INTERNATIONAL JOURNAL OF INDUSTRIAL MANAGEMENT
ISSN: 2289-9286 e-ISSN: 2590-3594
VOLUME 17, NO. 2, 2023, 99 – 107
DOI: https://doi.org/10.15282/ijim.17.2.2023.9458

REVIEW ARTICLE

FACTORS AFFECTING COST IN IRON AND STEEL INDUSTRY: A BRIEF REVIEW

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ABSTRACT - The iron and steel industry, which increases the competition between countries and directs the economic market, meets the demands of many sectors by providing sustainable steel production. The rapid developments in recent years have affected the costs of iron and steel products, causing problems in the sector. Addressing these problems will contribute to the development of countries and increase the competitiveness of enterprises. In this study, the factors affecting the cost of the iron and steel industry were examined and it was determined that the factors causing high costs should be kept at a minimum.

ARTICLE HISTORY
Received : 09-05-2022
Revised : 10-10-2022
Accepted : 26-10-2022
Published : 28-06-2023

KEYWORDS
Iron steel production,
Cost,
Factors,

1.0 INTRODUCTION

The iron and steel industry are a strong foundation of economic development throughout the world and provides important inputs to many industrial organizations. The iron and steel industry, which increases the competition among the economic powers of the countries and directs the economic market, is one of the sectors that are open to innovations and constantly changing. It also provides input to all industries (Akıncı, Alobaidi, & Ersöz, 2021). In the iron and steel industry, many problems such as the cessation of vehicle production, the inability of the agricultural industry to produce machinery, and the cessation of construction have come to the fore in recent years. Especially with the use of technology-based systems and techniques, the problems of the sector come to the fore and cause corporate and large enterprises to search for new ones in order to progress (Tunçkaya, 2021). The need for innovations such as raw steel supply, production, and energy is increasing (Aylin, Kaya, & Çakıt, 2022). However, the cost is one of the main problems in iron and steel production. The constant price changes in the market share of products with high-cost levels affect countries and businesses negatively.

Crude steel production in the world shows constant change over the years. As of December 2021, it decreased by 3% compared to December 2020, and the production amount was 158.7 million tons. Regions with the highest share in crude steel production are respectively, Asia, the European Union, and North America. Production amounts of the regions for 2021 are shown in Table 1.

Table 1. Steel production by regions (World Steel Association, 2022)

Regions	2021 (Mt)
Asia	116.1
European Union	11.1
North America	9.7
Commonwealth of Independent States	8.9
Europe and other	4.3
Middle East	3.9
South America	3.5
Africa	1.2
Total	158.7

Table 1 shows that the world's steel production in 2021 was realized in the Asian region with 116.1 million tons. This is followed by the European Union, North America, and the Commonwealth of Independent States. The regions in Table 1 constitute 98% of world steel production in 2021. The regions and countries covered in the table are shown in Table 2.

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Table 2. Defining regions (World Steel Association, 2022)

Regions	Countries
Asia	Australia, China, India, Japan, New Zealand, Pakistan, South Korea, Taiwan, Vietnam
European Union	Germany, Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Croatia, Netherlands, Ireland, Spain, Sweden, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Greece
North America	Canada, Cuba, El Salvador, Guatemala, Mexico, United States
Commonwealth of Independent States	Belarus, Kazakhstan, Moldova, Russia, Ukraine, Uzbekistan
Europe and other	Bosnia and Herzegovina, Macedonia, Norway, Serbia, Turkey, United Kingdom
Middle East	Iran, Qatar, Saudi Arabia, United Arab Emirates
South America	Argentina, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela
Africa	Egypt, Libya, South Africa

Table 2 shows that Turkey is located in Europe and other regions, and it was in the fourth region in the 2021 crude steel production market. The change in crude steel production amounts of countries between December 2021 and December 2020 is shown in Table 3.

