6th International conference on Research in Management

17-18 August 2023

Los Angeles, United States

The Impact of Back-Haul Trucking Service in the Environmental Dimension of Sustainable Supply Shain Management: CEMEX Egypt Case Study

[1]Ahmed Abd Rab Elnaby Mohamed*, [2]Mohamed Affifi Mahmoud

[1]Backhauling Advisor - CEMEX Egypt, [2]Logistics Director - CEMEX Egypt

Abstract

Recently, the initiatives and strategies that lead to green logistics are gaining interest. Backhaul trucking is a transportation approach whereby empty trucks deliver another load near to the previous unloading place rather than returning empty all the way to the original origin. CEMEX Egypt gave the Egyptian market the first implementation of Backhaul trucking service. It results in decreases the CO_2 emissions which affected the green logistics. This paper examines the impact of Backhauling in the Environmental aspect of sustainable supply chain practices through optimizing the truck's productivity and explains the factors that influence the effective Backhaul Trucking service. This paper initiated with a systematic literature review to scan the previous studies of the relationship between Backhauling and Environmental aspect of Sustainable supply chain practices. The quantitative approach was obtained from CEMEX Egypt case study through gathered historical data. Analysis and interpretation of the statistical data resulted from regression analysis and Structural equation modeling by using SPSS and AMOS tools.

Keywords: Average Trip Time; Back-Haul Network Size; Back-Haul Trucking; CEMEX; CO_2 Emissions; Environmental Aspect; Sustainable Supply Shain Management; Truck's Productivity

1. Introduction

Sustainability has become a widely researched topic academically and practically. The increase in analysis concerning sustainability dated back to the 1980's. the common definition of Sustainable supply chain management is the integration of environmental and social aspects with the economic dimension (Seuring and Muller, 2008). Transportation is one of the most important supply chain activities. Previous studies confirmed that a high percentage of the trucks on the roads returning empty, the Empty trips specially for the longer travel distances considered to be not efficient performance in transportation cost analysis. Although of its importance, it has been neglected in the existing literature (Santos et al, 2021).

CEMEX is a global building materials company that provides high-quality products and reliable service to customers and communities in more than 50 countries throughout the world. It maintains trade relationships in over 100 nations. And work hard to develop and deliver the best solutions in cement, ready-mix, and aggregates. CEMEX Egypt gives the Egyptian market the first implementation of Backhaul trucking service. This initiative resulted in decreases the CO_2 emissions.

The technique of this paper is to use systematic literature review approach of the period from the year 2014 to the year 2021 to scan the previous studies of the relationship between Backhauling and the environmental aspect of Sustainable Supply Shain Management. The objective of that is to know the literature gaps. According to the literature gaps the conceptual framework with its hypotheses was created. And tested by using quantitative method which is CEMEX Egypt case study by using 570 records of historical data of the period from May 2019 to December 2020. SPSS Regression analysis and Amos Structural equation modelling are used for analyzing and interpreting statistical significance.

2. Literature Review

Sustainable supply chain management, according to Seuring and Muller (2008), is the integration of environmental and social aspects with the economic dimension. Over the years, there has been a fast increase in interest in sustainable supply chain management. Researchers have studied three major aspects of sustainable supply chain management across time: the environmental aspect, the economic aspect, and the social side.

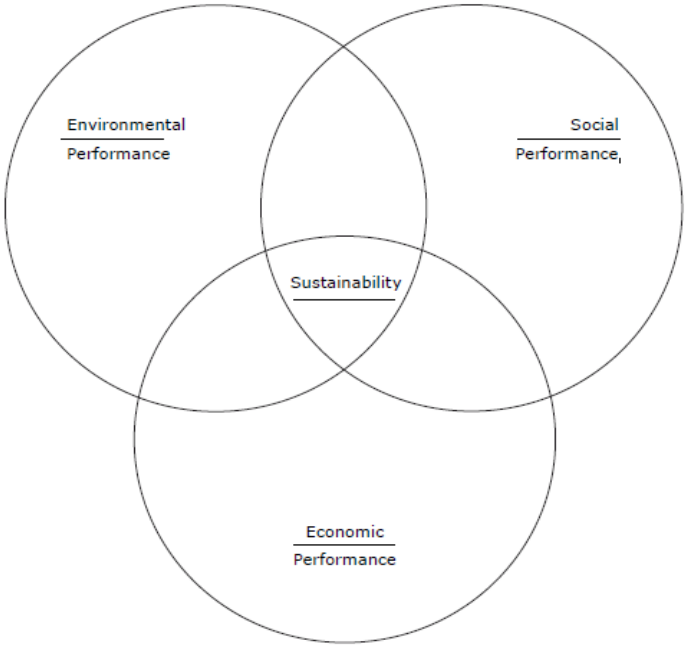


Figure 1: Aspects of Sustainability
Source: Elsaid, Ahmed Tarek, 2018

The environmental dimension of sustainable supply chain management refers to how a business may protect the environment in which it operates. Researchers discovered that by decreasing energy use to the bare minimum, approaches for efficient energy usage in manufacturing result in a significant reduction in carbon emissions (Bevilacqua et al., 2014).

