



Green supply chain management practices and ITS impacts on the sustainable performance / testing the mediating role of green technology

Prácticas de gestión de la cadena de suministro verde y sus impactos en el rendimiento sostenible / evaluación del papel mediador de la tecnología verde

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ABSTRACT

This research aims to use green practices to attain sustained performance. To apply that, an important question is rising, which is, how does GSCMP affect achieve sustained performance via green technology as an intermediate variable? the General Company for Electrical and Electronic Industries in Baghdad is chosen as a field to study the impact of these variables. The research community was represented by the employees of the researched company, and a purposive sample was chosen, which consisted of the administrative leaders, and a total of 221 individuals. To examine the validity of our supposed hypotheses, the related attitudes data of the respondents were collected through the questionnaire form and analyzed based on ready-made software such as SPSS Ver 21, and AMOS 24. Our model reached different results, the most remarkable one is that the substantial direct and indirect outcomes between the research variables. Accordingly, we have come up with some important recommendations, a significant one is that the management of the considered company should pay more attention to GSCMP and the application of green technology because of their prominent role in achieving sustained performance.

Palabras claves: sustainable performance; Green Supply Chain Management Practices; green technology.

RESUMEN

Esta investigación tiene como objetivo utilizar prácticas verdes para lograr un rendimiento sostenido. Para responder a esto, surge una pregunta importante: ¿cómo afecta GSCMP a la obtención de un rendimiento sostenido a través de la tecnología verde como variable intermedia? se eligió la Compañía General de Industrias Eléctricas y Electrónicas en Bagdad como campo de estudio para analizar el impacto de estas variables. La comunidad de investigación estuvo representada por los empleados de la empresa investigada, y se eligió una muestra intencional que consistió en líderes administrativos, con un total de 221 individuos. Para examinar la validez de nuestras hipótesis supuestas, se recopilieron los datos de actitudes relacionados con los encuestados a través del formulario de cuestionario y se analizaron con software preexistente como SPSS Ver 21 y AMOS 24. Nuestro modelo arrojó resultados diferentes, el más notable es que existe una relación directa e indirecta sustancial entre las variables de investigación. En consecuencia, hemos llegado a algunas recomendaciones importantes, siendo una de las más significativas que la dirección de la empresa considerada debe prestar más atención a GSCMP y a la aplicación de tecnología verde debido a su destacado papel en la obtención de un rendimiento sostenido.

Keywords: Rendimiento sostenido, GSCMP (Prácticas de Gestión de la Cadena de Suministro Verde), tecnología verde.

1. INTRODUCTION

Industrial companies face multiple pressures from the competitive market, government entities, and society to achieve a balance between environmental preservation and society's desire to survive in a more sustained environment. They also have an economic role that business companies must undertake. This poses a challenge for industrial companies in finding solutions to their sustainability problem in the market. Achieving sustained performance has become a crucial factor in addressing and overcoming these challenges. It represents a dependent variable that is influenced by a range of variables. Green supply chain management practices (GSCMP) are among the most important variables in this regard, as they serve as a useful and independent variable for industrial companies to impact their sustained performance and continuously enhance their competitive capabilities. Ensuring sustainability in the dependent variable is achieved through implementing modern technological improvements and changes everywhere to preserve resource sustainability by adopting environmentally friendly (green) technology. Based on the above, the research topic has been covered through four sections, including the research methodology in the first section, the theoretical aspect in the second section, while the third section encompasses the practical aspect of the research. The fourth section includes the conclusions and recommendations.

2. RESEARCH METHODOLOGY

2.1 Research Problem

GSCMP and green technology are new concepts that have emerged in the reality of the Iraqi industry. However, they have not been realistically and effectively implemented and utilized. This poses a problem for industrial companies, hindering their progress and reducing their opportunities for growth and success in addressing environmental, economic, and social challenges. This highlighted the need to study this topic in the General Company for Electrical and Electronic Industries in Baghdad, which is one of the leading industrial companies in Iraq and is relied upon by most state institutions.

From this perspective, the researchers found an entry point to present the current research problem by posing the following questions:

1. What is the impact of GSCMP on achieving sustained performance?
2. What is the impact of GSCMP on the implementation of green technology?
3. What is the impact of implementing green technology on achieving sustained performance?
4. Do GSCMP contribute to achieving sustained performance through the application of green technology as an intermediate variable within the researched company?

2.2 Research Significance

The importance of the research revolves around providing a theoretical framework and adding knowledge that helps understand the research variables and bridging the knowledge gap between them. It also aligns with the recent global trends regarding the application of GSCMP and green technology and its branches. Additionally, it aims to assist the management of the researched company in keeping up with the continuous changes in adopting modern management approaches to overcome its environmental, economic, and social problems and accommodate them.

2.3. Research Objectives

The objectives of the current research are as follows:

1. Measure the impact between GSCMP and sustained performance.
2. Measure the impact between GSCMP and green technology.

- Test the impact of GSCMP on achieving sustained performance through the mediation of green technology.

2.4. Hypothetical Research Model

In light of the questions that encompassed the research problem and to achieve its objectives, the formal research model Figure (1) was adopted, which represents the dynamics of the relationships between the research variables.

