



UNIVERSITY OF LEEDS

This is a repository copy of *Multimodal freight transportation: sustainability challenges*.

White Rose Research Online URL for this paper:

<http://eprints.whiterose.ac.uk/149686/>

Version: Accepted Version

Proceedings Paper:

Udo, EI, Huaccho Huatuco, L and Ball, PD (2019) Multimodal freight transportation: sustainability challenges. In: Ball, PD, Huaccho Huatuco, L, Howlett, RJ and Setchi, R, (eds.) Sustainable Design and Manufacturing 2019 (SIST, volume 155). 6th International Conference on Sustainable Design and Manufacturing (KES-SDM 2019), 04-05 Jul 2019, Budapest, Hungary. Springer , pp. 121-130. ISBN 9789811392702

https://doi.org/10.1007/978-981-13-9271-9_12

(c) 2019, Springer Nature Singapore Pte Ltd. This is an author produced version of a paper published in Sustainable Design and Manufacturing 2019. Uploaded in accordance with the publisher's self-archiving policy.

Reuse

Items deposited in White Rose Research Online are protected by copyright, with all rights reserved unless indicated otherwise. They may be downloaded and/or printed for private study, or other acts as permitted by national copyright laws. The publisher or other rights holders may allow further reproduction and re-use of the full text version. This is indicated by the licence information on the White Rose Research Online record for the item.

Takedown

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.



eprints@whiterose.ac.uk
<https://eprints.whiterose.ac.uk/>

Multimodal Freight Transportation: Sustainability challenges

E. I. Udo^{1*}, L. Huaccho Huatuco¹ and P. D. Ball¹

¹ The York Management School, University of York, YO10 5GD, York, UK

*corresponding author: eu546@york.ac.uk

Abstract. Due to Globalisation in trade, the development of multimodal cargo shipments and the related transport needs have created a range of challenges. Interestingly, sustainability of multimodal freight transportation is still subject to minor consideration, on the grounds that economic interests are frequently positioned much higher than social or environmental objectives. This proposed Research plan is needed to assess whether and to what extent the multimodal freight system is achieving the results in the sustainability dimensions: economic, social and environmental. Thus, it will carry out a critical appraisal of the multimodal freight transportation sector to provide an up to date knowledge on the sustainability challenges and the potential solutions through doctoral research. This paper structured to present a review of existing literature on freight transportation and multimodal freight transport highlighting the sustainability concerns with multimodal freight transport systems. It also highlights the gaps in knowledge with a justification on the need to address these gaps for the system to function optimally. It also covers the methodology that would be applied and the sources of data that would be reviewed to ensure the aim and objectives are clearly addressed. The paper concludes by discussing the significance of the expected findings in the light of sustainability in multimodal freight transport to the academia, policy makers and the freight transportation industry.

Keywords: Transportation, Freight, Multimodal, Sustainability, Effectiveness.

1 Introduction

This paper aims to present an overview of multimodal freight transport system with a view to highlighting the major sustainability challenges and the existing knowledge gaps which must be addressed if multimodal freight transport must function optimally. Multimodal freight transport can be seen as a combination of several modes of transport within a national or international transport operation, aimed at providing door-to-door services, under the charge of a single transport operator [1]. To paraphrase the Brundtland Commission's definition of a sustainable planet [2], it can be derived that a sustainable multimodal freight transportation system is a system that meets the needs of multimodal freight transportation today without compromising the ability of future generations to meet their own multimodal freight transport needs based on Black [3]. Mul-

multimodal freight transport connotes one transport operator carries out all transport functions, using various modes of transportation, under one contract. While this creates a certain level of ease in the contract and makes it less cumbersome, the sustainability of this has to be considered. The effectiveness of this method has to be taken into account as well as the general environmental impact caused using this mode as well as potential options and alternatives. The upsurge in the flow of knowledge, goods, services as well as resources among nations which has occurred as a by-product of globalization (interaction coordination of world economies) has led to a major increase in transport activity over the years [4, 5]. This has impacted the environment in several ways including increased economic activity, fluctuations and changes in production location and developments in the types and modes of transportation needed to support global trade.

