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TRANSFORMING THE FUTURE OF SUSTAINABILITY THROUGH GREEN TECHNOLOGY INNOVATIONS: A SYSTEMATIC LITERATURE REVIEW USING TCM FRAMEWORK

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Abstract

The aim of this study is to conduct a systematic literature review (SLR) of Green Technology Innovations to synthesize empirical results about how it is examined in the literature during the period 2020 to 2024. Furthermore, this study makes a connection between business and Emerging Green Technology (EGT) advancements for sustainability. The benefits of using green technology in business, particularly in developing nations, are also emphasized. The Systematic Literature Review (SLR) was carried out using the "PRISMA flow diagram method" and "inclusion/exclusion criteria." 57 articles have been considered for review finally from 75 publications. This study used TCM framework to give an in-depth understanding of prevalent theories, contexts, characteristics, and methodology applied in Green Technology Innovations research between the period of 2020 to 2024. This research offers insightful information for companies and policymakers who are looking to build a sustainable society and will be a useful tool for developing economies to develop sustainable strategies to promote long-term corporate growth.

Keywords: Green technology; sustainability, sustainable development, green innovation, economic growth, renewable energy, energy efficiency, green finance, policy frameworks.

1. INTRODUCTION

To foster a cleaner global environment, innovation becomes censorious. It encompasses technological advancements not only in technology but also in economic, social, and environmental governance (Islam, 2023). Given that innovation is the primary catalyst for modern times' economic growth, green transition renders an extensive array of avenues for enterprises, in addition to boosting economy over the long run (Islam, 2023). Innovation that is deemed to be "green" has the capability of not only assisting businesses and 2016).

Green innovation plays a pivotal role in addressing "environmental" and social issues. The development of innovative green technologies is profound and crucial aspect of sustainable development goals (Geels, 2018; Markard et.al, 2012). Green technology refers to various products, processes, and practices that minimize environmental impacts while promoting economic growth and social well-being. It includes renewable energy systems, sustainable agriculture, and waste management solutions, posing a transformative force that could reshape industries and societies.

Extant studies have given less importance to green technology innovation in achieving global environmental goals, as outlined in the "Paris Agreement and the United Nations Sustainable Development Goals (SDGs)"(Huang, 2020; Ramanathan, 2021). These goals necessitate a rapid transition toward low-carbon, resource-efficient economies, driven by the widespread adoption of clean and sustainable technologies. However, while the potential benefits of green technology innovation is immense, realizing its benefits requires overcoming significant

economic, technical, regulatory, and social barriers (Lüdeke-Freund et al., 2016). The pace and scale of this transition depend on a complex interplay of market forces, policy frameworks, technological advances, and stakeholder actions.

The innovation landscape within the green technology sector is characterized by dynamic shifts, with new technologies, business models, and policy approaches continually emerging. For instance, digital advancements like "artificial intelligence", the "Internet of Things (IoT)", and "block chain" are enabling new applications and efficiencies in renewable energy, energy storage, smart grids, and circular economy practices (Kohtamäki et al., 2019; Horbach & Rammer, 2018). Meanwhile, the urge for eco-friendly products and services is driving markets toward greener solutions, compelling businesses to innovate and adapt rapidly (Del Río, Peñasco, & Romero-Jordán, 2016). Yet, the diffusion of these innovations is uneven, with varying degrees of adoption across regions, sectors, and communities, often influenced by local regulatory environments, cultural factors, and access to finance (OECD, 2017).

However, there is still an urgent need to undertake a more qualitative analysis of the effects of green technologies in different industries in the world. According to Du., et al (2019), only through the systematic review one can determine how green technologies are being adopted in various sectors such as manufacturing and agriculture and how they are developed and applied in various regions. This is particularly important because what would be considered 'green' and viable to implement can drastically differ from one region to another based on regional policies, structures, and financial standing. The current paper seeks to determine the gap in the literature on green technology development and deployment. Hence, the study investigates the status of literature in green technological innovation, during recent times.

This systematic literature review (SLR) aims to answer the following questions through this study:

1) What is the current state of understanding about "green technological innovations"?
2) Which theories, methodologies and contexts have been applied in green technological innovations?
3) What are the further possibilities for green technology innovations research in future?

This study has the following sections. After the introduction, "Section 2" emphasises on topic selection criteria for this SLR, "Section 3" focus on number of articles included in the review along with top cited journals and authors, section 4 covers theoretical background using TCM approach, and "Section 5" emphasises on results, interpretations, and managerial implications. Next Section report the unique contribution of the study, directions for future research and conclusion.

2. STRUCTURE OF THE REVIEW AND METHODOLOGY:

This section discusses relevant literatures, the search strategies, and criteria for selecting topic adopted in this SLR study.

2.1 Selection criteria for Topic:

Paul, et.al., (2020) emphasize the importance of topic selection in SLR research, identifying if the chosen topic has not already been published. If it has, the new SLR should propose novel insights into relevant literature. The need for current research is twofold: first, lack of systematic review on the topic 'Green Technological Innovation', and second, the absence of SLR creates uncertainty in the status of literature. Therefore, an SLR is needed to synthesize existing literature on Green Technological Innovation.

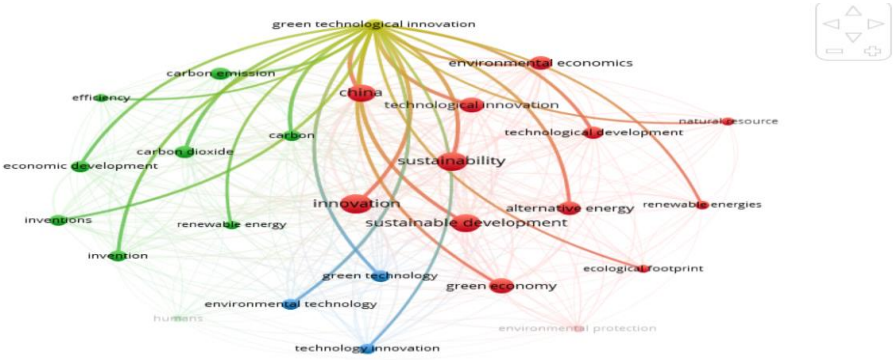
2.2 Search Strategy:

After selecting a topic, the study focused on finalizing the relevant keywords for searching the chosen topic. The process is outlined below:

2.2.1 Keyword and Database Selection:

Before selecting article, relevant keywords are crucial. Hence, the selection of keywords has been carried out with the help of Vos viewer software, which has been used to find relevant keywords used in the literature in the world. VOS viewer is a scientific technique which captures various maps based on bibliometric relationships, based on keyword co-occurrence, co-citation collaboration of various authors or journals (Aparicio, et.al2019). It is also known as keyword analysis.

Keyword Analysis:



Source: VOS Viewer

'Green Technological Innovation', 'Green Technological Innovation and Sustainability', 'Technology Innovation', ''Technological Development', 'Green Economy' are keywords used in the Scopus and ABDC databases.

In the words of Butler et al., 2016, the foremost step in framing a systematic literature review is to identify the review's goal derived from the research question (Nagaraj, et.al., 2024). As a result, the current study aims to identify and examine the extent of theories and the status of literature. Charrois (2015) suggest researchers to use minimum two databases while framing a structured review. Hence, the present study fulfils the condition by choosing the following databases: Scopus, Taylor and Francis and ABDC.

2.3 Criteria for Inclusion and exclusion of Journals:

Paul and Rosado-Serrano (2019), Srivastava et al. (2020), and Dogra et al. (2022), these studies have established inclusion and exclusion criteria to help us narrow down the selection of relevant research publications for this systematic literature review**.** The inclusion criteria include i) Studies where "green technological innovations" have been considered as a variable or a concept. ii) The studies were published before August 2024. iii) studies published in peer-reviewed journals only iv) Studies need to be published only in English. v) Studies published in Journals only B grade or above in the ABDC List and Scopus Indexed journals.

The study derived a total of 762 articles from the above search engines and the next step includes to eliminate duplicated articles (N=482), which had been downloaded more than once from more than two databases. The study is then shortlisted in line with inclusion and exclusion standards. The remaining 280 articles were screened and excluded 183 articles as the researcher identified them not relevant to the concept of green technology innovations, 9 articles were

removed as it is discovered to be chapters, 8 articles were eliminated for not furnishing the criteria of publishing in peer reviewed journals and 23 articles were excluded for including in ABDC list.

