CHAPTER III
RESEARCH METHODS

The main objective of this study is to examine the effects of green logistics management practices, operational efficiency, supply chain traceability, and logistics eco-centricity on the sustainability performance of manufacturing firms in Ghana and Indonesia. This chapter provides a comprehensive overview of the research design, methodology, and analytical approaches utilized to address the study's objectives and research questions. It begins by detailing the research design, which outlines the framework used to investigate the relationship between green logistics management practices and sustainability performance. Following this, the chapter discusses the population and sampling methods, research instruments, and data collection procedures, ensuring a rigorous approach for data accuracy and relevance. The research procedures and variables measurement are also explained, followed by an outline of the data analysis techniques employed to interpret the results. Additionally, this chapter addresses ethical considerations, ensuring adherence to research standards and integrity throughout the study. By systematically detailing these methodological components, this chapter establishes the foundation necessary for the study's empirical investigation, aimed at achieving valid and reliable results to inform sustainable logistics practices.

3.1 Research Design

This study employed a quantitative research design to investigate the effects of multiple factors, including green logistics management practices, operational efficiency, supply chain traceability, and logistics eco-centricity, on the sustainability performance of manufacturing firms in Ghana and Indonesia. The selection of the quantitative technique is based on its appropriateness for rigorously

testing hypotheses and meticulously investigating the associations among numerous variables (Creswell & Clark, 2017).

The collected data for this investigation, cross-sectional survey was conducted. This design is highly compatible with the research objectives for a number of factors. Initially, this strategy was characterized by its cost-effectiveness, as it optimizes resource allocation while concurrently providing significant research insights. Besides, the used of a survey design enables the collection of substantial amounts of data in a relatively brief time frame, a crucial aspect when investigating a diverse range of manufacturing enterprises in various geographic regions. Surveys offer a high degree of adaptability, allowing researchers to effectively engage with a diverse range of respondents, such as multiple stakeholders within organizations, such as management and employees. This adaptability facilitates the acquisition of a comprehensive understanding of the topic (Babbie, 2020).

This study aims to make a significant contribution to the existing body of knowledge concerning the interrelationships between green logistics practices, operational efficiency, supply chain traceability, logistics eco-centricity, and sustainability performance in the manufacturing sectors of Ghana and Indonesia. To accomplish this goal, a quantitative research design and survey methodology were utilised. The chosen methodology ensures a thorough and efficient examination of the key factors influencing sustainability outcomes in the countries, thereby ensuring the study is thorough and resource-efficient.

3.2 Respondents

The respondents, of the study were primarily consist of manufacturing firms situated within the dynamic economic environments of Ghana and Indonesia. The selection of these countries for this study was deliberate, as they are developing economies with an expanding manufacturing sector that incorporates a variety of industries. Ghana and Indonesia are prominent global producers of vital natural resources such as cocoa, oil palm, rubber, and minerals, providing support for this decision. This economic profile emphasizes the importance of the manufacturing industry to their respective economies.

Manufacturing firms have a high ecological footprint and contribute significantly to global greenhouse gas emissions and environmental degradation. Consequently, they serve as the central focus of global sustainability efforts. This

study aims to examine the effect of factors such as green logistics management practices, operational efficiency, supply chain traceability, and logistics eco centricity on the sustainability performance of Ghanaian and Indonesian manufacturing firms. The study intends to shed light on how strategic use of these practices can contribute to augmenting sustainability in the manufacturing sector of these nations.

The purpose of this study is to gain a comprehensive understanding of the practical implications of sustainable practices in the manufacturing sector of developing nations. The anticipated contribution of this study's findings to academic discourse and the formulation of practical approaches for manufacturing companies in Ghana and Indonesia is substantial. These approaches are intended to reduce their environmental footprint, improve operational efficiency, and promote economic, social, and environmental sustainability.

