Artificial Intelligence Leads to Circular Economy: A Bibliometric Review and Future Agenda

Zuhair Abbas[1], Jaroslav Belas[2] and Rasa Smaliukiene[1]

[1]Department of Creative Communication, Faculty of Creative Industries, Vilnius Gediminas Technical University, Lithuania

[2]Faculty of Social and Economic Relations, Alexander Dubček University in Trenčín, Slovakia

z.abbas@vilniustech.lt (Corresponding author)
jaroslav.belas.st@tnuni.sk
rasa.smaliukiene@vilniustech.lt

Abstract: Despite extensive research on industry 4.0 and circular economy (CE). There is limited research on nexus between artificial intelligence (AI) and circular economy. AI seems to be driving force for revolutionizing in businesses and industries for unlocking economic, environmental, and social benefits. We investigated how AI transform from linear to circular business models. Authors selected 105 peer-reviewed articles from Web of Science database by using bibiliometric analysis. Authors analyzed the data by using VoSviewer Software. The four core clusters were identified, (1) circular economy a pathway to sustainable business management, (2) big data models enhance CE outcomes, (3) I4.0 technologies leads to future of CE and (4) digitalized supply chains for sustainable development. This review advances our understanding on AI and circular economy in the existing literature due to less focus by prior scholars. More importantly, this review contributes to shifting the focus to technological perspective within circular economy, diverging from traditional linear model based on economic views. This review suggested companies should adopt AI as it plays a pivotal role in facilitating the shift to a circular economy by reshaping and enhancing existing models of product design, manufacturing, consumption, repair, regeneration, recovery, and end-of-life management while simultaneously improving the efficiency of waste management. This research provides fresh perspectives on AI and CE to better understand AI as an opportunity rather than cost due to ongoing fourth industrial revolution.

Keywords: Artificial intelligence, Circular economy, Bibliometric review, Big data models, Digital supply chains

1. Introduction

AI seems to be promising for achieving circular and sustainable goals for business and society (Saha et al., 2025). In a similar fashion, the adoption of new technology has accelerated the shift from linear to CE making it a focal point of sustainability policy agendas on a global and regional scale (Sanchez-Garcia et al., 2024). According to World Economic Forum, AI will revolutionize international trade by improving supply chains, logistics, trade finance, and customs compliance, making global business more equitable, sustainable, and effective (WEF, 2025). In 1955, John McCarthy first used the term "artificial intelligence" to refer to "the technical and scientific process involved in creating machines with intelligence." (Anderson, 2024). AI relied on human-established standards for making decisions, but machine learning and deep learning have enabled algorithms to gain insights from data, enabling goal achievement and task execution through adaptive and rapid learning mechanisms (Haenlein and Kaplan, 2019). AI seem to be potential driver for CE transition for achieving economic, environmental and social sustainability.

Despite the aspirations and high hopes expressed by those policies, the firm's response has been largely indifferent. For instance, 75% of the 618 European SMEs surveyed either did not engage in any CE activities or were just concerned with meeting their recycling legal obligations (Bassi and Dias, 2019), this is because companies can't afford to put money into things like clean production and CE-aligned business models, which demand more resources (Reim et al., 2025). The data demonstrating a decline in the "circularity" of the world economy from 9.1% in 2018 to 7.2% in 2023 provides a picture of the broader impact (Circular Economy Foundation 2023). In today's world, linear models are failed to protect the planet and human societies. By considering this issue, CE transition is an important at this moment for sustainable future.

Over the recent years, AI-CE nexus has been widely recognized (Akhtar et al., 2024; Fallahi et al., 2023; Jain et al., 2025; Tutore et al., 2024). Against this backdrop, the concept of AI has emerged (McCarthy et al., 1956; Turing, 2007). AI may enhance a system's ability to ingest data and acquire knowledge based on it; the knowledge can be leveraged to achieve expected objectives and tasks (Haenlein and Kaplan, 2019). This development has raised the interest of major IT companies in AI solutions. As a result, cloud computing services for machine learning began to be provided by businesses like Google, Amazon, Microsoft, Salesforce, and IBM, making cognitive technologies more accessible and usable (Davenport, 2018). This reflects many companies are investing a huge money on adopting AI for circularity.

