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Efficiency Evaluation and Performance Comparison of Third-Party Logistics Providers: AHP-DEA Approach

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Abstract
This research employs a novel approach for the systematic selection of third-party logistics (3PLs) providers in Zimbabwe by applying an integrated DEA/AHP methodology. The aim is to establish a framework for selection and analysis of 3PL providers so as to optimise efficiency and profitability of logistics companies. DEA is a non-parametric method that measures the efficiency of 3PLs by examining multiple inputs and outputs variables while AHP is a hierarchy structured decision-making tool that employs pairwise comparisons for evaluating third-party logistics providers (3PLs). This method enables the organised assessment and weighting of relevant factors and alternatives to facilitate informed decision-making. The results of the study indicate that 8 out of the 12 3PLs operate at full efficiency, while the remaining 4 have potential for improvement. Performance and logistics emanated as the most influential criteria in 3PL selection. This research addresses the increasing trend of 3PL evaluation and selection for outsourcing, as companies concentrate on core activities while benefitting from the advantages of professional distribution, cost savings and improved customer satisfaction provided by 3PLs. The study concludes that by using DEA/AHP methodology there is significant improvement in the analysis and selection of 3PLs, thereby improving profitability and efficiency by providing valuable insights to logistics companies.

Keywords- Third-party logistics (3PL), Data envelopment analysis (DEA), Analytical hierarchy approach (AHP), and Outsourcing.

1. Introduction

Due to population and market expansion, there has been an increased demand for efficiency and profitability within logistics sector. To ensure smooth operations companies employ the services of 3PL providers that assist by granting customers access to outlets, shipping and other logistic services. Logistic companies in turn, invest in their establishments, providing training and necessary equipment. Evaluating the performance of these 3PL providers is of utmost importance in determining their efficiency and profitability. Since the growth in the logistic is extending its reach in both urban and rural areas there is need to strategize on the position of each 3PL provider to enhance efficient distribution. It's stated by Mathiyachagan and Bhalotia (2018) that in today's logistics world, a close collaboration with 3PLs providers is crucial in achieving industry competitiveness thus these providers play a vital role in offering logistic services. Selviaridis and Spring (2007) pinpoints that these 3PL providers offer a bundle of services rather than just transport, further emphasising their vital role in improving logistic operations. Although these providers contribute significantly to companies by catering to customers, guaranteeing their satisfaction and security of their shipments, analysing and selecting them can be a challenging task for managers as it requires consideration of various criteria. According to Cook and Seiford (2009), evaluating efficiency is an important aspect of operations research particularly in logistics. To evaluate efficiency Data Envelopment Analysis has been widely used for assessing the performance of organisational units thus will be fit to be used in the assessment of 3PL providers. A recent study conducted by Burity (2021) highlights the close relationship between logistical efficiency and customer satisfaction, emphasising its importance as a key performance indicator for businesses seeking to improve their operations and customer experience. To achieve greater logistics efficiency while maintaining sustainability, companies need to establish strategic plans that not only improve current processes but also introduce innovate solutions. An innovative solution that can be used is the AHP method. Suryono and Julius (2019) argue that AHP is an ideal method in the selection and alternative ranking of third-party logistics providers as it may reduce corruption, since selection is transparent as the decisions are based on logical calculations.

1.1 Motivation

Despite the vital role that 3PLs play to contribute to smooth operations, there remains a significant gap in the evaluation of their efficiency and optimisation of their processes. This gap has been identified by Khulud et al. (2023) in their research on supplier selection. The lack of a systematic approach in evaluation of 3PLS leads to relative inefficiencies in the decision-making processes as emphasised by Salvador and Díaz (2024), where they acknowledge that lack of structure affects strategic supplier selection which plays a crucial role in optimising the company's efficiency. Sarkis and Talluri (2002) further emphasise the vital importance of the decision-making process in strategic supplier selection for boosting a company's operational efficiency. The lack of a clear framework in the selection of 3PL providers also presents a challenge for managers since selecting the right 3PLs requires assessment of various criteria making the process daunting. Salvador and Díaz (2024) emphasise that inefficiency negatively affects the quality of the company's logistics services, resulting in challenges such as uncertainty, lack of benchmarking, and problems with returns to scale, among others. The decision-making process is complex, involving multiple inputs, and is expected to produce multiple outputs beneficial to the organisation. Combining AHP and DEA gives a more comprehensive evaluation of the efficiencies of 3PLs. This hybrid optimisation model helps in decision making thus, it contributes to the profitability, efficiency and effectiveness of logistics operations. The process of selecting 3PLs is very complex due to the variety of services provided by 3PLs. Aggarwal (2019) stated that the use of multi-criteria optimisation methodologies simplifies the selection process. Wang et al. (2013) noted that efficiency evaluation methods such as DEA can be used to simplify the selection process. This research also contributes to the body of literature and offers practical tools for organisations to enhance their third-party logistics relationships.

