

A Research on Reasons Leading to Environmentally Responsible Manufacturing Practices and Their Effects

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ABSTRACT

This study aims to determine the reasons that lead businesses to environmentally responsible manufacturing, the practices carried out, and the effects of these practices on cleaner production performance and business performance. Within the scope of the research, the survey was applied to the companies operating in the shipbuilding sector in Turkey. Research data were analysed using descriptive analysis, correlation, and regression methods. As a result of the analysis carried out, it was concluded that in environmentally responsible manufacturing practices, internal reasons are more effective than external reasons, environmentally responsible manufacturing activities are positively associated with clean production performance, and cleaner production performance has a positive effect on business performance. The main limitation of the study is the small size of the sample, and it is recommended to contribute to the practitioners in environmentally responsible manufacturing by conducting new research with larger sample sizes in different sectors.

KEYWORDS

Cleaner Production, Environmentally Friendly Perspective, Environmentally Responsible Manufacturing, Firm Performance, Green Production

INTRODUCTION

With the decrease in natural resources and thus raw material resources, increase in pollution of water, air, and soil, and the decrease in the life quality, the development in environmental activities cannot be postponed anymore. For sustainable development in the face of the tangible serious consequences of climate change, all developed and developing countries should work towards the transition to a “green economy” in order to limit the negative impacts on the environment in all sectors (Hang, 2022). Grants for trademarks, patents and innovations and technological innovations should be used to reduce environmental impacts (Hysa et al., 2023). The public-private sector should develop collaborations for innovation and technological development to find new opportunities for green growth in the economy (Khan et al., 2022).

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While the consumption of green products is increasing in the world, it should not be forgotten that these products must be obtained with environmentally responsible manufacturing tools and processes. The environmental friendliness of the products is possible not only with the environmental friendliness of the materials used but also with the application of an environmental perspective in all supply chain processes. However, environmentally friendly products are indispensable not only for improving the purchasing tendencies of customers but also for a sustainable world. Accordingly, companies should assess their manufacturing operations by considering their environmental consequences and reorganize these operations within the context of environmentally responsible manufacturing.

Businesses establish and certify an environmental management system in order to demonstrate their environmental awareness. The existence of an environmental management system has positive outcomes in terms of legality, risk reduction, environmental performance documentation, and employee motivation (Fresner, 1998). Although environmental management systems do not fully meet environmentally responsible manufacturing activities, they provide an important infrastructure to organizations. Instead of developing measures to reduce environmental impacts at the end of production processes, environmentally responsible manufacturing aims to minimize waste and emissions with efficient material and energy management within the framework of a preventive perspective (Fresner, 1998). Environmentally responsible manufacturing consists of the following two main titles (Güngör & Gupta, 1999):

1. Understanding the impact on the environment in each of the product lifecycle and life stages.
2. Making better decisions during design and production, thus ensuring the environmental characteristics of the product are kept at the preferred level.

These activities require time and effort. First of all, it is necessary to determine the environmental consequences of products and their production operations, so that studies can be started to reduce these effects. Identification of environmental impacts is a large-scale and cumulative work that needs to be carried out on an enterprise basis, from raw material suppliers to product manufacturers, from enterprises establishing production facilities to enterprises producing production machinery. Obtained data should be stored in common databases, open to the use of affiliated enterprises. Considering the difficulty of the process and negative environmental trends, studies should be started on environmentally responsible manufacturing, both on the basis of enterprises and on a national and global scale, without wasting time.

In the short run, companies may see environmental protection actions as expenses, loss of workforce or loss of investment. However, environmentally responsible manufacturing approaches would provide significant benefits to the company in the long run. Besides, it is no longer optional for people to increase awareness and develop behaviours to prevent them from contributing to global environmental destruction (Karakuş, 2021). With the perceived effects of climate change in recent years, customers, governments, investors, and stakeholders such as employees and local communities are increasingly asking businesses to reduce pollution and improve their overall corporate environmental performance (Melnik et al., 2001). For this reason, all actors should be conscious of the fact that environmental practices are an application that will provide a win-win solution for both businesses and environment (Molina-Azorín et al., 2009). In line with this requirement, it is important to conduct sector-based research on environmentally responsible manufacturing in academic studies. Considering its importance, the study aims to understand the reasons that lead businesses to environmentally responsible manufacturing, the practices carried out and the results of environmentally responsible manufacturing. For this purpose, a research was carried out on Shipbuilding Sector enterprises operating in Turkey.

After the introduction, in the second part, the theoretical structure and research hypotheses are included, and also the starting point of the study is defined. In the third section, the method is explained. In the fourth section, the findings obtained in the shipbuilding sector are presented. In

the conclusion and discussion section, an overall evaluation is given in line with the findings, and suggestions are presented.

THEORETICAL CONTEXT AND RESEARCH PROPOSITIONS

Environmentally Responsible Manufacturing

Environmentally responsible manufacturing is a preventive strategy to minimize the impact of production and products on the environment (Fresner, 1998) and should be integrated into all business development activities to improve the quality of life (Kjaerheim, 2005). In this context, each business unit in the enterprise should work in a way to optimize the environmental impacts of its own processes within the scope of the product's life cycle (Bullinger et al., 1999) and should encourage eco-innovation activities in this direction (Popescu et al., 2022). Considering the industrial enterprises, it is seen that manufacturing is the function in which the negative impact on the environment is most intense. In the literature, different concepts are used within the scope of the reflection of the environmental perspective on the industry, and these concepts and definitions are briefly presented in Table 1.