With the world emerging from Covid-19 restrictions, in 2021 global CO2 emissions from the transportation sector growing by 8% to nearly 7.7 Gt CO2, up from 7.1 Gt CO2 in 2020. Transport emissions grew at an annual average rate of nearly 1.7% from 1990 to 2021, faster than any other end-use sector. To get on track with the Net Zero Emissions by 2050 Scenario, CO2 emissions from the sector must fall by about 3% per year by 2030 (Jacob Teter, 2022).

The amount of CO_2 produced per kWh is estimated as follows; The amount of diesel fuel consumed for truck applications is approximately 200 grams/ kWh (assuming 50% efficiency). The mass of diesel fuel is approximately 850 grams/liter. The amount of CO_2 emissions produced by diesel fuel is 2.668 kg/liter (Santos et al., 2021).

Santos (2021) discussed the Vehicle Routing Problem with Backhauls and its impact on sustainable aspects, environmental, economic, social. For the majority of vehicle routing problems with backhauls presented in previous studies, the solution to that problem was

focused on minimizing CO_2 emissions by minimizing the distance. Minimizing the distance indirectly reduces both emissions and fuel. Most of the previous studies and practical applications of the vehicle routing problem with backhauls focus on the costs savings by performing inbound and outbound trips together and neglect the quantitative assessment of the impact of transportation on the environment and society.

For the sustainable environmental aspect, Turkensteen and Hasle (2017) presented a method to assess the carbon emission effects. The carbon emissions are a function of the trip distance and the average load factor. The findings of this method are about savings in carbon emissions up to 25% and up to 42% can be reached for the vehicle routing problem with backhauls. Although the vehicle routing problem with backhauls can induce higher economic benefits (lower costs and reduce CO_2 emissions), the time of re-load in the vehicle during mixed trips are not considered in this study. Nevertheless, this extra time may lead to a drastic increase in the total time required to complete a route.

Systematic Review of the relation between Sustainability and Backhauling

This section presents the systematic literature review of most relevant articles that focused on the relation between the variables; Backhaul Trucking service and trucks' productivity and the environmental aspect of sustainable supply chain management during the period from 2014 till 2021. A systematic review has been carried out on seven published papers from 2014 to March 2021. articles spanning 07 years of research published in English-language, peer-reviewed journals for covering most of studies in that topic. and the aim from that part is to get the gap in literature which need to be studied to advance an understanding of the impact of trucking back-haul in the environmental aspect of Sustainable Supply Shain Management through the truck' productivity.

Year of publication	Article Title	Author	Aim	Methodology	Findings	Further studies
2021	A green lateral collaborative problem under different transportation strategies and profit allocation methods.	Maria Joao Santos, Sara Martins, Pedro Amorim, Bernardo Almada-Lobo	Examine a lateral collaboration between a leading retailer, 3rd party logistics service provider and several producers	a case study in the food supply chain to investigate three collaborative strategies.	Savings of 26% in fuel consumption and 28% in operational costs.	Social concerns, for example, the impact of the equity of working hours among drivers on their performance and motivation.
2021	Impacts of Road Infrastructure on the Environmental Efficiency of High-Capacity Transportation in Harvesting of Renewable Wood Energy	Teijo Palander, Stelian Alexandru Borz and Kalle Karha	Investigate the impact of high-capacity transportation in Reducing the environmental emissions by backhauling transportation method	- Data of wood transportation from the enterprise resource planning system between 6 July 2018 and 19 August 2020, 152 vehicles - Quantify Fuel Consumption and the index of environmental efficiency.	The reduction in average fuel consumption between 52% and 70% in backhauling transportation was 18.88%. In this respect, CO_2 emissions were reduced by 4.52 g t × km-1, achieving 19.48 g t×km-1.	Recommended to study the seasonal problems
2021	Sustainable supply chain management and its effects on the performance of sugar sub-sector in Kenya	Panya, K. O., 2 Ochiri, G., Achuora, J., and Gakure, R. W.	Investigated the effect of green procurement strategies (included the green logistics activities such as backhaul transportation approach).	180 questionnaires from of sugar companies in Kenya used SPSS and Microsoft word tools to examine the relationship between the variables.	Positive significant relationship between green procurement and performance of sugar sub-sector in Kenya.	- Expand the scope by study other industries such as cement - Using qualitative methods to come up