1.2 Limitations

The study primarily focuses on 3PL providers located in Zimbabwe and might not be applicable in other geographic locations. This focus may also limit other organisation without similar characteristics. Since the study relies on available data, there might be missing variables which could influence the accuracy of the assessments. Also, the research was conducted over a specific period, it may not reflect long term trends in the logistics industry. The study employs Data Envelopment Analysis (DEA) which allows inputs and outputs to be measured in different units. For example, one input might be measured in terms of exported goods, while another input could be in units of dollars. Additionally, the effectiveness of AHP, could be influenced by decision-maker bias. This element of subjectivity could potentially affect the reliability of the AHP results (Banihashemi and Khalilzadeh, 2020).

2. Literature Review

In this section, literature related to the application of DEA and AHP in the selection process of 3PLs is presented. Third-party logistics providers are independent companies that are contracted by other big or small companies to provide services such as transportation (Skender, 2023). To realise business growth and competitive advantage, 3PLs and their clients work as strategic partners (Burity, 2021). Burity (2021) highlighted that 3PLs companies help to improve customer satisfaction through logistics efficiency and the use of modern technology as well as artificial intelligence. Kmiecik (2022) stated that 3PLs play a crucial role in the management of inventory for their strategic partners, and coordinating logistics process. The complexity that logistics companies face when selecting the best 3PLs is acknowledged by several researchers. A hybrid optimisation model that integrates SWARA and WASPAS was considered by Akpinar (2021). A goal programming model that makes use AHP and TOPSIS hybrid model was proposed in Özcan and Ahiskali (2020). Sawant and Sarode (2021) used India's manufacturing sector as a case study to determine the best 3PLs.

Data envelopment analysis is a quantitative method used to measure the efficiency of DMUS (3PLs). DEA efficiency metric outcomes an efficiency score of 1 representing peak efficiency and lower values indicating a room for improvement. The literature discusses DEA models that is the Charnes Cooper Rhodes (CCR) and Banker Charnes Cooper (BCC) which differ in model assumption about returns to scale and convexity constraints as noted by Emrouznejad and Yang (2018). DEA has been used in the logistics industry to evaluate the efficiency of transportation, warehousing, and inventory management. In the case of Bayraktar et al. (2024), they analysed cross-country logistics efficiency using DEA to determine the key determinants of global efficiency where they concluded there is need for tailored strategies to improve efficiency, similarly Ding and Feng (2023) investigated the effect of logistic efficiency in Anhui province, China. Both these studies demonstrate the applicability of DEA in assessing global and regional logistics performance. In addition, Lepchak and Voese (2020) used DEA to assess the efficiency of logistical modes, transportation, and landing activities in Brazil, offering recommendations for enhancing efficiency based on their findings. Lee et al. (2023) assessed the efficiency of the logistics companies in Malaysia using Data envelopment analysis. Data envelopment analysis has been widely applied in several areas that are not even related to logistics. These areas include region vulnerability after a natural disaster (Wu et al., 2023), and Efficiency of healthcare departments (Jung et al., 2023; Mirmozaffari and Kamal, 2023).

Another multi-criteria decision making methodology that has been used to select the best 3PLs is the Analytical Hierarchy Process (AHP). AHP has also been used in complex selection problems such as logistics, transportation and supply chain management (Lin et al., 2023). In the selection of 3PLs, AHP was used by Suryono and Julius (2019), factors such as price, access, and communication were used as the selection basis. However, other important factors that might be considered when selecting 3PLs are highlighted in Narasimharajan and Venkatesan (2022). Several research have documented the use and applicability of AHP in other fields thus, risk management (Mızrak, 2023), Logistics service quality (Lestari et al., 2023), transportation problems (Moslem et al., 2023), facility location (Paçacı et al., 2022), and COVID-19 transmission risk reduction (Tawanda et al., 2023) among others. Several studies combined DEA and AHP to enhance the decision-making process. For example, DEA and AHP were applied in the following areas thus, production efficiency analysis (Ammirato et al., 2022), waste transportation problem (Hmamed et al., 2023), logistics provider selection problem (Wang and Dang, 2024), climate change studies (Meng et al., 2023), warehouse selection (Korpela et al., 2007) and Market risk in infrastructure projects (Komaki et al., 2024).

3. Integrated Approach to Third-Party Evaluation

This research proposes a hybrid AHP and DEA optimisation model to enhance the selection of the best 3PLs company. The hybridisation of AHP and DEA has been used to simplify the selection process in several studies (Ammirato et al., 2022; Hmamed et al., 2023; Komaki et al., 2024; Korpela et al., 2007; Meng et al., 2023; Wang and Dang, 2024). This framework is both qualitative and quantitative thus, providing a comprehensive selection process.

