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THE STUDY OF GREEN LOGISTICS PERFORMANCE INDEX: FREIGHT TRANSPORTATION INDUSTRY AT PADANG BESAR CONTAINER TERMINAL (PBCT)

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ABSTRACT

This research introduces the Green Logistics Performance Index (GLPI), a benchmarking tool intended to evaluate the extent to which companies employ environmentally friendly logistics practices. The GLPI, which combines the Logistics Performance Index (LPI) with the Environmental Performance Index (EPI), is a comprehensive metric inspired by The World Bank's LPI. The GLPI aligns with the Malaysian National Transport Policy (2019–2030) and the United Nations Sustainable Development Goals. If Malaysia does not adopt green logistics techniques, the GDP of the country may suffer. The study uses quantitative data analysis in a cross-sectional, descriptive manner. At the Padang Besar Container Terminal, a questionnaire is used to collect data. Mean scores, correlation, regression, and ANOVA are among the statistical analyses used. The results show a moderate to high degree of Green Administration, Green Technology, Green Transportation, and Green Logistics Performance Index with good reliability as indicated by the Cronbach Coefficient Alpha Values of GLPI (.862), GA (.888), GT (.737), and GTR (.755). The study's conclusions add to the expanding corpus of information on green logistics and lay the groundwork for future investigations and the formulation of new regulations aimed at achieving ecologically friendly supply chain practices.

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Introduction

Utilising the LPI, an interactive benchmarking tool, has many benefits, including helping organisations meet sustainability targets, identifying trade logistics opportunities and problems, and comparing national logistics performance (Aldakhil *et al*., 2018; Rezaei *et al*., 2018). The transport industry has the fastest rate of development for greenhouse gas emissions, according to Wang and Ge (2019). Thus, the transportation sector needs to adopt green transportation technologies. When it comes to green mobility, energy-efficient forms of transport are the main focus of conversation. This covers alternative fuel-powered cars, such as hybrid or electric models, sustainable energy-powered public transit, and active transportation choices, such as cycling or walking. This study introduces the Green Logistics Performance Index (GLPI), which enables us to evaluate the extent to which various nations or companies use eco-friendly logistics practices. The same technique serves as the foundation for both the World Bank's (2010) GLPI and Logistics Performance Index (LPI). The Environmental Performance Index (EPI) and the Logistics Performance Index (LPI) have been merged to form the new Green Logistics Performance Index (GLPI). The GLPI serves as a valuable tool for assessing the effectiveness of green logistics practices. Du and Li (2019) define "green technology" as the development and implementation of innovative products,

processes, and technologies that positively impact the environment.

In order to solve environmental issues like climate change and support sustainable economic growth, green technology is crucial (Du & Li, 2019). It is somewhat similar to the Logistics Performance Index (LPI), where data are gathered on various aspects of logistics performance for different industries or countries, and the more comprehensive our data is (covering different green logistics activities and involving more industries or countries), the better these comparisons and benchmarks are. The LPI, which takes into account a wide range of factors such as infrastructure, technology, service quality, and governmental rules, takes a different approach to logistics performance than the Green Logistics Performance Index (GLPI). It focuses on how much money a country or industry invests in environmentally friendly projects, how advanced its technology is, and how well it adheres to environmental regulations. These factors, according to Karaman *et al*. (2020), allow us to evaluate how well a nation or business is doing in green logistics. A very similar methodology was used to generate the GLPI and the LPI by rating a company's performance on a five-point scale across a range of green logistics tasks. These numerical ratings, which go from 1 (the lowest) to 5 (the highest), are used as benchmarks to show how an industry business is doing relative to others, regardless of how well or poorly it performs in these surveyed activities. The GLPI is then created by taking a weighted average of these performance scores (Fan *et al*., 2022).

The GLPI relies on businesses to assess and report on how they are doing in the green logistics activities that are being surveyed, in contrast to the Logistics Performance Index (LPI), which collects input from experts and logistics companies conducting business with the countries under examination to assess various aspects of logistics performance. This strategy was chosen for valid reasons. First, because green logistics activities frequently involve smaller, internal operations, most practices are still maintained within the firms themselves. Second, there are not many resource constraints because this study was first intended to serve as a pilot project to illustrate the idea of the GLPI. As a result, an expert panel was unable to be hired to carry out the evaluations.

Research Background

The world community has seen a rise in environmental sustainability awareness as well as a pressing need to solve the ecological problems brought on by industrial processes and transportation infrastructure. In response to this pressing need, the concept of "green logistics" has emerged as a key component of sustainable supply chain management. Green logistics refers to an all-encompassing strategy that minimises the environmental impact of transportation and logistics activities. This includes integrating eco-friendly practises throughout the logistics chain, minimising emissions, and making optimal use of resources. One important indicator for evaluating and comparing the environmental sustainability of logistics and transportation operations is the "Green Logistics Performance Index".

