



Review Article

Impact of Belt and Road Initiative on Energy and Environment for Sustainable Development: A Systematic Review and Meta-Analysis

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Abstract:

The Belt and Road Initiative (BRI), launched in 2013 by Chinese President Xi Jinping, aims to enhance economic relations between China and global regions, emphasizing sustainable development through renewable energy initiatives. Despite its potential benefits, concerns about the BRI's environmental and energy impacts persist, necessitating a comprehensive analysis. This systematic review and meta-analysis utilized a rigorous search across multiple databases and included studies from database inception to 2024. Criteria included research on the BRI's influence on energy, environment, and sustainable development, focusing on publications in energy, environmental science, economics, econometrics, and finance. Review encompassed 87 relevant documents, employing content analysis, bibliometric analysis, and systematic literature review techniques. Co-authorship, co-citation, and co-word analyses provided insights into research networks, thematic evolution, and keyword relationships. Findings highlighted the BRI's effects on green energy, carbon emission reduction, foreign direct investment, global value chains, and environmental sustainability, with notable contributions to understanding economic structures, trade patterns, and regulatory frameworks. Study contributes significantly to understanding how the BRI influences sustainable development, emphasizing the need for integrated impact assessments, governance frameworks, inclusive development, technological innovation, long-term environmental impacts, and policy evaluations. Future research directions include evaluating environmental laws, assessing social and environmental impacts, and promoting evidence-based policymaking for sustainable BRI initiatives. The Belt and Road Initiative's complex effects on energy, environment, and sustainable development underscore the importance of holistic assessments and interdisciplinary approaches to inform policymaking and achieve sustainable development goals within BRI projects.

Keywords: BRI, Carbon Emission, Climate Change, Sustainability, Systematic review, Meta-analysis

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INTRODUCTION

Unveiled in 2013 by Chinese President Xi Jinping, the Belt and Road Initiative (BRI) is a transformative plan aimed at enhancing economic relations between China and other global regions, including Southeast Asia, Central Asia, Russia, and Eastern Europe. The Silk Road Economic Belt, 21st-Century Maritime Silk Road, or One Belt, One Road, as it used to be known, has undergone substantial change, reflecting the dynamic nature of Chinese foreign policy. The Belt and Road Initiative (BRI), which consists of an extensive network of development and infrastructure projects, is China's strategic bid to increase its worldwide political, economic, and diplomatic influence. The ambitious land-based and marine routes of the Belt and Road Initiative (BRI) cover large geographical expanses, with a concentration on essential sectors like energy, infrastructure, transport, aviation, logistics, agriculture, and communications. One of the main objectives of the Belt and Road Initiative is to encourage sustainable development, with a focus on the development of renewable energy (Bhattacharya et al., 2017). As renewable energy can reduce greenhouse gas emissions, increase energy security, and stimulate economic growth, it is considered an essential component of sustainable development. To mitigate climate change, a low-carbon economy must be built; the expansion of renewable energy is essential to this move (C. Li & Umair, 2023). With a projected investment of over \$1 trillion, the BRI's sheer scope and size offer both potential and difficulties, therefore a thorough analysis of its effects on environmental and energy sustainability is required.

As Chinese companies embark on projects in more than 65 nations, including parts of Europe, Asia, Latin America, and Sub-Saharan Africa, worries about the BRI's effects on the environment and society have surfaced. Although the initiative has great potential to address infrastructure gaps, promote economic growth, and advance the Sustainable Development Goals (SDGs) of the UN, more research is necessary because the BRI Vision Statement does not contain clear guidelines regarding environmental protection or the roles of civil society. Researchers who have examined the BRI's impact on the SDGs, its ability to support or undermine sustainable infrastructure development, and its possible impacts on developing nations include (Yanqiang et al., 2018), (Anarfo et al., 2019), and (T. Feng et al., 2019). The Belt and Road Initiative (BRI), which developed from China's previous "Going Out" policy, offers a distinct challenge in navigating the intricate world of foreign investments. This highlights the significance of comprehending the BRI's nuances and effects on environmental and energy sustainability (T. Feng et al., 2019), (Yanqiang et al., 2018) and (Anarfo et al., 2019). Taking these factors into consideration, this systematic literature review aims to explore the body of research on how the Belt and Road Initiative relates to energy and the environment. In light of the BRI's broad scope, the assessment offers insightful information about the prospects, obstacles, and possible routes toward sustainable development.

Given that the Belt and Road Initiative (BRI) is still developing into an influential force that is changing world relations and development, this evaluation is very important. The integration of many study results will offer a comprehensive comprehension of the BRI's complex effects on the environment and energy. This review intends to inform policymakers, researchers, and practitioners involved in international infrastructure projects by carefully evaluating studies carried out by academics like (Thürer et al., 2020), (T. Feng et al., 2019), and others. A complex and detailed strategy is required due to the relationship among economic objectives, environmental sustainability, and geopolitical factors within the BRI framework. We hope to provide insightful information about the role of the Belt and Road Initiative (BRI) in accomplishing sustainable development through this comprehensive assessment of the literature (Thürer et al., 2020), (T. Feng et al., 2019).

While several studies have researched the influence and relationships between energy and the environment on the economy, our investigation focuses on the Belt and Road Initiative's (BRI) effects on the economy for sustainable development, with a particular focus on the interconnected dynamics of energy and environment. We used a meta-literature review approach from 2018 to 2024, combining content analysis, bibliometric analysis, and systematic literature review (SLR) to obtain an extensive comprehension. In the identification phase, the study carefully chose search terms, criteria, databases, and data extraction techniques. Our keyword search, "Belt and Road" AND Economy, fits with the study's main goal of determining how energy and environment affect the economy for sustainable development within the Belt and Road Initiative framework. Using metadata to ensure a robust analysis, we used 'Bibliometric,' an R-based software, for co-authorship, co-citation, and co-word analyses. This method successfully captures the intellectual, conceptual, and social network in the assigned research field, demonstrating patterns of collaboration/co-authorship and thematic evolution related to the Belt and Road Initiative's influence on energy, and environment for sustainable development.

Within the existing literature, we identified four different clusters of research interest: The impact of the Belt and Road Initiative on Green Energy and Carbon Emission Reduction; the Impact of the Initiative on Foreign Direct Investment; the Impact of the Initiative on Trade/Financial Digital Inclusion/Global Value Chain (GVC); and the Impact of the Initiative on Environmental and Climate Change for Sustainable Development. Prospective investors, policymakers, and scholars alike will find our identification of future research directions extremely interesting.

The review is organized as follows: Section 2 discusses the data and methodology; Sections 3 and 4 offer Analysis and Interpretation of result and content analysis respectively, while Section 5 finalizes the review with a discussion, future research direction, and conclusion.

MATERIALS AND METHODS

A systematic literature review (SLR) was used in this study, which includes inclusion/exclusion criteria, analysis methods, and a more objective way of the article selection process. The study complied with the suggested principles for systematic reviews (Liberati et al., 2009) and used the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) framework for article selection processes, which include identification, screening, and inclusion/exclusion as shown in figure 1A. The study carefully chose search terms, criteria, databases, and data extraction methods during the identification phase. The keyword search that we used is "Belt and Road" AND Economy; which corresponds with the overall objective of the study, which is to identify the impact of Energy and Environment on finance and economy for sustainable development based on the Belt and Road Initiative. The identified papers need to be screened by the PRISMA framework. The assessment, retrieval, and review of each article's eligibility were all part of the screening procedure. According to (Priyashantha et al., 2023), manuscripts that didn't fit the requirements for inclusion were excluded from every task. Empirical studies that had been reported in the English language and published in Journals between 2018 to 2024 and under the subject areas energy, environmental science, economics, econometrics, and finance were the articles considered in the inclusion criteria for screening.