3.3 Population and Sampling

This study focuses on manufacturing firms in Ghana and Indonesia that have implemented green logistics management practices as integral components of their operational strategy. According to official data, the Ghana Statistical Service (GSS, 2021) estimated that there were 1,625 registered manufacturing firms in Ghana in 2016. According to data from the Indonesian Central Bureau of Statistics (BPS, 2020), there were 13,085 industrial entities in Indonesia in 2019. These numbers demonstrate the extent to which industrial activities are present in both countries.

The datasets made available by the Ghana Investment Promotion Centre (GIPC) and the Indonesia Investment Coordinating Board (BKPM) was utilized to establish a comprehensive sample frame for the present research. These organizations are responsible for maintaining exhaustive registries of manufacturing companies that are officially recognized in their respective countries, thereby ensuring the representation of a diverse array of participants.

To assure an accurate selection of a representative sample from the large population, stratified random sampling was used in this study. This study's methodology involves dividing the population into distinct and comparable subgroups, known as strata, and then randomly selecting samples from each stratum (Kothari, 2004). Two primary factors determined the strata in our research study: the manufacturing industry and the scale of the firms. The manufacturing sector were divided into four categories: Electronics, Automotive, Food and Beverages

Textiles, and a miscellaneous category called "others." In addition, the categorization of business size stratified businesses into three distinct groups: small, medium, and large businesses. These size classifications were determined by the total number of employees within each respective organization. To determine a sample size that ensures statistical validity, the sample size formula for cross-sectional research outlined by Kothari (2004) must be applied. By using a precise sampling methodology, we can assure the procurement of data that is not only representative of the whole population but also enough for conducting rigorous statistical analysis. As a consequence, the dependability and validity of our study's findings will be strengthened.

$$n = \frac{z\,pq^2}{e^2}$$

where n is the sample size, z is the standard normal deviation (set at 1.96, corresponding to a 95% confidence level), *p* is the expected prevalence rate (set at 50%), q is the complementary probability (100%-p), and e is the margin of error (set at 5%).

The minimum sample size required for this study was 385 manufacturing firms (193 from Ghana and 192 from Indonesia). However, to account for potential non-response and incomplete data, the sample size was increased by 10%, resulting in a total of 424 manufacturing firms (212 from Ghana and 212 from Indonesia). Within each stratum, the sample was randomly selected using a computer-generated random number table. The inclusion criteria for the study are that the manufacturing firms must have adopted green logistics management practices and must have been in operation for at least two years. The exclusion criteria are manufacturing firms that have not adopted green logistics management practices, those that have been in operation for less than two years, and those that decline to participate in the study.

3.4 Research Instrument

This study's primary data collection instrument was carefully constructed structured questionnaire. The questionnaire was divided into two sections, each of which serves a distinct purpose. The first section is devoted to collecting demographic information about the respondents, including details such as gender, age, educational background, years of experience in the manufacturing industry, and the employee count of their respective businesses. These demographic insights

provide a useful context for analyzing subsequent responses, allowing for a more nuanced interpretation of the data.

The second section of the questionnaire delves into the nitty-gritty of the study, concentrating on variables essential to the achievement of the research objectives. In this section, respondents are asked to indicate their level of agreement with a series of statements concerning green logistics management practices, operational efficiency, supply chain traceability, and logistics eco centricity. This is accomplished using a seven-point scale, where a score of seven indicates "Strongly Agree" and a score of one indicates "Strongly Disagree." By assessing respondents' levels of agreement with these statements, the research can gain profound insights into how these variables interact in the context of sustainability performance within manufacturing firms.

For instance, participants were allowed to share their views on statements such as the active adoption of environmentally responsible logistics practices (GLM 1), the commitment to achieving optimal efficiency in logistical processes (OE 17), the presence of robust systems for supply chain traceability (SCT 25), and the emphasis on environmentally beneficial transportation solutions in logistics operations (LEC 9).

To ensure the questionnaire's veracity and cultural relevance when administered in Indonesia, a meticulous translation process was conducted. Employing competent translators who are fluent in both languages ensures that the questionnaire's meaning and nuances are accurately conveyed. In addition, a meticulous back-translation process was conducted to validate the questionnaire's consistency and accuracy. This stringent translation procedure is imperative to guarantee that the responses collected from Indonesian participants are an accurate reflection of their views and experiences, thereby enhancing the reliability and validity of the research findings.

