/2024).

⁴ Dioha, Michael O., and Atul Kumar. "Sustainable energy pathways for land transport in Nigeria." (2020) *Utilities Policy* 64.

⁵ Nwaedozi, Uche, et al. "Danfo in Lagos, Nigeria: unregulated, unsafe, and unreliable, yet meeting the growing transport needs." *Nigeria: Unregulated, Unsafe, and Unreliable, Yet Meeting the Growing Transport Needs (Feb 16, 2023)*. 2023.

marine transportation in Nigeria. By this methodology, this article aims to contribute to the scholarly discourse and dialogue on the practical interventions aimed at enhancing the governance and regulation of marine transportation in Nigeria.

Significance of Lessons from Belgium

Although Belgium is geographically a smaller nation compared to Nigeria, it is renowned for its advanced waterway infrastructure and serves as an exemplary case study for Nigeria. By a thorough examination of Belgium's successes in waterway transportation, including its innovative infrastructure, government policies, and industry best practices, we hope to unearth invaluable lessons that can be effectively implemented in Nigeria's marine transportation. On a broader scope, this paper sheds light on the challenges encountered by developing nations in planning a transition to greenway transportation systems and proffer solutions to overcome them, within an international context. While the international transfer of knowledge is of vital importance to many nations, this paper uses Belgium as a case study to emphasize the usefulness of such espoused knowledge to semi-peripheral nations and hence its importance today to the development of extra-urban sustainability in a globalising world.

Specifically, this study demonstrates the benefits that can be gleaned from the transfer of knowledge between countries on infrastructural development and how this knowledge can be effectively applied in a given context.⁶ Nigeria does have a unique advantage over several Western nations in terms of vast relatively untouched resources and ecosystems and a chance for pre-emptive planning to avoid the myriads of mistakes made elsewhere in urbanization and greenway development. This, combined with the fact that numerous nations are also now reaching a crucial point in urbanization and development makes it paramount that any information on effective waterway development is obtained and disseminated. Failure to do so will only see a replication of the same errors made in past infrastructural developments and an ignorantly modernist approach to development that will incur severe ecological and environmental costs that

⁶ Gryskiewicz, Anthony J. "*Outside of Your Normal*": *Models, Helps, and Hindrances of Multicultural Youth Ministry in Europe*. Diss. Biola University, 2022.

cannot be undone.⁷

Overview of Transportation in Nigeria

The Nigerian transportation sector is marked by a burgeoning urbanization, rapid population growth, and increased industrialization. While a lot of work has been done on transportation in Nigeria, there seems to be a paucity of literature on the legal framework for inland waterways transportation. Some of the works on transportation in Nigeria, include Ladan's⁸ analysis of the challenges of operational efficiency and safety in air transportation, Igwe's⁹ work examining the market impediments limiting entrepreneurial success. These factors come with significant challenges, particularly evident in increased road accidents, traffic congestion and environmental degradation. Nigeria's over-reliance on road transportation, coupled with inadequate infrastructure and inefficient traffic management has led to severe incidents of gridlocks, accidents, economic loss, and health hazards.¹⁰

In response to these challenges, there is a growing recognition of the need for a sustainable transportation solution that prioritizes environmental and economic needs.¹¹ This recognition is underscored by Nigeria's commitment to several international agreements and the enactment of a plethora of local laws that seek to address this malaise.

Within the context of Nigeria's legal framework, while several laws have been enacted and agencies created, the results have been marginal as there is an apparent misalignment between the legal framework and the

⁷ Foell, Andrew, and Kirk A. Foster. "We Roll our Sleeves up and get to Work!": Portraits of Collective Action and Neighbourhood Change in Atlanta's West End." (2022) 58(6) *Urban Affairs Review* 1652-1688. <https://doi.org/10.1177/10780874211027848>.

⁸ Ladan, Suleiman Iguda. "An analysis of air transportation in Nigeria." (2012) 10 *Journal of Research in National Development* 2.

⁹ Igwe, Chris Nwoha, et al. "A review: Nigeria's transportation system and the place of entrepreneurs." (2013) 3.2. *Journal of Sustainable Development Studies*.

¹⁰ Ogwude, Innocent C. "Managing transportation infrastructure in Nigerian cities." *Nigerian Institute of Town Planner (NITP) and Town Planner Registration Council of Nigeria (TOPREC) Mandatory Continuing Professional Development Programme (MCPDP)* (2011).

¹¹ Nze, Ibeawuchi C., et al. "Modelling the relationship between demand for river port services and vessel supply costs: Empirical evidence from Nigeria." (2016) 2(3) *Global Journal of Social Sciences Studies* 144-149.

implementation and enforcement. Drawing inspiration from successful models such as Belgium, Nigeria can glean important lessons in infrastructural development, regulatory framework, and environmentally sustainable approaches. These lessons can inform policy direction and strategic initiatives aimed at transitioning towards greener transportation and mitigating the environmental impacts of urbanization and industrialization.

This article accordingly examines the legal framework for inland waterways transportation with particular emphasis on its potential for sustainable development and environmental protection by exploring lessons from Belgium's waterways, to chart a path 'from Gridlocks to Greenways' for Nigeria's environmental future.

Environmental Impact of Road Transportation

Road transportation in Nigeria is dependent on petrol and diesel, with concerns about its impacts on regional and global environments.¹² Road transportation is one of the major contributors to air pollution, especially in Nigeria.¹³ Diesel exhaust is a known human carcinogen and contains over 40 other cancer-causing substances. Studies have linked diesel exhaust to incidents of cancer, childhood asthma, heart and lung disease, and other respiratory conditions.¹⁴

Nitrogen oxides and particulate matter (PM) are responsible for several health problems. The pollution from these substances is linked to various adverse effects on the respiratory and immune system and also causes of lung cancer.¹⁵ These pollutants are mostly transparent, colourless and easily inhaled and lodged in the lungs; the finer the particles, the more

¹² Sicard, Pierre, et al. "Urban population exposure to air pollution in Europe over the last decades." (2021) 33 *Environmental Sciences Europe* 1-12.