By enhancing ports, terminals, and airports, the Green Logistics Performance Index (GLPI) helps nations improve their green logistics performance by promoting trade, streamlining access to local and international markets, and enabling timely shipment delivery. Additionally, it lowers greenhouse gas emissions and energy usage. The Green Logistics Performance Index (GLPI), an interactive benchmarking tool, has several benefits, including helping businesses that operate or plan to operate in these countries meet sustainability goals, identifying trade logistics opportunities and challenges, and providing a comparative summary of logistics frameworks between countries. It also evaluates the efficiency of international logistics (Karaman *et al*., 2020).

By merging several indicators and components into a single index, the overall effectiveness of sustainable logistics practises is evaluated. It can include factors such as waste

management, fuel economy, carbon emissions reduction, and compliance with environmental laws. Analysing the correlation between the Green Logistics Performance Index and the three primary sustainability dimensions "Green Transportation", "Green Technology", and "Green Administration" is important because it can improve the comprehension of how sustainable logistics practises affect other business and management domains.

The GLPI enforces environmental norms and policies, which are carried out through the process of Green Administration (GA). Green Technology (GT) is the process of integrating environmentally friendly technologies into an industry's or nation's logistics practices. Since Green Transportation (GTR) and the Green Logistics Performance Index (GLPI) are related, the Green Logistics Performance Index (GLPI) evaluates how well companies and industries comply with these regulations as part of their overall green logistics performance. This includes assessing the effectiveness of government regulations and their impact on encouraging environmentally sustainable logistics practices. Each of these elements is essential to achieving sustainability objectives. Through rigorous data analysis and statistical methods, this study seeks to provide insights into whether a higher Green Logistics Performance Index is correlated with more sustainable practices in the domains of transportation, technology, and administration, ultimately contributing to the achievement of broader environmental sustainability goals. In the subsequent sections, this research will delve into the methodology, data analysis, findings, and implications of these relationships, offering valuable contributions to the field of green logistics and sustainability management.

Problem Statement

Increasing environmental concerns and regulatory pressures are driving the need for more sustainable and eco-friendly practices in logistics operations. However, many organisations face challenges in effectively implementing and measuring the performance of green logistics initiatives. This includes issues related to optimising transportation routes to minimise emissions, adopting energy-efficient technologies, managing waste and recycling, and ensuring compliance with environmental regulations (Rosanoa *et al*., 2022). Additionally, according to Zhou *et al*. (2019), the assessment of the environmental impact of logistics operations is bereft of standardised criteria and performance indicators. The development and implementation of efficient techniques for enhancing green logistics performance is therefore imperative in order to lessen the environmental impact of supply chain activities while preserving productivity and profitability. When it comes to environmental safety, international organisations like the United Nations (UN) have been firm.

An overview of several programmes, such as the United Nations Environment Programme (UNEP), which advocates for the environment within the UN system and has a global environmental agenda that encourages the cogent application of sustainable development's environmental component. It works on a wide range of issues, including climate change, biodiversity, pollution, and sustainable consumption and production. Another famous policy implemented by the UN is the Sustainable Development Goals, a set of 17 interconnected objectives that will be part of the sustainable development agenda by 2030. These objectives address a wide range of global issues, such as hunger, poverty, health, education, and environmental sustainability. One Sustainable Development Goal that can be directly related to environmental protection and sustainability is Goal 12: Responsible Consumption and Production, which most logistics companies are looking to achieve by practising green logistics (United Nations, 2015).

From the Malaysian government's point of view, one policy that caught the eyes of the logistics industry has been introduced as of late 2022 to reconstruct the framework of the logistics world. The policy mentioned is the Malaysia National Transport Policy (2019–2030). The

Malaysian government's National Transport Policy (2019–2030) aims to create a sustainable, efficient, and integrated transportation system. It prioritises safety, environmental responsibility, and connectivity for economic growth and societal well-being. This program focuses on reducing emissions from freight transportation. It encourages the adoption of fuel-efficient technologies, route optimisation, and other measures to minimise environmental impact (Ministry of Transport, 2019). If organisations do not embrace this strategy, especially those in the transportation and logistics sector, Malaysia would suffer. Developed nations like the United States, France, and even Germany have made progress in maintaining a more dependable, effective, and—above all—eco-friendly logistics sector. Furthermore, the OECD (2021) projects that by 2030, the logistics sector in Malaysia will account for 35.10 billion USD, or almost 13% of the nation's GDP, or 26.35 billion USD in 2023. The result of not adopting green logistics in time may cause the entire industry to be left behind by its competitors who keep improving every day.

Research Question and Research Objective

The research sought to answer the following questions:

i. What is the level of green logistics performance index of the freight transportation industry at Padang Besar Container Terminal (PBCT)?

ii. Is there any significant relationship between green transportation, green technology, green administration, and the green logistics performance index in the freight transportation industry at Padang Besar Container Terminal (PBCT)?

iii. Which independent variables, green administration, green technology, and green transportation, have the most impact on the green logistics performance index in the freight transportation industry at Padang Besar Container Terminal (PBCT)?