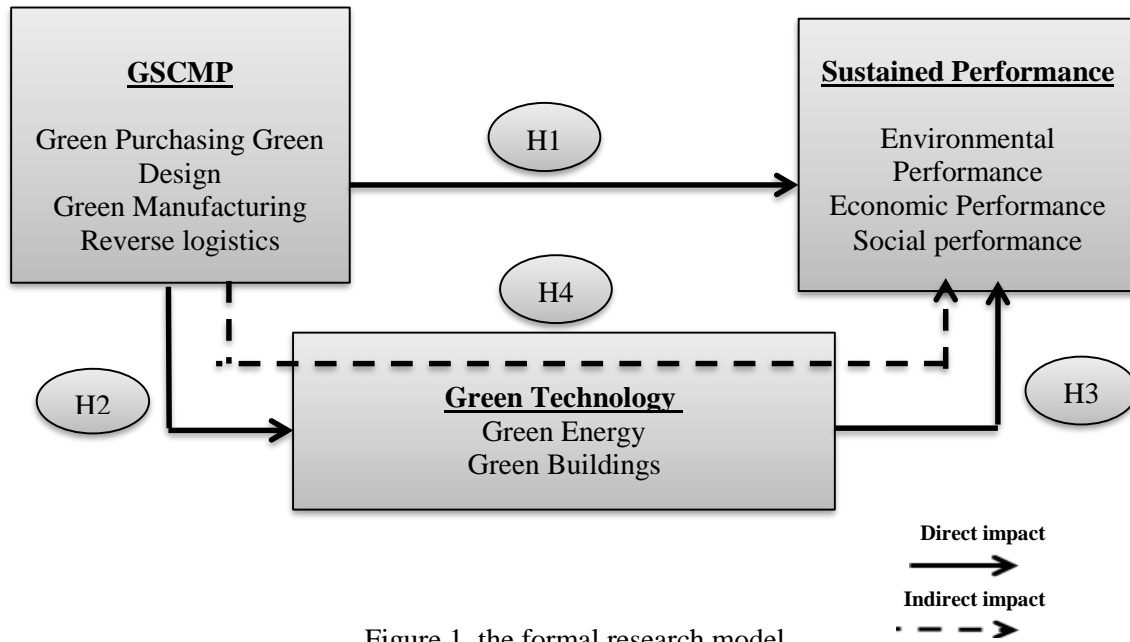


Figure 1. the formal research model

2.5. Research Hypotheses

The direct and indirect hypotheses for the research variables were formulated based on the research hypothetical model as follows:

Hypothesis 1: GSCMP in terms of its variables has no direct impact on sustained performance at the company level under study.

Hypothesis 2: GSCMP in terms of its variables has no direct impact on green technology at the company level under study..

Hypothesis 3: green technology in terms of its variables has no direct impact on sustained performance at the company level under study.

Hypothesis 4: GSCMP in terms of its variables has no indirect impact on sustained performance through green technology at the company level under study.

2.6. Research methodology

The researchers adopted a descriptive approach to present the theoretical framework and an analytical approach to present the applied framework through the questionnaire, which is the main data collection tool for the research. The researchers relied on academic scientific sources that aligned with the opinions of the referees in formulating the questionnaire questions, using the Likert five-point scale for respondents' answers, ranging from "strongly agree" with a weight of 5 to "strongly disagree" with a weight of 1.

3. THE THEORETICAL ASPECT

3.1. Theoretical Aspect, Green Supply Chain Management (GSCM)

1. Concept of Green Supply Chain Management: GSCM integrates environmental thinking into supply chain management, starting from product design and material sourcing, through manufacturing processes, and ending with the delivery of the final product to customers, as well as managing the product after its lifecycle (Srivastava, 2007, 54-55). It represents the integration of environmental concerns into the SCM activities of the company, aiming to achieve economic, environmental, and social improvements (Huang, 2013, 37). GSCM can be used as a tool to achieve a circular economy for sustained resource utilization (Bag et al., 2020, 2).
2. Practices of Green Supply Chain Management:
 - a. Green Purchasing: Green purchasing can be defined as an environmentally-oriented purchasing process that aims to meet the company's environmental goals for purchased products and materials, such as waste reduction, recycling, reuse, and material substitution. Green purchasing is of great interest to companies that evaluate the environmental performance of their suppliers before making purchasing decisions (Younis, 2016, 37).
 - b. Green Design: Green design, also known as ecological design and life cycle design, involves replacing materials or processes that have negative environmental impacts with alternatives that cause less harm. It aims to design products that are recyclable, reusable, and environmentally friendly (Gajendrum, 2017, 3).
 - c. Green Manufacturing: Green manufacturing helps reduce the environmental impact of industries by improving their economic performance through waste and emission reduction at the source. Green manufacturing focuses on reusing manufacturing for resource conservation and worker protection. It also helps improve product quality for customers with lower costs and minimal environmental pollution during production (Singh et al., 2019, 656).
 - d. Reverse logistics: Reverse logistics have evolved to adapt to major social, economic, and environmental trends such as market and corporate globalization, political and legislative changes, and technological advancements. These changes compel companies to reconsider their production, marketing, and distribution of products. Terms like recycling and retrieval of expired products have gained significance in response to societal requirements. The purpose behind these measures is to mitigate the negative impact on the environment. Reverse logistics allows companies to dispose of waste and maximize value (Romero, 2022, 4725).