3.1 Data Envelopment Analysis

Data Envelopment Analysis was used to improve resource allocation and optimisation of logistics processes of third-party logistics providers. Sternad et al. (2018) used Data Envelopment Analysis (DEA) to assess the efficiency of organisations that belong to the same peer group thus this study builds upon this study. The stages of the DEA analysis are as depicted in **Figure 1**.

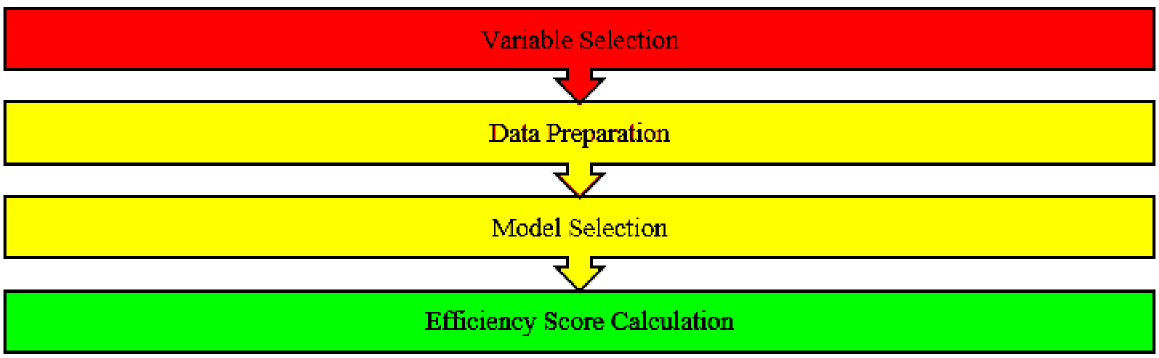

Figure 1. Steps of DEA analysis.

The returns to scale of the variables that are used in the study were tested in order to determine particular DEA model of evaluation of the efficiency of the logistics activities. Given the used variables, scatter plots were generated through SPSS and the correlations among the variables were verified in order to diagnose the returns to scale. An input-oriented CCR model with constant returns to scale (CRS) is used. The mathematical formulation of this CCR input-oriented model with CRS is as follows:

$$\max \frac{\sum_r u_r y_{io}}{\sum_i v_i x_{io}} \tag{1}$$

Subjected to:

$$\frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{io}} \leq 1 \text{ , for j} = 1,2, \dots , n \tag{2}$$

$$\frac{u_r}{\sum_i v_i x_{io}} \geq \in, for\ r = 1,2 \dots , s \tag{3}$$

$$\frac{v_r}{\sum_i v_i x_{io}} \geq \in, for\ r = 1,2 \dots , m \tag{4}$$

To calculate efficiency of the DMUS, you find values for the weight vectors u and v, in such a way that the efficiency measure for this DMU is maximized. To achieve this, we need to calculate the values of u and v that maximises the efficiency score for each 3PL. Efficient 3PLs, according to Cooper et al. (2011) are those with an efficiency score of 1 and inefficient 3PLs are identified as those with an efficiency score of less than 1.

3.2 Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP), offers a powerful method for decision-making. AHP enables the calculation of ratio scores from paired comparisons. This methodology incorporates both qualitative and quantitative aspects. It involves the decomposition of a complex problem into a hierarchy, with goal on top which is the main objective, criteria and sometimes sub-criteria, which are the factors used to evaluate the available alternatives, and decision alternatives at different levels. This hierarchical arrangement allows decision-makers to independently assess each criterion and alternative, enhancing their understanding of the decision environment.

3.3 Data Collection

The data collection process involved interviews with organisation managers who shared their insights on the relative importance of different criteria, analysing existing records and performance metrics of the organisation. The data collected was then inputted into the AHP-OS application. The inputs and outputs of Data Envelopment Analysis served as a basis for the evaluation. The study included 12 third-party logistics providers where stratified sampling was used for selection. Stratified sampling was used to ensure that our sample is a representative of the entire population

3.3.1 Steps Involved in the AHP Approach

Step 1. Construction of hierarchy with an objective at the top, criteria 2nd level and sub criteria at the 3rd level and, the alternatives at the 4th as shown in **Figure 2**.