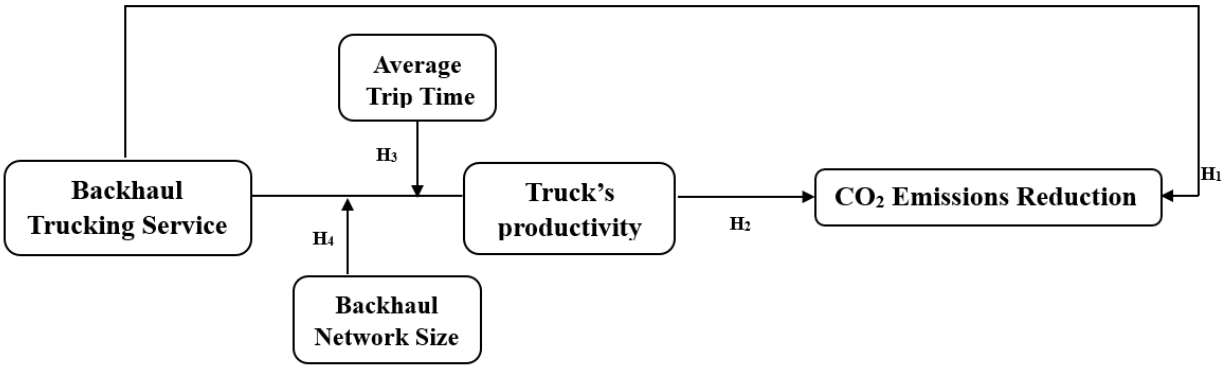
						with findings for comparison with the findings of this study.
2020	"Towards solving a robust and sustainable. Vehicle Routing Problem with Backhauls" PHD thesis.	Maria Joao Martins Dos Santos	Minimize the total routing costs minus the total revenue collected at backhaul customers by developing mathematical models and solution methods for the vehicle routing problem with backhauls.	Methodological approach based on following four steps: material collection, descriptive analytics, category selection and material evaluation.	Vehicle routing problem with backhauls allows reductions up to 20% in the total distance and up to 25% in CO_2 emissions and saving up to 30% in the total costs in comparison with the traditional vehicle routing problem.	Investigate the impact of NOx as one of environmental aspects.
2019	Environmental Impacts of Reusable Transport Items: A Case Study of Pallet Pooling in a Retailer Supply Chain	Riccardo Accorsi, Giulia Baruffaldi, Riccardo Manzini and Chiara Pini	investigate the impact of reverse logistics in environmental sustainability targets	- case study in Italy and conducted data collection from companies' Enterprise Requirement Planning Systems. - Calculated the logistical and environmental KPIs by a tailored GIS-driven decision support tool.	Reverse logistics reduced distance traveled of the truck by 65% and pollutant emissions by 60%.	Recommended to study the impact of reverse logistics approach on optimizing trucks productivity and cost reduction.

2017	Horizontal collaboration in freight transport: concepts, benefits, and environmental challenges	Adrian Serrano-Hernandez, Angel A. Juan, Javier Faulin and Elena Perez-Bernabeu	Present a literature review of transportation horizontal collaboration practices and analyze the main benefits of these practices in sustainability economic and environmental aspects.	Analyze the horizontal collaboration at three levels; the strategic, tactical, and operational levels.	Horizontal collaboration practices represent an efficient approach of reducing transportation freight cost and promote best practices for environmentally friendly.	Modeling and solving of realistic freight transport logistics scenarios including time-evolving and stochastic inputs.
2014	Horizontal cooperation in vehicle routing problem with backhauling and environmental criteria	Angel A. Juan, Javier Faulin, Elena Perez Bernabeu, Nicolas Jozefowiez	Examines different numeric examples to quantify saving costs and reduction in CO_2 emissions that can be attained from backhaul Horizontal cooperation.	Developed a metaheuristic algorism developed by Juan et al. (2011) to solve three numerical tests for three benchmark instances.	The use of backhaul allows reducing distance-based cost in about 16% and environmental emissions are reduced by 24% on the average.	Develop a metaheuristic approach for efficiently deal with routing problems with backhauling and to test this approach using a large set benchmark instance.