¹³ Breuer, Janos Lucian, et al. "The impact of diesel vehicles on NOx and PM10 emissions from road transport in urban morphological zones: A case study in North Rhine-Westphalia, Germany." (2020), *Science of the total environment* 727.

¹⁴ Ding, Siwen, et al. "Association between exposure to air pollutants and the risk of inflammatory bowel diseases visits." *Environmental Science and Pollution Research* (2022) 1-10.

¹⁵ Raj, M. Gokul, and S. Karthikeyan. "Effect of modes of transportation on commuters' exposure to fine particulate matter (PM 2.5) and nitrogen dioxide (NO 2) in Chennai, India." (2020) 25 (6) *Environmental Engineering Research*, 898-907.

harmful they are.¹⁶

There is also the problem of global warming which is caused by the release of carbon dioxide from burning fuel.¹⁷ This contributes to climate change and has its own set of environmental impacts. The time is ripe for preventive action aimed at curbing the adverse effects of global warming by reducing emissions of greenhouse gases, many of which are by-products of fuel combustion in motor vehicles.¹⁸

The exponential increase in the number of aged and rickety vehicles on Nigeria roads no doubt impacts the air quality in Nigeria. There is a large fleet of heavy-duty vehicles, such as trucks, buses, tricycles, and motorcycles which are old, poorly maintained, and consume fuel that contributes to higher levels of air pollution. In urban areas, motor vehicle emissions are the dominant source of air pollution.

Just recently between 2016-2019, Port-Harcourt Nigeria witnessed alarming levels of soot pollution. 'Soot' refers to fine black carbon particles that are emitted during incomplete combustion of organic matter such as from vehicles, burning of tyres, and industrial activities among others.¹⁹ The various impacts associated with road transportation include traffic congestion, higher fuel consumption, air pollution and environmental degradation. Road transportation reduces air quality which results in a plethora of respiratory diseases and difficulty in breathing.²⁰ An example of a city with high levels of air pollution in Nigeria is Lagos and Port

¹⁶ Breuer, Janos Lucian, et al. "How To Reduce the Greenhouse Gas Emissions and Air Pollution Caused by Light and Heavy Duty Vehicles with Battery-Electric, Fuel Cell-Electric and Catenary Trucks." (2021)152 *Environment International* 106474.

¹⁷ Shah, Surabhi, et al. "Can individual protective measures safeguard cardiopulmonary health from air pollution? A systematic review and meta-analysis." (2023) *Environmental Research* 115708.

¹⁸ Sun, Biao, et al. "The relationship between urbanization and air pollution affected by intercity factor mobility: A case of the Yangtze River Delta region." (2023) 100 *Environmental Impact Assessment Review* 107092.

¹⁹ Welu, Vincent Ezikornwor, Jimmy Adegoke, and Basse Justine Eyo. "The Incidence of Soot and Surface Boundary Layer Meteorology in Port-Harcourt Metropolis, Nigeria." (2018) 6(2) *Journal of Climatology and Weather Forecasting*.

²⁰ Anwar, Muhammad Naveed, et al. "Emerging challenges of air pollution and particulate matter in China, India, and Pakistan and mitigating solutions." (2021) 416 *Journal of Hazardous Materials* 125851.

Harcourt in the South.²¹ The failure of the government to manage the high rate of urban-urban migration in Nigeria has turned major cities into congested and unhealthy cities to live in.

Understanding Waterway Infrastructure and Framework in Belgium

Belgium is unique as a modern industrialized economy in possessing an extensive system of navigable inland waterways, which has played a crucial role in the country's economic development.²² The country's 2072km of waterways, of which 1627km is navigable by vessels of over 1000 tonnes, link ports in Antwerp, Gent, Brussels, Liege and several others with much of the surrounding hinterland, including parts of the Netherlands, France and Germany.²³

The waterways network in Belgium quite intricate, covering a total of about 2,043 miles, consisting of both public and privately held routes. It moves approximately 100 million tonnes of cargo per year, accounting for 13% of total goods transport in the country and consists of two main types of waterways.²⁴ The first are natural rivers and canals, most of which have been heavily engineered and canalized. The remainder are artificial waterways, several of which are open cut, but the majority of which are navigable channels alongside natural rivers, which connect the main waterways to inland industrial and commercial centres. The system as a whole is well connected to other modes of transport and 40% of goods loaded and unloaded at Belgian ports are transported by water, the remainder being transhipped with seaworthy vessels to or from other ports.²⁵

²¹ Yakubu, Okhumode H. "Particle (soot) pollution in Port Harcourt Rivers State, Nigeria—double air pollution burden? Understanding and tackling potential environmental public health impacts." (2017) 5 (1) *Environments* 2.

²² Meersman, H., Sys, C., Troch, F., Van de Voorde, E. & Vanelslander, T. "The indirect economic impact of rail freight transport: An input-output case study for Belgium", (2022) 10(2) *Case studies on transport policy* 1353-1365.

²³ Bu, F., & Nachtmann, H. Literature review and comparative analysis of inland waterways transport: "Container on barge".(2023) 25(1), *Maritime Economics & Logistics*140-173.

²⁴ Rubbrecht, Ilse. *Economic importance of the Belgian maritime and inland ports-Report 2020*. No. 407. NBB Working Paper, 2022.

²⁵ Troch, Frank, et al. "The added value of rail freight transport in Belgium." (2022) 44 *Research in Transportation Business & Management* 100625.