There are several reviews discussed barriers and benefits of digital technologies with CE (Chauhan et al., 2022a; Neri et al., 2025), eco-innovations (de Jesus Pacheco et al., 2017; Kuo and Smith, 2018), healthcare waste management (Sharma et al., 2025), building resilient supply chains (Chauhan et al., 2023b), sustainable product management (Rusch et al., 2023), digital health entrepreneurship (Weimar et al., 2025), stakeholder engagement (Prebanić, K. R., and Vukomanović, 2021; Tabas et al., 2025), Industry 4.0 and CE ecosystems in Central and European context (Abbas & Smaliukienė, 2025). Hence, few reviews highlighted role of AI with sustainability and business models (Kar et al., 2022; Jobstreibizer et al., 2025), entrepreneurship (Kalsoom et al., 2025), innovation capabilities (Gama and Magistretti, 2025), family businesses (Kumar & Ratten, 2025), human resource management (Gong et al., 2025). However, less focused has been given to AI with circular economy in existing literature (Agrawal et al., 2022; Huang et al., 2025). Recent studies encouraged to explore AI and CE by using bibliometric analysis technique to provide a clearer picture on it (Aivazidou et al., 2025; Neri et al., 2025). This shows lack of bibliometric review on nexus between AI and CE transition. By doing so, we address two notable research questions:

RQ1. What is the role of AI on CE transition?

RQ2. What are the future agendas on nexus between AI and CE?

2. Research Design

With the goal of consolidating and expanding our knowledge of how AI and circular economy, we deployed bibliometric review (Donthu et al., 2021). Scholars benefit by using bibliometric analysis in several ways. They can use it to find trends in the success of journals and papers, patterns in their partnerships, and trends in the research (Verma and Gustafsson, 2020). With the help of VoSviewer, the authors ran the data for analysis (Wong, 2018). We applied PRISMA by selecting our sample size for bibliometric review.

2.1 Data and Sample

We used Web of Science (WoS) database for selecting the peer-reviewed articles. The WoS is well-known for its tough journal selection standards, which ensure reliable, peer- reviewed articles (Martín-Martín et al., 2021). Many review studies use the WoS as their sole data source, and it is a trustworthy tool for bibliometric reviews, this is particularly relevant for studies focused on significant and prominent studies (Falagas et al., 2008; Visser et al., 2021). After considering other databases such as Scopus and Google Scholar, we settled on WoS due to its extensive indexing period (dating back to 1900), constant indexing of high-quality academic sources, and standardized metadata—all of which are essential for generating reliable and repeatable results (Singh et al., 2021). Despite its size, Scopus has issues with irregular metadata, duplicate records, improper or incomplete retrieval, and incorrect or missing citations (Franceschini et al., 2016).

The inclusion criteria as follows: We searched keywords “artificial intelligence” AND “circular economy”. The data extraction from Web of Science on 10th June 2025. Authors used documents only in English language, and selected Journal articles and followed specific fields, Management, Business, Economics, Engineering Environmental. This research mainly focused on specific fields due to inclusion on business, management and technology. The Table 1 shows identification, screening and eligibility stages by following PRISM. This reflects quality selection criteria for our sample for getting better and comprehensive results and provide rigor methodologically.