There were two approaches used in the screening process: manual and automated processes. The research type, language, report type, and publication date were among the criteria used to filter publications using the automatic article screening tools available in Science Direct (SD). (Vieira & Gomes, 2009) pointed out that (SD) is very comprehensive

because it contains a wide range of publications, properties, and academic disciplines. The author manually carried out this crucial stage, determining each article's eligibility on its own before proceeding. Duplicates were first removed from the searched articles dataset. After that, a review of the abstracts and titles was done to exclude publications that were irrelevant to the aim of the study. Lastly, the full texts of articles were reviewed in their entirety, and the references were checked for additional pertinent literature. Putting it all up, this literature review includes 87 documents and papers in total. Incorporating the previously studied aspects of energy, environmental science, economics, econometrics, and finance and also some documents or findings on belts and road initiatives and vision related to energy, environment, and economy.

An excellent approach for obtaining a wide range of insights from several sources is Meta-analysis (Fetscherin & Heinrich, 2015). Systematic literature reviews are becoming more and more popular, which is a witness to being able to provide evidence at the meta-level and identify areas that need more research (Snyder, 2019). We used content analysis and bibliometric analysis in our study to appraise the research's validity and reliability as well as its statistical properties. The concept of bibliometric analysis has evolved significantly in aligned with software upgrades designed for research mapping and visualization. Bibliometric is an R software package that we used to do mapping exercises and an in-depth analysis of different statistical parameters.

Data Analysis And Visualization

Our study is performed around two main approaches: content analysis for qualitative research and bibliometric analysis for quantitative and empirical research. Following the guidelines provided by (Fetscherin & Heinrich, 2015), we conduct Co-authorships, Co-citation, Co-word, and thematic evolution analyses. 'Bibliometric,' an R-studio package, is our main tool of choice; it was first offered by (Aria & Cuccurullo, 2017). Using metadata (bibliographic information) as input to create networks, clusters, and themes based on the data provided, this R-based software makes thorough science mapping analysis easier.

Co-authorship analysis provides a social network model that draws links between various authors. This framework offers insights into future research direction and makes it possible to anticipate future collaboration. As a result, we can construct a framework of research pyramids through the assessment of the social structure in the area, the identification of prominent researchers, and the capture of all publication production in the field. Examining Co-citations involves looking deeply into referenced works, analysing relationships, and inferring changes. Adapted to the research's scope, the co-citation framework aims to show relationships between sources, articles, and authors. By doing this, it helps to capture the influence of these many factors in the field and how they affect the research area (Aria & Cuccurullo, 2017); (Aria et al., 2020). Co-word analysis, which maps and clusters keyword co-occurrences, provides a conceptual framework. By using multiple correspondence analysis, the software makes it easier to extract the conceptual structure and find clusters of connected concepts (Sánchez-Núñez et al., 2020). By performing a keyword analysis, we sought to identify the primary concepts found in the literature. Using the software's word trend and thematic analysis features, we were able to graphically present significant shifts in the way that keywords were used over time. To add a qualitative viewpoint to the empirical research, we conducted content analysis which is in line with research by (Zamore et al., 2018) This included classifying and verifying the research stream, exploring the origins and growth of ideas further, investigating topics and significant findings, and closely examining research gaps.

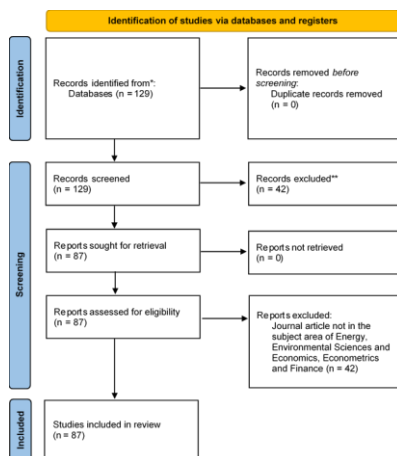


Figure 1. PRISMA Framework Flow chart diagram

Analysis and Interpretation of Result

The yearly production of articles is shown in Table 1 and Figure 1, which provide a summary of the research output over time. Indicating a consistent study effort and potentially increasing interest in the topic, the graph shows a continuous growth in publications from 2018 to 2024. This increasing trend can represent the research community's continued engagement in this area and its importance.

Table 1. Articles production per year

Year	Articles
2018	5
2019	6
2020	15
2021	16
2022	25
2023	18
2024	2

Sources. Produced by the author using R Bibliometric package (Biblioshiny).

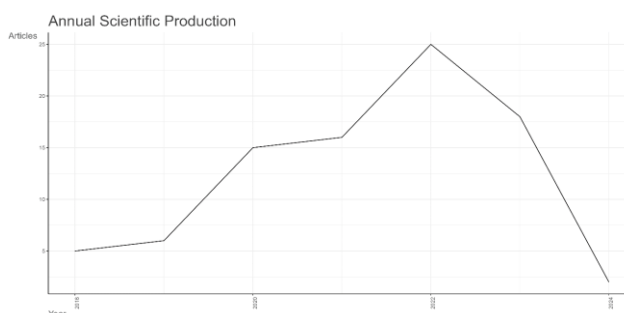


Figure 1. Graph, showing the number of articles produced by year, Sources: Produced by the author using R Bibliometric package (Biblioshiny).

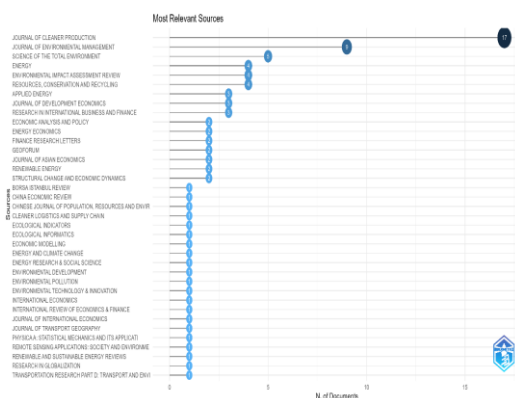


Figure 2. Graph, showing the Most Influential Journals, Sources: Produced by the author using R Bibliometric package (Biblioshiny).

The analysis is further expanded in Figure 3, which shows the production trends of the top six most relevant journals. This graph presents a dynamic viewpoint, showing changes in these journals' emphasis over time; these varying patterns might represent themes or changes in research focus within the field. Researchers can use this information to stay up to date on the landscape's development and to strategically target high-impact journals for dissemination. In general, these analyses offer an in-depth view of the research perspective, that involves both trends over time and journal relevance.

Upon examining the most relevant resources (journals) shown in Table 2, one can gain important insights from the rank, frequency (Freq), cumulative frequency (cumFreq), and zone. The most relevant journals are graphically represented in the graph Figure 2, highlighting their significance. This can assist researchers in locating important papers in the field and navigating significant outlets.

Table 2. Most relevant sources (Journals).

