

# Global Trend of Carbon Emissions Based on Year: A Bibliographic Study

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**Abstract.** One of the causes of increasing global warming or climate change is the high carbon emissions on earth, which impacts on the environment, health, and economic instability. This study conducts a qualitative mapping of research articles on carbon emissions from 2011 to 2022, focusing on publication year, publisher accreditation, theory used, research methods, research units, analysis period, sample size, research variables, and results. A total of 113 articles from accredited and Scopus indexed journals are included in the analysis, with the majority published in 2021. The Journal of Cleaner Production is identified as the most prominent publisher discussing carbon emissions. Most journals included in this study are classified as Scopus Q1. The theory of legitimacy is found to be the most commonly used theory, with quantitative methods being the dominant research approach. Country-level analysis is the most prevalent unit of analysis, with a coverage period of 1 year. The dependent variable in most quantitative studies is CO<sub>2</sub> emissions, while GDP per capita (PI) is often used as the independent variable. Carbon emissions are a critical concern globally due to their impact on climate change, environment, health, and economic stability.

## 1 Introduction

In this 4.0 era where the rapid growth of technology causes problems in the environment. Environmental problems are the most important factors that can affect sustainable development. One of the environmental problems that occur is climate change. Climate change is caused by an increase in the greenhouse effect resulting in ocean acidification, global warming, melting glaciers, snow, sea ice, more severe tropical storms, and sea-level rise [1]. In 1992, there was an international response to the scientific community's warnings about the contribution of Anthropogenic Greenhouse Gas (GHG) emissions to climate change, leading to negotiations of the UNITED NATIONS Framework Convention on Climate Change (UNFCCC), the goal is to stabilize the concentration of greenhouse gases. glass in the atmosphere at a level that would prevent harmful anthropogenic interference with the climate system. Carbon emissions are one of the causes of climate change in the world. This will have an impact on the environment, health, and economic instability. Carbon pollution is one of the problems that exist in the calculation of carbon.

To reduce climate change, countries are looking for ways to become low-carbon societies and low-carbon countries. Therefore, there is an expectation of technology to reduce carbon emissions as a solution to overcoming climate change. One example is carbon capture and storage (CCS) can help prevent the release

of large amounts of CO<sub>2</sub> into the atmosphere [2]. Some examples of contributions to reducing carbon emissions include the Ports of Jersey releasing an app to allow islanders to offset the amount of carbon emitted by travel plans. This app uses a calculator to determine the carbon dioxide emissions for a trip and how much it costs to balance them. In 2021, In China, President Xi Jinping announced that he would stop funding new coal-fired power projects abroad. But domestically, coal mines are being upgraded to meet soaring energy demand, despite Beijing's pledge to reduce coal use by 2026. In America, President Joe Biden has a \$150 billion (£100 billion) clean electricity program. This is to pay homage to utility companies that switched away from fossil fuels. The U.S. also promised "100% carbon pollution-free" electricity by 2035. In Europe, the top CO<sub>2</sub> emitters are Germany, Italy, and Poland. But all member states must agree on how they achieve the bloc's targets. They say 40% of energy is from renewables by 2030. Then India promises 50% of its electricity capacity from non-fossil fuels by 2030. India also argues that richer and more industrialized countries should bear more of the burden because they have contributed far more to global warming over time.

In this study, the authors use SLR because the scope of carbon emissions is so broad, so the authors want to see trends in carbon emissions from year to year. Besides that, using SLR can make it easier to do this research.

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### 1.1 Objectives

The objective of this study is to observe global trends in carbon emissions by mapping various research articles related to carbon emissions from 2011 to 2022. Mapping was done based on publisher, journal quality, theories used, the unit of analysis, number of years of analysis, dependent variable, and independent variable. The research articles used in this study are as many as 113 articles published by accredited journals and indexed by Scopus.