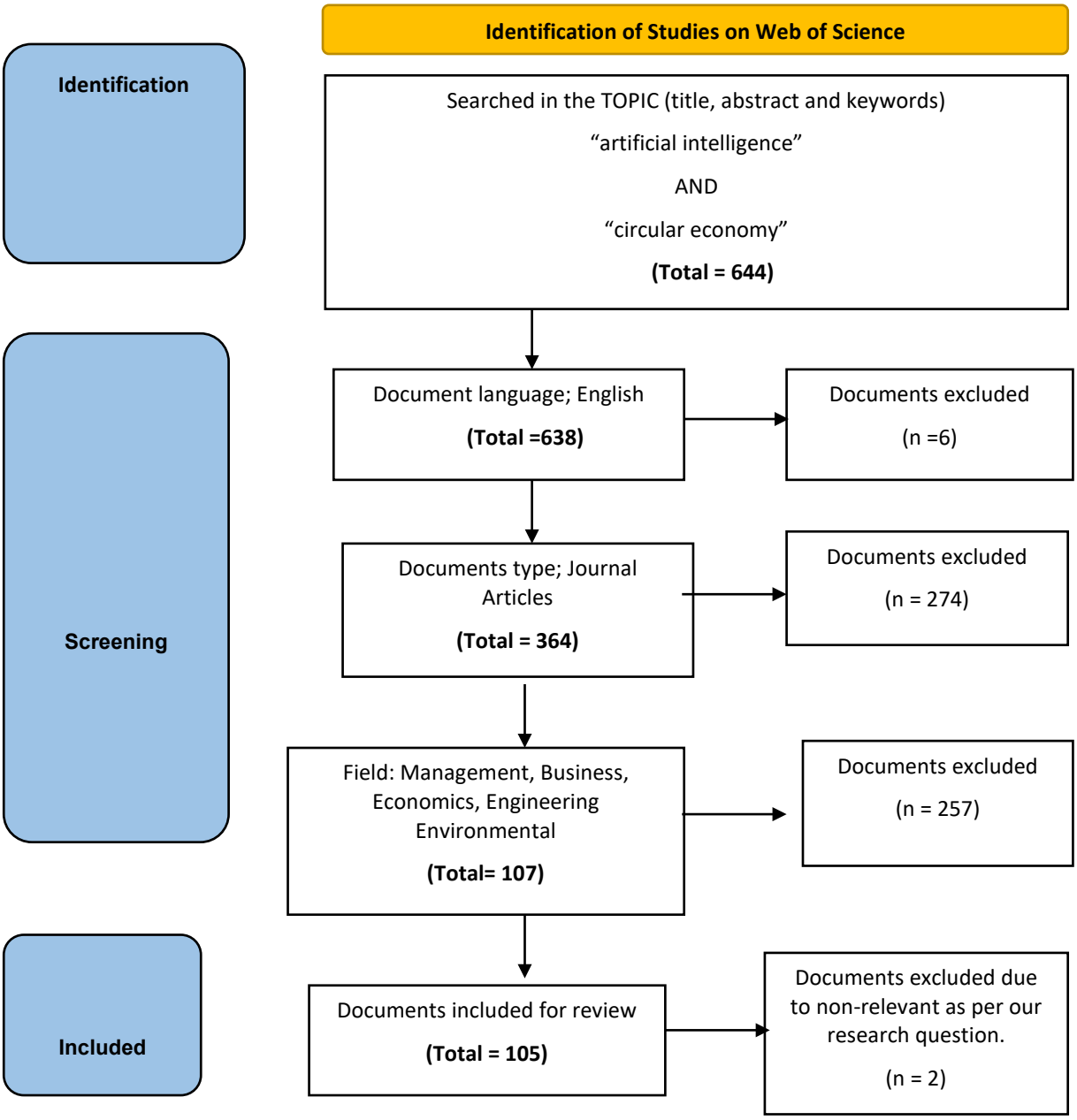

Figure 1: PRISMA adapted from Page et al., (2021)

3. Results

Recent years have seen a rise in the use of survey and case study approaches to discuss AI and the circular economy. Scholars are also doing literature reviews, meta-analyses, and bibliometric reviews to learn more about this new occurrence. The number of papers included in the study's analysis increased over time, as seen in Figure 1. Our sampling begins with an article published in 2019. Papers published up until 2024 are included in our analysis starting from that year. These publications were the most recent ones available when the manuscript was written. Publications grow from 2020 to 2021 as a result of increased digital transformation among businesses. On the flip side, 2023 has a smaller drop with 23 publications. Next year, in 2024, there will be 19 publications.