As seen in Table 1, the concepts of environmentally friendly manufacturing, green production, clean production, environmentally friendly production and environmentally responsible manufacturing are used for manufacturing activities carried out in line with the awareness of reducing environmental impacts. In fact, Walton et al. (1998) stated that if businesses really want to develop environmentally friendly approaches, they should contain the suppliers in this process, and they defined this as "greening the supply chain".

Table 1. Concepts used within the scope of environmentally responsible manufacturing

Author / Year	Concept	Definition
Handfield, Walton, Seegers & Melnyk, 1997	Environmentally-friendly practices	Develop propositions recognizing the importance of management's role in categorizing eco-friendly "green" best practices and promoting eco-friendly practices within the operations management value chain.
Fresner, 1998	Cleaner production	It is a preventive approach for controlling the environmental impacts of products at the source and hence increasing the environmental performance of companies.
Güngör & Gupta, 1999	Environmentally Conscious Manufacturing and Product Recovery	It refers to the activities of product recovery (reducing the amount of waste by recycling and remanufacturing) and creating strategies for new products, from conceptual design to end-of-life disposal.
Curkovic, 2003	Environmentally Responsible Manufacturing	It is an economically viable, system-wide, and integrated technique for reducing and eliminating waste streams coordinating with the design, manufacture, use, and disposal of products and materials.
Glavič, & Lukman, 2007	Cleaner production	To achieve environmental improvements in product and process development to contribute to a sustainable planet. Cleaner production includes minimizing resource use and improving eco-efficiency to enhance environmental conservation and also reduce risks to all living organisms.
Severo, de Guimarães, Dorion, & Nodari, 2015	Cleaner production	It refers to activities for increasing productivity, competitiveness, and improving corporate performance that enable a company to identify itself as an efficient buyer of raw materials and energy in production processes.
Curkovic & Sroufe, 2016	Environmentally Responsible Manufacturing	It is a proactive management practice that includes the efforts of a company to merge environmental protection practices with its decision-making processes.

Environmentally conscious manufacturing is an interdisciplinary field of study and includes some sample activities listed below (Fresner, 1998):

- Environmentally friendly approach on the material use and energy consumption,
- Training for the employees, more efficient logistics operations, enhanced data availability and communication between departments,
- Substituting raw and supplementary materials with less harmful, efficient, and recyclable alternatives,
- Product changes in line with the elimination of manufacturing stages with high environmental impact,
- Revision of processes for minimizing waste and emissions,
- Internal recycling,
- Integrate wastes in the external recycling.

By examining the studies in the literature, sub-activities and related criteria were determined, and a questionnaire was designed. It is aimed to determine the activities applied within the scope of environmentally responsible manufacturing in the shipbuilding sector and how often they are applied. Sub-factors and sources for the environmentally responsible manufacturing are presented in Table 3.

Reasons Leading to Environmentally Responsible Manufacturing Activities

Companies turn to practices to reduce environmental negative effects in manufacturing processes for various reasons: legal requirements, decrease in costs, increase in efficiency, improvement in company image, increase in market share and profitability, positive effect on corporate image, etc. (Karakuş & Erdirencelebi, 2018). Porter & Van Der Linde (1995) stated that while the environmentally friendly approach creates benefits for the products and processes, it also delivers a significant competitive advantage to the business. Similarly, although there are results in the literature that companies shift to environmentally-friendly for reasons such as strengthening their position in the market or accessing new markets (Halkos & Evangelinos, 2002), it is seen that these reasons are not clearly defined. These reasons were defined in line with the information obtained from the literature, the experience of the author on the subject, and the interviews with the businesses, and were added to the questionnaire by considering them in two classes as internal and external factors (Table 2). In this direction, the initial hypothesis of this study is:

H₁: Internal and external causes in businesses are positively associated with environmentally responsible manufacturing practices.

Within the scope of the study, besides determining the relationship between internal and external factors and environmentally responsible manufacturing, it was also aimed to understand which causes have more impact and the following sub-hypotheses were put forward.

H_{1a}: Internal causes in businesses are positively associated with environmentally responsible manufacturing practices.

H_{1b}: External causes in businesses are positively associated with environmentally responsible manufacturing practices.

Results of Environmentally Responsible Manufacturing Activities

Environmentally sensitized manufacturing activities not only improve environmental performance, such as better energy consumption, raw material efficiency and waste reduction, but also provide a better business image, increased competitiveness, access to new markets, and good cooperation

opportunities even with stakeholders (Halkos & Evangelinos, 2002). Some companies are evaluating and reorganizing their business models as they become aware of the environmental consequences of their operations (Kassinis & Soteriou, 2003). In addition to increasing environmental performance, many companies apply environmentally friendly activities to improve their quality and performance in working conditions such as health and safety (Zwetsloot, 1995). Another benefit obtained by carrying out these activities is the positive effect on social sustainability. Increasing the quality of the work environment, improving occupational safety conditions, improving the living standard and working in a more democratic work environment have positive effects on social sustainability, and this situation increases business performance by positively affecting job satisfaction, motivation and productivity (Getzner, 2002).

The Relationship Between Environmentally Responsible Manufacturing Activities and Cleaner Production Performance

Environmentally responsible manufacturing actions aim to define and eliminate the environmental effects of every production stage, from product design to raw material determination, from logistics to product disposal. Efforts to reduce environmental impacts in design and production processes create advantages such as waste reduction, energy-saving, and material efficiency; in this way, they positively affect the cleaner production performance of enterprises (Dunn & Bush, 2001, Burritt et al., 2009). Therefore, improvements in the cleaner production performance of enterprises are expected with the execution of environmentally responsible manufacturing activities.