The public waterways owned, operated, and maintained by the regional government authorities amount to 784 miles, and the private waterways, which are for the most part industrial in nature and used for on-site transportation, cover 1,259 miles.²⁶ The public waterways can be further divided into two categories: the international waterways, which are under the jurisdiction of the federal government and form a link between Belgium and neighbouring countries, and the regional waterways linking the regions within Belgium.²⁷

Belgium possesses a sufficient internal system for transporting goods through waterways, though it is seen as secondary to the country's extensive railway network, with the exception of the Albert Canal.²⁸ This is unsurprising given that railway transport was at its peak during Belgium's industrialization in the early 19th century. Even in modern times, Belgium's railway system remains one of the most densely connected in the world.²⁹ Nonetheless, there is a steady shift in focus towards road transportation and recognition of the environmental benefits of water transportation.³⁰ As a result, the federal and regional governments synergize through the initiation of investment programs aimed at enhancing its waterway infrastructure.³¹

<https://doi.org/10.1016/j.rtbm.2021.100625>; Dávid, Andrej, et al. "Transshipment activities in the Rhine ports." (2021) 53 *Transportation Research Procedia* 188-195.

²⁶ Varone, Frédéric, and David Aubin. "The Evolution of The National Water Regime in Belgium." *Report, Université Catholique De Louvain* (2002): 9; Fouché-Grobla, Olivier, et al. "Watershed-scale mapping of on-site sanitation-related environmental issue zones—Case study of Lys River (France and Belgium)." (2023)2(3) *River* 263-282. <https://doi.org/10.1002/rvr.2.54>.

²⁷ Bernacki, D., & Lis, C. (2022). Investigating the future dynamics of multi-port systems: The case of Poland and the Rhine–Scheldt delta region. *Energies* (Basel), 15(18), 6614. <https://doi.org/10.3390/en15186614>.

²⁸ Troch, F., Meersman, H., Sys, C., Van De Voorde, E. & Vanelslander, T. 2022, "The added value of rail freight transport in Belgium", *Research in transportation business & management*, vol. 44, pp. 100625.

²⁹ Rodrigue, J., & Notteboom, T. The terminalization of supply chains: Reassessing the role of terminals in port/hinterland logistical relationships. (2009) 36(2), *Maritime Policy and Management*, 165-183. <https://doi.org/10.1080/03088830902861086>.

³⁰ Merchan, A.L., Sandra, B. and Léonard Angélique,. *Life Cycle Assessment of Rail Freight Transport In Belgium*. (2020) 22(5), *Clean Technologies and Environmental Policy*, 1109-1131.

³¹ Meersman, H., Sys, C., Troch, F., Van de Voorde, E. & Vanelslander, T. "The indirect economic impact of rail freight transport: An input-output case study for Belgium", (2022) 10(2) *Case studies on transport policy*, 1353-1365.

Successes and Challenges in Belgium's Framework

A significant advantage of the Belgian experience over Nigeria is Belgium's regulatory framework. Though Nigeria and Belgium are federally structured, the control of resources and power distribution in Belgium is decentralized. This has a tremendous impact on development as various regions are allowed to develop at their pace compete among themselves within a national regulatory framework.

Also worthy of note is that waterways transportation is under the authority of the regional governments while the federal government makes the rules and regulations inland navigation. The implication is that regions must implement and apply the rules and regulations relevant to inland navigation. This is a positive step in developing inland water transportation.

Contrastingly, power and control of resources is highly centralized in Nigeria with the Federal Government controlling all waterways in the country. This was the decision of the Supreme Court of Nigeria in *National Inland Waterways Authority & 3 Ors v. Lagos State Waterways Authority & 5 Ors*.³² The Supreme Court of Nigeria held that the inland waterways whether in Lagos or any part of Nigeria is an item covered under the exclusive legislative list to which only the federal government can exercise authority. It further held that by the provisions of the NIWA Act, only NIWA can issue licences, collect taxes, and regulate dredging activities on inland waters. The Apex Court, relying on both the Constitution and the NIWA Act, declared all waterways in Lagos state, navigable waterways for which only NIWA (a federal government agency) can regulate.

While the Supreme Court of Nigeria was right in the regulation of waterways, the extension of the powers of the federal government to control and manage all inland waterways is with deference, draconian, against the tenets of federalism and will continue to pose a challenge to the development in waterway transportation.

Before the Supreme Court decision in *National Inland Waterways Authority & 3 Ors v. Lagos State Waterways Authority & 5 Ors*,³³ different states in Nigeria especially in the South, had their inland waterways

³² Delivered on Friday 5th January 2024.

³³ SC.17/2018.

authority that controlled and managed inland waterway transportation within the states. The legal uncertainties that greeted the regulatory framework was also a major deterrent factor and hindrance to investment in the waterway sector. It is now clear that the authority vested in the federal government by the Constitution on admiralty issues is exclusive and only within the legislative competence of the National Assembly and that includes all admiralty matters.³⁴

Belgium has also enjoyed a successful integration of more modern methods of transportation and uses its waterways network to aid them.³⁵ As Haezendonck³⁶ suggested, that investments in waterways transportation can be a rather efficient use for public funds in the short term. This is evidenced by the increasing trend of inland waterway transportation in Belgium; the average annual increase of goods transported on its waterways was 6.4% compared to a 3.7% increase in its volume.³⁷

There is also the establishment of an efficient single-window system termed (SWINWAT).³⁸ This idea originated from a consensus to move administrative functions away from the waterfront, following floods which affected the buildings to the southwest of Antwerp or Zuid in 1993. This began a movement to relocate old buildings for a better future development of waterways transportation. The single window concept was a simplification of administrative procedures in the form of a single desk where all necessary formalities could be fulfilled for inland navigation. The system was recognized across Europe and the world, thus receiving regional development grants and foreign contracts to study the

³⁴ Aidonojie, Paul Atagamen, et al. "Environmental Law in Nigeria: A Review on its Antecedence, Application, Judicial Unfairness and Prospects." (2020) 1 (2) *Archive of Science & Technology* 212- 221.

