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The International New Issues In SOcial Sciences

The Effect of Green Logistics Studies on Environmental Performance

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Orcid: 0000-0002-0868-7041

Year: 2025 Summer
Number: 13
Volume: 1
pp: 1-26.

Makalenin Geliş Tarihi: 07/02/2025
Kabul Tarihi: 02/06/2025
Makalenin Türü: Araştırma makalesi
Doi: 10.5281/zenodo.15663109, https://doi.org/10.5281/zenodo.15663109

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Abstract
The concept of "green" has emerged at the stage where the negative effects on nature and the environment have reached the potential to affect the world with the increase in production, consumption, and the logistics. With the adoption of the green perspective of countries and businesses, the concept of green logistics has developed. Green logistics has attracted the attention of researchers because of its benefits and the necessity of determining its sensitivity in the eyes of society. In this way, many academic studies have been published over the years and continue to be published. This article aims to measure the impact of studies published within the scope of green logistics and derivative expressions on the index expressed as the Environmental Performance Index (EPI), which provides a summary of the sustainability of countries. Regression analysis was conducted assuming that countries working in the field of green logistics have an impact on their performance within the scope of the index. While the expected relationship was predicted to be positive between the high number of publications and the high EPI score, it was found that there was no relationship as a result of the findings.

Keywords: Environment, Logistics, Green Logistics, Environmental Performance Index, Regression Analysis, Sustainability Logistics

Jel Code: L91, Q50

Yeşil Lojistik Çalışmalarının Çevresel Performans Üzerindeki Etkisi

Öz

Üretimin, tüketimin ve aradaki bağı sağlayan lojistik süreçlerin artışı ile doğaya ve çevreye verilen olumsuz etkilerin insan hayatını ve dünyayı etkileyecek potansiyellere ulaştığı aşamada "yeşil" kavramı ortaya çıkmıştır. Yeşil bakış açısı, doğaya verilecek zararı tamamen ortadan kaldırmayı veya en aza indirmeyi hedeflemektedir. Ülkelerin ve işletmelerin yeşil bakış açısını benimsemesi ile yeşil lojistik kavramı gelişmiş; iş yapma süreçleri buna göre dizayn edilmeye başlanmıştır. Faydaları, uygulama şekilleri, uygulama maliyetleri ve toplum nezdinde duyarlılığının tespit edilmesi

gerekliliği gibi konular nedeniyle yeşil lojistik araştırmacıların dikkatini çekmiştir. Bu şekilde yıllar içinde birçok sayıda akademik çalışma yayınlanmıştır ve yayınlanmaya da devam etmektedir. Bu makale yeşil lojistik ve türev ifadeleri kapsamında yayınlanmış olan çalışmalar ile Çevresel Performans Endeksi (EPI) olarak ifade edilen ve ülkelerin sürdürülebilirliği hakkında özet sunan global bir endeks arasındaki ilişkiyi ölçmeyi amaçlamıştır. Bu endeks kapsamında konumlanan ülkelerle yeşil lojistik alanında çalışma yapan ülkeler arasında bir ilişki olduğu varsayılarak regresyon analiz gerçekleştirilmiştir. Beklenen ilişki yüksek yayın sayısı ile yüksek EPI puanı arasında pozitif yönlü ilişki tahmin edilirken elde edilen bulgular sonucunda herhangi bir ilişki olmadığı tespit edilmiştir.

Anahtar Kelimeler: Çevre, Lojistik, Yeşil Lojistik, Çevresel Performans Endeksi, Regresyon Analizi, Sürdürülebilirlik Lojistiği

Jel Kodu: L91, Q50

1. Introduction

Mass production increased with the industrial revolution; in parallel with this, the transportation of the products produced to the markets triggered the development of the transportation sector. As the developments in trade contributed to the development of the transportation sector, the developments in the transportation sector also contributed to the development of the countries by supporting their domestic and foreign trade. Along with these developments, a rapid transformation has started to be experienced in the world, countries have started to develop and industrialize, businesses with the aim of growing and developing have used natural resources with the aim of making a profit, which is their main goal in this process, and they have caused various environmental problems. As a result of environmental awareness that started at the end of the 20th century, attempts were made to protect the environment, which could affect many sectors, before countries and international organizations. The increase in environmental awareness has affected the policies of countries, and way of business doing, and has brought researchers to focus on this issue. These developments have led to the development of new perspectives called green or sustainable. Green perspectives have begun to transform into environmental policies and legal regulations aimed at protecting the environment with the support of governments; businesses have also tended to design their business methods with a green perspective due to reasons such as legal obligation, increased competition, and corporate image.

In parallel with other sectors, the green perspective has shown its effect in the logistics sector to reduce the environmental impact of logistics activities. In many countries, political and legal regulations concerning the logistics sector have been implemented, logistics enterprises have turned to design their activities with a green perspective, and researchers have focused on conducting studies on green logistics. In this study, it is aimed to examine the effect of academic studies published on green logistics on the Environmental Performance Index (EPI, 2022), which represents the relations of countries with the environment. In this direction, the relationship between environment and logistics was first discussed in the study, and then EPI 2022 was introduced. In the continuation of the study, some academic studies on green logistics in the literature are listed, the research part of the study is transferred and finally, the conclusion part is given.

