

***Climate Neutrality of the Economy and the Green Transition***

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**THE EFFECT OF GREEN OPERATIONS
MANAGEMENT PRACTICES ON OPERATIONAL
SUSTAINABILITY IN GREEK MANUFACTURING
FIRMS****Abstract**

This study investigated the impact of greening the operations management practices on the operational sustainability of manufacturing companies in Greece. In particular, the study evaluated the impact of green procurement, green manufacturing processes, green logistics and distribution, and waste management and recycling practices on operational sustainability. A quantitative research method with a cross-sectional survey design was used. The sample consisted of 279 manufacturing companies in Greece selected using stratified random sampling and the data were gathered by using a structured questionnaire. A five-point Likert scale was used for the responses. Descriptive statistics, Pearson correlation analysis and binary logistic regression analysis were used to analyse the data with the Statistical Package for Social Sciences (SPSS Version 29). The dependent variable was a binary one, high operational sustainability versus low operational sustainability (based on the average composite score of the variables), which meant that logistic regression was

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the most suitable technique to use in order to estimate the probability of having high operational sustainability with satisfaction of the assumptions for binary outcomes. The results showed that all dimensions of green operations management positively and statistically significantly impacted operational sustainability. The study confirms that the implementation of effective green operations management approaches has a significant impact on the sustainability of the operation by positively affecting the efficiency of different resources, the environmental performance, and the long-term viability of the organization. The study suggests that manufacturing companies should enhance their operational strategies that are geared towards sustainability to gain sustainable competitive advantage and operational resilience.

Key Words:

green manufacturing processes, green operations management, green procurement, operational sustainability, waste management and recycling.

JEL: L23, M11, Q56, Q57.

2 formulas, 2 figures, 12 tables, 61 references.

Problem Statement

Environmental sustainability has become a key priority for manufacturers worldwide, driving the adoption of new practices and strategies (Scharmer et al., 2024; Sarkis, 2001; Tseng et al., 2013). Today, manufacturing companies are encouraged to limit carbon footprint, optimize the use of resources, prevent waste production, and embrace sustainability in their operational processes without compromising competitiveness (Herrmann et al., 2021). As a result, Green Operations Management (GOM) has been developed as a strategic approach incorporating environmental issues in procurement, production, logistics and waste management, to enhance environment and operational performance (Wong et al., 2012).

In recent years, other advances of Industry 4.0 technologies, digital manufacturing and circular economy projects have also further accelerated the implementation of green operational practices, as they provide the opportunity to monitor in real time, to use resources efficiently, to anticipate failures and to reduce waste (Lopes de Sousa Jabbour et al., 2018; Kumar et al., 2021; Felsberger & Reiner, 2020). Research has consistently found that companies that adopt integrated green operational practices are more efficient in their operations, perform better with respect to environmental impacts, and are more competitive in the long term than those that operate using traditional production methods (Ahmad et al., 2022; Queiroz et al., 2023). The major dimensions of Green Operations Management include the promotion of environmentally responsible sourcing and supplier selection through

green procurement, cleaner production and efficient use of resources through green manufacturing, reduction of emissions associated with transportation in green logistics, and the adoption of a circular production system by means of waste management and recycling (Agi & Nishant, 2017; Centobelli et al., 2020; Chatzoudes et al., 2024). These practices can help companies boost both their economic efficiency and environmental performance, thereby contributing to their overall operational sustainability.

In Europe, Greece has put extra measures in place to accommodate its manufacturing industry to the European Green Deal, the circular economy policies and the sustainable industrial development strategies (Stroumpoulis et al., 2024; Challoumis et al., 2025). Despite the growing trend of Greek manufacturing companies to implement environmentally friendly operational practices, knowledge about the overall impact of various Green Operations Management practices on operational sustainability is still limited (Agi & Nishant, 2017; Centobelli et al., 2020; Chatzoudes et al., 2024). Previous research mostly focuses either on a single green practice or on the concept of general green supply chain management, thus there is a lack of evidence regarding the impact of the combined dimensions of GOM on operational sustainability in Greek manufacturing companies (Trivellas et al., 2020; Chatzoudes et al., 2024; Endo et al., 2022). Thus, this study aims to contribute to the empirical literature on the impact of green procurement, green manufacturing processes, green logistics and distribution and waste management and recycling practices on operational sustainability of manufacturing companies in Greece.

Study Objectives

Major Objective

To examine the effect of green operations management practices on operational sustainability in European manufacturing firms, with evidence from Greece. The study aims to present empirical evidence to evaluate the contribution of different practices of Green Operations Management to the attainment of high operational sustainability (Kalogiannidis et al., 2022a). To assure alignment between the theoretical framework, research design, data collection, statistical analysis, and expected research outcomes, the major objective was broken down into four specific objectives, and corresponding testable hypotheses (Creswell & Creswell, 2018).

Specific Objectives

1. To evaluate the operational sustainability impact that green procurement has on manufacturing companies in Greece.
2. To investigate how operational sustainability of manufacturing companies in Greece are affected by green manufacturing processes.
3. To assess the impact of green logistics and distribution on operational sustainability of manufacturing companies in Greece.
4. To identify the impact of the waste management and recycling on the operational sustainability in Greek manufacturing companies.

Research Hypotheses

H1: Green procurement positively and statistically significantly affects operational sustainability of Greek manufacturing companies.

