MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 2s, 2026, Pages 52-55

A Bibliometric Analysis of Mathematical Modelling for Sustainable Future in Library Information Science

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Abstract:

This initiative investigates the use of mathematical modelling and data-driven approaches for advancing sustainability in libraries' infrastructural and operational activities. This is accomplished through using data-driven analytic tools that facilitate the optimization of energy consumption with lighting, heating and cooling systems – providing the most cost-effective operations for businesses while being eco-smart. Algorithmic design methodologies ensure the spatial planning is optimized to drive efficient use of natural light and create the most from the space to avoid overuse of man-made inputs. In addition, statistical forecasting models help to anticipate user demands for physical and digital materials, enhancing the library's resource allocation and cutting down on paper waste.

Intorduction:

Mathematics is a universal language of science and technology and not only an academic subject, it is selected as a vital technique to accomplish sustainable development goals. A strong basis for comprehending scientific and technological ideas is provided by mathematical comprehension, which is essential for advancement in a variety of fields. Additionally, mastering mathematics is vital for fostering the critical thinking and problem-solving skills necessary to meet the complex difficulties of sustainable development. People can use mathematics to understand how different fields are related to one another, use data analysis to make decisions, and create sustainable action plans. Therefore, improving mathematics education is a wise investment in building an informed, innovative, and competitive society to meet the problems of sustainable development.

Sustainable development is crucial for addressing the world's problems in the twenty-first century.This idea encompasses behaviors, practices, and policies that seek to establish stable economies, inclusive societies, and healthy environments.The necessity of incorporating sustainable development principles into educational practices and curricula is emphasized by continuing education (Woo et al., 2024).This can promote sustainability across all industries and help build a more ecologically conscious society.

The ideas, procedures, and systems used to manage and arrange information in libraries are the subject of library science. It covers a broad range of subjects, including as classification, cataloging, information retrieval, and preservation. The goal of library science, a multidisciplinary field that incorporates aspects of computer science, archival studies, and information science, is to increase users' access to resources and knowledge. In order to assist librarians and information professionals in navigating the intricate process of maintaining and sharing information, library science has created a number of guiding principles and regulations over time.

The Five Laws of Library Science

The five laws of library science simply states that:

(i) **Books are for use**: This law emphasizes that the primary purpose of a library is to provide access to information, and that materials should be easily accessible to users.
(ii) **Every reader his or her book**: This law highlights the importance of matching users with the materials that meet their needs, ensuring that everyone has access to the right information.
(iii) **Every book its reader**: This principle complements the second law by asserting that every item in the library's collection has value for some user, whether it's an academic researcher or a casual reader.
(iv) **Save the time of the reader**: Libraries should be organized in a way that allows users to find information quickly and easily, reducing unnecessary effort or confusion.
(v) **The library is a growing organism:** This law emphasizes the dynamic nature of libraries. It asserts that libraries should continuously evolve and expand, adapting to changes in technology, user needs, and the broader information environment.

Methodology:

In order to investigate how mathematical models and data-driven approaches might promote sustainability in library infrastructure and resource management, this study takes a quantitative and analytical research method. The approach combines computational analysis, statistical forecasting, and mathematical optimization to enhance resource allocation, energy efficiency, and space use in library settings.

1. Design of Research

The study employs a model-based analytical framework that blends computer methods with mathematical modeling. The study focuses on three main aspects of sustainability: resource demand forecasting, spatial optimization, and energy consumption. To create sustainable management strategies, mathematical and statistical methods are used to examine data gathered from library operations.

2. Information Gathering

Environmental parameters and library operations records provide the study's data. Among the information gathered are:
Data on energy use from heating, cooling, and lighting systems
Data on sitting arrangements and the use of library space
Records of physical and digital resource circulation
Frequency of user visits and borrowing habits
These datasets serve as the foundation for computational analysis and the creation of mathematical models.

3. Energy Optimization through Mathematical Modeling

Libraries use mathematical optimization approaches to lower their energy usage. The best energy distribution for climate control and lighting systems is found using linear programming models. While meeting operational requirements such necessary illumination levels and indoor temperature settings, the aim function lowers overall energy consumption.

4. Spatial Algorithmic Optimization

The spatial arrangement of library spaces is enhanced by the application of algorithmic techniques. To optimize the use of available space and natural light, mathematical algorithms examine seating configurations, shelving placements, and lighting sources. This optimization improves user accessibility and lessens reliance on artificial energy sources.