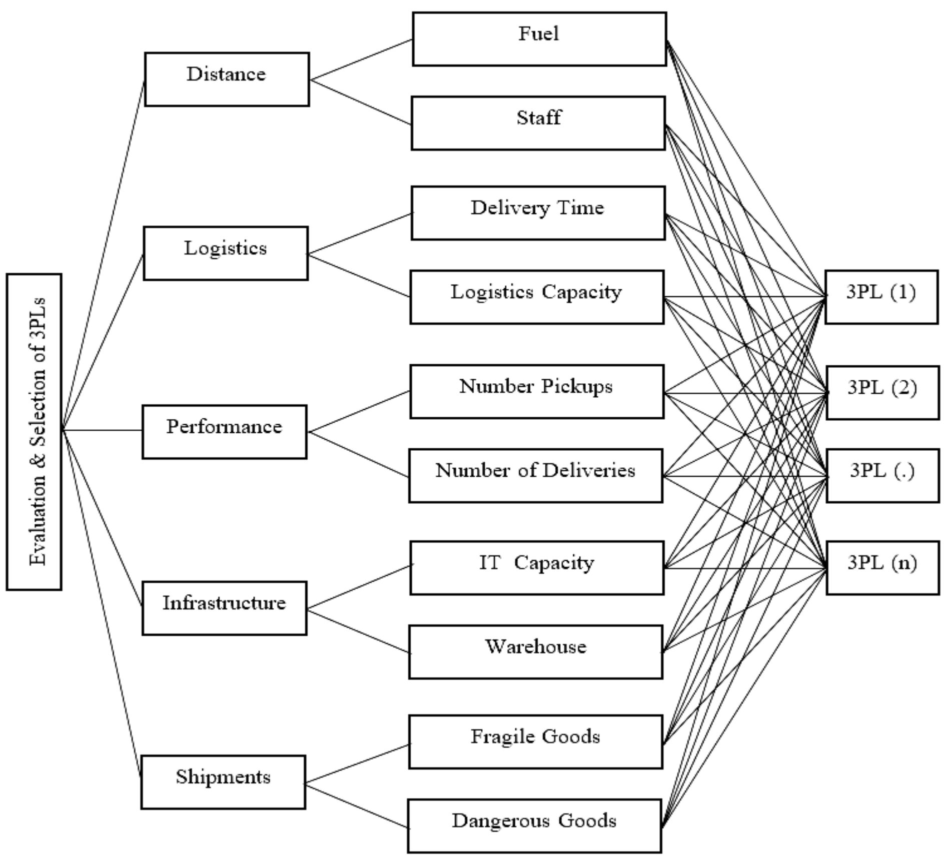

Figure 2. Hierarchy levels.

Step 2. Create a pairwise comparison matrix.

Decision-makers compare the criteria pairwise to evaluate their relative importance. This is typically done using a scale that varies from equally preferred to extremely preferred (**Table 1**), where a higher number indicates a greater preference for one criterion over another.

Table 1. Rating scale.

Importance intensity	Definition	Explanation
1	Equal importance	Two factors contribute equally to the objective.
3	Moderate importance	Experience and judgment slightly favour one over the other.
5	Strong importance	Experience and judgment strongly favour one over the other.
7	Very strong importance	Experience and judgement very strongly favour one over the other. Its importance is demonstrated in practice.
9	Extreme importance	The evidence favouring one over the other is of the higher possible validity.
2,4,6,8	Intermediate values	When compromise is needed.
Reciprocals	Reciprocals for inverse comparison	

Step 3. Calculate the weight of each criterion and sub criterion.

The results from the pairwise comparisons are used to calculate the weights for each criterion. This often involves creating a matrix and applying mathematical techniques to derive the priority vector, which represents the weights.

Calculate the weight / priority of the predetermined criteria. To determine the relative importance and weight of each criterion about the overall objective, a pairwise evaluation of the criteria is necessary. This process begins with an assessment of the relative weight of the initial criteria groups, followed by a comparison of each criterion in pairs to establish their relative importance and contribution to the global goal. In this study, the AHP-OS calculated the weights according to the information inputted by the decision maker.

Step 4. Calculate the weight / priority of each alternative.

After defining the alternatives to be evaluated, calculate the weights of each alternative as in the calculation of criteria weights.

To validate the consistency of subjective judgments and the accuracy of comparative weights, two indices are recommended: The Consistency Index (*CI*) and the Consistency Ratio (*CR*). For reliable results, it is advised that the *CI* value should not surpass 0.1. Additionally, the Consistency Ratio (*CR*) serves as a valuable indicator, calculable using Equation (5) where, RI is given in **Table 2**.

$$CR = \frac{CI}{RI} \tag{5}$$

Table 2. Average ratio index.

No. of elements	3	4	5	6	7	8	9	10	11	12	13
R.I	0.52	0,89	1.11	1.25	1.35	1.40	1.45	1.49	1.51	1.54	1.56

Step 5. Determine Choices: After finding the weights of each criterion and alternatives at different levels in the AHP-based model it reflects the relative importance of each criterion. Higher relative weights or ratings indicate greater importance. This synthesis of judgments demonstrates the comprehensive ability of the hierarchy model, ultimately helping in making the best decision based on the final results. The higher-ranking decision alternative is the optimal solution and thus can be used as a benchmark.

3.4 DEA-AHP Approach

The method combines the quantitative capabilities of data envelopment analysis (DEA) with the subjective evaluation advantages of the Analytic Hierarchy Process (AHP) to create a hybrid approach. The DEA-AHP method steps are depicted in **Figure 3**.