2. Logistics and Environment Relationship

Countries aim to offer a higher level of welfare to their citizens. In order to achieve this goal, countries have to grow and develop economically. Realizing the growth and development planned with public policies is mostly possible through businesses in today's liberal world. Businesses interact with their environment; In the supply chain stages such as procurement, production, and distribution, it obtains profit, which is its main purpose, by making use of the environment in certain amounts and often destroying the environment.

In the years before the 1960s, there were no concerns about environmental degradation. It was stated by some authors that before the 1960s, the idea that the power of the environment to eliminate waste and renew resources was endless (McKinnon, 2015). However, these environmental destructions have brought many problems such as air, soil, water, radiation, and noise pollution. All these pollutions did not have a great impact on those who caused environmental destruction, global warming, and climate change as a result of these pollutions started to affect the perspectives of states, businesses, and individuals.

With the industrial revolution, environmental pollution has accelerated, and especially air pollution has had a significant impact on global warming. Gases called greenhouse gases (CO_2, Methane, Nitrous oxide, Flora clora carbons, etc.), especially carbon dioxide (CO_2) that have started to accumulate in the atmosphere, have caused an increase in the world temperature by trapping the long wave rays coming from the sun in the world atmosphere. As a result,

the world average temperature has increased by 0.8 C° in the last century (Öztürk, 2002). In Table 1, the fossil fuel-induced CO_2 emissions of the sectors are shown globally and with 27 countries of the European Union (EU27).

Table 1: Industry CO_2 Emission (Crippa & et al., 2022)

	1990-2021 Global CO_2 Emission from Fossils	**1990-2021 EU 27 CO_2 Emissions from Fossils**
Energy Industry	+87% ↑	-39% ↓
Other Production Industries	+65% ↑	-41% ↓
Construction	+2% →	-32% ↓
Transportation	+65% ↑	+16% ↑
Other Sectors	+101% ↑	-23% ↓

As seen in Table 1, significant increases are seen in other sectors, excluding the construction sector, on a global scale. In addition, there were significant decreases in CO_2 emissions from all sectors except the EU27 transport sector. By 2021, China, the United States (USA), EU27, India, Russia and Japan will account for nearly half of the total world population, 62.4% of global GDP, 66.4% of global fossil fuel consumption and global fossil CO_2 emissions. It constitutes 67.8% of it.

According to the Global Atmosphere Research Emissions Database Report (2022), while global CO_2 emissions were around 16 Gigatons (Gt) in 1970, they reached approximately 37.9 Gt in 2019, decreased by 5.3% in 2020 due to the COVID pandemic, and again in 2021. increased to the pre-pandemic level. Following the massive decline as a result of the pandemic, CO_2 emissions from the transport sector rose to 7.6 Gt. This figure constitutes a significant share of approximately 20% of the total CO_2 emissions by 2021 (Crippa & et al., 2022).

The most important aim of the logistics sector, which is responsible for 20% of global CO_2 emissions, is to organize its activities in order to maximize profitability. Environmental and social costs that have not traditionally been accounted for in balance sheets have been largely ignored until recently. With the increasing public and government concerns for the environment since the beginning of the 2000s, businesses have also tended to reduce the environmental impact of logistics operations (Nikitakos, 2012).

Making logistics green or sustainable in the long run involves more than reducing carbon emissions. At the beginning of sustainability lies reconciliation by considering economic and social goals as well as environmental concerns (McKinnon, 2015). Economic goals are not just about economic growth or shareholder profits; It also includes issues such as fair pricing and purchasing policies and examples of economic responsibility. Social goals include how businesses treat their employees or stakeholders, health and safety policies, charitable contributions or donations, and maximum working hours (Piecyk & Björklund, 2015).

3. Literature Review

After approaching logistics from a sustainable perspective, the concept of green logistics, also known as sustainable logistics, started to develop. Although the concept of green logistics is a new perspective in the sector, it has been seen that it has gained recognition among both businesses and researchers. In addition to the green practices carried out by enterprises in logistics activities, researchers also conduct theoretical and empirical studies on green logistics. As stated, the concept of green logistics is often used synonymously with the concept of "sustainable logistics", or it is also referred to as "environmental logistics" or "environmentally friendly logistics". In this context, Web of Science (WoS), Scopus, and Google Scholar databases were searched with the logistics keywords specified in Table 2.

Table 2: Keyword Research

Database	WoS		Scopus		Google Scholar*
	Publication Type				
Keyword	**Article**	**Other**	**Article**	**Other**	**Article**
Green Logistics	518	426	529	427	1.120
Sustainable Logistics	230	128	209	176	566
Sustainability Logistics	4	1	5	6	48
Environmental Logistics	27	25	38	29	127
Environment Logistics	17	18	59	43	76
Eco-Friendly Logistics	1	0	1	1	4

*The title of "Other" was not given, as Google recursively treats the publications under the other title and includes content such as quotations under the other title.