The transportation framework is one of the key facilitators of trade logistics. In developed countries, organizations experience the best logistics and transportation experts, frameworks, and infrastructure in the world, but this may not be the same in developing countries due to outmoded production, distribution and supply systems; poor transportation infrastructure and inefficient third-party transportation; bureaucracy; political instability; and shortage of investment funds [6]. Transportation expenses are higher when managing shipping materials in international trade due to long distances [7]. As expressed in the Action Plan for Freight Transport Logistics [8], logistics is 'the oil in the EU's financial machine'. Economic activities rely on logistics coordination to supply materials to industry and to move items along the organization's network and in the long run to the final consumer, developed or developing nation notwithstanding.

This paper presents a review of existing literature on freight transportation and multimodal freight transport highlighting the sustainability concerns with multimodal freight transport systems. It also highlights the gaps in knowledge with a justification on the need to address these gaps for the system to function optimally. It also covers the methodology that would be applied and the sources of data that would be reviewed to ensure the aim and objectives are clearly addressed. The paper concludes by discussing the significance of the expected findings in the light of sustainability in multimodal freight transport both to the academia and the freight transportation industry.

2 Literature Review

Every transport system has its own complexities which occur as a result of the multi-dimensions of hardware being used (vehicles and supporting infrastructure) as well as social nature of the organisations and people involved. This type of complexity can be multiplied with the use of multiple modes with the associated interface with several regulatory bodies, legislative bodies, financial systems, technology, service providers and varying human behaviours. Several studies have shown that multimodal transportation evolved as a combination of numerous transport modes aimed at improving trading efficiency [1, 9]. This combination further complexes the use of multimodal freight transport, resulting in both positive (short transport time, reduced cargo damage, inventory reduction, improved quality of freight) and negative (safety, traffic congestion,

infrastructural damage, fuel consumption, air pollution, noise etc.) effects on sustainability issues.

Thus, with these challenges of complexity and sustainability effects, it becomes imperative for organisations to incorporate sustainability development frameworks into their corporate governance to cover such aspects as: economic viability, technological feasibility, social and environmental sustainability of their operations [10, 11, 12]. Hence, at this point it is important to provide a critical understanding of how freight is transported and the major stakeholders within this industry.

2.1 Freight Transportation

Russo and Comi [13], while analysing urban freight transportation, argued that there are two main freight movements. These are elucidated as follows:

(a) End-consumer movements: These movements occur when freight is moved by the end-consumers (private or business customers) that purchase and consumes the goods. That is, freight movement is conducted by generic purchasers who buy items from a shop, and then transport them to a different place where the goods are consumed. Russo and Comi [13] opined that in this type of movement, it may be hypothesised that end-consumer is the decision maker.

(b) Logistic movements: For logistic movements, freight gets to the facilities where it is delivered to the markets for producing other products (goods) or services (i.e., freight movement from the warehouse to the retail outlet) or directly delivered to the end-consumer/customers. It involves several decision makers and functional relationships in the trade schemes. These include: (i) Trade without any contact points (directly), e.g., online shopping and direct delivery to end-consumer (ii) Trade with one contact point (the retailer); where the producer engages networks of retailers to access the target market (or consumption zone); and (iii) Trade with more than one contact point usually employed to consolidate or deconsolidate the load. These trade scheme aims to reduce the cost of logistics and transportation.

2.2 Multimodal Freight Transport

Several authors have explained the concept of International Multimodal Transport in different ways, however, the most legitimate definition of the term is provided by the United Nations Conference on Trade and Development (UNCTAD) [14]. The 'Multimodal Transport' concept is viewed as a combination of several transport modes utilized as a part of a national or global transport operation, which offers door-to-door services, under the obligation of one single transport operator [13]. The 'Multimodal Transport' term was initially used by the UNCTAD on International Multimodal Transport of Goods in 1981 [15].

The person or organization in charge of the whole carriage is called a Multimodal Transport Operator. By definition, the Multimodal Transport Operator is any individual

who by him/herself or through someone else or other organizations, closes a multimodal transport contract and who acts as the principal, not as an agent or for the benefit of the consignor or of the carriers partaking in the multimodal transport operations, and who accepts accountability for the execution of the agreement [14].