H2: Green manufacturing processes positively and significantly affect operational sustainability of manufacturing companies in Greece.

H3: There is positive and statistically significant relationship between green logistics and distribution with operational sustainability in Greek manufacturing companies.

H4: There is a positive and statistically significant relationship between waste management and recycling practices with operational sustainability in Greek manufacturing companies.

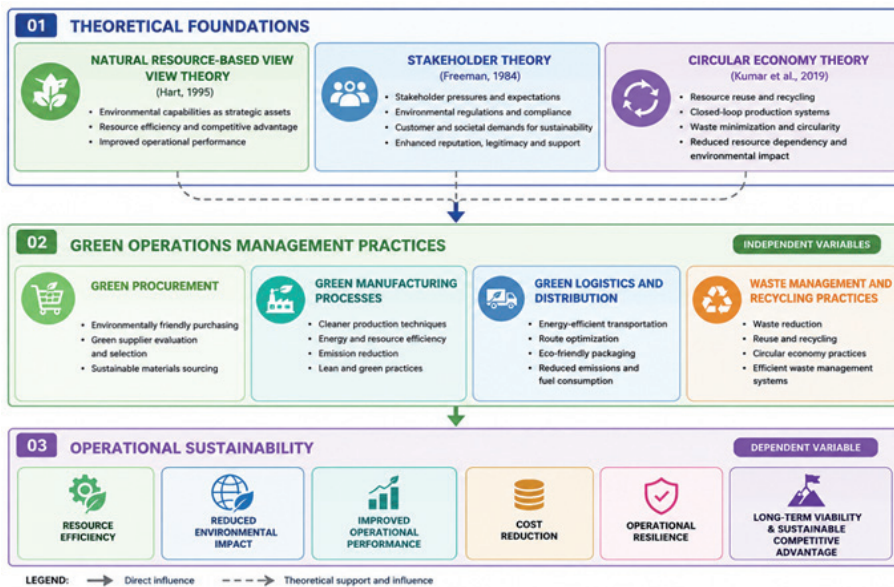
Literature Review

Theoretical Review

The study has three supporting theories, which are Natural Resource Based View (NRBV) of the firm, Stakeholder Theory and Circular Economy Theory. These theories offer an integrated view of the role of green operations management (GOM) practices for operational sustainability in manufacturing companies. The Natural Resource Based View (NRBV) by Hart (1995) is an extension of the traditional Resource Based View which posits that environmental capabilities can be viewed as strategic resources that can lead to a long-term competitive advantage. A recent study confirms that companies that embed green capabilities in their operational processes benefit from applying simultaneously efficiency, cost reduction, and strengthening resilience to achieve better sustainability results (Opoku & Li, 2025; Scharmer et al., 2024; Zourmatzidou et al., 2025). The idea of Stakeholder Theory was advanced by Freeman (1984) who suggested that businesses must consider the needs and expectations of various stakeholders, such as customers, governments, suppliers, employees, and communities. In the manufacturing industry, regulatory requirements, environmentally conscious consumers, and the desire by investors to invest in sustainable industries, have pushed companies to integrate green operations practices (Giuffrida & Mangiaracina, 2020). This study integrates stakeholder theory with capability theories in explaining sustainability outcomes of the Greek manufacturers. The Circular Economy Theory also supports the theoretical building by introducing the concept of the transition from linear production system to closed loop systems, which focus on reusing, recycling, and recovery of resources from manufacturing companies (Kumar et al., 2019; Ahmed et al., 2020; Lim et al., 2022). Digital technologies have increased the reinforcement of circular practices by providing tools for tracking resources, monitoring waste, and fostering sustainable decision-making (Bressanelli et al., 2018; Lopes de Sousa Jabbour et al., 2018). Despite this, while the literature on circular economy has increased significantly over the last years, empirical evidence on the effect of the circular economy oriented operational practices on manufacturing sustainability measures in Greece is still scarce.

Figure 1

Integrated conceptual model showing the theoretical foundations underpinning the relationship between green operations management practices and operational sustainability, drawing on the Natural Resource-Based View Theory, Stakeholder Theory, and Circular Economy Theory



Source: based on Hart (1995), Freeman (1984) and Kumar et al. (2019).

Empirical Review

Green Procurement and Operational Sustainability

Green procurement involves environmental factors in the process of supplier selection and procurement, and in material sourcing. It includes the identification of suppliers having good environmental practices, procurement of sustainable materials and minimizing life cycle environmental impacts. (Agi & Nishant, 2017). Empirical studies show that green procurement works in favour of sustainability by favouring environmental compliance, minimizing risks in the supply chain and optimizing resources (Micheli et al., 2020; Shaikh et al., 2020).

Ahmad et al. (2022) and Khan et al. (2022) indicated that the responsible procurement practices provide benefits of waste reduction and sustainability outcomes in manufacturing systems. Likewise, Herrmann et al. (2021) highlighted that environmentally responsible sourcing is an essential element of a successful green supply chain management. Other studies, however, suggest that procurement can lead to sustainability changes only if combined with collaboration between suppliers and the buyer, the technological ability, and organizational willingness of those suppliers (Bag et al., 2021; Chalmeta & Santos-deLeón, 2020). In Greece, the process of industrial transformation based on sustainability has given rise to a

raised awareness of responsible chains of supply. Gourgiotis et al. (2021) observed that Greek industries are becoming more and more green in order to comply with European environmental policies. Empirical studies that specifically investigate the relation between green procurement and operational sustainability of manufacturing companies in Greece, however, are still limited.