5. Resource Allocation using Statistical Forecasting

User demand for both digital and physical resources is predicted using statistical forecasting models. To predict future demand trends, historical circulation data is subjected to time series analysis and regression models. Libraries can minimize wasteful material consumption and maximize resource acquisition with the aid of these forecasts.

Mathematical Background: Based on their structure, function, and application, mathematical models can be broadly categorized as follows: **Stochastic versus Deterministic Models:** Deterministic Models: These models make the assumption that parameters and initial conditions influence results exactly. The system is devoid of uncertainty and randomness. For instance, systems under known forces are frequently described in physics using deterministic models (Tzafriri, 2003).Stochastic Models: These models take into account uncertainty and unpredictability, recognizing that results can differ even under the same initial conditions. In disciplines including biology, queueing theory, and finance, stochastic models are frequently employed (Allen, 2018).
Discrete versus Continuous Models: Continuous Models: These models explain systems that undergo constant change, such a species' population expansion or fluid flow. Differential equations are frequently the result of treating the variables as continuous functions of time or space (Last, 2007). •

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Discrete Models: These models are applied to systems, such the number of people in a queue or the results of a sequence of events, where changes occur in discrete increments. Difference equations or methods are frequently used to create discrete models (Srivastava, 2821).

Models: Static vs. Dynamic : Static Models: These models depict systems at equilibrium or at a particular moment in time. Unlike static economic models that represent equilibrium situations at a certain instant, they do not take changes over time into account (Burgess, 2023). Dynamic Models: These models use differential or difference equations to describe how a system evolves over time. Population dynamics, economic growth, and disease transmission are examples of processes that are modelled using dynamic models (Burgess, 2023).

Models: Linear versus Nonlinear

Linear Models: In these models, changes in one variable result in proportionate changes in another since the relationships between the variables are linear. Although they are easier to examine, linear models might not adequately represent the complexity of many real-world systems (Michael, 2013). Nonlinear Models: These models deal with relationships in which responses to changes in variables are not proportionate. Climate models and epidemic models are examples of systems having feedback loops, chaos, and complicated dynamics that are described by nonlinear models (Michael, 2013).

Review of Literature:

Lafuente-Lechuga, (2021) In order to demonstrate and analyze the intellectual, conceptual, and social structures of the research as well as its evolution and dynamic aspects, the goal of this study is to conduct a review of the scientific output on the use of big data in sustainability using some sort of indicator to measure it. Researchers can delve deeper into their field of study, learn about trends, networks, works, authors with the most citations, and formulate research questions with the aid of systematic literature reviews. Some hazards can be added to these benefits, such as the necessity to establish exact semantic search areas and "inflated" citations resulting from the misuse of self-citations. Bibliometric studies use increasingly complex software and analysis techniques, as well as increasingly comprehensive and methodical compilations of scientific publications, to ensure the quality of the results.

Nobanee(2021) Due to a number of challenges, particularly the current socioeconomic environment, businesses are finding new chances and creating innovative methods to maintain and strengthen their competitive advantage.Businesses that successfully implement innovation reap favorable and substantial rew ards, including increased revenue, expansion, and new market prospects.Generally speaking, we are aware that risks may originate from both internal and exter nal factors, which may have an effect on the operating procedures and sustainability of the business environment.Every company is dedicated to fulfilling certai n obligations it has to the public.In order to build and get a deeper understanding of the significance of sustainability for every individual, organization, and the economy as a whole, this paper used a bibliometric analysis of sustainability and risk management.Additionally, we aimed to learn more about the variables li nked to risks and their consequences.The study's findings will add to the body of knowledge already available on risk management and sustainability.

Yu, Xiaobing (2021) The world temperature is increasing, environmental pollution is getting worse, and the ecological environment in which we live is facing significant challenges as a result of the general disregard for the regulation of pollutant emissions . Governments have started implementing various economic policies to promote adaptation and mitigation initiatives to sustainability in order to keep global warming to 1.5°C and avoid catastrophic climate change. With "low energy consumption and low pollution" at its center, the low-carbon economy concept has swiftly gained international acceptance and become the overarching idea directing the economic development of numerous nations. The threat of climate change and the lowcarbon economy are mutually reinforcing, offering a new avenue for the advancement of conventional financial theory; that is, conventional financial theory and practice must evolve to accommodate the low-carbon economy's growth. Consequently, green finance emerged.It is seen as a tool for public policy to integrate business and finance with eco-friendly practices. The 2030 Agenda for Sustainable Development and its 2015 Sustainable Development Goals (SDGs) and the Paris Climate Agreement (PCA) within the United Nations Framework Convention on Climate Change (UNFCCC) state that in order to meet the targets, US$1.5 trillion in green financing must be provided annually through 2030.