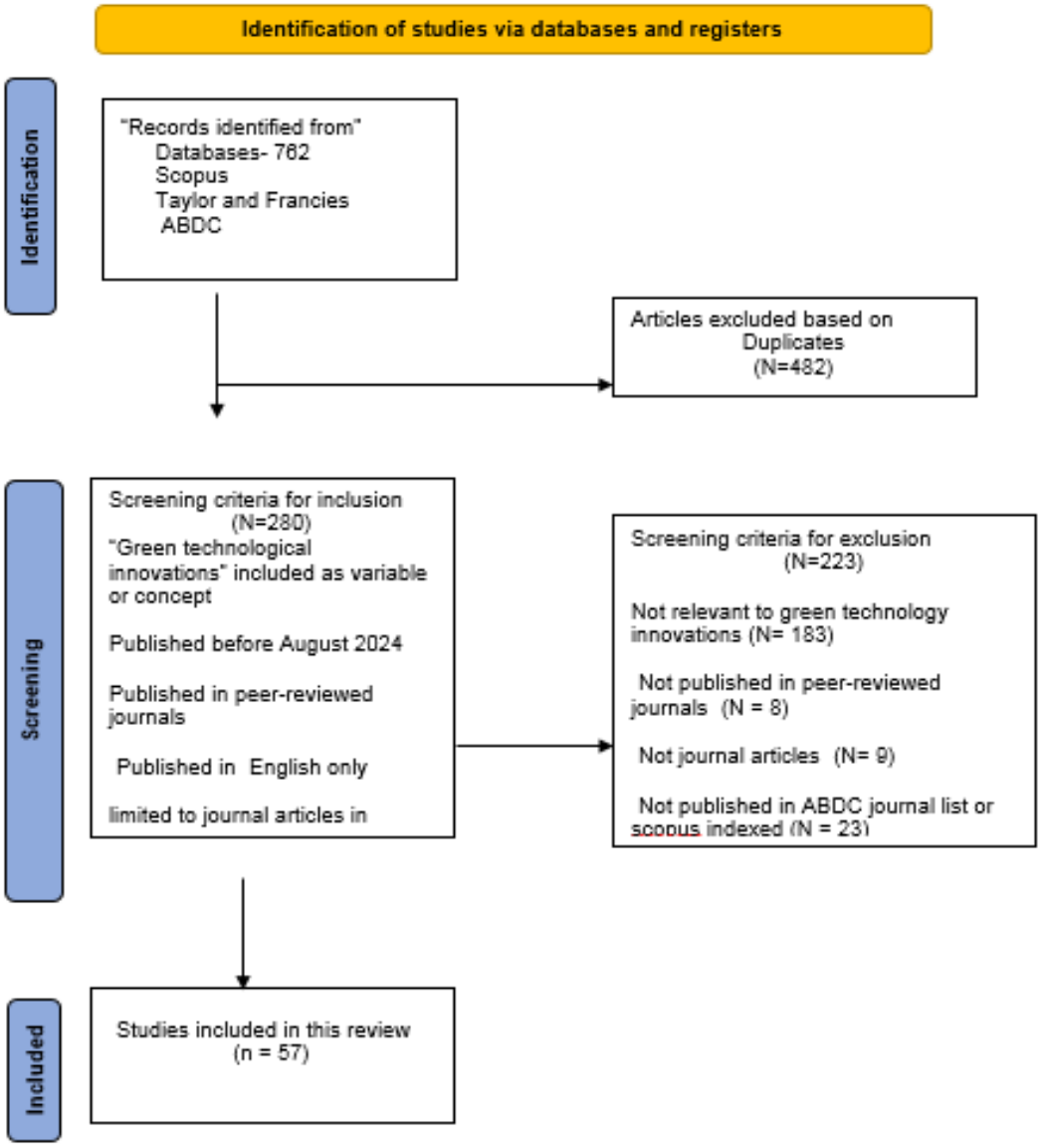


Figure 1: Selection of papers in the PRISMA flow diagram

3. WHAT IS THE CURRENT STATE OF UNDERSTANDING ABOUT "GREEN TECHNOLOGICAL INNOVATIONS"?

To answer the first research question, the study discusses on articles included in this review, top 10 journals which has more than one publication, and top 10 cited authors from among the selected literature reviews.

3.1. Publication Agenda:

This review analysis, which is arranged by year of publication, provides a broad overview of the momentum behind different disciplines of study. The selected papers are some of the recent investigations published across the five years of span, from 2020 to 2024.

Table 1: "Articles included in this review":

Sr. No.	"Author" (year)	"Title"	"Citations"	Impact factor	'Journal'
1	Sibt-E-Ali et al. (2024)	'Greening the future: assessing the influence of technological innovation, energy transition and financial globalization on ecological footprint in selected emerging countries'	2	Q1	Springer Science and Business Media B.V.
2	Gao et al. (2024)	'New industrial land use policy and firms' green technology innovation in China—an empirical study based on double machine learning model'	0	Q1	'Frontiers in Environmental Science'
3	Abbas and Najam (2024)	'Role of environmental decentralization, green human capital, and digital finance in firm green technological innovation for a sustainable society'	3	Q1	'Environment, Development and Sustainability'
4	Zhou et al. '(2023)'	'An assessment of the aggregated and disaggregated effects of natural resources rents on environmental sustainability in BRICS economies'	3	Q1	International Journal of Sustainable Development and World Ecology
5	Guo et al. (2024)	'The impact of new energy industry on environmental and economic benefits: Evidence from China'	0	Q1	'Energy'
6	Lin et al. (2024)	'Green economy transition in Asia Pacific: A holistic assessment of renewable energy production'	5	Q1 A	'Journal of Cleaner Production'
7	Radmehr et al. (2023)	'Spatial spillover effects of green technology innovation and renewable energy on ecological sustainability: New evidence and analysis'	23	Q1 C	'Sustainable Development'
8	Pan et al. (2024)	'Climate Policy Uncertainty and Entrepreneur Eco-Investment Behavior for Green Growth - Moderate Effect Analysis of Twin Transition'	3	Q1 A	'IEEE Transactions on Engineering Management'
9	Avcı et al. (2024)	'Analysis of the relationship between tourism, green technological innovation, and environmental quality in the top 15 most visited countries: evidence from method of moments quantile regression'	1	Q1	'Clean Technologies and Environmental Policy'
10	Ma et al. (2024)	'Digital economic, resource curse and the development of low-carbon transformation'	1	Q1 B	'Resources Policy'
11	Xu and Ding (2024)	'Sustainable growth unveiled: exploring the nexus of green finance and high-quality economic development in China'	0	Q1	'Frontiers in Environmental Science'
12	Li et al. (2024)	'Can environmental protection tax force enterprises to improve green technology innovation?'	0	Q1	'Environmental Science and Pollution Research'
13	Abbas et al. (2024)	'Pathways towards carbon neutrality in low carbon cities: The role of green patents, R&D and energy use for carbon emissions'	26	Q1 A	'Technological Forecasting and Social Change'
14	Zhao et al. (2024)	'Exploring the Role of Digital Economy in Enhanced Green Productivity in China's Manufacturing Sector: Fresh Evidence for Achieving Sustainable Development Goals'	1	Q1	'Sustainability (Switzerland)'
16	Yang et al. (2024)	'Unleashing the Influence Mechanism of Technology Innovation and Human Development for Ecological Sustainability in Emerging Countries'	4	Q1 B	'Emerging Markets Finance and Trade'
17	Yuerong et al. (2024)	'Revisiting the nexus between digital trade, green technological innovation, and environmental sustainability in BRICS economies'	8	Q1	'Environmental Science and Pollution Research'
18	Bozatli and	'Effectiveness of environmental protection	1	Q1 B	'Resources Policy'