3. Conceptual Framework and Hypotheses

Regarding the findings of the systematic review held, a conceptual framework has been analyzed to propose the relations between the variables that could be investigated. The following figure demonstrates the conceptual model for this research proposing the

following relations and hypotheses that would be investigated within this study.



Accordingly, the research hypotheses could be stated as follows:

H_1: The Backhaul Trucking service has a significant positive influence on CO_2 emissions reduction.

H_2: Truck's Productivity mediates the relationship between Backhaul Trucking service and CO_2 emissions reduction.

H_3: The Average Trip Time moderates the relationship between Backhaul Trucking service and Truck's Productivity.

H_4: The Size of Backhaul network moderates the relationship between Backhaul Trucking service and Truck's Productivity.

4. Research Methodology

The research depends on a daily historical data for CEMEX Egypt as a case study for the variables: Independent variable (Backhaul Trucking service), Mediator (Truck's Productivity), Dependent variable (CO_2 emissions reduction); which present the environmental aspect for Sustainable Supply Shain Management, the Moderator variables which are (Average trip time) and (Size of backhaul network). The total records of these data are 570 records for daily historical data for the variable: Backhaul Trucking service, trucking productivity, CO_2 emissions, logistics cost, average trip time and size of backhaul network During the period from May 2019 to December 2020.

The statistical packages of SPSS – version 26 and AMOS are used to test the research hypotheses. The regression analysis and SEM were fitted to predict research model.

Testing Research Hypotheses

In this section, the hypotheses under study are tested using Regression analysis in SPSS26 and Path analysis in Amos 26. The results analysis revealed the following:

H_1: The Backhaul Trucking service has a significant positive influence on CO_2 emissions reduction.

Table 2: Summary of linear regression for the impact of Backhaul trip on CO_2 emissions reduction. (N=570).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	R-square
		B	Std. Error	Beta			
1	(Constant)	28.36391	4.327304	0.820796	17.19443	0	0.83
	Backhaul trips	596.5039	2.736825	0.833347	232.9782	0	
a. Dependent Variable: CO_2 emission reduction							

Table (2) shows the linear regression for the impact of Backhaul Trucking service on the reducing CO_2 emissions. It was concluded that there is a positive significant effect of Backhaul Trucking service on the reducing CO_2 emissions. (p-value<0.05), regression coefficients greater than zero. Also, R-square is 0.83, which means that Backhaul Trucking service explains 83% of the variation in reducing CO_2 emissions. The impact could be presented by the following regression equation:

CO_2 emissions reduction =28.36+596.50Backhaul trips

It is concluded that for each increase in backhaul trips by one trip, the CO_2 emission reduction increases by 596.5 Kg.

H_2: Truck's Productivity mediates the relationship between Backhaul Trucking service and CO_2 emissions reduction.

Table 3: Summary of the mediation analysis of truck's productivity (N=570)

Effect	Variables	Backhaul trips				
		Lower C.I.	Upper C.I.	p-value	Effect	total
Direct effect	Truck's productivity	0.07	0.114	0.691	Sig	Partial mediation
	CO_2emissions reduction	0	0	0.01		
Indirect effect	Truck's productivity	0	0	...	sig	
	CO_2 emissions reduction	0.109	0.225	0.01		

As mentioned in Table (3) the results indicate that there is a direct significant effect of the Backhaul Trucking service on CO_2 emissions reduction (95% C.I. (0,0), p-value= 0.01),

and a significant indirect effect of the Backhaul Trucking service on CO_2 emissions reduction through truck's productivity (95% C.I. (0.109, 0.225), p-value= 0.01), therefore the truck's productivity **partially mediates** the relationship between Backhaul Trucking service and CO_2 emissions reduction.

H_3: The Average Trip Time moderates the relationship between Backhaul Trucking service and Truck's Productivity.

Table 4: Summary of the moderation analysis of Average trip time analysis of truck's productivity (N=570)

Model		B	Std. Error	Beta	t	Sig.	R^2
1	(Constant)	-0.041	0.028		-1.117	0.144	
	Backhaul trips	0.79477	0.005	0.755	124.719	0	0.749
2	(Constant)	-0.113	0.044	0	-2.218	0.009	
	Backhaul trips	0.939	0.013	0.892	63.51	0	
	Backhaul trips*Average trip time	-0.001	0.001	0.026	1.857	0.026	0.861
a. Dependent Variable: Truck's Productivity							

As shown in Table (4) that the value of the impact factor for the Backhaul Trucking service is R^2= 0.749 which reflects the impact of the Backhaul Trucking service on truck's productivity. And when observe that P-Value less than 0.01%, and when test the role of average trip time tested as a moderating variable, it has been found that the value of the impact factor increased to R^2 =0.861 which affect the model, which means average trip time moderate the relationship between Backhaul Trucking service and truck's productivity.