As a result of the scans made within the scope of three databases in Table 2, it has been found that the most used term is green logistics, followed by sustainable logistics. In the literature, the terms environmentalist logistics or environmentally friendly logistics (environmental logistics, environment logistics, eco-friendly logistics) are used less frequently. In this respect, "Green Logistics" and other keywords "Sustainable Logistics, Sustainability Logistics, Environmental Logistics, Environment Logistics, Eco-Friendly Logistics" are shown separately in the tables below.

Table 3: Researching Green Logistics and Other Keywords

WoS and Scopus					
Green Logistics			**Other Words***		
Rank	**Country**	**Studies**	**Rank**	**Country**	**Studies**
1	*Chinese*	610	1	*Chinese*	157

2	*Poland*	184	2	*Germany*	114
3	*Germany*	131	3	*Italy*	61
4	*USA*	109	4	*Sweden*	59
5	*Britain*	99	5	*USA*	55
6	*India*	80	6	*Britain*	50
7	*Türkiye*	57	7	*Brazil*	49
8	*Sweden*	58	8	*France*	47
9	*Italy*	54	8	*Holland*	47
10	*Brazil*	50	10	*Poland*	46
11	*Malaysia*	49	11	*Türkiye*	41
12	*France*	44	12	*Australia*	32
12	*Spain*	44	13	*Spain*	29
14	*Australia*	40	14	*India*	28
15	*Russia*	40	15	*Belgium*	27
16	*Holland*	39	15	*Canada*	27
17	*Iranian*	38	17	*Austria*	25
17	*Thailand*	38	17	*Malaysia*	25
17	*Taiwan*	38	19	*South Korea*	23
20	*Pakistan*	37	20	*Iranian*	19
21	*South Korea*	31	21	*Morocco*	16
21	*Canada*	31	22	*Russia*	15
23	*Ukraine*	30	22	*Slovakia*	15
24	*Slovakia*	29	24	*Thailand*	14
25	*Austria*	26	25	*Norway*	13
26	*Lithuania*	25	26	*Taiwan*	11
26	*Greece*	25	27	*Ireland*	10
28	*Morocco*	24	27	*Colombia*	10
29	*Denmark*	22	27	*Singapore*	10
29	*Japan*	22	30	*Mexican*	9

*Sustainable Logistics, Sustainability Logistics, Environmental Logistics, Environment Logistics, Eco-Friendly Logistics

In Table 3, "Green Logistics" in Web of Science and Scopus databases is discussed. In Table 4, the distribution of the studies conducted under the heading of other keywords by country is shown in the top 30 countries with the most publications. When Table 3 and Table 4 are examined together and all keywords are considered, it is seen that the academic studies on green logistics are mostly done by China. In the studies, the term of green logistics was generally accepted, especially in China, the USA, Poland, India, England, and the studies were mostly carried out within the scope of this keyword. In countries such as Germany, Italy, Sweden, Brazil, and France, other keywords are generally accepted and used in many studies.

Table 4: Top Ranking of Publications by Green Logistics Keywords

Wos			**Scopus**		
Rank	**Country**	**Studies**	**Rank**	**Country**	**Studies**
1	*Chinese*	372	1	*Chinese*	395
2	*Poland*	173	2	*Germany*	129
3	*Germany*	116	3	*USA*	107
4	*USA*	75	4	*Britain*	81
5	*Britain*	68	5	*Italy*	72
6	*Sweden*	57	6	*India*	63
7	*Türkiye*	51	7	*Sweden*	60
8	*Holland*	48	8	*Poland*	57
9	*France*	46	9	*Brazil*	55
10	*India*	45	10	*Türkiye*	47
10	*Italy*	45	11	*France*	46
12	*Brazil*	44	12	*Malaysia*	40
13	*Australia*	34	13	*Spain*	39
14	*Spain*	33	13	*Australia*	39
15	*Malaysia*	32	13	*Holland*	39
16	*Iranian*	30	16	*Russia*	37
17	*Austria*	28	17	*Thailand*	36
18	*S. Korea*	27	18	*Canada*	33

19	*Canada*	25	19	*S.Korea*	28
19	*Slovakia*	25	20	*Iranian*	27
19	*Taiwan*	25	20	*Finland*	27
22	*Finland*	24	22	*Morocco*	26
22	*Pakistan*	24	23	*Taiwan*	24
24	*Belgium*	21	23	*Hong Kong*	24
24	*Ukraine*	21	25	*Austria*	23
26	*Norway*	20	26	*Pakistan*	19
27	*Russia*	18	26	*Slovakia*	19
28	*Morocco*	17	26	*Ukraine*	19
29	*Thailand*	16	29	*Denmark*	18
29	*Greece*	16	30	*Colombia*	15

Table 4 lists the countries with the most publications with all green logistics keywords in the WoS and Scopus databases. It is seen that the country with the most publications within the scope of the two indices is China by far. It is noteworthy that after China, Germany, the USA, Poland, England, Italy, Sweden, and India achieved significant publication numbers. Although the ranking of the countries within the scope of the two indices varies, mostly the same countries (except Greece, Colombia, Belgium, Norway, Hong Kong, and Denmark) take place.