The research sought to achieve the following objectives:

i. To determine the level of green logistics performance index of the freight transportation industry at Padang Besar Container Terminal (PBCT).

ii. To determine the potential significant relationship between green transportation, green technology, green administration, and the green logistics performance index in the freight transportation industry at Padang Besar Container Terminal (PBCT).

iii. To determine which independent variables, green administration, green technology, and green transportation, have the most impact on the green logistics performance index in the freight transportation industry at Padang Besar Container Terminal (PBCT).

Literature Review

The Scholar and Relationship between Variables

The main focus of the current study is the application of Social Exchange Theory, Blau's conceptual framework from 1964. This theory clarifies human behaviour and the intricate social systems that support interactions inside companies by fusing sociological and psychological concepts. According to Meira (2021), researchers such as Choi and Lotz (2018) and Kim and Qu (2020) have further extended and applied Social Exchange Theory in diverse organisational contexts, providing a solid foundation for understanding the dynamics between employees and their organisations. In Table 1, the relationships between variables pertinent to this study are summarised based on Ismail (2012). This table, presented on the subsequent page, serves as a valuable reference point, encapsulating the scholarly insights that inform the current research. By drawing on Ismail (2012), this study builds on established knowledge and seeks to contribute novel perspectives to the discourse on green logistics performance. The following sections will expound upon the specific relationships outlined in Table 1, offering a detailed exploration of the

variables under scrutiny and the dynamics that shape their interplay within the context of green logistics.

Together, the academic works included in Table 1 demonstrate the complex interrelationships among Green Transportation, Green Technology, Green Administration, and Green Logistics Performance Index (GLPI). Interestingly, Karaman *et al*. (2020) examine the relationship between sustainability reporting and green logistics performance and find a positive correlation, with corporate governance acting as a major moderator. This insight establishes a vital link between ecologically conscious logistical operations and the broader corporate governance framework. By extending the focus to green administration, studies by Elshaer *et al*. (2023), Shou *et al*. (2023), and Karaman *et al*. (2020) all attest to the positive effects of green management practices on social, environmental, and financial results. Furthermore, staff engagement in pro-environmental actions amplifies this effect, highlighting the link between employee involvement and organisational strategy in achieving sustainable results.

Suhaiza Zailani *et al*. (2011, 2014) and Anser *et al*. (2020) offer valuable perspectives on the uptake of environmentally conscious innovations and the acceptability of environmentally friendly technology models in the field of green technology. The findings highlight the critical role that green investments play in promoting green product creation, influencing green buying decisions, and forming good attitudes towards technology. This synthesis demonstrates how technology integrates with sustainable practices in logistics operations and the larger supply chain. Lu *et al*. (2019), Klimecka-Tatar *et al*. (2021), Zhou *et al*. (2023), Raut *et al*. (2019), and Trivellas *et al*. (2020), Turning to Green Transportation, all together clarify the various facets of ecologically aware transportation. The findings stress how crucial it is to consider energy use, CO2 emissions, and fossil fuels when evaluating green transportation. Furthermore, the integration of sustainability practices, route optimisation, and performance indicators highlights the comprehensive strategy needed to achieve sustainable supply chain and company performance.

Table 1: The scholar between variables

Variable	Green Logistics Performance Index	Green Administration	Green Technology	Green Transportation
Green Logistics Performance Index		Karaman, A. S., Kilic, M., & Uyar, A. (2020).	Lu, M., Xie, R., Chen, P., Zou, Y., & Tang, J. (2019); Suhaiza Zailani, Azlan Amran & Herina Jumadi 2011	Khan, S. A. R., Zhang, Y., Anees, M., Golptra, H., Lahmar, A., & Qianli, D. (2018); Lu, M., Xie, R., Chen, P., Zou Y. &Tan J. 2019
Green Administration	Karaman, A. S., Kilic, M., & Uyar, A. (2020).		Elshaer, 1. A., Azazz, A. M. S., & Fayyad, S. (2023); Shou, Y., Wu, C., Shao J., Hu, W. & Lai, K.H. (2023)	Zhou, B., Siddik, A. B., Zheng, G.-W., & Masukujjaman, M. (2023); Raut, R. D., Luthra, S., Narkhede, B. E., Mangla, S. K., Gardas, B. B., & Priyadarshinee, P. (2019); Trivellas, P., Malindretos, G., & Reklitis, P. (2020).

Green Technology	Suhaiza Zailani, Mohammed Iranmesh, Nikbin, D. & Herina Binti Jumadi. (2014); Zailani, S., Amran, A., & Jumadi H. 2011	Zailani, S., lranmanesh, M., Nikbin, D., & Jumadi, H.B. (2014)		Anser, M. K., Yousaf, Z., & Zaman, K. (2020)
Green Transportation	Lu, M., Xie, R., Chen, P., Zou, Y., & Tang, J. (2019).	Klimecka-Tatar, D., lngaldi, M., & Obrecht, M. (2021)	Lu, M., Xie, R., Chen, P., Zou, Y., & Tang, J. (2019).	