SO	Rank	Freq	cumFreq	Zone
Journal of Cleaner Production	1	17	17	Zone 1
Journal of Environmental Management	2	9	26	Zone 1
Science of the Total Environment	3	5	31	Zone 1
Energy	4	4	35	Zone 2
Environmental Impact Assessment Review	5	4	39	Zone 2
Resources, Conservation and Recycling	6	4	43	Zone 2
Applied Energy	7	3	46	Zone 2
Journal of Development Economics	8	3	49	Zone 2
Research in International Business and Finance	9	3	52	Zone 2
Economic Analysis and Policy	10	2	54	Zone 2
Energy Economics	11	2	56	Zone 2
Finance Research Letters	12	2	58	Zone 2
Geoforum	13	2	60	Zone 2
Journal of Asian Economics	14	2	62	Zone 3
Renewable Energy	15	2	64	Zone 3
Structural Change and Economic Dynamics	16	2	66	Zone 3
Borsa Istanbul Review	17	1	67	Zone 3
China Economic Review	18	1	68	Zone 3
Chinese Journal of Population, Resources and Environment	19	1	69	Zone 3
Cleaner Logistics and Supply Chain	20	1	70	Zone 3

Sources. Produced by the author using R Bibliometric package (Biblioshiny).

Table 3. Most relevant authors

Authors	Articles	Articles Fractionalized
Xin Wang Xw	3	0.50
Alen Mulabdic Am	2	0.53
Boqiang Lin Bl	2	1.00
Chao Wang Cw	2	0.37
Chuanwang Sun Cs	2	0.83
Dabo Guan Dg	2	0.38
François De Soyres Fs	2	0.53
Jacob Wood Jw	2	0.37
Jun Bi Jb	2	0.45
Li-Jing Liu Ljl	2	0.45
Liang Zhong Lz	2	0.48
Miaomiao Liu Ml	2	0.45
Michele Ruta Mr	2	0.53
Xiaosheng Liu Xl	2	0.48
Yanchun Pan Yp	2	0.70
Yongjie Wang Yw	2	0.37
Yuli Shan Ys	2	0.38
Abay Yimere Ay	1	0.07
Abdelhak Senadjki As	1	0.25
Agni Klintuni Boedihartono Akb	1	0.17
Ahmad B. Albadarin Aba	1	0.11

Sources. Produced by the author using R Bibliometric package (Biblioshiny).

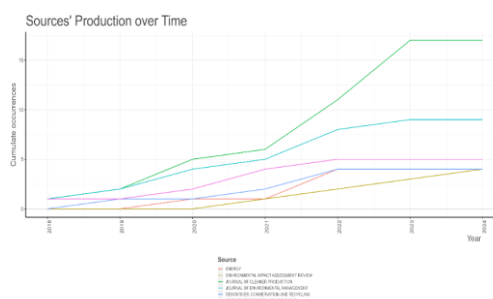


Figure 3. Graph, showing the Most Influential Journals production over the year, Sources: Produced by the author using R Bibliometric package (Biblioshiny).

As seen in Figure 4 (b), we carried out a study to determine the core authors based on their output over time (where the circle represents the number of articles and the shade thickness represents the amount of articles production produced). Finding the core authors makes it easier for us to investigate how these authors steer a research field's stream and how their future collaboration will progress. We observed Table 3 shows the influential articles based on their production over time. It is evident that XIN WANG XW's work has the highest number of articles, and the three-fold plot in Figure 4 (c) shows how the authors (AU) interconnect with each other in the research based on the Keyword (ID) and Abstract Term sector (AB_TM).

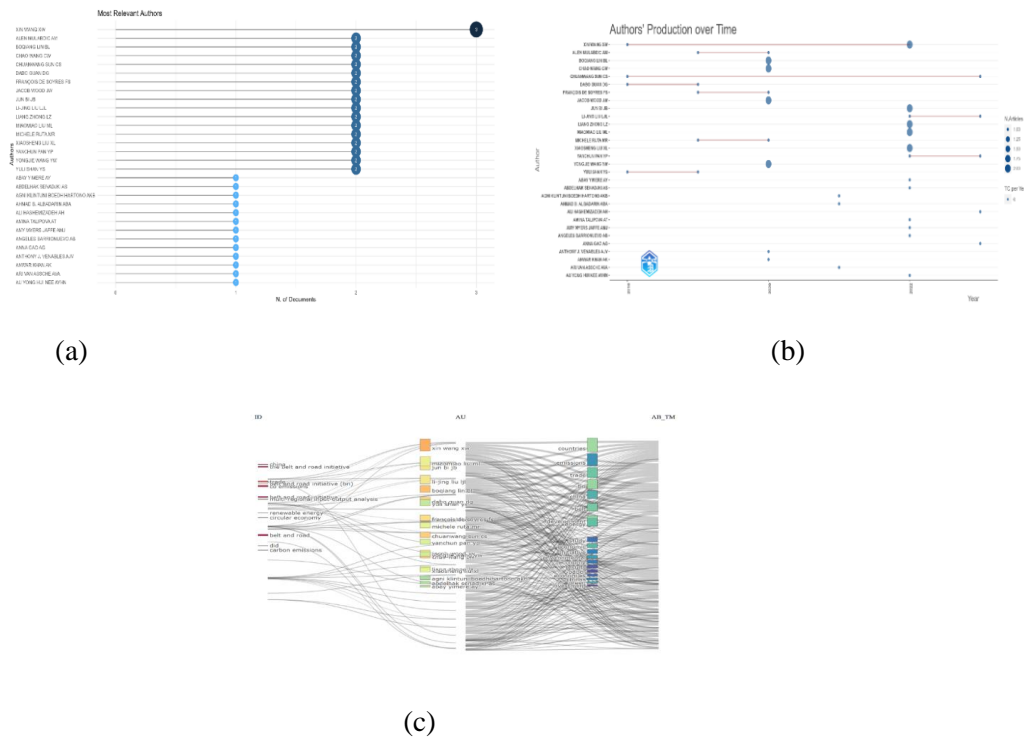


Figure 4. (a) Graph showing Most Relevant Authors, (b) Graph showing Authors' Production over Time, and (c) Graph showing Three Fold Plot of Authors (AU), Keyword (ID) and Abstract (AB). Sources: Produced by the author using R Bibliometric package (Biblioshiny).

Table 4. Lotka's author's productivity.

Lotka's Author's Productivity		
Documents written	N. of Authors	Proportion of Authors
1	328	0.951
2	16	0.046
3	1	0.003

Sources. Produced by the author using R Bibliometric package (Biblioshiny).

According to Lotka's Law, Table 4 shows the distribution of author productivity based on the quantity of papers authored. 95.1% of authors just contribute a little bit and have written one document. Just 4.6% of the population is moderately prolific, having written two documents, and even fewer (0.3%) are highly productive, having written three documents. According to Lotka's Law, this distribution shows a concentration of research production among a small number of authors, supporting this we also provide the graph Figure 5 showing how the numbers were distributed corresponding to authors.