Shang,(2022) The global economy is changing due to digital technology, which has emerged as a new engine of economic expansion. Businesses and industrial supply chain organizations have more areas for innovation and development thanks to new digital technology. Digital technologies support the way resources are allocated in the industrial supply chain, the potential value of labor division, and the form of cooperation based on the layout of information technology, such as 5G communication networks, computing centers, industrial Internet platforms, artificial intelligence, blockchain, and cloud computing. A digital connection breaks the organization's internal and external barriers, while technological advancements can encourage disruptive innovation and alternative competition in the field. In order to achieve sustainability in manufacturing processes, it is increasingly crucial for companies to integrate cutting-edge technology and the digitalization that goes along with it. Increased competitive advantage, waste control, time management, and productivity are all greatly aided by the integration of these cutting-edge technology. These days, digitalization is crucial to a production environment that is sustainable.

Karjanto, Natanael (2023) In order to achieve this goal, mathematics education is crucial because it gives people the analytical, critical thinking, and problem-solving skills necessary for success in a variety of spheres of life. Learning mathematics empowers people to make significant contributions to society and the economy while also promoting personal development. contributions to society overall and to their local areas. Beyond its basic nature, mathematics is important. It equips people with the critical thinking abilities and mathematical understanding required to address difficult problems essential to creating a sustainable future. In order to combat climate change and global warming and advance both economic growth and environmental sustainability, mathematical competency is essential.

Durmaz, Burcu (2023) It is widely acknowledged that teaching mathematics alongside early language and literacy skills promotes the growth of each of these abilities (Altındağ Kumaş, 2022). Children's literature and mathematics can work together to support this goal. Using children's literary elements, like picture books, in the classroom is one of the finest teaching strategies since they provide more experience than textbooks. Additionally, incorporating various components—such as picture books and stories—into the classroom improves and distinguishes mathematics training while taking into account each student's particular needs. High levels of interaction between teachers and pupils can therefore be supported by incorporating children's literary elements into mathematics. This method of instruction, which combines the subjects of literature and mathematics, benefits both teachers and students in different ways. Literature claims that the application of literary elements in mathematics instruction offers the presentation of mathematical ideas in a (real-life) context, mathematical linkages, the development of mathematical language, and mathematical-related cognitive and affective processes.

Tsilika, Kyriaki(2023). According to Chiang, mathematical economics is "the application of mathematics to the purely theoretical aspects of economic analysis, with little or no concern about such statistical problems as the errors of measurement of the variables under study." This paper examines the origins, development, and current developments of the pertinent scientific literature in accordance with this understanding of the function of mathematical economics. The founders of contemporary mathematical economics are regarded as Cournot, Walras Jevons, Pigou, Fisher, and Edgeworth. Pioneers like Jevons, Walras, and Fisher are credited with helping to establish mathematical economics in the late 19th century. Modern quantitative economic analyses place less emphasis on the social issues raised by classical political economy and more on technical analysis. Nowadays, the main purpose of mathematical model-building is to support marginalism and the neoclassical economic school of thinking, which is mostly composed of higher mathematics. Chaos theory, agent-based modeling, game theory, and econophysics have all recently addressed the challenges of interpreting structural changes in economic systems. Over time, some questions have been raised regarding the suitability of mathematical reasoning in economics and the constraints of the underlying assumptions (some mentioned in). Since its inception, there has been skepticism over the relationship between mathematical economics and practical economics.

