

# Nexus between innovation and sustainable economic development: A bibliometrics analysis

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**Abstract:** This article using thematic and content analysis investigated the contribution of innovation in achieving sustainable economic development. The objective of the bibliometric research was to assess the literature on this subject it identified research trends, ideas, and authors who contributed to this area so that future research and policy directions could be suggested. The data was derived from the Scopus database and was extracted between January 2020 and February 2024 by applying inclusion and exclusion criteria. The Scopus database search yielded 66 articles, published between 2020 and February 2024. Scopus analytics and Microsoft Excel were used for descriptive analysis and VOS Viewer software was used for network visualization of keywords. The descriptive analysis showed the trajectory of research, the prolific authors, their publication outlets, authors affiliation, and county of origin of the documents. The prolific visualization showed five clusters: red, green, blue, purple, and yellow. The main clusters are economic development, alternative energy, sustainable development, and innovation. This research showed where consideration should be given to drive sustainability and sustainable economic development. This research outcome will assist government agencies, corporations, and non-profit organizations in planning appropriate action and policies to support innovative and renewable energy initiatives so that participation in those fields could enhance the opportunity to achieve sustainable economic development.

**Keywords:** alternative energy; innovation; sustainability; sustainable economic development; bibliometrics analysis

## 1. Introduction

Achieving sustainable development has been one of the main agendas for nations globally. To achieve sustainable development countries introduced various actions and implemented initiatives. Many studies have been undertaken to help nations to achieve sustainable development. The importance of innovation in achieving sustainable development has been explored by many researchers. In this aspect, attention has been given to innovation and funding of innovation to accelerate sustainable development. Innovation could be related to technology, product, service, or improvement thereto (Ali et al., 2021). The Organization for Economic Co-operation and Development (OECD) defined innovation to include organizational structure, marketing method, and organizational arrangement that could result in the improvement of the environment besides innovation about products, services, and technologies (OECD, 2009, p. 40). United Nations Environment Programm Copenhagen Climate Center (UNEPCCC) and United Nations Framework Convention on Climate Change (UNFCCC) (2022) explained climate-related technologies as technologies that can reduce greenhouse gases and have a positive impact on climate change. The Intergovernmental Panel on Climate Change (IPCC) (2000) in defining technology stated that technology could be a product, technique, or skill that could be used in

production (IPCC, 2000). Innovation regarding climate change or sustainability could be equipment, software, skills, or organizational framework that is needed for the production and diffusion of technology (Burrell et al., 2023).

Studies revealed that innovations in controlling climate change to achieve sustainable development could be complex (Hassan, 2023; Jakobsen and Clausen, 2016) as such it requires research and development, funding, policies, and market incentives (Chu, 2013; Wu et al., 2021). Many countries introduced market incentives and subsidies to motivate innovation. For instance, China has invested more in innovation subsidies and drafted policies to sustain those subsidies (Chen et al., 2022). United Nations Sustainable Development Goal 9 emphasizes the need for technology for sustainable development. The United Nations and many countries concluded treaties like the Trans-Pacific Partnership (TPP) to manage green technology and transfer. Green technology transfer is considered vital to benefit many nations as it could help to control costs related to resources and capacities (Calza et al., 2017; Stefan and Paul, 2008). Countries and companies partner with market leaders during the diffusion phase of technology to market green innovation locally and internationally (Vimalnath et al., 2022). Government interference with appropriate policy and financing is expected to motivate innovation and avoid disputes (Rimmer, 2012; Wishart, 2018).

Incentivizing innovations and economic well-being have been considered important to attract more participation (Bassi et al., 2021; Cortes et al., 2021). Green innovation and technology diffusion must be financially and commercially attractive. Different strategies are needed in different stages of innovation to involve companies (Abid et al., 2022; Riehl et al., 2022; Wen et al., 2022). Additionally, having a decarbonization strategy is crucial. Revenue-oriented mechanisms and support of clean technology are required to achieve decarbonization. Researchers in this aspect suggested proportionate policies to achieve a transition to a knowledge economy that focuses on innovation (Siddiqui and Afzal, 2022; Wibisono, 2023). The research on developed and developing countries carbon emissions, the use of alternative energy, the area of forest, the number of patents registered, and expenditure of research for 23 years revealed that environmental quality can be improved through appropriate measures and strategies (Wen et al., 2022). The previous research on innovation highlights the significance of innovation in sustainable development and explores areas where improvement is necessary to support and uplift innovation.

A few studies looked at circular economy (CE) within sustainable economic development. Circular economy (CE) has become an important mandate that ensures environmental performance by closing material loops (Topliceanu et al., 2023). There is also a focus on circular economy rebound (CER). The CE will not be achieved because of the occurrence of rebound effects. The government and companies should introduce management guidelines to create a balance between economic and environmental performance to control CER. The guidelines should help to pursue profitable and environmentally friendly CER management. By doing so, opportunistic behaviors that impact the circular transition could be controlled (Pierluigi, 2022). To control CER early detection tools are necessary (Castro et al., 2022). For better control of CER, consumers were brought into play (Ranta et al., 2018). Governments and companies deploy marketing techniques unique for CE to ensure that safe features are

not overshadowed by the usual fears of contamination or perceptions of low quality (Geissdoerfer et al., 2017). The previous research discussed issues related to innovation and sustainable economic development. However, there is no research on identifying the prominent themes and contents in the literature on the research topic. There is also a lack of literature showing the important themes the governments should look into in promoting innovation to achieve sustainable economic development as well.

As such, this research aimed to assess the literature on this subject to identify research trends, themes, and ideas so that the research scope could be understood, and future research and policy directions could be suggested. The thesis statement for this research is “Innovation is one of the components that contribute to achieving sustainable economic development”. The research using four research questions tried to explore the contribution of innovation to sustainable economic development. To achieve the research objectives, the researcher collected the research data from the Scopus database by applying inclusion and exclusion criteria. Once the data was collected Scopus Analytics and Microsoft Excel were used for descriptive analysis and VOS Viewer software was used for network visualization of keywords and content analysis.

