

# Empirical Analysis of Multiple-Criteria Decision-Making (Mcdm) Process for Freight Transportation Mode Selection

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## Abstract

In Ghana, freight transport is growing continuously every year due to its location and business processes. However, road transport carries 86% of freight despite its numerous negative impacts. Hence, the government has invested in rail transport, with 70% of its capacity is for freight transport in her busy freight transport corridor (eastern transport regions of Ghana). Thus, awareness of criteria considered when deciding on freight transport becomes vital. Hence, this study aims to improve the understanding of the factors of freight transport mode selection in Ghana from the decision-making process by identifying criteria that affect their decisions on mode transportation. The combination of Fuzzy AHP and Topsis is used to find the weights and suggest suitable alternatives for the decision-makers in the Eastern transport regions of Ghana. The result of this study shows that the criteria to consider when selecting freight transport mode in the regions are prioritized in other of Transport cost (0.6544), transport Time factors (0.2562), reliability, and flexibility (0.0605), and security, Risk of damage and lose factors (0.0287). Additionally, the suitable mode(s) of transportation in the stated corridor is owned truck carrier transport compared to the railroad, road-barge, and Contracted Carrier, thus, in descending order. The results provide organizations to prioritize these factors when deciding to select freight transport mode. At the same time, the government must remove some inputs that result in high transport costs, enforce policies, and invest in the appropriate mode.

## Keywords

Freight Transport Mode, MCDM, Fuzzy AHP, TOPSIS and Ghana

## 1. Introduction

As globalization of trade keeps improving, freight transport, a derived demand, has also increased since it is driven by global commerce and economic activities [1]. Freight transport is a vital issue in the supply chain industry due to the increasing concern about congestion, environmental impacts, and safety. Also, the internationalization of trade is increasing the demand for flexible, reliable, cost-effective, timely, and visible door-to-door freight services and other related services in Ghana and the world at large.

According to [2], Ghana Investment Promotion Centre (GIPC) estimated that 96% of Ghana's domestic passengers and freight are transported by road, while rail transport only 14% of the total transportation of passengers and freight. However, road transport is having negative impacts such as pollution, congestion, and accidents. Hence, the government of Ghana, realizing these problems and knowing the significance of freight transport in its growing economy, the government has by far invested and still investing in its transport sector, which includes roads, railways, and waterways. Thus, awareness of criteria considered when deciding on freight transport becomes vital. However, very little research has been done to analyze the decision-maker choice and their logistics criteria. Two researchers [3] [4] have attempted to investigate freight transport and its impact on Ghana's economy, considering only road transport. However, none of these papers used MCDM to identify the weights of the criteria influencing decision-makers (both freight forwarders and cargo owners) mode selection.

Therefore, this study aims to improve the understanding of freight transport mode selection of freight forwarders, cargo owners, and firms in Ghana from the perspective of the decision-making process and identify the attached criteria that affect their decisions on mode transportation. The combination of Fuzzy AHP and Topsis is used to find the weights that affect their decisions and suggest suitable alternatives for the decision-makers in the Eastern transport corridor of Ghana. Hence, decision-makers can rely on high-ranking alternatives and implement them to achieve their strategic logistic fit. Before using the MCDM, Stated Preference (SP) method was used to identify the decision criteria. The data used came from over 200 respondents. This involves industrial experts in the Eastern transport corridor (connecting the landlocked countries, freighter forwarders, academicians, and government agencies in Ghana. Also, the criteria when making the decisions are critically determined and prioritized.

This study answers the questions: what are the criteria influencing freight mode selection? What criteria are applicable when deciding on transport mode selection in the northeast transport corridor of Ghana? What are the most prioritized criteria in the selection process? Which MCDM has been used often in transport mode selection and why? What is the suitable freight transport mode(s) in the northeast transport corridor of Ghana? And what are the policy implications of this study?

The rest of this paper is structured as follows: Section 2 contains previous re-

search on transport mode choice and the Multi Decision Criteria Method, focusing on these pros and cons. Sections 3 outline the methodology, models, and the factors and mode alternative derived for this study, and sections 4 discuss the application of the MCDM model, results, and the implications. Finally, section 5 summarizes the conclusion and outlines directions for further research.