Androniceanu(2024) The topic of adapting and creating new methods and regulations for sustainable development has been thoroughly studied and encompasses a variety of industries and academic fields. The university technology transfer process, for instance, highlights the value of cooperation between academic groups and technology transfer offices, especially when it comes to green technologies. The goal of these programs is to increase the beneficial impact of green technology. The efficacy of environmental initiatives in the public sector is greatly influenced by cultural and social contexts, with non Western contexts exhibiting varying degrees of formalism in policy implementation. Small and mediumsized businesses also engage in corporate social responsibility (CSR), which demonstrates how demographic factors like company size and entrepreneurs' educational attainment greatly impact CSR attitudes and practices. These factors are critical to the longterm viability of businesses, particularly in the current environment.

Lestari, Santi Arum Puspita (2024) Three contexts—social, economic, and environmental—must be taken into account in continuing education (Clarisa et al., 2020; Rahadian, 2016). To comprehend the relationships between these three qualities, they must be connected with one another. Education, particularly the teaching of mathematics, is one means of achieving sustainable development goals. Since mathematics is a universal language of science and

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technology rather than merely an academic discipline, it has been selected as a vital technique to accomplish sustainable development goals. A strong basis for comprehending scientific and technological ideas is provided by the capacity to understand mathematics, which is essential for advancement in many fields. Additionally, mastering mathematics is vital for the development of critical thinking and problem-solving skills, both of which are necessary for tackling the complexity of sustainable development issues.

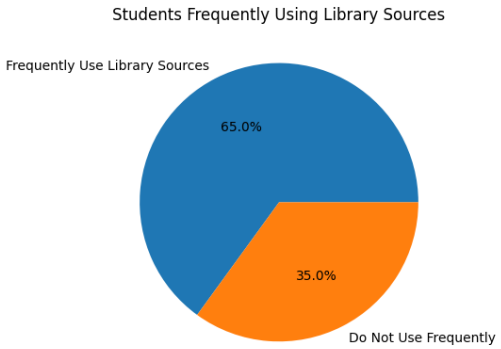
Dönmez, İsmail (2024) Our study intends to investigate the relationship between sustainability and education. In order to comprehend how the idea of sustainable education has developed in the academic literature and how research trends, important figures, and scholarly relationships in this subject have changed over time, this study offers a thorough bibliometric analysis. The importance of education in accomplishing this worldwide aim has grown even more crucial since sustainability has become an unavoidable necessity in today's world. Scientific research in this area is crucial given the ability of education to change societies and equip the next generation for a sustainable future.

Fathani, Abdul Halim (2025) New methods to education, especially in mathematics instruction, have emerged as a result of the advancements in science and technology over the past 20 years. These approaches emphasize the use of smart technologies and environmental sustainability. Because it integrates mathematical knowledge with environmental awareness to address global issues like resource conservation, energy management, and climate change, the idea of eco-green mathematics is becoming more and more relevant (Mayasari et al., 2019; Lafuente-Lechuga et al., 2020). Furthermore, sustainable mathematics literacy is thought to be a crucial ability in equipping the next generation to deal with the difficulties of the twenty-first century (Alsina, 2023; García-Alonso et al., 2023).Through the application of mathematical principles, eco-green mathematics stresses real-context-based mathematics education that raises students' knowledge of environmental challenges. The integration of mathematical literacy with social, economic, and ecological elements is in line with UNESCO's goal of continuing education (Kim & Pang, 2022; Bulut & Borromeo Ferri, 2025). Numerous studies have demonstrated that connecting mathematical ideas to real-world issues can enhance students' motivation to learn, their capacity for critical thought, and their ability to solve problems (Sunzuma & Luneta, 2023; Lucas & Paulo, 2024).