The Multimodal Transport Operator is responsible (in a lawful sense) for the whole carriage, despite the fact that it is performed by a few distinct methods of transport (by rail, water and road for instance). However, the Multimodal operator does not need to own every one of the methods for transport and in practice, typically does not, carriage is frequently performed by sub-carriers (often called in legal terms, "real carriers"). Rawindaran et al. [16] likewise certified that the expressions, "through transport", "consolidated transport", "multi-purpose transport" and "multimodal transport" are altogether utilized as a part of the setting of cargo movement from beginning to end, essentially including the use of containers. These four terms are fundamentally the same in significance, that is, the transportation of goods by more than one mode of transport and a through single cargo rate contract.

The rise of the container technology and of the multimodal transport originated from and facilitated increasing international trade [14]. The idea of international multimodal transport covers the door-to-door movement of goods under the duty of a solitary transport operator, though the idea may not be new, utilized as a part of the late 1950s by Malcolm Mclean and his trucking operation [17, 18].

Containerization adds to a higher productivity in the advancement of multimodal transport operation. Keeping in mind the end goal is to accomplish efficient and effective multimodal transport, intense co-operation and co-ordination among transport modes are important. The emergence of containers had allowed for a global reach through an expansion in trade volume with increment of operational effectiveness, which allows Multimodal Transport to be used in most global transport operations [19]. Hence, advancements of standard units, including containers, with enhanced ease of transfer, support Multimodal Transport. Preceding United Nation's formalization of Multimodal Transport in 1980, the phrasing has experienced a few phases of changes before it acquired its official status by the UNCTAD/ICC in 1992.

The development of multimodal cargo shipments and the related transport needs have created an extensive variety of challenges that are mostly noticeable in metropolitan and urban locales. These challenges are generally as a result of capacity and sustainability requirements of the present distribution framework, of which capacity is acknowledged as a genuine test for policy, planning and strategy. In the use of a single mode of freight transport, the sustainability challenges are slightly more specific in comparison to multiple transportation modes. For with the use of road transport, the challenges may include congestion, emission of GHGs such as CO₂ and utilization of space and these would be different from the challenges of rail transportation which may include noise pollution among other challenges [20, 21, 22]. According to the Oslo/Paris convention (for the Protection of the Marine Environment of the North-East Atlantic) (OSPAR Commission) [23], sustainability concerns for sea freights border on such issues as the consequences of consumption of non-renewable fuel sources, SO₂ emissions (both at the ports and at sea), discharge of sewage and garbage, contaminants from ballast water, space occupation which has the potential to interfere with the natural

ecosystem and habitats, ocean acidification and fluctuations of pH levels due to CO₂ and SO₂ emissions; whereas with air transport the sustainability challenges may include noise, contamination of land, incidental pollution of water, and habitat disruption [24].

Thus, it is expected that multimodal freight transport which incorporates various combinations of the modes of transportation highlighted above would feature the specific sustainability challenges identified/associated with each mode of transport and their associated actors to ensure that end users receive their desired product and service. This implies that the issue of sustainability should be placed at the forefront of multimodal freight transport especially as there a lot more factors to be considered and addressed if multimodal freight transport is to be operated optimally. This view is supported by Carrier et al. [9] who argued that the aggregated performance of a multimodal transport system cannot be fully understood from the separated performances of the component systems. Interestingly, sustainability of freight transportation is still subject to minor consideration, on the grounds that financial interests are frequently positioned much higher than social or ecological objectives. However, air contamination, commotion discharges and infrastructural degradation, principally brought on by heavy duty vehicles, ships and trains, occur at a specific cost to the environment and society – also the exceptional need for space at major passage areas for warehousing, vehicle operations, trans-shipment, or the storage of containers which are not in use [25]. This implies that researchers need to consider if the multimodal freight system is effectively achieving the results for which it was set up. And if it is, at what financial and environmental cost. Are the current practices sustainable at all and what future effects will multimodal freight have? What are the current industry best practices in other countries and are there alternatives? These and other important questions are expected to be answered in the course of this research.