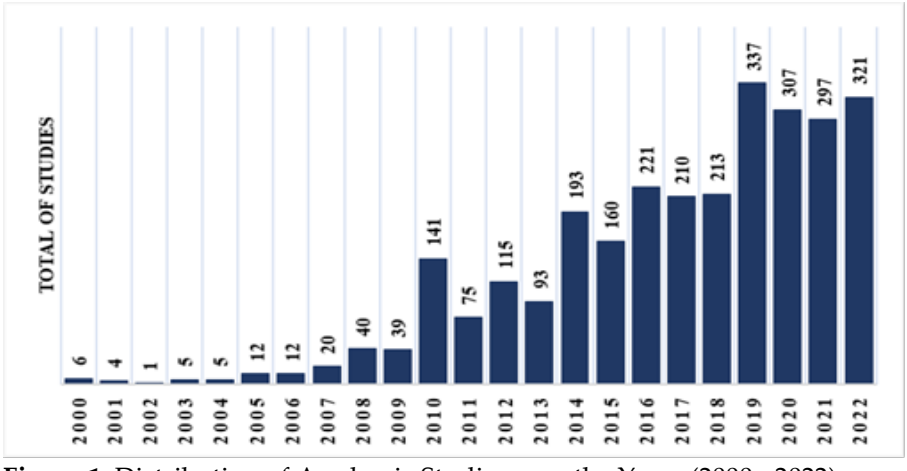

Figure 1: Distribution of Academic Studies over the Years (2000 - 2022)

The distribution of studies covering all keywords related to green logistics between the years 2000-2022 by years is shown in Figure 1. The first study examples on the subject started in the early 2000s, the recognition of the concept has increased since 2010 and reached the highest point in 2019. Within the scope of the empirical and theoretical studies examined, it has been seen that all studies contribute to literature as supporting and improving green logistics. In the literature, there are various examples of empirical studies made with a green perspective on the logistics sector.

Shang, Lu, and Li (2010) investigated the relationship between green supply chain practices and business performance by applying a survey to 167 businesses operating in logistics and supply chain management in the electronics manufacturing industry in Taiwan. In this context, six green supply chain management dimensions are defined in the study: green production and packaging, environmental participation, green marketing, green suppliers, green stock, and green eco-design. By means of cluster analysis, businesses are clustered as weak green-focused, green marketing-focused, green supplier focused and green stock focused. As a result of the analysis, it has been seen that green marketing-oriented businesses have the best business performance in terms of corporate image improvements, environmental regulation, market share, sales, customer satisfaction, and customer loyalty. After the green marketing-oriented businesses, the corporate image improvements of the green supplier-oriented group, customer satisfaction, and customer loyalty; market share and sales of the weak green-focused group; It has been determined that the green stock-focused group has the second best performance in environmental regulations. As a result of the study, the success of performance in enterprises with green supply chain capability was determined and its strategic importance was emphasized for electronic manufacturing industry enterprises to gain competitiveness (Shang, Lu, & Li, 2010).

Ubeda, Arcelus and Faulin (2011) focused on optimizing fleet planning to green the logistics activities of Spain's leading food distributor Eroski business. As a result of the study, it was stated that it is possible to shorten the distances and reduce the emission rates by fulfilling the changes in transportation planning. It has been stated that Eroski may experience some cost increases in relation to the changes aimed at eliminating the negative effects on the environment, but this may contribute to increasing its

competitive advantage and turn into a profit with remuneration policies (Ubeda, Arcelus & Faulin, 2011).

A model was created by Liyanage and Rupasinghe (2016) to strengthen green logistics operations. The analytical model developed after a comprehensive literature review is discussed in the perspective of the vehicle routing problem. A multi-depot vehicle routing problem has been tried to be solved for a two-stage forward supply chain network where there may be traffic congestion on the route or part of the route. In this context, seven questions were developed. These questions address important issues such as the distribution network where the customers will be, the customers to whom the determined vehicles will be directed, the number of vehicles to be used, the routes that provide advantages, the traffic jam situation on the route, alternative routes and the amount of cargo that the vehicles can carry. A mathematical model was developed based on these questions. Thanks to the model, it is aimed to help the logistics business to reduce carbon emissions and the costs caused by emissions (Liyanage & Rupasinghe, 2016).

Yangınlar and Sarı (2017) tried to determine the reasons forcing enterprises to green logistics activities by applying a survey to the enterprises in the health sector. As a result of the study, it was determined that customer demands, legal obligations, social pressure, and cost reduction efforts led businesses to green logistics practices (Yangınlar & Sarı, 2017).

Zowada (2020) conducted a survey on the development of green logistics in 200 small and medium-sized enterprises (SMEs) operating in Poland. As a result of the study, it has been seen that most of the activities related to environmental protection while carrying out logistics processes of SMEs are carried out within the scope of legal provisions. This situation has caused businesses to implement applications only within the minimum limits set by the state. In addition, it has been emphasized that the driving force behind the enterprises that are successful in the development of green logistics is the green perspective of the leading enterprises in the supply chain (Zowada, 2020).