Cleaner production performance is an indicator of efficient material use, lowered energy consumption and decreased emission, as well as encouraging preventive actions on the environment and providing a holistic approach for resources, manufacturing, economy, and environment (Kjaerheim, 2005). Fresner (1998) stated that business managers should focus on prevention instead of a remedy in reducing environmental impacts. In the study, which investigated the effect of implementing environmental standards and environmentally responsible manufacturing activities on reducing the environmental effects of the company, it has been stated that the inefficiency in the material use and energy consumption was reduced by ensuring the participation of employees with environmentally friendly activities. Burritt et al. (2009), in their research performed in the Philippines with a case study, stated that businesses can create positive effects on energy efficiency and emissions by applying new technologies that will make their processes environmentally friendly. Intelligent production systems equipped with Industry 4.0 technologies are important tools that can be used for every stage of environmentally responsible manufacturing, especially energy management (Stock & Seliger, 2016).

Melnyk et al. (2003) conducted a study in North America to investigate the influence of environmentally friendly approaches on environmental and overall performance. As a result, they noted that the environmental activities implemented by the enterprises have a positive and significant impact on both environmental and operational performance. Accordingly, the second hypothesis of this research is:

H₂: Environmentally responsible manufacturing activities in enterprises are positively associated with cleaner production performance.

In order to determine the relationship stated in the H₂ hypothesis, the more intensively applied sub-factors and the effects of the factors on cleaner production performance were examined. Accordingly, the sub-hypotheses are as follows:

H_{2a}: Raw material identification/supply activities are positively associated with cleaner production performance.

H_{2b}: Environmentally friendly design activities are positively associated with cleaner production performance.

- H_{2c}**: Environmentally responsible manufacturing activities are positively associated with cleaner production performance.
- H_{2d}**: Environmentally friendly logistics activities are positively associated with cleaner production performance.
- H_{2e}**: Recycling/disposal activities are positively associated with cleaner production performance.
- H_{2f}**: Ensuring employee participation in environmental activities is positively associated with cleaner production performance.

The Relationship Between Cleaner Production Performance and Business Performance

There are many studies in the literature to measure the results of cleaner production performance. The outcome of environmentally friendly approaches on business performance is discussed in two categories. The first is that the costs of companies that adopt a cost-based approach and adopt environmentally friendly practices will decrease. The second is the demand-based approach, and it is that businesses with better environmental performance will find new business opportunities in line with the demands of the stakeholders (Montabon et al. 2007).

Zeng et al. (2010) evaluated the effect of cleaner production performance on business performance with a survey they conducted in Chinese manufacturing enterprises. They emphasised that cleaner production has positive effects on business performance. Lin et al. (2013) performed a study to understand the results of green products on market demand and business performance in Vietnam. They noted that green product innovation is positively associated with market demand and business performance.

Montabon et al. (2007) analyzed the corporate reports of 45 businesses with the content analysis method to investigate the relationship between environmental management approaches and business performance. As a result, they stated that environmental practices are linked with business performance. Sambasivan et al. (2013) studied the effects of environmentally friendly practices in Malaysia using the survey method. As a result of the research, they concluded that environmental efficiency is positively associated with operational performance, organizational knowledge, environmental performance, stakeholder satisfaction and financial performance.

There are various studies on the service industry for measuring the influence of environmental activities on business performance. Kassinis and Soteriou (2003) conducted a study in which they examined the impact of environmental practices on business performance in the hospitality sector in Europe. As a result of the research, they concluded that environmental practices have a positive impact on business performance by increasing customer satisfaction and loyalty. Molina-Azorin et al. (2009) performed a study to investigate the connection between environmental practices and business performance in the Spanish housing sector. As a result of the research, they showed that hotels with a strong commitment to environmental approaches achieved better performance levels.

While the environmental results of cleaner production are at the forefront, it should not be neglected that it also has positive effects on the other two sub-dimensions of sustainability; economic and social. With the increase in their cleaner production performance, in addition to improving their environmental performance, businesses obtain positive effects such as quality, health and safety, reducing costs and increasing competitiveness (Kliopova & Staniskis, 2006). Increasing the quality of the work environment, improving occupational safety conditions, improving the standard of living, working in a more democratic work environment have positive effects on social sustainability and this situation increases business performance by positively affecting job satisfaction, motivation and productivity (Getzner, 2002). Getzner (2002) conducted a research using the survey method in five European countries to understand the ecological positive effects of clean production technologies as well as the effects on the employment structure of enterprises. According to the research, it has been expressed that besides the ecological and economic positive effects, there are also positive social effects in the enterprises that adopt clean technologies. In the study, it was emphasized that

there were quantitative and qualitative results on employment, and with the reduction of noise and emission, improvements in the physical qualities of the working conditions ensured. Thus, the third hypothesis is as follows:

H₃: Cleaner production performance is positively associated with business performance.

The theoretical model proposed in line with the research hypotheses based on the assumptions is presented in Figure 1.

