STRATEGIES FOR GREENING CROSS-BORDER ROAD FREIGHT TRANSPORT, IN SOUTH AFRICA

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Abstract

The purpose of this paper is to investigate strategies to reduce greenhouse gas emissions and assess the readiness of the cross-border road freight industry in adopting green alternatives.

A literature review and qualitative descriptive survey approach were utilised within the interpretivist paradigm. A semi structured interview guide with open ended questions was used for data collection. The data was analysed using a thematic approach to represent data as reliably as possible.

Results indicated that the study responded to the research questions in a bid to determine the status quo and readiness by cross-border road freight transport industry in South Africa in reducing carbon emissions. Cross-border road freight transportation industry is reliant mostly on government. The study revealed that operators are willing to comply with government regulations that would be informed by the industry insights and support. The results moreover shown that the industry has expectation of government response in encouraging green transport.

The paper is presented as one of the studies concerning carbon reduction and promotion of electric vehicle and alternatives fuels that would contribute to achieving sustainable development goal (SDG) 13, by reducing the rise in greenhouse gas (GHG) emissions.

Keywords: Carbon, greenhouse gas emissions, road freight transport, reduction, alternative fuel.

1. Introduction

The African continent is particularly vulnerable to impacts of climate change affecting key economic drivers such as transport, energy, agriculture, water resources, health, forestry, wildlife, land, and infrastructure, amongst others (UNFCCC, 2007). The largest contributor to global climate change is, fossil fuels; coal, oil, and gas accounting for over 75% of global greenhouse gas (GHG) emissions and nearly 90% of all carbon dioxide emissions (www.un.org). For the purposes of this study, the focus will be on reducing GHG emissions in the cross-border road freight transport industry in South Africa.

The Southern African Development Community (SADC) region is a major transport hub in Africa, with road freight transport being a critical component of regional trade and economic development. However, the sector is also responsible for significant GHG emissions, contributing to climate change and air pollution. Therefore, there is a need to shift towards sustainable and cleaner road freight transport options in the SADC region (Ncube, *et al*., 2015; Rucińska, *et al*., 2018; Yesufu, 2020; and Wang, *et al*., 2020).

Road freight transportation is an indicator of a thriving economy. However, it is also associated with negative externalities such as GHG emissions, air pollution, accidents, noise pollution, resource consumption, land use deterioration, and climate change risk. It is highlighted that globally, 68% of surface freight is carried by road vehicles. These vehicles account for 73% of freight transport GHG emissions. By 2050 the demand for road freight is expected to be more than double. If the current situation is not mitigated and there is no policy action, this can lead to higher levels of GHG emissions (DOT, 2018). Concequently, the International Transport Forum (ITF) suggested that rapid decarbonisation of the heavy-duty road freight sector is vital to meeting the goals of the Glasgow Climate Pact adopted at the 2021 UN Climate Change Conference (COP26). Active policy interventions by governments to help promote zero-emission road freight are essential, considering the speed of the required carbon dioxide (CO2) emissions reductions. Given this urgency, policymakers do not have the indulgence of pursuing all technological avenues equally. They must lay the regulatory foundation to support the technologies with the most promise (Global Climate Action Summit, 2018).

Attaining resolute reductions in GHG emissions is predominantly challenging for transportation due to the technical limitations of replacing oil-based fuels. The transition to a non-carbon society is a matter of serious concern among researchers interested in achieving sustainable societies. The need to reduce GHGs will motivate decarbonisation efforts and avoid worst-case climate change impacts. There must be a concrete regulatory foundation to support greening initiatives in the country as well as to achieve the reduction of GHG emissions.