The current study applying bibliometric and content analysis explained different themes and connections between sustainable economic development and factors that contribute to achieving sustainable economic development. The descriptive analysis showed the trajectory of research, the prolific authors, their publication outlets, authors affiliation, and county of origin of the documents. The prolific visualization showed five different clusters: red, green, blue, purple, and yellow. The result of the research showed alternative energy, innovation, economic, and social conditions are vital to achieve sustainable economic development.

This research contributed to enlightening the relationship between innovation and achieving sustainable economic development. This study could also fill the void in literature through systematic analysis by showing the research trend for the past few years, the main theme, and the commonality of the research cluster. Additionally, it presented the importance of factors for each theme in achieving sustainable development. The research suggested that it is vital to involve all the stakeholders, provide appropriate laws, and policies, and make funding availability to achieve sustainable development. Appropriate strategies, plans, execution of plans, and creating awareness on this matter to empower the stakeholders can contribute positively to sustainable economic development.

The remainder of the article is organized as below: Section 2 discussed the methods including data extraction protocols and the process of analysis of data. Section 3 analyzed the bibliometric findings. Section 4 explored the content of the research. Discussion of the research and the implications of the research were explained in Section 5 before concluding the research with the limitation of research in Section 6.

## **2. Methodology**

This research used bibliometrics analysis to investigate the existing scholarly

literature on the contribution of innovation in achieving sustainable economic development. It used both numerical and graphical methodologies (Zheng et al., 2020). Scopus database was used as it has many journals of various quality with extensive coverage of reputable journals in various fields. The publication requirements in the Scopus-listed journals ensure rigor and quality. In addition, the depth and breadth of the coverage of the Scopus database were found to be adequate to achieve the research objectives of this article as such other databases were not used. VOS Viewer was employed to provide valuable network visualization. The overlay, network visualizations, and clustering analysis helped to understand the literature trends, themes, and relationships (Khan et al., 2020). The research also used descriptive analysis provided by the Scopus database and Microsoft Excel that assist in uncovering knowledge on research patterns, collaborative relationships, and publication trends. This offers insights into the field. The study addressed the following research questions:

RQ1. What are the current publication's trends and who are the authors who contributed to innovation and sustainable economic development research?

RQ2. Which are the countries contributing to the research related to innovation and sustainable economic development?

RQ3. What are the major research clusters and items on the contribution of innovation and sustainable economic development?

RQ4. What is the future trend of research that could contribute to the field of innovation and sustainable economic development?

## **2.1. Data extraction**

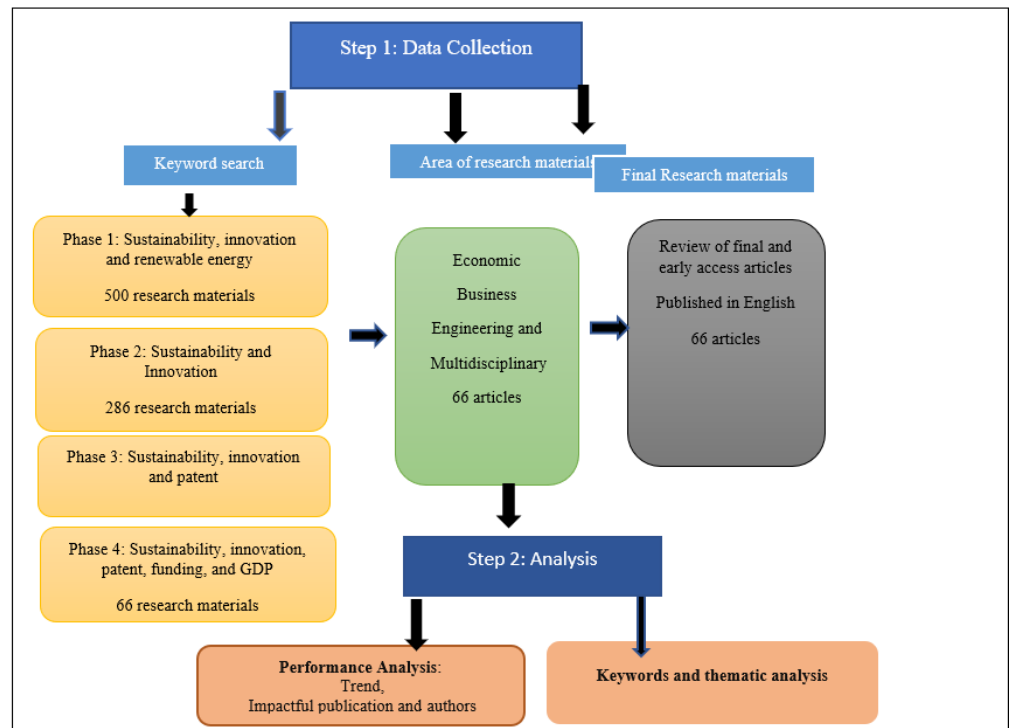
### **2.1.1. Inclusion and exclusion criteria**

For rigorous and quality research, the researcher sourced data from the Scopus database, and the data was extracted up to February 2024. Since the research aim is to assess the current trend on the nexus of innovation to achieve sustainable economic development, the author investigated the research materials for 5 years. The 5 years analysis helped to understand the themes in the research area and helped to focus on the imminent issues that need attention from various stakeholders to achieve sustainable development. The research materials using the keywords “sustainability” “innovation,” and “renewable energy” were searched and the search produced over 500 materials. These results were filtered and narrowed down to sustainability and innovation which resulted in 286 research materials. The keywords “sustainability”, “innovation” and “patent” produced 193 results. The search was refined with the keywords “sustainability”, “patent”, “innovation” “funding”, and “GDP” and it generated 66 articles: 32 articles were on innovation, 16 articles were on sustainable development, 12 articles were on sustainability and economic development and 10 articles were on research and development. A further restriction was applied to collect only the English language from the economics, business, engineering, or multidisciplinary journals. The search results were further refined to published or early accessed articles between 2020 and February 2024.