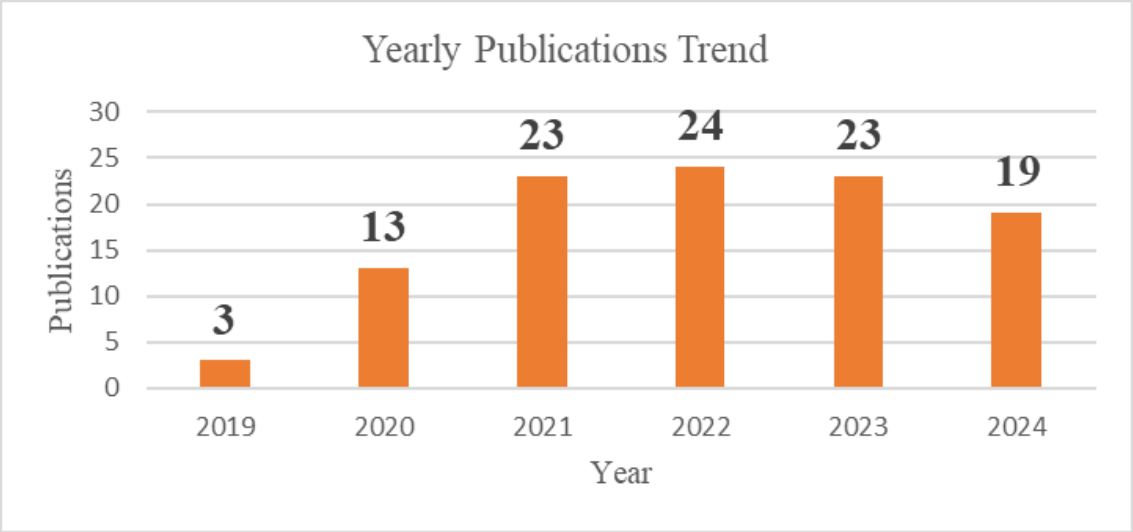

Figure 1: Yearly Publications on AI and CE (Source: Web of Science)

The Journal performance is shown in Figure 2. The sustainability journal is the leading publisher with 18 papers published by writers. Next up is the Journal of Cleaner Production, which features six papers. Therefore, Energy with five articles. Four articles were also published by the authors in the Process Journal and the Applied Sciences Basel. Lastly, the writers' publications may be found in Electronics, the Annals of Operations Research, and Business Strategy and Environment.

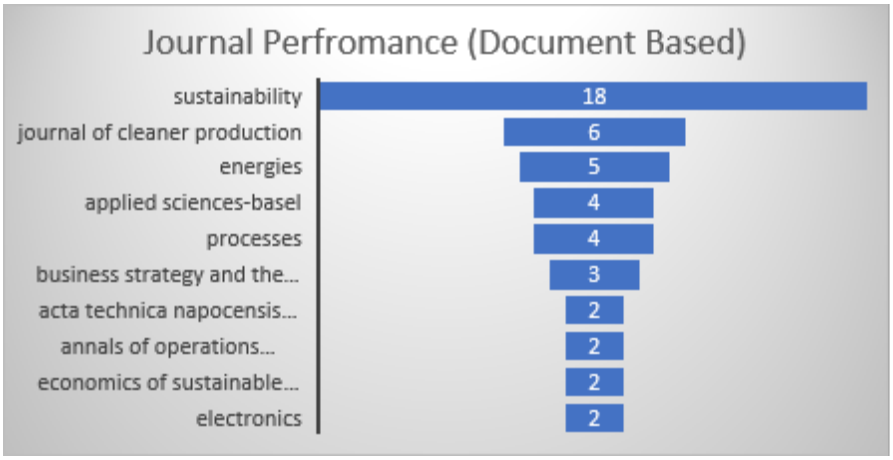

Figure 2: Journal Performance Document Based (Authors' own)

The citation count is a measure of a journal's impact, as seen in Figure 3. The following journals have contributed to this body of work: The Journal of Cleaner Production (508 citations), Journal of Business Research (311 citations), Sustainability (261 citations), Waste management (235 citations), Business Strategy and Environment (176 citations), International Journal of Manpower (144 citations), Processes (130 citations), Transportation Research Part e-logistics and Transportation Review (123 citations), Computers in Industry (122 citations), and Production Planning Figure 3 shows that the top five journals receive a lot of citations.