## 2 Literature Review

Legitimacy theory is a social contract relationship that arises between companies and society [3]. In other words, companies should have the ability to adapt to the social system and values of society [4]. The way that can be done to get recognition of legitimacy, companies must disclose environmental activities [5]. Environmental problems are currently the most important factor that can affect sustainable development, this is because environmental pollution is currently getting worse. Therefore, a strategy emerged to achieve a sustainable economy with low-carbon energy sources [6]. Carbon dioxide is the most common greenhouse gas produced as a result of human activities [7]. [8] states that based on the source, greenhouse gases are divided into two, namely natural greenhouse gases and industrial greenhouse gases. Natural greenhouse gases can be beneficial for living things because they are considered capable of keeping the earth's temperature warm, while industrial greenhouse gases come from industrial activities carried out by humans. The carbon-free emission targets that have been set and the emission reductions from year to year cannot be ascertained, and it is estimated that carbon emissions will still increase in the future [9]. Therefore, to address these concerns, both government and non-government help change the behavior of companies by implementing voluntary company-specific climate management strategies [10]. Based on research [11] found that stakeholders with operational excellence in environmental friendliness will benefit from increased environmental demand. As part of the sustainable development strategy, eco-innovation can be used as a long-term green capability investment, assisted by support from top management, eco-technology, and R&D investments [12]. Environmental disclosures in companies include the intensity of greenhouse gases, energy use, corporate governance, strategies to deal with climate change, performance to contribute to reducing greenhouse gas emissions, risks faced, and opportunities from the impact of climate change [13].

## 3 Methods

This study uses a qualitative method and a bibliographic approach where this method measures literature using a statistical approach. There are three processes in researching the literature, namely data collection, data compilation, and data analysis [14]. The purpose of

bibliographic research is to be able to know the development of research on a topic so that a research gap can be found [15].

Qualitative research is research that intends to understand the phenomena experienced by research subjects, can be done through of descriptions in the form of words and language with natural contexts and using natural methods [16]. This study takes data by looking at the quality of the journal through scimago.jr and the number of citations to the paper that is the object of this research. The bibliographic approach in this research comes from the Scopus web by doing a search using the keyword carbon emissions. Next, select several criteria, namely open access, on the criteria for the field of study the selected criteria are Business Management and Accounting, the criteria for the type of document selected are articles, on the criteria for the type of source selected, namely journals. After selecting the criteria, the results were 565 articles. Out of the 565 articles, a selection was made based on coverage in the fields of business, management, and economics. This last selection is done by reading in its entirety each article or journal, this selection produces 113 articles that are used as research objects.

## 4 Data Collection

From 113 articles that would be used as research objects. Furthermore, the data is processed and analyzed for mapping. This study uses 113 data because the field researcher wants to research is only around business or things that are still related to accounting, which is following with the researcher's field.

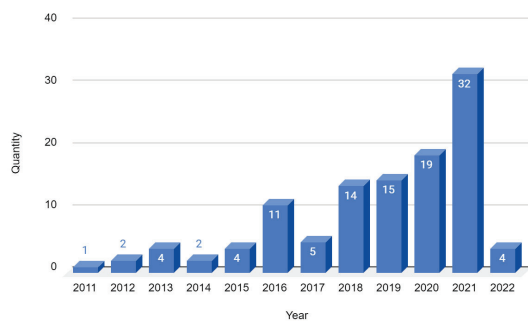


Fig. 1. Data Collection

## 5 Results and Discussion

### 5.1 Mapping Based on Year of Publication

First, mapping was carried out based on the year of publication of the 113 articles. It can be seen in Figure 1 where it can be seen that this research on carbon emissions started from 2011 to 2022. From 2011 to 2015 several studies discussed carbon emissions. Then, since 2016 research on carbon emissions has been an increase in research compared to previous years. However, in 2017 there was a decrease and an increase in the number of carbon emission studies starting in 2018 until 2021. The results of research on carbon emissions were mostly published in 2021. Even in 2022, there were already several who researched carbon emissions. Recent studies on carbon emissions were carried out by [17-20].



**Fig. 2.** Mapping Based on Year of Publication

### 5.2 Mapping Based on Publisher

In addition to the year of publication, this study also groups research findings related to carbon emissions by the publisher in each journal which can be seen in table 1. Based on table 1 it can be seen that the journals that discuss carbon emissions are mostly published in the Journal of Cleaner Production which as many as 32 journals published by them. In table 1 there is another column in the publisher column, the other columns are obtained from various publishers which have a total of 1.