3.2. Theoretical Aspect - Green Technology

1. Concept of Green Technology: Global companies have started prioritizing environmental protection and have enacted laws, regulations, and procedures to make their products, operations, and facilities environmentally friendly. They manufacture products that do not negatively impact natural resources, which essentially means preserving a clean environment. With the depletion of natural resources, the world has begun searching for alternative sources of renewable energy. The United Nations emphasizes in its report on green technology that the environmental policy of countries has become extremely important with the increase in their population (Mohammed, 2021, 1-2). Green technology is considered an important criterion for achieving regional and international sustained development goals. It also helps reduce the environmental impact of economic growth and enhances social progress (Ikram, et al., 2022, 1).
2. Branches of Green Technology
 - a. Green Energy: The use of green energy is crucial for achieving sustained development goals. Global energy needs have become highly important due to the greenhouse gas emissions from oil, coal, and natural gas and their ultimate impact on climate change, especially regarding the risks that threaten the environment and public health. Therefore, green (renewable) energy reduces greenhouse gas emissions and is hence extremely important. It is one of the critical strategies for sustainability, involving the production of renewable or green energy from solar, hydro, biomass, wind, and geothermal sources. Despite presenting challenges, it is a necessary response to the current climate crisis, and promoting

renewable energy sources has become an important goal in combating climate change and improving energy security (Hojnik, et al., 2021, 733).

- b. **Green Buildings:** Green buildings are a system that considers environmental concerns, comfort, and health of occupants. It has been practiced, promoted, and has become an important trend in architectural development worldwide. It focuses on materials recycling, efficient building design to ensure its extended lifespan and enhance sustained development (Zhang, et al., 2021, 1298-1299). Building materials significantly impact the depletion of natural resources, and adhering to sustainability requirements (environmental, social, and economic) and incorporating green building principles is necessary to reduce the impacts of materials on the environment and building occupants. Green buildings emphasize the relationship between the building and nature, reduce environmental impacts, health risks, and energy consumption, and preserve natural resources (Mayhoub, 2021, 1-2).

3.3. Theoretical Aspect - Sustained Performance

1. **Concept of Sustained Performance:** The impact of industrial companies on the environment is a growing concern, leading to a demand for sustained practices that meet environmental, economic, and social needs. In fact, all companies are now obligated to make more efforts to achieve a balance between their economic, social, and environmental performance, especially for companies facing societal, competitive, and regulatory pressures. Implementing environmental systems effectively to improve environmental and social performance while enhancing the company's economic performance is challenging (Zaid, et al., 2018, 1). Sustained performance is defined as the performance achieved by a company from a social and environmental perspective to reduce costs, improve product quality, and enhance market reputation (Rodríguez & Taha, 2022, 2).
2. **Dimensions of Sustained Performance:**
 - a. **Environmental Performance:** Environmental performance focuses on reducing negative impacts on the environment by minimizing carbon dioxide emissions, using natural resources, and recycling and disposing of waste. Manufacturers need to apply environmental concepts in collaboration with suppliers and develop innovative environmentally friendly technologies. Government legislation related to environmental protection also drives companies to achieve environmental performance (Phan & Siegfried, 2022, 20).
 - b. **Economic Performance:** Economic performance focuses on organizational practices aimed at generating economic value by pursuing financial and non-financial company goals. Various measures are used to assess economic performance, including strategic decision-making, and pursuing environmentally, economically, and socially beneficial practices. It indicates organizational efforts to facilitate trade, gain competitive advantage, and maintain profit based on utility, technology, and innovation (Faulks et al., 2021, 7).
 - c. **Social Performance:** External pressures and government regulations encourage companies to excel in social performance. A company can achieve a prominent position in social performance by strategically coordinating all shared business operations between companies. Contemporary companies seeking sustained performance can achieve social performance through ethical practices, open communication with the community, and compliance with social obligations (Gupta et al., 2019, 4).

4. FIELD ASPECT

4.1. **Testing the first main hypothesis:** From the data in Figure (2) and Table (1), it is evident that there is a significant positive effect of the variable of GSCMP on sustained performance. Therefore, the first main hypothesis of the research is rejected, and the alternative hypothesis is accepted.