## 2. Brief Literature Review

In this section, the literature review starts with a discussion of the previous studies concerning freight mode choice or selection and the Multi-Criteria Decision Method (MCDM). The focus of the previous studies on freight mode choice or selection is on the locations or case studies, factors, and models used. The focus of the literature reviews on MCDM is on the MCDM methods used, delimitation of research, and the pros and cons of the models. In Ghana, some researchers such as [3] [4] and [5] have written on the factors influencing the port competitions for landlocked countries and industries.

The freight transport mode selection topic is vital but controversial for many years, especially in the supply chain industries. Researchers such as [6] asserted that [7] published in 1998 termed freight transport mode choice as freight allocation among modes of transport. Most researchers on freight mode choice include but are not limited to [8] [9] [10] [11].

In Denmark, [12] analyzed transport mode choice and crossing using the weighted discrete choice model in Oreund region. At the end of the model estimation, the researcher ascertained the optimal decoupling of shipments and agents while demonstrating demand elasticities in the context of value of time, cost, and travel time for five modes and 13 commodity groups.

In Norway, [13] compared vertical or horizontal cooperation between freight forwarders. The study analyzed three freight forwarders with two different transportation means. To achieve the objective of the paper, a two-stage game model was implemented. By implementing the model, the study was concluded that vertical cooperation is better than horizontal cooperation, that is, the coalition between a truck-operating company and a ship-operating company. However, the cooperation can gain profit for the players who have not joined the coalition.

In the United States, [14] studied what had to be Interstate freight mode choice between rail and truck for freight modelers and policymakers in Maryland. They used Binary probit and logit models to verify the differences in mode choice behavior between three zones and compare modal behavior. The data used were Revealed Preference data which was ascertained from the database of Freight Analysis Framework of USA. As a result, variable such as time, distance, value, fuel cost and others were identified.

In Brazil, [15] attested to the fact that the focus of Brazil's freight mode choice or split is mainly on road transport. To strengthen the competitiveness among the modes of transportation, there is a need to enhance alternative modalities. Hence, they aimed at freight mode choice study, which focuses on identifying

preferences for freight mode service attributes and discussed transport policies that improve multimodality and sustainable uses of transport infrastructures available in the Rio Grande de Sul. The study concluded that freight transport mode choice delivery time and cost attributes are most significant in Rio Grande de Sul in Brazil.

In summary, cost and time factors are most important selection factors in freight transportation. This indicates that, it is insufficient to conduct research on transportation mode selection without considering cost and time factors. Based on the reviewed pieces of literature, there are limited studies on freight mode choice due to the difficulties in collecting data associated with freight mode choice; it appears to be more limited in the developing countries (Africa countries in specific) than most developed countries. Also, it can be seen in the review literature that the populist methods for the decision-making process are AHP and Topsis with their modification aside from the so-called European trend such as ELECTRE and PROMETHEE.

Contributing to the studies on freight mode choice, this present study uses a Stated Preference survey to collect hypothetical data of the freight mode choice considering modes of transport in Ghana's Eastern transport corridor, where most freight from the Port of Tema moves. As this study is a concern, no freight mode selection studies have taken place in Ghana that look at transportation modes. Moreover, based on the carried-out analyses, it's seen that the MCDM keeps evolving, with fuzzy being the populist in their modifications. As a result of the limitation of individual models, hybrid method (combination of several models). This approach is used as part of this study by combining Fuzzy-AHP and Topsis. This hybrid approach is proven to be best for mode choice [16]. Hence, the Topsis model is used to choose the best freight transport mode since its limitation is solved by Fuzzy.

### 3. Methodology

The selection of suitable freight transport modes in this paper is accomplished through two methodological approaches. Thus, quantitative, and qualitative approaches. With the quantitative approach, fuzzy Analytical Hierarchical Process (Fuzzy-AHP) is used to gain the weights of the criteria. In contrast, the Technique for Order Performance by Similarity to Ideal Solution (Topsis) is used to prioritize the alternatives. To improve the multi-Criteria Decision-making (MCDM) process, these models are integrated as a supporting tool, although only Fuzzy-AHP can be used. The use of fuzzy solves the problem of uncertainty and impreciseness of the framework of this research. Moreover, this integrated approach is used due to its suitability in the complexity of the MCDM environment.