Research Methodology

In conducting this study, the chosen research design was a descriptive study involving quantitative data analysis. Researchers employed survey research, specifically utilising questionnaires, to gather responses from participants. The focus was on examining the green logistics performance index within freight transport companies at the Padang Besar Container Terminal. A research design serves as a comprehensive plan, encompassing specific methods for collecting and analysing relevant data from the study population to address the stated research problem (Creswell, 2017). The selection of a quantitative approach was driven by its suitability, formality, and objectivity in describing and scrutinising relationships, as well as statistically calculating correlations among the study variables (Zikmund *et al*., 2013).

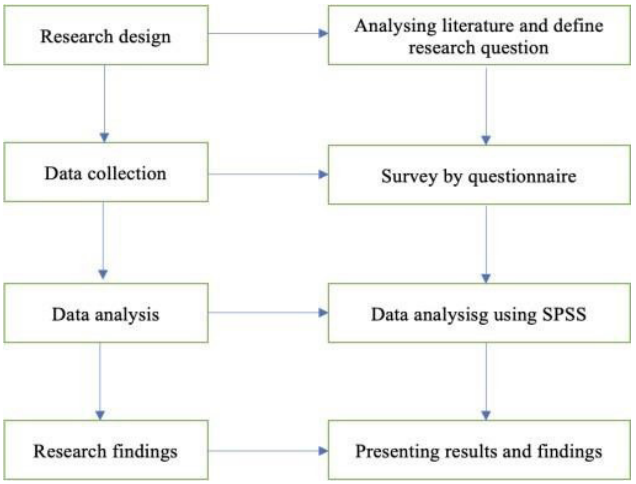

Figure 1: Research flowchart

The study setting was non-contrived, and a cross-sectional design was employed as a quantitative research method. The study adopts a non-manipulative approach with minimal interference by the researchers. This means that the researchers do not manipulate or influence the data collected. The study is conducted in a non-contrived setting, specifically at Padang Besar Container Terminal (PBCT), making it a field study. The time horizon for the research is cross-sectional. In a cross-sectional study, researchers collect data from a population at a specific point in time. No continuous data collection needed.

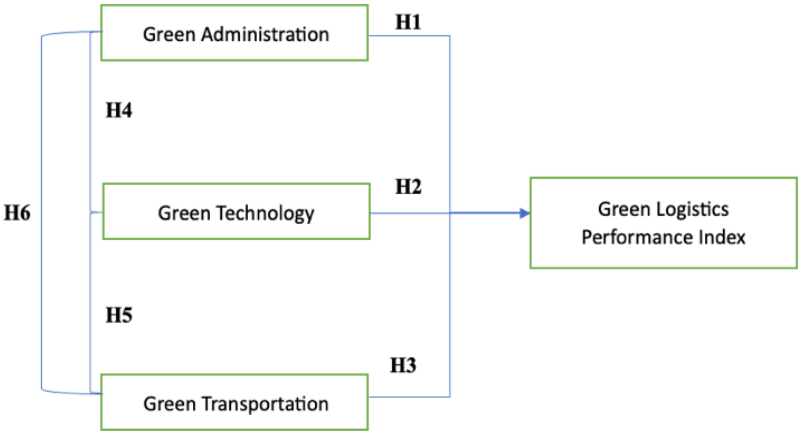

Figure 2: Research framework

Construction of the Green Logistics Performance Index (GLPI)

The GLPI was developed as a composite organisational-level performance index designed to evaluate the extent to which freight transportation companies implement environmentally sustainable logistics practices. Unlike conventional logistics performance measures that primarily assess operational efficiency, the GLPI integrates environmental sustainability into logistics performance evaluation through three core dimensions: Green Administration (GA), Green Technology (GT), and Green Transportation (GTR).

The development of the GLPI involved four sequential stages. First, measurement indicators representing each dimension were adapted from established literature on green logistics and environmental sustainability. Second, respondents evaluated each indicator using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Third, individual item scores within each construct were aggregated by calculating the arithmetic mean to obtain composite scores for Green Administration, Green Technology, and Green Transportation. Finally, the overall GLPI score was computed by combining these three composite dimensions into a single index representing the organisation's overall green logistics performance.

Population, Sample Size and Sampling Technique

A sample is a portion of the population that has been chosen according to certain standards (Sekaran & Bougie, 2014). A non-probability convenience sampling strategy was used to distribute surveys to the target group. A total of ten freight transportation businesses at Padang Besar Container Terminal (PBCT) were given surveys via email, phone calls, and in-person contacts over the course of two weeks. According to Zikmund *et al*. (2013), the population is the whole set of individuals, occasions, things, or documents that researchers have looked at and that have similar characteristics. The enterprises operating at Padang Besar Container Terminal (PBCT) that carry goods make up the population of this research. The emphasis is specifically on middle management personnel who have handled business operations before. It is advised that 10 employees from each organisation participate in this research, with a goal of 100 responses overall.