### **2.1.2. Data analysis**

The research used the Scopus analysis feature and Microsoft Excel for descriptive

analysis and VOS viewer software for overlay and network visualization of keywords (Afzaal et al., 2024; Siddique et al., 2023; Van Eck and Waltman, 2009; Zheng et al., 2020). An analysis of content was conducted to identify research clusters as per the co-occurrence network and five-field plots. This provided the researcher with a profound comprehension of the use of innovation in achieving sustainable economic development (Demir et al., 2024; Umar et al., 2024). The research derived the trajectory of the research, the prolific authors, their publication outlets, authors affiliation, and county of origin of the document. The clustering of the network was derived using the VOS viewer. The research map is explained in **Figure 1**.



**Figure 1.** Research map.

## 2.2. Overview of data

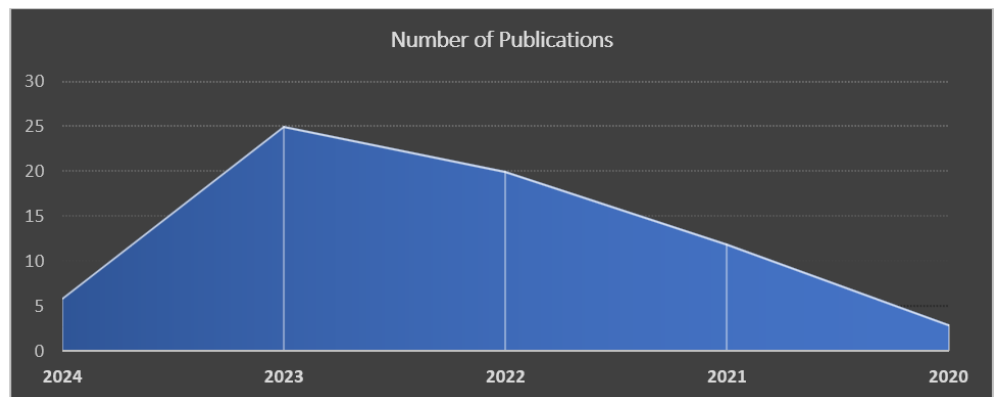
**Table 1** shows the main information of the data set. The data was collected from 66 relevant articles spinning from 43 academic sources. The Data set reflected the comprehensiveness of the data collected. The keywords chosen showed diversity in their range in terms of concepts. The data was collected for the period of 5 years ranging from 2020 to 2024 to ensure that the data set consisted of the recent literature only. The total citation for all the 66 data for the past 5 years was 1266, signifying the acceptability and acknowledgment of the research findings. The data comprised 170 authors, 5 of which are authored by single authors. 61 of the articles are written by more than 1 author total 165 authors with a collaboration average of 3.73. This suggested the trend of collaborative research activities. The dataset showed the scope of the scholarly work featuring various disciplines, broad literature, collaboration, insight, and trends in the literature on the research topic.

**Table 1.** Data overview: Number of documents, period, subject matter, and scope.

Description	Results
Documents	66
Sources	43
Period	2020–2024
Subject area	15
Authors	170
Single authored articles	5
Multiple authored articles	61 (165 authors involved)
Collaboration average	3.73

### 2.3. Publication trend

**Figure 2** shows a steady increase in the number of publications in the area related to innovation, sustainability, and sustainable economic development. The year 2023 produced 25 articles and the first 2 months of 2024 showed the possibility of a surge in publication in this area. The increased publication trend indicated the importance of the topic in achieving sustainability. The articles shed light on the recognition of achieving sustainability and most importantly discussed the ways it achieves sustainable economic development. They also showed the opportunities, challenges, risks, and consequences of adopting sustainable practices.



**Figure 2.** Publication trend.

Subject areas of the search included environment science, social sciences, business, management, and other related fields. The leading areas of publications were environmental science, and social sciences followed by energy and business, management, and accounting. The summary of the search result and the number of articles published in the area between 2020–2024 is provided in **Table 2**.

**Table 2.** Areas of research and number of publications.

Area of Research	Number of Publications
Environmental Science	30
Social Sciences	26
Energy	22

**Table 2.** (Continued).

Area of Research	Number of Publications
Business, Management and Accounting	18
Economics, Econometrics and Finance	15
Engineering	9
Computer Science	6
Decision Sciences	4
Medicine	4
Psychology	3
Agricultural and Biological Sciences	2
Mathematics	2
Earth and Planetary Sciences	1
Materials Science	1
Multidisciplinary	1