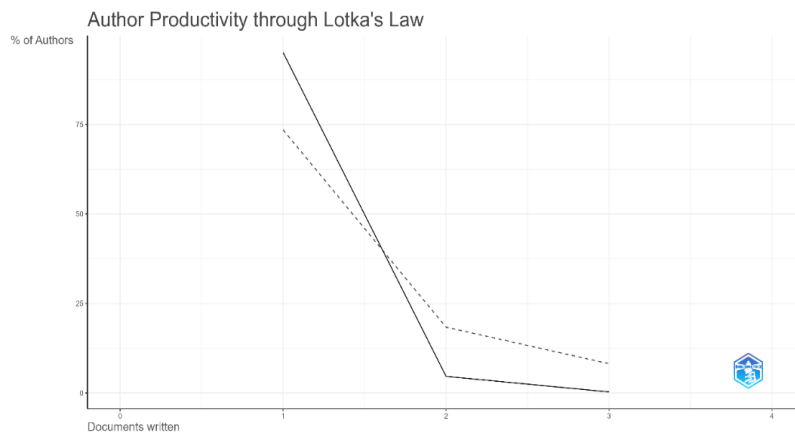


Figure 5. Graph showing Authors' productivity through Lotka's Law. Sources: Produced by the author using R Bibliometric package (Biblioshiny).

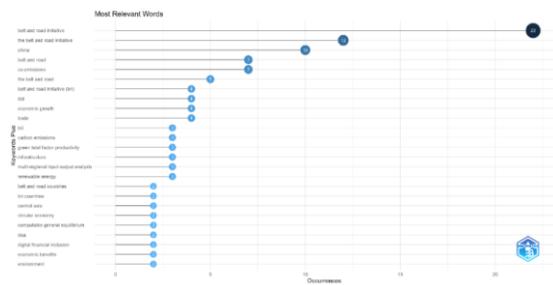
The co-word analysis in Table 5 sheds light on the frequency of three-word keywords/factors from the Abstract and keyword appearance in the research. The word counts for abstract three-word appearance and keyword appearance are shown graphically in Figures 6(a) and (b), respectively. The frequency distribution is presented in detail in the figures, which also emphasize the terms that are most frequently used in the literature. In addition, word clouds and tree maps are displayed in Figures 7(a), (b), (c), and (d), providing a graphical representation of the significance and connections between terms

Table 5. Keywords and abstract co-words appearance.

Keywords Appearance		Abstract Three Words Appearance	
Words	Occurrences	Words	Occurrences
belt and road initiative	22	road initiative bri	29
the belt and road initiative	12	foreign direct investment	10
china	10	digital financial inclusion	8
belt and road	7	green economic growth	7
co emissions	7	green investment transformation	6
the belt and road	5	low-carbon economy development	6
belt and road initiative (bri)	4	direct investment fdi	5
did	4	financial development level	5
economic growth	4	green economic development	5
trade	4	total factor productivity	5
bri	3	water scarcity risk	5
carbon emissions	3	china-brcs bilateral trade	4
green total factor productivity	3	effective energy services	4
infrastructure	3	green total factor	4
multi-regional input-output analysis	3	multi-regional input-output model	4
renewable energy	3	renewable energy infrastructure	4
belt and road countries	2	sustainable development goals	4
bri countries	2	achieve sustainable development	3

Sources. Produced by the author using R Bibliometric package (Biblioshiny).

(a) Keyword Count



(b) Abstract Three Word Count

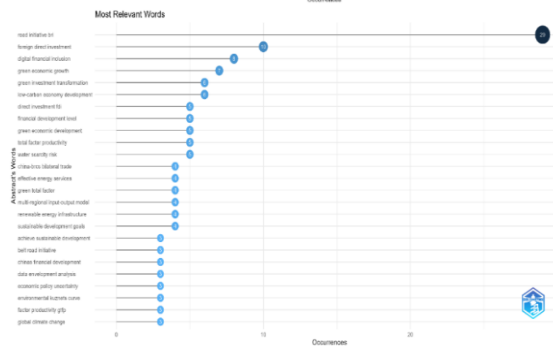


Figure 6. (a) Graph showing Keyword's Co-word appearance count, (b) Graph showing abstract three words Co-word appearance count. Sources: Produced by the author using R Bibliometric package (Biblioshiny).



(a) Keywords Cloud



(b) Keyword Tree Map



(c) Abstract Three Word Tree Map



(d) Abstract Three Word Cloud

Figure 7. (a) Graph showing keyword's co-words cloud, (b) Graph showing Keyword's Co-words tree map. (c) Graph showing abstract's three words co-words tree map and (d) Graph showing abstract's three words co-words cloud. Sources: Produced by the author using R Bibliometric package (Biblioshiny).

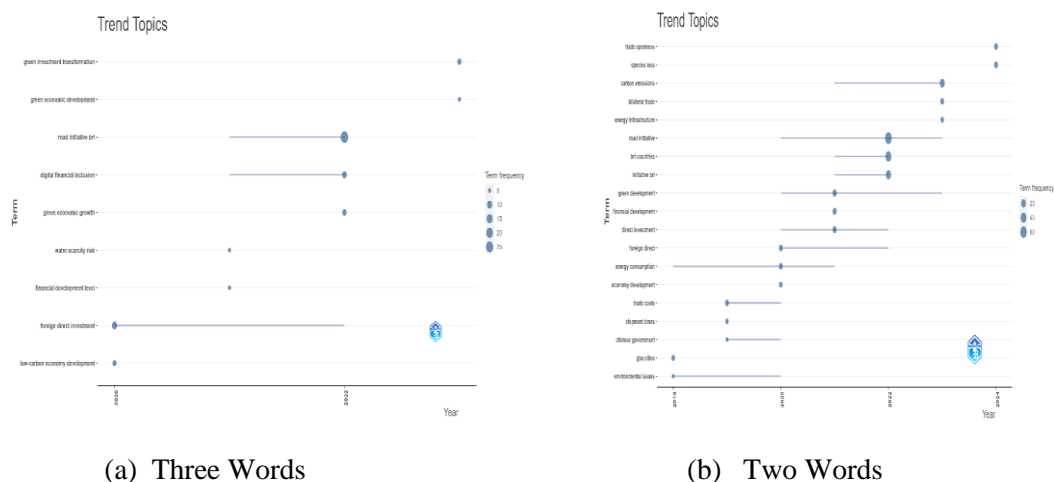


Figure 8. (a) Graph showing the three co-word trending topics and (b) Graph showing the two co-word trending topics. Sources: Produced by the author using R Bibliometric package (Biblioshiny).

Table 6. Trending topic.

Two Words Factor		Three Words Factor	
Sector	freq	Sector	freq
gba cities	7	foreign direct investment	10
environmental issues	5	low-carbon economy development	6
trade costs	9	financial development level	5
shipment times	6	water scarcity risk	5
chinese government	5	road initiative bri	29
energy consumption	10	digital financial inclusion	8
foreign direct	10	green economic growth	7
economy development	7	green investment transformation	6
green development	13	green economic development	5
financial development	12		
direct investment	11		
road initiative	67		
bri countries	44		
initiative bri	29		
carbon emissions	25		
bilateral trade	9		
energy infrastructure	7		
species loss	10		
trade openness	10		

Sources. Produced by the author using the R Bibliometric package (Biblioshiny).

Table 8. Three Co-Words Clusters.

Node	Cluster	Betweenness	Closeness
road initiative bri	1	25.33	0.09
foreign direct investment	1	4.19	0.07
direct investment fdi	1	3.48	0.07
multi-regional input-output model	1	0	0.05
sustainable development goals	1	0	0.05
environmental kuznets curve	1	0	0.06
bri region due	1	0	0.06
chinas outward fdi	1	0	0.05
data envelopment analysis	2	0	0.04
global climate change	2	8	0.06
panel threshold model	3	0	1
provincial panel data	3	0	1
total factor productivity	4	0	0.5
green total factor	4	0	0.5
factor productivity gtfp	4	0	0.5

Sources. Produced by the author using R Bibliometric package (Biblioshiny)

Keyword Co-Word Occurrence Analysis

Table 9. Two co-words clusters.