#### 3.1. Population of Survey

The population of interest were freight forwarders and consigners who are involved in shipping decisions in Ghana and transiting for a meaningful distance

through the eaten corridor of Ghana. Freight forwarders in this research are firms who owned trucks to move goods and consigners are those that owned goods (e.g: wholesale, retailers, manufactures, and raw material producers). From the Revealed Preference (RP) survey, the result revealed that 60% of the total respondents attested that mode selection decisions are made by forwarders, brokers, or contracted carriers, while 20% responded that the decisions are made by cargo owners. The population of the Stated Preference (SP) survey involves over 200 Ghanaians from business sectors such as freight logistics providers, Agriculture, wholesales and manufactures. In this research, SP is used to collect data from 120 firms including Shipping Agents and Shippers Authority. **Table 1** stipulates the backgrounds of the respondents.

### 3.2. Survey Structure and Choice Experiment

The data used in this research was ascertained through Stated Preference (SP) survey with choice experiment tasks. The SP survey was divided into two parts. The three parts are to find out the respondents' business types and shipment size. Based orthogonal design principle, the respondents were assigned nine hypothetical questions. According to [17] [18], orthogonal reduces the variation in the process via the robust design of the experiments. Orthogonal design approach offers flexibility which is more appealing than an efficient design technique. Recently, researchers such as [19] [20] in the freight mode choice research attested that orthogonal design approach works well. The hypothetical questions were designed by diversifying the levels of the preselected factors and were formed in a way that reflect the respondents' situations. The second part of the survey focused on obtaining the respondents factors to consider when selecting a mode of transport aside the preselected factors. Finally, respondents were asked to select and rate according to their preferences among three transport mode alternatives such as owned truck carriers, contracted carriers, and rail-road transport. Out of these transport alternatives, contracted carrier was set as base alternatives: thus, the respondents' normal transport choice. This was to give the stakeholders the choice to select and improve on other alternatives when considered better or conditions are considered better. The result from freight mode choice study by [21] [22] concluded that "status-quo" choice is better and mostly reflects economic preference. Although there are drawbacks of "status-quo" choice such as participants' resistance to change, learning effect and fatigue, status-quo helps to investigate the attractiveness of the factors rating of the alternatives when respondents switched to another alternative.

**Table 1.** Backgrounds of respondents.

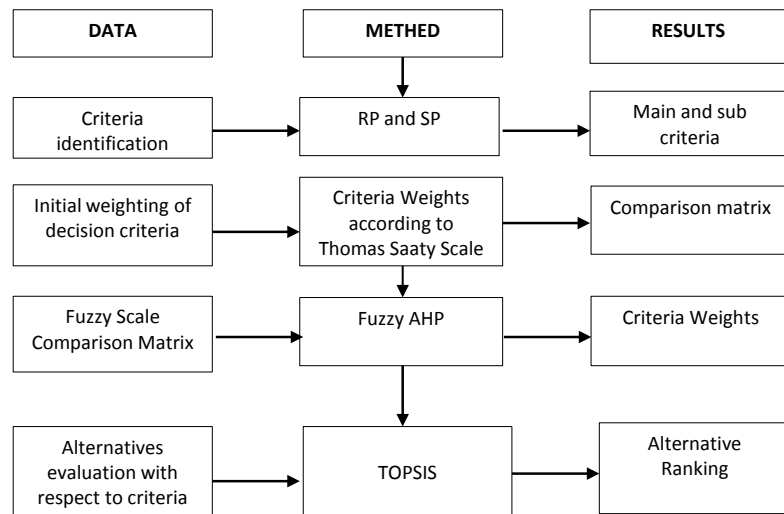
RESPONDENTS	NUMBERS	NO. OF EXPERIENCE	POSITION
Freight Forwarders	150	≥5 years	Transport Managers
Cargo owners	52	≥5 years	Logistics Managers
Other	48	≥2 years	Businessmen