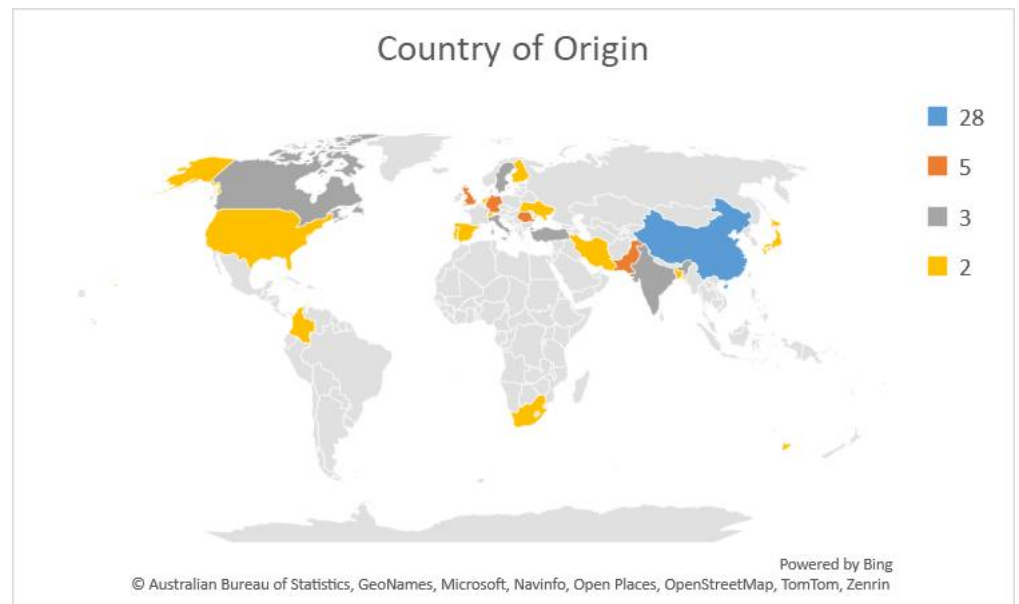
#### 2.4. Most cited documents

The scholarly contribution to innovation and sustainable economic development covered 15 different fields across different countries as shown in **Table 2**. Sun et al. (2021) article on “energy efficiency: The Role of technological innovation and knowledge spillover” was the leading publication. It was published in the Technological Forecasting and Social Change and was cited 278 times. The article talked about the need for local research and development capabilities to enhance innovation-based infrastructure. Another prominent paper titled “Remittance Inflows Affect the ecological footprint in BICS countries: do technological innovation and financial development matter?”, was published in the Environmental Science and Pollution Research with a total citation of 152. This examined the impact of inflows of remittance, innovations, and financial development on the quality of environmental quality in four selected countries for a period of 26 years. The finding revealed that innovations or technological advancements were an essential factor in controlling ecological footprint and a high level of remittance and financial development could negatively affect the environment. **Table 3** displays the other leading publications on technology innovation and sustainability. The publications investigated the role of innovation and technology in establishing sustainable development. It also looked at the important aspects of sustainable economic development: investment in research, innovations, alternative energy, and sustainability. The issue related to sustainable society by facilitating financial development through innovation has also been explored. The mitigating effects of environmental degradation were explored by researchers. They looked at diverse facts including innovation, laws, and institutional measures. The connection between research, energy alternatives, environmental impact, the impact of energy technology, and structural change on energy demand are discussed too. The research in this area offers a comprehensive understanding of the influence of innovation, and technology on sustainable development. Collectively, these papers direct the dynamic landscape of the advancement in technology, and innovation in achieving sustainability.

**Table 3.** Most cited documents, total citation, and citation average.

Authors	Publication Year	Source	Total Citations	Average per Year
Sun H, Edziah BK, Kporsu AK, Sarkodie SA, Taghizadeh-Hesary F	2021	Technological Forecasting and Social Change	278	69.5
Yang B, Jahanger A, Ali M	2021	Environmental Science and Pollution Research	152	38
Fernandes CI, Veiga PM, Ferreira JJM, Hughes M	2021	Business Strategy and the Environment	104	26
Zhao S, Cao Y, Feng C,	2022	Science of the Total Environment	76	25.3
Liu Q, Qu X, Wang D, Abbas J, Mubeen R	2022	Frontiers in Psychology	69	23
Altintas H, Kassouri Y	2020	Journal of Cleaner Production	67	13.4
Abid N, Ceci F, Ahmad F, Aftab J	2022	Journal of Cleaner Production	58	19.3
Li S, Shao Q	2021	Technology in Society	43	10.75
Khurshid A, Rauf A, Calin AC, Qayyum S, Mian AH, Qayyum S, Fatima T	2022	International Journal of Environmental Science and Technology	42	14
Shahzadi I, Yaseen MR, Iqbal Khan MT, Amjad Makhdum MS, Ali Q	2022	Renewable Energy	28	9.3
Huang J, Zhang H, Peng W, Hu C	2021	Science of the Total Environment	24	6

Regarding the country of origin of researchers or research, most of the articles originated from China followed by Germany, Pakistan, Romania, and the United Kingdom. Chinese researchers produced 28 research articles while researchers from Germany, Pakistan, Romania, and the United Kingdom published 5 respectively. The details of the country of the research are presented in **Figure 3**.



**Figure 3.** Country of origin where the majority of research on this area has been carried out.

### 2.5. Most relevant source and source dynamics

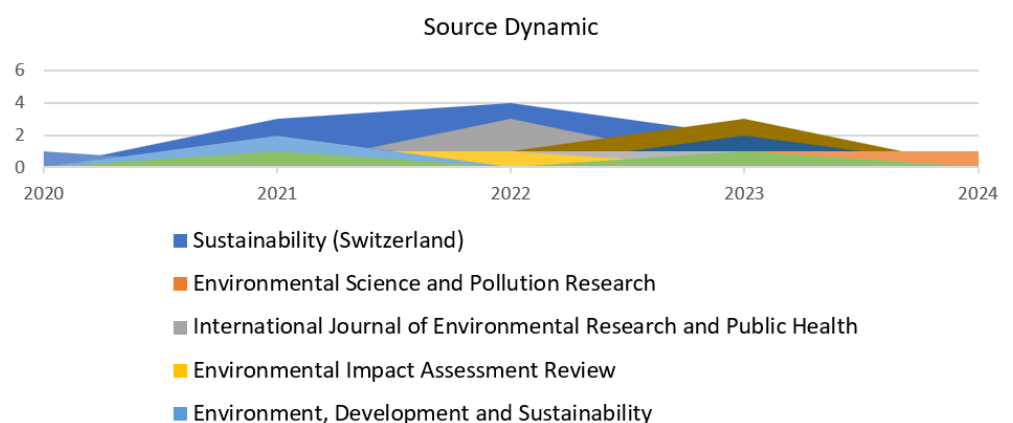
**Table 4** and **Figure 4** display the sources of research data on innovation and



sustainability and the trajectory of publications in main sources. The top sources were “Sustainability (Switzerland), Environmental Science and Pollution Research, and the International Journal of Environmental Research and Public Health”. All sources have 2 or more publications in the area and Sustainability (Switzerland) published 9 articles for the said period. As a publisher, Elsevier has many journals that publish on topics related to innovation and sustainability. MDPI and Springer have two prominent journals that were published in the subject matter. The leading journals were published by prestigious publishers who applied rigorous peer-review processes before accepting research articles. There is an increase in the publications on the topic in 2023 and 2022 which was evident to show the importance of the topic in various fields.