Decarbonising transport is significant as it is one of the major sectors where emissions are well above their 1990 levels and have continued to increase at about 33% over the same period. GHG emissions have however, started to decline recently due to high oil prices and improved vehicle efficiency. More than two-thirds of transport-related GHG emissions are from road transport. Emissions from the transport sector in South Africa account for 10.8% of the country's total GHG emissions. This places the transport sector second only to the energy sector in terms of emissions volume (DOT,2018). These figures represent direct emissions only, principally consisting of tailpipe emissions. If indirect GHG emissions associated with the transport sector were to be included, such as GHG emissions associated with fuel refineries

and electricity generation for transport, these figures would be substantially higher (DOT,2018).
The consensus of the scientific opinion, as reflected in the Intergovernmental Panel on Climate Change, is that climate change in the form of global warming is real and driven by emissions of greenhouse gases caused by human activity. Nonetheless, as a developing country with a historical dependence on its extensive coal deposits for energy, South Africa encounters particular challenges in reorienting to a low-carbon economy (Bauer N, McGlade C, Hilaire J, 2018).

This paper is intended to evaluate the readiness of the cross-border road freight industry and effectiveness of different strategies to reduce emissions from road freight transport and identify barriers to their implementation. By addressing these barriers, the transportation sector can move towards a more sustainable and low-carbon future.

1.1 Aim of study

The aim of this study was to evaluate strategies to reduce greenhouse gas emissions, assess the readiness of cross-border freight operators to shift to greener energy sources. The study was undertaken to confront the challenges and barriers that currently hinder the widespread adoption of low-carbon technologies and fuels in the road freight sector. The study further aimed to identify opportunities for operational improvements, such as driver training, overloading, traffic congestion by the border posts and vehicle maintenance that can contribute to emissions reductions.
Overall, the aim of this study is to inform policy and industry decisions and support the transition to a more sustainable and low-carbon transport system, which is essential for achieving global climate goals and improving air quality in urban areas.

1.2 The research objectives include the following:

1. Assess the cross-border road freight sector readiness to use green energy sources and the potential for emissions reductions through the adoption of low-carbon technologies and fuels.
2. Identify the barriers and challenges to the adoption of low-carbon technologies and fuels and develop strategies to overcome these barriers.
3. Analyse the potential for operational improvements, such as optimizing transport routes and vehicle maintenance, to contribute to emission reductions and improved sustainability in the cross-border road freight industry.
4. Develop recommendations and guidelines for policymakers and industry stakeholders to support the transition to a more sustainable and low-carbon transport system in the cross-border road freight sector.

1.3 Research questions

Based on the research objectives outlined above, research questions in greening cross-border road freight transport, include the following:

1. Is the cross-border road freight sector ready to use electrified trucks or other alternative fuel, and how can emissions be reduced through the adoption of low-carbon technologies and fuels?

2. What are the barriers and challenges to the adoption of low-carbon technologies and fuels in the cross-border road freight sector, and what strategies can be developed to overcome these barriers?
3. How can operational improvements, such as optimizing transport routes and vehicle maintenance, contribute to emission reductions and improved sustainability in the cross-border road freight industry?
4. What are the most effective policy and industry strategies for supporting the transition to a more sustainable and low-carbon transport system in the cross-border road freight sector?

1.4 Significance of study

Studies on decarbonisation strategies are significant in several ways in South Africa.

Road freight transport is a significant contributor to greenhouse gas emissions, and addressing this issue is crucial for achieving climate change mitigation goals. South Africa, as a developing country, is facing increasing pressure to reduce its carbon emissions, and the transportation sector is a key area for achieving this. (DOT, 2018)

This study provides insights into the current state of road freight transport in South Africa, including the challenges and opportunities for decarbonizing the sector. This information can be valuable for policymakers, industry stakeholders, and researchers who are interested in identifying and implementing effective strategies for reducing carbon emissions in the transportation sector. This study further highlights the potential of alternative fuels, such as biodiesel, compressed natural gas, and liquefied petroleum gas, in reducing carbon emissions in the road freight transport sector in South Africa. This can provide guidance for policymakers and industry stakeholders who are interested in promoting the use of alternative fuels in the transportation sector.