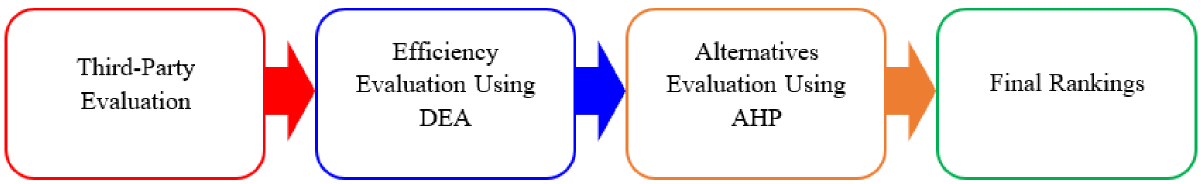

Figure 3. Steps DEA-AHP analysis.

Saaty and Vargas (2012) highlighted how AHP can be hybridised with other multi-criteria methodologies. The final weights or scores for the DEA and AHP hybrid optimisation model can be determined through aggregation of DEA and AHP final scores as illustrated in Popović et al. (2020).

3.5 DEA-AHP Model Challenges

Several challenges that maybe encountered when working with a hybrid model of DEA and AHP include model interpretation challenges (Hong and Qu, 2024), computational complexity as well as the accuracy of the final score maybe affected by personal bias (Tavana et al., 2023).

4. Data Analysis

This section focuses on data analysis following the steps detailed in the methodology section. To conduct the Data Envelopment Analysis DEAP version 2.1 software was used, for the Analytic Hierarchy Process AHP-OS was used and then for the combined analysis Microsoft Excel was used.

4.1 DEA Results

The evaluation of operational efficiency using DEA begins with the selection of appropriate input and output units that can be combined into a unit of overall performance standards (efficiency). The inputs are:
(1) Alert phones (X1)
(2) Trained staff (X2)
(3) Vehicles (X3)
(4) Cost of distribution (X4)
(5) Fuel consumption (X5)
(6) Warehouse capacity/m² (X6)

Meanwhile, the outputs are:
(1) Pickups (Y1)
(2) Deliveries (Y2)
(3) On-time delivery rate (Y3)

Table 3. Efficiency results.

Firm	Score
1	1.000
2	1.000
3	0.737
4	0.947
5	1.000
6	0.842
7	0.947
8	1.000
9	1.000
10	1.000
11	1.000
12	1.000
mean	0.956

Table 3 shows the efficiency of each 3PL, with a score of 1.000 indicating efficiency. The following 3PLs achieved an efficiency score of 1.000, indicating that they are operating at full efficiency: 3PL (1), 3PL (2), 3PL (5), 3PL (8), 3PL (9), 3PL (10), 3PL (11) and 3PL (12). On the other hand, some 3PLs obtained efficiency scores below 1.000, indicating that there is room for improvement in their operations. 3PL (3) achieved an efficiency score of 0.737, 3PL (4) scored 0.947, 3PL (6) scored 0.842, and 3PL (7) scored 0.947. These 3PLs may need to identify areas where they can improve their efficiency to boost their overall performance. The mean efficiency score was 0.956, indicating a considerable level of overall efficiency.

Table 4. Summary of slacks.

Firm / Output	1	2	3			
1	0.000	0.000	0.000			
2	0.000	0.000	0.000			
3	0.000	1.547	0.000			
4	0.000	36.780	0.000			
5	0.000	0.000	0.000			
6	0.000	33.022	0.000			
7	0.000	0.000	0.000			
8	0.000	0.000	0.000			
9	0.000	0.000	0.000			
10	0.000	0.000	0.000			
11	0.000	0.000	0.000			
12	0.000	0.000	0.000			
mean	0.000	5.946	0.000			
Firm / Input	**1**	**2**	**3**	**4**	**5**	**6**
1	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000
3	3917.200	0.737	158.677	1546.991	0.593	0.000
4	2521.561	2.842	49.297	2376.914	0.720	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000
6	2996.250	3.250	121.025	717.184	1.287	0.000
7	937.574	1.877	533.763	735.703	0.802	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000
mean	864.382	0.725	71.897	448.066	0.284	0.000

Input slacks in **Table 4** reveal that 3PL (3, 4, 6, and 7) had slacks in their inputs, indicating that these firms could potentially reduce their input usage without affecting their output levels. The absence of slacks in the first and third outputs across all firms indicates that these outputs were fully utilised. This suggests that the 3PLs used their resources to achieve the desired outputs in these areas. 3PLs (3, 4, and 6) have slacks in the second output which suggests that these firms could potentially increase their output in this area without requiring additional inputs.

Table 5. Levels of inputs and outputs.