Table 3. Steel production by country (World Steel Association, 2022)

Ülkeler	2021 (Mt)	% 2020
China	86.2	-6.0
India	10.4	0.9
Japan	7.9	5.4
USA	7.2	11.9
Russia	6.6	0.0
South Korea	6.0	1.1
Turkey	3.3	-2.3
Germany	3.1	0.1
Brazil	2.6	-11.4
Iran	2.8	15.1
Total	136.1	

According to Table 3, China, which ranks first in steel production, produced 86.2 million tons of steel in December 2021 with a decrease of 6.8 per cent compared to December 2020. Ranking second, India produced 10.4 million tons of steel, increasing by 0.9 per cent. Ranking third, Japan produced 7.9 million tons of steel, increasing by 5.4 per cent. The USA, which ranks fourth, produced 7.2 million tons of steel with an increase of 11.9 per cent. Russia, which is in fifth place, produced 6.6 million tons of steel by remaining stable. Ranking sixth, South Korea produced 6.0 million tons of steel, increasing by 1.1 per cent. Turkey, which ranks seventh, produced 3.3 million tons of steel with a decrease of 2.3 per cent. Ranking eighth, Germany produced 3.1 million tons of steel, increasing by 0.1%. Ranking ninth, Brazil produced 2.6 million tons of steel, down 11.4 per cent. Iran, which ranks tenth, produced 2.8 million tons of steel with an increase of 15.1 per cent. It was determined that Iran produced 2.8 Mt with an increase of 15.1 per cent. It was determined that while crude steel production amounts decreased in Brazil, China, and Turkey, it increased in other countries. Among the reasons for the decrease in production amounts; are geopolitical risks, energy, inflation, and unemployment problems.

1.1 Factors Affecting Cost Analysis

It is also defined as the provision of goods and functions consumed by a manufacturing enterprise. The accuracy of business activity analysis is very important in order to make appropriate decisions in businesses. Consistency of results ensures correct decision making; provides the right marketing and competitive advantage. Various factors are effective in the product costing process. In an environment of unlimited resources, the concept of cost is not important. Environments, where the concept of cost needs to be handled and controlled carefully, are areas where resources are limited (Kapanşahin, 2021). During the production-sales process of iron and steel products, many inputs and cost levels are formed. In this direction, the factors affecting product costs are explained in the following sub-headings.

Measurement uncertainty is expressed as the correlation between the measured quantity value and the analysis evaluation result (Ecemiş, 2018). Although there is a margin of error in each analysis performed, it provides information about the size of the measurement error. One of the most common methods used to determine measurement uncertainty is a cause-and-effect diagram (Fishbone) (Hicham, Mohammed, & Anas, 2012). Fishbone charts are based on the principle that all parameters affecting the analysis result are shown in the chart and the uncertainties arising from them are expressed by summing. It was deemed appropriate to use four of the variables that are thought to affect the iron-steel cost in the literature. Factors affecting the cost of iron and steel; geopolitical risk can be listed as energy, inflation, and labor-unemployment (Figure 1).