	Akca (2024)	expenditures and resource tax policy in the Netherland's load capacity factor: Do government effectiveness and renewable energy matter? Evidence from Fourier augmented ARDL'			
19	Alessa et al. (2024)	'Does stakeholder pressure influence firms environmental, social and governance (ESG) disclosure? Evidence from Ghana'	2	Q2	'Cogent Business and Management'
20	Xie et al. (2024)	'Impact of digital finance on corporate green innovation: Exploring role of land resource misallocation in China'	2	Q1 B	'Resources Policy'
21	Laradi et al. (2024)	'Understanding sustainable outcomes in the digital age: The vital role of digital leadership in leveraging the impact of green innovations'	0	Q2	'Uncertain Supply Chain Management'
22	Ma et al. (2024)	'Do natural resource rents, green technological innovation, and renewable energy matter for ecological sustainability? Role of green policies in testing the environmental kuznets curve hypothesis'	3	Q1 B	'Resources Policy'
23	Liang et al. (2023)	'Studying financial development with low-carbon architecture development and green technological innovation: sustaining SDG-9'	0	Q1	'Environmental science and pollution research international'
24	Anas et al. (2023)	'Moving towards sustainable environment development in emerging economies: The role of green finance, green tech-innovation, natural resource depletion, and forested area in assessing the load capacity factor'	13	Q1 C	'Sustainable Development'
25	Gao et al. (2024)	'Impact of natural resource dependence on green technology development: Role of digital governance in mitigating resource-curse using big data'	0	Q1 B	'Resources Policy'
26	Aydin and Degirmenci (2023)	'The impact of clean energy consumption, green innovation, and technological diffusion on environmental sustainability: New evidence from load capacity curve hypothesis for 10 European Union countries'	16	Q1 C	'Sustainable Development'
27	Gaeta (2023)	'Green and Sustainable Mobility in Road Transport: How Private Law Can Guarantee the Right Balance between Environmentally Sustainable Development and Digital Transformation'	3	Q2 C	'European Business Law Review'
28	Hamid et al. (2023)	'Evaluating green productivity of the regional transport sector in South Asia considering environmental and safety constraints: the evolution from static and dynamic perspectives'	3	Q1	'Environmental Science and Pollution Research'
29	Hasan and Du (2023)	'Nexus between green financial development, green technological innovation and environmental regulation in China'	61	Q1	'Renewable Energy'
30	Li et al. (2023)	'Role of green technological innovation in the green economic growth in China's natural resource markets'	4	Q1 B	'Resources Policy'
31	Li et al. (2023)	'From oil and mineral extraction to renewable energy: Analysing the efficiency of green technology innovation in the transformation of the oil and gas sector in the extractive industry'	11	Q1 B	'Resources Policy'
32	Efthymiou et al. (2023)	'A Study on Sustainability and ESG in the Service Sector in India: Benefits, Challenges, and Future Implications'	30	Q2	'Administrative Sciences'
33	Amin et al. (2023)	'A step towards environmental mitigation: Do green technological innovation and institutional quality make a difference?'	80	Q1 A	'Technological Forecasting and Social Change'
34	Yikun et al. (2022)	'Green growth, governance, and green technology innovation. How effective towards SDGs in G7 countries?'	21	Q2	'Economic Research-Ekonomska

					Istrazivanja ‘
35	Liu et al. (2023)	‘Assessing the role of green finance in sustainable energy investments by power utilities: Evidence from China’	11	Q1	‘Utilities Policy’
36	Waqas and Tan (2022)	‘Big data analytics capabilities for reinforcing green production and sustainable firm performance: the moderating role of corporate reputation and supply chain innovativeness’	25	Q1	‘Environmental Science and Pollution Research’
37	Cui et al. (2023)	‘Can green finance effectively mitigate PM2.5 pollution? What role will green technological innovation play?’	7	Q2 C	‘Energy and Environment’
38	Zhang et al. (2023)	‘Nexus of institutional quality and technological innovation on renewable energy development: Moderating role of green finance’	23	Q1	‘Renewable Energy’
39	Chang et al. (2023)	‘The impact of green technology innovation on carbon dioxide emissions: The role of local environmental regulations’	67	Q1 A	‘Journal of Environmental Management’
40	Apergis et al. (2023)	‘Renewable and non-renewable energy consumption, energy technology investment, green technological innovation, and environmental sustainability in the United States: Testing the EKC and LCC hypotheses with novel Fourier estimation’	21	Q1	‘Environmental science and pollution research international’
41	Hu et al. (2023)	‘Green financing and technological innovation influence on e-commerce industry green environment’	2	Q1	‘Environmental Science and Pollution Research’
42	Lv et al. (2022)	‘Influence of green technology, tourism, and inclusive financial development on ecological sustainability: exploring the path toward green revolution’	12	Q2	‘Economic Research-Ekonomska Istrazivanja’
43	Borojo et al. (2023)	‘A pathway to the green revolution in emerging economies: how does green technological innovation affect green growth and ecological sustainability?’	6	Q2	‘Economic Research-Ekonomska Istrazivanja’
44	Wang et al. (2023)	‘Greening the Future: Harnessing ICT, Innovation, Eco-Taxes, and Clean Energy for Sustainable Ecology—Insights from Dynamic Seemingly Unrelated Regression, Continuously Updated Fully Modified, and Continuously Updated Bias-Corrected Models’	15	Q1	‘Sustainability (Switzerland)’
45	Abbas et al. (2022)	‘The effect of renewable energy development, market regulation, and environmental innovation on CO2 emissions in BRICS countries’	70	Q1	‘Environmental Science and Pollution Research’
46	Zhang and Liu (2022)	‘Influence of digital finance and green technology innovation on China's carbon emission efficiency: Empirical analysis based on spatial metrology’	246	Q1	‘Science of the Total Environment’
47	Song et al. (2022)	‘How Low-Carbon Pilots Affect Chinese Urban Energy Efficiency: An Explanation from Technological Progress’	6	Q1	‘International Journal of Environmental’ Research and Public Health
48	Sharif et al. (2022)	‘Nexus between green technology innovation, green financing, and CO2 emissions in the G7 countries: The moderating role of social globalisation’	6	Q1	‘Sustainable Development’
49	Wang et al. (2022)	‘Optimized Variables for Environmental Dynamics: China’s Renewable Energy Policy’	2	Q1	‘Frontiers in Environmental Science’
50	Wang et al. (2022)	‘Study of the Impact of Industrial Restructuring on the Spatial and Temporal Evolution of Carbon Emission Intensity in Chinese	8	Q1	‘International Journal of Environmental

		Provinces—Analysis of Mediating Effects Based on Technological Innovation'			Research and Public Health'
51	Udeagha and Ngepah (2022)	'Dynamic ARDL Simulations Effects of Fiscal Decentralization, Green Technological Innovation, Trade Openness, and Institutional Quality on Environmental Sustainability: Evidence from South Africa'	76	Q1	'Sustainability (Switzerland)'
52	Wang et al. (2022)	'Interplay among institutional actors for sustainable economic development—Role of green policies, ecopreneurs, and green technological innovation'	7	Q1	'Frontiers in Environmental Science'
53	Luo et al. (2021)	'The heterogeneous effects of different technological innovations on eco-efficiency: Evidence from 30 China's provinces'	69	Q1	'Ecological Indicators'
54	Ren and Ji (2021)	'How do environmental regulation and technological innovation affect the sustainable development of marine economy: New evidence from China's coastal provinces and cities'	81	Q1 A	'Marine Policy'
55	Zheng et al. (2021)	'Terrorism and green innovation in renewable energy'	150	Q1 A*	'Energy Economics'
56	Wang and Yang (2020)	'Analysing the green innovation practices based on sustainability performance indicators: a Chinese manufacturing industry case'	95	Q1	'Environmental Science and Pollution Research'
57	Liu et al. (2020)	'Environmental regulation, green technological innovation, and eco-efficiency: The case of Yangtze river economic belt in China'	275	Q1 A	'Technological Forecasting and Social Change'

3.2 Top 10 Journals:

Next, the study scrutinized the performance of different journals categorised in green technological innovations by ABDC 2024. The researcher identified top 10 journals through review procedure. Table 2 shows that "Resource Policy" and "Environmental Science and Pollution Research" Journals has 7 publications each. The other journals in the context of green technology innovations, include, "sustainable development", "Technological forecasting and social change, sustainability (Switzerland), Frontiers in Environmental Science,"Economic Research-Ekonomska Istrazivanja,"International Journal of Environmental Research and Public Health. Some other studies included in this review are from diverse disciplines, like, "All Earth, "International Journal of Hospitality and Tourism Systems, Uncertain Supply chain Management" etc.