Node	Cluster	Betweenness	Closeness
green economic	1	1.848	0.016
economic development	1	16.833	0.017
developing countries	1	0.828	0.016
green development	1	0.386	0.016
green economy	1	2.820	0.017
development level	1	0	0.015
developed countries	1	0.040	0.015
economy development	1	0	0.011
international trade	1	0.020	0.015
economic performance	1	0	0.015
carbon emissions	2	2.884	0.016
renewable energy	2	0.735	0.015
sustainable development	2	30.970	0.020
economic growth	2	2.944	0.017
direct investment	2	0.101	0.015
energy consumption	2	0.725	0.015
foreign direct	2	0.101	0.015
ecological sustainability	2	0	0.014
bilateral trade	3	0	0.014
road countries	3	1.218	0.015
br countries	4	0	0.014
road br	4	0.727	0.015
road initiative	5	403.766	0.027
bri countries	5	27.315	0.018
initiative bri	5	42.637	0.02
participating countries	5	0	0.014
energy infrastructure	5	0	0.014
economic benefits	5	0	0.015
final demand	5	0.057	0.015

Sources. Produced by the author using R Bibliometric package (Biblioshiny).

Table 6 and Figure 8 (a) and (b) show how the temporal evolution of the two-word and three-word keywords illustrates the evolving study focus over time. This is achieved through a study of trending topics. Tables 8 and 9 represent the Keyword Co-Word Occurrence

Analysis, which offers an extensive review of co-occurrence patterns among terms in the literature. The network's structural features, such as nodes, clusters, betweenness centrality, and closeness centrality, are displayed in Table 8's Two Co-Words Clusters table. Similarly, this analysis is expanded to three co-word clusters in Table 9. Individual keywords are represented by nodes, and groups of closely related keywords are represented by clusters. Metrics such as betweenness and closeness centrality can provide information about the significance and closeness of terms inside clusters.

The visual representation of the network plots for the two and three co-word clusters (a) and (b), respectively in Figure 9 provides an added feature to these tables. These graphs provide a visual representation of the interactions and connections between the terms. High relevance and influence keywords within the study domain are indicated by dense clusters and centre nodes. Researchers can use this data to determine important topic clusters and comprehend the semantic connections among different concepts in the literature. Scholars can better understand hidden patterns and the underlying structure of keyword correlations in the studied literature by combining quantitative metrics and visual representations.



(a) Two Co-Word Factor Network Plot

(b) Three Co-Word Factor Network Plot

Figure 9. (a) Graph showing the network plot of the two co-word clusters and (b) Graph showing the network plot of the three co-word clusters. Sources: Produced by the author using R Bibliometric package (Biblioshiny).

The content structure of the literature is examined in the thematic analysis presented in Table 10. Within theme clusters, the "Occurrences" indicates how frequently particular words occur, indicating the predominance of particular notions. The "Words" provides a collection of specific terms that give an overview of the essential terminology. Clusters help identify unique topics by grouping related words, as shown in the "Cluster". The "Cluster_Label" column gives each thematic cluster a descriptive description that gives a brief synopsis of the main theme each cluster represents.

Furthermore, the structural features of every cluster are revealed by network measures like "btw_centrality," "clos_centrality," and "PageRank Centrality." Lower closeness centrality denotes central, well-connected keywords, whereas higher betweenness centrality reveals crucial words enabling linkages. Based on the linkages and relevance of those links, Pagerank Centrality assesses the importance of a word. With a graphical representation of the relationships and organizational frameworks among the topic clusters, Figure 10 illustrates this thematic analysis visually. To help researchers better understand the thematic landscape, the network plot graphically conveys the links and significance of words.

Table 10. Thematic analysis.

Occurrences	Words	Cluster	Cluster_Label	btw_centrality	clos_centrality	pagerank Centrality
22	belt and road initiative	1	belt and road initiative	9604.5	0.0017	0.049
10	china	1	belt and road initiative	4513.7	0.0016	0.022
7	co emissions	1	belt and road initiative	2381.5	0.0014	0.017
2	circular economy	1	belt and road initiative	10.7	0.0010	0.006
2	environmental sustainability	1	belt and road initiative	2150.3	0.0015	0.004
2	sustainable development goals (sdgs)	1	belt and road initiative	97.6	0.0012	0.005
2	trade shocks	1	belt and road initiative	206.0	0.0013	0.004
4	economic growth	2	the belt and road	3638.9	0.0016	0.01
2	foreign direct investment	2	the belt and road	1815.4	0.0013	0.005
2	fdi	3	fdi	1795.0	0.0014	0.006
2	panel threshold model	3	fdi	1029.6	0.0013	0.006
2	transportation infrastructure	3	fdi	1269.3	0.0013	0.005
12	the belt and road initiative	4	the belt and road initiative	4358.5	0.0016	0.025
4	did	4	the belt and road initiative	3177.6	0.0016	0.009
4	trade	4	the belt and road initiative	2429.9	0.0015	0.009
2	economic benefits	4	the belt and road initiative	8.2	0.0012	0.005
2	environment	4	the belt and road initiative	40.1	0.0013	0.005
2	governance	4	the belt and road initiative	40.1	0.0013	0.005
7	belt and road	5	belt and road	5202.5	0.0014	0.015
2	evaluation	5	belt and road	206.2	0.0013	0.004
2	index system	5	belt and road	206.2	0.0013	0.004
2	Night-time light remote sensing	5	belt and road	13.5	0.0010	0.005
2	outward foreign direct investment	5	belt and road	424.0	0.0013	0.005
3	bri	6	bri	1320.8	0.0013	0.008
3	green total factor productivity	7	Green,total factor productivity	1051.0	0.0008	0.009
3	carbon emissions	8	belt and road initiative (bri)	3740.8	0.0012	0.007
3	infrastructure	9	infrastructure	956.8	0.0014	0.006
3	renewable energy	9	infrastructure	332.7	0.0012	0.007
2	computable general equilibrium	9	infrastructure	862.8	0.0015	0.004
2	resource	9	infrastructure	574.5	0.0015	0.005

Sources. Produced by the author using R Bibliometric package (Biblioshiny).

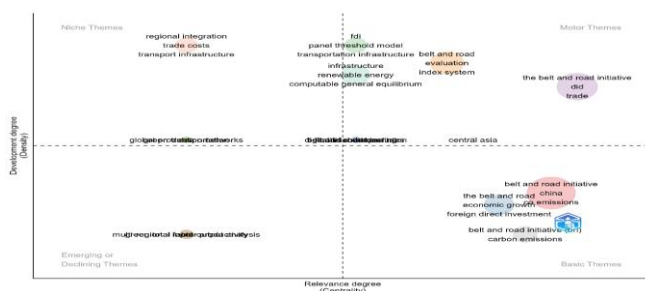


Figure 10. Graph showing thematic analysis. Sources: Produced by the author using R Bibliometric package (Biblioshiny).

Table 11: Thematic map network.