**Table 4.** Most relevant leading sources, the publisher, and their ranking.

Relevant Sources	Number of publications	ISI	Scopus	Publisher
Sustainability (Switzerland)	9	Q2	Q1	MDPI
Environmental Science and Pollution Research	4	Q1	Q1	Springer Science and Business Media
International Journal of Environmental Research and Public Health	3	Q1	Q1	MDPI
Environmental Impact Assessment Review	2	Q1	Q1	Elsevier
Environment, Development and Sustainability	2	Q2	Q2	Springer
Renewable and Sustainable Energy Reviews	2	Q1	Q1	Elsevier
Technological Forecasting and Social Change	2	Q1	Q1	Elsevier
Technology in Society	2	Q1	Q1	Elsevier
Science of the Total Environment	2	Q1	Q1	Elsevier
Energy Policy	2	Q1	Q1	Elsevier
Industrial and Corporate Change	2	Q1	Q1	Oxford Academic
Journal of Cleaner Production	2	Q1	Q1	Elsevier
Renewable Energy	2	Q1	Q1	Elsevier



**Figure 4.** Source dynamic: Most leading journals in the area.

## 2.6. Most prolific authors and documents

Considering the current and important nature of the topic, research on innovation and sustainability has increased. The analysis of publications indicates that the topics covered include innovation, sustainable development, renewable energy, research and development, technological innovation, alternative energy, patents, economics,

economic development, economic growth, and investment. The recent trend in the area of research was the nexus between innovation, investment, economic development, and sustainable development. This signifies the recognition of innovation to accelerate alternative energies to achieve sustainable economic development. To evaluate the influence, impact, and visibility of the journals, the ISI and Scopus rankings of the journal were used as shown in **Table 4**.

The assessment of the most prolific authors showed that Feng, C.'s co-authored publication "The Carbon Emissions Trading Policy on Enterprises and Green Technology Innovations" was cited as a top publication. He also published "GDP as an indicator to develop a mathematical model to decide on the share of domestic R&D expenditures as a percentage of GDP". Another prolific researcher was Kruse who published on innovation as an important pillar of sustainable transition and sustainable transition. He found that the involvement of various partners and strategies is necessary for a sustainable transition. He also published another research on "research and innovation strategies for smart specialization in macro-regions in the European Union (EU). Besides, Wen, J. was considered a leading researcher in this area too. He studied renewable energy, energy efficiency, and sustainability and found that there was an acceleration in the search for alternate energy sources. The author investigated government size and green innovation so that suggestions could be presented for the most suitable size of government needed to cultivate green innovation.

## 2.7. Most relevant affiliation

The affiliation and publication count regarding innovation and sustainability are shown in **Table 5**. There were 12 universities affiliated with the publication on innovation and sustainability. The Lulea University of Technology is in the lead followed by other universities. Much of the research originated from Chinese universities and it indicated Chinese desire for innovation and sustainable development as the country has been trying to control environmental degradation. Governmental funding, research culture, and infrastructure helped them to have a higher publication rate. Universities in Pakistan have produced several publications as well showing the need for innovation in sustainable economic development in developing countries. The leading institutions in this research tend to provide a positive research environment, proactive policies, funding, and help in creating collaboration opportunities. The research collaboration can be seen in many publications, however, there is a need for greater local and global collaboration to promote research and development in the research area.

**Table 5.** The top affiliation: The institutions where the researchers affiliated or funded.

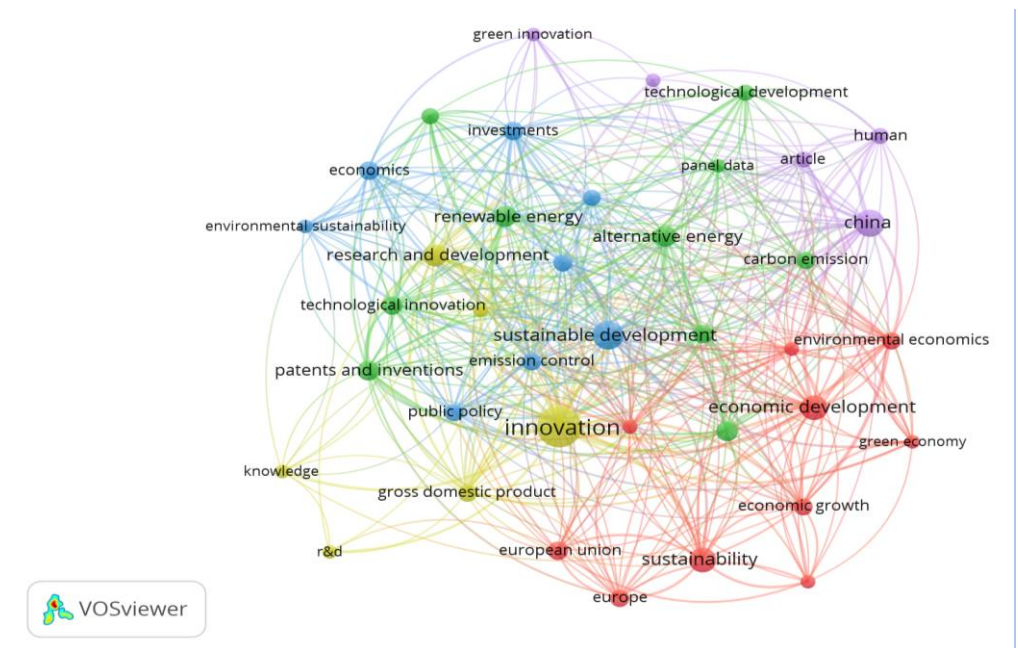
Affiliation	Number of publications
Luleå University of Technology	3
Shenzhen University	2
Universidade da Beira Interior	2
Zhejiang Normal University	2
Universität Bremen	2

**Table 5.** (Continued).

Affiliation	Number of publications
Xi'an Jiaotong University	2
Universitatea Stefan cel Mare din Suceava	2
Chongqing University	2
Zhejiang University of Technology	2
Lanzhou University	2
Hazara University Pakistan	2
University of Management and Technology Lahore	2