Table 2: Top ten Journals with more than 1 publications incorporated in this review:

"No."	Journals	"No. of articles"	Articles	Impact factor
1	Sustainable Development	4	Radmehr "et al. (2023)" Anas 'et al. (2023)' Aydin 'and' Degirmenci '(2023)' Sharif 'et al. (2022)'	9.9
2	Resources Policy	7	Ma et al.'(2024) Bozatli and Akca (2024) Xie 'et al. (2024)' Gao 'et al. (2024)' Li 'et al. (2023)' Li 'et al. (2023)'	10.2
3	'Environmental Science and Pollution Research'	7	Li 'et al.' (2024) Yuerong 'et al.' (2024) Hamid 'et al.' (2023) Waqas 'and' Tan (2022) Hu 'et al.' (2023) Abbas 'et al. (2022)' 'Wang and Yang' (2020)	5.8

4	Technological Forecasting and Social Change	5	Abbas ‘et al. (2024)’ ‘Amin et al.’ (2023) Liu ‘et al.’ (2020) Javed ‘et al. (2024)’ Abbas (‘2024’)	12.9
5	Sustainability (Switzerland)	3	Zhao ‘et al. (2024)’ Wang ‘et al. (2023)’ ‘Udeagha and Ngepah’ (2022)	3.3
6	Frontiers in Environmental Science	3	‘Wang et al. (2022)’ Xu ‘and’ Ding (2024) Wang ‘et al. (2022)’	4.5
7	‘Environmental science and pollution research’ international	2	Liang ‘et al.’ (2023) Apergis ‘et al.’ (2023)	5.8
8	Renewable Energy	2	Hasan and Du (2023) Zhang et al. (2023)	8.1
9	Economic Research-Ekonomska Istrazivanja	3	Yikun ‘et al. (2022)’ Lv ‘et al. (2022)’ Borojo ‘et al. (2023)’	1.4
‘10’	‘International Journal of Environmental Research and Public Health’	2	‘Song et al. (2022)’ ‘Wang et al. (2022)’	4.6

Source: Scopus and Google scholar

3.33Authorship’:

‘Table 3’ identifies the ‘top ten’ authors according to their citation counts. The analysis of citation structure reveals some of the most prolific ‘authors’ in the field of, ‘green technology innovations’ are Liu ‘et al.’ (2020), Zhang ‘and’ Liu (2022), Zheng ‘et al.’ (2021), Wang ‘and’ Yang (2020), Ren, ‘et.al.,’ (2021), Amin ‘et al.’ (2023), Udeagha ‘and’ Ngepah (2022), Abbas ‘et al.’ (2022), Chang ‘et al.’ (2023), Hasan ‘and’ Du (2023). The author, Liu (2020) has been considered as one of the most influential authors with 275 citations followed by Zhang (2022) with 246 citations and Zheng (2021) with 150 citations.

Table 3: Ten most cited studies

‘Rank’	‘Source’	‘Journal’	‘Citations’
1	Liu et al. (2020)	‘Technological Forecasting and Social Change’	275
2	Zhang ‘and’ Liu (2022)	‘Science of the Total Environment’	246
3	Zheng ‘et al. (2021)’	Energy Economics	150
4	Wang and Yang (2020)	‘Environmental Science and Pollution Research’	95
5	Ren ‘and’ Ji (‘2021’)	Marine Policy	81
6	Amin et al. (2023)	‘Technological Forecasting and Social Change’	80
‘7’	Udeagha and Ngepah (2022)	Sustainability (Switzerland)	76
8	Abbas ‘et al. (2022)’	‘Environmental Science and Pollution Research’	70
9	Chang ‘et al.’ (2023)	Journal of Environmental Management	67
10	Hasan and Du (2023)	Renewable Energy	61

4. THEORETICAL FRAMEWORK:

The Systematic Literature Review uses a different approach. Some of the approaches quotes are, structured review by (Ulker et.al., 2020), framework-based review (“Takey”, et.al., 2016), bibliometric review (‘Kim’, et.al., 2022) and meta-analytical review by (Maseeh, et.al., 2022). This study adopted a structured review to accomplish desired research objectives. The present study aims to develop detailed insight into green technological innovations by figuring out recent trends in research, signalling research gaps, and giving significant future directions (Paul, et.al., 2021; Sana et al., 2023). As per Paul, et.al., (2021) there are some established frameworks for structuring an SLR such as antecedents, decisions, and outcomes (ADO) (Paul, et.al., 2018), theories, contexts, and methods (TCM) (Paul, et.al., 2017), and what, why, where,

when, who and how framework (5W1H) (Lim, et.al., 2020). The TCM framework has been chosen for the high level of clarity and coverage in the literature review.

Our review was structured according to the TCM framework, which lists the most popular theories (T), contexts (C), and techniques (M) related to a particular research area. It is simpler to recognize and evaluate contemporary theories, the research context, and the methodology used by researchers in past studies when using the TCM framework. This aids in locating and filling up research gaps (Paul, et.al. 2017).

It is therefore a helpful tool that ensures a full understanding of a particular field of study. TCM Analysis opens new directions for future research and helps fill in gaps found in previous studies. This study identifies the primary TCM, facilitating more research into underserved or undiscovered locations. Additionally, it makes it possible to create theoretical models from the perspective of less studied nations and industries to generalize research in the issue domain. The most popular "Theories" are summed up in the first section of this paper's study. The second section evaluates the "Contexts" in the different countries and industries that were considered in the previous study. The third section discusses the "Methodologies" used in earlier research to explain green technology innovations (Pandey et al., 2023).

4.1 Theoretical foundations of 'the' relevant green technology innovation studies:

Theories aid researchers in answering their research questions, and as a result, they can greatly enhance the body of existing literature (Lim et al., 2021). One of the most relevant theories in the analysis of green technology implementation is resource-based theory (Li, et.al., 2022). The other applied theories include innovation diffusion theory (Wani, 'et.al.,'2015), 'institutional theory' (Ahmed, 'et.al.', 2023; Singh, 2022), 'theory of planned behaviour' (Peng 'et al., 2021) and' Environmental Kuznets Curve theory (Abbas, et al. 2024). The innovation diffusion theory initiates at how innovations, whether they are technological, procedural, or even social, are passed through different mediums through time in a social system. In the context of green technology, the innovation diffusion theory assists in the understanding of the process of adoption of technologies such as renewable energy technologies, electric vehicles, and environmentally friendly industrial processes. According to ('Sahoo., et al., 2023'), there comes some key factors affecting the diffusion of green technologies which include technological infrastructure, market demand, policy-level support, and public acceptability. The resource-based view is widely used in enterprise performance studies and showcases its effectiveness on utilising the firm's resources in its most appropriate manner to render competitive edge among its competitors ('Adomako,' et.al., 2023; Simmou, et.al., 2023). The success of green innovation depends on its resources. Although the practice of green innovation will be constrained by a shortage of resources (Li, et.al., 2022). According to the institutional theory, organizations' decision-making is influenced by three distinct kinds of external forces in uncertain situations. Specifically, normative, mimetic, and coercive 'pressures' ('Chu, et.al., 2018; Qi, et.al., 2021; Acquah, et.al, 2023)'. According to the 'Theory of planned behaviour (TPB)', which is also one of the most widely applied theories, asserts that the intention is the direct predecessor of behaviour (Hazarika, et.al., 2019). Abbas, (2024) has taken 'Environmental Kuznets Curve (EKC) theory' to examine within the framework of energy use, Research and development, and green patents. The empirical findings supported the existence of Environmental Kuznets Curve (EKC) theory. Thus, these theories may help the future researchers to see green technological innovations in different perspectives based on various logical arguments.

For a similar level of understanding of how the green technologies are aligned to the variety of ecological and economic theories, environmental economics and sustainability theories are

useful. These theories try to explain how economic activities affect the environment and how one can improve this by inventing technologies that would minimize on the negative effects that affect the environment like pollution and exhaustion of earth's resources. In like manner, Wang, et. al., (2021) state that sustainability theories suggest that there should be Technologies for Environmentalism with Long-Term Resilient Economy. More specifically, environmental economics more broadly examines potential investment costs in green technologies versus potential long-term savings in terms of external environmental and public health damages. As a theoretical background of the argument, this perspective asserts that the advancement of 'green technologies' leads to generating new demand for green economy, decreased cost of energy, and new technology development for growth and progress of the economy as well as for environmental preservation. Thus, by using these theories, the analysis of green technology is more complex and unites innovation diffusion, economic and environmental perspectives to consider technologies that are reasonable for the further large-scale usage in the long-term period.

4.2 Context:

Contextually, we investigate and assess the nations and sectors that have supported green technology innovations research. As per TCM framework, the context is explained in two sections: Industry wise and Geographical wise.

4.2.1 Industry-Specific Context

Considering the importance of green technology innovations, it has been researched in a variety of sectors, such as the Energy sector, Manufacturing sector, Tourism sector, Transport sector, Service sector and Oil and gas sector. The industry-wise analysis reveals that 30 research studies are done in manufacturing sector between the period 2020 to 2024 like, Abbas and Najam (2024), Zhao 'et al. (2024)', Alessa 'et al. (2024)', Laradi 'et al. (2024)'etc. Seven research studies are associated with renewable energy sector between the period 2020 to 2024 (like, Sibt-E-Ali 'et al. (2024)', Guo 'et al. (2024)', Lin 'et al. (2024)', Gao 'et al. (2024)', Li 'et al. (2023)', Apergis 'et al. (2023)', Zheng 'et al. (2021)'. Others are done in Tourism sector, Transport sector, Stock exchanges, Marine economy, Oil and gas sector and Service sector.

