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The Effects of Green Supply Chain Management Practices on the Performance of the Turkish Iron and Steel Industry

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Abstract

Sustainability is fundamental to complete development since it minimizes the negative impacts of work that is beneficial to the society. Some sectors, such as the Iron and Steel Industry (ISI) have served the development of humanity for centuries and have enabled humanity to create new tools and build solid structures. ISI is a main material provider for different industries such as household appliances, car production, building, and medical devices. The importance of iron and steel for humanity is obvious and the sector serves humanity for being an advanced civilization. On the other hand, iron and steel production requires complex production methods, high energy consumption, and toxic materials. The industry that is so important for the development of civilization harms the planet and threatens all living creatures when it doesn't have environmental consciousness. The iron and steel sector should make its production model more environmentally friendly. In this context, this study aims to detect the application level of Green Supply Chain Management (GSCM) practices in the Turkish Iron and Steel (ISI) Industry and explore the effects of GSCM practices on 3 performance aspects (environmental, operational, and economic) of Turkish ISI. Findings indicate that every single GSCM practice has a different level of positive and significant impact on environmental and operational performance. However, the findings suggest that the effects of GSCM practices on economic performance have a positive relationship, but the relationship is not significant. Only, green purchasing has a significant impact on economic performance.

Keyword

GSCM,
Iron and Steel Industry,
GSCM performance outcomes,

1. INTRODUCTION

The iron and steel industry (ISI) which makes a great contribution to GDP across the world is crucial, especially for developing countries (Cheng et al., 2020). ISI is directly related to other sectors since it is one

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of the main material providers for automotive, construction, household appliances, railways, and defense industry, etc. Although the industry contributes to the development of humanity, from an environmental perspective it harms human beings due to high energy consumption requirements, use of toxic materials, and poor waste management systems. Complex production methods which ignore negative environmental impacts have caused inevitable environmental issues which have lasted for decades such as ozone layer depletion, global warming, water, soil, and air pollution, regional acid rains, and diseases (Zhu et al., 2012).

According to World Steel Organization statistics, Global crude steel production is about 1,900 million tons **(**Mt**)** globally and nearly 20 Gigajoules (GJ) energy consumption is required to produce a ton of steel. Globally, annual ISI energy consumption covers nearly 20% of the total industrial energy consumption. The sector mainly uses fossil fuels to generate energy and releases harmful material into the environment. International Energy Agency (IEA) has stated that ISI is responsible for nearly 6.7% of the total Carbon Dioxide (CO2) emissions of the world. These statistics show that ISI is highly polluting and the second largest energy-consuming sector in the world (Tsai et al., 2007; Olmez et al., 2016; Mousa et al., 2016).

Iron and steel production which includes steps like sintering, coke production, pelletizing, etc. has complicated production processes that may vary due to the type of used raw material and energy resources (Sun et al., 2020; Fabian, 1958). The furnace that requires high energy consumption and generates high heat to melt the iron ore is the basic tool for ISI and preference of the type of the furnace changes the production techniques. Blast furnaces (BF) and basic oxygen furnaces (BOF) are the most preferred melting techniques across the globe, and they nearly cover %75 of global steel production. Electric Arc Furnace (EAF) is the second most used technique after BF and BOF, it covers about 25% of steel production in the world. The use of EAF is limited because EAF is a secondary production technique that requires waste iron and scraps to melt. Since iron is a durable product, the recycling of iron and steel is limited. Lastly, open hearth technology nearly covers less than %1 and it continues to decline due to its higher negative environmental and economic effects (Huitu et al., 2013; Sun et al., 2020). These polluting production techniques direct ISI to follow GSCM practices which enable to control of negative side effects of product and production processes on the environment at every stage of production starting from the beginning to the final phase in which the product is disposed of or used by the final user (Al-Sheyadi et al., 2019). In this context, this study aims to assess the application level of GSCM practices of Turkish ISI and detect if these practices influence the operational performance (OP), environmental performance (EP), and economic performance (ECP) of companies. This study aims to answer.

'How does each GSCM activity affect the environmental, economic, and operational performance of ISI?'

The paper is organized as follows: In section 2, a literature review and hypotheses are presented. Section 3 discusses the research survey, sample, data collection, and method. The results and data analyses are explained in Section 4. The discussion and conclusion are presented in sections 5 and 6.

2. LITERATURE REVIEW

2.1. The shift from Supply Chain Management to GSCM

Increasing competition has driven companies to aggressively increase production capacity to take advantage of economies of scale. In many cases, companies apply hazardous production methods to make a profit (Zhu et al., 2012). The shift from 4P to 4C puts the consumer's wants and needs at the center of the business. Increasing consumer awareness toward the natural environment forces companies to prefer sustainable production methods, use renewable energy resources, and start recycling because many studies

proved that consumers' purchase decision is directly linked with the GSCM performance of companies. (Lee et al., 2021; Chen et al., 2012; Chavez et al., 2016). Market expectations and feedback direct industries to increase their green performance and company image by creating and adding value at every single stage of the value chain. For a successful value chain, establishing communication channels between customers and suppliers is crucial to satisfy the consumers' needs properly (Chavez et al., 2016).