³⁵ Rubbrecht, Ilse. *Economic Importance of The Belgian Maritime and Inland Ports-Report 2020*. NBB Working Paper, (2022) 407.

³⁶ Haezendonck, Elvira, et al. "The Competitive Advantage of Seaports." (2000) 2 *International Journal of Maritime Economics* 69-82.

³⁷ Lagneaux, Frédéric, Economic Importance of Belgian Transport Logistics (January 9, 2008). National Bank of Belgium Working Paper No. 125, Available at SSRN: <http://dx.doi.org/10.2139/ssrn.1685846>

³⁸ Li, Jinyu, and Theo Notteboom. "The Development of The Inland Waterway Transport System in Flanders (Belgium): An Institutional Analysis." *Asian Logistics Round Table 2012 Conference (ALRT 2012)*, University of British Columbia (UBC), Vancouver, 14-15 June 2012.

offered solutions to other countries.³⁹

Examining the Regulatory and Legal Framework for Waterways Transportation

The Constitution of the Federal Republic of Nigeria makes all admiralty matters exclusive to the Federal Government. Part 1 of the Second Schedule to the Constitution, provides that the federal government has powers over maritime shipping and navigation. This has been given judicial construction in *National Inland Waterways Authority & 3 Ors v. Lagos State Waterways Authority & 5 Ors*.⁴⁰ where it was held that by the combined provisions of the Constitution and Section 10 of the National Inland Waterways Act, the Federal Government has exclusive authority over all navigable waters within Nigeria. This is despite the fact that Nigeria is a federal state, and the central government lacks the capacity to manage and control except for regulation, all maritime and admiralty matters. This constitutional provision and the interpretation given to it by the apex court has further decapitated the efforts of state governments within the coastal regions to develop in invest in waterways transportation in Nigeria.

There are other subsidiary legislations from the central government which include: The National Inland Waterways Act Cap N14 LFN 2004. Section 10 of the Act provides that the rivers and their tributaries, distributaries, creeks, lakes, lagoons, and intra-coastal waterways specified in the Second Schedule to this Act are Federal navigable waterways. The Act also establishes an authority to control and manage all navigable waterways in Nigeria.

There is also the Nigerian Maritime Administration and Safety Agency, (NIMASA Act) of 2007, which also establishes an agency with the responsibility of regulating the entire maritime industry with a mandate extending into many areas such as shipping and navigation, prevention of marine pollution, promoting maritime safety and security, training and certification of seafarers, maritime labour, and cabotage. Further, there is

³⁹ Mihic, Svetlana, Mirjana Golusin, and Milan Mihajlovic. "Policy and promotion of sustainable inland waterway transport in Europe–Danube River." (2011) 15(4) *Renewable and sustainable energy reviews* 1801-1809.

⁴⁰ *National Inland Waterways Authority & 3 Ors v. Lagos State Waterways Authority & 5 Ors* SC.17/2018.

also the Nigerian Ports Authority established under the Nigerian Ports Authority Act Cap N126 LFN 2004 which was established in response to inefficiencies at the Nigerian ports and concerns about the pace of port development. The Authority was created to improve sector efficiency by modernizing ports that had deteriorated throughout colonial rule.⁴¹

Other legislations include the Merchant Shipping Act of 2007, Coastal and Inland Shipping (Cabotage) Act, of 2003, International Conventions and Treaties, Environmental Impact Assessment Act CAP E12 LFN 2004 etc.

These legislations and agencies, together with case laws establish the framework for the regulation, control and management of waterways transportation in Nigeria. A critical examination of the above agencies reveals the obvious that most of these are merely revenue- generating agencies for the federal government with little or no impact on infrastructural development and planning.

Olisa et al identify poor interagency coordination and cooperation as a major problem in sector regulation.⁴² This is evident, for example, between the National Inland Waterways Agency (NIWA), the River Basin Development Authorities and NIMASA. Those and all organizations involved with water transportation do not have a single unified body to coordinate and harmonize their activities.

Duplication and overlap in administrative and regulatory functions are also commonplace with each organization believing its role to be more important than the other. This creates inconsistent standards for service providers and a further lack of clear direction or understanding of proposed regulation. All this serves to seriously undermine the regulation itself and the quality of service it should offer.⁴³ These agencies which are often

⁴¹ Okeleke, Uka J., and Moses O. Aponjolosun. "A study on the effects of COVID-19 pandemic on Nigerian seafarers." (2020) 5 (2) *Journal of Sustainable Development of Transport and Logistics* 135-142.

⁴² Olisa, Awogu Charles, Diyoke Michael Chika, And Obilor Ngozi Mary. "Inter-Agency Rivalry and Border Security Management in Nigeria." (2022) 3(1) *Gusau Journal of Sociology* 10.

⁴³ Asiegbu, Martin F., et al. "Natural resource fund governance and the institutionalization of rent-seeking in Nigeria's oil sector." *Politics & Policy* (2024) 52(1) 169-195.

associated with inexplicable cost, have been identified by Asigbu⁴⁴ as agencies whose operations are mostly bordered on rent seeking and revenue generation, which is not in the best interest of the maritime sector. The perception of corruption also undermines the long-term objectives of the sector and creates further inefficiency.⁴⁵ A one stop fulfilment centre where all water and admiralty matters can be transparently processed is therefore key to reviving the sector. We have already discussed the SWINWAT approach in Belgium which has gotten the support of other European countries.