Chhabra, Singh and Kumar (2022) developed a tracking system that digitizes logistics activities by sending real-time GPS (Global Positioning System) information to the server with the help of an Internet of Things-based camera. The digitized data was mathematically analyzed for the development of green logistics activities. The data used for the analysis were selected from

performance indicators consisting of carbon emissions and travel time savings. The study findings showed that the actual travel time and distances were higher than the estimated indicators, and deviating routes included higher carbon emissions. It is stated that carbon emission, time and cost savings can be achieved with the effective implementation of the established green logistics monitoring system (Chhabra, Singh, & Kumar, 2022).

Guo, Zhang and Liu (2022) have created a time-dependent green vehicle routing model for cold chain logistics in accordance with green logistics activities, considering the time-dependent effects caused by traffic congestion. Firstly, gradual travel speed and partial travel time are modeled according to the real traffic situation. The model has been optimized by adding the total distribution cost, including shipping cost, cooling cost, carbon emission cost, and labor cost, to the model. In the first stage, a wide area search was made to develop the vehicle route, then the shortest route was modeled to optimize the departure time. It has been determined that the optimization ability of the model is 11% to 16% more successful than similar routing algorithms (Guo, Zhang & Liu, 2022).

Yontar (2022), examining the important factors that greatly affect the performance of logistics activities, identified 44 sub-criteria with Pareto Analysis. A structural equation model was established with these comprehensive sub-criteria determined. While waste management, transportation and warehouse management, external factors, and logistics performance factors are independent variables; environmental factors, resource use, social factors, and internal factors were determined as dependent variables. As a result of the study, it was seen that the use of recycled materials, warehouse and stock management, road safety, customs follow-up, noise pollution, vehicle selection, and efficiency criteria, employee benefits, and supply chain integration were the most influential factors (Yontar, 2022).

Another study on fleet optimization was conducted by Scholl, Boysen, and Scholl (2023) based on Germany's longest highway and Europe's most congested north-south trunk line. In this context, an optimization method that proposes a new mathematical framework called adaptive large mathematical search has been developed in order to create a central transportation team that records transportation demands and generates plans in order to be able to plan the assembly of electric vehicles and their long-distance transportation

applications. Theoretically, 10% to 20% energy savings can be achieved in the trucks that are put together in the study, but similar to diesel trucks, this saving cannot be realized for every electric team. Vehicles that cannot form a joint team must continue to drive individually. Despite this, it has been stated that most of the technical savings rates of vehicles that create suitable teammates can actually be realized (Scholl, Boysen & Scholl, 2023).

4. Environmental Performance Index

Environmental performance assessment is a measurable environmental management tool that can assess environmental protection impacts and provide guidance to improve the efficiency of governments (Zuo et al., 2017). The Environmental Performance Index is an index that provides a summary of the sustainability status of countries. This index is made by a team of Yale University and Columbia University researchers with funding from the Canadian-based McCall MacBain Foundation.

With the United Nations' Sustainable Development Goals, states are increasingly willing to explain their performance on the environment by referring to quantitative data. With the creation of the Environmental Performance Index, the world has entered a period of developing a new data-driven environmental strategy. Because an empirical approach to environmental protection, based on data, makes it easier to identify problems, follow trends, highlight the successes or failures of countries, determine the best methods and optimize environmental processes (Akar, 2018).

The index focuses on 11 main problems, primarily improving environmental health, protecting ecosystem vitality, and mitigating climate change. It uses 40 performance indicators to evaluate these problems. This index, which ranks 180 countries by scoring as a result of these indicators, is of great importance in terms of seeing the position of countries in environmental policies (EPI, 2022). The 11 main problems studied in the index are as follows:

Figure 2: Main Issues in the Environmental Performance Index

This index is an indicator consisting of important data that helps to support sustainable development to realize an environmentally safer and more equitable future. According to the latest research conducted in 2022, the rankings of the first 20 countries and the last 20 countries are as follows.

Table 5: Environmental Performance Index Top 20 Country Rankings and Scores

Rank	Country	Score
1	*Denmark*	77.9
2	*United Kingdom*	77.7
3	*Finland*	76.5
4	*Malta*	75.2
5	*Sweden*	72.7
6	*Luxembourg*	72.3
7	*Slovenia*	67.3
8	*Austria*	66.5
9	*Switzerland*	65.9
10	*Iceland*	62.8
11	*Holland*	62.6
12	*France*	62.5
13	*Germany*	62.4
14	*Estonia*	61.4
15	*Latvia*	61.1
16	*Croatia*	60.2
17	*Australia*	60.1
18	*Slovakia*	60.0
19	*Czechia*	59.9
20	*Norway*	59.3

Among the top 20 countries, 6 countries with a score above 70 stand out. These countries were identified as Denmark, United Kingdom, Finland, Malta, Sweden and Luxembourg, respectively.