The recent development of related technology has made a great contribution to the development of GSCM. Industry 4.0 revolution, sustainable energy resources, and changing business climate have contributed to the development of environmentally friendly products and processes. (Wang & Gupta, 2011; Khan et al., 2022).

2.2. GSCM and ISI (Iron and Steel Industry)

GSCM literature has been a popular and attractive research field for decades. In GSCM studies, scholars assessed different aspects, used different methods, and developed different models to examine GSCM practices. Various studies show that there are differences between sectors and countries. In this section, some studies that analyze the GSCM performance of the iron and steel sector in different countries and the GSCM performance analyses of other sectors in Turkey will be presented to identify the research gap. Iron and steel production requires complex production processes that cause high environmental damage such as carbon emission, and soil, and water pollution, so an environmentally friendly approach is needed. GSCM practices are essential for environmentally friendly production since they cover every step of production. Most of the studies which target ISI in different countries mainly focus on 3 main performance aspects which are economic, environmental, and operational. GSCM literature suggests that GSCM practices generally affect a firm's environmental performance positively, but operational and environmental performance can differ based on distinctive factors. A study conducted in China found that Carbon Dioxide (CO_2) reduction practices affect environmental performance positively, but they did not observe a certain effect on economic performance (Zhang et al., 2012). Another study conducted in India by Goyal et al. (2018) indicates that ESE (Environmental Sustainability Enablers) increased the environmental performance of Indian ISI. The company, which is chosen as a case study, attempted to apply ESE and put in a huge effort and they experienced a significant environmental performance increase.

Some other studies examine other performance dimensions rather than environmental performance. Xu et al. (2016) propose a cost reduction strategy for GSCM of ISI by applying a method that aims to reduce waste amount and cost. The optimization model which provides cost reduction strategies is offered as a future guidance for the steel industry. Khorasani and Almasifard (2018) propose a model that aims to minimize overall expenditure but additionally aims to reduce the negative impact on the natural environment. The model focuses on uncertainties about consumers, suppliers, production, demand capacity, etc. The study suggests that the model can support GSCM under uncertain conditions. Also, they reveal that bad management of the supply chain (SC) increases the uncertainty of business practices, and it may cause a negative impact on performance. Pang et al. (2011) mentions GSCM as the solution to sustainable development and claims lowering input and pollution level and rising utilization is the required step for sustainable development. They claim that GSCM provides economic benefits to ISI and in addition to economic benefits for business, it provides social and environmental benefits to the society. Another study conducted in Indonesia found energy consumption is the main factor that directly affects the success of GSCM applications in ISI. Also, they stated that the proportion of reusable materials should be increased since it is found as the most important performance metric (Yu et al., 2022).

As it is presented in this part ISI and GSCM have been examined by different scholars across the globe. Different studies that directly target ISI have attempted to find out different aspects of the relationship between GSCM and ISI.

2.3. GSCM studies in Turkey

In Turkey's GSCM literature, scholars target different sectors such as the cement industry (Kazancoglu et al., 2018), the aluminum sector (Atrek & Özdağoğlu, 2014), the electric industry (Andiç et al., 2012) the automobile industry (Gozde et al., 2019), hotels (Akandere & Zerenler, 2017), the chemical industry(Coskun & Bozyigit, 2019), the health care sector (İre et al., 2017) and SME's (Kasap & Ufuk, 2019). Every different study brings a new contribution to the existing literature because there are some differences across the different sectors.

For instance, Yıldız (2020) analyzes the effects of GSCM practices which are internal environmental management, green purchasing, cooperation with customers, and eco-design on environmental and economic performance through surveys from 191 manufacturing firms in Istanbul and Kocaeli. The results show that green purchasing and cooperation with customers don't significantly affect environmental and economic performance. On the other hand, internal environmental management affects environmental performance positively, but eco-design affects both environmental and economic performance positively. Cankaya and Sezen (2018) examine the relationship between GSCM practices and the performance of organizations in terms of economic, environmental, and social. They found that GSCM practices affect environmental performance as it was mentioned in GSCM literature but the effect of GSCM on social and economic performance was not as obvious as environmental performance, but some GSCM practices affect social and economic performance in a small portion. Dinçer et al. (2018) evaluate the financial and economic performance outcomes of GSCM. They examined beverage and food corporations that are traded on the Istanbul Stock Exchange (BIST). They found that decreasing pollution and increasing reverse logistic applications reduce operational costs, but they cannot find a significant connection between GSCM and profitability. Also, they found that bigger firms are better at conducting GSCM than smaller firms.

As it is presented in this chapter, GSCM attracts scholars to work in different sectors and every different sector contributes to the literature. The effects of GSCM practices which are Internal Environmental Management (IEM), Green Purchasing (GP), ECO Design (ECO), Cooperation with Consumer (CC), and Investment Recovery (IR) on operational, economic, and environmental performance can be different across industries. In this context, the GSCM literature in Turkey and other countries has been examined, and it is found that there is no GSCM study that aims to examine the effects of GSCM practices on Turkish ISI which has high energy consumption, carbon footprint, and pollution. The sector has a high potential to effectively apply GSCM. The supply chain starts from the raw material phase and the Iron and Steel Industry is the main material provider for automobiles, household appliances, medical devices, etc. In Turkey's literature, many studies were conducted in the automobile, household, medical device industry, etc. but the Iron and Steel sector was not examined. This study aims to fill that gap in the literature. As stated in the literature, different studies in different sectors have common points but there are also certain differences. Different industries of different countries should be examined to see the bigger picture. Therefore, it is important to find out the relationship between GSCM practices and the performance outcomes of Turkish ISI.