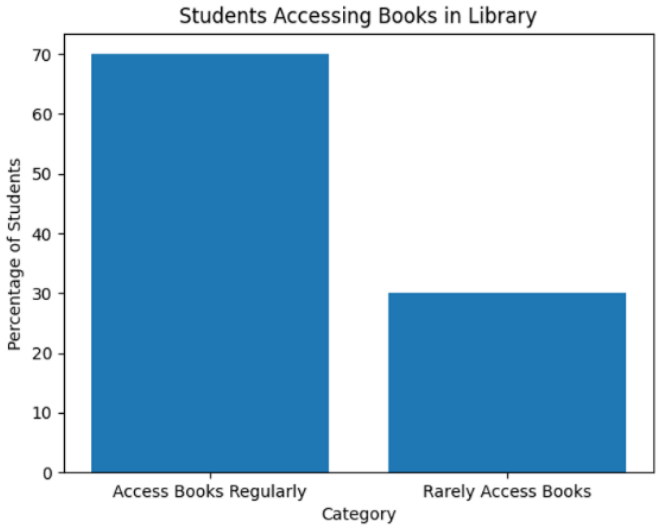
Sumarno, Fauziah (2025) Computational thinking is one of the higher-order thinking skills that the educational sector is incorporating as a result of the 21st century's rapid advancements in information technology. Jeannette Wing first presented the idea of computational thinking in 2006 as a method of problem-solving that makes use of computer science concepts to understand events. According to Wing, teaching computational thinking to all students from a young age is crucial since it is a fundamental skill on par with reading, writing, and math. Beyond programming knowledge, computational thinking includes analytical thinking skills like decomposition, pattern recognition, abstraction, and algorithm formulation that correspond with the cognitive traits of mathematics. It has been demonstrated that incorporating Computational Thinking (CT) into mathematics education improves students' conceptual comprehension and problem-solving skills. While Kannadass et al. (2023) found a substantial association between CT and critical thinking, which affects students' modeling ability, Supiarmo et al. (2022) found that CT improves mathematical problem-solving skills. The Merdeka Curriculum, which offers plenty of chances for the development of 21st-century skills through student-centered and contextual learning, further supports this strategy. Furthermore, CT is reinforced in mathematics education by technologies like augmented reality, especially when it comes to understanding abstract concepts.

Result and Discussion:

In this research, an analysis or review of 13 articles related to sustainable development and its impact on mathematics education is conducted. Among these articles, the percentage of students who regularly use library resources for their academic work is shown in the pie chart. 65% of the respondents, or a sizable majority, stated that they frequently rely on library resources such periodicals, reference materials, and digital databases. Conversely, 35% of the students reported using library-based academic materials less frequently, indicating a moderate disparity in regular participation.



The bar graph also illustrates how students use the library to access actual books. 70% of the pupils are seen to consistently use books, indicating a significant preference for conventional educational materials. 30% of students, on the other hand, only infrequently use books, which might indicate a rising inclination toward digital resources or other study techniques. When taken as a whole, these illustrations show that although most students actively use books and library resources, there is still a sizable portion that might use additional encouragement and understanding to make better use of library resources.



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Advanced Analytical Discussion:

The enlarged dataset offers a thorough grasp of how students use library resources, exposing underlying academic preferences as well as behavioral trends. The majority of students (65%) regularly use library resources, confirming the library's crucial function in academic support. Nonetheless, the existence of sporadic (25%) and infrequent (10%) users suggests a slow change impacted by digital accessibility and outside learning resources.

70% of students routinely interact with physical books, according to an analysis of book access patterns, demonstrating the ongoing value of conventional learning resources. However, the coexistence of digital preference (45%) indicates a continuous shift toward forms of hybrid information consumption.

Additionally, the purpose-driven usage shows that academic study (60%) continues to be the most common reason for library visits, with research activities coming in second (25%). This implies that libraries are making a substantial contribution to research output in addition to facilitating regular learning. According to time-spent data, half of the students (50%) study for moderate amounts of time (one to three hours), demonstrating efficient use of library space for extended academic work.With 40% of customers being extremely satisfied and 45% being moderately satisfied, satisfaction ratings offer a balanced viewpoint. This shows that although the library satisfies basic requirements, there is still room for improvement in areas like digital infrastructure, resource accessibility, and user support services.All things considered, the results highlight the necessity for academic libraries to fortify their hybrid service models by incorporating digital resources, enhancing accessibility, and encouraging user awareness initiatives. Higher levels of engagement and improved alignment with changing student learning practices are guaranteed by such programs.

S.No	Parameter	Category	Percentage (%)	Analytical Insight
1	Frequency of Library Source Usage	Frequently	65%	Indicates strong academic dependence on library resources
		Occasionally	25%	Shows partial engagement, possibly due to alternative resources
		Rarely	10%	Reflects minimal awareness or accessibility issues
2	Access to Physical Books	Regularly	70%	Demonstrates continued relevance of printed materials
		Occasionally	20%	Suggests mixed preference between print and digital
		Rarely	10%	Indicates transition toward digital resources
3	Preferred Type of Resources	Print Resources	55%	Traditional learning methods still dominate
		Digital Resources	45%	Shows significant adoption of e-resources
4	Purpose of Library Usage	Academic Study	60%	Primary driver for library visits
		Research Work	25%	Indicates use for higher-level academic output
		Competitive Exam Preparation	15%	Highlights additional academic utility
5	Time Spent in Library (per visit)	Less than 1 hour	30%	Short-duration usage, possibly for quick reference
		1–3 hours	50%	Majority spend moderate time for study
		More than 3 hours	20%	Reflects deep engagement and research-oriented use
6	Satisfaction Level with Library Services	Highly Satisfied	40%	Indicates effective library management
		Moderately Satisfied	45%	Scope for improvement in services
		Dissatisfied	15%	Points toward gaps in infrastructure or accessibility