This paper is significant in providing valuable insights into eagerness from industry operators on potential for adopting various decarbonisation strategies as well as addressing challenges and opportunities for decarbonising or reducing carbon in the transportation sector in a developing country context.

1.5 Delimitations

The study had several delimitations that should be considered when interpreting the findings.

The study focused solely on the road freight transport sector in South Africa and does not address other modes of transportation, such as rail or maritime transport. Therefore, the findings may not be generalisable to other sectors of the transportation industry or to other countries. Furthermore, the study relied on data from a limited number of sources, including government reports, academic studies, and industry reports. This may limit the scope and depth of the analysis, and the findings may not be representative of the entire industry.

The study did not address the social or economic impacts of decarbonising the road freight transport sector in South Africa, which could have important implications for policymaking and implementation. This paper was based on current technologies and practices and did not consider future developments in technology or changes in policy that could impact the feasibility or effectiveness of the proposed strategies for decarbonising the transportation sector.

In summary, while the study provides valuable insights into the various decarbonisation strategies and challenges and opportunities for decarbonising the road freight transport sector in South Africa, the findings should be interpreted with consideration of the delimitations.

2. Literature review

2.1 Introduction

The transportation sector is a major contributor to greenhouse gas emissions, with the road freight transport sector being a significant contributor. As a developing country, South Africa is facing increasing pressure to reduce its carbon emissions and address climate change. This has led to increased interest in exploring strategies to decarbonise the transportation sector, including the road freight transport sector (Liimatainen *et al*., 2014).

East African Community (EAC), Common Market for Eastern and Southern Africa (COMESA) and Southern African Development Community (SADC) member countries have a position on climate change and have agreed that climate change is a global problem because it will not affect only the countries with high greenhouse gas emissions, but all countries. Changes in climate can vary in the different geographical and climatic regions in Africa. (Greenpeace Africa, 2019).

2.2 Historical perspective

The 2015 Paris Agreement of which South Africa is also a signatory to, includes a long-term temperature goal of "holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels" (Paris Agreement Article 2.1 (a)). In the same agreement, countries requested the Intergovernmental Panel on Climate Change (IPCC) to produce a special report on the impacts of global warming above 1.5°. In response, in 2018 the IPCC produced the Special Report on Global Warming of 1.5°. The Report makes it very clear that; we are already facing climate impacts; these will be significantly worse at 2° than at 1.5°; and global carbon dioxide (CO2) emissions pathways consistent with keeping the global temperature within the 1.5° limit require rapid global emissions reductions – 45% by 2030 (in relation to 2010 levels) and global CO2 emissions should reach net zero by 2050 (IPPC, 2018).

2.3 Challenges and opportunities associated with the decarbonisation strategies

Literature suggests that alternative fuels and electrification are promising strategies for decarbonising the road freight transport sector in South Africa, but significant barriers exist that must be addressed for these strategies to be effective (du Plessis *et al*., 2022).

The literature highlights several challenges to decarbonising the road freight transport sector in South Africa. These include the high cost of alternative fuels and EVs, the limited availability of charging infrastructure, and the lack of policy support for the adoption of low-carbon technologies (Greenpeace Africa, 2019; Kotzé *et al*., 2017).

In South Africa, the number of heavy vehicles increased considerably because of the shift of cargo from rail to road due to deregulation and the subsequent underutilisation of rail. The greater the number of heavy vehicles on South Africa's roads, the greater the deterioration of the country's roads, and the increased maintenance costs. There is no doubt that the outcome is worsened by the following factors that contribute significantly to truck emissions:

- On-going delays at border posts that are worsened by the ongoing load shedding in South Africa which has impacted technical equipment at the crossing.
- Overloaded heavy vehicles. Overloaded trucks are also associated with safety concerns and increased carbon emissions. Careful long-term planning is thus required to ensure that there is sufficient infrastructure to support the efficient functioning and growth of the transport sector in the future while minimising externalities.
- Over speeding truck
- Unroadworthy trucks
- Lack of driver training
- Unimproved driver wellness