Within the realm of organisational management and research, middle management assumes a pivotal role in facilitating communication between top-level executives and frontline employees. Positioned as department heads, team leaders, or supervisors, middle managers are responsible for translating high-level organisational goals into actionable

plans, overseeing day-to-day operations, and ensuring the efficient achievement of strategic objectives. Because access to respondents depended on company approval and the availability of middle management personnel, this study employed a non-probability convenience sampling technique. This approach was considered appropriate because the target respondents possessed the specific operational knowledge required to evaluate green logistics practices within their respective organisations. Although convenience sampling limits statistical generalisation to the broader logistics industry, it is widely accepted in exploratory organisational studies where access to specialised respondents is constrained.

Data Collection Method

In the context of this study, primary data was acquired through a questionnaire survey targeting middle management professionals in freight companies situated at Padang Besar Container Terminal (PBCT). The questionnaire was divided into two primary sections: demographic questions were asked in the first portion, while the second portion covered research questions on independent variables, including green administration, green technology, and green transport. The dependent variable under scrutiny was the Green Logistics Performance Index. Companies received questionnaires via Google Forms, and respondents rated each item on a 5-point Likert scale, with strongly disagree (1) and strongly agree (5) being the extremes. A total of 31 items were included in the six sections of the poll, excluding the demographic question.

Data Analysis Method

The survey questionnaire underwent coding and analysis utilising the Statistical Package for the Social Sciences (SPSS 23). The analytical process encompassed both descriptive and inferential analyses. Frequency counts and percentages were applied to all survey variables, while mean scores were employed for the Green Logistics Performance Index and image variables. Two distinct statistical techniques were employed in the data analysis: (1) Descriptive statistics, encompassing frequency descriptions, standard deviation, and means; and (2) Inferential statistics, which included correlation analyses, regression analysis, significance testing (level), and Analysis of Variance (ANOVA). The data analysis commenced with a reliability test, utilising Cronbach's Alpha, to assess the consistency and accuracy of the items within each variable. Reliability, in this context, refers to the degree to which the results are consistent over time and faithfully represent the entire study population. In this study, all variables underwent testing for internal consistency. The goal of this test was to assess the measurement's dependability for the study. Internal consistency was chosen to ensure that each scale item or indicator measured the same construct efficiently, resulting in a high degree of correlation (Churchill, 1979; Nunnally, 1978). Cronbach's alpha, recognised as the most common and widely accepted metric for internal consistency reliability (Cavana *et al*., 2001), is presented in Table 2 detailing the findings of the reliability test.

Table 2: Results of reliability test

Research Instrument	No. of Items	N	Cronbach Coefficient Alpha Value
Green Logistic Performance Index	7		.862
Green Administration	9	100	.888
Green Technology	8		.737
Green Transportation	8		.755

Analysis and Result

Profile of Respondents

This section contains a full description of the respondents' demographic characteristics. The questionnaires were distributed to 10 middle management staff members from each company and ten goods transportation companies at random. The focus of this study was on the effectiveness of green logistics in day-to-day corporate operations. Based on the descriptive statistics of the background data from Section A of the questionnaire, a profile of the respondents and the characteristics of their firms is provided below. The next subsections include an overview of the descriptive statistics of the respondent profiles.

Table 3: Respondent's demographic profile

Profile	Frequency	Percentage (%)
Company Name		
BBF Logistics	10	10.0
Dong Hua Forwarding Agent Sdn. Bhd.	10	10.0
E.A.E Freight & Forwarding Sdn. Bhd.	10	10.0
Infinity Logistic and Transport	10	10.0
Setia Kawan Forwarding Agencies Sdn. Bhd.	10	10.0
Shee Mah Forwarding	10	10.0
Sino Malay Thai Forwarding Agent	10	10.0
Straits Forwarding Agency	10	10.0
Thaimal Forwarding Agent	10	10.0
Yong Seng Chan	10	10.0
Type of Truck Fleet		
A Permit	30	30.0
C Permit	30	30.0
KA Permit	40.0	40.0
Nature of Company		
Partnership investment	20	20.0
Private investment	80	80.0
Period of Operation		
≥ 30 years	30	30.0
11–20 years	10	10.0
21–30 years	60	60.0
Number of Employees		
≤ 20	56	56.0
21–50	24	24.0
501–1000	10	10.0
51–100	10	10.0
Number of Vehicles		

2.0	8	8.0
3.0	10	10.0
5.0	20	20.0
8.0	30	30.0
10.0	22	22.0
16.0	10	10.0

Descriptive Statistics of Variables of Study

Based on a 5-point Likert-type scale, the mean and standard deviation scores for the green transportation, green technology, green administration, and green logistics performance index are at a modest level.