Green Manufacturing Processes and Operational Sustainability

Green manufacturing is manufacturing systems which aim to reduce emissions, waste, energy consumption and better utilize resources. Green manufacturing has been shown to be among the most powerful factors affecting operational sustainability since it directly affects the efficiency and environmental impact of manufacturing (Abualfaraa et al., 2020; Sharma et al., 2021). According to Afum et al. (2020), the benefits of environment friendly manufacturing to the competitiveness of the operations of the Manufacturing sector are enhanced resource management and organizational reputation. Likewise, Khan et al. (2021) showed that green manufacturing principles lead towards better sustainability performance through increased resource usage efficiency and cleaner production. Studies by Nagadi (2022) and Queiroz et al. (2023) noted that synergistic effects can be achieved by combining lean and green approaches, as they not only reduce waste but also enhance productivity.

In recent studies, the importance of Industry 4.0 technologies for sustainable manufacturing has been highlighted. Digital technologies contribute to sustainability by automating, monitoring and optimizing production resources, as Felsberger & Reiner (2020); Kapetanopoulou et al. (2021) and Choudhary et al. (2025) found. Zhou et al. (2026) also demonstrated the application of advanced optimization technologies in enhancing the green manufacturing capacity planning. In addition, lean manufacturing practices have been shown to have a significant impact on the operational performance of manufacturing companies based on evidence from Greece (Psomas et al., 2026; Hasan et al., 2024). However, there are few studies that directly address the impact of green manufacturing processes on operational sustainability in manufacturing companies in Greece.

Sustainability in Green Logistics and Distribution and Operational Processes

The concept of green logistics is based on environmentally friendly transport, logistics, packaging and distribution operations with the aim of reducing emissions and efficiency of the use of resources (Zaman & Shamsuddin, 2017). The existing literature has shown that the implementation of green logistics can help to achieve sustainability through various aspects including minimizing fuel consumption, transport efficiency, and environmental costs.

Trivellas et al. (2020) conducted research on the impact of green logistics management on sustainable business performance in Greek companies, and concluded that green logistics management positively affects sustainable business performance and supply chain efficiency. The same was observed by Vienažindienė et al. (2021), who have concluded that energy saving and emission reduction are prerequisites to become more sustainable in logistics with environmentally friendly practices. Chatzoudes et al. (2024) also stressed the growing significance of sustainable logistics capabilities in enhancing supply chain competitiveness. There are also recent developments that demonstrate how digitalisation has enhanced green logistics by means of better coordination, transparency and decision making,

as reported by Stroumpoulis et al. (2024) and Kalogiannidis et al., (2022b). Nevertheless, although there is an increasing interest in sustainable logistics, there is still a lack of evidence from manufacturing companies in Greece, especially in terms of its contribution to operational sustainability (Politis et al., 2014).

Waste Management and Recycling Practices and Operational Sustainability

Waste management and recycling are key pillars of circular economy-based business operations. The practices include minimizing waste production, recovering wastes, and reusing resources in production systems (Centobelli et al., 2020). It has been proven that the effective waste management contributes to the reduction of production costs as well as the efficiency of the use of resources and environmental performance (Incekara, 2022).

Circular economy concepts are more and more being highlighted as very useful solutions to the waste management problem as can be seen in recent studies. Emmanouil et al. (2025) revealed that the implementation of circular economy waste management systems has a positive impact on sustainability outcomes in Greece, and Konstantinos et al. (2025) showed that circular economy projects can play a role in waste reduction and sustainable development. In turn, Kostakis et al. (2025) highlighted the role of institutional and economic factors in the successful recycling process. Moreover, digital technologies have contributed to the effectiveness of waste management in real time, by allowing the tracking of resources and waste (Kristoffersen et al., 2020; Bressanelli et al., 2018). However, previous research has tended to study the municipal waste system or individual recycling programs, but not waste management as a part of the manufacturing system.

Methodology

Research Design

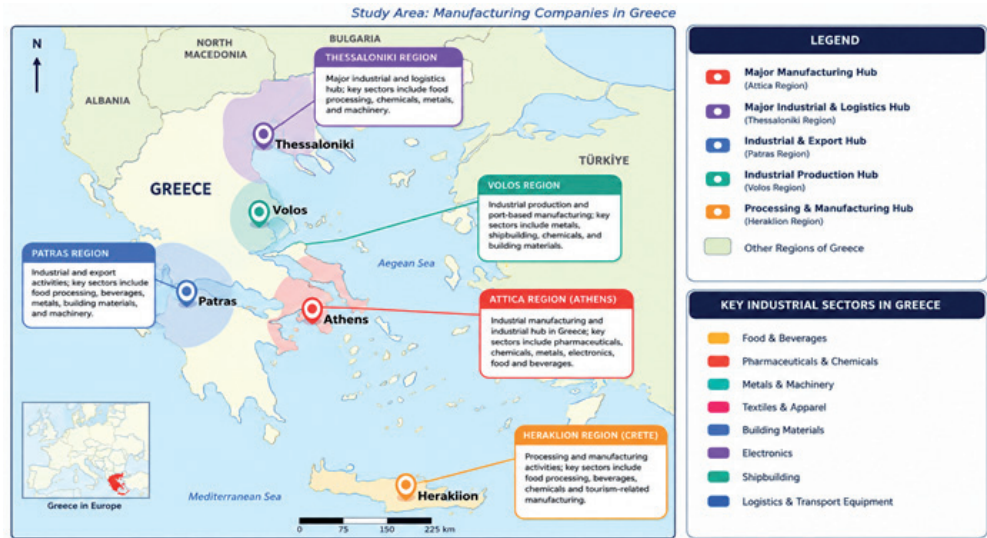
The study used quantitative research methods with cross sectional survey research design. This was deemed suitable because it enabled the researcher to consider the relationship between green operations management practices and operational sustainability on an objective basis, using numerical data obtained from the answers of the respondents in manufacturing companies in Greece (Creswell & Creswell, 2018). The cross-sectional design is effective in examining relationships between variables and is common in organizational research because it can be used to gather data from a large population in a short period of time as cited by Bryman (2016).