3.4.1 Validity and Reliability of Research Instrument

Two foundational concepts, reliability and validity, play crucial roles in guaranteeing the credibility and integrity of the collected data in the domain of research. Reliability refers to the consistency and stability of the results derived from the research instrument, whereas validity refers to the extent to which the research instrument measures the intended constructs. To determine the

dependability and validity of the research instrument utilized in this study, an exhaustive and methodical evaluation will be conducted.

3.4.1.1Reliability testing

Reliability was evaluated using the rigorous test-retest method. A select group of respondents was asked to complete the questionnaire on two distinct occasions, separated by one week. The responses from these two instances were then be analyzed statistically, using the Pearson correlation coefficient. As a measure of the instrument's dependability, a correlation coefficient of at least 0.70 was be utilized. Any coefficient that meets or exceeds this threshold was regarded as evidence of acceptable reliability, indicating that the instrument consistently produces comparable results over time.

3.4.1.2 Validity testing

In contrast, validity was evaluated from two distinct perspectives: content validity and construct validity.

a. Validity of content

The content validity of the research instrument was meticulously evaluated to ensure that it encompasses all pertinent aspects of the study variables. A council of logistics and supply chain management specialists were conducted thorough examination of the questionnaire as part of this evaluation. With their extensive knowledge and expertise, these specialists evaluate whether the instrument adequately covers all relevant dimensions of the study variables. Their expert opinion will be indispensable in confirming the questionnaire's content validity.

b. Construct validity

Using confirmatory factor analysis (CFA), the construct validity, a crucial aspect of validity evaluation, were rigorously examined. This statistical technique was used to investigate the underlying factor structure of the research instrument and casted light on the interrelationships of the various study variables. Through CFA, the instrument's ability to accurately measure the intended constructs was evaluated, providing crucial insights into the research's validity. Confirmatory factor analysis will provide a quantitative and systematic evaluation of how well the questionnaire items correlate with the theoretical constructs they are intended to assess, thereby confirming the construct validity of the instrument. By meticulously

conducting these reliability and validity assessments, the research instrument used in this study was thoroughly validated to ensure that it consistently generates reliable results and accurately measures the intended study constructs. This exhaustive validation process had strengthened the credibility and robustness of the collected data, thereby improving the quality and integrity of the research findings.

3.5 Research Procedures

This study's research methodology is comprised of a well-planned sequence of phases designed to ensure the methodical and rigorous execution of the research endeavour. The process consists of three primary phases: data collection, data preparation, and data analysis, with the ultimate aim of generating comprehensive insights into the research's fundamental factors. The preliminary phase of the research methodology involved the collection of primary data from employees of manufacturing enterprises in both Ghana and Indonesia. To achieve this objective, a carefully constructed survey was distributed to the selected participants. This questionnaire was meticulously designed to capture exhaustive data pertaining to the variables of primary interest, such as green logistics management practices, operational efficiency, supply chain traceability, logistics eco-centricity, and sustainability performance. Participants were actively encouraged to share their distinct thoughts and perspectives on these crucial issues, thereby facilitating a comprehensive and exhaustive data collection process.

Following the fulfilment of the data collection phase, a comprehensive process of data preparation was conducted to ensure that the collected information was in the proper format for rigorous analysis. The process of preparation entailed a number of crucial steps, including the meticulous purification of data, the systematic application of codes, and the precise entry of data. The purpose of the data cleansing process was to identify and remedy any discrepancies, inaccuracies, or instances of missing data within the dataset, thereby increasing the overall data quality. Following this, data coding was performed to transform the collected responses into a format that could be easily processed and analyzed. Subsequently, the encoded data was painstakingly transcribed into a digital format to facilitate further analysis, thereby ensuring its systematic arrangement and readiness for examination.