3. METHOD

In GSCM literature, GSCM practices are collected under 5 different headings which are Internal Environmental Management (IEM), Green Purchasing (GP), Cooperation with Consumers (CC), Eco Design

(ECO), and Investment Recovery (IR). Performance outcomes are collected under 3 headings which are Operational Performance (OP), Economic Performance (ECP), and Environmental Performance (EP). In this study, ECO and CC are collected under the same factor. The new factor is named CC+ECO. (It is explained in the following parts.) Figure 1. represents the research model of this study. This study aims to explain, every single relationship between GSCM practices and 3 different performance outcomes rather than a superficial explanation of GSCM and performance. In this context, 12 hypotheses were developed by examining the existing literature. Some of the resources that were used to develop the hypotheses are presented in Table 1.

Table 1. Resources used to develop hypotheses.

	Related Literature
Hypothesis 1(a, b, c, d)	**(Zhang et al., 2012; Liu, 2015)**
Hypothesis 2(a, b, c, d)	**(Xu et al., 2016; Liu, 2015)**
Hypothesis 3(a, b, c, d)	**(Liu, 2015; Huang et al., 2020; Goyal et al., 2018)**

H1a: Internal Environmental Management (IEM) has a positive impact on the Environmental Performance of ISI

H1b: Green Purchasing (GP) has a positive impact on the Environmental Performance of ISI

H1c: Cooperation with Consumer +Eco design (CC+ECO) has a positive impact on the Environmental Performance of ISI

H1d: Investment Recovery (IR) has a positive impact on the Environmental Performance of ISI

H2a: Internal Environmental Management (IEM) has a positive impact on the Economic Performance of ISI

H2b: Green Purchasing (GP) has a positive impact on the Economic Performance of ISI

H2c: Cooperation with Consumer + Eco design (CC +ECO) has a positive impact on the Economic Performance of ISI

H2d: Investment Recovery (IR) has a positive impact on the Economic Performance of ISI

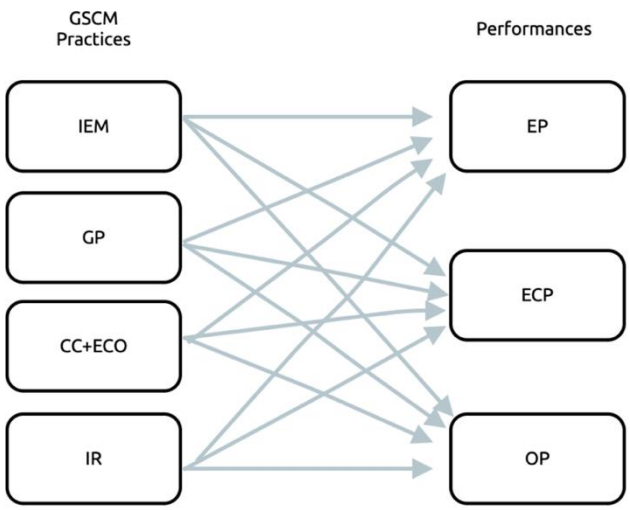
H3a: Internal Environmental Management (IEM) has a positive impact on the Operational Performance of ISI

H3b: Green Purchasing (GP) has a positive impact on the Operational Performance of ISI

H3c: Cooperation with Consumer +Eco design(CC+ECO) has a positive impact on the Operational Performance of ISI

H3d: Investment Recovery (IR) has a positive impact on the Operational Performance of ISI

Figure 1. Research Model



3.1. Sample And Data Collection

According to the Turkish Steel Producers Association, there are nearly 41 crude steel producers in Turkey. Additionally, hot rolling mill plants which are supplied billet iron, etc. by integrated iron and steel companies are included in this study. In this context, nearly 120 hot rolling mill plants were included in this study. In total, nearly 161 iron and steel companies were detected, and questionnaires were sent to these companies. In return 72 usable questionnaires were collected through e-mail across Turkey. Questionnaires were filled out by the high-level managers in the companies. The positions of managers (72) who filled out the questionnaire were supply chain managers (29,2%), upper-level managers (23,6%), logistic managers (18,1%), marketing managers (12,5%), finance managers (5.6%) and (11%) others. The questionnaire is presented in the appendix.