**Table 1.** Mapping Based on Publisher

Publisher	Total
Journal of Cleaner Production	32
Business Strategy and the Environment	17
Technological Forecasting and Social Change	4
International Journal of Production Economics	3
Journal of Industrial Engineering and Management	3
Others	54
<b>Grand Total</b>	<b>113</b>

### 5.3 Mapping Based on Journal Quality

The next step in this research is mapping based on the quality of the journal. As previously explained, the object of this research comes from internationally accredited journals through Scopus. It can be seen in Table 2 that the results show that articles discussing the topic of carbon emissions are dominated by the quality of Q1 journals with a total of 85 journals. So, it can be concluded that the journal on the topic of carbon emissions has very good quality.

**Table 2.** Mapping Based on Journal Quality

Journal Quality	Total
Q1	85
Q2	17
Q3	8
Q4	1
Non-Q	2
<b>Grand Total</b>	<b>113</b>

### 5.4 Mapping Based on Theory

Of the 113 articles that became the object of research, only 27 journals described the research theory. This is because not all articles include the theory used in each study, then some articles include more than two theories. Based on table 3 shows that the most widely used research theory is legitimacy theory. Research related to carbon emissions using legitimacy theory was first conducted by [21]. After that, this theory was reused in research related to carbon emissions in 2020, namely [22-24].

**Table 3.** Mapping Based on Theory

Theory	Total
Legitimacy Theory	4
Agency Theory	3
Institutional Theory	3
Stakeholder Theory	3
Signaling Theory	3
Others	11
<b>Grand Total</b>	<b>27</b>

### 5.5 Mapping Based on Unit Analysis

Based on Table 4, the most widely used samples are from various countries. The first study using units of analysis from various countries was initiated in 2018, and conducted by [25]. Then in 2019, there were two studies using units of analysis from various countries, including research by [26, 27]. Then, in 2020, there was only one study using a multi-country unit of analysis, conducted by [28]. In 2021, research using objects from various countries began to be widely used, including research by [29-35]. In 2022, as many as two studies are using this unit of analysis, namely [17, 18].

**Table 4.** Mapping Based on Unit of Analysis

Unit Analysis	Total
Multiple Countries	14
Europe	5
Manufacturing Company in Japan	3
Others	74
<b>Grand Total</b>	<b>96</b>

### 5.6 Mapping Based on Research Approach

In Table 5 it can be seen that mapping is based on a research approach. The most researched approach in this study is the Generalized Method of Moments, namely research conducted by [36-37].

**Table 5.** Mapping Based on Research Approach

Research Approach	Total
Generalized method of moments	3
Regressions analysis	3
Autoregressive distributed lag	2
Others	76
<b>Grand Total</b>	<b>84</b>

### 5.7 Mapping Based on Research Methods

It can be seen in Table 6 that from 113 research objects, more studies use quantitative methods, namely as many as 87 journals. In addition, not many previous researchers used qualitative methods or used 2 methods, namely quantitative and qualitative. The research that uses the most quantitative methods comes from 2021, which is researched by [39], [33], [40-44], [34], [45-49], [31], [38], [30], [32], [50], [51], [29], [52-55].

**Table 6.** Mapping Based on Research Methods

Methods	Total
Quantitative	87
Qualitative	23
Qualitative & Quantitative	3
<b>Grand Total</b>	<b>113</b>

### 5.8 Mapping Based on Number of Years Analysis

The number of years of analysis is the number of years used as the scope of the research. Table 7 shows that the number of years of analysis used in research is very diverse. Based on Table 5, the most widely used number of years of analysis is 1, namely [56-64].

**Table 7.** Mapping Based on the Number of Years Analysis

Number of Years Analysis	Total
1	10
5	7
12	6
Others	84
<b>Grand Total</b>	<b>113</b>

### 5.9 Mapping Based on Dependent Variables

Table 8 below shows the results of mapping the dependent variable used in research related to carbon emissions. Based on Table 8, the most widely used dependent variable is CO2 Emissions. The initial study using the dependent variable CO2 emissions was in 2018 [65] followed by research by [27]. However, in 2020, no studies are using this variable. Then in 2021, there are three studies using this variable, including research by [29], [54], and [45].