Firm / Output	**1**	**2**	**3**			
1	1520.000	11300.000	85.000			
2	345.000	10.000	90.000			
3	58.000	27.547	70.000			
4	88.000	42.780	90.000			
5	658.000	355.000	95.000			
6	174.000	56.022	80.000			
7	67.000	26.000	90.000			
8	32.000	27.000	71.000			
9	367.000	20.000	87.000			
10	16.000	3.000	95.000			
11	2700.000	15.000	95.000			
12	42.000	11.000	65.000			
Firm / Input	**1**	**2**	**3**	**4**	**5**	**6**
1	12500.000	10.000	2000.000	6000.000	3.000	2.000
2	7500.000	3.000	204.000	3800.000	2.000	1.000
3	2714.379	1.474	195.007	1400.377	0.144	0.737
4	3636.334	1.895	253.861	1886.244	0.227	0.947
5	10000.000	2.000	400.000	5600.000	2.000	1.000
6	3740.592	1.802	333.712	1977.553	0.397	0.842
7	3325.584	1.913	262.027	1704.718	0.146	0.947
8	11100.000	4.000	75.000	2590.000	0.000	1.000
9	9500.000	3.000	230.000	2500.000	2.000	1.000
10	3000.000	2.000	250.000	1500.000	0.000	1.000
11	9600.000	7.000	4500.000	5500.000	4.000	1.000
12	2300.000	4.000	80.000	2800.000	2.000	1.000

The target summary shows the levels of inputs and outputs that 3PLs should be using or producing to be efficient. The output and input targets serve as standard for evaluating the performance of each agent as shown in **Table 5**. Comparing the actual values with the target values can help identify areas where each agent can improve its performance. For example, Input 5 for 3PL 3 can be increased, to become efficient as its peers.

4.2 AHP Results

To apply the Analytic Hierarchy Process (AHP) for comparing 12 third party agents, this research considered criteria such as distance, performance, shipment, logistics, and infrastructure. Each criterion has specific sub-criteria that were taken into consideration during the evaluation process. The Analytic Hierarchy Process (AHP) model is a structured decision-making approach consisting of four phases: problem structuring, data collection, normalised weight determination, and solution synthesis. The model also includes an evaluation system with five criteria categories, outlined in **Table 6**, to provide a comprehensive framework for decision-making.

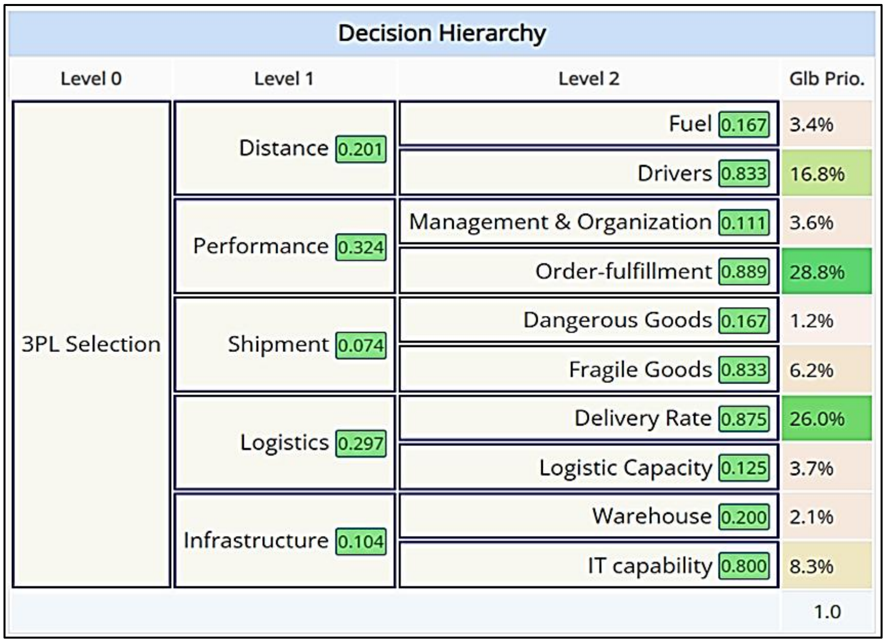

Figure 4. Criteria weights.

Table 6. Criteria selection.

Criteria	Sub-criteria	Explanation
Performance	• Management and organisation • Order fulfilment	• The performance serves as a gauge of how effectively a 3PL provider manages and organizes its operations. The objective is to maximize performance. This implies that both the general management and organization of the 3PL provider, as well as the specific task of order fulfilment, should be optimised. The aim is to ensure the highest level of performance, thereby enhancing the overall efficiency and effectiveness of the 3PL provider.
Logistics	• Delivery rate • Logistics capacity	• In the context of logistics, the delivery rate is crucial for evaluating the efficiency of last-mile delivery processes, while logistics capacity measures a company's ability to handle goods effectively and sustainably.
Distance	• Drivers • Fuel consumption	• Distance measures the fuel consumption of 3PL providers and the drivers responsible for it.
Infrastructure	• Warehouse • IT capability	• Infrastructure considers warehouse storage and IT capability. 3PL which has a bigger storage space tends to perform better.
Shipments	• Fragile goods • Dangerous goods	• Shipment refers to shipment handling of special goods ensuring the 3PL provider follows DHL standards and procedures in handling the goods.