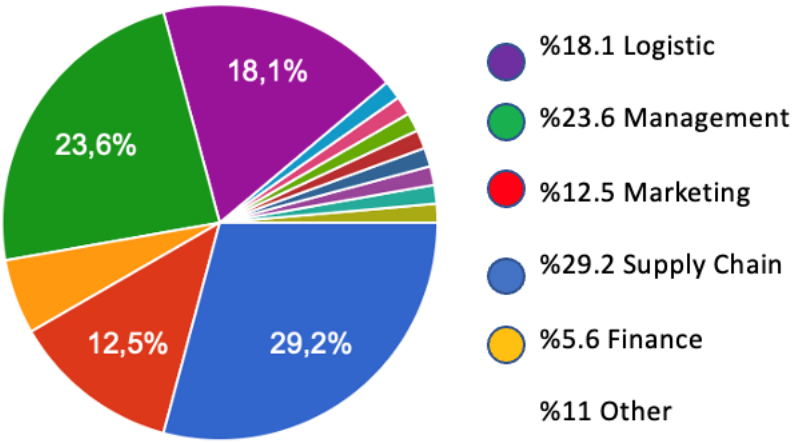


Figure 2. Working Areas of Managers

3.2. Determining Test Statistics and Organizing Data

To analyze the result that is gathered through an online survey over 2 months (April & June 2023), SPSS 27.0.1 package program which is commonly used in social science studies employed. Correlation analysis and regression analysis were determined to test the hypotheses. Before testing the hypotheses, some reliability and validity analyses such as factor analysis, item-to-total correlation, and inter-item correlation matrix were conducted.

3.3. Scale

In this study, a validated measurement scale which is created by Zhu et al. (2008) is used. The scale consists of two parts. The first part which aims to find out the GSCM practice level has 21 measurement items underlying 5 different factors which are IEM (Internal environmental management), GP (Green Purchasing), CC(Cooperation with Consumers), ECO(Eco design), and IR(Investment recovery). The second part which aims to find out the effects of GSCM practices on different performance perspectives has 17 items underlying 3 performance dimensions which are Economic Performance (ECP), Operational

Performance (OP), and Environmental Performance (EP). (See Appendix A) In the GSCM literature, the scale is used in different sectors and different countries. Zhu et al. (2008) stated that the validity of the scale is a continuing process and every different study which targets different industries and different countries contributes to the validation and development of the scale.

3.3.1. Reliability of the scale

Two parts of the scale were tested for reliability. Firstly, an item-to-total correlation was conducted for GSCM practices implementation and performance outcomes parts. IR1(Sale of excess inventories/materials) was found as -0.103 and ECP5(Decrease of fine for environmental accidents) is found as 0.070. Also, an inter-item correlation matrix for each different factor was conducted and ECP5 was found lower than 0.50 or has a negative relationship with some other items. According to these tests' results, IR1 and ECP5 items were decided to be removed from the scales.

After calculating item to total correlation & inter-item correlation matrix and removing insufficient items from the scale, Cronbach's Alpha test was conducted. Table 2. below shows the Cronbach's alpha results of the scale. Cronbach's Alpha degree for the GSCM application scale was found as ''IEM (.823), GP (.847), CC (.884), ECO (.754), IR (.768)''. The Cronbach's Alpha degree for performance scale was found as ''EP (.916), ECP (.845), OP (.820). The findings are statistically sufficient. Cronbach Alpha results are displayed in Table 2.

Table 2. Cronbach Alpha Results

Scale name	Number of Items	Cronbacht's Alpha
1-GSCM APPLICATIONS	20	.903
1.1 Internal environmental management (IEM)	7	.823
1.2 Green purchasing(GP)	5	.847
1.3 Cooperation with customers (CC)	3	.884
1.4 Eco-design (ECO)	3	.754
1.5 Investment recovery(IR)	2	.768
2- PERFORMANCE OUTCOMES	16	.856
2.1 Environmental performance (EP)	6	.916
2.2 Economic performance (ECP)	4	.845
2.3 Operational performance (OP)	6	.820

3.3.2. Factor Analysis

Zhu et. all, (2008) stated that the scale can be adapted to different sectors and different countries due to their different conditions. In order to evaluate the GSCM performance of different sectors, the scale can be modified according to the sector. In this context, factor analysis should be employed to observe if the items are loaded under the desired factors or not. The KMO test is crucial before doing a factor analysis. KMO

value is bigger than 0.70 for GSCM practice implementation and performance outcomes scales, so factor analysis can be applied. (Table 3. and Table 4.)

Factor analysis for GSCM practice implementation was conducted and factor analysis results indicate that GSCM practice items were collected under 4 different factors. CC and ECO were identified as different factors by Zhu and others, but in this study, they are loaded under a single factor. The new factor is named CC+ECO. Other factors are identified as IEM, GP, and IR. IEM1(commitment of senior managers to GSCM practices), IEM2(commitment of mid-level managers to GSCM practices), and IEM3(ISO 14001 certification) are loaded under undesired factors and factor weights of IEM1, IEM2, and IEM3 are not suitable, so they are removed from the scale after factor analysis.

Table 3. KMO and Factor analysis results of GSCM practices implementation

KMO		.798		
Bartlett's Test	Approx. Chi-Square	934.983		
	df	190		
	Sig.	<.001		
Favtor Analysis				
Component	1	2	3	4
IEM4			.652	
IEM5			.779	
IEM6			.700	
IEM7			.756	
GP1	.803			
GP2	.490			
GP3	.733			
GP4	.705			
GP5	.792			
CC1		.806		
CC2		.873		
CC3		.808		
ECO1		.535		
ECO2		.412		
ECO3		.493		
IR2				.859
IR3				.861

The items of the performance scale were collected under convenient factors as it is mentioned by Zhu. The result of factor analysis for performance outcomes indicates that the factor weights are enough, and they are loaded under 3 factors which are EP, ECP, and OP. (Table 4.) The findings are statistically significant. After factor analysis is conducted, the hypothesis can be tested.