**3. Co-occurrence**

**Figure 5** represents the Vos viewer author-keyword network. The keyword network pictures five main clusters: economic development (red cluster) alternative energy (green cluster) sustainable development (blue cluster), innovation (yellow cluster), and China (purple cluster). Many publications originated from China and Europe on the topic of sustainability and innovation. The keywords, innovation, sustainable development, sustainability, innovation, alternative energy renewable energy, resource and development, technological innovation, environmental economics, carbon emission, economic development, and growth, have appeared frequently indicating their importance in the area of sustainability and sustainable



**Figure 5.** Vos viewer author keywords.

development. A comparison between **Figures 3** and **4**, and **Tables 4** and **5** displayed countries that are leaders in the research, relevant keywords, publication outlets, and the researchers. They also showed an overview of the research clusters regarding sustainability, sustainable economic development, and innovation. Further study and collaboration locally and internationally should be carried out so that appropriate and relevant knowledge can be transferred that could facilitate the achievement of

sustainable development through innovation. Further research could also facilitate a specialized solution, knowledge-sharing, and capacity-building, that could be adaptable to various cultural, economic, and social conditions.

#### **4. Content analysis**

According to the co-occurrence results, five interrelated nodes have been depicted. The author went through all the relevant articles and found some overlapping and suggested three interrelated themes:

- 1) Alternative energy accelerates sustainable development.
- 2) Sustainable economic development intertwine with innovation.
- 3) Sustainable economic development has a nexus to green economic initiatives, economic social well-being, and public policy.

All the themes have been elaborated below:

##### **4.1. Theme 1—Alternative energy accelerates sustainable development**

Theme 1 analyzed alternative energy as part of innovation to accelerate sustainable development. To be successful in coming up with renewable energy innovation, research and development and protection of intellectual property are important. (Du et al., 2023; Lu et al., 2022; Li and Shao, 2021; Riehl et al., 2022; Wen et al., 2022). There is a relationship between carbon emission and factors like energy alternatives, forest area, registered patents, and expenditures on research. It was found that a reduction in carbon emissions could be achieved if renewable energy is used (Bicil et al., 2022; Riehl et al., 2022). To improve environmental quality, an increase in alternative energy use and subsidies for green projects are needed. Li and Shao (2021) affirmed that renewable energy sources were effective in reaching emission reduction targets. The interaction of green innovation and technology diffusion in attracting positive corporate decisions to invest in green innovation is necessary. Additionally, political, economic, and cultural factors play important roles in green innovation though some factors' contribution could vary in various stages (Lu et al., 2022). Accordingly, diverse strategies for every stage of technological advancement were necessary. Legal protection for physical property rights, government support, and a positive economic framework were also needed to stimulate green innovation (Im and Cho, 2021). The increase in renewable energy sources increased renewable energy patents too. Determinants like the capacity to adopt renewable energy, a contribution to government funding, and the adoption of local and international guidelines on the environment can positively improve innovation (Kotlebova et al., 2020). The finding further showed that the law, regulation, and trade liberalization were the driving advances in renewable energy. To optimize this sector, it is suggested that there was a need to enhance renewable energy capacity, research and development investment, and a positive institutional environment.

Du et al. (2024) analyzed “the effects of government venture capital on the innovation performance of alternative energy production in China for a period of 16 years”. The researchers confirmed that the capital injection from the government was important to spur innovation. Similarly, proportionate intervention and mechanisms from various stakeholders are crucial too. Wen et al. (2022), further showed the effect

of renewable energy and energy efficiency on technological innovation. The finding suggested that there was a need to centralize the energy industry to allow more private-sector participation. Financial incentives should be introduced to encourage energy consumers to use renewable energy in addition to issuing green certificates, intensification of feed-in-tariffs, and polluter-pay principles. Bicol et al. (2022) studied factors affecting R&D trends in the energy sector in 29 International Energy Agency (IEA) countries. They found variables like efficiency, renewable energy use, and dependency on imports affect research and development.

The rise in GDP and use of conventional energy can lead to greater CO<sub>2</sub> emissions and the use of alternative energy contributes to the reduction of CO<sub>2</sub> (Pattak et al., 2023). Therefore, the availability of financial support was needed to achieve sustainable development (Dobrovolska et al., 2023; Hussain et al., 2023). Ali et al. (2023) conducted research in China, India, Indonesia, the United States, and Brazil and found a positive relationship between urbanization and CO<sub>2</sub> emissions. They suggested that green urban infrastructure, renewable energy options, and digital technologies should be improved to ensure the environmental quality of urban areas. Li et al. (2023) proposed to have the government departments and financial institutions join forces to promote the growth of green finance scale. On the policy aspect, there should be policies to control the negative impact on the environment to decarbonize the power sector (Santos and Coad, 2023; Zha et al., 2023). The introduction of feed-in tariffs, carbon emissions trading, and R&D subsidies could create a positive synergistic effect. Having a renewable portfolio standard, and tradable green certificates to create synergy in the renewable energy sector could encourage decarbonization in the energy sector (Zha et al., 2023).

In conclusion, research on alternative energy, innovation, and sustainable development is diverse. The researchers looked at the impact of GDP on innovation, investment, and adoption of alternative energy. Nevertheless, more research is needed in the area of the legal protection for physical property rights, government support, and positive economic, types of financial incentives to encourage energy consumers to use renewable energy.

#### **4.2. Theme 2—Sustainable economic development intertwined with innovation**

Theme 2 plotted the scholarly contribution of research on sustainable economic development and its relationship to innovation. Over 13 research discussed the issues of innovation and sustainable economic development. Xiao et al. (2022) found that an innovation-driven strategy can contribute significantly to the quality of economic development. They suggested investment in high-tech industries like environmental protection technologies. Zhao et al. (2022) stated that the Chinese contribution to research and development exceeded the GDP growth rate. Even so, there should be an increase in environmentally oriented research investment and guide green innovation so that sustainable economic development can be materialized. The Green Finance Development (GFD) and the effect of renewable energy development have been explored (Guo et al., 2023). The government's supporting policy and institution support are considered very important so that inward remittance and financial

development can be focused appropriately (Yang et al., 2021).