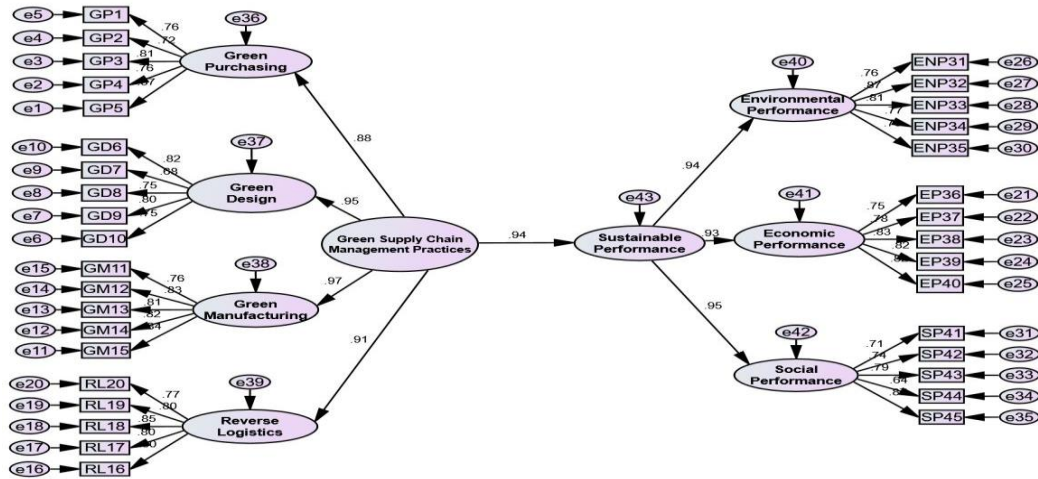


Figure 2. Model for testing the first main hypothesis.

Table (1) Estimating the standard regression coefficients for the impact of GSCMP on sustained performance.

P-value	95% Confidence Interval		Estimate(β)	The dependent variable	direction of impact	The independent variable
	Lower	Upper				
0.013	0.618	0.841	0.733	Sustained Performance	←	GSCMP

In light of the above, the sub-hypotheses derived from the first main hypothesis are tested as follows: Figure (3) and Table (2) indicate the nature of the impact of each practice of GSCMP on sustained performance.

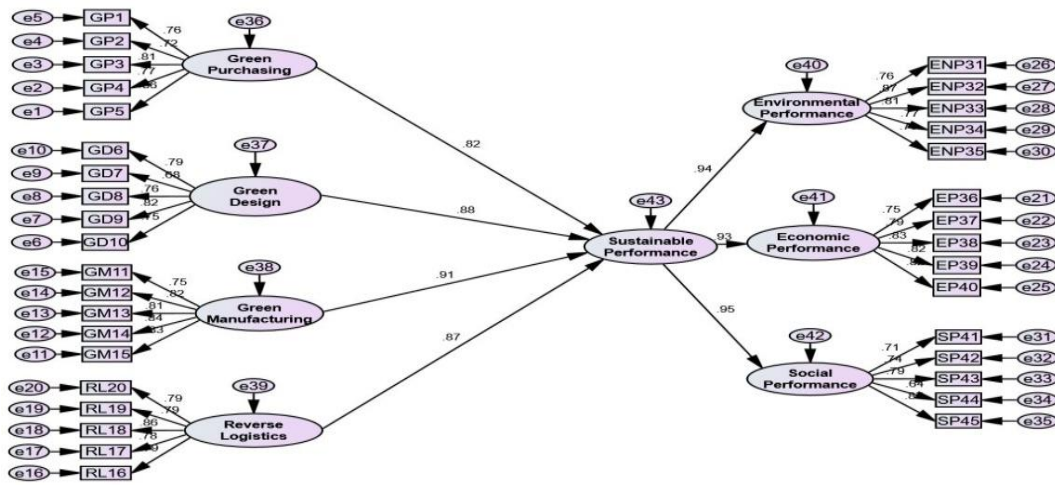


Figure 3. Model for testing the sub-hypotheses of the first main hypothesis.

Table 2. Estimating the standard regression coefficients for the impact of GSCMP on sustained performance.

P-value	95% Confidence Interval		Estimate(β)	The dependent variable	direction of impact	The independent variable
	Lower	Upper				
0.019	0.468	0.573	0.573	Green Purchasing	←	GSCMP

	0.650	Upper			
0.007	0.681	Lower	0.813	←	Green Design
	0.970	Upper			
0.007	0.653	Lower	0.746	←	Green Manufacturing
	0.879	Upper			
0.005	0.675	Lower	0.760	←	Reverse Logistics
	0.888	Upper			

- 1- Green purchasing has impact significant positive on sustained performance. Therefore, the first subhypothesis regarding the first hypothesis is disproved, and the alternative hypothesis is accepted.
- 2- Green design has impact significant positive on sustained performance. Therefore, the second subhypothesis regarding the first hypothesis is disproved, and the alternative hypothesis is accepted.
- 3- Green manufacturing has impact significant positive on sustained performance. Therefore, the third subhypothesis regarding the first hypothesis is disproved, and the alternative hypothesis is accepted.
- 4- Reverse logistics has impact significant positive on sustained performance. Therefore, the fourth subhypothesis regarding the first hypothesis is disproved, and the alternative hypothesis is accepted.

4.2. Testing The Second Main Hypothesis: Figure (4) and Table (3) indicate a significant positive effect of GSCMP on green technology. Therefore, the second main hypothesis of the research hypothesis is rejected, and the alternative hypothesis is accepted.