However, a direct copy of the Belgian system of navigation would not be effective and may result in rigidity and resistance against change. Therefore, a clear understanding is needed of what features of the Nigerian regulatory and legal framework are beneficial and should be maintained, what aspects need changing and how this can be best achieved. This assessment provides an overview of key similarities and differences between the two systems and considers the translation of successful Belgian policies into effective Nigerian reforms.

Leveraging insights to Nigeria's Inland Waterway Transportation System

Leveraging insights garnered from Belgium's water transport system and applying them to Nigeria, requires an assessment of the efficiency or otherwise of the Nigerian legal and institutional framework for water transportation. The goal is to simplify private and public investment into transportation and improve its cost-effectiveness by identifying the need for procedural changes.⁴⁶ For Nigeria, the expectation is that regulatory change should reduce governmental investment and control of waterways transportation and facilitate the transition towards a privatized transport industry.

⁴⁴ Asiegbu, Martin F., et al. *supra*.

⁴⁵ Bhatnagar, Mukul, Sanjay Taneja, and Ercan Özen. "A wave of green start-ups in India — The study of green finance as a support system for sustainable entrepreneurship." (2022) 4(2) *Green Finance* 253-273.

⁴⁶ Onokala, Patience Chinyelu, and Chidinma Joy Olajide. "Problems and challenges facing the Nigerian transportation system which affect their contribution to the economic development of the country in the 21st century." (2020) 48 *Transportation Research Procedia* 2945-2962.

This is largely due to the consistent failure of publicly controlled transport provision to deliver effective services and evidence that private provision is often more efficient. This transition in transport control and provision requires a stable environment with legal certainty and expectations.⁴⁷ Inspired by Belgium, it is suggested that Nigeria develop a national transport policy with detailed plans for all potential infrastructure development. This will require the creation of a hierarchical mapping system for Nigerian waterways like the Rijkswaterstaat for Belgium.⁴⁸ With deference to the Nigerian Supreme Court's decision in *National Inland Waterways Authority & 3 Ors v. Lagos State Waterways Authority & 5 Ors* The Federal government cannot alone control and manage the waterway sector whether for freight services or human transportation. The federal government should rather stick to developing regulatory designs and supervise the implementation of those designs. A clear definition of boundaries and robust partnerships with the states and private investors is crucial if the sector is to be revitalized.

There should be a total deregulation or concession of the sector to enable states and private investors to control and manage some of the waterways under a uniform legal framework. This transition towards increased investment in a cost-effective manner will be similar to Belgian practice, making it favourable. The current Nigerian transport architecture is poor, and without the needed change, further investment in a similar system will only replicate the inefficiency of the past. Nigeria will need to make an initial investment in new infrastructure. However, it is important to avoid overinvestment in infrastructure, which has been a common issue in the past. To prevent this, Nigeria's new policy will use an adapted form of future discounting.⁴⁹ This approach will compare the costs of repairing currently degraded facilities versus investing in new facilities.^{50,51}

⁴⁷ Otuoze, S. H., Dexter V. L. Hunt, & Jefferson, I. Neural Network Approach to Modelling Transport System Resilience for Major Cities: Case Studies of Lagos and Kano (Nigeria). (2021) 13(3) Sustainability (Basel, Switzerland) 1371. <https://doi.org/10.3390/su13031371>.

⁴⁸ Moor, Martina De, and Torsten Wiedemann. "Reconstructing territorial units and hierarchies: A Belgian example." (2001) 13(1) *History and Computing* 71-97.

⁴⁹ Gollier, Christian. *Pricing the planet's future: the economics of discounting in an uncertain world*. Princeton University Press, 2013.

⁵⁰ Broome, John. "Discounting the future." (1994) 23(2) *Philosophy & Public Affairs* 128-156.

Drawing on past and projected Nigeria transport investment and considering Belgium's past mistakes with overinvestment in low-value projects, it is possible to simulate a situation in which the investment of the next 20 years is used to phase out the traditional system of transport with its low-technology manual methods and internal combustion engines, for a modern system based on clean and renewable electric-powered vehicles.

In changing Nigeria's transport sector, particularly with regard to infrastructure implementation and changing modes, it is essential to have a stable and regulated environment. The development of a national policy and careful allocation of investment has already been addressed. Step-specific funding has been identified as the most effective means of ensuring new infrastructure implementation.⁵² This will mean taking loans to fund specific projects and only allowing investments from revenue to maintain targeted capital/output ratios.⁵³ This is expected to be succeeded by concerted integration of project migration with funds from outgoing projects to prevent a sudden halt in the middle of projects due to lack of funding. These are clear improvements from Belgium's experience of overinvestment.⁵⁴

Addressing Challenges and Implementing Reforms

Improving Nigeria's waterway transportation requires addressing infrastructural deficits, regulatory gaps and operational inefficiencies drawing from Belgium's experiences. These require sincerity, commitment, and the political will of policymakers and stakeholders.⁵⁵ This paper advocates the following proposals towards revitalising the Nigerian creaking transportation sector.

⁵¹ Ibid.

⁵² Bayer, W. H. "Dredging of Navigational Channels." (2015) *International Compendium of Coastal Engineering* 339.

⁵³ Zammit, Dino, et al. "Step-specific simulation: the utility of 3D printing for the fabrication of a low-cost, learning needs-based rhinoplasty simulator." (2020) 40(6) *Aesthetic Surgery Journal* NP340-NP345.

⁵⁴ Faiyetole, Ayodele Adekunle, and Emmanuel Oluwaseun Fulani. "Consideration of users' needs in regard to planning of intelligent transport solutions in an African Metropolis." (2020) 16(1) *Transportation in Developing Economies* 7.

⁵⁵ Adeyemo, Abiola A., and Benedict Amade. "Corruption and construction projects in Nigeria: manifestations and solutions." (2016) 5(10) *PM World Journal* 1-14.