2.3 Sustainability in Multimodal Freight Transport

The World Trade Organization says that globalization and International trade provide long haul relationship between economies where one entity has the capacity to impact on the management of an element occupant in another economy [26, 27]. Thus, globalization permits organizations to pick up international experience necessary for survival in today's dynamic business world and allows countries and regions accomplish economic development. Notwithstanding, neither International trade nor globalization is conceivable without transport as trade and transport are inseparably connected: effective transport administrations are essential to successful international trade. Remarkably, international trade comprises of utilizing more than one mode of transport for some interfaces and modes are explored during the time spent moving merchandise starting with one country then onto the next.

According to Russo and Comi [13], there is a recent worldview focused on setting out and clearly outlining sustainable development strategies, through which to continually deliver long-lasting improvements in quality of life. They argued that this could be achieved through creation of sustainable communities which are able to manage and utilize resources more effectively and efficiently. Also, sustainable development can be

achieved through the identification and use of the ecological and social innovation potential of the economy, thereby ensuring economic prosperity, environmental protection and regeneration, as well as social cohesion and stability. But what really does it mean to have a sustainable multimodal freight transportation system?

In multimodal freight operations, this implies that sustainability practices observed using one mode of transportation or with one sub-carrier does not necessarily lead to a total sustainability in the whole transport system as this implies the use of various modes and several carriers. Hence, sustainability practices must be evenly applied throughout the multimodal freight system. This raises sustainability issues in and of itself about the effectiveness and efficiency of multimodal freight transport especially in the achievement of business viability and economic development, so this leads us to ask the question, does multimodal freight transport achieve expected results and with what financial and social implications? However, while addressing this question, we should also ask what the effect will be on the environment.

The use of multimodal freight transport implies the use of various carriers, various transportation methods and the involvement of several organisations scattered in several countries and locations. This connotes that varying practices amongst the various actors, for the various modes and in the different location. This leads to the question, what are current industry practices in comparable countries and regions? This has created a necessity for this research to fill in the knowledge gaps in this regard by offering the most complete and comprehensive answers to four key objectives and questions within this theme, which include:

- Does multimodal freight transport achieve expected results and with what financial and social implications?
- What are current industry practices in comparable countries and regions?
- What are the future effects of multimodal freight transport on the environment and businesses?
- Are there any alternatives to current and future freight transport practices?

3 Methodology

The research will use a case study methodology which allows the researcher to carry out a thorough investigation. Case study as a research methodology looks into and searches through reports of past studies, permits the investigation and understanding of complex issues. It is a powerful research technique used especially when a comprehensive, thorough examination is required. It is viewed as an instrument in numerous social sciences, the role of a case study strategy in research turns out to be progressively noticeable when issues concerning social sciences [28], education [29], and challenges affecting specific communities [30] are being investigated. Thus, this method will allow for interactions with the participants in order to gain access to the participants social meaning. The research will also employ the use of industry expert interviews to triangulate findings.

Both primary and secondary data will be applied in this study to fully address the research questions and objectives. This research will carry out semi structured interviews to allow in depth discussions with participants as the primary method for data collection. The research will also review documents as listed in the section for sources of data as the secondary data collection method. The adoption of multiple data collection methods and techniques will allow for the different research objectives and questions to be fully explored.

In the first stage of the work extensive analysis of academic work and qualitative data from different international organizations will be used to build the background of multimodal freight transport, with focus on the United Kingdom (UK) in relations with its trade partners in the European Union, given the current Brexit context and Nigeria for a comparison between developed and developing countries. Based on the data collected, comparative analyses will be made with data collected in the next stage, in order to shed a light on several research questions.

The second stage will capture data obtained from observation of actual industry situations in different cities within the UK/EU and Nigeria in order to find out how to develop a framework that would offer the best course of action in terms of the efficiency and sustainability of freight transport. In addition, there may be qualitative interviews several industry experts who may be willing to participate.

4 Sources of data

The accessibility and availability of relevant data are the most vital aspects of any research, and in this proposed study it is expected that relevant data may be scarce probably because not so much research has been previously done in this area. Thus, the data sources that will be consulted include:

- Research and datasets from industry experts and organisations within EU countries and partner countries.
- Secondary data from researches carried out by scholars in developing countries as well as the United Kingdom.
- Data set from UNCTAD, World Trade Organisation (WTO) and other relevant international organisations.

Primary data from multiple case studies will consist of semi-structured interviews with senior managers (industry experts), direct observations and historical data from relevant multimodal freight organisations.