Table 4: Industry specific context

Industry	Number of studies	Examples
Manufacturing sector	30	Abbas and Najam (2024), Zhao 'et al. (2024)', Alessa 'et al. (2024)', Laradi 'et al. (2024)', Laradi 'et al. (2024)'
Renewable energy sector	7	Sibt-E-Ali 'et al. (2024)', Guo 'et al. (2024)', Lin 'et al. (2024)', Gao 'et al. (2024)', Li 'et al. (2023)', Apergis 'et al. (2023)', Zheng 'et al. (2021)'
Tourism sector	2	Avcı 'et al. (2024)', Lv 'et al.' (2022)
Transport sector	2	Gaeta (2023), Hamid et al. (2023)
Marine economy	1	Ren and Ji (2021)
Oil & Gas Sector	1	Li et al. (2023)
Service Sector	1	Efthymiou et al. (2023)

4.2.2 Geographical Context:

In this part, the sample's country of origin is discussed. Most of the research studies has been undertaken among Asian researchers. China accounted for the greatest number of research, around 45 studies. Pakistan is another contributor to the study with 7 research studies in the field of "green technological innovations". Other contributors include Saudi Arabia, Netherlands, Malaysia, Turkey, UK, India. China has become a pioneer in green technology technologies mainly because the government has been active, and the country was able to adopt

an important strategy of environmental conservation without compromising on the growth of the country's economy. In the recent past, China's government has established a number of regulatory policies and economic incentives to drive the growth and increase the utilization of green technologies. Wang, Q. et al. (2019) further argue that Chinese leadership stems from the nation's grand strategies of the 'Made in China 2025,' and of adding environmental goals into the five-year development plans. These policies concern itself with the promotion of new power sources, energy efficient manufacturing and emergence reduction. China has increased its investment in renewable energy both capacity and demand with the country becoming the largest manufacturer as well as consumer of solar panels globally. Through this focus on renewable energy China has not only succeeded in reducing greenhouse emissions but has also become a principal exporter of green technologies to other countries.

Besides that, the government has even helped through imposition of strict environmental laws and measures along with financing the green technology through subsidies as seen in the case of subsidies towards production of electric vehicles and organizations of renewable energy projects. Hong, Li, and Drakeford (2021) show that Chinese authorities' green credit policy encouraging financial institutions to finance environmentally sustainable initiatives have boosted corporate investment in green technologies. Through such a favourable policy climate, China has attracted private and public investment in green technology, and has been defined as one example of how governmental policy can motivate technological advancement in the direction of a sustainable future.

4.3 Methodological Approaches:

Green technology research has embraced a variety of methodological approaches to analyse its impact, adoption, and diffusion across industries and regions. One of the most employed methods is econometric modelling, which uses statistical techniques to measure the association between 'green technology' innovations 'and' key variables such as 'carbon emissions', energy efficiency, and economic prosperity. Wang, et.al., (2021) explain that econometric models are particularly valuable for isolating the effects of green technologies on environmental outcomes while controlling for other factors such as industrial output, regulatory policies, and market conditions. These models allow researchers to quantify the degree to which specific green technologies contribute to carbon reductions or improvements in productivity.

Another essential approach is spatial analysis, which examines the geographic distribution and regional impacts of green technologies. Spatial analysis is crucial for understanding how green technology adoption varies across different regions and how localized factors—such as access to natural resources, infrastructure, or government policies—affect the success of these technologies. Wang et al. (2021) highlight that spatial econometric model are useful for assessing how the proximity of green technology initiatives in one region influences neighbouring regions. This approach is commonly applied to evaluate the diffusion of renewable energy projects or the impact of environmental regulations across regions.

In addition, bibliometric analysis is increasingly being used to identify trends and impacts around 'green technology innovation'. Bibliometric analysis involves quantitative study of scientific publications to map out the research landscape, identify key themes, and assess the influence of various studies or researchers within the field. Qing et al. (2022) emphasize that this method proposes a comprehensive overview of the 'evolution' of green technology studies, tracking how particular innovations, such as electric vehicles or carbon capture, have gained prominence over time. Bibliometric tools also allow for the identification of emerging trends, collaboration networks, and gaps in the literature, offering valuable insights for future research directions.

Various statistical techniques are commonly used to analyse data in green technology studies. One of the most widely used is regression analysis, which helps researchers examine the relationships between dependent and independent variables, such as the link between the adoption of green technologies and reductions in carbon emissions. By using regression models (Abbas and Najam, 2024), researchers can determine how much green technology adoption contributes to changes in environmental or economic indicators, while controlling for other influencing factors. ANOVA (Analysis of Variance) is another popular technique used to compare means across different groups and assess the statistical significance of differences. For example, ANOVA can be used to compare the performance of different green technologies in reducing emissions across various industries or regions (Hu, Hu, & Zhang, 2023).

PLS SEM (Structural equation modelling) is a more complex technique that allows researchers to assess the relationships between multiple variables simultaneously (Alessa et al.., 2024). This method is particularly useful in green technology research because it enables the modelling of complex relationships between technological innovation, environmental policies, and economic outcomes (Feng 'et al., 2022)'. The study by Gao 'et al., (2024)' had applied machine learning which helped to contribute to the knowledge on industrial land policy 'and' innovation, and also, aids in to a more thorough understanding of the mechanism by which new industrial land policy influences businesses' green technological innovation, and offer policy recommendations for boosting the implementation of industrial land reform for green economy. The 'study' by 'Zhou et al. (2023)' used 'STIRPAT model' ('Stochastic Impacts by Regression on Population, Affluence and Technology') to examine its impact on environmental sustainability which is measured by 'CO2 emissions and PM2.5 air pollution in Brazil, Russia, India, China, and South Africa (BRICS) economies from 1995 to 2019'. In the perspective of digitization and sustainability, the study by Efthymiou et al. (2023) explores the application of environmental, social, and corporate governance (ESG) in the service sector in India.

5. WHAT ARE THE FURTHER POSSIBILITIES FOR GREEN TECHNOLOGY INNOVATIONS RESEARCH IN FUTURE?

5.1 Results and Interpretation:

With reference with third objective, the researcher proposes future research directions in green technology innovations literature review. The study has followed (Paul, et.al. 2017) by using TCM approach and could identify future research directions based on synthesis. This framework, which considers theory development, context, and methodology, assisted in finding the gaps in the literature on four different grounds (Paul, et.al. 2017). The TCM framework is utilized to conduct a literature review with the aim of providing an integrated overview of previous research studies and their findings. This framework offers an integrated summary of past research works and insights. In order to figure out the way this topic has changed over time, this research has evaluated studies based on TCM framework.

To begin, most used theories in the study include resource-based view theory, institutional theory, innovation diffusion theory (Wani, 'et.al.,2015)', 'institutional theory' (Ahmed, 'et.al'., 2023; Singh, 2022), 'Theory of planned behaviour' (Peng 'et al., 2021)' and Environmental Kuznets Curve theory (Abbas, et al. 2024).

Regarding the next parameter, context, the study identified various industries and countries that contributed to the study. It is evident through the study that most of the studies has considered manufacturing sector. These technologies not only reduce negative effects on the environment but also make it possible to use resources more effectively (Islam, 2023). For example,

sustainable construction materials are less prone to deplete, and sustainable agriculture practices may assist prevent soil deterioration brought on by monoculture (Islam, 2023). The studies represent that the newly developed green innovations and technologies helped the manufacturing sector for a green and sustainable transition from traditional business. Moreover, the current level of green technology innovations has proved to aid global corporate sustainability (Islam, 2023). Additionally, the topic has been investigated in various other industries like renewable energy, tourism sector, transportation sector. In terms of country, China has shown the dominance which calls for more research in other developing countries along with India, G-7 countries etc.

Furthermore, this study has identified various methodologies and tools used in the above studies. Most of the studies had used panel data and applied econometric analysis, Structural Equation Modelling, machine learning model (Gao et al., 2024), regression model (Abbas and Najam, 2024), STIRPAT model (Zhou et al. 2023), SMART PLS (Alessa et al.., 2024), ESG framework (Efthymiou et al. 2023).

5.2 Managerial Implications:

Government authorities are among the most essential stakeholders of green technology innovations because they have an incredible impact on its development by supporting new ideas and projects through the adoption of new regulation and financial tools. The primary instrument in this respect is green credit and this is a financial instrument that offers attractive credit conditions to organizations and enterprises that implement environmentally friendly programs. To commence, giving the green funds cheaper rates of interest or longer repayment periods for the green initiatives will reduce the cost of availing innovative technologies like renewable energy and energy-efficient equipment in agriculture.