Study Area

The research was carried out in Greece, and included manufacturing companies from various industrial subsectors. The choice of Greece was due to its trend towards sustainability practices in compliance with EU environmental directives and circular economy policies. The manufacturing sector in Greece encompasses food processing, pharmaceuticals, chemicals, textiles, production of machinery, construction materials, and metal fabrication. Industries have a significant impact on the economic development of the country, but are also linked to environmental issues like carbon emissions, waste generation and energy consumption.

Figure 2

Map of Greece – Major manufacturing and industrial regions



Source: based on ELSTAT (2024).

Target Population

The sample consisted of employees in managerial and operational roles in manufacturing companies in Greece. The companies included were small, medium and large manufacturing companies from the large industrial centers of Greece (Attica, Central Macedonia, Thessaly, Western Greece, and Central Greece). The Hellenic Statistical Authority (ELSTAT, 2024) indicates that these areas represent significant manufacturing areas of the country. A population of 920 managers was made up from directories and industry records of the 18 companies under study. The respondents were selected from people who are directly engaged in the decision-making process and in the operational activities of the procurement, production, logistics and environmental management as they are suited to provide reliable information for the present study.

Sample Size Determination

The sample size was determined using Yamane's (1967) formula for finite populations, which is widely applied in survey research due to its simplicity and statistical reliability. The formula is expressed as:

$$n = \frac{N}{1+N(e)^2} \tag{1}$$

Where n represents the sample size, N represents the population size, and e represents the level of precision set at 0.05. Substituting the values:

The sample size was therefore rounded to 279 respondents.

$$n = \frac{9201}{1 + 9201(0.05)^2}$$

$$n = \frac{9201}{1 + 2.3}$$

$$n = \frac{9201}{3.3}$$

$$n = 278.8 \cong 279$$

Table 1

Sample Size Distribution

Category	Population	Sample
Operations Managers	120	36
Procurement Managers	180	55
Production Supervisors	240	73
Logistics Managers	150	45
Environmental Officers	130	39
Sustainability Coordinators	100	31
Total	920	279

Source: developed by the authors.

Sampling Technique

The study employed a stratified random sampling technique. This method was appropriate because it ensures that each subgroup is adequately represented in the final sample, thereby improving representativeness and reducing sampling bias (Saunders et al., 2019). The population was first divided into homogeneous strata based on job categories. Proportional allocation was then applied to determine the number of respondents selected from each stratum. Finally, simple random sampling was used within each group to select individual respondents. This approach ensured equal opportunity for selection while maintaining proportional representation of all job categories.

Data Collection

The study employed a survey method for data collection. Surveys are widely used in quantitative research because they allow for efficient collection of standardized data from large populations. This method facilitates statistical analysis and comparison across respondents (Bryman, 2016). Data were collected using structured questionnaires administered to employees in selected manufacturing firms in Greece. Respondents completed the questionnaires independently based on their experiences and perceptions of green operations management practices and operational sustainability. The primary instrument used was a structured self-

administered questionnaire divided into six sections. All variables were measured using a five-point Likert scale. The study adhered to ethical principles of research including voluntary participation, informed consent, confidentiality, and anonymity. Respondents were informed of their right to withdraw at any stage without penalty. Data were used strictly for academic purposes and securely stored.

Data Analysis

Data were analysed using SPSS version 29. Descriptive statistics including frequencies, percentages, means, and standard deviations were used to summarize data. Inferential statistics including Pearson correlation and binary logistic regression were used to test hypotheses. The dependent variable was dichotomized based on the composite mean score to separate firms with a relatively high operational sustainability from those with a relatively low performance in operational sustainability. The binary logistic regression procedure was chosen over the ordinary least squares regression procedure, as the latter makes assumptions of normality and homoscedasticity for the dependent variable that are not met by categorical variables. (Hosmer et al., 2013; Field, 2024). The dependent variable, operational sustainability, was transformed into a binary variable where firms with operational sustainability scores above the overall mean were coded as 1 (High Operational Sustainability) and those below the mean were coded as 0 (Low Operational Sustainability). The logistic regression model was estimated at a 95% confidence level with a significance threshold of 0.05. The model was specified as:

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1GP + \beta_2GMP + \beta_3GLD + \beta_4WMR + \varepsilon \tag{2}$$

Where p represents the probability of high operational sustainability, GP represents green procurement, GMP represents green manufacturing processes, GLD represents green logistics and distribution, and WMR represents waste management and recycling practices.