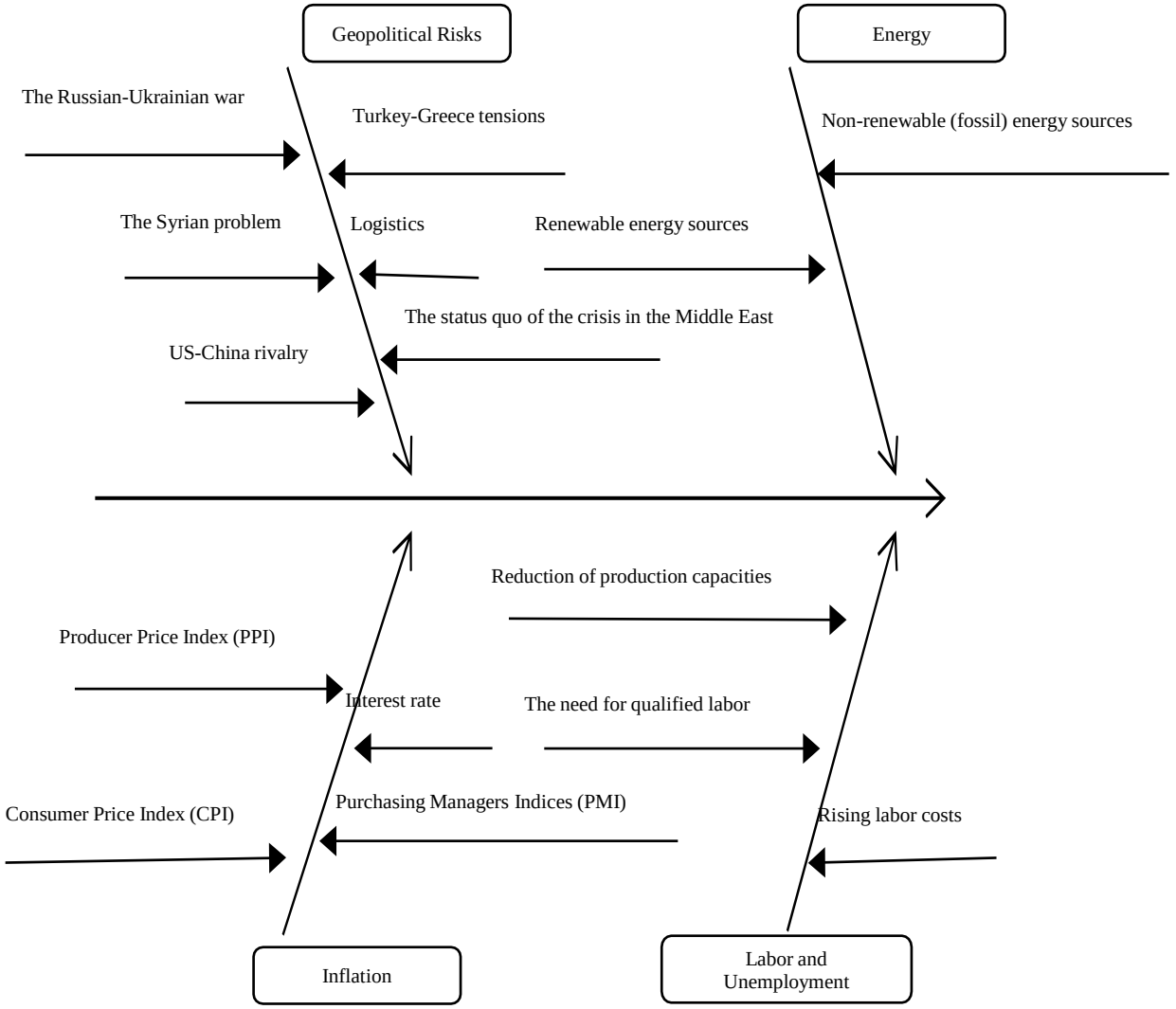

Figure 1. Factors affecting the cost of iron and steel production

1.2 Geopolitical Risks

The concept of geopolitical risk is one of the main causes of political and economic uncertainties that create stagnation and adversely affect the economy. War, terrorism, and interstate tensions that directly affect the peaceful and ordinary processes of nations are defined as geopolitical risks (Caldara & Iacoviello, 2018). The threat of tension in countries, nations, and interstate relations and the uncertainties they experience in their ordinary processes increase the level of geopolitical risk between countries. It affects many sectors such as industry, tourism, agriculture, and food (Levet, Kayaz, & Özdemir, 2020).

The new variants of Covid-19, which affect the world, have a negative effect on global growth. With the problems encountered in combating the pandemic, especially in China, the risk of war increases the concerns considerably. With the tension between China and Taiwan, the Russia-Ukraine war leads to the emergence of problems in international relations (Presidency of the Republic of Turkey Strategy and Budget Department, 2022). NATO's enlargement process, which became evident with the Russia-Ukraine war, causes the level of tension to remain at a high level. However, the sanctions against Russia have reflections on many commodities such as natural gas, food, iron and steel. On the other hand, high energy, food, and iron and steel prices are important for countries due to the increase in the tension between the UK and the EU and the increase in trade restrictions between the USA and China. On the other hand, Turkey has a high level of energy dependency and its effect on costs is very important due to the direct use of energy in iron and steel production.