Notwithstanding the growing demand for transport, the sector has a critical role to play in achieving South Africa's GHG reduction targets and the South African Department of Transport (DoT) will need to focus all resources available to meet these ambitious targets. (DoT, 2018)

2.4 Strategies for decarbonising or reducing carbon on road freight transport

One of the primary strategy for decarbonising the road freight transport sector is using alternative fuels, such as biodiesel, hydrogen fuel, compressed natural gas (CNG) and liquified petroleum gas (LPG).

Biodiesel is a renewable fuel produced from renewable sources such as vegetable oils or animal fats. It is a non-petroleum based diesel fuel. It improves air quality and the environment. It is also one such alternative fuel that has shown promise in reducing carbon emissions in the transportation sector (Kweon *et al*., 2017).

Hydrogen fuel refers to hydrogen that is burned as fuel with pure oxygen. It can be a zero-carbon fuel depending on the creation process (Parra *et al.*, 2019). Compressed natural gas is a fuel gas composed mainly of methane, compressed to less than 1% of the volume it occupies at standard atmospheric pressure (Khan *et al.*, 2015). Liquified petroleum gas is a fuel gas that has a highly flammable mixture contents of hydrocarbon gases (Yao *et al*., 2019). CNG and LPG are also alternative fuels that have been explored as options for reducing carbon emissions in the road freight transport sector (Nishiumi *et al*., 2016). Though the feasibility and effectiveness of these alternative fuels in South Africa's context require further exploration. Nevertheless, South Africa's Department of Transport recently published a Green Strategy that outlines efforts to contribute towards a 5% reduction of emissions in the transport sector by 2050. (DOT, 2018)

A more popular strategy for decarbonising the road freight transport sector is through the electrification of vehicles. Electric vehicles (EVs) have been shown to be effective in reducing carbon emissions in the transportation sector (Kotzé, *et al*., 2017). However, the high cost of EVs and the limited charging infrastructure in South Africa pose significant barriers to the widespread adoption of EVs in the road freight transport sector.

There are other strategies that the Department of Transport in South Africa identified and categorised into short- and long-term strategies. (DOT,2018). Below are the short-, and long-term strategies that are relevant to road freight transport.

2.4.1 Short-term strategies

- To realise modal shifts in the transport sector that reduce GHG emissions, reduce transport congestion and improve temporal, spatial and economic efficiency in the transport sector. Achieve a 30% modal shift of freight transport from road to rail.
- To reduce fossil-fuel related emissions in the transport sector by promoting norms and standards for fuel economy and putting in place regulations that promote improved efficiency in fossil fuel powered vehicles and improved environmental performance of fossil fuels. This will eventually lower carbon emissions.
- To develop best practice guidelines to ensure that integrated, climate- friendly transport options are incorporated into land use and spatial planning at national, provincial, and local levels.
- Invest in sources of green energy's infrastructure, such as biogas filling stations, electric car charging points, GIS integrator ICT technology platforms for locating stations, regulating future pricing and proving statistics.

2.4.2 Long-term strategies

- An identifiable long-distance freight will be restricted to rail, with the development of Green Corridors in the road network to promote the use of cleaner efficient technologies in the freight industry.
- The replacement of fossil fuels by vehicle technologies with low or zero tailpipe emissions, such as electric and fuel cell vehicles, will be far advanced and, coupled with meaningful lower national electricity grid emissions factor due to a comprehensive switch to renewable energy improvements that will lead to a notable reduction in the carbon intensity of motorised transport.

3. Research Methodology

The aim of the paper is to assess emission reduction strategies and their potential. The paper will also identify opportunities for operational improvements, such as driver training, mitigate overloading, traffic congestion by the border posts and vehicle maintenance, that can contribute to emissions reductions and improved sustainability by the cross-border road freight transport industry in South Africa.