### 3.3. Identification of Criteria

According to three empirical studies on freight mode selection by [8] [23] [24], it resulted that decisions on transport mode are affected by transport time, cost and reliability. In Ghana, van Dyck & Ismael [3] conducted a study on freight mode and concluded that, the key factors that shippers decision are transport cost in USD, distance, quantity, transport cost in ton-kilometers. Furthermore, the results of [25] on freight mode choice suggested that the low service frequencies of coastal shipping and rail are more discouraging variable by shippers. Kim, Nicholson and Kusumastuti [26] also attested that shippers have negative perceptions of freight transport by rail than truck because of the risk of loss or damage although many researchers prefer rail than truck. Hence, the selected main criteria in this study are transport cost, reliability and service frequency, risk of damage and lose, and transport time, while the definitions of sub criteria were deduced from respondents through interviews (Table 2 and Figure 1).

**Table 2.** Shows the description of criteria and sub-criteria.

CRITERIA/FACTORS	DESCRIPTION OF CRITERIA/FACTORS
<b>Cost (C1)</b>	
<i>Freight rate (C11)</i>	<i>The rate per container transport from point A to B.</i>
<i>Cargo Penalty (C12)</i>	<i>The cost to cur by the cancellation of space reservation.</i>
<i>Incentives of cargo (C13)</i>	<i>The cost reduction based on cargo quantity.</i>
<i>Additional transport cost (C14)</i>	<i>Additional cost to incur when cargo is in transit.</i>
<b>Transport Time and Capacity (C2)</b>	
<i>Connectivity (C21)</i>	<i>Mode connectivity of transport means</i>
<i>Capacity (C22)</i>	<i>Available space of the transport options</i>
<i>Transit time (C23)</i>	<i>The time to transport cargo from point A to B.</i>
<i>Handling speed (24)</i>	<i>The speed of cargo handling of an incident in transit.</i>
<i>Frequency in transport (C25)</i>	<i>Number of transportations per day</i>
<b>Reliability &amp; Flexibility (C3)</b>	
<i>Seasonal Availability (C31)</i>	<i>Cargo loading space possibility during peak seasons</i>
<i>On-time reliability (C32)</i>	<i>Reliable time of delivery cargo at the agreed time.</i>
<i>Cargo tracking factor (C33)</i>	<i>Easy tracking of cargo location via the internet or smartphone.</i>
<i>Easy Booking (C34)</i>	<i>Flexible and convenient booking of cargo space.</i>
<b>Risks of damage and lose (C4)</b>	
<i>Cargo Safety and security (C41)</i>	<i>Less risk of damage and loss of cargo</i>
<i>Custom Clearance (C42)</i>	<i>Excellent and flexible custom clearance procedure.</i>
<i>Pollution (C43)</i>	<i>The degree of pollution of the transport options on the environment and the inhabitants.</i>
<i>Cargo transportation regulation (C44)</i>	<i>The degree of cargo-carrying regulation in the transport options based on cargo type.</i>



**Figure 1.** Shows the methodological flowchart of the approached used (Figure 1).

## 4. Application of the Methods for Freight Mode Selection

### 4.1. Weight Calculation Using Fuzzy AHP

This section stipulates the application of Fuzzy AHP to calculate the weights of the criteria and sub-criteria. Prior to the weight calculation, 21 key experts of freight forwarders (15 managers) and cargo owners (6 major cargo owners—supply chain managers) rated the criteria and sub-criteria via questionnaires and the guideline of the author. In zoom conference breakroom of 3, each room filled one questionnaire of pairwise comparison using the TFN, and the weights of the criteria and sub-criteria were calculated using Chang's extend analyses method (EAM) through excel software.

The qualitative data collected from the questionnaire was quantified as a linguistic scale and pairwise comparison matrix was constructed after the data was then converted to trigonometric fuzzy measure. The pairwise comparison matrix stipulates the lower, middle, and upper limits of trigonometric fuzzy measure. The tables below show the pairwise comparison of criteria and sub-criteria and the calculated weights (see **Tables 3-8**).