As regards to diffusion of innovation and sustainable economic development, Chen et al. (2024) stated that green innovation and technology diffusion need a conducive economic framework. Khan et al. (2023) explored the contribution of the imposition of the tax, innovation, renewable energy, and green growth in 26 environmentally responsive European Union (EU) countries to control carbon emissions. The study revealed a positive contribution of the research factors in controlling CO<sub>2</sub> emissions. As such there is a need to prioritize green growth and to encourage eco-innovations (Li, 2023). In support of innovation and sustainable economic development, Liao et al. (2022) argued that innovation is the choice to achieve stable economic growth, and an increase in air pollution inhibits regional innovation. Improvement in air quality in the long run requires an effective policy framework. Further, it was found that strong support for innovation, talent subsidies, and various trade-offs between heavily polluting and low-polluting enterprises could encourage sustainable economic growth.

Knowledge sharing to advance economic growth is also explored. In this aspect, Wu et al. (2023) argued that knowledge sharing is pertinent for promoting economic activities and solving global environmental issues. They stated that foreign technology transfer and diffusion can boost the eco-innovation of local firms. It is particularly evident in technology-intensive, pollution-intensive, and highly competitive industries. Shkarupa et al. (2022) analyzed the economic development and the country's knowledge economy and transfer of innovations. They found that the old European Union countries, give higher regard to innovative progress and invest more in science and its infrastructure than the new European Union countries.

Some researchers looked at various SDGs and their relationship with innovation and sustainable economic development (Sharif et al., 2024; Udeagha and Muchapondwa, 2023). Solaymani et al. (2023) examined the effects of forest plantation area, renewable energies, gross domestic product (GDP), and technological innovation on CO<sub>2</sub> emissions in 9 regions of New Zealand. It was concluded that an increase in the current level of forest areas and the use of renewable energy can help to achieve its sustainable goals. Similarly, Cao et al. (2022) analyzed the implementation of SDG in the Belt and Road Initiative (BRI) and the effect of the BRI on a social and economic continuum. It was established that SDG initiatives in BRI have a strong economic and social effect. There was a nexus between financial development and the performance of marine living resources too (Nham and Ha, 2023).

The research trend signals the interconnectivity of innovation, sustainability, and economic development. The impact of innovation on economic development was argued and supported. The future study could highlight the policy needs and financial strategies as well as the challenges, and complications.

### **4.3. Theme 3—Sustainable economic development has a nexus to economic, and social well-being and good public policy**

Since sustainable development and economic expansion were mutually exclusive, researchers in this area analyzed various items related to sustainable

economic development. According to the researchers, action on climate change requires adequate economic and financial capacity along with appropriate measures to control carbon emissions. A country with good living conditions can assist in climate change action and financial market access (Altintas et al., 2020; Mart et al., 2022). Countries with strong economies can focus on sustainable development than the others. Especially to reduce carbon footprints as they have provided public support to energy technology, research and development, and other spheres of sustainability (Ionescu et al., 2021). For the transformation of economic development, the adoption of smart cities was critical too. Smart cities could be achieved through technology and environmental regulation. Further research showed that the manufacture of technology-intensive technology could strengthen internal technological skills that in turn control ecological harm (Chen et al., 2024). Improvement in technology and innovation not only helped in the manufacturing and distribution of green items locally it also positively impacted the local economy (Gyamfi et al., 2023). According to Ionescu et al. (2021) having a regional sustainable development model would encourage close corporations to achieve sustainable goals.

Sustainable economic achievement correlated well with innovation. Appropriate public policy on innovation was necessary to stimulate green innovation and its protection. The optimal government size was linked to better green innovation output too. The size of the government has an impact on environmental regulations and financial support (Wen et al., 2022). Having the right size of government could ensure appropriate implications for innovation and economic development. Abid et al. (2022) asserted that financial development and green innovation play significant roles in environmental sustainability in leading economies. Correct policies in this aspect would lead to long-term environmental protection. Innovation is also said to be critical to leverage regional prosperity, sectoral renewal, and control of climate change (Kruse, 2024). Cooperation between different actors is warranted to succeed in introducing and capitalizing on innovation (Mascarenhas et al., 2020). Kruse et al. (2023) stated that there was a connection between the levels of R&D expenditure (as a percent of GDP) and innovation. They suggested having a comprehensive state policy and regulatory framework to support innovation is necessary. The relationship between the digital economy and renewable energy innovation was found to be strong, especially in countries with high incomes and policy intensity that have strong manufacturing fundamentals. The development of digital infrastructure and applications and the integration digital economy with renewable energy innovation could lead to fecund results in the management of sustainable economic activities (Yi et al., 2024; Zhussipova et al., 2023).

Financing and government support were also factoring that helped in achieving advancement in this area (Grafström et al., 2023). Green finance development (GFD) can promote development by reducing the enterprises' financial constraints. Hence, government departments and financial institutions should provide administrative means and market tools and promote GFD (Guo et al., 2023). Li and Shao (2021) argued that government contribution to R&D expenditure as a share of GDP can drive technological progress and therefore, there was a need for initiatives to optimize funding structure, capacity, and investment. Resource depletion and environmental degradation pushed the Chinese government to invest more in environmentally

induced research and development. It was said that guiding and investing in environmentally induced research investment could lead to sustainable and high-quality economic development (Zhao et al., 2022). Evidence from Germany, France, the UK, the Netherlands, and Switzerland revealed that sustainable efficiency growth could be linked through innovation and related policies (Sun et al., 2021).

The correct laws, policies, and taxes may mitigate environmental effects (Tingbani et al., 2023). Shaikh and Randhawa (2022) studied the social cost of the US National Innovation System (NIS) and found that certain policies are outdated in controlling risks and providing rewards. Therefore, new incremental and radical policies to drive institutional reforms to promote research-related governance are necessary to ensure continuous growth in innovation. Similarly, Khurshid et al. (2022) investigated the role of eco-patents and trademarks in environmental policy, energy consumption, and economic growth. The study revealed a positive relationship between trademarks and eco-patents and a reduction in carbon emissions. Additionally, investing in public utilities like health and education was also considered as catalysts for sustainable economic development. Cao et al. (2022) studied the Belt and Road Initiative (BRI) about sustainable development and found that public health expenditure stimulates economic growth as such policies on proper public health expenditure can enhance sustainable economic growth. Like health, education affects sustainable economic development as well. Liu et al. (2022) found that inequalities in a region could affect higher education. Economic and social sustainability and environmental sustainability could affect higher education too. Providing support for regional development in higher education could improve sustainable development.