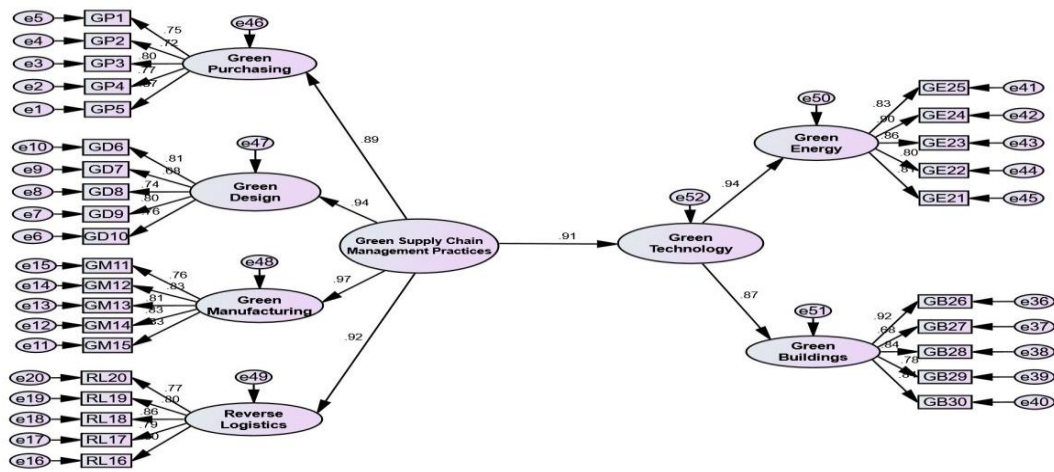


Figure 4. Model for testing the second main hypothesis.

Table 3. Estimating the standard regression coefficients for the impact of GSCMP on green technology.

P-value	95% Confidence Interval		Estimate(β)	The dependent variable	direction of impact	The independent variable
0.018	0.735	Lower	0.854	Green	←	GSCMP

	0.955	Upper		Technology		
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Consistent with the above, the sub-hypotheses derived from the second main hypothesis are tested as follows: Figure (5) and the data in Table (4) indicate the nature of the impact of each practice of GSCMP on green technology.

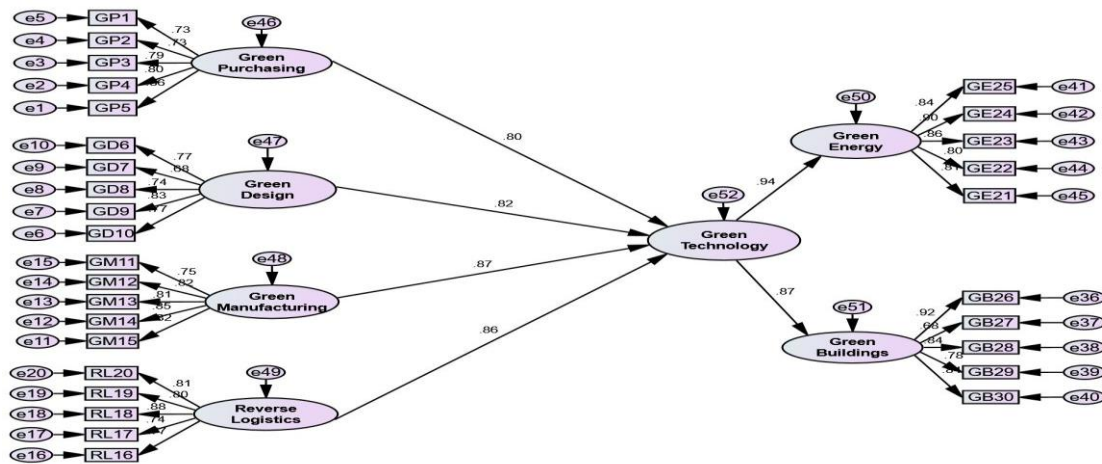


Figure 5. Model for testing the sub-hypotheses of the second main hypothesis.

Table 4. Estimating the standard regression coefficients for the impact of GSCMP on green technology.

P-value	95% Confidence Interval		Estimate(β)	The dependent variable	direction of impact	The independent variable
	Lower	Upper				
0.013	0.565	Lower	0.670	Green Technology	←	Green Purchasing
	0.766	Upper				
0.007	0.755	Lower	0.888			
	1.047	Upper				
0.010	0.765	Lower	0.876			
	1.012	Upper				
0.004	0.844	Lower	0.941			
	1.073	Upper				

- 1- Green purchasing has impact a significant positive on green technology. Therefore, the first subhypothesis regarding the second hypothesis is disproved, and the alternative hypothesis is accepted.
- 2- Green design has impact a significant positive on green technology. Therefore, the second subhypothesis regarding the second hypothesis is disproved, and the alternative hypothesis is accepted.
- 3- Green manufacturing has impact a significant positive on green technology. Therefore, the third subhypothesis regarding the second hypothesis is disproved, and the alternative hypothesis is accepted.

- 4- Reverse logistics has impact a significant positive on green technology. Therefore, the fourth subhypothesis regarding the second hypothesis is disproved, and the alternative hypothesis is accepted.

4.4. The Third Main Hypothesis: Based on the data in Figure (6) and Table (5), green technology has impact a significant positive on sustained performance. Therefore, the third main hypothesis of the research hypothesis is rejected, and the alternative hypothesis is accepted.