Cluster	Callon Centrality	Callon Density	Rank Centrality	Rank Density	Cluster Frequency
belt and road initiative	0.59	48.38	18	6	49
the belt and road	0.55	37.50	16	5	11
fdi	0.25	66.67	10.5	18.5	6
the belt and road initiative	1.23	56.94	19	15	26
belt and road	0.26	60.00	14	17	15
bri	0.00	33.33	4	2.5	3
green total factor productivity	0.00	33.33	4	2.5	3
belt and road initiative (bri)	0.58	33.33	17	2.5	7
infrastructure	0.25	59.03	10.5	16	10
regional integration	0.00	66.67	4	18.5	6
bri countries	0.25	50.00	10.5	10.5	2
digital financial inclusion	0.25	50.00	10.5	10.5	2
multi-regional input-output analysis	0.00	33.33	4	2.5	3
global production networks	0.00	50.00	4	10.5	2
central asia	0.50	50.00	15	10.5	2
financial deepening	0.25	50.00	10.5	10.5	2
belt and road countries	0.25	50.00	10.5	10.5	2
green transportation	0.00	50.00	4	10.5	2
dea	0.00	50.00	4	10.5	2

Sources. Produced by the author using R Bibliometric package (Biblioshiny).

Providing more details, Table 11 presents the Thematic Map Network. Measures of the significance and interdependence of clusters include "Callon Centrality" and "Callon Density". The methods "Rank Centrality" and "Rank Density" are used to evaluate cluster prominence. "Cluster Frequency" gives details on how often each cluster occurs. The Thematic Map Network plot, which provides a visual depiction of the thematic relationships, is shown in Figure 11, researchers can identify significant topic clusters and their network dynamics with this visual aid, which improves comprehension of thematic relationships. Researchers can fully explore thematic patterns in the literature with the help of the tables and figures created with the R Bibliometric package.

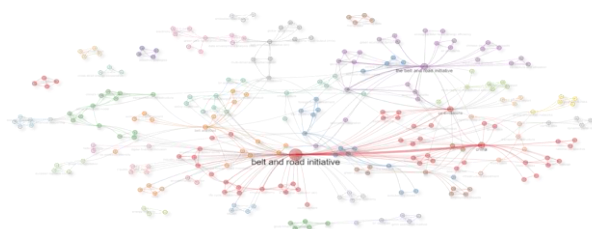


Figure 11. Thematic Map Network plot. Sources: Produced by the author using R Bibliometric package (Biblioshiny).

About author collaboration in the literature, Table 12 (Co-Authorship/Collaboration) offers important insights. The "Cluster" column organizes authors according to their collaboration links, the "Node" reflects individual authors. Network centrality measures are displayed in the "Betweenness" and "Closeness", providing insight into the proximity and influence of writers within the cooperation network. writers with higher betweenness values are those who play a vital role in bridging gaps in the collaboration

network, whereas writers with closer betweenness values are well-connected within their collaborative clusters.

Table 12. Co-authorship/collaboration.

Node	Cluster	Betweenness	Closeness
xin wang xw	1	6	0.2
jun bi jb	1	0	0.13
miaomiao liu ml	1	0	0.13
barbara bramble bb	1	0	0.14
bowen tan bt	1	0	0.14
carmen chen cc	1	0	0.14
dabo guan dg	2	0	1
yuli shan ys	2	0	1
liang zhong lz	3	0	0.5
xiaosheng liu xl	3	0	0.5
congcong zou cz	3	0	0.5
alen mulabdic am	4	0	0.5
françois de soyres fs	4	0	0.5
michele ruta mr	4	0	0.5
chao wang cw	5	0	0.33
jacob wood jw	5	0	0.33
yongjie wang yw	5	0	0.33
chi yeol kim cyk	5	0	0.33
abay yimere ay	6	0	0.5

Sources. Produced by the author using R Bibliometric package (Biblioshiny).

With the co-authorship network map in Figure 12, this comprehension is further enhanced visually. The graph highlights important nodes and clusters while highlighting the collaboration links between the authors. Strong collaborative groups are represented by dense clusters and core nodes, and the connections between authors show how closely they collaborate. The overall structure of the co-authorship network, as well as patterns in collaboration, may be easily identified with the help of this visual representation. With the help of the R Bibliometric package (Biblioshiny), the resultant output offers an in-depth look at the dynamics of co-authorship in the literature. Researchers can use this data to analyse the collaborative environment in the area, identify major contributors, and spot possible collaboration opportunities. Researchers are better able to comprehend the collaborative structure of the topic or issue they are analysing because of the combination of network parameters and visual representation.

As shown in Figure 13, we identified five primary clusters: red, blue, green, yellow, and purple. These clusters represent Energy and carbon emissions, Foreign Direct Investment, Financial Digital Inclusion, Global Value Chain (GVC), and Environmental and Climate Change, respectively. The identified streams are as follows: (1) Energy and Carbon Emission Reduction, (2) Foreign Direct Investment, (3) Trade/Financial Digital Inclusion/Global Value Chain (GVC), and (4) Environmental and Climate Change.



Figure 12. Graph showing Co-authorship network plot. Sources: Produced by the author using R Bibliometric package (Biblioshiny).

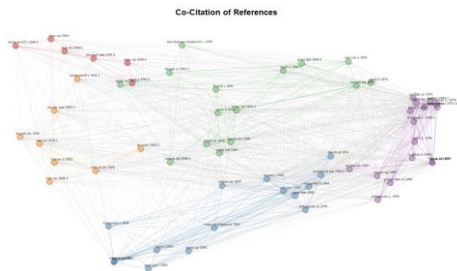


Figure 13. Graph showing Co-Citation of References network plot. Sources: Produced by the author using R Bibliometric package (Biblioshiny).

CONTENT ANALYSIS

Impact of Belt And Road Initiative On Green Energy And Carbon Emission Reduction

The Belt and Road Initiative (BRI) has a multidimensional impact on the green economy and carbon emission reduction for sustainable development, which is in line with this systematic literature review. It summarizes research findings from numerous research studies carried out by different scholars. In their analysis of the dynamics of green investment transformation, (J. Liu et al., 2023) clarify how green investment positively affects environmental friendliness and highlight how it drives green economic dynamics. (C. Zhang et al., 2020) outline political, social, and economic challenges to the growth of small hydropower projects along the Belt and Road (BRI), offering insights into the sustainability of these projects. Specifically, (W. Zhang & Sun, 2023) examine how outbound foreign direct investment (FDI) helps low- and middle-income nations that are part of the Belt and Road Initiative (BRI) transform their businesses into green a nation.

In the study of the BRI's impact on the rise of green total factor productivity (GTFP) across 121 nations, (J. Li et al., 2022) emphasize the initiative's benefits for green development while lowering economic risks. (L. Wang et al., 2021) article highlights the significance of collaborative water resource management for sustainable development by focusing on trade-related water scarcity risk under the Belt and Road Initiative. Under the BRI, (Soyres et al., 2020) offer a structural model that analyses the impacts of global transportation infrastructure, the study highlights issues and the possibility of negative welfare impacts in certain nations as a result of high infrastructure costs, even as it indicates potential GDP growth.

D. Zhang et al., (2021) systematically review ecological and environmental aspects along the BRI, emphasizing the importance of understanding and mitigating environmental risks for sustenance; (Bompard et al., 2022) and conduct a multidimensional assessment of energy sustainability and carbon pricing impacts along the BRI. Their quantitative framework emphasizes the significance of evaluating sustainability across society, economy, energy, and environment. They advocate for carbon pricing mechanisms as crucial tools to enhance

sustainability. (Zhai, 2018) uses a global computable general equilibrium model to assess the macroeconomic impact of the BRI, highlighting substantial benefits in terms of welfare and trade globally and emphasizing the need to address challenges for successful BRI implementation.

