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Article

The Impact of Reverse Supply Chains on Enhancing Environmental Performance through Green Logistics (An Exploratory Study at the General Company for Iron and Steel in Basra)

Noor Naji Hussein Al-Tamimi[1], Iman Asker Hawi[2]

1. Business Management Techniques Department, Management Technical College – Basra, Southern Technical University, Basra, Iraq.
2. Business Management Techniques Department, Management Technical College – Basra, Southern Technical University, Basra, Iraq.

* Correspondence: -

Abstract: This study aimed to improve environmental performance by diagnosing the impact of reverse supply chains on environmental performance through green logistics. Data were analyzed using SPSS software, based on a sample of 30 employees at the General Iron and Steel Company. The results showed that reverse supply chains play a significant role in improving environmental performance, and the study found a positive impact of average green logistics on environmental performance. The study emphasized the necessity of using green logistics practices as a tool to improve environmental performance in industries such as the iron and steel industry.

Keywords: Reverse supply chain, environmental performance, green logistics

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1. Introduction

Reverse supply chains and green logistics are among the most important concepts that form the basis for research and development in the field of environmental management and sustainability. These concepts reflect the urgent need to protect the environment and reduce the negative impacts of economic activities on it, while achieving economic efficiency and sustainable development. Raising awareness of the importance of adopting sustainable environmental practices in business has become a pressing necessity in light of the environmental challenges facing the world today.

However, the existence of efficient and sustainable reverse supply chains can play a major role in reducing these negative impacts and improving the industry's environmental performance.

This study aims to explore the impact of reverse supply chains in the iron and steel industry on environmental performance by analyzing the extent to which companies in the sector have adopted green logistics principles and technologies. This research comes in the context of increasing pressure on companies to adopt sustainable practices and improve their environmental performance, whether from regulatory bodies or from consumers and investors concerned with corporate social and environmental responsibility.

Problem Statement

One of the fundamental aspects of business success is reverse sourcing, which directly improves environmental performance and enhances environmental efficiency by focusing on reducing air and water pollution and solid waste through recycling, reuse, repair, and renewal. Green logistics impacts productivity and the competitiveness of the global economy, encompassing green manufacturing, green purchasing, and green design. Given the increasing pressure on companies, particularly iron and steel companies, to fulfill their environmental and social responsibilities, they have been driven to adopt reverse sourcing chains while adhering to environmental quality standards and improving service quality to maintain a clean environment and achieve high sustainability.

Therefore, the research problem can be expressed through the following questions:

1. To what extent does the reverse sourcing chain affect environmental performance?
2. What role does green logistics play in improving environmental performance?
3. Does the reverse sourcing chain affect green logistics, and is this effect reflected in environmental performance?

Objectives of the Study

1. To study the current impact of reverse supply chains in the iron and steel industry on environmental performance.
2. To assess the extent to which iron and steel companies have adopted green logistics principles and technologies.
3. To reveal the impact of green logistics principles on reducing emissions and improving resource management.
4. To develop a model for improving reverse supply chain performance using green logistics.

Importance of the Study

In the iron and steel company, reverse sourcing played a significant role in enhancing business efficiency, reducing environmental impact and costs, and contributing substantially to meeting customer needs. The importance of this research is evident from the following:

1. Waste and Raw Material Management: The reverse supply chain facilitates the recycling of used or damaged products.
2. Product Recycling: Recyclable, reusable, or damaged products are collected for reprocessing to extract valuable materials for reuse in new production cycles.
3. Inventory and Cost Management: The reverse supply chain helps reduce inventory of damaged or consumed products and lowers disposal costs.
4. Meeting Customer Needs: The reverse supply chain allows the iron and steel company to meet customer needs related to product recycling or reuse.

Research Hypotheses

Main Hypothesis 1: There is a statistically significant relationship between reverse supply chain practices and green logistics at a significance level of 0.05.

Sub-hypotheses:

1. There is a statistically significant relationship between reverse supply chain practices and green marketing.
2. There is a statistically significant relationship between reverse supply chain practices and green design.
3. There is a statistically significant relationship between reverse supply chain practices and green purchasing.
4. There is a statistically significant relationship between reverse supply chain practices and green manufacturing.

Main Hypothesis 2: There is a statistically significant relationship between reverse supply chain practices and environmental performance at a significance level of 0.05.

Sub-hypotheses:

1. There is a statistically significant relationship between reverse supply chain practices and water pollution management.
2. There is a statistically significant relationship between reverse supply chain practices and air pollution management. 3- There is a statistically significant relationship between reverse supply chain practices and solid waste management.
3. There is a statistically significant relationship between reverse supply chain practices and environmental efficiency.

Main Hypothesis 3: There is a statistically significant relationship between green logistics practices and environmental performance at a significance level of 0.05.

Sub-hypotheses:

1. There is a statistically significant relationship between green logistics practices and water pollution management.
2. There is a statistically significant relationship between green logistics practices and air pollution management.
3. There is a statistically significant relationship between green logistics practices and solid waste management.
4. There is a statistically significant relationship between green logistics practices and environmental efficiency.

Main Hypothesis 4: There is a statistically significant relationship between reverse supply chain practices and environmental performance, mediated by green logistics, at a significance level of 0.05.