Table 4. KMO and Factor analysis results of performance outcomes

KMO		.773	
Bartlett's Test of Sphericity	Approx. Chi-Square	832.380	
	df	120	
	Sig.	<.001	
Factor Analysis			
Component	1	2	3
EP1	.849		
EP2	.848		
EP3	.896		
EP4	.916		
EP5	.800		
EP6	.618		
ECP1		.889	
ECP2		.908	
ECP3		.926	
ECP4		.859	
OP1			.755
OP2			.820
OP3			.627
OP4			.452
OP5			.485
OP6			.834

4. RESULTS

4.1. Descriptive Statistic

Descriptive statistics are conducted to examine GSCM application levels of iron and steel producers. Table 5. shows the descriptive statistic result of GSCM practices implementation. The means of IEM change between 4,11 and 3,89. IEM has the highest mean (4,00) in GSCM applications. It shows managers and

employees are aware of the importance of GSCM practices and internal environmental management and highly respect for GSCM. After Internal environmental management, CC+ECO has the second-highest mean value which changes between 3,85 and 3,21. It shows ISI considers cooperation with consumers in addition to reducing the use of energy and harmful materials. IR has a 3,40 mean value which makes it the third biggest value. This value shows some firms in ISI started to reduce inventory levels by selling scrap materials and excess capital equipment. Lastly, the means of GP change between 3,60 and 2,64. GP has a 3,11 mean value which indicates that Green Purchasing practices are the lowest GSCM practice that ISI minds. Even though some of the companies started to communicate with suppliers about environmental concerns, ISI has a low interest in GP.

Table 5. Descriptive Statistic Result of GSCM practices implementation

APPLİCATİONS		Mean	Std. Deviation
IEM	IEM4	3,89	0,76
	IEM5	3,94	0,69
	IEM6	4,04	0,64
	IEM7	4,11	0,78
IEM mean		4	0,72
GP	GP1	3,60	0,85
	GP2	2,64	0,98
	GP3	3,38	0,94
	GP4	3,24	0,99
	GP5	2,69	1,03
GP mean		3,11	0,96
CC+ECO	CC1	3,21	0,92
	CC2	3,29	0,90
	CC3	3,44	0,89
	ECO1	3,64	0,86
	ECO2	3,85	0,64
	ECO3	3,67	0,82
ECO mean		3,52	0,84
IR	IR2	3,72	1,04
	IR3	3,07	0,94
IR mean		3,40	0,99

Table 6. shows the descriptive statistic result of GSCM performance outcomes. Environmental performance (EP) is the most important dimension with a mean value of 3,71. Means of EP changes between 3,56 and 3,88. Environmental performance is the highest performance outcome of GSCM. It shows that the

companies in ISI consider reducing harmful materials, pollution, and energy consumption. GSCM causes an advancement in the environmental performance of companies. Operational performance (OP) is the second important performance dimension with a 3.43 mean value. Means of OP changes between 3,15 and 3,72. The OP shows companies consider product quality, product diversification, and increasing the product amount, etc. Economic performance (ECP) has a 2,58 mean value and it is the lowest mean value of performance dimensions. Means of ECP change between 2,47 and 2,69. Results show that GSCM has a lower effect on the Economic Performance of ISI such as cost of energy consumption, profitability, raw materials, etc. Descriptive statistics indicate that GSCM practices affect environmental performance the most with the 3,71mean value. Operational performance is detected as the second highest performance outcome which is affected by GSCM practices. Environmental performance is detected as the lowest performance outcome which is affected by GSCM practices. However, descriptive statistics is not enough to explain the relationship between GSCM practices and performance outcomes, so correlation and regression analyses are required to explain the relationship.

Table 6. Descriptive Statistic Result of GSCM Performance Outcomes

Performance Outcomes		Mean	Std. Deviation
EP	EP1	3,71	1,01
	EP2	3,72	0,92
	EP3	3,56	0,92
	EP4	3,63	0,86
	EP5	3,79	0,63
	EP6	3,88	0,69
EP Mean		3,71	0,84
ECP	ECP1	2,50	0,87
	ECP2	2,64	1,03
	ECP3	2,69	0,91
	ECP4	2,47	0,93
ECP Mean		2,58	0,94
OP	OP1	3,49	0,73
	OP2	3,35	0,75
	OP3	3,40	0,74
	OP4	3,72	0,77
	OP5	3,47	0,77
	OP6	3,15	0,83
OP Mean		3,43	0,77