The central focus of the study methodology was on the process of data analysis, wherein the gathered data was meticulously examined in order to derive

significant insights and identify trends. To achieve this goal, sophisticated statistical software tools were utilized, with a particular emphasis on the application of Structural Equation Modelling (SEM) through the use of Smart PLS. Structural Equation Modelling is a robust multivariate statistical technique that is ideally suited for analysing complex relationships between variables within a complex model. This allows researchers to investigate the intricate relationships and interdependencies between variables, thereby facilitating a comprehensive understanding of their mutual effects. This study used structural equation modelling to examine the intricate relationships between green logistics management practices, operational efficiency, supply chain traceability, logistics eco-centricity, and sustainability performance in the context of manufacturing firms.

The SEM analysis was facilitated by Smart PLS, a robust and widely-utilized software application. The software presented here facilitates the complex process of structural equation modelling by providing the capacity to analyse the interrelationships between variables in a rigorous and efficient manner. Utilising a sophisticated analytic methodology, the study aimed to elucidate the complex dynamics inherent to the investigated setting and make substantial contributions to scholarly discourse.

3.5.1 Measurement of Variables

Table 3.1 Measurement of Variables

Variables	Concept Variables	Indicators	Measurement	Scale
				Interval
Green Logistics Management Practices (Bo Zhou et al., 2023)	Environmentally Responsible Logistics	Responsible logistics practices	Extent of environmentally responsible logistics practices	
		Eco-friendly logistics practices	Extent of prioritization of ecofriendly logistics practices	Interval
		Green transportation methods	Extent of investment in green transportation methods	Interval
		Minimized waste in logistics operations	Level of waste minimization in logistics operations	Interval

	Environmental Sustainability	Sustainability in procurement decisions	Extent of consideration of sustainability in procurement decisions	Interval
		Monitoring and reporting carbon emissions	Extent of monitoring and reporting carbon emissions	Interval
	Employee Training	Employee training on green logistics practices	Extent of employee training on green logistics practices	Interval
		Proactive reduction of environmental impact	Extent of proactive reduction of environmental impact	Interval
Logistics Eco-Centricity (Moreira et al., 2022)	Prioritizing Environmental Solutions	Prioritization of eco-friendly transportation	Extent of prioritization of ecofriendly transportation	Interval
	Sustainable Packaging	Utilization of sustainable packaging materials	Extent of utilization of sustainable packaging materials	Interval
	Environmental Consideration	Consideration of environmental effects	Extent of consideration of environmental effects	Interval
	Reducing Non-Renewable Resource Use	Minimization of non-renewable resource use	Extent of minimization of nonrenewable resource use	Interval
	Eco-Centric Supply Chain Strategies	Use of eco centric logistical strategies	Extent of use of eco centric logistical strategies	Interval
	Supplier and Partner Collaboration	Collaboration with eco conscious partners	Extent of collaboration with eco-conscious partners	Interval
	Minimizing Ecological Footprint	Minimization of ecological footprint	Extent of minimization of ecological footprint	Interval
	Proactive Pursuit of Ecological Solutions	Proactive pursuit of ecological solutions	Extent of proactive pursuit of ecological solutions	Interval
Operational Efficiency (Zhang et al., 2016)	Efficiency in Logistic Processes	Achievement of optimal logistical efficiency	Extent of achievement of optimal logistical efficiency	Interval
		Analysis and optimization of logistics	Extent of analysis and optimization of logistics	Interval