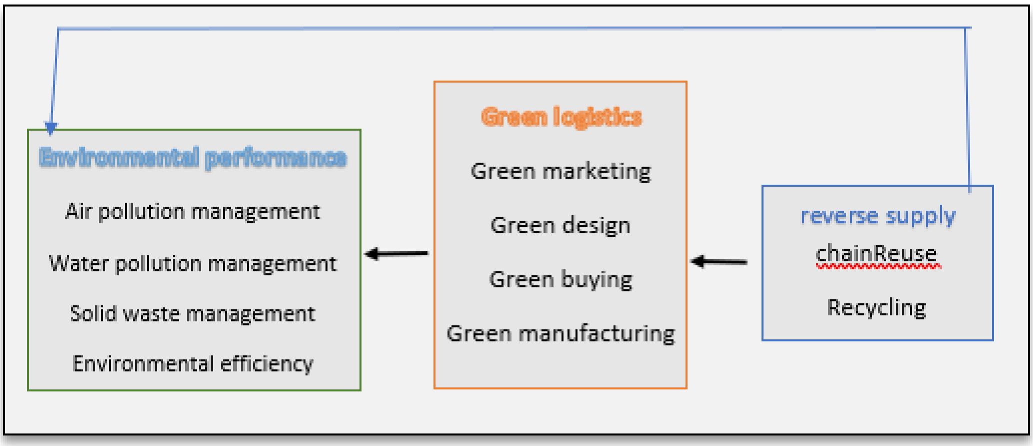

Figure 1. Hypothesis Scheme.

Study Limitations

The research boundaries are as follows:

1. Temporal boundaries: The research was limited to the 2025-2026 academic year.
2. Spatial boundaries: The research was conducted at the General Company for Iron and Steel in Basra.
3. Human boundaries: The research included 30 employees of the General Company for Iron and Steel in Basra.
4. Knowledge boundaries: The research addresses reverse supply chain, environmental performance, and green logistics.ce.

Theoretical Framework

1. The concept of a reverse supply chain:

The concept of the reverse supply chain was first studied in the 1990s, gaining prominence in the first decade of the 21st century [1]. It is defined as the process of collecting used products from customers and returning them to manufacturers for reprocessing, a process facilitated by distributors. It is also described as a series of activities necessary for recycling products used by customers, with the aim of processing or recycling recyclable products [2]. Furthermore, it is defined as the processes by which products are returned at the end of their life cycle from consumers or customer service centers for the purpose of recovering their value and ensuring their proper disposal.

Some view it as the planning, implementation, and cost-effective control of the flow of raw materials, products, and information from the point of consumption to the point of origin, with the goal of recovering the value of returned products and ensuring the proper disposal of waste and excess materials [3]. It has also been defined as "the planning, implementation, and control of the efficient and cost-effective flow of raw materials, work-in-process inventory, finished goods, and related information from the point of consumption to the point of production." The original purpose is to recover value or ensure proper disposal [4].

Generally, a reverse supply chain design incorporates a set of activities to recover expired, post-use, and intermediate by-products from original equipment manufacturers (OEMS), suppliers, or other third parties [5].

2. The scientific importance of the reverse supply chain:

The importance of reverse processes [6], [7]

1. lies in their ability to create tangible and intangible value by helping companies extract value from returned used products.
2. Improved customer satisfaction and loyalty by focusing more on goods with recurring manufacturing defects and correcting them before they reach the market.
3. Furthermore, it presents a significant opportunity to enhance business performance and improve a company's public image by attracting environmentally conscious consumers. It also improves the company's standing with the government, thereby maintaining customer support, increasing sales, and gaining a competitive edge in the evolving business environment.

3. Stages of the reverse supply chain [8]:

1. The first stage involves collecting end-of-life or discarded products from customers (which can come from customers' homes and retailers). These products are collected at designated collection points through permanent collection stations and curbside collection programs.
2. The second stage involves transporting these products to dismantling centers for processing into various components and materials. Good quality components are sent directly to secondary markets, while non-recyclable components or toxic waste are sent to landfills.
3. The third stage involves recycling and repair centers. Ferrous metals and plastics are sent to recycling centers, while unusable parts are taken to repair centers**.**

4. Dimensions of the reverse supply chain [8]:

1. **Recycling**: The process of breaking down worn-out products into their basic components and reprocessing them. This begins with collecting containers holding recyclable materials, which are then processed. The process depends on the type of material being recycled. This process contributes to cost and energy savings.
2. **Reuse**: This involves returning any usable product for reuse, making it more versatile. This helps rid the environment of excess and worn-out materials, saves energy, reduces operational costs, and improves the speed of resource and product delivery.
3. **Repair and Refurbishment**: This involves retrieving products from sales outlets and repairing any defects or damage. Products may require spare parts, and customers are notified accordingly.

2. Materials and Methods

This study adopted a quantitative, explanatory research design to examine the impact of reverse supply chain practices on environmental performance, with green logistics serving as a mediating variable, within the context of the General Company for Iron and Steel in Basra. The empirical data were collected through a structured questionnaire developed on the basis of the study’s theoretical framework and prior validated scales related to reverse supply chains, green logistics, and environmental performance. The questionnaire employed a five-point Likert scale ranging from strong disagreement to strong agreement to capture respondents’ perceptions accurately. The study population consisted of employees of the General Company for Iron and Steel, and a purposive sample of 30 respondents was selected due to their direct involvement in operational, logistical, and environmental activities relevant to the research variables.