To respond to the research questions, a qualitative descriptive survey approach was utilised, within the interpretivist paradigm. As Saunders *et al*., (2014) indicated, the interpretivist paradigm is more closely associated with qualitative research. Furthermore, Saunders *et al*., (2014) explained that the focus of the interpretivism paradigm is to understand and explain what is going on without necessarily wanting to change the status quo. Interviews were used to collect data. A semi structured interview guide with open ended questions was used for data collection, Interviews were conducted telephonically. Interviews lasted about an hour each and were audio-recorded and transcribed for analysis. The voice data was transcribed from interviews into text according to the responses from the interview and grouped the text data into the following four themes: significant sources of GHG in the cross-border road freight sector, strategies of GHG reduction through low-carbon technologies and alternative fuels, barriers and challenges to the adoption of low-carbon technologies and alternative fuels, operational improvements as contributing factors to emission reduction and improved sustainability in the road freight industry, and effective policy and industry strategies for

supporting the transition to sustainable and low-carbon transport system in the road freight sector

The target population was made up of South African cross-border freight operators. Purposive sampling was used to select a sample of 10 out of 15 participants who agreed to take part in the study. The other five operators declined the invitation to take part in the study. The data was analysed using a thematic approach to represent data as reliably as possible.

4. Results and Discussion

Reporting of the results was done in a manner that ensures the anonymity of the respondents and protection of sensitive information. The interviews covered the themes as indicated in the research methodology section.

4.1 Presentation and Interpretation

The study data was summarised during transcription from voice into text data. Respondents interviewed were as per target population outlined under research methodology. The summarised data is presented in four thematic analysis segments that was covering each theme mentioned above.

4.2 Findings from the Primary Research

The study sought to assess emission reduction strategies and their potential. In the transcription process, a reductionist approach was used by researchers, only summary of responses was put into text, not all the words of the respondents. Findings indicate the emissions reduction strategies that would work in South Africa on a short, and long term. Findings also show that cross-border freight operators are ready to implement green transport solutions. Respondents further made suggestions that government regulations and policies should put more pressure on emitters, government should introduce reward initiatives like, tax rebates when buying vehicles that are green compliant. It was further suggested that government should provide infrastructure that will provide for electric cars along the corridors to SADC member states. Suggestions were made that government regulations and policies should put more pressure on emitters. Furthermore, government should introduce reward initiatives like, tax rebates when buying vehicles that are green compliant. It was suggested that government should provide infrastructure that will provide for electric vehicles along the corridors to SADC member states. On the part of the analysis of the potential for operational improvements, the study revealed that operators are not adopting green alternatives, no operator is using electrified or other alternative fuel vehicles due to unavailability of infrastructure that will cater for such vehicles along the corridors with SADC member states.

The respondents further indicated that the mechanisms of reducing carbon emissions on road freight transportation industry is reliant mostly on government, as operators are willing to comply with government regulations that would be informed by the industry insights and the support.

4.3 Findings from literature review

Looking at the trends in implementing green transport solutions, Africa is notably lagging when it comes to freight transportation. Most initiatives taken so far are not coordinated at continental or sub regional level and are done intermittently as it was revealed in literature.

The outcomes of the study also revealed that the volume of trucks using high carbon emitting fuel in South Africa is around 12 000 trucks on owed and managed trucks. This coincides with the notion that emissions from the transport sector in South Africa account for 10.8% of the country's total GHG Emissions (DOT, 2018) as cited in the literature. Considering that the provided data on truck volume doing cross-border operations stipulates 12000 trucks. 90% of what emerged from the transcripts confirms what the literature says.