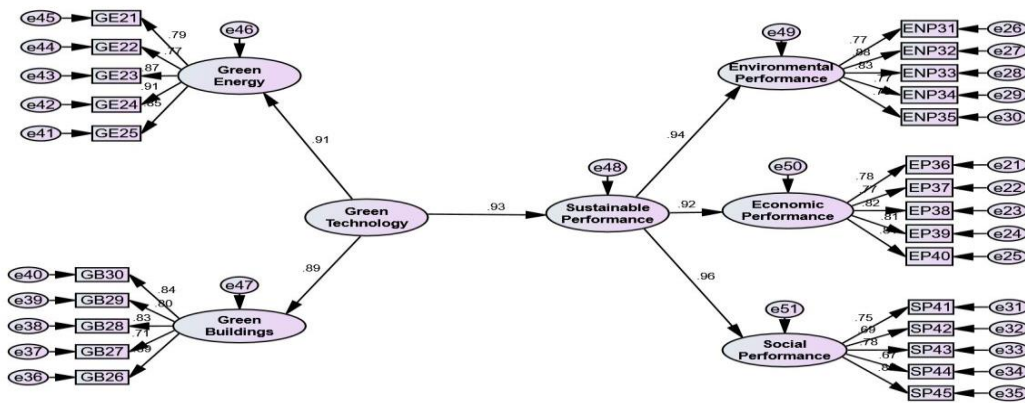


Figure 6. Model for testing the third main hypothesis

Table 5. displays the standard regression coefficients for the impact of green technology on sustained performance.

P-value	95% Confidence Interval		Estimate(β)	The dependent variable	direction of impact	The independent variable
0.012	0.658	Lower	0.782	Sustained Performance	←	Green Technology
	0.925	Upper				

Building on the above, the sub-hypotheses derived from the third main hypothesis are tested as follows: Figure (7) and the data in Table (6) indicate the nature of the impact of each branch of green technology on sustained performance.

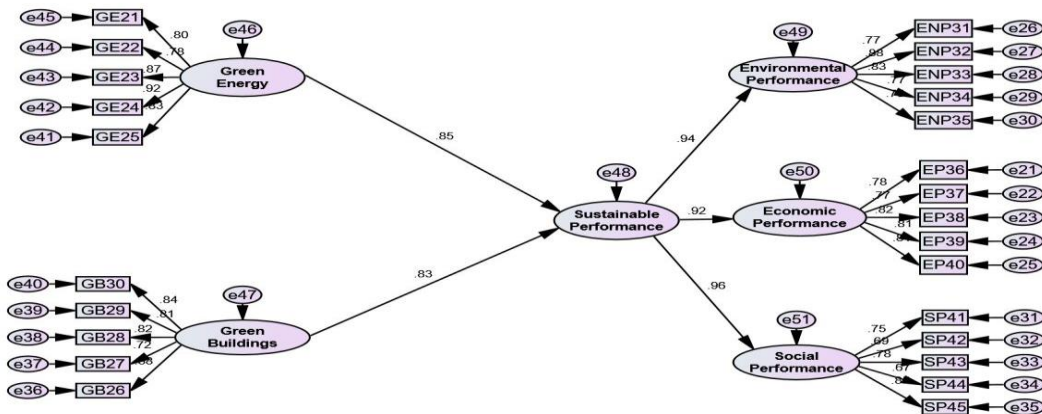


Figure 7. presents the model for testing the sub-hypotheses of the third main hypothesis.

Table 6. displays the standard regression coefficients for the impact of different branches of green technology on sustained performance.

P-value	95% Confidence Interval		Estimate(β)	The dependent variable	direction of impact	The independent variable
0.011	0.562	Lower	0.666	Sustained Performance	←	Green Energy
	0.773	Upper				
0.008	0.553	Lower	0.638			Green Buildings
	0.735	Upper				

- 1- We find a significant positive impact of green energy on sustained performance, thus rejecting the first subhypothesis of the third main hypothesis and accepting the alternative hypothesis.
- 2- There is a significant positive impact of green buildings on sustained performance. Therefore, the second subhypothesis regarding the third hypothesis is disproved, and the alternative hypothesis is accepted.

4.5. Testing The Fourth Main Hypothesis: Based on the data presented in Figure (8) and Table (7), the following observations can be made:

- 1- There is a significant direct positive impact of the independent variable, GSCMP (X), on the dependent variable, sustained performance (Y).
- 2- There is a significant direct positive impact of the independent variable, GSCMP (X), on the mediating variable, green technology (W).
- 3- There is a significant direct positive impact of the mediating variable, green technology (W), on the dependent variable, sustained performance (Y).
- 4- There is a significant indirect positive impact of the independent variable, GSCMP (X), on the dependent variable, sustained performance (Y), mediated by the mediating variable, green technology (W). Therefore, the fourth main hypothesis of the research is rejected, and the alternative hypothesis is accepted.