Data analysis was conducted using SPSS software, where descriptive statistics such as means and standard deviations were used to assess the level of adoption of reverse supply chain and green logistics practices. Reliability and internal consistency of the measurement instrument were verified using Cronbach’s alpha coefficients, all of which exceeded acceptable thresholds, indicating strong scale reliability. Inferential statistical techniques, including Pearson correlation analysis and multiple linear regression, were applied to test the direct and indirect relationships among the variables and to evaluate the proposed hypotheses at a significance level of 0.05. Additionally, mediation analysis using regression-based procedures was employed to determine the extent to which green logistics mediates the relationship between reverse supply chain practices and environmental performance. This methodological approach ensured robustness, validity, and suitability for achieving the research objectives.

The Concept of Green Logistics

1. The concept of green logistics

Green logistics is defined as an organizational activity that considers and integrates environmental issues into the management of the supply chain to improve the environmental performance of both the supplier and the customer [9]. It is seen as activities or practices aimed at reducing the environmental impact of logistics practices by implementing effective environmental management of the forward and reverse flow of products [10], [11]. It is also defined as a systematic and sustainable process. From the researcher's perspective: Green logistics is a crucial strategy for companies and institutions striving for environmental sustainability and achieving sustainable development.

The Importance of Green Logistics: The importance of green logistics lies in the following [12]:

1. The importance of green logistics is highlighted by its focus on reducing pollution resulting from all logistics activities.
2. Conventional logistics does not implement environmentally friendly logistics, while green logistics performs the same logistical operations but by adhering to environmental standards.

3. Benefits of Adopting Green Logistics

A number of benefits of green logistics can be identified, including the following: (Rifai, 2016: 105-106)

1. Building a company's business reputation by demonstrating its environmental friendliness and commitment to corporate social responsibility.
2. Th- Improving the public image: through the positive response of consumers, investors, and employees to companies with a reputation for environmental performance.
3. Improving product quality: as green logistics helps maintain relationships between buyers and suppliers, leading to increased control over product quality.

4. Green logistics focuses on several objectives, including [13]:

1. Green logistics works to meet the demand for green products and services, maintain a good level of performance, and achieve environmental sustainability.
2. Organizations become environmentally conscious to meet customer demands without harming the environment.

5. Dimensions of Green Logistics

a. Green Procurement: Green procurement includes environmental practices that reduce waste sources and increase the regeneration of purchased items. It takes environmental concerns into account in various procedures. Therefore, green procurement promises that the purchased materials are environmentally friendly in terms of their characteristics, non-harmful components, and recyclability and reuseability[14]. Green purchasing is defined as the function that secures a company's needs for materials with a minimal environmental impact. It is considered one of the most important activities practiced in green logistics [15]. Green purchasing practices include: environmental labeling, environmental cooperation with suppliers, supplier environmental audits, supplier environmental management systems, and secondary supplier environmental assessments [16].

b. Green Manufacturing: Green manufacturing is defined as the process of planning manufacturing, reducing energy consumption, utilizing materials efficiently, and minimizing waste during the manufacturing process [17]. Green manufacturing is a production process that uses inputs with relatively low environmental impacts, is highly efficient, and generates minimal or no waste or pollution. Green manufacturing practices are environmentally and socially responsible practices that reduce the negative impacts of manufacturing activities while simultaneously achieving economic benefits. The main goal of green manufacturing is to reduce the environmental impact of the product by using appropriate materials and technology. Green manufacturing includes activities such as reducing resource use and recycling. …..

c. Green Design: Green design is considered one of the essential activities of the green value chain. It seeks to reduce the environmental impact of the product throughout its life cycle. Thinking in a green direction in design It can distinguish the environmental image of the product and the organization. The goal of green design is to provide or develop existing products in a safe and environmentally friendly way [18].

d. Green Marketing: It is defined as a comprehensive concept that includes production and marketing, focusing on green products manufactured with green technology that does not harm the environment [19]. These products are characterized by being naturally grown or manufactured with materials that do not contain toxic substances, and are biodegradable, recyclable, or reused, and have environmentally friendly packaging. Green marketing is defined as "an integrated, systematic process that aims to influence customer behavior in a way that encourages them to demand environmentally friendly products and modify their consumption habits accordingly, and to work on providing products that satisfy this trend so that the end result is environmental preservation, consumer protection, and achieving the company's profitability goal."Green logistics

3. Environmental performance

a. Th In recent times, stakeholders have increasingly focused their attention on the environmental performance of companies**.** This is due to the impact of manufacturing on the environment, such as climate change and soil, air, and water pollution. Therefore, many companies aim to act responsibly and set targets for environmental improvements. Consequently, they must measure performance in terms of energy and freshwater conservation, or the reduction of waste, volatile organic compounds (VOCs), and greenhouse gas emissions [20]. The term "performance" is not new; numerous theoretical and applied studies and research have been conducted to refine its concept. However, there is no general agreement on its definition, and there is also variation in the terminology used to denote the concept of performance [21]. Environmental performance reflects a company's ability to rely on efficient and clean renewable energy and resources to reduce emissions, solid waste, and hazardous materials during the manufacturing process and minimize environmental damage. It is crucial that renewable resources are used at a rate that allows them to regenerate themselves and prevents increased pollutants and overuse [22], [23]. Adopting an environmental approach, such as waste management and sustainable product design, can enhance environmental performance.Environmental performance refers to the degree to which companies conserve resources, avoid negative impacts on their operating environment, minimize environmental damage, and maintain high levels of efficiency and effectiveness [23].

b. Importance of Environmental Performance: The environmental performance of organizations has gained increasing attention from scientists and researchers over the past decades, and governments are focusing on it as part of their policies to preserve natural resources and the surrounding environment. Environmental performance also plays a vital role in protecting the natural environment from negative impacts (such as pollution, emissions, and waste) and maintaining the overall performance of organizations [24].

c. Dimensions of Environmental Performance:

1) Environmental efficiency: The emergence of environmental efficiency stemmed from the rise of environmental degradation, which became a major concern for many. As its consequences became increasingly apparent, concerted efforts were made to address the human-caused problems. In parallel with prevailing international concerns about environmental disasters resulting from the increasing exploitation of natural resources and pollution, researchers focused on a range of systems for measuring environmental pollution factors**.** Environmental efficiency is defined as a concept of how to reduce the consumption of material resources and energy, minimize impacts on the natural environment, and enhance value in the production of products and services [25].