Carbon reduction, electrification, and alternative fuels have been identified as key strategies to reduce emissions in the road freight sector. However, from a social perspective the adoption of these measures is still limited by various challenges, including a lack of infrastructure, the limited range of current EV technologies and long charging times, and high costs (Tob-Ogu *et al*., 2018; Gruden, 2006 and Liimatainen, 2014). The respondents were positive about the strategies presented to them, but they emphasised the issue of government support on funding and EV infrastructure. They were of the view that tackling the issue of vehicle congestion at the border posts, training of drivers on how and when to accelerate the vehicle, overloading campaigns would assist in the short term meanwhile government is planning on long term strategies to support operators by providing EV infrastructure and funding for EV.

5. Discussion

The study responded to the research questions in a bid to determine the status quo and readiness by cross-border road freight transport industry in South Africa in reducing carbon emissions. It investigated different vehicle standards in the cross-border road freight industry and how these have evolved overtime. The study also explored from the industry the expectation of government response in encouraging green transport. As per data extracted from respondents, cross-border freight operators are ready for green transport solutions implementation subject to government interventions, regulations, and support.

The urgency to reduce GHG emissions necessitates a strategic approach that balances effectiveness and feasibility. Given this context, it becomes evident that prioritizing low-hanging fruit solutions presents a pragmatic pathway for South Africa to expedite its progress towards meeting emission reduction targets.
South Africa, like many nations, faces the dual challenge of minimizing its carbon footprint while fostering economic growth and development. To achieve this delicate equilibrium, the country must harness solutions that offer both immediate emissions reductions and require minimal upfront investment. By identifying and focusing on these low-hanging fruit solutions, South Africa can make rapid strides in its emission reduction efforts, paving the way for long-term sustainability.

Among these solutions, the emphasis on alternate fuels emerges as a pivotal approach for South Africa. Integrating alternate fuels into the existing energy and transportation infrastructure holds the potential for rapid and tangible emissions reductions. This approach is especially advantageous given the ease with which these fuels can be incorporated into the current systems without requiring significant modifications. The seamless integration of alternate fuels into vehicles and established energy networks provides an avenue for swift action, leading to substantial emissions cuts in a short timeframe.

The rationale behind prioritizing alternate fuels lies in their compatibility with existing technology and infrastructure. This compatibility not only streamlines the adoption process but

also minimizes disruption to daily operations. Consequently, this approach aligns with South Africa's goals to make immediate progress in emission reduction without overburdening its resources or requiring protracted timelines.

5.1 Managerial Implications

The following recommendations are desirable to reduce carbon and utilise green transport solutions like electrification, and alternative fuels like hydrogen powered vehicles. This would be achieved if the following is considered:

- Government should have intensive consultations with the freight industry on green transport initiatives.
- Government should subsequently develop and implement policies and framework on reducing carbon in the freight space.
- Government should practically support the green initiatives on transport by introducing reward initiatives (tax rebates), exemption from paying road-toll or parking fees for a certain period when buying electric or alternative fuel freight vehicles to offer financial support for freight transporters.
- Government should invest on charging stations for electric freight vehicles along the corridors to SADC member states.

5.2 Limitations of the study

The researcher assumed that there would be at least ten respondents of the study but only six participated in the study. The findings of the study are limited to only these six participants' data provided. The result of the study is applicable only to the respondents of the study.

1. Data limitations: The study might face data limitations regarding the availability and accuracy of data on alternative fuel adoption and usage in the country.
2. Sample size: The study might have a limited sample size, which can affect the generalizability of the results.

6. Recommendations and Conclusion

The paper will be utilised when making recommendations to relevant authorities with the hope of effecting change to policy and procedure or framework on greening cross-border road freight transport in the country. The freight industry is an important contributor to South Africa's GDP and plays a key role in facilitating trade in the SADC region. The findings indicate that should government take a position on introducing green transport regulations on emitters and support operators that are willing to buy green complying trucks, there would be a drastic increase in compliance on green transport solutions. The data obtained during the interviews was aimed at answering the research questions provided on the result section above.

There is a need, therefore, for collaboration between governments, industry stakeholders, and researchers to develop and implement sustainable and cleaner road freight transport systems in the SADC region.

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