A comprehensive review of China's foreign loan practices and the effects they have on developing nations can be found in the research by (Horn et al., 2021). The paper emphasizes the prevalence of "hidden" debts and its implications for debt sustainability, citing China as the largest official creditor in the world. Also, important insights are provided by regional studies conducted by (Lin & Raza, 2020) on energy security indicators for Pakistan and by (Y. Zhou et al., 2018) on CO₂ emissions in the Guangdong-Hong Kong-Macao Greater Bay Area. Additionally, (H. Feng et al., 2022) emphasize the positive and considerable impact of government spending on green economic performance by focusing on the relationship between green economic performance, green financing, and green expenditures. Key elements for sustainable resource management of the water-energy-food nexus in the Belt and Road Initiative (BRI) are identified by (Qian et al., 2022) who also point out inefficiencies in resource utilization. Finally, by combining many viewpoints and research findings from eminent academics in the field, this content analysis offers an in-depth understanding of the BRI's influence on sustainable development.

Impact of Belt And Road Initiative On Foreign Direct Investment

Using information from numerous reputable studies, this extensive study of the literature critically analyses how the Belt and Road Initiative (BRI) affects foreign direct investment (FDI). According to (Y. Li et al., 2024), the Belt and Road Initiative (BRI) has a beneficial policy effect by elevating the Global Value Chain (GVC) position of participating nations. The research conducted by (C. Zhou & Lin, 2023) provides more depth to this story by demonstrating that Chinese enterprises use investments in Belt and Road countries as a risk mitigation strategy, with private and highly institutionally owned firms benefiting most from this approach. The BRI's complex economic effects on the Global Value Chain and risk management techniques for Chinese businesses are highlighted in this summary of findings.

Geng & He, (2021) investigate an important aspect of the influence of digital financial inclusion on sustainable employment in Belt and Road countries, their study notes the important contributions to employment while highlighting the variations in employment based on income levels. (Anwar et al., 2021) explore the complex interplay in BRI economies between CO₂ emissions, renewable energy, and forestation. By looking at the environmental sustainability of the Belt and Road Initiative, this study widens its reach. Evaluating the relationship between government spending and emissions, (Jin et al., 2022) advances our understanding of the environmental impact and highlights particular trends in the ecological and economic performance of BRI countries. Collectively, these studies highlight the necessity for a comprehensive approach to assessing the BRI's effects by shedding light on the initiative's wider socioeconomic and environmental implications.

Liao et al., (2021) provides further depth to the discussion by analysing the relationship between China's Outward FDI (OFDI), industrial structure upgrading, and domestic employment. Their research indicates that OFDI has a positive effect on domestic employment, and the Belt and Road Initiative (BRI) acts as a positive moderator, suggesting that the BRI shapes domestic labour markets in addition to foreign economies. (Niczyporuk & Urpelainen, 2021) add more context by analysing Chinese overseas energy finance, paying particular attention to the role of state-owned banks and their contentious investments in fossil fuel projects. An additional aspect is added by the policy suggestions made by (Yang & Zheng, 2021) on the effects of China's Outward Foreign Direct Investment (OFDI) on the domestic environment while taking financial development thresholds into account. When

taken as a whole, these studies highlight the complex relationships that exist between the BRI, employment dynamics, environmental sustainability, and economic development. This helps to provide a comprehensive knowledge of the initiative's many effects on the participating nations.

Impact of Belt And Road Initiative On Trade/Financial Digital Inclusion/Global Value Chain (GVC)

The various effects of the Belt and Road Initiative (BRI) on trade, financial digital inclusion, the Global Value Chain (GVC), and economic growth for sustainable development are evaluated critically in this extensive review of the literature. (Ma, 2022) establishes the tone by emphasizing the BRI's considerable benefits for local business expansion. This first result points to the initiative's role as an economic development accelerator and paves the way for a more thorough examination of its particular aspects. The studies that follow cover a wide range of topics, including government spending, connectivity projects, economic shocks, trade-induced air pollution, government spending, and the globalization tactics of China's national oil companies.

According to (Ali & Wang, 2023) analysis, GVCs in BRI nations have a beneficial impact on GTFP (Green Total Factor Productivity), with a particular focus on the complex relationship with environmental sustainability. (Bastos, 2020) the study examines how vulnerable the economies along the Belt and Road are to trade shocks from China, highlighting notable effects on exports that vary depending on regional and economic circumstances. By examining the development of bilateral commerce between China and the BRI nations, (Xiong et al., 2023) provide a valuable contribution by shedding light on the benefits and drawbacks for the environment. Together, these studies help to clarify how the Belt and Road Initiative (BRI) affects trade patterns, economic structures, and reactions to external shocks.

Although the research by (Zhao et al., 2022) on the China-Pakistan Economic Corridor (CPEC) emphasizes advances in transport network connectivity, it also raises questions regarding possible inequalities in development. The relationship between government spending, green economic performance, and the function of green finance study by (H. Feng et al., 2022), highlights the substantial positive impact of government spending on green economic performance. To shed light on the factors influencing Chinese funding of climate-friendly projects, (Bhandary et al., 2022) provide a valuable contribution by investigating the political economics of climate finance and Chinese investments abroad. The influence of digital financial inclusion on environmental sustainability and economic growth in BRI countries is examined (Ozturk & Ullah, 2022), the study reveals complex dynamics that have positive impacts on economic growth but a negative impact on environmental quality due to increased CO₂ emissions. These studies highlight how important it is to have a grasp of how the Belt and Road Initiative (BRI) will affect environmental sustainability, government policies, and connectivity to promote coordinated and sustainable development.

Guo et al., (2023) add to the body of literature by analysing China's national oil companies (NOCs) globalization initiatives in the framework of the Belt and Road Initiative (BRI). Our knowledge of the dynamics of global production networks (GPNs) and global financial networks (GFNs) within the framework of the Belt and Road Initiative (BRI) is enhanced by the study, which throws light on the state-firm nexus and geopolitical concerns related to NOCs' foreign investments. To provide a comprehensive understanding of the ecological implications of the Belt and Road Initiative, (Jabeen et al., 2023) examine the effects of economic openness, financial depth, biological capacity, and human capital on ecological sustainability in BRI member economies. (Rasoulinezhad et al., 2022) focus on Central Asian energy trade policies, stressing the important roles played by the gravity index,

free space of trade, and level of urbanization in determining the region's patterns of energy trade. These studies contribute to a thorough understanding of the BRI's implications for sustainable development by providing insightful information about the initiative's broader economic, environmental, and geopolitical aspects.

Impact of Belt And Road Initiative On Environmental And Climate Change

The Belt and Road Initiative (BRI) offers a comprehensive analysis of various studies addressing sustainability challenges and opportunities associated with this ambitious infrastructure and economic development project. This is made possible by the systematic literature review on the impact of the BRI on environmental and climate change. (Z. Zhang et al., 2023) highlight how important Chinese outward FDI and renewable energy infrastructure are to improving ecological sustainability in BRI economies. The attention is shifted to ecological dangers in BRI mining by (Chen et al., 2022), who offer answers and difficulties for ecological restoration in mining areas. The numerous studies, which cover everything from energy efficiency and ecological restoration to the impact of trade and logistics on ecological variables, all highlight the necessity of sustainable practices and regulations within the BRI framework.