Table 4: Descriptive statistics of all constructs

Variables/Dimensions	N	Mean	Std. Deviation
Green Logistics Performance Index	100	4.1514	.52590
Green Administration		3.6156	.54580
Green Technology		4.1275	.39528
Green Transportation		4.0188	.45657

Note: Calculations for the analysis are based on sum scores. Based on a Likert-type scale of 1 (strongly disagree) to 5 (strongly agree)

The GLPI score represents the average environmental sustainability performance of participating organisations across the three dimensions of Green Administration, Green Technology, and Green Transportation. Higher GLPI values indicate stronger implementation of environmentally sustainable logistics practices, whereas lower scores suggest greater opportunities for organisational improvement. Because all dimensions were measured using the same five-point scale, the resulting GLPI remains directly interpretable within the original measurement framework.

Thus, this suggests that the Padang Besar Container Terminal (PBCT) has a moderate degree of green logistics performance index, green administration, green technology, and green transportation for freight transportation. The green logistics performance index, which is accounted for at 4.15, appears to be higher than all other constructs in this study. Green transport received a score of 401 and green technology, 4.12. Green administration is rated lower than others, at 3.61. Nonetheless, the study's overall mean scores for every variable fall into the high to moderate range. Overall, the analysis's findings showed that the levels of green technology, green transportation, green administration, and green logistics performance index fell into the moderate range. Nonetheless, the study's overall structures had a very high mean score.

Test of Differentiation

To examine the variations in the demographic parameters, inferential statistics analyses were carried out in this section. A one-way ANOVA was used to compare two or more groups appropriately. The following lists the research hypotheses:

i. There is a significant difference between companies in their green logistics performance index level.

ii. There is a significant difference between companies' number of vehicles and the green logistics performance index level.

iii. There is a significant difference between companies' types of trucks on the green logistics performance index level.

iv. There is a significant difference between companies' type of ownership on the green logistics performance index level.

v. There is a significant difference between companies' periods of operation on the Green Logistics Performance Index level.

vi. There is a significant difference between companies' number of employees on the Green Logistics Performance Index level.

vii. The analyses' comprehensive results are displayed in accordance with the theories' dissections, as the next subsection explains.

Table 5: ANOVA result on demographic

Profile	F	Sig.
GLPI* company name	24.722	.000
GLPI* type of truck fleet	13.676	.000
GLPI* nature of company	9.618	.003
GLPI* period of operation	5.110	.008
GLPI* number of employees	5.211	.002
GLPI* number of vehicles	31.239	.000

An ANOVA test was conducted to identify factors influencing Green Logistics Performance Index (GLPI) across a diverse spectrum of companies. Utilising Analysis of Variance (ANOVA), the study scrutinised various dimensions, including company name, type of truck fleet, nature of company ownership, period of operation, number of employees, and number of vehicles. The findings underscored the significance of nomenclature, revealing statistically significant differences in GLPI among companies ($F = 24.722$, $p = .000$). Moreover, the type truck fleet emerged as a pivotal determinant, with distinctive variations noted in GLPI across various fleet types ($F = 13.676$, $p = .000$). Company ownership structure also played a substantial role, as evidenced by significant differences in GLPI based on ownership types ($F = 9.618$, $p = .003$). Furthermore, GLPI varied with the period of a company's operation ($F = 5.110$, $p = .008$), underscoring the evolving nature of sustainable logistics practices over time. The size of a company, measured by the number of employees, and its fleet composition also significantly influenced GLPI ($F = 5.211$, $p = .002$ and $F = 31.239$, $p = .000$, respectively). These findings highlight the nuanced interplay of organisational characteristics in shaping green logistics outcomes, emphasising the need for tailored sustainability strategies aligned with specific company attributes.

Test of Correlation

Using the green logistics performance index, objective two sought to ascertain potential relationships among green technology, green transportation, and green administration. Examining a correlation or connectivity between all study variables was another goal of the mission. The second query was, "Is there any significant relationship between green administration, green technology, and green transportation with green logistics performance index?" was addressed by the theory developed, which focused on the correlational component. The second question addressed the study's construct association. According to Tabachnik and Fidell (2007), a correlation analysis is a technique for characterising the link between variables and may also show bivariate association and strong significance. The Pearson product-moment correlation was computed in this investigation. As stated by Ismail (2012), the correlation coefficient's interpretation range is taken from Cohen (1997).

Table 6: The guideline for interpreting the value of Pearson correlation (*r*) from Cohen (1997) as cited by Ismail (2012)

Value of Pearson Correlation (*r*)	Interpretation
-0.10 to -0.29 and +0.10 to +0.29	Small correlation
-0.30 to -0.49 and +0.30 to +0.49	Medium correlation
-0.50 to -1.00 and +0.50 to +1.00	Large correlation

To examine the relationship and prove the nomological validity of the developed hypotheses, correlation hypotheses between these variables were generated. The following is the developed hypothesis:

H2. There is a significant relationship between green transportation, green technology, green administration, and green logistics performance index in the freight transportation industry at Padang Besar Container Terminal (PBCT).