**Table 8** below presents the summary of the weighted analysis where the global weights are calculated by multiplying the sub-criteria with it respect criteria weight. For instance, C11 by C1 and C44 by C4 are 0.4377 and 0.0047 global weights respectively. Cost (C1) is shown to have the highest weighting value of 0.6544. Similarly, to previous studies, shippers consider cost when choosing transportation mode.

Due to space constraints, not all processes of extent analysis in determining the weights of the criteria and sub-criteria are given.

### 4.2. TOPSIS for Ranking the Best Mode of Transportation

The focus group (Same breakroom) of freight forwarders and cargo owners evaluated the pairwise comparison matrix of sub-criteria and modes of transporta-

tion (alternatives) by assigning linguistic values. Dues to the space constraint, only the numerical values of the results are presented in this study. The final ranking (Pi) of the modes of transportation is derived and presented in **Table 9**. The whole process has been done using MS Excel application.

**Table 3.** Fuzzy comparison matrix of the criteria.

	C1	C2	C3	C4	Weights
C1	1, 1, 1	7/9, 7/6, 5/3	5/8, 8/3, 11/3	4, 5, 6	0.6544
C2	3/5, 6/7, 9/7	1, 1, 1	2, 3, 4	11/3, 14/3, 17/3	0.2565
C3	3/11, 3/8, 3/5	1/4, 1/3, 1/2	1, 1, 1	5/3, 7/3, 6	0.0605
C4	1/6, 1/5, 1/4	3/17, 3/14, 3/11	1/6, 3/7, 3/5	1, 1, 1	0.0287

**Table 4.** Pairwise comparison matrix of sub-criteria w.r.t cost.

	C11	C12	C13	C14	Weights
C11	1, 1, 1	3, 4, 5	2, 3, 4	4, 5, 6	0.6689
C12	1/5, 2/4, 1/3	1, 1, 1	4/3, 2, 8/3	13/9, 11/6, 7/3	0.214
C13	1/4, 1/3, 1/2	3/8, 1/2, 3/4	1, 1, 1	2, 3, 4	0.0776
C14	1/6, 1/5, 1/4	3/7, 6/11, 9/13	1/4, 1/3, 1/2	1, 1, 1	0.0394

**Table 5.** Pairwise comparison matrix of sub-criteria w.r.t. transport options.

	C21	C22	C23	C24	C25	Weights
C21	1, 1, 1	5/9, 2/3, 1	23/45, 7/12, 7/9	2, 3, 4	23/45, 7/12, 7/9	0.1165
C22	1, 3/2, 9/5	1, 1, 1	4/3, 2, 8/3	7/3, 10/3, 13/3	19/36, 11/18, 5/6	0.2864
C23	9/7, 12/7, 45/23	3/8, 1/2, 3/4	1, 1, 1	3, 4, 5	5/3, 8/3, 11/3	0.3357
C24	1/4, 1/3, 1/2	3/13, 3/10, 3/7	1/5, 1/4, 1/3	1, 1, 1	47/180, 13/36, 11/18	0.0153
C25	9/7, 12/7, 45/23	6/5, 18/11, 36/19	3/11, 3/8, 3/5	18/11, 36/13, 180/47	1, 1, 1	0.2461

**Table 6.** Pair-wise comparison matrix of sub-criteria w.r.t. reliability & flexibility.

	C31	C32	C33	C34	Weights
C31	1, 1, 1	19/36, 11/18, 5/6	7/9, 7/6, 5/3	19/36, 11/18, 5/6	0.1834
C32	6/5, 18/11, 36/19	1, 1, 1	10/9, 11/6, 8/3	5/9, 2/3, 1	0.311
C33	3/5, 6/7, 9/7	3/8, 6/11, 9/10	1, 1, 1	3/4, 10/9, 3/2	0.201
C34	6/6, 18/11, 36/19	1, 3/2, 9/5	2/3, 9/10, 4/3	1, 1, 1	0.3046