5 Conclusions

Though environmental sustainability is only one aspect of the triple bottom line effect, it is important across all industries of human endeavours as they need to show commitment to making their operations environmentally sustainable and meeting consent

standards relevant to attaining national and international legislation protecting the environment [31]. When operations of companies pose threats of harm to human health or the environment, precautionary measures should be taken even when cause and effect relationships are not fully established scientifically [32]. Thus, such companies must undertake adequate and satisfactory risk assessment and risk management approach for their operation beyond regular environmental impact assessment requirements [33]. Thus, it has to be adopted as a key element for policy decisions concerning environmental protection and management of such companies.

In view of the above, this research contributes to the existing body of knowledge which future researchers and academicians can build up on. The research is of great significance to policy makers and industry representatives in the transportation and logistics industry. It also draws on the findings from publications in the field to present the state of knowledge regarding the operation of the freight industry. It is evident that, even though these studies have highlighted key aspects of freight services and have establish some key framework upon which the sector has been regulated, there are, however, existing gaps in knowledge with regards to the effectiveness and efficiency in its application as a viable business model and adequate tool to be utilised to drive economic development. These must be addressed if freight operations are to be conducted with a sustainability consciousness.

Thus, it is imperative for more research to expand on existing knowledge in attempt to find out if multimodal freight systems are effectively achieving the results for which they were set up. And if they are, at what financial and environmental cost are these being delivered? Also, are the current practices sustainable at all? and what potential future effects will multimodal freight have? What are the current best practices in other countries and are there alternatives? The resulting information will be of immense significance and benefits especially to the major stakeholders within the industry. This is because this information will create a more transparent policy framework which runs on an environmental sustainability consciousness adopted at an industry-wide framework. Finally, the importance of sustainability cannot be overemphasized and this research positions to provide at the very least, more knowledge and potentially impact on future policies to be made in the transport and logistics industry.

References

1. Butta, T. L. and Abegaz, M. B. (2016). Challenges in the operation of multimodal transport system: The case of Ethiopian shipping and logistics services enterprise. *International Journal of Applied Research*; 2(7): 927-932
2. United Nations (1987). *Our Common Future*. Oxford University Press, Oxford, England
3. Black, W. R. (1996). Sustainable transportation: a US perspective. *Journal of Transport Geography* 4, 151–159
4. Surugiu M. and Surugiu C. (2015) International Trade, Globalization and Economic Interdependence between European Countries: Implications for Businesses and Marketing Framework. *Procedia Economics and Finance* 32, 131 - 138.
5. Kherbash O. and Mocan M. (2015) A Review of Logistics and Transport Sector as a Factor of Globalization. *Procedia Economics and Finance* 27, 42 – 47