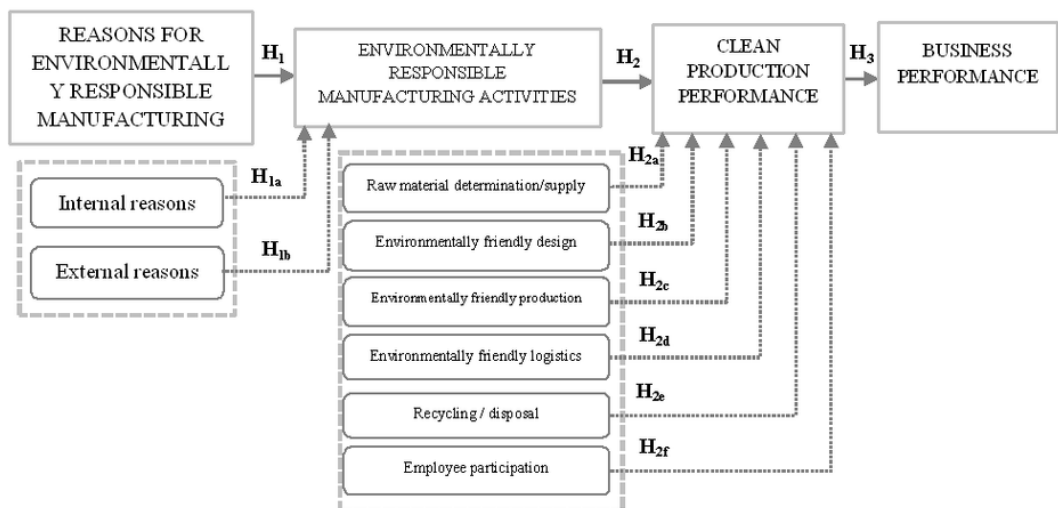
METHODOLOGY

The Population and Sample of the Research

The survey research method was used to determine the reasons that lead to environmentally responsible manufacturing, the practices carried out within the scope of environmentally responsible manufacturing and the results of these practices. The purpose of determining the sample in the research is to obtain data that will allow the generalization of the findings obtained from the enterprises with the factors in the conceptual model created. In this context, the purposeful sampling method was preferred in the research, and the population was determined as companies operating in the shipbuilding sector in Turkey. The reason why the shipbuilding industry is defined as the population can be listed as the fact that the industry operates in the international market, it carries out intensive studies on compliance with international standards, and the majority of the operating companies are medium and large-scale corporate enterprises.

The shipbuilding industry in Turkey has a history of 600 years, and the first shipyard was established in 1390 during the Ottoman period. After the establishment of the Republic of Turkey in 1923, a special interest and modernization process was experienced in the shipyards. In 2019, Turkey is the world's 11th largest shipbuilding economy, and in the last ten years, fishing vessels, trawlers, tankers, tugboats, cruise/passenger ferries, dry cargo vessels, offshore service vessels, bulk carriers, etc., have been produced. Due to their flexible structure against unexpected changes in market conditions, Turkish shipyards carried out market development reflections during the global crisis and occupied a strong position in some niche markets such as small chemical tankers, tugboats and

Figure 1. Research model



superyachts. Besides shipbuilding, the industry is also active in repair and maintenance, conversion and recycling (<https://www.oecd.org/turkey/peer-review-turkey-shipbuilding-industry.pdf>, Accessed: 10.11.2021, www.gisbir.org.tr, Accessed: 10.09.2021).

Following the determination of the research population, research permission was obtained by contacting the Shipbuilders' Association. There are 84 enterprises operating in the sector (<https://tkygmistatistikleri.uab.gov.tr/tersane-sayisi-2021>, Accessed: 29.01.2022), 70 of which are members of the association. Questionnaire forms were sent to 70 enterprises with the support of the association. Then, using face-to-face interviews, phone calls, e-mail and online form methods, 51 enterprises were returned between June and November 2022. In the study, the sample's representation rate of the population is 60.7%.

Limitation of the Research

The low sample size is the main limitation of the study. The fact that the population is 84 enterprises creates a constraint on the validity of the analysis, while the awareness and competence of the sector on environmentally responsible manufacturing practices has created an important motivation for including it in the scope of the research.

Data Collection

Before collecting data, the survey was pretested for content validity in two phases. Firstly, an experienced researcher was asked to review the survey with regard to clarity and suitability of the items. In line with the researcher's suggestions, the question items were rearranged to prevent repetition and reduce ambiguity. Afterwards, the questionnaire was sent to an expert experienced in the Shipbuilding Sector for evaluation. The expert reviewed the questionnaire for industry relevance, readability, uncertainty, and completeness and made recommendations. Necessary adjustments were made in the questionnaire in line with the suggestions, and the questionnaire was made ready for application.

It is aimed to reach more reliable results about the reasons that lead to environmentally responsible manufacturing, the practices carried out and the results by presenting the surveys to people in managerial positions (administrative manager, environmental officer, energy management system manager, occupational safety specialist) in companies operating in the shipbuilding industry.

A Likert scale was used in which 1 expressed "I strongly disagree" and 5 expressed "I totally agree". The questionnaire consists of four parts. In the first part, there were questions to obtain descriptive information such as the establishment date of the enterprise, the number of employees, the education level of the employees, whether they have an environmental management system and certificate.

In the second part, questions were asked to understand the reasons that lead the business to environmentally responsible manufacturing. In the literature research, it was seen that these reasons were not clearly defined. These factors were defined in line with the information obtained from the literature, the experience of the author, and the interviews with the businesses, and they were added to the questionnaire as shown in Table 2 by considering them in two classes as internal and external factors.

The third part is aimed at determining the activities within the concept of environmentally responsible manufacturing in enterprises. In the literature, it has been observed that no studies have defined activities to reduce environmental impacts for each stage of production, and the scales in different studies were arranged in line with the experience of the author and placed in the questionnaire (Table 3).

The fourth chapter is about understanding the results of environmentally responsible manufacturing activities. In this section, cleaner production performance and operating performance factors are included, and information on these factors is shown in Table 4.