4.2.Correlation Analysis

Correlation represents the degree of the relationship between variables. The correlation coefficient value is between 1 and -1. Table 7. shows the correlation ratios of GSCM practices and performance outcomes. Firstly, the correlation coefficient between environmental performance (EP) and GSCM practices was examined. The correlation coefficient between EP and IEM is found 0,429(moderate). The correlation coefficient between EP and CC+ECO is found 0,476(moderate). These ratios are statistically significant and show that EP has a moderate correlation coefficient with IEM and CC+ECO. CC+ECO and EP have the highest relationship degree. Also, IEM and EP have the second-highest relationship degree. GP and IR have a low correlation coefficient with environmental performance, but they are statistically significant. Secondly, the correlation between economic performance and GSCM practices was examined. Economic performance has a low correlation coefficient with GP (0,303) and nearly does not correlate with IEM, CC+ECO, and IR(Investment Recovery). Thirdly, the correlation between operational performance and GSCM practices was examined. Every single GSCM practice and operational performance has a low but significant correlation coefficient. Correlation coefficient degrees between GSCM practices and OP are found as IEM (0,388), GP (0,262), CC+ECO (0,261), and IR (0,337). The findings are statistically significant. IEM has the highest correlation degree with OP, compared to other GSCM practices. After detecting the correlation coefficient between variables, regression analysis is applied to discover the causal relationship between dependent and independent variables and test the hypotheses.

Table 7. Correlation Analysis Results

	IEM	GP	CC+ECO	IR	EP	ECP	OP
IEM	1						
GP	.573**	1					
CC+ECO	.529**	.635**	1				
IR	.003	-.152	-.060	1			
EP	**.429****	**.252***	**.476****	**.355****	1		
ECP	**.179**	**.303****	**.179**	**.079**	.078	1	
OP	**.388****	**.262***	**.261***	**.337****	.515**	.085	1

4.3. Regression Analysis

Regression analysis is a set of statistical processes for estimating the relationships between a dependent variable and one or more independent variables. In simple linear regression analysis, it is assumed that there is a linear relationship between two variables. In multiple regression analysis, it is assumed that there is a linear relationship between more than two variables. The general linear regression model can be stated by the equation:

$$y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} + \varepsilon_i$$

where,

y_i=dependent variable

x_i=explanatory variables

β_0= constant term

β_k=slope coefficients for each explanatory variable

ε_i=the model's error term

In order to ensure the accuracy of the multiple regression model, it is important to ensure that the following assumptions are met:

- There is a linear relationship between the dependent variables and the independent variables.
- The independent variables are not too highly correlated with each other.
- The observations are independently and randomly selected from the population.
- Residuals should be normally distributed with a mean of 0 and a variance σ.

After it was determined that these features were met, regression analysis was employed.

In this part, GSCM practices which are organized according to the factor analysis result are examined, and every possible relationship between GSCM practices and performance outcomes are controlled one by one. Table 8. shows regression analysis between GSCM practices and EP (Environmental Performance).

Table 8. Regression analysis of GSCM practices and EP

Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
EP	.184	Constant	1.644	.526	3.127	.003	15.823
		IEM	.518	.130	3.978	<.001	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
EP	.064	Constant	2.974	.349	8.527	<.001	4.748
		GP	.238	.109	2.179	.033	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
EP	.226	Constant	1.884	.411	4.585	<.001	20.481
		CCE+ECO	.520	.115	4.526	<.001	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
EP	.126	Constant	2.750	.313	8.774	<.001	10.083
		IR	.284	.089	3.175	.002	

Results indicate that the data obtained are statistically significant. (P<.001). R^2 indicates the percentage of the impact which the independent variable has on the dependent variable and F indicates the significance

level of a regression model. When regression and correlation analyses are examined to explore the effects of GSCM practices on environmental performance, it is found that GSCM practices have a positive impact on EP, and it supports hypotheses H1a, H1b, H1c, and H1d. CC+ECO has the biggest percentage of affecting Environmental Performance while GP has the lowest.

Table 9. shows the regression analysis between GSCM practices and Economic Performance. Regression analysis of ECP and GSCM practices shows that Green Purchasing has the highest impact on economic performance while investment recovery has the lowest percentage. Hypothesis H2b is the most supported hypothesis in economic performance hypotheses. Hypothesis H2d has the lowest support for economic performance hypotheses. H2a and H2c also have low support. They are not found statistically significant. Mainly, the impact of GSCM practices on ECP is positive but very low to declare a certain positive relationship. Findings indicate that GSCM factors have the lowest impact on the economic performance of firms when compared to other performance dimensions (EP and OP). Only GP has a certain and significant effect on economic performance.

Table 9. Regression analysis of GSCM practices and ECP

Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
ECP	.032	Constant	1.973	.558	3.536	<.001	2.304
		IEM	.210	.138	1.518	.134	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
ECP	.092	Constant	1.947	.335	5.818	<.001	7.054
		GP	.278	.105	2.656	.101	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
ECP	.032	Constant	2.141	.448	4.781	<.001	2.318
		CCE+ECO	.191	.125	1.522	.132	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
ECP	.006	Constant	2.602	.326	7.991	<.001	.442
		IR	.062	.093	.665	.508	

Table 10. shows the regression analysis of operational performance and GSCM practices. The results indicate that IEM has the biggest impact on operational performance. IR is also significantly high. GP and CC+ECO have a lower impact on operational performance when they are compared to other GSCM practices but all operational performance hypotheses H3a, H3b, H3c, and H3d are supported, and they are significant.