Along with the tensions between countries in recent years, various problems such as high freight prices, high logistics costs, container supply, the Covid-19 effect, and deadline problems have begun to be experienced in international trade (Kanberoğlu, Yaşar & Yıldırımçakar, 2022). For this reason, the cost excesses that may occur cause the current iron and steel costs to increase, leading to an increase in prices.

1.3 Energy

Energy is an indispensable part of life and has an important role in improving the social and economic living standards of societies. Various energy sources have been used from wood to nuclear energy from past to present. The energy sources used are divided into renewable and non-renewable. Renewable energy sources are reproduced naturally and there is no problem with their supply. Wind, solar, hydro (water), biomass, and geothermal are among the main renewable energy sources. Non-renewable energy sources, on the other hand, are not produced again in the same way after being produced. For this reason, it is very difficult to supply and is non-recyclable. Oil, nuclear, gas, and coal are among the non-renewable energy sources (Shafiei & Salim, 2014). Today, most countries meet their non-renewable energy needs through fossil fuels such as coal and natural gas, especially developing countries' excessive use of fossil fuels as an energy source that increases their foreign dependency. The iron-steel sector is one of the sectors where energy demand increases in developing countries that use fossil fuels more, and where energy use is especially intense (Şanlı & Ersöz, 2021). The fact that Turkey is among the top ten in the iron and steel industry worldwide compared to 2022 is an indication that our country uses energy resources frequently (World Steel Association, 2022). In order for the Turkish economy to grow and develop further in the iron and steel industry, it is necessary to examine energy resources and make a cost analysis (Güney, 2019).

Energy has different types such as heat energy, light (radiant) energy, mechanical energy, electrical energy, chemical energy, and nuclear energy, and it is defined as the capacity to do work (International Energy Agency, 2022). Energy resources are divided into primary and secondary. Primary energy is the energy taken directly or assimilated from natural sources such as oil, natural gas, and coal. Primary energy sources are oil, coal, lignite, natural gas, nuclear energy fuels (uranium and thorium), hydraulic, solar energy, wind energy, geothermal energy, wave power, and wood (Satman et al., 2007). An update on the geothermal energy potential of Turkey was discovered. In Table 4, the energy sources used in iron and steel production are presented.

Table 4. Types of energy used in iron-steel production (Nazilli Chamber of Commerce, 2022).

Energy Sources	2021 (%)
Electric	30
Natural Gas	20
Diesel	10
Coal	30
Oil	10
Total	100

Energy in iron and steel production is basically divided into coal, electricity, and natural gas. Table 4 shows the energy resources used in iron and steel production facilities in Turkey (Nazilli Chamber of Commerce, 2022). In the literature, energy sources are divided into renewable energy sources and non-renewable (fossil) energy sources.

1.4 Renewable energy sources

Renewable energy sources are expressed as a type of energy that can be obtained naturally and reused (Emeksiz, Cem, & Fındık, 2021). Renewable energy sources are energy sources that are naturally found in nature such as geothermal, wave, biomass, sun, and wind. Today, changes in energy prices are experienced quite frequently and the importance of using renewable energy sources is increasing (Aydoğdu, 2021). For this reason, the use of renewable energy is becoming widespread in the iron-steel sector, where there is intense energy demand, as in many other sectors. With the use of renewable energy, it provides a positive effect by reducing the cost levels in iron and steel enterprises. However, high renewable energy installation costs have a negative impact on the sector.