**Table 7.** Pair-wise comparison matrix of sub-criteria w.r.t. security, environment & regulatory.

	C41	C42	C43	C44	Weights
C41	1, 1, 1	10/9, 3/2, 2	16/9, 5/2, 10/3	13/9, 11/6, 7/3	0.4594
C42	1/2, 2/3, 9/10	1, 1, 1	10/9, 11/6, 8/3	10/9, 11/6, 8/3	0.3586
C43	3/10, 2/5, 9/16	3/8, 6/11, 9/10	1, 1, 1	19/36, 11/18, 5/6	0.0175
C44	3/7, 6/11, 9/13	3/8, 6/11, 9/10	6/5, 18/11, 36/19	1, 1, 1	0.1645



**Table 8.** Summarized weighted analysis.

Criteria	Weight	Sub-Criteria	Local Weights	Global Weights	Rank
C1	0.6544	C11	0.6689	0.4377	1
		C12	0.214	0.1400	2
		C13	0.0776	0.0508	6
		C14	0.0394	0.0258	8
C2	0.2562	C21	0.1165	0.0298	7
		C22	0.2864	0.0734	4
		C23	0.3357	0.0860	3
		C24	0.0153	0.0039	16
		C25	0.2461	0.0631	5
C3	0.0605	C31	0.1834	0.0111	13
		C32	0.311	0.0188	9
		C33	0.201	0.0122	12
		C34	0.3046	0.0184	10
C4	0.0287	C41	0.4594	0.0132	11
		C42	0.3586	0.0103	14
		C43	0.0175	0.0005	17
		C44	0.1645	0.0047	15

**Table 9.** The Euclidean distance from the ideal best and worst and performance score.

Modes	Si+	Si-	Pi	Rank
Rail-Road (A1)	0.10748794	0.12337499	0.53440797	2
Contracted Carriers (A2)	0.1863211	0.04958882	0.21020237	4
Owned Carriers (A3)	0.03066548	0.20168102	0.86801831	1
Rail-Barge (A4)	0.14345409	0.06537155	0.3130437	3

The positive ideal and the negative ideal solutions are calculated according to the weighted decision matrix via excel considering the beneficial criteria and the non-beneficial criteria. After that, the separation distance of each alternative from the ideal and non-ideal solution is calculated. Hence S+ and S-.

For each alternative the relative closeness of the potential mode with respect to the ideal solution is computed. See Pi in **Table 9**.

Hence the maximum value of Pi is the best mode. If the value of Pi is lesser than the value of 1, then it is acceptable condition.

### 4.3. Results and Discussion

In determining the transportation mode in the Eastern corridor of Ghana, decision-makers consider cost (C1) as the highest priority factor with the value of

0.6544, followed by transport time (C2), reliability and flexibility (C3), and risk of damage and lose (C4) amounted as 0.2562, 0.0605 and 0.0287 respectively. Different from previous studies, the weights of the criteria are numerically far from each other. Hence, priorities placed on these criteria in this geographic area are widely different.

It is very difficult to say which criterion is more important than others but prioritizing them by using this hybrid method, it more logical and helpful for decision makers. The prioritization of the criteria of transport mode selection has been done by observing the highest weightage value which shows that cost factor, transport time factor, reliability and flexibility, and risk of damage and lose factor are in decreasing order which is given in **Table 3**. It indicates that cost factors are dominating factors in choosing mode of transport. And the ranking of reported cost sub-criteria in this study are  $C11 > C12 > C13 > C14$  (**Table 4**), which shows freight rate is the topmost factor in all cost factors. Similarly in transport time factors, sub-criteria, C23 is the highest weightage factor and C24 is the lowest weightage factor, however other factors rating are  $C22 > C25 > C21$  (**Table 5**) in order decreasing. Reliability and flexibility factor rating are  $C32 > C34 > C33 > C31$  (**Table 6**), which attest on-time reliability is the highest-ranking factor for mode selection in this criterion. Finally, security, environmental and regulatory factor rating are  $C41 > C42 > C44 > C43$  (**Table 7**) which conclude that cargo safety and security is the top-ranking factor in this criterion. Irrespective of the identified and prioritized criteria and sub-criteria, it is very difficult to say which solution of mode of transportation is more important in the Eastern transport corridor of Ghana but prioritizing the alternatives by using this mixed approach made it more systematic and helpful for decision makers. The ranking of the alternatives of mode transportation has been done by observing the highest closeness coefficient value which is in **Table 9**. Ranking are  $A3 < A1 < A4 < A3$  (**Table 9**).