2) Air Pollution Management: In the 21st century, air pollution has been identified as one of the most significant environmental pollutants, and these pollutants have increased markedly over time. Recently, air pollution has had a profound impact on human health and life, and has been classified as one of the most dangerous and deadly environmental threats to humanity [26]**.** The presence of these substances in the air, in the form of solid particles or droplets, can cause harm to the environment and humans [27].

3) Water Pollution Management: Water is essential for life, serving as a source of energy for humans and other living organisms. Therefore, it must be preserved, treated, and protected from pollution. With the development of life, pollutants such as metals, household waste, and chemicals have increased, posing a significant threat to water quality. [28]. Several measures can improve water safety, starting with protecting the water source; treating water at distribution, collection, or consumption points; and ensuring that the treated water is safe. These measures can be effectively planned, implemented, and monitored using water safety plans [29].

4) Solid Waste Pollution Management: With rapid population growth and unprecedented rates of urbanization, waste production is increasing rapidly, particularly in cities and especially in developing countries. Effective waste management, particularly of toxic materials, is a major challenge for global sustainable development [30]. Waste can be defined as household, industrial, or agricultural materials that have been used and can be classified as household waste, industrial waste, oil refinery waste, electronic waste, construction waste, food processing waste, medical waste, or nuclear waste.e concept of environmental performance [31], [32], [33], [34], [35]

3. Results and Discussion

Practical Aspect

An overview of the research community (the General Company for Iron and Steel in Basra):

1. **About the Research Community (Basra General Company for Iron and Steel):** The Basra General Company for Iron and Steel (SCIS) is a subsidiary of the Iraqi Ministry of

Industry and wholly owned by the government. It specializes in the production of reinforcing wire, sections, and iron pipes. It is located in the Khor Al-Zubair complex, approximately 45 km south of Basra city center, near Umm Qasr, and only 5 km from the Khor Al-Zubair port. The company was established in 1972 with the aim of contributing to the national economy and developing industrial production in the field of iron production from its raw materials and manufacturing it into various shapes and sizes, in line with the objectives of development plans. Commercial production began in the late 1970s but was temporarily halted in the 1980s due to the Iran-Iraq War. Production resumed intermittently in the 1990s due to the economic embargo and international sanctions. In 2003, the company's factories were damaged, looted, and robbed, leading to a complete halt in production, which continues to this day. Currently, the company's factories are undergoing renovation and rehabilitation to resume production [36], [37], [38], [39], [40].

2. Statistical Analysis:

The SPSS software was used to obtain the arithmetic mean, standard deviation, multiple linear regression, Pearson's coefficient, and a one-sample t-test for a five-point Likert scale with a significance level of 0.05. This level is generally considered acceptable in the social sciences and corresponds to a confidence level of 95. Use a default arithmetic mean of 3, according to the Likert scale below:

Table 1. Five-Point Likert Rating

I strongly disagree	**I disagree**	**neutral**	**I agree**	**I completely agree**	**Classification**
1	2	3	4	5	**Degree of approval**

(Source: Prepared by the researcher)

Class Length = 5-1/5=4/5 =0.80 (the class length).

the scale in the following table:

indication	**Degree**	**Categories**
High degree of rejection	I strongly disagree	**1.00-1.79**
Low degree of rejection	I disagree	**1.80-2.59**
Average	neutral	**2.60-3.39**
Low level of approval	I agree	**3.40-4.19**
High degree of approval	I completely agree	**5.00-4.20**

(Source: Prepared by the researcher)

3. Characteristics of the Research Sample:

A. Gender

Table 3. Number of Male and Female Employees

ratio%	**repetition**	**Gender**
56.7	17	**male**
43.3	13	**feminine**
100	30	**the total**

(Source: Prepared by the researcher)

Table (3) shows that 56.7% of the total sample are males, compared to 43.3% females.

B. Age

Table 4. shows the distribution of the sample by age.

ratio%	**repetition**	**the age**
6.7	2	**21-25**
6.7	2	**26-30**
16.7	5	**31-35**
10	3	**36-40**
60	18	**40…**
100	30	**the total**

(Source: Prepared by the researcher)

Table (4) shows that the majority of the sample members are aged 40 and above (60%), followed by those aged 31 to 35 (16.7%), then those aged 36 to 40 (10%). Individuals aged 21 to 25 and 26 to 30, both at 6.7%, represent the smallest percentage

C. Marital Status

Table 5. Distribution of Sample Members by Marital Status

ratio%	repetition	marital status
26.7	8	**Single**
73.3	22	**married**
100	30	**the total**

(Source: Prepared by the researcher)

From Table No. (5), it can be observed that most of the sample members, at a rate of 73.3%, are married, and the remaining percentage, 26.7%, represents single people.