Revisiting the Legal Framework

Powers should be devolved to states and private investors in matters related to the control and management of navigable waterways. This would mean specifying a range of nautical miles within which states and private investors can exercise jurisdiction while the federal government maintains oversight functions and control beyond that specified range.

This would of necessity, involve the revisiting of the legal framework for water transportation by moving marine transportation and navigation from the exclusive legislative list to the concurrent list by amending the Constitution and other federal enactment.

Successful elements of reform in other nations often involve the simplification of bureaucratic processes through deregulation and decentralization of governmental oversight.⁵⁶ Although this is a delicate balancing act, it must also prevent the amplification of a fragmented state of water transportation in Nigeria. Building safety regulations to enforce industry compliance and resource pool development are other policy areas that will necessitate careful consideration to execute effectively.

This will also involve the harmonization of operational standards and regulations across states and partners to ensure consistency and coherence in maritime governance through licencing, specialized training and certification and personnel, upholding safety standards and environmental protection.

This reform will strengthen the regulatory framework as federal agencies will be more focused on regulation rather than revenue generation. It will promote localized decision-making, foster accountability, and facilitate investments and sustainable development.

Promoting Public-Private Partnerships

Initiatives to promote public-private partnerships (PPP) to improve waterway transport are essential in the Nigerian context. Despite several unsuccessful attempts in the past, the potential benefits to be gained from well-structured partnerships are such that the idea deserves revisiting. Partnerships must be sincere, transparent, and devoid of

⁵⁶ Oszlak, Oscar. "Trends of Public Management Reform in Latin America." (2022) 45 (4) *International Journal of Public Administration* 308-318.

politics.⁵⁷ The economic and fiscal constraints on the Nigerian Government mean that it is unlikely to be able to commit the funds necessary to rehabilitate and expand the waterway network. As such, the government will be looking to cost-effective initiatives to improve transport infrastructure.⁵⁸

Public-private partnerships are an internationally recognized model of financing long-term contracts between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance.⁵⁹ PPPs are not for any particular type of project or a specific form of contract, they are a high-level, principle-based approach to government procurement.⁶⁰

Developing an Intermodal Transport System

Integrating the various modes of transportation will be a game-changer in the revitalization of Nigeria's waterways transport system. According to Arnold, this is the design where the carriage of goods and persons by at least two different modes of transport in the same loading unit- the intermodal transport unit, without stuffing or stripping operations when changing modes. A major part of the journey is done by rail, inland waterway or sea, and any initial and/or final legs carried out by road are as short as possible.⁶¹ This will enable cargo and passengers to seamlessly transfer between the different modes with rail lines terminating at the waterfronts and airports while also linking bus terminals at the

⁵⁷ Amade, Benedict. "An Evaluation of Factors Constraining the Implementation of Public Private Partnerships (PPPs) in Construction Infrastructure Projects in Nigeria." *International Journal of Science and Engineering Investigations* 1.9 (2012): 106-117.

⁵⁸ B.O Olojede, "Public-Private Partnership Procurement Transport Infrastructure Delivery: Assessing the Managerial Capabilities of Public-Sector Organizations in Africa." *Journal of Silesian University of Technology. Series Transport* (2024) 122, 253-280.

⁵⁹ Martin, Lawrence, et al. "Internationally Recommended Best Practices in Transportation Financing Public-Private Partnerships (P3s)." (2013) 2(2) *Public Administration Research* 15-25.

⁶⁰ Itu, Madu, and W. Emmanuel Kenigua. "The Role of Public-Private Partnership (PPP) on Infrastructural Development in Nigeria." (2021) 2(5) *Journal of Global Social Sciences* 23-43.

⁶¹ Arnold, Pierre, Dominique Peeters, and Isabelle Thomas. "Modelling a rail/road intermodal transportation system." *Transportation Research Part E: (2004) 40 (3) Logistics and Transportation Review* 255-270.

waterfronts. This will maximise efficiency, connectivity and reduce waste. Discouraging road haulage through higher taxes and redirecting traffic to the waterways transport markets is also a practical way of decongesting highways and maintaining the roads.

Conclusion

The transitioning from gridlocks to greenways in Nigeria's transportation sector requires embracing sustainable practices by investing in infrastructure, reviewing current legal and regulatory frameworks, and promoting public-private partnerships. This requires sincerity and the political will of policymakers in the oil-rich country. The global demand for efficient transportation is on the rise for a lot of reasons including globalization, the exponential increase in international trade as well as the working of different stages of the production process across disparate geographic locations and the environmental impact of road transportation. The purpose of this article was to examine the potential lessons Nigeria could draw from Belgium in the development of a more efficient mode of freight transportation.

Belgium has established itself as having one of the World's most advanced transportation systems and accordingly has so much to offer Nigeria by way of insight. In examining Belgium, we have seen, in the context of transportation, a country rich in diversity and facing similar political challenges to Nigeria. Although the dynamics of both countries are very different, Belgium's expertise in managing these influential factors to their advantage provides valuable insight to Nigeria as the most populous nation in Africa and the biggest economy on the continent.⁶²

The limitation of comparing two countries with vastly different economic and political power structures is that solutions that may be feasible in Belgium could be impracticable in Nigeria. However, Nigeria can adopt the general principles of Belgium's successes and implement tailor-made policies for its situation.

The development of Nigeria's transportation infrastructure would be a significant step towards enabling the country to compete more favourably

⁶² De Block, Greet. "The Material Politics of Infrastructure Networks Infrastructure Design and Territorial Transformation in Belgium, 1830–40s." (2021) 45(2) *Social Science History*, 341-362.

in the global market by tackling issues of infrastructure decline, ineffective management, and multiplicity of regulations. The case of Belgium and Nigeria can also provide a useful benchmark for other similar countries to gauge the benefits of implementing change in their transportation systems.