Table 2. Questionnaire items to understand the reasons that lead businesses to environmentally responsible manufacturing

Factor	Sub-factor	Question items	Sources
The reasons that lead companies to environmentally responsible manufacturing	Internal reasons	Request of top management	Writer
		Continuous improvement approach of the business	
		Increasing profitability	
		Increase efficiency	
		Reduce costs	
		Considering it as a social responsibility	
		Improving the reputation of the business	
	External reasons	Request from customers	
		Competitors' environmental activities	
		Achieve preferred supplier status for their customers	
		Legal obligation for the business	

Table 3. Factors for determining the activities carried out within the scope of environmentally responsible manufacturing in enterprises

Factor	Sub-factor	Sources
Environmentally responsible manufacturing activities	Raw material determination/supply (2 questions)	Fresner (1998)
	Environmentally friendly design (6 questions)	Güngör & Gupta (1999)
	Environmentally responsible manufacturing (8 questions)	Fresner (1998)
	Environmentally friendly logistics (3 questions)	Yazar
	Recycling/Disposal (4 questions)	Güngör & Gupta (1999)
	Employee participation (3 questions)	Fresner (1998)

Table 4. Cleaner production performance and operating performance factors

Factor	Sub-factors	Question items	Sources
Results of environmentally responsible manufacturing	Clean production performance	Compliance with the law	Writer
		Emission reduction	
		Hazardous chemical reduction	
		Waste reduction	Severo, de Guimarães, Dorion & Nodari (2015)
		Raw material consumption	
		Energy consumption	
		Water Consumption	
	Business performance	Reduction in costs	Severo, de Guimarães, Dorion & Nodari (2015)
		Increase in quality	
		Increase in productivity	
		Improvement in reputation	
		Increase in sales	Writer
		Increase in profitability	
		Increase in competitiveness	

FINDINGS OF THE STUDY, CONCLUSION, AND RECOMMENDATIONS

In this section, first of all, descriptive analyzes about the survey participants are given. Afterwards, reliability, correlation and regression analyzes were performed using the SPSS 27 package program and the findings were presented.

Demographic Findings

All companies participating in the survey operate in the shipbuilding industry. The information about the companies is presented in Table 5.

Participants who filled out the questionnaire are people in managerial positions in the shipbuilding industry such as General Manager, Shipyard Manager, Administrative Affairs Manager, Environmental Coordinator, Quality Assurance Officer. When the establishment date and number of employees in Table 5 are examined, it can be seen that businesses of different sizes and life spans have been reached. 73% of the participating enterprises have an Environmental Management Department, and 90% have a certified environmental management system. This is an indication that the questionnaires are filled in more consciously and more valid results are achieved.

Reliability of Data Collection Tool

Cronbach's alpha coefficient was used to evaluate the reliability (internal consistency) of the scales in the survey. Cortina (1993) states that the Cronbach alpha value must exceed 0.7 for the scale to be reliable.

In Table 6, Cronbach's alpha coefficients of the scales are presented by making use of the total score of the items. The values indicate that the internal consistency is quite high.

Correlation and Regression Analysis

The normality test was carried out with the Kolmogorov-Smirnov test, and the skewness and kurtosis values of the factors were examined. It was determined that $p < 0.05$ for the factors, and the skewness

Table 5. Frequency distribution regarding the characteristics of participating companies

Parameters		Frequency	Percent	Parameters		Frequency	Percent
Establishment date	Before 1970	7	14	Number of employees	0-50	22	43
	1970-1980	6	12		50-100	7	14
	1980-1990	7	14		100-150	5	10
	1990-2000	7	14		150-200	3	6
	2000-2010	12	24		200-250	3	6
	2010-2020	11	22		250-300	1	2
	After 2020	1	2		300-350	2	4
Total		51	100		350-400	0	0
Environmental management department	Yes	37	73		400-500	4	8
	No	14	27		500-600	1	2
Total		51	100		600-700	1	2
Certified environmental management system	Yes	46	90		700-800	2	4
	No	5	10	Total		51	100
Total		51	100				

Table 6. Reliability coefficients of scales

Scale	Number of Items	Cronbach Alpha Coefficient
Reasons Leading to Environmentally Responsible Manufacturing	11	,881
Internal reasons	7	,875
External reasons	4	,811
Environmentally Responsible Manufacturing Activities	26	,961
Raw material determination / supply	2	,715
Environmentally friendly design	6	,891
Environmentally friendly production	8	,905
Environmentally friendly logistics	3	,781
Recycling / disposal	4	,853
Employees participation	3	,833
Clean production performance	7	,865
Business performance	7	,921
Total	51	,971

and kurtosis values of some factors were between -1.5 and +1.5, while some of them were out of range. After it was determined that the scales did not provide the normality assumption, correlation analyses were carried out for understanding the link between the factors and the Spearman correlation coefficient was taken into account in the evaluations.

Reasons Leading to Environmentally Responsible Manufacturing

In line with the hypothesis “H₁: Internal and external causes in enterprises are positively associated with environmentally responsible manufacturing practices”, a correlation analysis was performed to investigate the relationships between internal and external causes that lead to environmentally responsible manufacturing and environmentally responsible manufacturing activities and is presented in Table 7.

As a result of the analysis, it is seen that the sub-factors (internal and external causes) of the environmentally responsible manufacturing activities and the reasons that lead to environmentally responsible manufacturing have a positive, significant, and moderate relationship. Regression analysis was applied to test the H_{1a} and H_{1b} hypotheses and the analysis results are given in Tables 8 and 9.