**Table 8.** Mapping Based on Dependent Variables

Dependent Variables	Total
CO2 emission	5
Carbon dioxide emission per capita	4
Carbon emission	3
Carbon emission per capita	3
Others	55
<b>Grand Total</b>	<b>70</b>

### 5.10 Mapping Based on Independent Variables

Based on Table 9, we can see that the most independent variable is GDP per Capita. This research using the independent variable GDP per capita was started in 2018 [66], followed by research by [26]. In 2020, no studies are using this independent variable. So that it will continue until 2021, when two studies use this variable, including [31] and [45].

**Table 9.** Mapping based on Independent Variables

Independent Variables	Total
GDP per capita (PI)	4
Foreign direct investment (FDI)	3
Trade openness (TO)	3
Others	82
<b>Grand Total</b>	<b>92</b>

### 5.11 Mapping Based on Results

Finally, the researchers conducted a mapping based on the results of the study. Mapping based on research results based on carbon emissions is discussed in the articles that are the object of research. From table 10 it can be seen that the majority of articles in the object of this study have a positive relationship, namely as many as 86 papers. Articles that discuss the positive relationship are meant to talk about reducing carbon emissions [67-73]. Also on this positive relationship, two studies have similar results [29]; [45]. Both studies state that renewable energy has an impact on reducing carbon emissions. However, based on research by [29], this impact only applies in low-income countries and does not affect high-income countries. Then in the research of [45], growth in R&D spending can encourage the consumption of renewable energy so this indicator is also an important factor in reducing carbon emissions.

Then 14 articles have a positive and negative relationship simultaneously [74-79]. Also, in this positive-negative relationship, two studies have similar topics [30]; [38]. Both studies discuss the relationship between trade openness and carbon emission, and the results show that there is a positive impact between trade openness and carbon emissions. However, according to research by [30], only rich countries have a positive impact, and the opposite impact is in poor countries. Then [38] research, apart from discussing trade openness, also discusses the impact of FDI, the results of which show that FDI has a negative impact on carbon emission. Furthermore, there is one neutral article, namely [80]. Lastly, which has a negative relationship, there are 12 articles namely, [81, 82]. And according to the research of [56], many respondents think that there is a lack of knowledge about the impact of household electrical appliances as a cause of carbon emissions, so there is a possibility that the local Environmental Service will not provide sufficient information to the public about the importance of carbon emissions from households.

**Table 10.** Mapping Based on the Results

Results	Total
Positive relation	86
Positive & negative relation	14
Negative relation	12
Neutral	1
<b>Grand Total</b>	<b>113</b>

## 6 Conclusion

This study aims to map various research results related to carbon emissions from 2011 to early 2022. The mapping is based on the level of year of publication, publisher accreditation, the theory used, research methods, research units, number of years analysis, sample size, research variables, and results. This study also uses a qualitative method with a bibliographic approach. The objects used in this study were 113 research articles published by Scopus indexed journals. The results showed that the year most journals were published was 2021. The journal publishers that discussed the most carbon emissions were the Journal of Cleaner Production, which consisted of 32 journals. Most of the journal quality levels in this study were Scopus Q1. The most widely used theory in this research is the theory of legitimacy which uses quantitative methods. This study discusses various countries as the unit of analysis with the scope of the unit of analysis being 1 year. Most quantitative studies use CO2 emission as the dependent variable and GDP per capita (PI) as the independent variable.

This research was conducted to contribute to the form of a research gap that can be used as material for further research for academics and provide input for regulators in carbon emission research in the future. With the results of the mapping based on theory, this study recommends further researchers use evolutionary game theory, inventory theory, neo-institutional theory, or queuing theory in researching carbon. Related to the next unit of analysis, you can use Companies in the US, Companies in China, SAARC (South Asian Association for Regional Cooperation), or sub-Saharan Africa (SSA). In addition, for the next year of research analysis, it is better to use the latest analysis year or one that has never been used in previous research, namely 2019 to 2022 with a total of four years of research. As for the dependent variable, further research should use Carbon performance, Carbon intensity, Climate finance, green score, green rank, or labor productivity as the dependent variable of the research. Furthermore, further researchers can use independent variables such as Company size, Emission performance, Board environmental orientation, Energy use, Environmental operational performance, Environmental management performance, Fossil fuel emissions, Coal consumption, Climate Change Act, Carbon Management Practice, Carbon risk management, or Real effective exchange rates.

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