		Reduction of delays and disturbances	Extent of reduction of delays and disturbances	Interval
		Strategic minimization of resource use	Extent of strategic minimization of resource use	Interval
		Use of technology for operational efficiency	Extent of use of technology for operational efficiency	Interval
		Promotion of efficiency culture	Extent of promotion of efficiency culture	Interval
		Monitoring of key performance indicators	Extent of monitoring of key performance indicators	Interval
Supply Chain Traceability (Yi et al., 2022)	Product Traceability	Maintenance of robust product traceability	Extent of maintenance of robust product traceability	Interval
		Emphasis on traceability for quality control	Extent of emphasis on traceability for quality control	Interval
		Communication of traceability efforts	Extent of communication of traceability efforts	Interval
		Identification and addressing of ethical issues	Extent of identification and addressing of ethical issues	Interval
		Traceability of raw material origin	Extent of traceability of raw material origin	Interval
		Ensuring regulatory compliance	Extent of ensuring regulatory compliance	Interval
		Use of traceability for informed decisions	Extent of use of traceability for informed decisions	Interval
		Enhancement of supply chain transparency	Extent of enhancement of supply chain transparency	Interval
Sustainability Performance (M. T. Khan et al., 2022)	Goal Achievement	Consistent achievement of sustainability goals	Extent of consistent achievement of sustainability goals	Interval
		Priority given to sustainability by leaders	Extent of priority given to sustainability by leaders	Interval
		Seeking opportunities to reduce	Extent of seeking opportunities to reduce	Interval

		environmental footprint	environmental footprint	
		Incorporation of sustainability in decision making	Extent of incorporation of sustainability in decision-making	Interval
		Favorable reputation earned through sustainability efforts	Extent of favorable reputation earned through sustainability efforts	Interval
		Regular provision of sustainability reports	Extent of regular provision of sustainability reports	Interval
		Significant business impact from sustainability initiatives	Extent of significant business impact from sustainability initiatives	Interval
		Proactive investment in sustainability related R&D	Extent of proactive investment in sustainability-related R&D	Interval
Environmental Dynamism (Ferreira et al., 2020; Ye et al., 2022)	Variable and Unpredictable Environmental Conditions	Experience of variable and unpredictable environmental conditions	Extent of experiencing variable and unpredictable environmental conditions	Interval
		Impact of regulatory changes on business operations	Extent of impact of regulatory changes on business operations	Interval

3.6 Data Analysis

Data analysis is a crucial stage in any research study as it allows for the interpretation of the collected data to draw meaningful conclusions and make informed decisions based on the research objectives. In this study, data analysis involves both descriptive and inferential statistics to explore the relationship between the independent and dependent variables. Descriptive statistics will be used to describe the characteristics of the study participants and the variables under study. These statistics will include measures of central tendency (mean, median, and mode), measures of variability (range, standard deviation, and variance), and frequency distributions.

Inferential statistics, particularly structural equation modelling (SEM), will be used to test the hypotheses and examine the relationships between the variables. SEM is a multivariate statistical technique that allows for the examination of complex relationships among multiple variables simultaneously. In this study, we will use SmartPLS software to perform the SEM analysis. Thus, Smart PLS was used to test the research hypotheses and to determine the mediating effects of supply chain traceability and logistics eco-centricity on the relationship between green logistics management practices and sustainability performance. Smart PLS was chosen because of its ability to handle small sample sizes, non-normal data, and complex relationships between variables. The SEM analysis involved several steps, including model specification, measurement model assessment, and structural model assessment. In the measurement model assessment, the reliability and validity of the measurement model were evaluated using criteria such as factor loadings, composite reliability, and convergent and discriminant validity. The structural model assessment involved testing the hypothesized relationships between the variables and determining the strength and significance of the relationships.

The use of SmartPLS in this study will enable the examination of both the direct and indirect effects of the independent variables (green logistics management practices, operational efficiency, supply chain traceability, and logistics eco centricity on the dependent variable (sustainability performance), as well as the mediating effects of supply chain traceability and logistics eco-centricity.

SmartPLS offers several advantages for SEM analysis, including its ability to handle both reflective and formative measurement models, assess model fit using a variety of indices and provide reliable estimates of path coefficients even with small sample sizes. Additionally, it allows for the evaluation of measurement and structural model reliability and validity, as well as the examination of the significance and effect size of the relationships among variables. In brief, this is how each of the study objectives was analysed:

1. To examine the effect of green logistics management practices on the sustainability performance of manufacturing firms in Ghana and Indonesia: This objective was analysed using multiple regression analysis to determine

the relationship between green logistics management practices and sustainability performance.