6. Razzaque, M. A. (1997) Challenges to logistics development: the case of a Third World country – Bangladesh. *International Journal of Physical Distribution & Logistics Management*; 27 (1) 18 – 38.
7. Wood, D. F., Barone, A. P., Murphy, P. R., Wardlow, D. L. (2002) *International logistics*. 2nd edition, American Management Association (United States of America), 47-5.
8. European Commission (2007). *The EU's freight transport agenda: Boosting the efficiency, integration and sustainability of freight transport in EuropeCOM*.
9. Carlier, A., Tschirhart, F., Da Silva, F., Stephan, F., Thoni, O., Munier-Kordon, A., Abid, M., Scremin, L. and Couturier, L. (2015). *An Overview of Multimodal Transport Design and Challenges Underlined by a Carsharing Case Study*. In *Complex Systems Design & Management* (pp. 257-268). Springer, Cham.
10. Cormier, R., Kannen, A., Elliott, M., Hall, P., Davies, I.M. (2013). *Marine and Coastal Ecosystem-based Risk Management Handbook* (eds.). International Council for the Exploration of the Sea, Copenhagen. ICES Cooperative Research Report No. 317.
11. Borja, Á, Elliott, M., Uyarra, M.C., Carstensen, J., Mea, M. (eds.) (2017). *Bridging the Gap between Policy and Science in Assessing the Health Status of Marine Ecosystems*, *Frontiers Media*, Lausanne, pp. 548 <http://dx.doi.org/10.3389/978-2-88945-126-5>.
12. Borja, A. (2014). *Grand challenges in marine ecosystems ecology*. *Front. Mar. Sci.* 1:1 doi: 10.3389/fmars.2014.00001
13. Russo F. and Comi A (2011).: *Measures for Sustainable Freight Transportation at Urban Scale: Expected Goals and Tested Results in Europe*. *Journal of Urban Planning and Development*
14. UNCTAD (2001) *Implementation of Multimodal Transport Rules*. UNCTAD/SDTE/TLB/2
15. UNCTAD (1981).: *United Nations Conference on a Convention on International Multimodal Transport*. UNCTAD, TD/MT/CONF/17, New York
16. Rawindaran V., Gardener B., and Banomyong R. (2012).: *Theories and Practices of Multimodal Transport in Europe*
17. Odeleye, J. (2015). *The need for multimodal transport development in Nigeria*. *Journal of Geography and Regional Planning* Vol. 8(9), pp. 239-243
18. Heins M. (2013) *The Shipping Container and the Globalization of American Infrastructure* (doctoral dissertation) University of Michigan, Michigan, USA. Available at https://deepblue.lib.umich.edu/bitstream/handle/2027.42/102480/mheins_1.pdf
19. Cullinane, K., Wang, T., Song, D., and Ji, P. (2005) *A Comparative Analysis of DEA and SFA approach to estimating the technical efficiency of container ports*. *Transportation Research A: Policy and practice*. 40(4):354-374
20. Richardson B. (2005) *Sustainable transport: analysis frameworks*. *Journal of Transport Geography* 13: 29–39
21. Akyelken, N. and Keller, H. (2014) *Framing the Nexus of Globalisation, Logistics and Manufacturing in Europe*. *Transport Reviews*, 34: 674–690
22. Grant, D. and Elliott, M. (2018) *A proposed interdisciplinary framework for the environmental management of water and air-borne emissions in maritime logistics*. *Ocean and Coastal Management* 163: 162-172
23. OSPAR Commission (2009) *Assessment of the Impacts of Shipping on the marine Environment*. OSPAR Commission, London
24. Lutte, R. and Bartle, J. (2016) *Sustainability in the Air: The Modernization of International Air Navigation*. *Public Works Management & Policy* [online] Available at pwm.sagepub.com DOI: 10.1177/1087724X16679845
25. Waters, D. (2010) *Global Logistics New directions in supply chain management*. 6TH Edition, the Chartered Institution of Logistics & Transport (UK), 494- 497-498

26. Wto.org, WTO | News - Foreign direct investment seen as primary motor of globalization, says WTO Director-General, http://www.wto.org/english/news_e/pres96_e/pr042_e.htm, last accessed 2013/05/07.
27. UNCTAD (2007) World Investment Report: Transnational Corporations, Extractive Industries and Development, http://unctad.org/en/Docs/wir2007p4_en.pdf, last accessed 2013/05/07.
28. Grassel, E. and Schirmer, B. (2006) The use of volunteers to support family caregivers of dementia patients: results of a prospective longitudinal study investigating expectations towards and experience with training and professional support. *Zeitschrift Fur Gerontologie Und Geriatrie* 39 (3): 217-226.
29. Gulsecen, S. and Kubat, A. (2006). Teaching ICT to teacher candidates using PBL: A qualitative and quantitative evaluation. *Educational Technology & Society*, 9 (2): 96-106.
30. Johnson, M.P. (2006). Decision models for the location of community corrections centres. *Environment And Planning B-Planning & Design* 33 (3): 393-412
31. Boyes, S. J., Elliott, M. (2014).: Marine legislation – the ultimate ‘horrendogram’: international law, European directives & national implementation. *Mar. Pollut. Bull.* 86, 39–47
32. Kriebel, D., Tickner J., Epstein, P., Lemons, J., Levins, R., Loechler, E. L., Quinn, M., Rudel, R., Schettler, T. and Stoto, M. (2001) The Precautionary Principle in Environmental Science. *Environmental Health Perspectives*, 109 (9) 871 – 876
33. Lonsdale, J., Weston, K., Blake, S., Edwards, R., Elliott, M. (2017). The amended European environmental impact assessment directive: UK marine experience and recommendations. *Ocean Coast Management*. 148, 131–142.