1.5 Non-renewable (fossil) energy sources

Non-renewable (fossil) energy sources are defined as energy sources that cannot be reused (Taşdemiroğlu, 1988). Resources such as petroleum, coal, fuel oil, kerosene, and natural gas are expressed as non-renewable energy resources. Today, non-renewable energy resources are used by many sectors. They are directly affected by factors such as geopolitical risks, inflation, and unemployment (Güllü & Kartal, 2021). Thus, the production and service sectors may face problems because of price instabilities. It is inevitable that the increases in energy prices will reflect on the products and services of the enterprise. At this point, the demand for high-priced products and services decreases and it becomes difficult for the business to continue its activities.

1.6 Inflation

Inflation is an economic concept that concerns the value of the medium of exchange used in the economy (Mankiw, 2011). The high level of inflation is a macroeconomic problem in the economies of developed or developing countries, and its effects last for many years. Many countries around the world have implemented various anti-inflation policies in order to overcome the inflation problem. In Turkey, the inflation problem started in the early 1970s and continued for many years (Özkurt, 2016).

According to the IMF report, inflation levels are predicted to increase in 2022. While the inflation rate is predicted to be around 5.7 per cent for developed countries, it is expected to be 8.7 per cent for developing countries (Presidency of the Republic of Turkey Strategy and Budget Department, 2022). One of the most important factors of the increase in the level of inflation is that the commodity prices that have risen with the war are thought to be permanent. Problems encountered in the supply chain cause disruptions in production and accordingly, imbalances in demand quantities arise. In addition, the harsh interest policies of countries cause recessions in the sector. With the increase in inflation in the iron and steel industry, the cost of labor has also been affected. In addition, it is seen that the price differences in the supply of consumables have a negative impact on the sector.

It was deemed appropriate to use four of the variables thought to affect inflation. These variables can be listed as Producer Price Index (PPI), Interest Rate, Consumer Price Index (CPI), and Purchasing Managers' Indices (PMI) for inflation.

1.7 Producer Price Index (PPI)

PPI is defined as the price index that is calculated by comparing the price changes in production for a certain period in the country (Kuşkaya, Ün, & Gençoğlu, 2021). Since it is not possible to follow the price of all products produced in the country in determining the PPI, the price index is determined according to the share of the total sales value of the manufactured goods from the total sales revenues. While determining the index, all sectors and sub-sectors of production are included (TÜİK, 2008). Due to the fact that the iron and steel industry is used as raw materials and products in many areas, the change in the production price causes it to be affected in other sectors (Özkale & Karaman, 2006).

1.8 Consumer Price Index (CPI)

CPI expresses the price changes in expenditures made by a family in order to meet their needs for goods and services for a certain period (Özbek & Naimoğlu, 2022). The purpose of the CPI is to measure the changes in general prices in family expenditures. However, since it is not possible to categorize all expenditures, goods and services are listed according to their consumption values. Food and non-alcoholic beverages, alcoholic beverages, tobacco, clothing, shoes, housing, household goods, restaurants, and hotels are listed as various goods and services (TÜİK, 2008). The change in the CPI directly affects the iron and steel industry, which interacts with many fields from housing to automotive, from furniture to the construction industry (Morgil, 2006).

1.9 Interest rate

Interest rate refers to the buying and selling value of the national currency value in the global market. The exchange rate shows the buying and selling value of foreign currencies (Şenol, 2021). Appraisal of interest rate and exchange rate in harmony with each other directly affects the production-consumption balance in the economy. While inflation and exchange rates react positively to possible interest rate increases, a negative reaction is experienced in inflation and exchange rates when the interest rate decreases (Gedik, 2021). However, the effect of the reactions on inflation shows its effect in the medium-long term. High-volume transactions are carried out in the iron and steel sector, which is one of the important sectors of the country's economy. However, changes in interest rates directly affect the access of sector companies to money. Product stocks created with appropriate interest rates increase the competitiveness of enterprises by increasing their profit share (Pekkaya & Uysal, 2021). On the other hand, with the high-interest rate, national and international trade becomes more difficult, making it difficult for businesses to reach the money.