Table 6: Environmental Performance Index Ranking and Scoring of the Last 20 Countries

Rank	Country	Score
160	*Chinese*	28.4
161	*Morocco*	28.4
162	*Nepal*	28.3
163	*Nigeria*	28.3
164	*Indonesia*	28.2
165	*Chad*	28.1
166	*Mauritania*	28.1
167	*Guatemala*	28.0
168	*Madagascar*	28.0
169	*Iraq*	27.8
170	*Ghana*	27.7
171	*Sudan*	27.6
172	*Türkiye*	26.3
173	*Haiti*	26.1
174	*Liberia*	24.9
175	*Papua New Guinea*	24.8
176	*Pakistan*	24.6
177	*Bangladesh*	23.1
178	*Vietnamese*	20.1
179	*Myanmar*	19.4
180	*India*	18.9

China and Morocco were included in the list of the last 20 countries in the Environmental Performance Index, sharing the same score. Türkiye also entered this ranking and ranked 172nd among 180 countries in the world with 26.3 points. As seen in Table 6, the last five ranking countries are Pakistan, Bangladesh, Vietnam, Myanmar, and India.

Index indicators are a good tool to identify problems, set goals, monitor trends, and see the best strategies. The Environmental Performance Index

provides an important policy tool that supports achieving the results set by the United Nations Sustainable Development Goals and moving societies to a more livable and environmentally friendly future (EPI, 2022).

The Environmental Performance Index is not a single data ranking. The index also includes separate numerical evaluations and measurements for the 11 main problems it deals with. On the other hand, this index, which has been published regularly every two years since 2006, provides the opportunity to compare countries both globally and regionally (Savaş, 2012). In the calculation of the environmental performance index, the calculation was carried out by giving specific weights to 11 main problems. These weightings were realized as follows after certain analyzes:

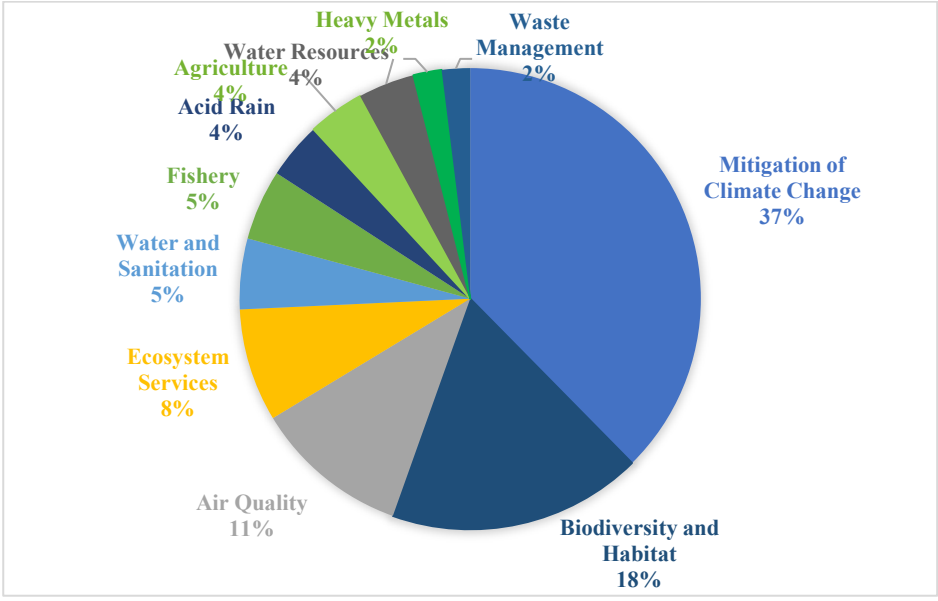

Figure 3: Environmental Performance Index Weighting Ratio (%)

Considering the weighting criteria that make up the index, it has been determined that climate change reduction of 37%, biodiversity, and habitat 10%, air quality 11%, and ecosystem services 8% have a large share. Other criteria are fisheries with 5% water and sanitation, 4% acid rain, agriculture and water resources, and 2% heavy metals and waste management.
The overall performance rankings show which countries are best addressing the environmental challenges facing each nation. Going beyond aggregate

scores and digging into data to analyze performance by issue category, policy objective, peer group, and country offers even greater value for policymakers (EPI, 2022).

5. Aim of Research

The aim of this study is to investigate the impact between academic studies covering green logistics keywords on the environmental performance indicators of countries.

6. Scope of Research

In the study, the number of publications of the 30 countries with the most publications on green logistics in WoS and Scopus databases and the environmental performance scores of these countries are included.

7. Research Design and Data Sources

In the study, two models were created in which the data obtained from the WoS database and the data obtained from the Scopus database were independent variables. In both databases, academic studies containing green logistics keywords between 2000-2022 were examined within the scope of countries, and the first 30 countries with the most publications to be used as independent variables are shown in Table 5. In this study, using 40 performance indicators in 11 categories as the dependent variable and covering 180 countries; The Environmental Performance Index 2022 (EPI 2022) is used, which scores countries according to their progress in improving environmental health, maintaining ecosystem vitality, and mitigating climate change (Wolf & et al., 2022). EPI was first piloted in 2006 and has projected an environmental performance score between 0-100 every two years since 2006.