Advantages of the adoption of green technology is not only in the operational front but it also has a financial advantage. As emphasized by Sahoo et al. (2023), organizations with green technologies are favoured by clients who are conscience about the environment hence improving the company's market standing. It is with such core competencies that businesses can set themselves up to capture more markets in competitive markets, since sustainability practices of products or services have gained more value in the modern society. Getting green certifications, and adhering to sustainability requirements may also help unlock new business prospects, since most businesses are increasingly looking for like-minded business associates. To this end, green innovations can help companies pave their way ahead of compliance issues and costly penalties and achieve or avoid technology breakneck transformations due to emerging legislation.

Companies that embrace green innovations in their operations tend to reap great benefits on their environmental concern in as much as emissions on the environment. The green technology innovation is an enabler whereby companies can think anew their business models, processes and make sustainability as its core. For instance, companies operating from the manufacturing industry that embrace technology that includes waste management systems, efficient ways of water usage, and energy, reducing equipment emission significantly reduces the business impact on the environment. These innovations not only minimize pollution, but also create new circular production system whereby waste products are eliminated or recycled for use in other production processes hence attaining other sustainable development goals.

LIMITATIONS OF THE STUDY:

The first limitation includes the review period since the present study assessed articles

published between 2020 to 2024. Secondly, as the study is systematic in nature, it does not incorporate detailed insights on co-authorship relationships or bibliographic coupling. Thirdly, the current literature search is narrowed by use of limited keyword usage, suggesting that the future researchers should add on more keyword analysis. Forth, the review is done based on only two databases. The future researchers can further conduct the review with more than two databases.

Unique contribution:

This study has applied TCM framework by Paul, 2017 which is one of the scientific ways of doing systematic literature review. The insights of this research would of great help for the companies, and policymakers to encourage economic development, and build a sustainable society. The results will be especially helpful to developing countries that are struggling with issues of technological innovation, environmentally sound practices, dependable renewable energy sources, and sustainable economic and ecological progress.

Future Prospects:

The present study, however, pinpoints on the need to understand several other theories which may help to figure out the phenomena of green technology innovations such as Tripple bottom line performance, Circular Economy model, Environmental innovation theory. With regards to Context, the topic should be widely studied in various sector of manufacturing, and service sector. The topic needs to be extensively researched in service sector and as well individually in different sectors. The study also demands meticulous investigation in many more parts of developed, developing and emerging countries. In terms of methodology, most of the studies has adopted quantitative studies wherein this SLR clearly pinpoints on the prerequisite for qualitative and mixed aspect of methodology.

Conclusion:

Studies with effect to understanding the impact of green technology innovations' on reducing carbon emission and progressing economic development, are also underlined in the review. Businesses need to switch from outdated technologies to new eco-friendly ones in order to attain sustainability. Green technologies such as low-emission and climate change adaptation can help developing nations with waste management, water purification, and other areas. In order to lower greenhouse gas emissions and assist waste management and air pollution control, developing nations must adapt their existing economic models to embrace green technological breakthroughs. Sustainable business concepts and technologies can be used by developing countries to boost economic progress, while businesses and politicians can use this research to protect the environment, economy, and society. Green technologies have led to greater innovations of sustainable business models which are efficient in the long-run, and effective in managing natural resources. This transformation has had a domino effect on global markets, creating new impetus to green finance, new job opportunities in clean energy sector and enhancing environmental standards.

References

1. Abbas, J., & Najam, H. (2024). Role of environmental decentralization, green human capital, and digital finance in firm green technological innovation for a sustainable society. Environment Development and Sustainability. https://doi.org/10.1007/s10668-024-04783-3

2. Abbas, S., Gui, P., Chen, A., & Ali, N. (2022). The effect of renewable energy development, market regulation, and environmental innovation on CO2 emissions in BRICS countries. Environmental Science and Pollution Research, 29(39), 59483–59501. https://doi.org/10.1007/s11356-022-20013-7

3. Abbas, S., Saqib, N., Mohammed, K. S., Sahore, N., & Shahzad, U. (2024). Pathways towards carbon neutrality in low carbon cities: The role of green patents, R&D and energy use for carbon emissions. Technological Forecasting and Social Change, 200, 123109. https://doi.org/10.1016/j.techfore.2023.123109

4. Acquah, et.al, (2023). Green procurement and green innovation for green organizational legitimacy and access to green finance: The mediating role of total quality management. Global Business and Organizational Excellence, 42(3), 24-41.)

5. Adil, M., Sadiq, M., Jebarajakirthy, C., Maseeh, H. I., Sangroya, D., & Bharti, K. (2022). Online service failure: antecedents, moderators and consequences. Journal of Service Theory and Practice, 32(6), 797–842. https://doi.org/10.1108/jstp-01-2022-0019

6. Alessa, N., Akparep, J. Y., Sulemana, I., & Agyemang, A. O. (2024). Does stakeholder pressure influence firms environmental, social and governance (ESG) disclosure? Evidence from Ghana. Cogent Business & Management, 11(1). https://doi.org/10.1080/23311975.2024.2303790

7. Amin, N., Shabbir, M. S., Song, H., Farrukh, M. U., Iqbal, S., & Abbass, K. (2023). A step towards environmental mitigation: Do green technological innovation and institutional quality make a difference? Technological Forecasting and Social Change, 190, 122413. https://doi.org/10.1016/j.techfore.2023.122413

8. Anas, M., Zhang, W., Bakhsh, S., Ali, L., Işık, C., Han, J., Liu, X., Rehman, H. U., Ali, A., & Huang, M. (2023). Moving towards sustainable environment development in emerging economies: The role of green finance, green tech-innovation, natural resource depletion, and forested area in assessing the load capacity factor. Sustainable Development. https://doi.org/10.1002/sd.2833

9. Apergis, N., Degirmenci, T., & Aydin, M. (2023). Renewable and non-renewable energy consumption, energy technology investment, green technological innovation, and environmental sustainability in the United States: Testing the EKC and LCC hypotheses with novel Fourier estimation. Environmental Science and Pollution Research, 30(60), 125570–125584. https://doi.org/10.1007/s11356-023-30901-1

10. Avcı, P., Sarıgül, S. S., Karataşer, B., Çetin, M., & Aslan, A. (2024). Analysis of the relationship between tourism, green technological innovation and environmental quality in the top 15 most visited countries: evidence from method of moments quantile regression. Clean Technologies and Environmental Policy, 26(7), 2337–2355. https://doi.org/10.1007/s10098-023-02708-8

11. Aydin, M., & Degirmenci, T. (2023). The impact of clean energy consumption, green innovation, and technological diffusion on environmental sustainability: New evidence from load capacity curve hypothesis for 10 European Union countries. Sustainable Development. https://doi.org/10.1002/sd.2794

12. Borojo, D. G., Yushi, J., Hongyu, Z., Xiao, L., & Miao, M. (2023). A pathway to the green revolution in emerging economies: how does green technological innovation affect green growth and ecological sustainability? Economic Research-Ekonomska Istraživanja, 36(1). https://doi.org/10.1080/1331677x.2023.2167223

13. Bozatli, O., & Akca, H. (2024). Effectiveness of environmental protection expenditures and resource tax policy in the Netherland's load capacity factor: Do government effectiveness and renewable energy matter? Evidence from Fourier augmented ARDL. Resources Policy, 92, 105030. https://doi.org/10.1016/j.resourpol.2024.105030

14. Chang, K., Liu, L., Luo, D., & Xing, K. (2023). The impact of green technology innovation on carbon dioxide emissions: The role of local environmental regulations. Journal of Environmental Management, 340, 117990. https://doi.org/10.1016/j.jenvman.2023.117990

15. Chen, Y., Chang, C., & Wu, F. (2012). Origins of green innovations: the differences between proactive and reactive green innovations. Management Decision, 50(3), 368–398. https://doi.org/10.1108/00251741211216197

16. Cui, Y., Zhong, C., Cao, J., & Guo, M. (2023). Can green finance effectively mitigate PM2.5 pollution? What role will green technological innovation play? Energy & Environment. https://doi.org/10.1177/0958305x231204030

17. Dogra, N., Adil, M., Dhamija, A., Kumar, M., & Nasir, M. (2022). What makes a community sustainably developed? A review of 25 years of sustainable community tourism literature. Community Development, 53(5), 585-606.