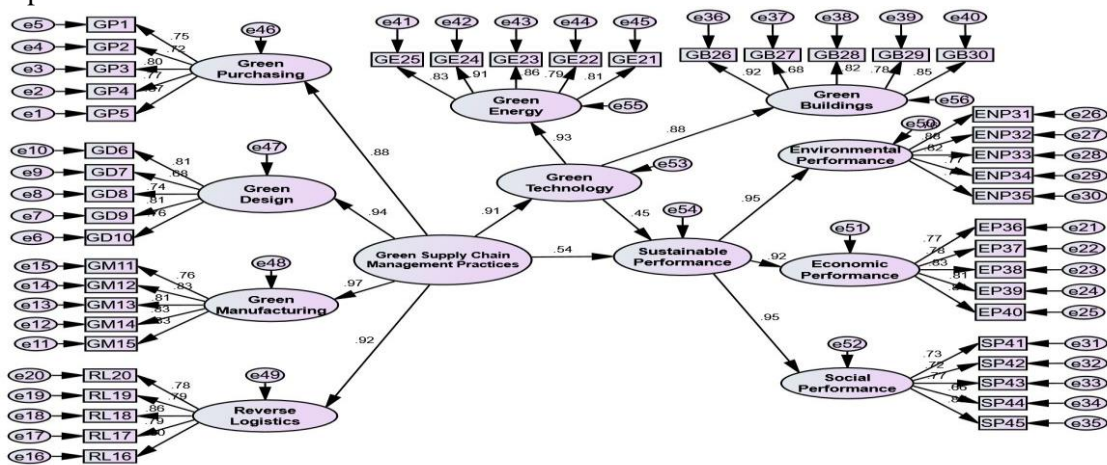


Figure 8. Model Testing the Fourth Main Hypothesis

Table 7. Standardized Regression Coefficients for Direct and Indirect Effects of GSCMP on Sustained Performance through Green Technology.

P-value	95% Confidence Interval		Estimate(β)	mathematical relationship	type of effect
0.037	0.171	Lower Bound	0.425	$Y \leftarrow X$	Direct effects
	0.634	Upper Bound			
0.010	0.765	Lower Bound	0.860	$W \leftarrow X$	
	0.983	Upper Bound			
0.008	0.165	Lower Bound	0.372	$Y \leftarrow W$	
	0.732	Upper Bound			
0.007	0.185	Lower Bound	0.404	$Y \xleftarrow{W} X$	indirect effects
	0.737	Upper Bound			

Based on the above, the sub-hypotheses derived from the fourth main hypothesis are tested as follows: Figures (9) and (10), along with the data in Table (8), indicate the values of the path coefficients and the type of indirect effects.

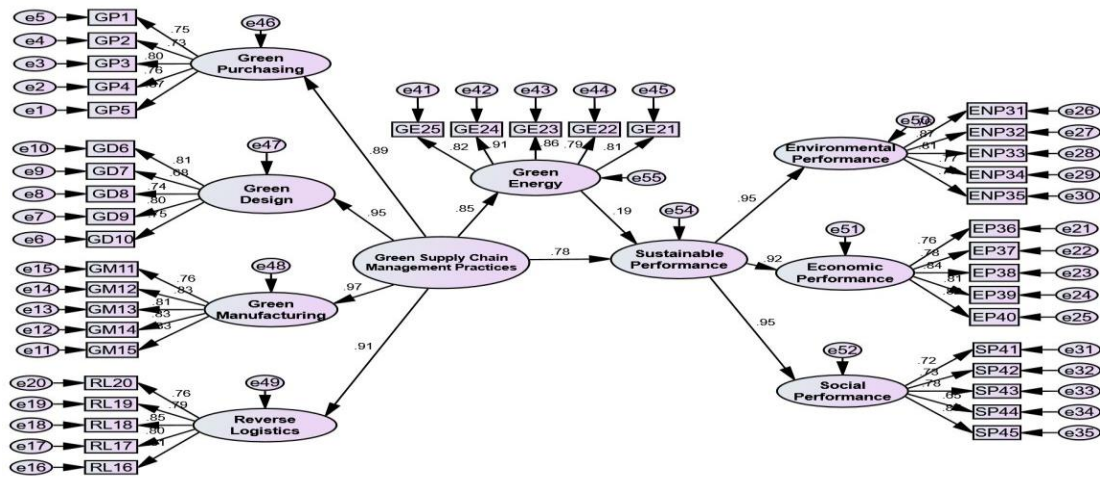


Figure 9. presents the model for testing the first sub-hypothesis of the fourth main hypothesis.

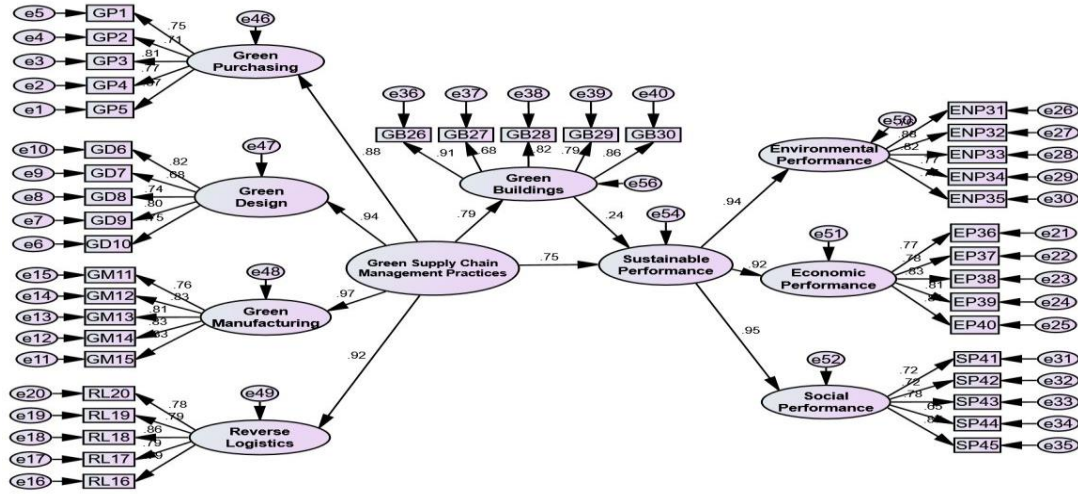


Figure 10. presents the model for testing the second sub-hypothesis of the fourth main hypothesis.