As seen in Table 8, the model is significant and it turns out that 53.7% of environmentally responsible manufacturing practices in enterprises are related to internal reasons ($R^2=.537$,

Table 7. Correlation analysis one

Scale		Environmentally Responsible Manufacturing Activities
Internal reasons	Correlation Coefficient	,647
	Sig. (2-tailed)	,000**
External reasons	Correlation Coefficient	,536
	Sig. (2-tailed)	,000**

**Correlation is significant at the 0.01 level (2-tailed), N=51

Table 8. Regression analysis showing the effect of internal reasons leading to environmentally responsible manufacturing on environmentally responsible manufacturing activities

R	R ²	Sig.	B	Standard error	t
.732	.537	.000**	2.322	.308	7.531

**P<0.05

p=.000). In this direction, it has been determined that the hypothesis of “H_{1a}: Internal reasons leading to environmentally responsible manufacturing in enterprises are positively associated with environmentally responsible manufacturing practices” is supported.

As seen in Table 9, the model is significant, and it turns out that 12.6% of environmentally responsible manufacturing practices in enterprises are related to external internal causes (R²=,126, p=,011). In this direction, it has been determined that the hypothesis of “H_{1b}: External causes that lead to environmentally responsible manufacturing in enterprises are positively associated with environmentally responsible manufacturing practices” is supported.

At this stage, it was also investigated which of the reasons that led the enterprises to environmentally responsible manufacturing had a greater impact. Within the scope of the analysis, the average of the answers between 1-5 given by each enterprise for internal and external reasons is presented in Figure 2.

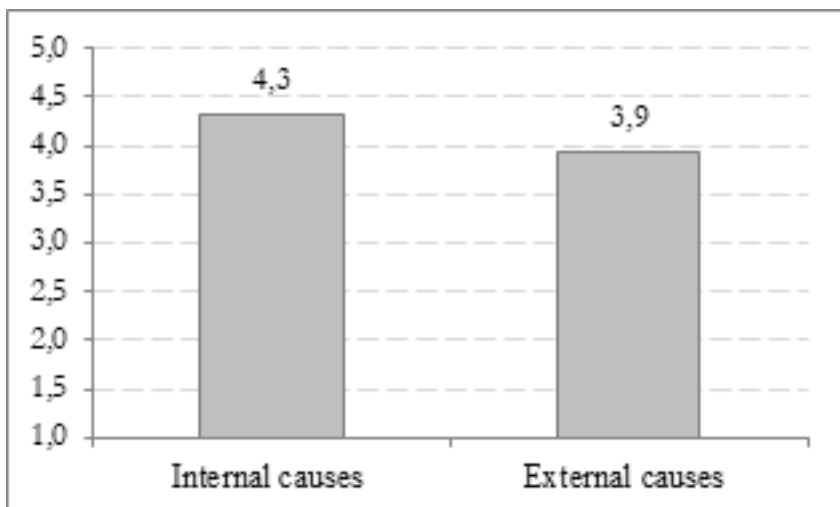
As can be seen in Figure 2, while internal causes have an average score of 4.3, external causes have a score of 3.9. When the internal reasons are examined based on the question item, it is seen that the items regarding environmental practices as social responsibility (4,6), improving the image

Table 9. Regression analysis showing the effect of external factors leading to environmentally responsible manufacturing on environmentally responsible manufacturing activities

R	R ²	Sig.	B	Std. Error	t
.355	.126	.011**	1.626	.611	2.661

**P<0.05

Figure 2. The reasons that lead businesses to environmentally responsible manufacturing



of the business (4,5), and the understanding of continuous improvement of the company (4,5) have the highest averages. This is an indication that businesses have a high level of awareness to reduce environmental impacts, and this is a promising situation.

Lee (2009) studied the adoption process of green management in small and medium-sized enterprises and stated that environmental legislation is a significant environmental trigger, but its results are limited to the scope of the regulation. Also, in this study, the item “being a legal requirement for the business”, one of the external reasons leading to environmentally responsible manufacturing, had an average of 4.3 and showed itself as an important reason. Melnyk et al. (2001) studied the perceptions of environmentally responsible production in enterprises and stated that the support and participation of the management departments has a critical importance on the efficiency of environmental activities, environmental responsibility and reducing pollution. Similarly, in this study, the desire of the top management reached an average value of 4.3, emphasizing the importance of the subject.

The Relationship Between Environmentally Responsible Manufacturing Activities and Cleaner Production Performance

Correlation analysis was conducted in line with the hypothesis of “H₂: Environmentally responsible manufacturing activities are positively associated with cleaner production performance” and is presented in Table 10.

It is seen that the cleaner production performance has a positive, significant, and moderate relationship with the sub-factors of environmentally responsible manufacturing activities (raw material determination and supply, environmentally friendly design, environmentally friendly production, environmentally friendly logistics, recycling/disposal, employee participation). It has been determined that each sub-activity is in close relationship with the cleaner production performance.

According to Table 11, it is seen that the determination/supply of raw materials from environmentally responsible manufacturing activities can explain 26.6% of cleaner production performance in a meaningful way ($R^2=.266$, $p=.000$). In this direction, it has been determined that the hypothesis of “H_{2a}: Raw material determination/supply activities are positively associated with cleaner production performance” is supported.

Table 10. Correlation analysis two

Scale		Cleaner Production Performance
Raw material determination / supply	Correlation Coefficient	.459
	Sig. (2-tailed)	.001**
Environmentally friendly design	Correlation Coefficient	.625
	Sig. (2-tailed)	.000**
Environmentally friendly production	Correlation Coefficient	.692
	Sig. (2-tailed)	.000**
Environmentally friendly logistics	Correlation Coefficient	.632
	Sig. (2-tailed)	.000**
Recycling / disposal	Correlation Coefficient	.599
	Sig. (2-tailed)	.000**
Employee participation	Correlation Coefficient	.446
	Sig. (2-tailed)	.001**

**Correlation is significant at the 0.01 level (2-tailed), N=51

Table 11. Regression analysis showing the effect of raw material determination/supply on cleaner production performance

R	R²	Sig.	B	Std. Error	t
.516	.266	.000**	1.609	.381	4.219

**P<0.05

According to Table 12, it is seen that environmentally friendly design, one of the environmentally responsible manufacturing activities in enterprises, can significantly explain 40.8% of the cleaner production performance ($R^2=.408$; $p=.000$). In this direction, it has been determined that the hypothesis of “H_{2b}: Environmentally friendly design activities are positively associated with cleaner production performance” is supported.