1.10 Purchasing Managers Indices (PMI)

Purchasing is the process of purchasing the product or service to be procured from the right supplier, at the right time, in the required quantity, at the most affordable price, and at the highest quality (Kurdoğlu & Parlak, 2022). Purchasing has strategic value for each process. The purchasing process encompasses many processes, starting with the supply order, quoting, supplier analysis, and delivery. Purchasing is very important in the iron and steel sector, which is one of the sectors where the competitive environment is very high. With the purchase of the appropriate product at an affordable price, the business gains a high level of profit. However, the company's inability to supply the product to be supplied in a timely manner causes a possible increase in loss.

1.11 Labour and Unemployment

The workforce is defined as the men and women assigned to the production of economic goods and services (ILO, 1990). The workforce includes all those who are active and those who are not actively working. Changes in the supply-demand balance in the global economy directly affect the workforce. The decrease in demand for products and services causes a decrease in production.

The concept of unemployment, which is among the economic problems experienced throughout the world, is one of the important topics in the economic policies of countries (Layard, Richard, & Stephen, 2005). Friedman (1968) defines unemployment as a static process and argued that cyclical fluctuations in the labor market often have a lasting effect on the unemployment rate and lead to long-term persistence. The increasing unemployment problem in our country and in the world is a major obstacle to economic progress. While it is very difficult to completely eliminate unemployment in the labor market, the need for new strategies to reduce the unemployment problem is increasing.

Problems in the iron and steel industry have led to the emergence of unemployment in many countries. Irregularities in production activities in industrial establishments and the Covid-19 outbreak have led to labor savings by disrupting investments. According to the reports of international organizations, although progress has been made in reducing unemployment in the first quarter of 2022, there is an increase in unemployment in the last quarter of 2022 due to geopolitical risks and other environmental factors (Republic of Turkey Presidency of Strategy and Budget, 2022). These problems experienced in the workforce capacity caused the irregular operation of the enterprises and negatively affected the cost of iron and steel products.

In this study, the factors affecting the cost analysis of the iron and steel industry were examined. In this direction, in the second part, the literature research is presented, and in the third part, information about the research result is discussed.

2.0 LITERATURE REVIEW

In this study, cost analyses used in all sectors, especially the iron and steel sector, from various academic studies between the years 2020-2022 were examined. The literature and techniques used in this study are presented in Table 5.

Table 5. Literature review and research findings

Authors, Year	The Purpose of Research
Huang vd., 2022	In the research, the effect of the problems experienced in the iron and steel industry in China on the cost optimization analysis was made. As a result of the analysis, it has been determined that there is a significant difference between the precision and the performance of the targets under uncertainty.
Shao vd., 2022	In this study, the effects of carbon dioxide emissions and costs in iron and steel industries in 30 countries were investigated. As a result of the research, it shows the existence of the environmental Kuznets curve hypothesis in the iron and steel industry.
Fennell vd., 2022	In the research, the effect of using cement and steel on carbon emission and cost was examined. As a result of the research, infrastructure, technology transfer, and financial risk mitigation mechanisms should be established to allow the development of low-emission heavy industry.
Lin vd., 2022	In this study, operating costs and financial structures in the steel industry were examined. As a result of the study, it was determined that CCUS's cost estimates related to technology performance are more important.
Ballı vd., 2022	In this study, the economic, social and environmental effects of using natural gas instead of coke gas in a reheating furnace in a steelmaking company were investigated. As a result of the research, the regeneration project was found to reduce the global warming potential and carbon emissions of blast furnace gas components by 0.84% per month.
Toktarova vd., 2022	The study investigated the interactions between a steel industry applying direct hydrogen reduction (H-DR) and the electrical system of northern Europe. It has been found to be cost-effective for steel production to keep track of wind and solar-specific variations.
Sun vd., 2022	In the research, a cost-benefit analysis was made in the manufacturing industry. The analysis highlighted that each business has its own marginal benefits relative to its production situation and market economy.
Li vd., 2022	In the study, a cost analysis was carried out with multivariate data collection and feature preprocessing in the iron and steel factory.
Lim vd., 2022	In the research, the effect of freight on production in iron and steel enterprises was examined. Industrial growth, bunker fuel oil, Baltic Dry Index, and shipping distance were found to have positive effects on freight rates.
Lincicome vd., 2022	In this study, the effects of inflation on rebar were investigated. Taxes will increase the cost of construction, causing housing shortages and higher house prices.