The sub-hypotheses are as follows:

H2a: There is a significant relationship between green administration and the green logistics performance index in thein the freight transport industry at Padang Besar Container Terminal (PBCT).

H2b: There is a significant relationship between green technology and the green logistics performance index in the freight transport industry at Padang Besar Container Terminal (PBCT).

H2c: There is a significant relationship between green transportation and the green logistics performance index in the freight transport industry at Padang Besar Container Terminal (PBCT).

H2d: There is a significant relationship between green administration and green technology.

H2e: There is a significant relationship between green technology and green transportation.

H2f: There is a significant relationship between green administration and green transportation.

Table 5 displays the correlation data using Pearson correlation using SPSS version 23.0. All the constructs have demonstrated a satisfactory degree of connection at the $p < 0.01$ level. Because they were statistically significant, the strength of all correlations between variables in this investigation was substantial and acceptable. All the factors in this study demonstrated a positive, substantial association with one another. Two correlation categories have been created from this association. The first category deals with the relationship between the dependent and independent variables (H2a to H2c). The link was accounted for as .443, and the result indicates a medium correlation between this construct, in response to H2a, which suggests that the green logistics performance index has a positive significant correlation with green administration. However, it continues to respond to H2a, 1997, as stated by Ismail (2012).

H2b sought to determine how green technologies and the green logistics performance index relate to one another. These variables had the strongest association among all the constructs in the study. This construct has an r value of roughly .548. The result indicates a high degree of correlation between the variables according to Cohen's (1997) correlation guidelines. A strong, positive association has been observed between the green logistics performance index and the other metrics. H2c sought to determine the relationship between green transport and the green logistics performance index. These variables have the weakest relationship—with a value that is almost zero—among all the constructs in this investigation. The two variables have a weak and negative association, as indicated by the r value of -0.068. The correlation between the independent variables (H2d to H2f) makes up the second category.

The r value of .641 for H2d indicates a strong link between green technology and

green administration. There is a strong positive association. H2e was created to ascertain how green mobility and green technologies relate to one another. The results showed a significant degree of correlation between the constructs, with a $p < 0.01$ level r value of .533. (Cohen, 1997) as referenced by Ismail (2012). H2f is the final sub-hypothesis for correlation in the study's inferential statistics. H2f was created to ascertain how green transport and green administration relate to one another. The r value of.633 for this linkage denotes a high degree of correlation between the constructs. At the $p < 0.01$ level, there was a substantial positive association between all the constructs. The table below displays the specifics of this study's association.

Table 6: Intercorrelation between variables (N = 100)

	GLPI	GA	GT	GTR
GLPI	1	.443**	.548**	-.068
GA		1	.641**	.633**
GT			1	.533**
GTR				1
Mean	4.1514	3.6156	4.1275	4.0188
Standard Deviation	.52590	.54580	.39528	.45657

Regression

Although Green Transportation demonstrated a weak and negative bivariate correlation with the Green Logistics Performance Index ($r = –0.068$), the multiple regression analysis revealed a statistically significant negative standardised regression coefficient ($\beta = –0.817$). This apparent discrepancy may be attributed to the simultaneous inclusion of Green Administration and Green Technology in the regression model. Because these predictors are themselves positively associated with Green Transportation, the regression analysis estimates the unique contribution of Green Transportation after controlling for the shared variance among the predictors. Consequently, the regression coefficient reflects the independent effect of Green Transportation rather than its simple bivariate relationship with GLPI. This finding suggests that investments in green transportation alone may not necessarily improve overall green logistics performance unless accompanied by complementary improvements in green administration and green technology.

H3. There is a significant effect of green administration, green technology and green transportation on the green logistics performance index in the freight transportation industry at Padang Besar Container Terminal (PBCT).

Hypothesis 3 examines the significant effect of green administration, green technology, and green transportation on the green logistics performance index in the freight transportation industry at Padang Besar Container Terminal (PBCT). The findings of the hierarchical regression analysis (shown in Table 7) indicate that the three factors had a substantial impact on the dependent variable. In Step 1, independent variables for green administration, green technology, and green transportation were entered. These variables explained 60.3% of the variance in the green logistics performance index. In the end, three factors with the lowest beta values were found to be statistically significant: green technology (=.802, p =.000), green transportation (= -.817, p =.000), and green administration (=.487, p =.000). The table presents the particular outcomes.