Several studies explore the complex relationships between economic growth, environmental challenges, and BRI policy systems. (Y. Wang & Xin, 2020) examine how trade with BRI economies has affected China's logistics industry's ecological total factor energy efficiency, they find mixed results, but overall beneficial. An inverse U-shaped relationship between economic growth and environmental deterioration is revealed by (W. Li et al., 2022) analysis of the environment-economy link in BRI nations, with foreign direct investment (FDI) having a beneficial impact on environmental quality. In addition, (Wen et al., 2023) highlight the need for trade structural policy changes while concentrating on the health effects and economic advantages of PM2.5. A policy mix to direct foreign direct investment (FDI) towards a low-carbon economy is suggested by (Mahadevan & Sun, 2020), who offers a critical viewpoint on the impact of FDI on carbon emissions in China and the BRI nations. (Ozturk & Ullah, 2022) investigate how digital financial inclusion affects environmental sustainability and economic growth, emphasizing the interplay between negative environmental impacts and positive economic growth.

The works of (Huang & Zhu, 2023) quantify the global impact of China's climate policy, extending the scope of the literature globally. The results highlight the need for concentrated research in particular areas by revealing regional and industry variations in the economic effects and emission reductions. Research and development (R&D) spending in the low-carbon energy transition of Belt and Road (BRI) economies is examined by (Luo & Zhang, 2022), who emphasize the importance of federal policies. Complex perspectives on environmental evaluations and financial implications in the context of Belt and Road Initiatives (BRI) are offered by studies of (Aung et al., 2022) and (H. Liu et al., 2020). By evaluating CO2 emission decoupling in the Eurasian logistics corridor, (C. Wang et al., 2020) make a valuable contribution by offering an understanding of the factors that motivate emission reductions. (Muhammad et al., 2022) insightful analysis of the nonlinear relationship between energy intensity, environmental efficiency, and industrial structure in developed and developing BRI countries points to areas for potential improvement through the reorganization of the energy system and industrial clustering strategies. The literature review concludes by reflecting a rich and varied collection of studies that together add to our understanding of the effects of the Belt and Road Initiative (BRI) on the environment and climate change.

DISCUSSION, FUTURE RESEARCH DIRECTION AND CONCLUSION

DISCUSSION

This review makes a significant contribution to both sustainable development and the research community by exploring how the Belt and Road Initiative (BRI) affects sustainable development with the use of bibliometric and content analysis. From 2018 to 2024, the number of publications increased continuously, indicating ongoing interest and giving academics and professionals access to a growing body of information. An outline that facilitates the effective passage of important sources is provided for researchers by the identification of relevant journals and their dynamic focus. Acknowledging significant contributions and relevant authors not only reveals research trends but also promotes a cooperative research context. Lotka's Law provides more light on the concentration of research output and makes it easier to identify key authors in the field. Through the co-word analysis, the academic community can communicate more clearly by having a better understanding of frequently used keywords. Furthermore, analyses of temporal evolution and evaluations of keyword co-occurrence offer an interactive viewpoint on patterns in the literature, promoting lively academic interactions. To aid with the synthesis of complex information, thematic maps, and network plots provide a visual depiction of topic relationships. The visualization of collaboration dynamics using co-authorship network maps fosters a sense of community and facilitates possible chances for collaboration. Essentially, these bibliometric statistics contribute to the field's knowledge and practice advancement by enriching our collective understanding of the multifaceted effects of the BRI on sustainable development, while also complementing the extensive literature.

In the context of content analysis, the review highlights the interrelationships between the BRI and different dimensions, including Carbon emission reduction and green energy, foreign direct investment (FDI), global value chain (GVC), and environmental and climate change. The research emphasizes the benefits of green investment and the complex effects on the world's transportation network. The body of research highlights how crucial it is to comprehend the wider effects of BRI initiatives on risks, GDP growth, and the management of water resources. The impact analysis on foreign direct investment sheds light on how the Belt and Road Initiative (BRI) is helping member nations' Global Value Chains (GVCs) stand out. The relationship between CO₂ emissions, renewable energy, and the benefits of digital financial inclusion for sustainable employment are some noteworthy findings. The analysis of commerce, digital financial inclusion, and Global value chain expansion clarifies the BRI's function as a catalyst for economic development. The impact on green total factor production, the advantages for small enterprises, and the significance of cooperative water resource management are all emphasized in the literature. The evolution of bilateral trade, the vulnerability of countries to trade shocks, and the effects of government spending on green economic performance are among the noteworthy findings offered. All of the studies point to the necessity of having an awareness of how the BRI would affect economic structures, trade patterns, and environmental sustainability. The literature highlights the necessity of sustainable practices and regulations within the BRI framework in the context of environmental and climate change. The research clarified ecological sustainability, environmental quality, and the links between environmental issues and economic growth. Studies emphasize the significance of financial implications, R&D expenditures, and the nonlinear relationships between environmental efficiency, energy intensity, and industrial structure.

FUTURE RESEARCH DIRECTIONS

The wide range of studies presented in this review of the literature reveals interesting directions for further research into the Belt and Road Initiative (BRI) and the promotion of

sustainable development. Future study areas include the requirement for an Integrated Impact Assessment, which calls on scholars to do thorough analyses that take into account the social, environmental, and economic aspects simultaneously to provide an improved comprehension of the overall sustainability of the BRI. An important field of study is the analysis of BRI Governance Frameworks, which has led to research on their creation and effectiveness with an emphasis on social impact, environmental sustainability, and risk reduction related to concealed debt opportunities. Among possible directions, inclusive development stands out as one that calls for research on the inclusivity of Belt and Road Initiative (BRI) projects, examining their effects on underprivileged populations and guaranteeing a fair distribution of financial gains, environmental preservation initiatives, and job prospects. Within the framework of the Belt and Road Initiative (BRI), the role of technological innovation becomes central, stimulating research into the use of green technology, renewable energy sources, and environmentally friendly infrastructure. Additionally, it emphasizes how important it is to comprehend the long-term ecological effects of BRI initiatives, with a focus on biodiversity preservation, climate resilience, and the overall ecological footprint. This underscores the necessity of looking into Long-Term Environmental Impacts. The final essential component is Policy Evaluation, which calls on scholars to evaluate the efficacy of environmental laws and regulations linked to Belt and Road Initiatives (BRI) from the standpoints of investors and host nations. This evaluation should include evaluations of enforcement procedures and the integrity of policies.

CONCLUSION

The Belt and Road Initiative and sustainable development, as revealed by the systematic literature assessment, present an interconnected narrative with interrelated elements. The Belt and Road Initiative's (BRI) multifaceted effects on trade, green energy, foreign direct investment, global value chains, and environmental sustainability differ according to the area and problems. All of the studies point to the necessity of having an advanced understanding of how the initiative will affect all elements that contribute to sustainable development. Building on these results, future studies should fill in knowledge gaps and use an interdisciplinary method to evaluate the Belt and Road Initiative's overall effects. Research efforts aim to support evidence-based policymaking as the initiative develops, guaranteeing that sustainable development objectives are given top priority and realized for the BRI initiatives.

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Declaration of competing interest

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