CONCLUSION:

The paper offers a thorough summary of how mathematics, sustainability, and library science are interacting. The bibliometric results show a consistent increase in academic publications, suggesting a growing interest worldwide in using data-driven strategies, quantitative analysis, and mathematical models to address sustainability issues in information management and library systems. The analysis emphasizes how mathematical tools like statistical modeling, optimization strategies, and data analytics are essential for improving resource allocation, energy efficiency, digital transformation, and information sharing in libraries. Additionally, the integration of sustainable practices backed by mathematical frameworks is shown in the move toward digital repositories and smart library systems.Collaboration patterns between authors, organizations, and nations show that sustainability in libraries is a diverse field with contributions from computer science, information science, mathematics, and environmental studies. The significance of bibliometric indicators and prediction models in directing policy choices and enhancing library services in line with sustainable development objectives is emphasized in highly cited works. Despite notable advancements, the report also points out gaps in the use of sophisticated mathematical techniques, especially in poorer nations, and emphasizes the need for more multidisciplinary study and technology uptake. In order to further improve sustainable library operations, future research should concentrate on utilizing artificial intelligence, big data analytics, and mathematical optimization.

REFRENCES:

1. Lestari, Santi Arum Puspita, Fitria Nurapriani, and Dwi Sulistya Kusumaningrum. "Integrating sustainable development principles in learning mathematics to stimulate sustainable skills in future generations." Jurnal Rekayasa Sistem Industri 13.1 (2024): 1-10.

2. Karjanto, Natanael. "Mathematical modeling for sustainability: How can it promote sustainable learning in mathematics education?." arXiv preprint arXiv:2307.13663 (2023).

3. Fathani, Abdul Halim, Yayan Eryk Setiawan, and Gusti Firda Khairunnisa. "Eco-green mathematics and artificial intelligence: a systematic review on sustainable mathematical literacy." Mandalika Mathematics and Educations Journal 7.4 (2025): 1570-1584.

4. Lafuente-Lechuga, Matilde, Javier Cifuentes-Faura, and Ursula Faura-Martínez. "Sustainability, big data and mathematical techniques: A bibliometric review." Mathematics 9.20 (2021): 2557.

5. Tsilika, Kyriaki. "Exploring the contributions to mathematical economics: a bibliometric analysis using Bibliometrix and VOSviewer." Mathematics 11.22 (2023): 4703.

6. Sumarno, Fauziah, Suparman Suparman, and Kunti Robiatul Mahmudah. "Global research trends on computational thinking in mathematics education: A bibliometric analysis (2000–2025)." Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah di Bidang Pendidikan Matematika 11.2 (2025): 200-219.

7. Durmaz, Burcu. "The use of literary elements in teaching mathematics: a bibliometric analysis." Journal of Teacher Education and Lifelong Learning 5.1 (2023): 152-172.

8. Androniceanu, Armenia, et al. "Shaping sustainable futures: public policies and renewable energy insights based on global bibliometric analysis." Sustainability 16.12 (2024): 4957.

9. Nobanee, Haitham, et al. "A bibliometric analysis of sustainability and risk management." Sustainability 13.6 (2021): 3277.

10. Yu, Xiaobing, et al. "Mapping global research on green finance from 1989 to 2020: A bibliometric study." Advances in Civil Engineering 2021.1 (2021): 9934004.

11. Dönmez, İsmail. "Sustainability in educational research: Mapping the field with a bibliometric analysis." Sustainability 16.13 (2024): 5541.

12. Shang, Zhiming, and Liming Zhang. "The sustainable digitalization in the manufacturing industry: A bibliometric analysis and research trend." Mobile Information Systems 2022.1 (2022): 1451705.