Table 8. shows the standard regression coefficients for the indirect effects of GSCMP on sustained performance through green technology branches.

P-value	95% Confidence Interval		Estimate(β)	mathematical relationship	type of effect
0.046	0.052	Lower Bound	0.162	W1 ($Y \leftarrow X$)	indirect effect
	0.278	Upper Bound			
0.003	0.107	Lower Bound	0.192	W2 ($Y \leftarrow X$)	indirect effect
	0.302	Upper Bound			

1. There is a significant positive indirect effect of the independent variable, GSCMP (X), on the dependent variable, sustained performance (Y), mediated by green energy (W1). Therefore, the first sub-hypothesis of the fourth main hypothesis of the research is rejected, and the alternative hypothesis is accepted.

2. There is a significant positive indirect effect of the independent variable, GSCMP (X), on the dependent variable, sustained performance (Y), mediated by green buildings (W2). Therefore, the second sub-hypothesis of the fourth main hypothesis of the research is rejected, and the alternative hypothesis is accepted.

5. CONCLUSIONS AND SUGGESTIONS

5.1. Conclusions

- Green supply chain management emerged in the early 1970s due to the increasing environmental protection legislation and laws addressing issues of toxic emissions and greenhouse gases resulting from industrial activities. Based on its evolutionary stages, it is considered an extension of traditional supply chain management, and sustained supply chain management represents an extension of it.
- Green energy includes solar energy, wind energy, hydroelectric power, biomass energy, geothermal energy, and tidal power. It originated in response to the global demand for achieving zero emissions as an alternative source to fossil fuels, which contribute to the generation of harmful gases and emissions.

Green energy is a continuous renewable energy source that generates revenue for the company while preserving the environment and community health.

3. If companies want to maintain their presence in the local and global markets, they need to achieve a balance between the dimensions of sustained performance by focusing on green practices, starting from the use of raw materials and ending with the final products, as well as conserving energy and resources. Additionally, they should meet stakeholders' needs and improve community activities.
4. The test results revealed a significant direct positive effect (both overall and individually) of the independent variable (GSCMP) on the dependent variable (sustained performance overall). This indicates that GSCMP are among the essential components for achieving sustained performance in the researched company.
5. The test results revealed a significant direct positive effect (both overall and individually) of the independent variable (GSCMP) on the mediating variable (green technology overall). This suggests that GSCMP are crucial factors that facilitate the implementation of green technology in the researched company.
6. The test results indicated a significant direct positive effect (both overall and individually) of the independent variable (green technology) on the dependent variable (sustained performance overall). This indicates that the adoption of green technology serves as an input for achieving sustained performance in the researched company.
7. The test results indicated both direct and indirect effects, showing a significant indirect positive effect of the independent variable (GSCMP) on the dependent variable (sustained performance) mediated by (green technology). This indicates that the mediating variable plays an important role in enhancing the relationship between the independent variable and the dependent variable. It signifies that both GSCMP and green technology contribute, whether directly or indirectly, to achieving sustained performance. This suggests that the adoption and focus on green technology stem from the company's interest in green practices, starting from the procurement of raw materials to product design, manufacturing, and utilization at the end of its productive life, all of which have an impact on achieving sustained performance.

5.2. Suggestions

- 1-The company management should choose suppliers based on their environmental performance in order to rely on them when needed and prioritize their evaluation process to determine the best supplier in terms of providing environmentally friendly raw materials.
- 2- The company management should minimize the components of the designed product and use materials and energy efficiently to reduce waste while maintaining quality, cost, and performance standards.
- 3- The company management should work on reducing the negative impact of production processes on the environment by installing advanced filters on air exhaust systems to purify the air from gases and particulates generated by machines during operation.
- 4- The company management should establish relationships with customers, communicate with them, and encourage them to return and repair defective products to benefit from the recycling of damaged parts.
- 5- The company management should harness renewable natural resources to generate green electricity as a real alternative to traditional energy sources, and utilizing them represents an opportunity for progress and improving sustained performance.
- 6- The company management should collaborate with qualified architects and engineers in this field to conduct necessary maintenance and improvement of old buildings.
- 7- The company management should shift from end-of-pipe environmental protection (treating water, emissions, and waste) to closing the circular loop by applying the concept of the circular economy (from cradle to cradle).
- 8- It is essential for the company to focus on achieving resource efficiency, reducing energy consumption, and minimizing waste in all company activities.

- 9- The company management should increase its focus on health and safety standards by encouraging employees to adhere to them to reduce accidents and mitigate the impact of toxic emissions on them, as well as minimize their impact on the community.

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