By using this approach, decision makers can identify factors and select appropriate mode of transportation in this corridor.

### **Managerial and Governmental Implications**

Transport or logistics managers must understand the advantages in prioritizing the factors that contribute to their transport mode decisions in recent time where their massive investment in different modes of transport, resource scarcity, enforced legislations and environmental issues. From the obtained results and MCDM, many observations can be made when it comes to the practical implications of this paper's proposed approach.

Firstly, the vital point in any decision-making problem is the selection of suitable decision criteria. In the case of transport mode selection, especially in the Eastern transport corridor of Ghana, some specific factors such as cost, transport time, reliability and flexibility, and risk of damage and lose factors play a vital role, with the cost being the most important, as identified in this paper. The selection of decision-making criteria, when it comes to transport mode,

should be the result of experts and top-level managerial assessment (considering the selected criteria), as well as the assessment of the internal conditions that stem from the specificity of an organization.

Secondly, transportation plays a major key role in the economy. Hence, transportation has been initiated as the priority. From the selection results, decision makers would prefer using their own truck when the roads are better. To eliminate the drawbacks of trucks such as congestion, and accidents, there should be investment in Rail transportation infrastructure in Ghana. Hence, impede the development of rail transportation sector. As government remains the major financier of infrastructure in every economy. Ghana government must see transportation system (especially, rail system) as its priority and continue to increase capital expenditure in the rail sector to rehabilitate abandoned rail tracks and construct new rail tracks across the country. This will improve the contribution of rail transportation in contributing to economic growth and employment generation in Ghana.

Last but not the least, transportation is one of the important services of any government so regulations and policies should be enforced in public transportation, especially on road transportation so that more people can use the rail to generate more revenue, also reduce congestion and control traffic in the city. Proper regulation of the current and future activities of Ghana Railway sector like what obtains in the telecommunication sector will improve the rail infrastructural provision and services delivery of the country since decision maker would prefer using rail and road than only road (contracted carrier). Also, policies such as the very high fee for street parking should be highly enforced by the government of Ghana so that there would be less congestion in the port area. It would also encourage people to use the new rail transport that has 70% of its capacity for freight transport.

## 5. Conclusions

The decision to consider when selecting a mode of transport in the geographical area of this study is becoming more difficult. Hence, this study applies stated preference approach to identified factors and MCDM method for rating the factors of mode transport for desirable choice. In this study, 4 criteria, 17 sub-criteria and 4 alternatives have been chosen by decision makers. The result stipulates that Road (Owned Truck Carrier) is the highest ranked mode of transportation when selecting a mode of transport in the corridor in this study. The results provide organizations to prioritize factors when making a decision to select freight transport mode while the government removes some inputs that result in high transport cost, enforces policies to and invest in the appropriate mode. This method considered the vagueness/impresiseness of expert opinions in the evaluation process that makes this method is a powerful tool in multi-criteria decision-making process.

Irrespective of the contributions of this paper to both the literature on freight

mode transport and decision-making behavior, there are possible research areas in the future. Future study approaches could consider corridors having a greater network of ports, such as Takoradi port where most bulk cargoes trade instead of just container as done in this study. From the methodological perspective, this study can also explore by using several approaches such as ANP and integrated FUZZY AHP-TOPSIS. Last but not least, this study can be extended by looking at its impact on port competition.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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## Abbreviations

The following abbreviations are used in this paper:

AHP: Analytic Hierarchical Process;

EAM: Extend Analyses Method;

ELECTRE: ÉLimination et Choix Traduisant la REalité;

PROMETHEE: Preference Ranking Organization METHod for Enrichment of Evaluations;

TFN: Triangular Fuzzy Number;

TOPSIS: Technique for Order of Preference by Similarity to Ideal Solution.