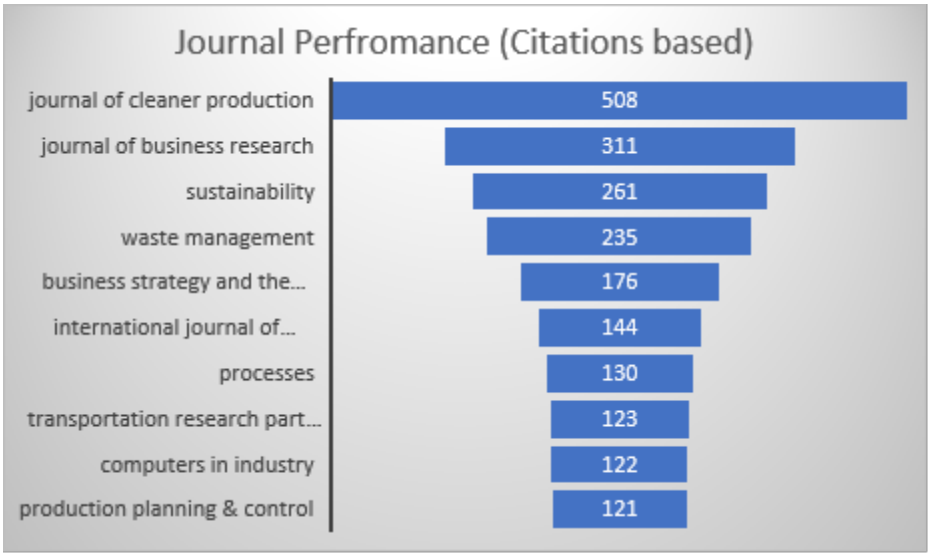

Figure 3: Journal Performance Citations Based (Authors' own)

Figure 4 shows authors conducted research on AI with CE in the Poland with 27 studies. The second most active country is Germany for adopting AI technologies and transformation towards circularity with 26 studies. The third country is Austria which is also quite concern for climate change issues rising from linear economy so they are also transforming to circular economy with 12 studies. The fourth country is Italy as it is also famous for "circular fashion" for using AI technologies into textile and fashion firms with 11 studies. This goup of countires are considered as a Leaders of circular economy and AI technologies. This shows these four countries is implementing Circualr Economy Action Plan and Net-Zero Industry Act quickly and rapidly for achieving their goals towards sustainable future.