18. Efthymiou, L., Kulshrestha, A., & Kulshrestha, S. (2023). A Study on Sustainability and ESG in the Service Sector in India: Benefits, Challenges, and Future Implications. Administrative Sciences, 13(7), 165. https://doi.org/10.3390/admsci13070165

19. Gaeta, M. C. (2023). Green and Sustainable Mobility in Road Transport: How Private Law Can Guarantee the Right Balance between Environmentally Sustainable Development and Digital Transformation. European Business Law Review, 34(Issue 1), 63–80. https://doi.org/10.54648/eulr2023006

20. Gao, P., Li, Z., & Shi, R. (2024). Impact of natural resource dependence on green technology development: Role of digital governance in mitigating resource-curse using big data. Resources Policy, 92, 105023. https://doi.org/10.1016/j.resourpol.2024.105023

21. Guo, K., Huang, C., Zhang, Z., Paiz, A. Y. D., & Chen, W. (2024). The Impact of New Energy Industry on Environmental and Economic Benefits: Evidence from China. Energy, 132111.

22. Gururaja, B.L., & Nagaraj, B. (2024). Barriers to the Social Enterprise Performance: A Literature Review. Empirical Economics Letters, 23 (special issue 3): (may 2024) https://doi.org/ 10.5281/zenodo.11353534

23. Hamid, S., Wang, Q., & Wang, K. (2023). Evaluating green productivity of the regional transport sector in South Asia considering environmental and safety constraints: the evolution from static and dynamic perspectives. Environmental Science and Pollution Research, 30(17), 50969–50985. https://doi.org/10.1007/s11356-023-25865-1

24. Hasan, M. M., & Du, F. (2023). Nexus between green financial development, green technological innovation and environmental regulation in China. Renewable Energy, 204, 218–228. https://doi.org/10.1016/j.renene.2022.12.095

25. Hu, C., Wang, C., Luo, Y., & Zheng, C. (2023). Green financing and technological innovation influence on e-commerce industry green environment. Environmental Science and Pollution Research, 30(47), 104886–104900. https://doi.org/10.1007/s11356-023-29231-z

26. Huang, Z., Liao, G., & Li, Z. (2019). Loaning scale and government subsidy for promoting green innovation. Technological Forecasting and Social Change, 144, 148–156. https://doi.org/10.1016/j.techfore.2019.04.023

27. Kim, H., & So, K. K. F. (2022). Two decades of customer experience research in hospitality and tourism: A bibliometric analysis and thematic content analysis. International Journal of Hospitality Management, 100, 103082. https://doi.org/10.1016/j.ijhm.2021.103082

28. Laradi, S., Elfekair, A., & Shneikat, B. (2024). Understanding sustainable outcomes in the digital age: The vital role of digital leadership in leveraging the impact of green innovation. Uncertain Supply Chain Management, 12(4), 2413–2428. https://doi.org/10.5267/j.uscm.2024.5.026

29. Li, C., Teng, Y., Zhou, Y., & Feng, X. (2024). Can environmental protection tax force enterprises to improve green technology innovation? Environmental Science and Pollution Research. https://doi.org/10.1007/s11356-023-31736-6

30. Li, M., Hou, Y., Jia, Z., & Li, J. (2023). Role of green technological innovation in the green economic growth in China's natural resource markets. Resources Policy, 86, 104187. https://doi.org/10.1016/j.resourpol.2023.104187

31. Li, M., Tian, Z., Liu, Q., & Lu, Y. (2022). Literature review and research prospect on the drivers and effects of green innovation. Sustainability, 14(16), 9858.

32. Li, N., Dilanchiev, A., & Mustafa, G. (2023). From oil and mineral extraction to renewable energy: Analyzing the efficiency of green technology innovation in the transformation of the oil and gas sector in the extractive industry. Resources Policy, 86, 104080. https://doi.org/10.1016/j.resourpol.2023.104080

33. Liang, X., Liu, M., & Huang, Y. (2023). Studying financial development with low-carbon architecture development and green technological innovation: sustaining SDG-9. Environmental Science and Pollution Research, 31(2), 2009–2025. https://doi.org/10.1007/s11356-023-31155-7

34. Lim, W. M. (2020). Challenger marketing. Industrial marketing management, 84, 342-345.

35. Lin, Y., Mahmood, M. A., Meng, W., & Ali, Q. (2024). Green economy transition in Asia Pacific: A holistic assessment of renewable energy production. Journal of Cleaner Production, 437, 140648. https://doi.org/10.1016/j.jclepro.2024.140648

36. Liu, Y., Zhao, X., Dong, K., & Jiang, Q. (2023). Assessing the role of green finance in sustainable energy investments by power utilities: Evidence from China. Utilities Policy, 84, 101627. https://doi.org/10.1016/j.jup.2023.101627

37. Liu, Y., Zhu, J., Li, E. Y., Meng, Z., & Song, Y. (2020). Environmental regulation, green technological innovation, and eco-efficiency: The case of Yangtze river economic belt in China. Technological Forecasting and Social Change, 155, 119993. https://doi.org/10.1016/j.techfore.2020.119993

38. Luo, Y., Lu, Z., Muhammad, S., & Yang, H. (2021). The heterogeneous effects of different technological innovations on eco-efficiency: Evidence from 30 China's provinces. Ecological Indicators, 127, 107802. https://doi.org/10.1016/j.ecolind.2021.107802

39. Lv, J., Wang, N., Ju, H., & Cui, X. (2022). Influence of green technology, tourism, and inclusive financial development on ecological sustainability: exploring the path toward green revolution. Economic Research-Ekonomska Istraživanja, 36(1). https://doi.org/10.1080/1331677x.2022.2116349

40. Ma, F., Saleem, H., Ding, X., Nazir, S., & Tariq, S. (2024). Do natural resource rents, green technological innovation, and renewable energy matter for ecological sustainability? Role of green policies in testing the environmental kuznets curve hypothesis. Resources Policy, 91, 104844. https://doi.org/10.1016/j.resourpol.2024.104844

41. Ma, S., Gao, Y., & Li, H. (2024). Digital economic, resource curse and the development of low-carbon transformation. Resources Policy, 91, 104931. https://doi.org/10.1016/j.resourpol.2024.104931

42. Maseeh, H. I., Sangroya, D., Jebarajakirthy, C., Adil, M., Kaur, J., Yadav, M. P., & Saha, R. (2022). Anti-consumption behavior: A meta-analytic integration of attitude behavior context theory and well-being theory. Psychology and Marketing, 39(12), 2302–2327. https://doi.org/10.1002/mar.21748

43. Pan, X., Mangla, S. K., Song, M., & Vrontis, D. (2024). Climate Policy Uncertainty and Entrepreneur Eco-investment Behavior for Green GrowthModerate Effect Analysis of Twin Transition. IEEE Transactions on Engineering Management, 1–11. https://doi.org/10.1109/tem.2024.3383475

44. Paul, J., & Bhukya, R. (2021b). Forty-five years of International Journal of Consumer Studies: A bibliometric review and directions for future research. International Journal of Consumer Studies, 45(5), 937–963. https://doi.org/10.1111/ijcs.12727

45. Paul, J., & Criado, A. R. (2020). The art of writing literature review: What do we know and what do we need to know? International Business Review, 29(4), 101717

46. Paul, J., & Criado, A. R. (2020). The art of writing literature review: What do we know and what do we need to know? International Business Review, 29(4), 101717. https://doi.org/10.1016/j.ibusrev.2020.101717

47. Paul, J., & Criado, A. R. (2020). The art of writing literature review: What do we know and what do we need to know? International business review, 29(4), 101717.

48. Paul, J., & Rosado-Serrano, A. (2019). Gradual Internationalization vs Born-Global/International new venture models. International Marketing Review, 36(6), 830–858. https://doi.org/10.1108/imr-10-2018-0280

49. Paul, J., & Rosado-Serrano, A. (2019). Gradual internationalization vs born-global/international new venture models: A review and research agenda. International Marketing Review, 36(6), 830-858.

50. Paul, J., Parthasarathy, S., & Gupta, P. (2017). Exporting challenges of SMEs: A review and future research agenda. Journal of world business, 52(3), 327-342.Paul, J., & Benito, G. R. (2018). A review of research on outward foreign direct investment from emerging countries, including China: what do we know, how do we know and where should we be heading? Asia Pacific Business Review, 24(1), 90-115.

51. Paul, J., Parthasarathy, S., & Gupta, P. (2017). Exporting challenges of SMEs: A review and future research agenda. Journal of world business, 52(3), 327-342.