Table 5. (cont.)

Authors, Year	The Purpose of Research
Jiang vd., 2022	In this study, the effects of electricity and natural gas energy on production costs were examined. Model validation and analysis results and our approach have been found to be good at solving industrial problems under uncertainty.
Xiao vd., 2021	In the study, the effect of steel slag on the cost was investigated. It has been determined that steel slag can expand the high-value use method and provide alternative cost savings for mine filling.
Xu vd., 2021	Investigation of factors and costs affecting iron and steel production in the research has been made. Future work on the operation optimization of the steelmaking process, based on the integration of multiple technologies and the intersection of multidisciplinary disciplines, is outlined.
Pan vd., 2021	In this study, the cost of electrolytic hydrogen in China and the effect of low carbon on operating costs were investigated. When comparing seven paths towards electrolytic hydrogen development from 2020 to 2050, it was found that the cost of producing electrolytic hydrogen decoupled from the CO constraint.
Hebrisha vd., 2020	In this study, the effect of electricity and desalination plants on production costs in iron and steel plants in Libya was investigated. Thus, it has been determined that it is one of the necessary factors to improve the performance of maintenance teams, maintain old equipment, and extend the standard operating life of the equipment.
Yuan, 2020	In the study, environmental cost management and the current situation of the steel industry were examined.
Jebli vd., 2015	In the study, the effect of energy resources on international trade was examined.
Pedroni, 2001	In the study, the effect of purchasing power parity on trade was examined.

When Table 5 is examined in the literature, it is seen that there are quite a lot of publications with cost analysis. It is noteworthy that most of the studies carried out are cost analyses. Especially in the iron-steel sector, no study has been found on the factors that will affect the cost. It is very important to make an iron-steel cost analysis. By determining the factors together with the cost analysis, it will be possible for the business to take a position and gain an advantage in a short time in the global competitive environment.

3.0 DISCUSSION AND CONCLUSION

Steel material is the material of choice for many elements of the construction, logistics, and manufacturing industries and a wide variety of consumer products. It is the basic product needed in white goods, railways, automobiles, bridges, and construction constructions in countries. Iron and steel, which is one of the most important sectors of economies around the world, affect the development of countries. Having an important role in world steel production, Turkey has aimed to reach more market share. With the policies it has implemented in this direction, with its value-added products, wide product options and renewable energy resources investments, it ensures to keep the cost levels at a minimum.

In the iron and steel industry, where national and international competition is getting harder day by day, it is very important to monitor cost levels so that businesses can maintain and develop their current financial structures. It has been determined that factors such as energy price differences in input costs, changes in geopolitical risk, inflation level, and unemployment are directly related to business profit and loss. Energy cost is one of the biggest energy consumers in the manufacturing sector.

In this study, the factors affecting the cost in the iron and steel industry have been determined, and it has been determined that cost analysis is very important in production. It has been determined that the factors that will cause high costs should be kept at a minimum level. In this direction, there is a need to develop a decision support system by using data mining methods in order to make cost analyzes of iron and steel products effective. It will create a decision support system and contribute to the sector.

Apart from the factors that affect the production input cost in the sector mentioned above, tax reductions, credit facilitation, subsidies, etc., in the development of the iron and steel sector in Turkey, increasing government incentives will reduce production costs. Thus, energy costs and carbon emissions will decrease, and together with new technologies, it will increase the global competitiveness of our country and will be a pioneer in the production of products that provide high-added value in the iron and steel sector.

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