In the analysis of the study, whether the number of academic publications had any effect on EPI 2022 was tested with simple linear regression analysis. Regression is a statistical technique that involves estimating a dependent variable with the help of an equation created by making use of the independent variable or variables with a certain amount of random error. Although there are many regression techniques, simple linear regression aims to obtain a linear function for estimating one (independent variable) and the other (dependent variable) thanks to two variables, one dependent and one independent (Tan, 2016). Simple linear regression is formulated as follows:

$y = \beta_0 + \beta_1 x + \varepsilon(1)$

In Equation 1, β_0 represents the point where the line cuts the y axis, β_1 represents the slope of the line, ε represents the random error term, y represents the predicted (dependent variable), x represents the variable used

as the estimator (independent variable) (Küçüksille, 2017, Erkan, 2002).
Since it is not possible to reach the whole study population in the studies, it is possible to reach the desired information about the population parameters with a sample that will represent the study population. The predicted values at this point are represented as b_0 and b_1. The estimated value of y is shown as yˆ and the estimated equation is formulated as follows (Küçüksille, 2017):

$\hat{y} = b_0 + b_1 x (2)$

In statistical studies, it is important that the data show normal distribution. The most important descriptive statistics representing normality are kurtosis and skewness measures. If the data is perfectly symmetrical, the arithmetic mean, mode and median will be equal to each other, and the skewness coefficient will be zero. If this equality is broken, the distribution will become skewed. The skewness coefficient can take values between -∞ and +∞. It is considered normal if the skewness measure takes values in the range of ±3 (Karaatlı, 2017). In the regression analysis, it is important that the data are in accordance with the normal distribution. Therefore, checking the normality of the data first is necessary for the reliability and validity of the regression analysis.

8. Data Analysis and Result

In the study, two simple linear regression models were established to examine the effect of the number of academic publications on the Environmental Performance Index 2022 (EPI 2022). These models are formulated as follows:

$EPI = \beta_0 + \beta_1 Wos + \varepsilon (3)$

$EPI = \beta_0 + \beta_1 Sco + \varepsilon (4)$

In Model 1 and Model 2, EPI Environmental Performance Index 2022 represents studies made with green logistics keywords at the country level in Wos Web of Science database, and studies made with green logistics keywords at country level in Sco Scopus database. The regression equation is shown in Equation 5:

$y = b_0 + b_1 x (5)$

In the equation showing the regression equation, y Environmental Performance Index 2022 shows the studies conducted with the green logistics keywords at the x country level. Within the scope of the two models, firstly, the conformity of the data to the normal distribution was examined. The kurtosis and skewness values of the two models are shown in Table 7.

Table 7: Kurtosis and Skewness Values for Regression Models

Data	Test Type	Value	Standard Error	Data	Test Type	Value	Standard Error
WoS	Skewness	3,905	0,427	**Sco**	Skewness	4,323	0,427
	Kurtosis	17,039	0,833		Kurtosis	20,962	0,833
EPI	Skewness	-0,221	0,427	**EPI**	Skewness	-0,440	0,427
	Kurtosis	-0,709	0,833		Kurtosis	-0,796	0,833

As seen in Table 7, the variables Wos and Sco do not show normal distribution. The countries that broke the normality assumption in the WOS variable were China, Poland and Germany; It is determined that the countries that violate the normality assumption in the Sco variable are China, Germany and the USA. Univariate normal distribution has been tested and since it does not comply with the normality assumption, the logarithmic transformation method is used to transform these variables into normal distribution. Logarithmic transformations are divided into two: full logarithmic transformation and semi-logarithmic transformation. In the full logarithmic transformation, two variables, the independent variable and the dependent variable, are transformed logarithmically, while in the semi-logarithmic transformation, only one of the dependent or independent variables is transformed logarithmically (Eroğlu, 2017, Yavuz, 2009). The regression equation created for two different models to be established with two data sets transformed by taking their natural logarithm is shown in Equation 6:

$y = b_0 + b_1 log x (6)$

After taking the logarithm of the dependent variable, the normality test was performed again in both models. Although the kurtosis and skewness values of the variables in both models are between ±3 values, they should be standardized by dividing the skewness and kurtosis values by the standard error. The data obtained in this way (according to 5% significance level) should be between 1.96 and -1.96 (Karaatlı, 2017).

As a result of the examinations, it was seen that the number of studies in China and Poland in the model, in which the number of Wos studies was an independent variable, did not provide the 5% confidence interval even after the transformation, since the number of studies in China and Poland were extreme values. Therefore, data for China and Poland were excluded from this model. In the model in which the number of Sco studies is an independent

variable, it was observed that the number of studies from China did not provide the 5% confidence interval even after the transformation, due to the extreme value nature of the study numbers. In this way, data for China was excluded from this model. The results of kurtosis, skewness and confidence interval tests of the models established after these stages are shown in Table 8.

Table 8: Kurtosis, Skewness, and Confidence Interval Results

Data	Test Type	Value	Sta. Error	Critical Value	Data	Test Type	Value	Sta. Error	Critical Value
LnWoS	Skewness	0,659	0,441	**1,494**	**LnSco**	Skewness	0,348	0,434	**0,801**
	Kurtosis	0,021	0,858	**0,024**		Kurtosis	-0,391	0,845	**-0,462**
EPI	Skewness	-0,288	0,441	**-0,653**	**EPI**	Skewness	-0,105	0,434	**-0,241**
	Kurtosis	-0,626	0,858	**-0,729**		Kurtosis	-0,677	0,845	**-0,801**

When Table 8 is examined, it is seen that the kurtosis and skewness values are in the range of ±3, so the data for the two models are in accordance with the normal distribution. In addition, it was found that the critical values obtained by dividing the skewness and kurtosis values by the standard error ranged from 1.96 to -1.96, and the data conformed to the normal distribution. After this stage, regression analysis was deployed.