According to Table 13, it is seen that environmentally friendly production can explain 47.6% of cleaner production performance in a statistically significant way ($R^2=.476$; $p=.000$). In this direction, it has been determined that the hypothesis of “H_{2c}: Environmentally friendly production activities are positively associated with cleaner production performance” is supported.

According to Table 14, it is seen that environmentally friendly logistics can explain 37.7% of cleaner production performance in a statistically significant way ($R^2=.377$; $p=.000$). In this direction, it has been determined that the hypothesis of “H_{2d}: Environmentally friendly logistics activities are positively associated with cleaner production performance” is supported.

According to Table 15, it is seen that recycling/disposal activities in enterprises can explain 48.5% of cleaner production performance in a statistically significant way. ($R^2=.485$; $p=.000$). In this direction, it has been determined that the hypothesis of “H_{2e}: Recycling/disposal activities are positively associated with cleaner production performance” is supported.

According to Table 16, it is seen that the participation of employees in environmentally responsible activities in enterprises can explain 24.4% of cleaner production performance in a statistically significant way. ($R^2=.244$; $p=.000$). In this direction, it has been determined that the hypothesis of “H_{2f}: Employee participation is positively associated with cleaner production performance” is supported.

Table 12. Regression showing the effect of environmentally friendly design on cleaner production performance

R	R²	Sig.	B	Std. Error	t
.639	.408	.000**	.564	.097	5.814

**P<0.05

Table 13. Regression analysis showing the effect of environmentally friendly production activities on cleaner production performance

R	R²	Sig.	B	Std. Error	t
.690	.476	.000**	.625	.094	6.667

**P<0.05

Table 14. Regression analysis showing the effect of environmentally friendly logistics activities on cleaner production performance

R	R²	Sig.	B	Std. Error	t
.614	.377	.000**	1.306	.240	5.440

**P<0.05

Table 15. Regression analysis showing the impact of recycling/disposal activities on cleaner production performance

R	R ²	Sig.	B	Std. Error	t
.697	.485	.000**	1.086	.160	6.797

**P<0.05

Table 16. Regression analysis showing the effect of employee participation in environmentally responsible manufacturing activities on cleaner production performance

R	R ²	Sig.	B	Std. Error	t
.494	.244	.000**	1.035	.260	3.979

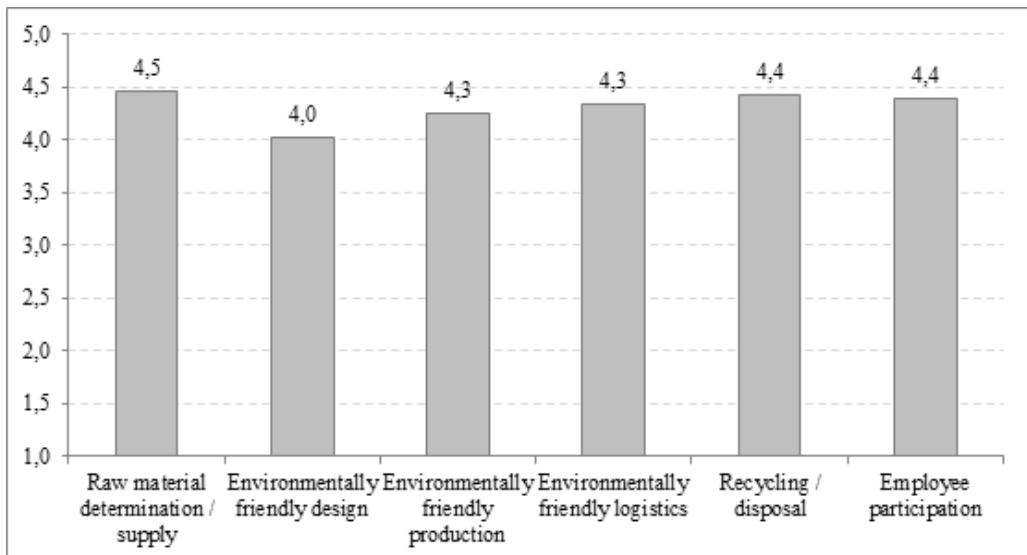
**P<0.05

Fresner (1998) stated that the inefficiency in the material use and energy consumption is reduced by ensuring the participation of employees along with environmentally friendly activities, Burritt et al. (2009) stated that businesses increase their clean production performance by making their processes environmentally friendly. Melnyk et al. (2003) investigated the consequence of environmental activities on environmental performance and stated that they have a positive and significant impact on the environmental performance. The analysis findings obtained in this study are in agreement with the literature.

At this stage, another subject that is desired to be learned within the scope of the research is the intensity of implementation of environmentally responsible manufacturing sub-activity of enterprises. The average responses on the 1-5 scale given by each enterprise within the scope of environmentally responsible manufacturing sub-activities were determined as activity points, and the results are presented in Figure 3.

As seen in Figure 3, the average scores of the enterprises are above the value of 4 for each sub-activity, which indicates that the shipbuilding industry is very sensitive to environmental practices.