REFERENCES

Table of Cases

- A.G Rivers State v. A.G Akwa Ibom State (2011) LPELR 633(SC).
Barasimpiri v. Daewoo (Nig) Ltd (2018) LPELR-44844(CA)
- National Inland Waterways Authority & 3 Ors v. Lagos State Waterways Authority & 5 Ors C.17/2018.

Table of Statute

- Constitution of the Federal Republic of Nigeria (as amended) 1999 United Nations Convention on the Carriage of Goods by Sea 1978.
- Carriage of Goods by Sea Act 2004
- Coastal and Inland Shipping (Cabotage) Act, 2003
- Environmental Impact Assessment Act CAP E12 LFN 2004 Exclusive Economic Zone and Continental Shelf Act 2004.
- National Inland Waterways Authority the National Waterways Authority Act of 1996 now Cap. N4 LFN, 2004
- Nigerian Maritime Administration and Safety Act 2007 The Merchant Shipping Act of 2007
- The Nigerian Ports Authority Act Cap N126 LFN 2004

List of Secondary Sources

- Christian, G. *Pricing the planet's future: the economics of discounting in an uncertain world*. Princeton University Press, 2013.
- Abiola A.A, and Benedict, A. "Corruption and construction projects in Nigeria: manifestations and solutions." (2016) 5(10) *PM World Journal* 1-14.

- Adekunle, F.A and Fulani. E.O “Consideration of Users’ Needs in Regard to Planning Of Intelligent Transport Solutions in an African Metropolis.” (2020) 16(1) *Transportation in Developing Economies* 7.
- Andrej, D. et al. “Transshipment activities in the Rhine ports.” (2021) 53 *Transportation Research Procedia* 188-195.
- Andrew, F. and Foster, K.A. “We Roll our Sleeves up and get to Work!”: Portraits of Collective Action and Neighbourhood Change in Atlanta's West End.” (2022) 58(6) *Urban Affairs Review* 1652-1688. <https://doi.org/10.1177/10780874211027848>.
- Atagamen, P.A. et al. “Environmental Law in Nigeria: A Review on its Antecedence, Application, Judicial Unfairness and Prospects.” (2020) 1 (2) *Archive of Science & Technology* 212- 221.
- Baver, W. H. “Dredging of Navigational Channels.” (2015) *International Compendium of Coastal Engineering* 339.
- Benedict, A. “An Evaluation of Factors Constraining the Implementation of Public Private Partnerships (PPPs) in Construction Infrastructure Projects in Nigeria.” (2012)1(9) *International Journal of Science and Engineering Investigations* 106-117.
- Bernacki, D., and Lis, C. Investigating the future dynamics of multi-port systems: The case of Poland and the Rhine–Scheldt delta region. (2022) 15(18) *Energies (Basel)*, 6614. <https://doi.org/10.3390/en15186614>.
- Biao, S. et al. “The relationship between urbanization and air pollution affected by intercity factor mobility: A case of the Yangtze River Delta region.” (2023) 100 *Environmental Impact Assessment Review* 107092.
- Bu, F., & Nachtmann, H. Literature review and comparative analysis of inland waterways transport: “Container on barge”. (2023) 25(1), *Maritime Economics & Logistics*140-173.
- De Block, G. “The Material Politics of Infrastructure Networks Infrastructure Design and Territorial Transformation in Belgium, 1830–40s.” (2021) 45(2) *Social Science History*, 341-362.

- Elvira, H et al. "The Competitive Advantage of Seaports." (2000) 2 *International Journal of Maritime Economics* 69-82.
- Ezikornwor, W.V., Adegoke, J. and Eyo, B. J. "The Incidence of Soot and Surface Boundary Layer Meteorology in Port-Harcourt Metropolis, Nigeria." (2018) 6(2) *Journal of Climatology and Weather Forecasting*
- Frank, T. et al. "The added value of rail freight transport in Belgium." (2022) 44 *Research in Transportation Business & Management* 100625. <https://doi.org/10.1016/j.rtbm.2021.100625>;
- Frédéric, V. and Aubin, D. "The Evolution of The National Water Regime in Belgium." *Report, Université Catholique De Louvain* (2002): 9; Fouché-Grobla, Olivier, et al. "Watershed-scale mapping of on-site sanitation-related environmental issue zones—Case study of Lys River (France and Belgium)." (2023)2(3) *River* 263-282. <https://doi.org/10.1002/rvr.2.54>.
- Gokul, R.M. and S. Karthikeyan, S. "Effect of modes of transportation on commuters' exposure to fine particulate matter (PM 2.5) and nitrogen dioxide (NO 2) in Chennai, India." (2020) 25 (6) *Environmental Engineering Research*, 898-907.
- Ibeawuchi N. C., et al. "Modelling the relationship between demand for river port services and vessel supply costs: Empirical evidence from Nigeria." (2016) 2(3) *Global Journal of Social Sciences Studies* 144-149.
- Igwe, C.N, et al. "A review: Nigeria's transportation system and the place of entrepreneurs." (2013) 3.2. *Journal of Sustainable Development Studies*
- Itu, M., and W. Kenigua, W. E. "The Role of Public-Private Partnership (PPP) on Infrastructural Development in Nigeria." (2021) 2(5) *Journal of Global Social Sciences* 23-43.
- Jinyu, L. and Notteboom, T "The Development of The Inland Waterway Transport System in Flanders (Belgium): An Institutional Analysis." *Asian Logistics Round Table 2012 Conference (ALRT 2012), University of British Columbia (UBC), Vancouver, 14-15 June 2012.*
- John, B. "Discounting the future." (1994) 23(2) *Philosophy & Public Affairs* 128-156.