D. Educational Qualification

Table 6. Distribution of Sample Members According to Educational Qualification

ratio%	repetition	Academic qualification
3.3	1	**doctorate**
3.3	1	**Master's**
73.3	22	**Bachelor's**
0	0	**Higher Diploma**
20	6	**diploma**
0	0	**Other**
100	30	**the total**

(Source: Prepared by the researcher)

Table (6) shows that the majority of the sample hold a bachelor's degree (73.3%), followed by a diploma (20%). The lowest percentages are doctorates (3.3%) and master's degrees (3.3%).

E- Length of Service in Current Position

Table 7. shows the number of years of service in the current position.

ratio%	repetition	Working period
20	6	**1-5**
30	9	**6-10**
16.7	5	**11-15**
33.3	10	**16…**
100	30	**the total**

(Source: Prepared by the researcher)

Table (7) shows that most members of the sample have been working in the same position for 16 years or more (33.3%), followed by those with 6 to 10 years of experience (30%), then those with less than 5 years of experience (20%), and finally those with 11 to 15 years of experience (16.7%), which is the lowest percentage.

F. Period of experience (number of years of experience)

Table 8. Number of years of experience

ratio%	repetition	Years of experience
10	3	**1-5**
23.3	7	**6-10**
10	3	**11-15**
3.3	1	**16-20**
30	9	**21-25**
23.3	7	**26…**
100	30	**the total8**

(Source: Prepared by the researcher)

Table (8) shows that 30% of the sample have more than 20 to 25 years of experience, reflecting the high level of skill possessed by the institutions. This is followed by 23.3% with more than 26 years of experience, and another 23.3% with 6 to 10 years of experience. The remaining 10% have 1 to 5 years of experience, and the remaining 3.3% have 16 to 20 years of experience.

4. Descriptive Statistics for the Research Sample: Descriptive statistics were used for the independent and dependent research variables. The arithmetic mean and standard deviation were calculated for each variable individually. The arithmetic mean and standard deviation were also calculated for all items within the axes. The acceptance or rejection of each statement by the research sample was determined based on the average of the responses [41][42][43][44][45].

A. Analysis of Questionnaire Items Related to the Independent Variable (Reverse Supply Chain):

Table 9. presents the analysis of the questionnaire items related to the independent variable.

standard deviation	**arithmetic mean**	**Paragraphs**	
1.05	3.70	My company has the ability to recycle leftover waste from products in its showrooms.	**1**
1.24	3.36	My company has the ability to retrieve old sold products and replace them with new ones.	**2**
0.98	3.70	My company can benefit from recycling waste as a raw material used in other industries.	**3**
0.98	3.93	My company focuses on product design when creating a product that can be reused for new purposes or a new function after it has performed its primary function.	**4**
1.09	3.80	My company reuses materials to reduce the amount of industrial waste.	**5**
1.13	3.76	My company is interested in its recovered products for the purpose of reusing them as raw materials in the manufacturing processes of other products.	**6**
1.09	3.66	If the product cannot be repaired within the warranty period, my company will replace it or refund its full value if no alternative is available to the customer.	**7**
1.16	3.76	My company provides the customer with a written estimate of the value of the repairs.	**8**
1.06	3.63	My company benefits from returned products to reduce the consumption of rare materials.	**9**
1.09	3.70	The axis as a whole	

(Source: Prepared by the researcher)

Table (9), which includes the results of the descriptive statistics, shows the following:

1. The arithmetic mean values for all scale variables ranged between (3.93 - 3.36), all of which are higher than the hypothetical arithmetic mean (3), indicating a high level of interest among the sample members in the study variables.
2. The standard deviation values for the inverse supply chain variable ranged between (1.24 - 0.98). Most of them were equal to one, indicating small variations among the opinions of the sample members.

B. Analysis of the questionnaire items related to the mediating variable (green logistics):-

Table 10. shows the analysis of the questionnaire items related to the mediating variable.

standard deviation	**arithmetic mean**	**Paragraphs**

1.00	3.76	My company takes environmental considerations into account when purchasing raw materials.	**1**
0.90	3.93	My company prefers to purchase environmentally friendly raw materials.	**2**
0.98	3.93	My company focuses on planning and monitoring production processes with the aim of reducing waste.	**3**
0.96	3.60	My company is working to reduce the noise pollution from its operations to the lowest possible levels.	**4**
0.86	3.93	My company uses processes that use less material while reducing emissions.	**5**
0.88	3.96	My company focuses on planning and monitoring production processes with the aim of reducing waste.	**6**
0.93	3.50	My company strives to reduce environmental impact by packaging products in eco-friendly containers.	**7**
0.98	3.70	My company shares all information related to distribution outlets and methods with the green supply chain partners.	**8**
1.05	3.70	My company has marketing outlets throughout the province to market its new and remanufactured products.	**9**
0.92	3.90	My company designs its products in a way that ensures reduced energy consumption.	**10**
1.06	3.63	My company designs its products in a way that allows them to be reused and recycled.	**11**
1.13	3.76	My company strives to reduce the complexity of product components and remanufacturing.	**12**
0.97	3.77	The axis as a whole	

(Source: Prepared by the researcher)

Table (10), which contains the results of the descriptive statistics, shows the following:

1. The mean values for all scale variables ranged between (3.96 - 3.50), all of which are higher than the hypothetical mean (3), indicating a high level of interest among the sample members in the study variables.
2. The deviation values for the green logistics variable ranged between (1.13 - 0.86). Most of these values were less than one, indicating small differences in the opinions of the sample members.