Figure 3. Intensity of sub-activities carried out within the scope of environmentally responsible manufacturing



While raw material determination/supply activity (4,5) has the highest average, they have the lowest score for environmentally friendly design. When the reason for this situation was asked to the experts of the industry, it was stated that the use of service procurement in the design activities of most of the enterprises caused this situation.

It should not be forgotten that environmentally friendly products and manufacturing are possible with environmentally friendly design. It is important to specify environmentally friendly design as a technical requirement when purchasing a design service. Another requirement is the support of the industry associations (training, consultancy, etc.) in the product life cycle studies of the companies that carry out the design work in-house.

The Relationship Between Cleaner Production Performance and Business Performance

Correlation analysis was made in line with the hypothesis of “H₃: Cleaner production performance is positively associated with business performance” and is presented in Table 16.

When the correlation analysis in Table 17 is studied, it is seen that there is a positive, significant, and high-level relationship between cleaner production performance and business performance. Regression analysis was conducted to understand the extent of the relationship and is presented in Table 18.

Considering Table 18, it is seen that cleaner production performance can explain 68.9% of business performance significantly ($R^2=.689$; $p=.000$). In this direction, it has been determined that the hypothesis of “H₃: Cleaner production performance is positively associated with business performance” is supported. The result is consistent with similar studies in the literature. Montabon et al. (2007), Zeng et al. (2010), Sambasivan et al. (2013), and Lin et al. (2013) stated that cleaner production performance has positive effects on business performance. Karakuş and Erdirencelebi (2018) stated that businesses that have a high awareness of environmental management and that make their business functions environmentally friendly have achieved significant performance gains. Similar results were obtained in the researches carried out for the service sector. Kassinis and Soteriou (2003) and Molina-Azorín et al. (2009) stated in their research in the accommodation sector that accommodation establishments that are sensitive to environmentally friendly approaches have reached a better performance level.

CONCLUSION AND RECOMMENDATIONS

This study aims to define the reasons that lead businesses to environmentally responsible manufacturing, the practices carried out, and the results of these practices on cleaner production

Table 17. Correlation analysis three

Scale		Business performance
Clean production performance	Correlation Coefficient	.859
	Sig. (2-tailed)	.000**

**Correlation is significant at the 0.01 level (2-tailed), N=51

Table 18. Regression analysis showing the effect of cleaner production performance on business performance

R	R ²	Sig.	B	Std. Error	t
.830	.689	.000**	1.086	.104	10.428

**P<0.05

performance and business performance. Accordingly, data were collected, and analyses were carried out in line with the survey application carried out in the shipbuilding industry. Empirical findings show that environmentally responsible manufacturing activities are affected by internal and external factors and these activities positively affect cleaner production performance. In addition, the results show that cleaner production performance has a positive correlation with business performance. Therefore, all hypotheses in this study were supported.

When the descriptive analysis is examined, it is seen that 73% of the participating enterprises have an environmental management department and 90% have a documented environmental management system. This shows the high validity of the survey results and indicates the sensitivity of the sector to reduce environmental impacts. The fact that the sector enterprises operate in international markets and their efforts to comply with international standards have enabled them to fulfil many requirements in terms of environmentally responsible manufacturing.

When the reasons that lead to environmentally responsible manufacturing are examined, it is seen that internal reasons have a more important effect than external reasons, which is an indicator of the high awareness of enterprises about environmentally responsible manufacturing. In the interviews with the representatives of the sector, they stated that the environmental activities initially started in line with legal reasons or customer demands, but as the years progressed, the companies developed environmental activities voluntarily with the perception of the benefits related to the results of the activities carried out. In addition, the desire and support of the top management increases the efficiency of the studies.

The second purpose of the research is to determine the intensity of the environmentally responsible manufacturing practices of businesses. It has been observed that environmentally friendly processes are developed in all manufacturing processes from raw material determination to recycling, and studies are carried out on the participation of employees.

The final purpose of the study is to understand the results of environmentally responsible manufacturing. Accordingly, the effect of sub-activities on cleaner production performance was investigated as the second hypothesis of this study, and all sub-hypotheses were supported. The third and final hypothesis is to examine the impact of cleaner production performance on business performance, and a high correlation has been determined. When similar studies performed in different sectors are examined in the literature, it is seen that parallel results are obtained. This result is very important and it is a result that all businesses should understand and will prevent them from seeing environmental activities as a loss of business or cost factor. Increasing the cleaner production performance causes a decrease in costs and growth in quality, sales, profitability, productivity and competitiveness, and improves the corporate image.

This study contributed to the literature on two issues. First of all, while the reasons that lead to environmentally responsible manufacturing have not been clearly defined in the literature, this study has contributed to the definition of these reasons. Secondly, while environmentally responsible manufacturing activities are partially handled in different studies, all processes are handled within the scope of environmental sensitivity in this study. The low sample size is the main limitation of the study. The fact that the population is 84 enterprises creates a limitation on the validity of the analysis. However, the results obtained are compatible with similar studies in the literature, which indicates that the sector has been chosen correctly. It is recommended to repeat the study in different sectors and with a higher sample size, and even to compare different sectors.

Today, due to globalization and industrial development, it is seen that global concerns regarding pollution and the environment are increasing since environmental issues have negative consequences on the whole ecosystem. This problem can be solved by localized regulations to be created by multinational authorities and by developing practices that will increase awareness and reduce environmental impacts by all stakeholders. The environmental destruction that has occurred over the years has now exceeded the degree to be postponed or set aside. By saying 'Right now!', work should be started on a global basis, and all innovative ideas and Research and Development (R&D)

activities should be environmentally friendly or shaped for the environment. It is crucial to advance research studies for decreasing environmental impacts and expanding environmentally responsible manufacturing practices in all industries.

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