- Ladan, S.I. “An analysis of air transportation in Nigeria.” (2012) 10 *Journal of Research in National Development* 2
- Lagneaux, F. Economic Importance of Belgian Transport Logistics (January 9, 2008). National Bank of Belgium Working Paper No. 125, Available at SSRN: <http://dx.doi.org/10.2139/ssrn.1685846>
- Lawrence, M., et al. “Internationally Recommended Best Practices in Transportation Financing Public-Private Partnerships (P3s).” (2013) 2(2) *Public Administration Research* 15-25.
- Lucian, B.A. et al. “How To Reduce the Greenhouse Gas Emissions and Air Pollution Caused by Light and Heavy Duty Vehicles with Battery-Electric, Fuel Cell-Electric and Catenary Trucks.” (2021)152 *Environment International* 106474.
- Lucian, B.A. et al. “The impact of diesel vehicles on NOx and PM10 emissions from road transport in urban morphological zones: A case study in North Rhine-Westphalia, Germany.” (2020), *Science of the total environment* 727.
- Meersman, H., et al. “The indirect economic impact of rail freight transport: An input–output case study for Belgium”, (2022) 10(2) *Case studies on transport policy* 1353-1365.
- Merchan, A.L., Sandra, B. and Léonard A., Life Cycle Assessment of Rail Freight Transport in Belgium. (2020) 22(5), *Clean Technologies and Environmental Policy*, 1109-1131.
- Michael D. O., and Kumar, A. “Sustainable energy pathways for land transport in Nigeria.” (2020) *Utilities Policy* 64
- Moor, M. D., and Wiedemann, T. “Reconstructing territorial units and hierarchies: A Belgian example.” (2001) 13(1) *History and Computing* 71-97.
- Mukul, B., Taneja, S, and Özen, E. “A wave of green start-ups in India — The study of green finance as a support system for sustainable entrepreneurship.” (2022) 4(2) *Green Finance* 253-273.
- Naveed, A.M., et al. “Emerging challenges of air pollution and particulate matter in China, India, and Pakistan and mitigating solutions.” (2021) 416 *Journal of Hazardous Materials* 125851.

- Ogwude, I. C. "Managing transportation infrastructure in Nigerian cities." *Nigerian Institute of Town Planner (NITP) and Town Planner Registration Council of Nigeria (TOPREC) Mandatory Continuing Professional Development Programme (MCPDP)* (2011).
- Okhumode, H. Y. "Particle (soot) pollution in Port Harcourt Rivers State, Nigeria—double air pollution burden? Understanding and tackling potential environmental public health impacts." (2017) 5 (1) *Environments* 2.
- Olisa, A. C, Chika, D.M. and Obilor N. M. "Inter-Agency Rivalry and Border Security Management in Nigeria." (2022) 3(1) *Gusau Journal of Sociology* 10.
- Olojede, B.O "Public-Private Partnership Procurement Transport Infrastructure Delivery: Assessing the Managerial Capabilities of Public-Sector Organizations in Africa." *Journal of Silesian University of Technology. Series Transport* (2024) 122, 253-280.
- Onokala, P. C. and Olajide, C. J. "Problems and challenges facing the Nigerian transportation system which affect their contribution to the economic development of the country in the 21st century." (2020) 48 *Transportation Research Procedia* 2945-2962.
- Oscar, O. "Trends of Public Management Reform in Latin America." (2022) 45 (4) *International Journal of Public Administration* 308-318.
- Otuoze, S. H., Dexter V. L. Hunt, and Jefferson, I. Neural Network Approach to Modelling Transport System Resilience for Major Cities: Case Studies of Lagos and Kano (Nigeria). (2021) 13(3) *Sustainability* (Basel, Switzerland) 1371. <https://doi.org/10.3390/su13031371>.
- Pierre, A., Peeters, D. and Thomas, I. "Modelling a rail/road intermodal transportation system." *Transportation Research Part E: (2004) 40 (3) Logistics and Transportation Review* 255-270.
- Pierre, S. et al. "Urban population exposure to air pollution in Europe over the last decades." (2021) 33 *Environmental Sciences Europe* 1-12.
- Rodrigue, J., and Notteboom, T. The terminalization of supply chains: Reassessing the role of terminals in port/hinterland logistical relationships. (2009) 36(2), *Maritime Policy and Management*, 165-183. <https://doi.org/10.1080/03088830902861086>.

- Rubbrecht, I. *Economic importance of the Belgian maritime and inland ports-Report 2020*. No. 407. NBB Working Paper, 2022.
- Surabhi, S. et al. “Can individual protective measures safeguard cardiopulmonary health from air pollution? A systematic review and meta-analysis.” (2023) *Environmental Research* 115708.
- Svetlana, M. and Golusin, M., and Mihajlovic, M. “Policy and promotion of sustainable inland waterway transport in Europe–Danube River.” (2011) 15(4) *Renewable and sustainable energy reviews* 1801-1809.
- Uche, N. et al. “Danfo in Lagos, Nigeria: unregulated, unsafe, and unreliable, yet meeting the growing transport needs.” *Nigeria: Unregulated, Unsafe, and Unreliable, Yet Meeting the Growing Transport Needs (Feb 16, 2023)*. 2023.
- Uka O. J., and Moses O. Aponjolosun. “A study on the effects of COVID–19 pandemic on Nigerian seafarers.” (2020) 5 (2) *Journal of Sustainable Development of Transport and Logistics* 135-142.
- Williams-Elegbe, S. “Systemic Corruption and Public Procurement in Developing Countries: Are There Any Solutions?” (2018) 18(2) *Journal of Public Procurement* 131-147.
- Zammit, D. et al. “Step-specific simulation: the utility of 3D printing for the fabrication of a low- cost, learning needs-based rhinoplasty simulator.” (2020) 40(6) *Aesthetic Surgery Journal* NP340-NP345.