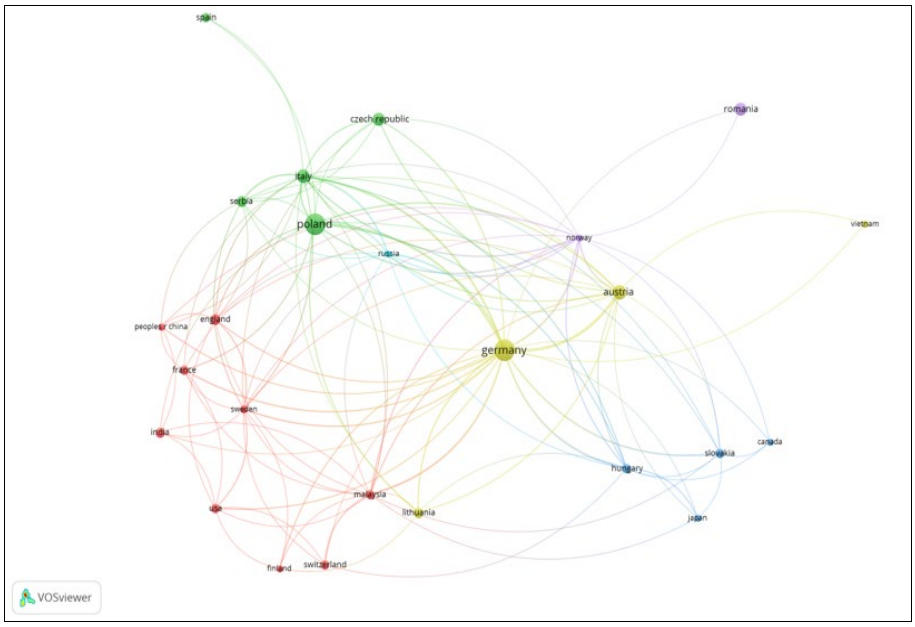

Figure 4: Country scientific production (Source: VOSviewer)

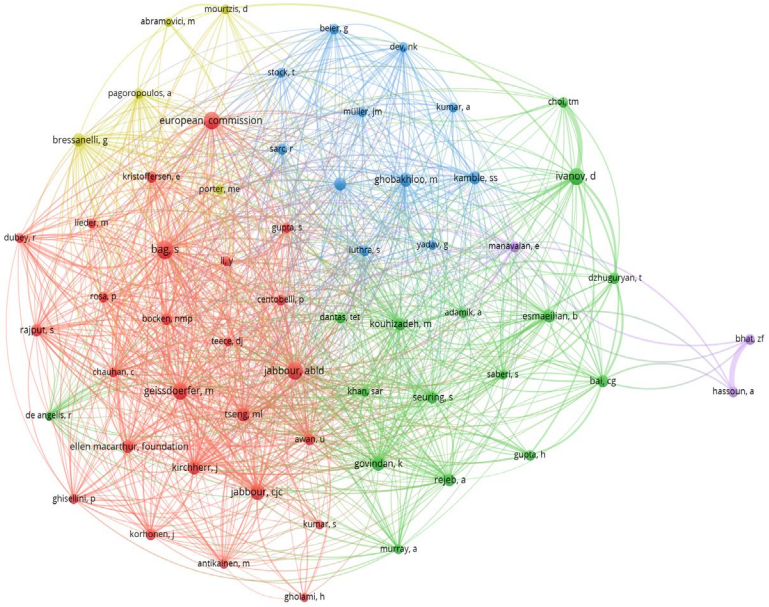

Figure 5: Co-Occurrence Networks Authors (Source: VOSviewer)

This network emphasized key research themes and their interrelations within the domains of AI and CE. The co-occurrence network reveals four main thematic clusters (Figure. 4). The red cluster centers on *circular economy on sustainable business management* which are strongly interconnected with circular economy, sustainability, management, strategies, blockchain, logistics, optimization, reverse logistics, and supply chain. The green cluster focuses on *Leveraging big data models to enhance CE outcomes* which are highly interlinked on bigdata, model, performance, opportunities, innovation, digital transformation, efficiency, and digitization. The blue cluster focuses on *Impact of IR4.0 and digital technologies on the Future of Circular Economy*, which strongly linked to industry 4.0, design, impact, future, smart, internet of things, systems, bigdata analytics. The yellow cluster focuses on *Digitalized Sup-ply chains, A way to foster CE and Sustainable development* which strongly related with supply chain management, sustainable development, digitalization, models, energy efficiency.