C. Analysis of the questionnaire items related to the dependent variable (environmental performance):

Table 11. Analysis of the questionnaire items related to the dependent variable

standard deviation	**arithmetic mean**	**Paragraphs**	
0.74	4.00	My company is working to increase its investments in equipment and machinery that reduce emissions.	**1**
0.91	3.83	My company has clear procedures and guidelines that will provide a positive working environment for employees.	**2**
0.86	3.93	My company is taking steps to help reduce air pollution.	**3**

1.13	3.56	My company has a clear policy regarding solid waste management.	**4**
0.87	4.00	My company uses procedures that reduce the accumulation of solid waste.	**5**
1.05	3.70	My company uses modern technology to dispose of solid waste in environmentally friendly ways.	**6**
0.88	3.96	My company has the appropriate methods for dealing with industrial wastewater, rainwater, and sewage drainage.	**7**
0.94	3.93	My company published a clear policy with simple guidelines for dealing with water pollution.	**8**
1.09	3.66	My company has contingency plans to deal with water pollution.	**9**
0.71	4.10	My company has the ability to achieve high levels of production with minimal environmental damage.	**10**
1.13	3.76	My company has the necessary capabilities to achieve acceptable levels of inter-company sustainability.	**11**
1.06	3.63	My company provides training and awareness to employees on sustainable environmental practices and the importance of preserving the environment.	**12**
0.96	3.84	The axis as a whole	

(Source: Prepared by the researcher)

Table (11), which contains the results of the descriptive statistics, shows the following:

1. The mean values for all scale variables ranged between 3.56 and 4.10, all of which are higher than the hypothetical mean (3), indicating a high level of interest among the sample in the study variables.
2. The deviation values for the environmental performance variable ranged between 0.71 and 1.13. Most were less than 1, indicating small variations in the opinions of the sample.
3. Cronbach's Alpha: Internal Consistency Test - 5. Internal consistency refers to the consistency of items within a measurement instrument to determine how well the characteristics of the items are measured within the test. The internal consistency test provides an estimate of the confidence level based on the internal correlations of independent items within the test.

Table 12. Values of Cronbach's Alpha Coefficient

Less than 0.50	**0.50**	**0.60**	**0.70**	**0.80**	**0.90**	**Value**
unacceptable	weak	questionable	acceptable	good	excellent	**Appreciation**

Source: George, D., & Mallery, SPSS for Windows step by step: A simple guide and reference. 11.0 update (4th ed.). Boston: Allyn & Bacon, (2003), P: 231.

Table 13. shows the values of the alpha scale statistics for the independent variable.

Cronbach's Alpha if Item Deleted	**Paragraphs**
0.932	**My company has the ability to recycle leftover waste from products in its showrooms.**
0.934	**My company has the ability to retrieve old sold products and replace them with new ones.**
0.935	**My company can benefit from recycling waste as a raw material used in other industries.**

0.935	**When designing a product, my company focuses on reusing it for new purposes or a new function after it has performed its primary function.**
0.934	**My company reuses materials to reduce the amount of industrial waste.**
0.933	**If the product cannot be repaired within the warranty period, my company will replace it or refund its full value if no alternative is available to the customer.**
0.935	**My company provides the customer with a written estimate of the value of the repairs.**
0.935	**My company benefited from returned products to reduce the consumption of rare materials.**
0.934	**The axis as a whole**

(Source: Prepared by the researcher)

Based on the above, Table (13) shows the scale statistics, with alpha values ranging between (0.932 - 0.935) for the items of the independent variable, indicating very strong homogeneity among the scale items.

Table 14. presents the alpha values for the mediating variable.

	Paragraphs
0.935	**My company takes environmental considerations into account when purchasing raw materials.**
0.933	**My company prefers to purchase environmentally friendly raw materials.**
0.935	**My company focuses on planning and monitoring production processes with the aim of reducing waste.**
0.934	**My company is working to reduce the noise pollution of its operations to the lowest possible levels.**
0.934	**My company uses processes that use less material while reducing emissions.**
0.936	**My company focuses on planning and monitoring production processes with the aim of reducing waste.**
0.935	**My company strives to reduce environmental impact by packaging products in eco-friendly containers.**
0.935	**My company shares all information related to distribution outlets and methods with the green supply chain stakeholders.**
0.932	**My company has marketing outlets throughout the province to market its new and remanufactured products.**
0.937	**My company designs its products in a way that ensures reduced energy consumption.**
0.934	**My company designs its products in a way that allows them to be reused and recycled.**
0.933	**My company seeks to reduce the complexity of product components and remanufacturing.**

(Source: Prepared by the researcher)

Table (14) of the scale statistics, which showed that the alpha values for measuring the items of the variable, ranging between (-0.932)(0.937 indicate a very strong homogeneity of the scale items for the mediating variable.

Table 15. shows the values of the alpha scale statistics for the dependent variable.

Cronbach's Alpha if Item Deleted	Paragraphs

0.934	My company is working to increase its investments in equipment and machinery that reduce emissions.
0.935	My company has clear procedures and guidelines that will provide a positive working environment for employees.
0.934	My company is taking steps to help reduce air pollution.
0.933	My company has a clear policy regarding solid waste management. b
0.935	My company uses procedures that reduce the accumulation of solid waste.
0.932	My company uses modern technology to dispose of solid waste in environmentally friendly ways.
0.936	My company has the appropriate methods for handling industrial wastewater, stormwater, and sewage drainage.
0.936	My company publishes a clear policy with simple guidelines for dealing with water pollution.
0.935	My company has contingency plans to deal with water pollution.
0.934	My company has the ability to achieve high levels of production, with the least possible environmental damage.
0.933	My company has the necessary capabilities to achieve acceptable levels of environmental sustainability.
0.934	My company provides training and awareness to employees on sustainable environmental practices and the importance of preserving the environment.