Research Results

Demographic Characteristics of Respondents

Table 2

Demographic Characteristics (N = 279)

Variable	Category	Frequency	Percent (%)
Gender	Male	171	61.3
	Female	108	38.7
Age	20–29 Years	52	18.6
	30–39 Years	103	36.9
	40–49 Years	81	29.0
	50 Years and Above	43	15.5

Variable	Category	Frequency	Percent (%)
Education Level	Diploma	48	17.2
	Bachelor's Degree	146	52.3
	Master's Degree	71	25.4
	Doctorate	14	5.0
Position	Operations Managers	36	12.9
	Procurement Managers	55	19.7
	Production Supervisors	73	26.2
	Logistics Managers	45	16.1
	Environmental Officers	39	14.0
	Sustainability Coordinators	31	11.1
Experience	Less than 5 Years	59	21.1
	5–10 Years	121	43.4
	11–15 Years	68	24.4
	Above 15 Years	31	11.1
Total		279	100.0

Source: authors' survey data (2026).

Table 2 presents the demographic characteristics of the 279 respondents who participated in the study. The findings reveal that males constituted the majority of respondents, accounting for 61.3%, while females represented 38.7%. Regarding age, most respondents (36.9%) were between 30 and 39 years, followed by those aged 40–49 years (29.0%). In terms of educational qualifications, more than half of the respondents (52.3%) possessed bachelor's degrees, while 25.4% held master's degrees. Concerning job positions, production supervisors formed the largest category (26.2%), followed by procurement managers (19.7%) and logistics managers (16.1%). Additionally, the majority of respondents (43.4%) had between five and ten years of work experience, while 24.4% had eleven to fifteen years of experience.

Descriptive results

Green Procurement

Table 3

Descriptive Results for Green Procurement (N=279)

Statement	SD	D	N	A	SA	Mean	SD
Our organization prioritizes environmentally friendly suppliers	11 (3.9)	21 (7.5)	37 (13.3)	132 (47.3)	78 (28.0)	3.88	0.91
Environmental criteria are considered during supplier selection	10 (3.6)	24 (8.6)	35 (12.5)	131 (47.0)	79 (28.3)	3.88	0.89
Procurement policies emphasize sustainable sourcing	12 (4.3)	23 (8.2)	34 (12.2)	130 (46.6)	80 (28.7)	3.89	0.92

Statement	SD	D	N	A	SA	Mean	SD
Suppliers are required to comply with environmental standards	9 (3.2)	26 (9.3)	33 (11.8)	133 (47.7)	78 (28.0)	3.88	0.88
Procurement staff receive sustainability training	13 (4.7)	25 (9.0)	35 (12.5)	128 (45.9)	78 (28.0)	3.85	0.95
Green procurement objectives are monitored regularly	11 (3.9)	23 (8.2)	36 (12.9)	131 (47.0)	78 (28.0)	3.87	0.90
Eco-friendly materials are preferred in purchasing decisions	10 (3.6)	22 (7.9)	38 (13.6)	130 (46.6)	79 (28.3)	3.88	0.89

Note: Grand Mean = 3.88, SD = 0.91.

Source: authors' survey data (2026).

Table 3 presents respondents' perceptions regarding green procurement practices among manufacturing firms in Greece. The findings indicate that respondents generally agreed with all the statements describing green procurement, as reflected by an overall mean score of 3.88 and a standard deviation of 0.91. Respondents agreed that their organizations prioritize environmentally friendly suppliers, incorporate environmental criteria during supplier selection, and emphasize sustainable sourcing through procurement policies. The findings further show that suppliers are required to comply with environmental standards and that procurement personnel receive sustainability-related training.

Green Manufacturing Processes

Table 4

Descriptive Results for Green Manufacturing Processes (N=279)

Statement	SD	D	N	A	SA	Mean	SD
Production systems emphasize resource efficiency	8 (2.9)	21 (7.5)	34 (12.2)	137 (49.1)	79 (28.3)	3.92	0.85
Energy-saving technologies are utilized	9 (3.2)	20 (7.2)	35 (12.5)	136 (48.7)	79 (28.3)	3.91	0.86
Manufacturing processes minimize waste generation	10 (3.6)	22 (7.9)	32 (11.5)	137 (49.1)	78 (28.0)	3.90	0.88
Environmentally friendly production methods are implemented	9 (3.2)	24 (8.6)	31 (11.1)	137 (49.1)	78 (28.0)	3.90	0.87
Production activities support sustainability goals	8 (2.9)	23 (8.2)	34 (12.2)	135 (48.4)	79 (28.3)	3.91	0.85
Manufacturing operations comply with environmental regulations	9 (3.2)	21 (7.5)	33 (11.8)	138 (49.5)	78 (28.0)	3.91	0.86
Continuous improvement programs promote sustainability	10 (3.6)	22 (7.9)	34 (12.2)	135 (48.4)	78 (28.0)	3.89	0.89

Note: Grand Mean = 3.91, SD = 0.87.

Source: authors' survey data (2026).