H_4: The Size of Backhaul network moderates the relationship between Backhaul Trucking service and Truck's Productivity.

Table 5: Summary of the moderation analysis of back haul network size of truck's productivity (N=570)

Model		B	Std. Error	Beta	t	Sig.	R^2
1	(Constant)	0.0443	0.030242	0	1.21076	0.12	0.749
	Backhaul trips	0.8619	0.005272	0.818721	135.262	0.00	
2	(Constant)	0.1060	0.041963	0	2.09078	0.01	0.813
	Backhaul trips	0.8853	0.012233	0.840932	59.87866	0.00	
	Backhaul trips*Backhaul network-size	0.0015	0.000707	0.0246	1.75145	0.03	
a. Dependent Variable: Truck's Productivity							

As illustrated in table (5) that the value of the impact factor for the Backhaul Trucking service is R^2=0.749 which reflects the impact of the Backhaul Trucking service on truck's productivity. And when we observe that P-Value less than 0.01%, and when we test the role of network size tested as a moderating variable, it is found that the value of the impact factor equals R^2=0.813 which means backhaul network size moderate the relationship between Backhaul Trucking service and truck's productivity.

Finding Discussion

The statistical packages of SPSS, version 26 and AMOS are used to test the research hypotheses. The regression analysis and SEM were fitted to predict research model. It is concluded that H1, H3 and H4 are fully accepted, while H2 are partially accepted.

The statistical analysis of the study model also indicated that there is no problem of Multicollinearity between the independent variables and some of them, as well as the normality distribution of the data collected from the study sample.

Backhaul Trucking service showed 83% of the variation in reducing CO_2 emissions. For each increase in backhaul trips by one trip, the CO_2 emission reduction increases by 596.5 Kg, which represents approximately 24.3% from CO_2 emission for the whole completed trip (cement trip + Back-haul trip).

There is a direct significant effect of the Backhaul Trucking service on CO_2 emissions reduction (95% C.I. (0,0), p-value= 0.01), and a significant indirect effect of the Backhaul Trucking service on CO_2 emissions reduction through truck's productivity (95% C.I. (-.225, -0.109), p-value= 0.01). Therefore, the truck's productivity partially mediates the relationship between Backhaul Trucking service and the environmental aspect of sustainable supply chain practices (CO_2 emissions reduction).

The value of the impact factor for the Backhaul Trucking service is R^2=.749 which reflects the impact of the Backhaul Trucking service on truck's productivity. When testing the role

of average trip time tested as a moderating variable, it has been found that the value of the impact factor increased to $R^2 = 0.861$. Also, when test the role of network size tested as a moderating variable, it has been found that the value of the impact factor increased to R^2=813. Therefore, the variables: average trip time and backhaul network size are moderating the relationship between Backhaul Trucking service and truck's productivity.

5. Conclusion

The interest in sustainable supply chain management has been growing rapidly over the years. Any successful organization seeks to minimize negative environmental emissions impact on their community. The environmental aspect in sustainable supply chain management is about how to conserve the environment that organization is working in. Researchers found in previous studies that the techniques for optimal use of energy in manufacturing results in a substantial decrease of carbon emission by minimizing energy consumption to the minimum. One of the main findings in the systematic literature review is that there is a strong relationship between Backhauling and environmental aspect through the addition of backhaul routes and has a positive impact of reducing the CO_2 emissions. Also, the analysis of CEMEX case study confirmed that hypothesis, for each increase in backhaul trips by one trip, the diesel fuel consumption decreases by 223.4 liters, and the CO_2 emissions decreases by 596.5 Kg, which represents approximately 24.3% from CO_2 emission for the whole completed trip (cement trip + Back-haul trip).

This study highlights the significance of backhauling in logistics practices. clarify the ecological benefits and identify the forces driving the effective backhaul tucking service. The high backhaul trips lead to creating green logistics through conserving the environment by reducing carbon emissions. One of the ecological benefits of backhaul trucking service is its contribution in solving the problem of climate change by reducing CO_2 emissions.