(Source: Prepared by the researcher)

Table (15) of the scale statistics, showing that the alpha values for the items of the dependent variable ranged between (-0.932 and 0.936), indicates very strong homogeneity among the scale items for the dependent variable.

It follows from the above that the scale possesses the required validity, reliability, and internal homogeneity for measurement purposes.

-6Data analysis using correlational relationships:

Table 16. shows the correlation between independent and dependent variables.

Environmental performance	**Green logistics**	**reverse supply chain**	**Variables**
		1	**reverse supply chain**
	1	0.675	**Green logistics**
1	0.534	0.673	**Environmental performance**

(Source: Prepared by the researcher)

Table (16) shows the following:1- The matrix above shows strong correlations between the dimensions of the independent variables and the dependent variable, with a correlation value of (0.673).2- The mediating variable (green logistics) showed a correlation of (0.675), indicating that all dimensions of the independent variable are strongly correlated with the mediating variable.3- The dependent variable (environmental performance) showed a correlation of (0.534) with the mediating variable, indicating a strong correlation with the mediating variable.

7. Testing the Research Hypotheses

1. Testing the Direct Effect Hypotheses:

A. The first main hypothesis: There is a relationship of influence between the independent variable, reverse supply chain practices, and green logistics at a significance level of 0.05. This hypothesis tested the linear relationship of a set of parametric data from managers of the Basra Iron and Steel Company. From this hypothesis, which tests the direct relationship between the independent variable

Using the ANOVA regression method, a set of results was extracted for these hypotheses, as shown in Table (17) below:

Table 17. Impact model between the hypothesis of reverse supply chain practices and green logistics

Sig.	R Square	F	t	Beta	Standardized Coefficients Std Error	Model
0.002	0.039	10.012	6.852	0.418	0.061	**Green logistics**
0.000	0.022	11.07	5.372	0.231	0.043	**Green marketing**
0.000	0.041	9.02	4.818	0.265	0.055	**Green design**
0.000	0.036	17.00	3.256	0.433	0.133	**Green buying**
0.000	0.027	14.10	6.092	0.530	0.087	**Green manufacturing**

(Source: ANOVA analysis outputs using SPSS V.24 softwar)

From Table (17) above, the ANOVA results show that the null hypothesis is not valid compared to the affirmative hypothesis, which indicates a significant effect between the independent variable and green logistics. The results showed a significance level of (0.01), with a t-value of (6.852), which is within the acceptable range at a saturation level of (B = 0.418). This confirms the significant effect when the supply chain practices variable explains (0.039) of the change in green logistics. This is a high percentage when (F = 10.012), indicating that any increase in the independent variable directly affects the green logistics variable. Similarly, the results for the sub-hypotheses showed a significant effect relationship.

B. The second main hypothesis: Regarding the relationship between the independent variable (reverse supply chain practices) and performance (at a significance level of 0.05):We test this hypothesis on the linear relationship of a set of parametric data. This hypothesis examines the direct relationship between the independent and dependent variables. Using ANOVA regression analysis, a set of results for these hypotheses was obtained, as shown in Table (18) below:

Table 18. shows the impact model between the hypothesis of reverse supply chain practices and environmental performance

Sig.	R Square	F	t	Beta	Standardized Coefficients Std Error	Model
0.000	0.051	17.010	10.510	0.515	0.049	**Environmental performance**
0.000	0.028	13.00	11.696	0.538	0.046	**Air pollution management**
0.000	0.044	22.021	9.684	0.368	0.038	**Water pollution management**
0.000	0.030	17.05	7.629	0.473	0.062	**Solid waste management**
0.000	0.037	19.101	6.580	0.533	0.081	**Environmental efficiency**

(Source: ANOVA analysis outputs using SPSS V.24 software)

From Table (18) above, the ANOVA results show that the null hypothesis is not valid compared to the affirmative hypothesis, which indicates a significant effect between the independent variable and the dependent variable (environmental performance). The results showed a significance level of (0.01), with a value of (1 = 10510), which is within the acceptable limits at a saturation level of (0515 = 0). This confirms the significant effect when the supply chain practices variable explains (0.039) of the change occurring in green logistics. This is a high percentage when (F = 17.010), which is significant, indicating that any increase in the independent variable directly affects the dependent variable. Similarly, the results of the sub-hypotheses showed a significant effect relationship.The third main hypothesis: The effect relationship between the independent variable, green logistics practices, and performance at a significance level of 0.05: This hypothesis tested the linear relationship of a set of parametric data. This hypothesis tests the direct relationship between the independent variable and the variable The dependent hypothesis. Using ANOVA, a set of results was extracted for these hypotheses. As shown in Table (19) below:

Table 19. Shows the effect model between the hypothesis of green logistics practices and environmental performance.