2. To ascertain the effect of logistics eco-centricity on the sustainability performance of manufacturing firms in Ghana and Indonesia: This objective was also analysed using multiple regression analysis to determine the relationship between logistics eco-centricity and sustainability performance.
3. To examine the effect of operational efficiency on the sustainability performance of manufacturing firms in Ghana and Indonesia: This objective was analysed using multiple regression analysis to determine the relationship between operational efficiency and sustainability performance.
4. To examine how supply chain traceability mediates the relationship between green logistics management practices and the sustainability performance of manufacturing firms in Ghana and Indonesia: This objective was analysed using structural equation modelling (SEM) to test the mediating effect of supply chain traceability on the relationship between green logistics management practices and sustainability performance.
5. To determine the mediation effect of logistics eco-centricity on the nexus between green logistics management practices and the sustainability performance of manufacturing firms in Ghana and Indonesia: This objective was also analysed using structural equation modelling to test the mediating effect of logistics eco-centricity on the relationship between green logistics management practices and sustainability performance general, both multiple regression analysis and SEM was used to conducted using the SmartPLS software to test the hypotheses and determine the significance of the relationships between the variables.
6. To evaluate the relative importance and performance of green logistics management practices, operational efficiency, supply chain traceability, and logistics eco-centricity in enhancing the sustainability performance of manufacturing firms in Ghana and Indonesia, this study utilized Importance-Performance Map Analysis (IPMA) as part of the Smart Partial Least Squares (SmartPLS 4) software. The IPMA approach enables a detailed assessment of each predictor variable's contribution to sustainability performance by measuring not only the path coefficients but

also the average scores of each construct. These two dimensions' importance and performance the IPMA provides insights into which variables exert the strongest influence on sustainability outcomes and identifies areas where improvements can most effectively enhance sustainability. This dual-layered analysis allows for targeted recommendations, helping firms prioritize specific practices within green logistics management, operational efficiency, supply chain traceability, and logistics eco-centricity based on their impact and current performance levels.

3.7 Ethical Consideration

The importance of ethical considerations in the conduct of research studies cannot be emphasised, and this study is no exception. In order to protect the rights and well-being of the participants, the study procedure has been conducted with strict adherence to several ethical guidelines. The concept of informed consent has been adhered to stringently. Before the start of the experiment, informed consent was obtained from all participants. Extensive information was provided to the participants regarding the objectives of the study, the voluntary nature of their participation, their absolute right to withdraw from the study at any time without negative consequences, and the stringent confidentiality protocols implemented to protect their responses. The participants were authorized to make an informed decision regarding their participation in the study, and their consent was obtained voluntarily and without coercion.

The adoption of stringent measures to protect privacy and confidentiality. The research was conducted with the utmost care to protect the privacy and identity of the participants. No identifying information was disclosed in any subsequent reports or publications that resulted from the research, and the data collected from the participants was scrupulously managed and kept in strict confidence. This measure was taken to ensure that all participant responses were entirely anonymous and attribution-free. The principle of voluntary participation was rigorously adhered to, ensuring that participants had complete autonomy over their decision to participate in the study. No force or duress was used to compel the volunteers to participate in the investigation. In addition, the participants had the option to discontinue their participation in the study at any time without confronting any negative consequences or penalties.

To protect the health of vulnerable populations, such as infants, those with disabilities, and marginalised communities, special consideration was given to the study's design and execution. The study refrained from investigating sensitive or potentially harmful topics, thereby mitigating any potential discomfort or harm to individuals in these categories. In addition, comprehensive methods for data preservation and storage were employed in order to assure the security and integrity of the information obtained from participants. The data were stored securely, protecting them from unauthorised access or use, and only the research team had access to them. The data was collected solely for the purposes of the study, emphasising the importance of ethical data handling and protection.

Throughout the study procedure, all ethical considerations, including informed consent, confidentiality, voluntary participation, the protection of vulnerable populations, and data protection, were strictly adhered to. The implementation of these ethical safeguards serves the dual purpose of preserving the integrity of the study and protecting the rights and dignity of the participants, thereby ensuring that the research is conducted in an ethically sound and responsible manner.