Table 7: Regression of constructs

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.366	.384		6.162	.000
Green Administration	.487	.090	.505	5.389	.000
Green Technology	.802	.114	.603	7.019	.000
Green Transport	-.817	.098	-.709	-8.337	.000
$R^2 = .603$				F = 48.515	
Adjusted $R^2 = .590$				P = .000	

Overall Hypotheses

The finding that H2c shows a weak and negative correlation between green logistics performance index (GLPI) and green transportation in the context of the freight transportation industry at Padang Besar Container Terminal (PBCT) raises interesting implications, particularly for companies reluctant to invest in costly green transport initiatives. Despite the common expectation that adopting environmentally friendly transportation practices contributes positively to overall green logistics performance, the study's results suggest that this relationship is not straightforward, and other factors may be influencing the observed correlation.

Hypotheses	Result	Decision
Hl. There is significant level of green logistics performance index of freight transportation industry at Padang Besar Container Terminal (PBCT).	M = 4.15 (GLPI) M =3.61 (GA) M = 4.12 (GT) M= 4.01 (GTR)	Moderate High level
H2. There is significant relationship between green transportation, green technology, green administration, and green logistics performance index at freight transportation industry at Padang Besar Container Terminal (PBCT).		
H2a *There is significant relationship between green administrationand green logistics performance index at freight transport industry at Padang Besar Container Terminal (PBCT).*	β= .443; p<0.01	Accept
H2b *There is significant relationship between green technology and green logistics performance index at freight transport industry at Padang Besar Container Terminal (PBCT).*	β= .548; p<0.01	Accept
H2c *There is significant relationship between green transportation and green logistics performance index at freight transport industry at Padang Besar Container Terminal (PBCT).*	β= -.0.68; p>0.01	Reject
H2d *There is significant relationship between green administrationand green technology.*	β= .641; p<0.01	Accept
H2e *There is significant relationship between green technology and green transportation.*	β=.533; p<0.01	Accept
H2f *There is significant relationship between green administration and green transportation.*	β== .633; p<0.01	Accept

H3. There is significant effect of green administration, green technology and green transportation on green logistics performance index at freight transportation industry at Padang Besar Container	R2=.603; Adj R^2 = .590; F = 48.515; p=.000	Accept

Conclusion and Recommendations

This study makes noteworthy contributions to both theoretical understanding and practical application within the realm of GLPI. The theoretical insights generated by this research highlight the pivotal role of GLPI in offering a nuanced perspective on logistics performance and its intricate relationship with environmental sustainability. By emphasising the benefits of applying GLPI, the study provides a solid foundation for refining and enhancing the accuracy of research findings in the broader academic community. The theoretical framework proposes a path towards a deeper comprehension of sustainability practices by suggesting a focused examination of individual variables within logistics.

From a theoretical perspective, this study extends the green logistics literature by introducing the GLPI as a structured organisational sustainability assessment framework. Unlike conventional logistics performance measures that primarily emphasise operational efficiency, the GLPI integrates environmental governance, technological innovation, and sustainable transportation practices into a single composite performance measure, thereby offering a more comprehensive approach to evaluating green logistics performance.

Furthermore, the study underscores the need for a diversified research approach, encouraging future investigations to incorporate various data collection techniques. This approach, as advocated by the study, ensures a more comprehensive and multifaceted analysis, bolstering the generalizability of findings across industries. The call for a synthesis of GLPI methodology, detailed variable exploration, and a comprehensive research design sets the stage for elevating the overall quality of research in the domain of green logistics. The findings of this study provide several practical implications for key stakeholders. For logistics companies, the proposed GLPI offers a practical benchmarking tool for evaluating environmental sustainability performance, identifying operational weaknesses, and prioritising investments in green administration, technology, and transportation initiatives. For terminal operators such as Padang Besar Container Terminal, the GLPI can be used to monitor the environmental performance of freight operators, facilitate sustainability reporting, and encourage continuous improvement among terminal users.

From a policy perspective, government agencies may utilise the GLPI as a complementary performance measurement framework to support the implementation of Malaysia's National Transport Policy (2019–2030), promote environmentally responsible freight transportation, and monitor organisational progress toward national sustainability objectives and the Sustainable Development Goals (SDGs). Collectively, these applications demonstrate that the GLPI extends beyond an academic measurement framework by serving as a practical decision-support tool for organisational and public-sector sustainability management.

While acknowledging limitations such as a small sample size and time constraints, the study suggests that future research can overcome these by adopting diverse data collection methods. The recommendations include combining virtual and physical approaches to enhance dataset comprehensiveness. The study concludes by affirming the accomplishment of its goal in evaluating the green practices of transportation companies at Padang Besar Container Terminal, providing a foundation for future investigations. The accepted hypotheses, positive relationships

between green technology, green administration and green logistics performance index, set the stage for continued exploration into green logistics performance index instruments within transportation companies.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

Author's Contributions Statement

Elias Md Radzi was responsible for the formal analysis and writing of the original draft. Mohd Azril Ismail contributed to the conceptualisation, visualisation, and proofreading of the manuscript. Nuraina Balqish Zulkeflay conducted the data collection. Khairul Azam Mohd Salleh performed the analysis and interpretation of the results. Naquib Adam Sirajuddin contributed to the writing by reviewing and editing the final manuscript.

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