Sig.	**R Square**	**F**	**t**	Beta	Standardized Coefficients Std Error	**Model**
0.000	0.041	14.011	20.314	0.711	0.035	**Environmental performance**
0.000	0.028	15.23	15.800	0.632	0.040	**Air pollution management**
0.000	0.029	22.321	18.097	0.561	0.031	**Water pollution management**
0.000	0.031	16.00	18.333	0.770	0.042	**Solid waste management**
0.000	0.025	13.11	6.086	0.493	0.081	**Environmental efficiency**

(Source: ANOVA analysis outputs using SPSS V.24 software)

From Table (19) above, the ANOVA results show that the null hypothesis is not valid compared to the affirmative hypothesis, which indicates a significant effect between the independent and dependent variables (environmental performance). The results showed a significance level of (0.01), with a t-value of (20314), which is within the acceptable limits at a saturation level of (0.11). This confirms the significant effect when the variable of reverse supply chain practices explains (0.041) of the change in green logistics, a high percentage when (F = 14.010), which is significant. This indicates that any increase in the independent variable directly affects the dependent variable. Similarly, the results of the sub-hypotheses showed a significant effect relationship.

2. Testing the Indirect Effect Hypothesis:

The indirect effect hypothesis states: "H4: There is a statistically significant effect of reverse supply chain practices, mediated by green logistics practices, on the level of environmental performance," as shown in Table (21)

The effect path for both the independent variable (B = 0.416) and the mediating variable (p = 0.298) was statistically significant (p-value ≤ 0.01), indicating partial mediation of the relationship by the green logistics model, as shown in Table (20) below:

Table 20. Testing the Hypothesis of the Effect of the Mediating Variable: Green Logistics

ULCI	**LLCI**	**P**	**t**	**Se**	**coeff**	**model**		
0.2576	0.0416	0.0008	7.577	0.0549	0.416	Environmental performance	←	reverse supply chain
0.9216	0.718	0000	5.753	0.0518	0.298	Environmental performance	<--	Green logistics
		Bootstrapping	test		indirect	effect		

Partially	Partially	indirect	Effects of	SSCI on	PSO:		
	BootULCI	BootULCI		BootSE	Effect		
	0.9415		0.6432	0.0703		0.819	PLL

(Source: Bootstrapping analysis of indirect effects)

After the statistical analysis, the research reached several conclusions, the most important of which are:

1. significant relationship between reverse supply chain and environmental performance, with a coefficient of 0.515.
2. statistically significant relationship between reverse supply chain and green logistics, with a coefficient of 0.418.
3. The results demonstrated a statistically significant positive correlation between reverse supply chain and green logistics, both at the macro and micro levels, with a correlation coefficient of 0.675..
4. The supply chain practices are an integrated process that enables companies to protect the environment.
5. reverse supply chain contributes to enhancing environmental performance through green logistics.

Result

This study demonstrated that reverse supply chain and green logistics principles can significantly contribute to enhancing environmental performance. S, and also showed that green logistics practices play a crucial role in this impact. Therefore, this research indicates that adopting reverse supply chain strategies aligned with green logistics principles can have a positive impact on the environment, contributing to improved resource management and pollution reduction. I. Thus, this research strengthens our understanding of the role of reverse supply chains and green logistics principles in enhancing environmental performance and encourages further research and development in this field to achieve sustainable environmental and economic goals.

Based on the theoretical and practical aspects of the study, the following conclusions can be drawn:

1. The results showed a positive and significant correlation between reverse supply chain practices and improved environmental performance in the iron and steel industry
2. The results indicated that companies adopting green logistics principles and techniques achieved better environmental performance compared to those that did not. This highlights the importance of adopting green logistics practices in enhancing the environmental performance of industries.
3. The results highlight the importance of adopting environmental practices in the iron and steel industry to achieve sustainable development and reduce negative environmental impacts. This indicates the need to focus on using innovations and developing policies that support environmental performance in related industries.

The results indicate that adopting green logistics practices and reverse supply chains motivates companies to invest in innovation and the development of environmental technologies.

Recommendations

The study presents several recommendations aimed at enhancing the impact of the reverse supply chain on environmental performance through green logistics, as follows:

1. Products should be designed to be easily recyclable, utilizing biodegradable and easily detachable materials to facilitate recycling processes.

2. Products should be encouraged to be reused rather than discarded. This can be achieved by designing products that are easily repairable and remanufactured.
3. Effective waste management policies should be implemented for the reverse supply chain.
4. Periodic environmental performance assessments of the reverse supply chain should be conducted, data analyzed, and areas for improvement identified.

4. Conclusion

We find solid evidence that highlighted reverse supply chain practices are vital for having a superior environmental performance for an iron and steel industry over and above green logistics as a mediator. Indicators of reverse supply chain activities—namely, recycling, reuse, repair, and refurbishment—are shown to be positively and statistically significantly associated with dimensions of environmental performance including air and water pollution management, solid waste management, and environmental efficiency. In addition, the positive relationship between RSCA and environmental performance was found to be partially mediated by green logistics practices, suggesting that together with reverse logistics, incorporating green procurement, green manufacturing, green design, and green marketing complements environmental benefits from reverse supply chains. The macroeconomic analysis further indicates that substantial gains in environmental performance and resource efficiency are possible for industrial firms, especially those in energy and resource-intensive industries such as iron and steel, from integrating reverse supply chain elements into an overarching green logistics strategy. At a managerial and policymaker level, the findings highlight the need for the adoption of environmentally focused logistics systems, training of relevant personnel, and favourable regulatory policies to facilitate sustainable industrial practices. However, because the study relied on small (<30), sector- and location-specific samples (and thus, cannot be generalized), future research should test this model across different sectors and geographical contexts, utilize larger, more diverse samples, and apply longitudinal or mixed-method approaches to better capture causal processes and sustainable impact over time.

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