Table 10. Regression analysis of GSCM practices and OP

Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
OP	.150	Constant	1.970	.419	4.697	<.001	12.381
		IEM	.365	.104	3.519	<.001	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
OP	.069	Constant	2.830	.272	10.407	<.001	5.171
		GP	.085	.085	2.274	.026	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
OP	.068	Constant	2.648	.353	7.508	<.001	5.099
		CCE+ECO	.223	.099	2.258	.027	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
OP	.114	Constant	2.715	.247	11.005	<.001	8.979
		IR	.211	.070	2.997	.004	

5. DISCUSSION

This study aimed to examine the effects of GSCM practices on the environmental, operational and economic performance of the Turkish iron and steel industry.

Findings align well with the existing GSCM literature in which there are different studies that target diverse sectors (Yıldız, 2020; Cankaya and Sezen, 2018; Dinçer et al. (2018).

This study covers iron and steel sector because different sectors should be analyzed individually due to differences in their production processes and other internal and external factors. The environmental performance increase for the companies that apply GSCM practices is found positive almost in every study, but operational performance and economic performance depend on distinctive factors. The majority of the GSCM studies indicate that GSCM practices tend to increase the environmental performance of organizations. Similar to GSCM literature, in this study we found that GSCM practices have an important positive impact on environmental performance. Additionally, operational performance was found to be affected by GSCM practices in the iron and steel sector, but its significance was relatively low compared to environmental performance. However, the effect of GSCM practices on economic performance is not as significant as their impact on operational and environmental performance. Even if there are some studies that found a positive relationship between economic performance and GSCM practices (Zhang et al., 2012; Liu, 2015), the majority of the studies indicate there is no direct, significant and positive impact of GSCM on economic performance. In support of this, this study found that GSCM practices have no significant and direct impact on the economic performance of Turkish iron and steel sector. In some studies, the authors mention indirect effects of GSCM practices on economic performance (Al-Sheyadi et al., 2019) such as cost saving, positive image, good performance in stock market, good positioning in consumer's mind etc. however these factors are not only affected by GSCM performance of the organizations, there are other contributing conditions to these factors. GSCM is only a small portion of positive image, good performance in stock market and good positioning in consumer's black box. Based on literature and the result of this study

it can be argued that GSCM practices have no significant cost reduction impact. Conversely, it can cause additional costs for different processes in the iron and steel sector.

When the results of the analyses were compared to the other GSCM studies, the results were interpreted according to the results of other studies in GSCM literature. The results of correlation and regression analyses were found relatively low in this study however, due to the destructive earthquake that happened in Turkey during the data collection period, the attendance rate for the questionnaire was low so, the results were calculated based on 72 proper questionnaires. However, the results are significant and compatible with the literature.

6. CONCLUSION

The iron and steel industry (ISI) is considered a highly polluting industry and it requires environmentally friendly approaches for the sustainable development of countries. In this study, the effects of GSCM practices on different performance aspects of the Turkish Iron and Steel Sector are analyzed. An online survey was conducted, and it was filled out by managers of 72 hot rolling mill plants and integrated iron and steel companies from different regions of Turkey. The answers of the managers were converted into scientific data by a series of analyses. Firstly, reliability tests were conducted for the scale, and after that, a factor analysis was conducted to examine how the items were collected under different factors. Then, correlation and regression analyses were conducted to test the hypotheses. According to the findings, GSCM practices obviously increase the environmental performance of factories in ISI. It means GSCM helps businesses reduce the negative effects of their operations on the natural environment and it is crucial for sustainability. An increase in environmental performance is an important result, especially for a polluting industry. IEM and CC+ECO have the biggest impact on environmental performance. Additionally, the effects of GSCM practices on operational performance are found significant. It means GSCM contributes to business operations for a seamless workflow and increases production quality and efficiency. It is also an important finding because it indicates that GSCM is not only an environmental approach, and it contributes to business operations. IEM and IR have the biggest impact on operational performance. Lastly, the effect of GSCM practices on economic performance is examined and the results indicate that even if there is a positive contribution to economic performance, the relationship rate is too low and the effect on economic performance is not remarkable. Only green purchasing has a significant but low relationship with economic performance. In conclusion, findings suggest that GSCM practices and performance outcomes are statistically significant and GSCM practices contribute to a firm's different performance dimensions, especially in Environmental Performance (EP) and Operational Performance (OP). In Table 11. all hypotheses and results are summarized.

Table 11. Evaluations of the hypotheses

Hypotheses	Used Analses	Explanation
· H1a: Internal Environmental Management (IEM) has a positive impact on the Environmental Performance of ISI	Correlation&Regression	IEM has the second highest impact on environmental management when it is compared to other GSCM practices. The impact is found positive and moderate.
· H2a: Internal Environmental Management (IEM) has a positive impact on the Economic Performance of ISI	Correlation&Regression	IEM has a positive impact on economic performance, but findings don't indicate a significant impact on economic performance.