52. Radmehr, R., Shayanmehr, S., Baba, E. A., Samour, A., & Adebayo, T. S. (2023). Spatial spillover effects of green technology innovation and renewable energy on ecological sustainability: New evidence and analysis. Sustainable Development. https://doi.org/10.1002/sd.2738

53. Rebouças, R., & Soares, A. M. (2020). Voluntary simplicity: A literature review and research agenda. International Journal of Consumer Studies, 45(3), 303–319. https://doi.org/10.1111/ijcs.12621

54. Ren, W., & Ji, J. (2021). How do environmental regulation and technological innovation affect the sustainable development of marine economy: New evidence from China's coastal provinces and cities. Marine Policy, 128, 104468. https://doi.org/10.1016/j.marpol.2021.104468

55. Roy Bhattacharjee, D., Pradhan, D., & Swani, K. (2022). Brand communities: A literature review and future research agendas using TCCM approach. International Journal of Consumer Studies, 46(1), 3-28.

56. Sana, Chakraborty, S., Adil, M., & Sadiq, M. (2023). Ecotourism experience: A systematic review and future research agenda. International Journal of Consumer Studies, 47(6), 2131-2156.

57. Sana, N., Chakraborty, S., Adil, M., & Sadiq, M. (2023). Ecotourism experience: A systematic review and future research agenda. International Journal of Consumer Studies, 47(6), 2131–2156. https://doi.org/10.1111/ijcs.12902

58. Sharif, A., Saqib, N., Dong, K., & Khan, S. a. R. (2022). Nexus between green technology innovation, green financing, and CO2 emissions in the G7 countries: The moderating role of social globalisation. Sustainable Development, 30(6), 1934–1946. https://doi.org/10.1002/sd.2360

59. Sibt-E-Ali, M., Xiqiang, X., Javed, K., Javaid, M. Q., & Vasa, L. (2024). Greening the future: assessing the influence of technological innovation, energy transition and financial globalization on ecological footprint in selected emerging countries. Environment Development and Sustainability. https://doi.org/10.1007/s10668-024-05076-5

60. Song, J., Wang, J., & Chen, Z. (2022). How Low-Carbon Pilots Affect Chinese Urban Energy Efficiency: An Explanation from Technological Progress. International Journal of Environmental Research and Public Health, 19(23), 15563. https://doi.org/10.3390/ijerph192315563

61. Takey, S. M., & Carvalho, M. M. (2016). Fuzzy front end of systemic innovations: A conceptual framework based on a systematic literature review. Technological Forecasting and Social Change, 111, 97–109. https://doi.org/10.1016/j.techfore.2016.06.011

62. Udeagha, M. C., & Ngepah, N. (2022). Dynamic ARDL Simulations Effects of Fiscal Decentralization, Green Technological Innovation, Trade Openness, and Institutional Quality on Environmental Sustainability: Evidence from South Africa. Sustainability, 14(16), 10268. https://doi.org/10.3390/su141610268

63. UNCTAD. (2018). Technology and innovation report 2018: Harnessing frontier technologies for sustainable development.

64. Wang, J., Yu, S., Li, M., Cheng, Y., & Wang, C. (2022). Study of the Impact of Industrial Restructuring on the Spatial and Temporal Evolution of Carbon Emission Intensity in Chinese Provinces—Analysis of Mediating Effects Based on Technological Innovation. International Journal of Environmental Research and Public Health, 19(20), 13401. https://doi.org/10.3390/ijerph192013401

65. Wang, Q., Qu, J., Wang, B., Wang, P., & Yang, T. (2019). Green technology innovation development in China in 1990–2015. The Science of the Total Environment, 696, 134008. https://doi.org/10.1016/j.scitotenv.2019.134008

66. Wang, X., Javaid, M. U., Bano, S., Younas, H., Jan, A., & Salameh, A. A. (2022). Interplay among institutional actors for sustainable economic development—Role of green policies, ecoprenuership, and green technological innovation. Frontiers in Environmental Science, 10. https://doi.org/10.3389/fenvs.2022.956824

67. Wang, Y., & Yang, Y. (2020). Analyzing the green innovation practices based on sustainability performance indicators: a Chinese manufacturing industry case. Environmental Science and Pollution Research, 28(1), 1181–1203. https://doi.org/10.1007/s11356-020-10531-7

68. Wang, Y., Qamruzzaman, M., & Kor, S. (2023). Greening the Future: Harnessing ICT, Innovation, Eco-Taxes, and Clean Energy for Sustainable Ecology—Insights from Dynamic Seemingly Unrelated Regression, Continuously Updated Fully Modified, and Continuously Updated Bias-Corrected Models. Sustainability, 15(23), 16417. https://doi.org/10.3390/su152316417

69. Wang, Y., You, Y., & Teng, Y. (2022). Optimized Variables for Environmental Dynamics: China's Renewable Energy Policy. Frontiers in Environmental Science, 10. https://doi.org/10.3389/fenvs.2022.862714

70. Wani, T. A., & Ali, S. W. (2015). Innovation diffusion theory. Journal of general management research, 3(2), 101-118.

71. Waqas, M., & Tan, L. (2022). Big data analytics capabilities for reinforcing green production and sustainable firm performance: the moderating role of corporate reputation and supply chain innovativeness. Environmental Science and Pollution Research, 30(6), 14318–14336. https://doi.org/10.1007/s11356-022-23082-w

72. Weina, D., Gilli, M., Mazzanti, M., & Nicolli, F. (2016). Green inventions and greenhouse gas emission dynamics: a close examination of provincial Italian data. Environmental Economics and Policy Studies, 18, 247-263.

73. Xie, C., Ye, L., Zhong, N., & Wan, W. (2024). Impact of digital finance on corporate green innovation: Exploring role of land resource misallocation in China. Resources Policy, 91, 104920. https://doi.org/10.1016/j.resourpol.2024.104920

74. Xu, Y., & Ding, Z. (2024). Sustainable growth unveiled: exploring the nexus of green finance and high-quality economic development in China. Frontiers in Environmental Science, 12. https://doi.org/10.3389/fenvs.2024.1414365

75. Yang, L., Chen, J., & Li, H. (2015). Validating a model for assessing the association among green innovation, project success and firm benefit. Quality & Quantity, 50(2), 885–899. https://doi.org/10.1007/s11135-015-0180-6

76. Yang, X., Shafiq, M. N., Nazir, R., & Gillani, S. (2024). Unleashing the Influence Mechanism of Technology Innovation and Human Development for Ecological Sustainability in Emerging Countries. Emerging Markets Finance and Trade, 1–24. https://doi.org/10.1080/1540496x.2024.2308180

77. Yikun, Z., Leong, L. W., Cong, P., Abu-Rumman, A., Shraah, A. A., & Hishan, S. S. (2022). Green growth, governance, and green technology innovation. How effective towards SDGs in G7 countries? Economic Research-Ekonomska Istraživanja, 36(2). https://doi.org/10.1080/1331677x.2022.2145984

78. Yuerong, H., Javaid, M. Q., Ali, M. S. E., & Zada, M. (2024). Revisiting the nexus between digital trade, green technological innovation, and environmental sustainability in BRICS economies. Environmental Science and Pollution Research, 31(6), 8585–8607. https://doi.org/10.1007/s11356-023-31661-8

79. Zhang, M., & Liu, Y. (2022). Influence of digital finance and green technology innovation on China's carbon emission efficiency: Empirical analysis based on spatial metrology. The Science of the Total Environment, 838, 156463. https://doi.org/10.1016/j.scitotenv.2022.156463

80. Zhang, P., Li, Z., Ghardallou, W., Xin, Y., & Cao, J. (2023). Nexus of institutional quality and technological innovation on renewable energy development: Moderating role of green finance. Renewable Energy, 214, 233–241. https://doi.org/10.1016/j.renene.2023.05.089

81. Zhao, F., Xu, Z., & Xie, X. (2024). Exploring the Role of Digital Economy in Enhanced Green Productivity in China's Manufacturing Sector: Fresh Evidence for Achieving Sustainable Development Goals. Sustainability, 16(10), 4314. https://doi.org/10.3390/su16104314

82. Zheng, M., Feng, G. F., Jang, C. L., & Chang, C. P. (2021). Terrorism and green innovation in renewable energy. Energy Economics, 104, 105695. https://doi.org/10.1016/j.eneco.2021.105695

83. Zhou, F., Samsurijan, M. S. B., Ibrahim, R. L., & Al-Faryan, M. a. S. (2023). An assessment of the aggregated and disaggregated effects of natural resources rents on environmental sustainability in BRICS economies. International Journal of Sustainable Development & World Ecology, 31(4), 375–394. https://doi.org/10.1080/13504509.2023.2291135