Table 9: Model 1 Regression and ANOVA Test Results

Model 1 (LnWoS)	**R**	**R Square**	**Adjusted R Square**	**Standard Error**	**Signification**
	0,094	0,009	-0,028	16,445	0,629
	Sum of Squares	**Degree of Freedom**	**Average Square**	**F**	**Signification**
Regression	64,625	1	64,625	0,239	0,629
Residue	7301,821	27	270,438	-	-
Total	7366,446	28	-	-	-

With the regression analysis, it was examined whether the independent variable had a semi-logarithmic effect on the dependent variable. According to the analysis results, it was determined that the significance value (0.629) was greater than 0.05, meaning that the variable did not have a significant effect. The number of published papers related to green logistics represents only -0,028 (-%028) effect on EPI.

Table 10: Model 2 Regression and ANOVA Test Results

Model 2 (LnSco)	**R**	**R Square**	**Adjusted R Square**	**Standard Error**	**Sig.**
	0,258	0,066	0,031	15,496	0,185
	Sum of Squares	**Degrees of Freedom**	**Average Square**	**F**	**Sig.**
Regression	444,648	1	444,648	1,852	0,185
Residue	6243,369	26	240,130	-	-
Total	6688,017	27	-	-	-

With the regression analysis, it was examined whether the independent variable had a semi-logarithmic effect on the dependent variable. According to the analysis results, it was determined that the significance value (0.185) was greater than 0.05, meaning that the variable did not have a significant effect. The number of published papers related to green logistics represents only 0,03 (%3) effect on EPI.

9. Conclusion and Suggestions

The Environmental Performance Index is an index that provides a summary of the sustainability status of countries. Businesses and industries operating in countries continue their activities in very similar environments due to the existence of factors such as commercial structure, competition, legal rules, and policies. In other words, if there is an environmentalist perspective in a country, all institutions and organizations operating in the country are affected by this structure and must design their activities according to this structure. In this sense, the Environmental Performance Index is important data reflecting the situation of countries in terms of green logistics.

In this study, the effect of the number of academic publications, which are representative of the green logistics perspectives of the countries, on the Environmental Performance Index was examined. It has started with the assumption that the studies on green logistics will have a positive effect on the Environmental Performance Index because the political, legal, and academic debates on a particular issue in a country will be systematically paralleled. However, because of the analysis, it was seen that academic studies had no effect on EPI. It is thought that this situation may be due to the fact that academic studies are not considered by policymakers, studies that are suitable for the sector are not carried out or the sector does not follow these studies, publications are made by considering academic concerns or the Environmental Performance Index does not adequately reflect the green logistics perspective.

This study is one of the first studies to measure the effect of the number of academic publications on the sectors. In this context, it has the potential to be expanded with different environmental indices or other variables that reflect the environmentalist perspective, by guiding future studies. In addition, it is possible to increase the databases used by differentiating them and to make an examination by deriving the number of keywords such as green supply chain and sustainable supply chain.

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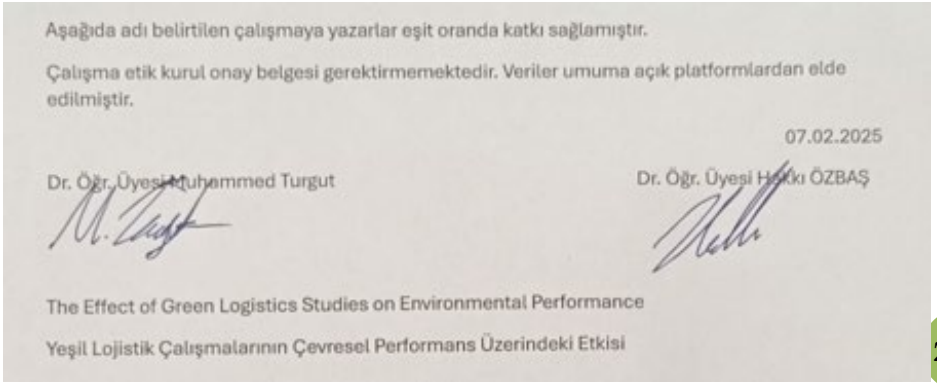
There is no conflict of interest between the authors or any third-party individuals or institutions.

Ethics committee approval is not required for this study.

No financial support has been received for this article.

We would like to thank the anonymous reviewers for their constructive and constructive comments throughout the article process and the editorial team for their contribution to the process management.



Aşağıda adı belirtilen çalışmaya yazarlar eşit oranda katkı sağlamıştır.

Çalışma etik kurul onay belgesi gerektirmemektedir. Veriler umuma açık platformlardan elde edilmiştir.

07.02.2025

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Yeşil Lojistik Çalışmalarının Çevresel Performans Üzerindeki Etkisi