Moving forward, the research in this area can assess the innovation in developing economies and their impact on sustainable development (Hintringer et al., 2021). They also could assess policies on enhancing sustainable development. Further research on challenges about innovation funding, technology transfer, and the ways to move forward on technology transfers are necessary. In-depth research on the impact of social well-being on sustainable development needs to be analyzed for appropriate frameworks to be drafted.

## **5. Discussion and implication of the study**

The thematic analysis revealed major three themes- alternative energy accelerates sustainable development; sustainable economic development intertwine with innovation and sustainable economic development has a nexus to green economic initiatives, economic social well-being, and public policy. Theme 1 mainly focused on the contribution of alternative energy to sustainable development. All the studies under this theme agreed that alternative energy has the potential to accelerate the achievement of sustainability goals. Therefore, governments and corporations need to collaborate, create opportunities, and implement decisive actions to motivate the production and use of alternative energies. The actions could be in the form of funding, subsidies, legislation, guidelines, and education. The research suggests that there is a need for future research that should focus on the guidance and strategies regarding alternative energy and its consumption. Research on the types of rules and regulations on property rights and freedom to trade internationally should be carried out so that



the advancement and implementation of renewable energy can be escalated. Essentially, research in these areas will enhance the prospects of more innovation in the alternative energy sector. This in turn could enhance renewable energy capacity, R&D investment, and a positive institutional environment. It could also positively contribute to the government departments and financial institutions to contribute to the socioeconomic landscape. The involvement of wider stakeholders can empower innovators and businesses for greater achievement in this field (Domazet et al., 2024; Khatik and Shrivastava, 2023; Terzis, 2022).

Theme 2 investigated the contribution of innovation to sustainable economic development. It was established that developed countries with financial means, funding for sustainable innovation, right laws, and policies could drive innovations that in turn could contribute to sustainable economic development. Therefore, there is a need to work with other countries and organizations on technology transfers and other intellectual property management issues so that not only developed countries but also developing countries can rightfully achieve sustainable economic development (Xing et al., 2023). Priority also should be given to strategies and ways to enhance sustainable economic development by introducing environmental taxation, and green growth incentives. Education and promotion should be part of the strategies to involve different types of stakeholders, particularly students of all levels to change their perceptions and behavior toward sustainable economic well-being. Future research could look at the ways to effectively implement these strategies and their significant impacts on achieving sustainable development. They also could investigate barriers like societal, legal cultural, and literacy to achieve sustainable development vis-à-vis innovation (Castaneda et al., 2023).

Theme 3 assessed the extent of economic, and social factors and policies in sustainable economic development. In this context, the research found that public, government, and corporate support are crucial to achieving any nation's goals including suitability-related goals. Support could be about the consumption of alternative energy, funding for research and development, adoption of smart cities, consumer education, sustainable production, and related environmental regulation so that balanced economic growth (Ionescu et al., 2021). It is shown that improvement in technology and innovation not only helps in the manufacturing and distribution of green items and services locally it also positively impacts the local economy (Gyamfi et al., 2023). In addition to sustainable economic activities, social initiatives like the introduction of the right laws, policies, tax, and governance to mitigate environmental effects are necessary too. The studies suggested a positive relationship between social initiatives and sustainable economic development. Further investing in public utilities like health and education was considered crucial for sustainable development and found that such expenditure stimulated the economy. Economic social, and environmental factors affect economic growth, and providing support for regional development policies could improve sustainable development. Future research could investigate the impact of cultural, societal, and policy factors. These studies could facilitate the development of effective policies to address various social, economic, and environmental barriers and propose measures to overcome these barriers.

The current research has few practical and policy implications.

Practical implications: The research facilitated mapping the impact of innovation

on sustainable economic development. It showed the importance of various factors in making sustainable economic development a success. Factors like social, economic, cultural, and environmental conditions need to be assessed to understand their impact on innovation and sustainable economic development.

**Policy implications:** The regulators and policymakers should understand the importance of each factor and draft appropriate policies to encourage participation and contribution in achieving sustainable economic development. They also could come up with strategies and action plans to implement the policy. The action plan should have a periodic assessment so that improvements can be made. Policies could create awareness among various stakeholders as well as other international partners. The study will pave the way for creating the need for comprehensive education mechanisms so that all awareness can be created that could attract greater participation.

## **6. Conclusion**

Bibliometric and content analysis were undertaken in this study to explain different themes and connections between sustainable economic development and factors that contribute to achieving sustainable economic development. Using relevant datasets solicited from the Scopus database that were published over the period of 5 years revealed the trend in publications, the leading articles and authors, and countries along their affiliations. The analysis revealed five main themes and all themes were explored well. The finding suggested that alternative energy, innovation, and economic, and social conditions are vital to achieve sustainable economic development. As such the support of all the stakeholders, appropriate laws, policies, and funding are important to materialize the commitment towards sustainable development. This also necessitates participation in all levels of planning and execution of actions and strategies. Educating and creating awareness on this matter will empower the stakeholders to contribute positively to sustainable economic development. This could lead to an inclusive understanding of the urgency of collective contribution.

The research has a few limitations. One of the limitations is that the dataset was collected from Scopus journals only as the database has a comprehensive set of journals that publish on the subject matter. The other limitation is the period of data collection where the data was collected from articles that were published or in early circulation between 2020 and February 2024 as the researcher was interested in investigating the current state of the study and the future trajectory of publications on the subject matter. Future researchers could use the Web of Science or other databases to collect data for a wider period. Future research could also be conducted on a particular country or region to provide customized suggestions to the country or region. Studies could also be carried out to validate or compare findings derived from various data sources. It could compare the sustainable economic development initiatives taken by countries of various cultures and social systems.

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