One of the main findings of this study is that influencing role of the factors; trip time and the size of backhaul network on effective Backhaul Trucking service. The analysis of CEMEX case study confirmed that the variables: average trip time and backhaul network size are moderating the relationship between Backhaul Trucking service and truck's productivity.

6. Recommendations

Uncertainty is increasing each day worldwide and in Egyptian market. Firms, especially multinational Corporations face the problem of demand uncertainty which lead to create a weakness point for dispatch scheduling the sales orders in both of long and short time.
It is hard to use algorisms because there is no data to feed these algorisms. This study reinforced the significance of backhauling in logistics practices. CEMEX Egypt case study is a good example and gives the market one of the best practices to implement the backhaul

initiative. Therefore, it is recommended to use this study model. From practically point of view, it has been recommended the following:

- Consider the trip time as the most important factor to achieve effective backhaul. That time can be optimized by choosing the backhaul sources that are the nearest located from unloading place of the origin shipment.
- To optimize the truck's productivity, it must be considered the factors: the backhaul loading capacity and the size of backhaul network.
- To generate more reduction in CO_2 emissions, it is preferred to choose the long trips distance.
- Insurance for the products of backhaul trips because the backhaul method represents a risk due to the responsibility of those products.
- The Legality aspects must be taken into considerations. The company will use the backhaul trucking service must add the transportation activity in its commercial register.
- Make Segmentation for the backhaul market and choose the target segments and knowing well the competitive advantage that will give to each segment such as time or/and cost.

7. Further Studies

It is recommended to:

- Study the role of digitalization of influence the effective Backhaul trucking service.
- Study the impact of Backhaul trucking service in increasing the market share.
- Study the contribution of Backhaul trucking service in solving the problem of climate change.

8. References

Abdrabelnaby, Ahmed (2022), "THE IMPACT OF BACK-HAUL TRUCKING SERVICE IN THE SUSTAINABLE SUPPLY CHAIN MANAGEMENT; Case Study of CEMEX Egypt", *DBA, Graduate School of Business of Arab Academy of science, technology and maritime transport*, pp. 27-44.

Accorsi, R., Baruffaldi, G., Manzini, R. and Pini, C. (2019),"Environmental Impacts of Reusable Transport Items: A Case Study of Pallet Pooling in a Retailer Supply Chain", *Department of Industrial Engineering, University of Bologna*, *Sustainability*, Vol. 11, No. 11.

Bevilacqua, M., Ciarapica, F.E., Mazzuto, G. and Paciarotti, C. (2014), "Environmental analysis of a cotton yarn supply chain", *Journal of Cleaner Production*, Vol. 82, November, pp. 154-165.

Elsaid, Ahmed Tarek (2018), "The effect of product design modularity on sustainable supply chain management", *PHD, University of Huddersfield Repository*, pp. 43-50.

Jacob Teter (September 2022). Transport tracking report. Available: https://www.iea.org/reports/transport.

Juan, A., Faulin, J., Bernabeu, E. and Jozefowiez, N. (2014), "Horizontal cooperation in vehicle routing problem with backhauling and environmental criteria", *Procedia - Social and Behavioral Sciences*, Vol. 111, pp. 1134-1140.

Palander, T., Alexandru, S. and Karha, K. (2021), "Impacts of Road Infrastructure on the Environmental Efficiency of High-Capacity Transportation in Harvesting of Renewable Wood Energy", *Energies*, Vol. 14 (2).

Panya, K., Ochiri, G., Achuora, J. and Gakure, W. (2021), "Sustainable supply chain management and its effects on the performance of sugar sub-sector in Kenya", *Strategic Journal of Business & Change Management*, Vol. 8, pp. 681-694.

Santos, M. J., Martins, S., Amorim, P. and Almada-Lobo, B. (2021), " A green lateral collaborative problem under different transportation strategies and profit allocation methods", *Journal of Cleaner Production*, Vol 288.

Santos, Maria Joao Martins Dos (2020), "Towards solving a robust and sustainable Vehicle Routing Problem with Backhauls", *PHD, Faculty of Engineering of the University of Porto*, pp. 28-34.

Saunders, Mark., Lewis, P. and Thornhill, A. (2016), "Research Methods for Business Students", *www.pearson.com/uk: British Library*.

Seuring, S. and Muller, M. (2008), "From a literature review to a conceptual framework for sustainable supply chain management", *Journal of Cleaner Production*, Vol. 16 No. 15, pp. 1699-1710.