Table 4 presents respondents' views concerning green manufacturing processes. The results reveal that respondents generally agreed with all the statements, as indicated by a grand mean of 3.91 and a standard deviation of 0.87. The findings demonstrate that production systems emphasize resource efficiency and that organizations utilize energy-saving technologies. Respondents also agreed that manufacturing processes are designed to minimize waste generation and that environmentally friendly production methods are implemented. Furthermore, respondents indicated that production activities support sustainability goals and that manufacturing operations comply with environmental regulations. Continuous improvement programs aimed at promoting sustainability were also reported to be common. The overall mean score above 3.90 reflects a high level of implementation of green manufacturing practices.

Green Logistics and Distribution

Table 5

Descriptive Results for Green Logistics and Distribution (N=279)

Statement	SD	D	N	A	SA		SD
Transportation routes are optimized	12 (4.3)	22 (7.9)	35 (12.5)	132 (47.3)	78 (28.0)	3.87	0.91
Environmentally friendly packaging is used	11 (3.9)	24 (8.6)	33 (11.8)	132 (47.3)	79 (28.3)	3.88	0.89
Logistics activities emphasize fuel efficiency	10 (3.6)	25 (9.0)	34 (12.2)	132 (47.3)	78 (28.0)	3.87	0.90
Green transportation initiatives are implemented	12 (4.3)	23 (8.2)	35 (12.5)	131 (47.0)	78 (28.0)	3.86	0.92
Distribution systems support sustainability goals	11 (3.9)	22 (7.9)	36 (12.9)	131 (47.0)	79 (28.3)	3.88	0.88
Carbon emissions are monitored	13 (4.7)	23 (8.2)	34 (12.2)	131 (47.0)	78 (28.0)	3.85	0.93
Sustainable logistics policies are regularly reviewed	11 (3.9)	24 (8.6)	34 (12.2)	132 (47.3)	78 (28.0)	3.87	0.90

Note: Grand Mean = 3.87, SD = 0.90.

Source: authors' survey data (2026).

Table 5 presents respondents' perceptions regarding green logistics and distribution practices. The results show an overall mean score of 3.87 and a standard deviation of 0.90, indicating that respondents generally agreed with the statements measuring this construct. Specifically, respondents agreed that transportation routes are optimized and that environmentally friendly packaging materials are utilized. Distribution systems were also perceived to support sustainability objectives, while carbon emissions are monitored and sustainable logistics policies are regularly reviewed. The dominance of responses in the "Agree" and "Strongly Agree" categories demonstrates that manufacturing firms in Greece have adopted environmentally responsible logistics practices.

Waste Management and Recycling Practices

Table 6

Descriptive Results for Waste Management and Recycling Practices (N=279)

Statement	SD	D	N	A	SA	Mean	SD
Waste segregation is practiced	8 (2.9)	21 (7.5)	35 (12.5)	136 (48.7)	79 (28.3)	3.92	0.85
Recycling programs are actively promoted	9 (3.2)	22 (7.9)	34 (12.2)	136 (48.7)	78 (28.0)	3.91	0.86
Reusable materials are utilized	10 (3.6)	20 (7.2)	35 (12.5)	135 (48.4)	79 (28.3)	3.91	0.87
Waste reduction initiatives are implemented	9 (3.2)	21 (7.5)	35 (12.5)	136 (48.7)	78 (28.0)	3.91	0.86
Circular economy principles guide operations	10 (3.6)	22 (7.9)	33 (11.8)	136 (48.7)	78 (28.0)	3.90	0.88
Employees participate in recycling activities	11 (3.9)	21 (7.5)	34 (12.2)	135 (48.4)	78 (28.0)	3.89	0.89
Waste management systems are regularly monitored	9 (3.2)	22 (7.9)	34 (12.2)	136 (48.7)	78 (28.0)	3.91	0.87

Note: Grand Mean = 3.91, SD = 0.87.

Source: authors' survey data (2026).

Table 6 presents respondents' opinions regarding waste management and recycling practices. The findings indicate a high level of agreement among respondents, as evidenced by a grand mean score of 3.91 and a standard deviation of 0.87. Respondents agreed that waste segregation is practiced and that recycling programs are actively promoted within their organizations. They further indicated that reusable materials are utilized and that waste reduction initiatives are implemented. In addition, circular economy principles were reported to guide organizational operations, while employees actively participate in recycling activities. The grand mean above 3.90 demonstrates that respondents perceived waste management and recycling practices to be highly implemented.

Operational Sustainability

Table 7

Descriptive Results for Operational Sustainability (N=279)

Statement	SD	D	N	A	SA	Mean	SD
Operations remain efficient over time	8 (2.9)	20 (7.2)	34 (12.2)	138 (49.5)	79 (28.3)	3.93	0.84
Resources are utilized sustainably	9 (3.2)	21 (7.5)	33 (11.8)	137 (49.1)	79 (28.3)	3.92	0.85
Operational costs are effectively managed	10 (3.6)	21 (7.5)	34 (12.2)	136 (48.7)	78 (28.0)	3.90	0.87

Statement	SD	D	N	A	SA	Mean	SD
Organizational processes support sustainability	8 (2.9)	22 (7.9)	34 (12.2)	136 (48.7)	79 (28.3)	3.92	0.85
Operations are resilient to environmental challenges	9 (3.2)	21 (7.5)	35 (12.5)	136 (48.7)	78 (28.0)	3.91	0.86
Sustainability objectives are achieved consistently	10 (3.6)	22 (7.9)	34 (12.2)	135 (48.4)	78 (28.0)	3.89	0.88
The organization maintains long-term operational viability	8 (2.9)	21 (7.5)	35 (12.5)	136 (48.7)	79 (28.3)	3.93	0.84

Note: Grand Mean = 3.91, SD = 0.86.