The results indicate the relative weights and rankings of each criterion. **Figure 4** shows that the general positioning is based on the global value obtained through the AHP approach. This global value is determined by multiplying the relative weight of each criteria category by the relative weight of its sub-criterion, yielding a comprehensive global weight that drives the positioning decision. The selection of 3PL services is influenced by several criteria. The most influential criterion is the performance criterion with a weight of 0.324. The second most influential criterion is logistics criteria with a weight of 0.297. The third criterion is the distance criteria with a weight of 0.201. The fourth criterion is the infrastructure criteria with a weight of 0.104, and the fifth criterion is the shipment criteria with a weight of 0.074. **Figure 5** depicts the criteria overall results in a bar graph.

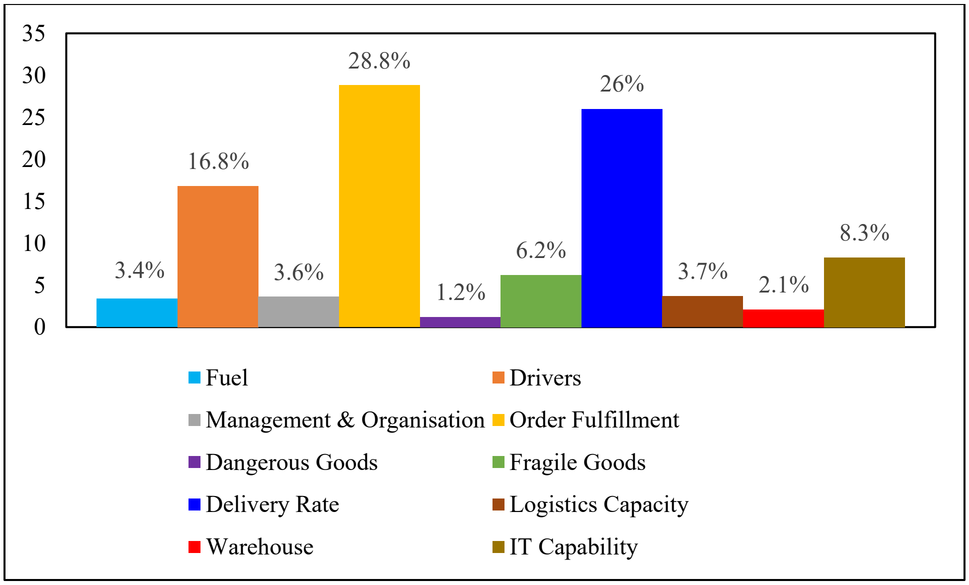

Figure 5. Criteria results graph.

The top-performing Third-Party Logistic Provider, Alternative 1, shows the greatest adherence to the defined objective, with a contribution of 0.1657. **Figure 6** highlights the rankings, demonstrating the importance of the differences in weights and priorities. With the highest score of 0.1657, 3PL 1 is selected as the top provider.

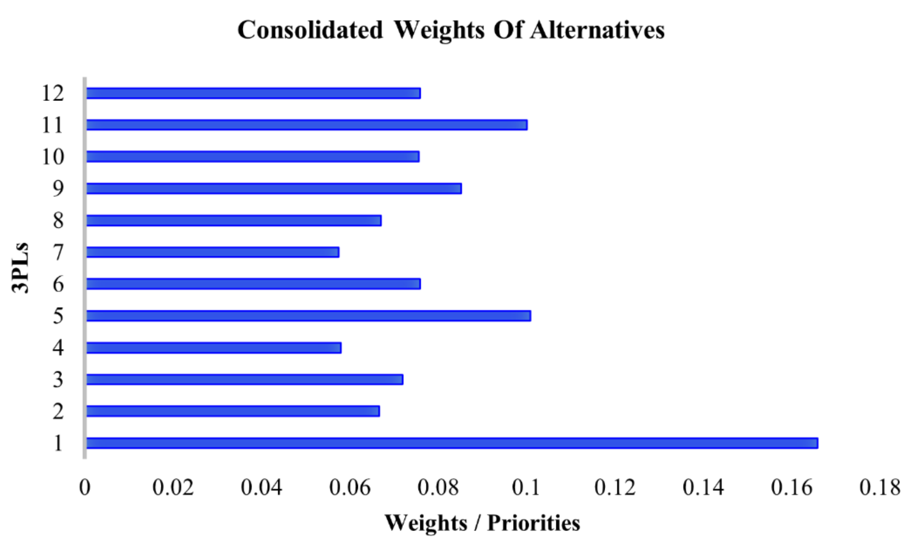

Figure 6. Decision alternative ranking.