· H3a: Internal Environmental Management (IEM) has a positive impact on the Operational Performance of ISI	Correlation&Regression	IEM has the highest impact on operational performance when it is compared to other GSCM practices.
· H1b: Green Purchasing (GP) has a positive impact on the Environmental Performance of ISI	Correlation&Regression	Since the implementation of GP practices by ISI is low, the impact on environmental performance is found low but GP has a positive impact on environmental performance.
· H2b: Green Purchasing (GP) has a positive impact on the Economic Performance of ISI	Correlation&Regression	GP has the highest impact on economic performance when compared to other performance areas. The impact is found positive but low because GP is the lowest application that ISI minds.
· H3b: Green Purchasing (GP) has a positive impact on the Operational Performance of ISI	Correlation&Regression	GP has a positive but low impact on operational performance. The impact is found positive but low because GP is the lowest application that ISI minds.
· H1c: Cooperation with Consumer (CC) +ECO design has a positive impact on the Environmental Performance of ISI	Correlation&Regression	CC+ECO has the highest impact on environmental performance. The impact rate is the highest impact rate when it is compared to all possible relationships between GSCM practices and performance outcomes.
· H2c: Cooperation with Consumer (CC) +ECO design has a positive impact on the Economic Performance of ISI	Correlation&Regression	CC+ECO has a positive impact, but the impact rate is very low and it is not significant.
· H3c: Cooperation with Consumer (CC) +ECO design has a positive impact on the Operational Performance of ISI	Correlation&Regression	CC+ECO has a positive impact, but the impact rate is very low.
· H1d: Investment Recovery (IR) has a positive impact on the Environmental Performance of ISI	Correlation&Regression	IR has a positive impact on environmental performance and the impact rate is detected as moderate.
· H2d: Investment Recovery (IR) has a positive impact on the Economic Performance of ISI	Correlation&Regression	IR has a positive impact on economic performance but the impact rate is the lowest one that effect economic performance and it is not significant.
· H3d: Investment Recovery (IR) has a positive impact on the Operational Performance of ISI	Correlation&Regression	IR has a positive impact on environmental performance and the impact rate is detected as moderate.

Since GSCM is a wide topic, this study has some limitations. The data used in this study was gathered within 2 months. The questionnaire assesses the economic and other performance indicators; however, they can be affected by other external factors.

For future research, the other external factors that support or hinder GSCM practices can be examined. A similar study can be conducted in different time periods and the results can be compared. Different studies that target different industries may bring a new approach to the literature. This study didn't find a direct effect of GSCM practices on economic performance, except for Green Purchasing (GP). However, GSCM may have a positive indirect effect such as an increase in the stock market due to taking a good place in consumer's and investor's mind by adopting environmental practices so indirect effects on economic performance can be examined in future research.

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Appendix A

NUMBERS	FACTORS	CODES	GSCM practices	Likert Scale				
				1	2	3	4	5
1	IEM	IEM1	Senior managers are committed to GSCM practices.					
2		IEM2	Mid-level managers support GSCM practices.					
3		IEM3	The facility has ISO 14001 certification.					
4		IEM4	Environmental compliance and auditing programs are applied carefully.					
5		IEM5	Cross-functional cooperation for environmental improvements exists.					
6		IEM6	Total quality environemntal management is considered.					
7		IEM7	Environmental management systems exist.					
8	GP	GP1	Cooperation with suppliers for environmental objectives is considered.					
9		GP2	ECO labelling of products is considered.					
10		GP3	Environmental audit for suppliers' internal management is considered.					
11		GP4	Suppliers' ISO 14000/14001 certificate is considered.					
12		GP5	Second- tier suppliers's environmentally friendly practices are considered.					
13	CC	CC1	Cooperation with customer for eco-design is considered.					
14		CC2	Cooperation with customers for cleaner-production is considered.					
15		CC3	Cooperation with customer for green packaging is considered.					
16	ECO	ECO1	Products are designed to require reduced consumption of material/energy.					
17		ECO2	Products are designed to be easily reused, recycled and recovered.					
18		ECO3	Products are designed to avoid or reduce the use of hazardous products and/or manufacturing process.					
19	IR	IR1	Excess inventories/materials are sold.					
20		IR2	Scrap and used materials are sold.					
21		IR3	Excess capital equipments are sold.					

NUMBERS	FACTORS	CODES	Performance Outcomes of GSCM Practices	Likert Scale				
				1	2	3	4	5
1	EP	EP1	Reduction of air emission.					
2		EP2	Reduction of waste water.					
3		EP3	Reduction of solid wastes.					
4		EP4	Decrease of consumption for hazardous/harmful/toxic materials					
5		EP5	Decrease of frequency for environmental accidents					
6		EP6	Improvement of an enterprise's environmental situation					
7	ECP	ECP1	Decrease of cost for materials purchasing.					
8		ECP2	Decrease of cost for energy consumption.					
9		ECP3	Decrease of fee for waste treatment.					
10		ECP4	Decrease of fee for waste discharge.					
11		ECP5	Decrease of fine for environmental accidents.					
12	OP	OP1	Increase in the amount of goods delivered on time.					
13		OP2	Decrease in inventory levels.					
14		OP3	Decrease in scrap rate.					
15		OP4	Increase in product quality.					
16		OP5	Increase in product line .					
17		OP6	Improvement of capacity utilization.					