Source: authors' survey data (2026).

Table 7 presents respondents' perceptions regarding operational sustainability. The results reveal an overall mean score of 3.91 and a standard deviation of 0.86, indicating that respondents generally agreed with all the statements measuring operational sustainability. Specifically, respondents agreed that organizational operations remain efficient over time and that resources are utilized sustainably. They also indicated that operational costs are effectively managed and that organizational processes support sustainability objectives. The overall mean score above 3.90 signifies that respondents perceived their firms as capable of sustaining operations efficiently while maintaining environmental responsibility and resilience.

Logistic Regression Analysis

A binary logistic regression analysis was conducted to determine the effect of green procurement, green manufacturing processes, green logistics and distribution, and waste management and recycling practices on operational sustainability among manufacturing firms in Greece. Multicollinearity between the independent variables was checked before the model's estimation by means of Variance Inflation Factors (VIF). The multicollinearity was not a problem as all VIF values were less than 5, which is the recommended value. The binary specification was chosen because the study aimed to identify those firms that have relatively high operational sustainability from those with lower sustainability performance (Field, 2024; Hosmer et al., 2013).

Omnibus Tests of Model Coefficients

The Omnibus Test of Model Coefficients was conducted to determine whether the inclusion of the predictor variables significantly improved the prediction of operational sustainability compared to a model containing only the constant.

Table 8

Omnibus Tests of Model Coefficients

Test	Chi-Square	Df	Sig.
Step	182.473	4	.000
Block	182.473	4	.000
Model	182.473	4	.000

Source: authors' computation using SPSS Version 29 (2026).

The results in Table 8 indicate that the logistic regression model was statistically significant ($\chi^2 = 182.473$, $p = .000$). This implies that the inclusion of green procurement, green manufacturing processes, green logistics and distribution, and waste management and recycling practices significantly improved the prediction of operational sustainability. Therefore, the model was considered appropriate for further analysis.

Model Summary

The Model Summary was examined to determine the explanatory power of the logistic regression model.

Table 9

Model Summary

-2 Log Likelihood	Cox & Snell R ²	Nagelkerke R ²
167.318	.480	.642

Source: authors' computation using SPSS Version 29 (2026).

The findings indicate that the model explained between 48.0% (Cox & Snell R²) and 64.2% (Nagelkerke R²) of the variation in operational sustainability. The Nagelkerke R² value of 0.642 suggests that the predictor variables jointly accounted for a substantial proportion of operational sustainability among manufacturing firms in Greece.

Hosmer and Lemeshow Test

The Hosmer and Lemeshow Goodness-of-Fit Test was conducted to assess the adequacy of the logistic regression model.

Table 10

Hosmer and Lemeshow Test

Chi-Square	Df	Sig.
6.184	8	.627

Source: authors' computation using SPSS Version 29 (2026).

The Hosmer and Lemeshow Test produced a significance value of 0.627, which is greater than the threshold of 0.05. This indicates that there was no significant difference between observed and predicted values, implying that the model adequately fitted the data.

Classification Accuracy

The classification table was used to assess the predictive accuracy of the logistic regression model.

Table 11

Classification Table

Observed Category	Predicted Low Sustainability	Predicted High Sustainability	Percentage Correct
Low Sustainability	102	21	82.9
High Sustainability	17	139	89.1
Overall Percentage	86.4		

Source: authors' computation using SPSS Version 29 (2026).

The results indicate that the model correctly classified 86.4% of the cases. This level of predictive accuracy demonstrates that the model possessed strong capability in distinguishing between firms exhibiting high and low levels of operational sustainability.

Logistic Regression Coefficients

The logistic regression coefficients were examined to determine the individual effect of each predictor variable on operational sustainability.

Table 12

Logistic Regression Coefficients

Variable	B	S.E.	Wald	Sig.	Exp(B)
Green Procurement	0.847	0.182	21.671	.000	2.333
Green Manufacturing Processes	1.126	0.214	27.673	.000	3.083
Green Logistics & Distribution	0.735	0.176	17.440	.000	2.086
Waste Management & Recycling	0.964	0.198	23.697	.000	2.622
Constant	-4.291	0.817	27.593	.000	0.014

Source: authors' computation using SPSS Version 29 (2026).

The logistic regression coefficients that explain the individual impact of green operations management practices on the operational sustainability are shown in Table 12. The results show that all the predictor variables were positive and statistically significant ($p < .001$). In terms of operational sustainability, a negative influence was found for green procurement ($B = 0.847$, $\text{Exp}(B) = 2.333$), which means that companies with green procurement and environmentally responsible supplier practices were 2.33 times more likely to have better sustainability outcomes than those that did not. The positive effect was observed in the buffer of green manufacturing processes where the values of $B = 1.126$ and $\text{Exp}(B) = 3.083$ indicate that resource efficiency, energy-saving technologies, and waste reduction practices were most crucial to operational sustainability. The same was true for the other two areas of Green logistics and

distribution ($B = 0.735$, $\text{Exp}(B) = 2.086$) and Waste management and recycling ($B = 0.964$, $\text{Exp}(B) = 2.622$), which had a positive influence. Overall, the most robust predictor was green manufacturing, which reinforces the Natural Resource-Based View predicted that environmentally oriented capabilities are strategic resources that will drive future performance (Hart, 1995; Sarkis, 2001). The results also are in line with European Green Deal goals focusing on sustainable industrial change (European Commission & Directorate-General for Climate Action, 2024). Longitudinal designs could be used in the future to evaluate sustainability changes over time.