The results of this study differ from those of other studies, and this discrepancy may be attributed to differences in the interests of decision-makers in each company. In this particular study, the highest priority is given to performance, indicating that customers highly value timely and cost-effective services.

Therefore, on-time delivery and cost efficiency are considered the essential aspects of service excellence provided by third-party logistics (3PLs). Simatupang and Sridharan (2002) emphasise the significance of meeting customer expectations by delivering high-quality services efficiently and cost-effectively.

In a separate research conducted by Suryono and Julius (2019), they reviewed the findings which utilized the AHP to select goods delivery services for online shops. The results revealed that the most important criteria are area coverage.

4.3 Integrated DEA-AHP Results

The results were obtained by multiplying the efficiency values with the weights from AHP as used in the study by Popović et al. (2020). The analysis was done on AHP-OS software and the aggregated scores and ranks are given in **Table 7**.

Table 7. Aggregate scores evaluation.

3PL	DEA	AHP weights	Aggregate efficiency	Std aggregate score	Overall rank
1	1.000	0.166	0.166	0.172	1
2	1.000	0.067	0.067	0.069	8
3	0.737	0.072	0.053	0.055	12
4	0.947	0.058	0.055	0.057	10
5	1.000	0.101	0.101	0.105	2
6	0.842	0.076	0.064	0.066	9
7	0.947	0.057	0.054	0.056	11
8	1.000	0.067	0.067	0.070	7
9	1.000	0.085	0.085	0.088	4
10	1.000	0.076	0.076	0.078	6
11	1.000	0.100	0.100	0.104	3
12	1.000	0.076	0.076	0.079	5

3PL (1) still remains the most efficient 3PL with an overall score of 0.172, 3PL (5) and 3PL (11) follow with scores of 0.105 and 0.104, respectively. 3PL (9), 3PL (10) and 3PL (12) exhibit moderate efficiency scores, ranging from 0.079 to 0.088. The remaining 3PLs, 3PL (2), 3PL (3), 3PL (4), 3PL (6), 3PL (7) and 3PL (8) demonstrate relatively low-efficiency scores, less than 0.070.

The 3PLs have been ranked based on their new combined weighted DEA scores, providing a clearer picture of their performance. Areas of improvement can be identified from the results of this study and as a result decisions maybe improved when it comes to resource allocation and operational efficiency.

5. Implications for the Logistics Industry in Zimbabwe

This study has several positive implications to the logistics industry in Zimbabwe. The identification of efficient and non-efficient as well as ranking of the 3PLs can enhance the decision making process when it comes to the selection process. Informed selection process can improve the quality of service delivery as well as minimising unnecessary operational costs. On the other hand, DEA benchmarking provides a platform on which logistics companies in Zimbabwe can compare their performance against the most performing logistics companies. Logistics companies can focus of the key criteria identified in this research when selecting the best 3PLs company to partner with in the competitive business environment.

5.1 Practical Implications for Logistics Managers and Policy Makers

The research findings also have practical implications for logistics managers and policymakers thus,

(a) ***Performance Evaluation*****:** Logistics managers can use the DEA-AHP to evaluate 3PLs helping them identify areas for improvement, optimise resource allocation and establish efficient operations.

(b) ***Policy Formulation*****:** The study promotes efficiency in the logistic industry thus policymakers can use information and results of the study as a basis in policy formulation in encouraging efficiency in 3PL and company relationships.

(c) ***Infrastructure Development*****:** Policymakers can prioritise infrastructure development in areas that support the growth and efficiency of the logistics industry.

(d) ***Industry Standards*****:** The findings can play a crucial role in setting industry standards for the efficiency of 3PL provide organisations can create guidelines that help operations and maintain a consistent service throughout the industry.

6. Conclusion

The research aimed at evaluating efficiency of Third-Party Logistics (3PL) providers to assist in decision-making to improve resource allocation and reduced corruption. The analysis was done using DEAP 2.1 and AHP-OS software. 12 3PLs providers were analysed, revealing 8 3PLs with an efficiency value of 1, indicating high overall efficiency. The AHP analysis results show performance as the most influential criterion in 3PL provider selection. However, Suryono and Julius (2019) argue that the effectiveness of AHP could be influenced by the bias of the decision-maker.

6.1 Scope for Future Research

Future studies should focus on extending the application of the DEA and AHP hybrid model to areas such as health, education, elections, politics, emergency management, agriculture productivity, military operations research, and manufacturing among other areas. Other hybrid models can be considered that combines more than two methodologies. For example, DEA-AHP-SWARA-TOPSIS hybrid model. Future research could examine the impact of Artificial Intelligence (AI), Internet of Things (IoT), and block chain on the overall efficiency and selection of 3PL providers.

Conflict of Interest

The authors declare no conflict of interest.

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