Discussion

The aim of this study was to examine the impact of the green operations management practices on operational sustainability of manufacturing companies in Greece. The results showed that 4 levers have a direct impact on the operational sustainability: green procurement, the green manufacturing processes, green logistics and distribution, and waste management and recycling. This has been an indicator of the transition of sustainability from being purely an environmental issue to being a strategic option to boost efficiency, competitiveness, and organisational resilience (Sarkis, 2001; Rehman Khan et al., 2021; Scharmer et al., 2024). The findings validate the growing trend of integrated green and circular operations, which introduce environmental aspects into the production, supply chain and business strategies (Lopes de Sousa Jabbour et al., 2018; Chalmeta & Santos-deLeón, 2020; Nimsai et al., 2020). The green procurement positively affected the operational sustainability, suggesting that green supplier selection, sustainable sourcing, and green purchasing policies support firms to enhance resource efficiency and mitigate environmental risks. This is consistent with the results of Ahmad et al. (2022); Agi & Nishant (2017); and Micheli et al. (2020) who determined that green procurement practices improve supply chain sustainability and organizational performance. Likewise, Bag et al. (2021) emphasized the importance of enhancing the effectiveness of green procurement through the use of technological capabilities that enable better coordination among suppliers and information management. In the Greek manufacturing sector, the knowledge of the environment and the green supply chain capabilities are recognised as key factors in the sustainable transformation of the industry (Baresel-Bofinger et al., 2011).

The research also confirmed that the most important determinant of operational sustainability was green manufacturing processes. This shows the importance of internal operational activities such as energy efficiency, waste minimisation, better technologies and the maximisation of resources in order to sustain operations. The results are corroborative of the Afum et al. (2020) findings which stated that green manufacturing positively influences operational competitiveness and sustainability of operations. Similarly, lean-green manufacturing techniques are efficient and less environmentally damaging (Abualfaraa et al., 2020; Nagadi, 2022; Queiroz et al., 2023). The findings are also consistent with the findings of Despeisse et al. (2022) and Felsberger & Reiner (2020), which emphasize the need for sustainable production practices and Industry 4.0 technologies to improve the use of resources and operational performance. Additionally, the scope of green logistics and distribution was identified as having an important impact on operational sustainability (Stroumpoulis et al., 2024; Stroumpoulis & Kopanaki, 2025). The results agree with

those of Trivellas et al. (2020) which concluded that green logistics improves the performance of the supply chain in Greece. There were also similar findings from European context, showing that green logistics can enhance both environmental and economic efficiency by optimizing the use of resources (Zaman & Shamsuddin, 2017; Vienažindienė et al., 2021).

The operational sustainability was greatly enabled by waste management and recycling. The results show that waste minimization, waste recycling, resource recovery and circular economy strategies can help companies to minimize their environmental burden and enhance efficiency. It corroborates the research of Kumar et al. (2019) and Lim et al. (2022) that identified that circular economy practices improve the sustainability of manufacturing. Digital technologies also play a role in the circular operations, such as material tracking and closed-loop supply chain management (Bressanelli et al., 2018; Yadav et al., 2020). Awareness and uptake of circular economy measures are increasing in Greece, and this indicates the role of sustainable waste management systems (Drimili et al., 2020; Emmanouil et al., 2025; Konstantinos et al., 2025). The results overall show that the manufacturing companies can have sustainable operational performance through the integrated green operations management practices. Lastly, waste management and recycling made a major impact on the operational sustainability, further emphasizing the necessity of circular economy principles. For firms, effective recycling, reuse and resource recovery systems can help them lower costs and enhance their environmental performance (Bressanelli et al., 2018; Yadav et al., 2020). The results are very relevant to Greece, where the promotion of circular economy is becoming more popular in the national and European policies and agendas for sustainability (European Commission & Directorate-General for Climate Action, 2024; ELSTAT, 2024).

Conclusions

The study found that green operations management practices have a positive impact on operational sustainability of manufacturing companies in Greece. Most prominent was the contribution from green manufacturing, emphasizing the need for sustainable manufacturing systems, resource efficiency, and cleaner technologies. Sustainability in procurement, logistics and waste management also showed promising results, emphasizing the need to address sustainability issues in the entire value chain. For managers, the study offers a number of practical implications, including the need to invest in green technologies, sustainable suppliers, efficient logistics, and circular economy. The European Commission & Directorate-General for Climate Action (2024) recommends reinforcing sustainability rules, incentives and environmental standards to drive green transition in manufacturing companies. The results theoretically enrich the NRB and CE theory and the Stakeholder theory by providing support for the idea that environmental capabilities provide a sustainable competitive advantage. The study has some limitations, however. The cross-sectional design does not allow for assessment of change over time, and self-reported data from questionnaires can lead to response bias. Longitudinal designs, comparative studies between industries and more sophisticated analyses, such as difference-in-differences analysis, should be used in future studies to investigate the long-term sustainability impacts.

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