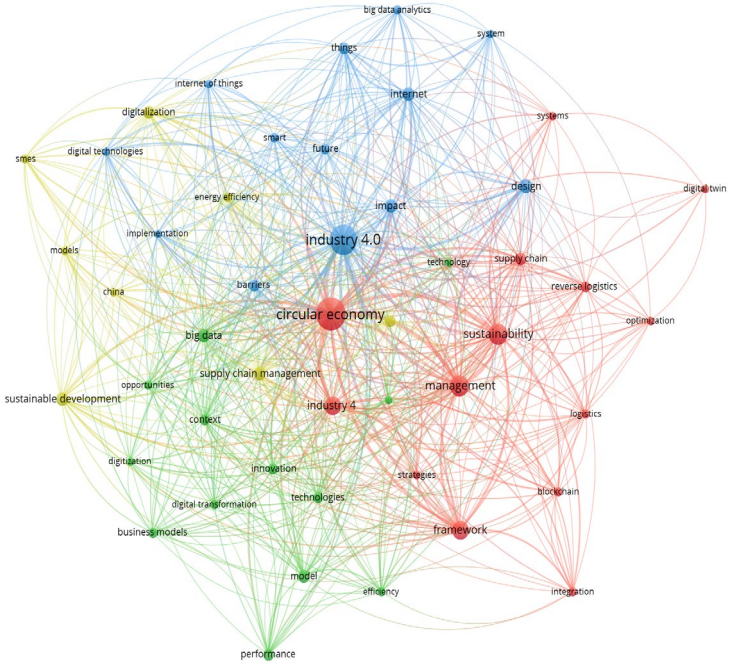

Figure 6: Co-Occurrence network (Source: VOSviewer)

4. Discussions and Implications

4.1 Thematic Analysis

Cluster 1: Circular Economy a pathway towards sustainable business management

The critical importance of sustainable business management is compelling individuals across all industries to adopt sustainability practices for circularity (Kumar and Saravanan, 2019). Recent years scholars realized transformation from linear to circular is an important for sustainable business management to address grand challenges such as climate change and rising temperatures (Agyemang et al., 2025). Notably, researchers have extensively examined how organisations might evolve towards enhanced sustainability; nonetheless, it is only recently that they have started to explore a fundamentally novel approach in sustainability discourse: the circular economy paradigm (Graessler et al., 2024). This reflects sustainable business management is only possible to transform linear to circular business model due to protect the planet for a sustainable future.

Cluster 2: Leveraging big data models to enhance CE outcomes

The circular economy relies on big data for mitigating resource constraints (Modgil et al., 2021). Various ecosystems, from transportation to smart cities, can benefit from big data produced by various platforms in their real-time management of waste, energy, and pollution (Dubey et al., 2019), as a result, big data can make it easier to examine multiple perspectives in order to quickly come to a consensus. The tremendous promise of big data to address business challenges and pave the way for new opportunities has garnered a lot of interest from the business community in the past decade (Raut et al., 2019). This warranted big data is driving circularity in industries, cities and as a whole in society.

Cluster 3: Impact of IR4.0 on the Future of Circular Economy

The industry 4.0 technologies refers to artificial intelligence, internet of things, virtual reality and digital twin. The first IR4.0 technology; AI has advantages in speed, intelligence, and scalability. It turns information into understanding. In doing so, it transforms impersonal procedures into dynamic, tailored workflows. The second technology is internet of things (IoT); the sensors installed in factory machinery can communicate with other web-enabled equipment thanks to their unique IP addresses. The ability to gather, analyse, and share vast amounts of important data is made possible by this network of interconnected machines on smart factories (IBM, 2025). The third technology is digital twin: an item, person, system, or process can have a digital twin if it is digitally replicated and placed in a digital representation of its actual physical surroundings. Some of the benefits by using digital twin: simplified planning and design procedures, scenario modelling, operational optimization, cost reduction, and the integration of industrial and physical AI into buildings (NVIDIA, 2025). This shows industry 4.0 technologies can be good for circular economy and sustainable future.

Cluster 4: Digitalized Supply chains, A way to foster CE and Sustainable development

Digital supply chain refers to the interconnected web of businesses, processes, and tools that use digital technology to manufacture and ship goods and services to consumers (Garay-Rondero et al., 2020). For businesses to make the transition from a linear to a circular economy, companies may have to reevaluate and restructuring their approaches to creativity, cooperation, and business models. The whole value chain is affected by this change, not just internal processes (Hofmann and Jaeger-Erben, 2020). The main goal is to reduce wastage by designing better products, systems, materials, and business models; this will be achieved by optimizing the use of resources and closing loops across value chains (Kirchherr et al., 2017). This shows digital supply chains playing their crucial role in sustainable development for circular economy.

5. Conclusion

This review attempts to address notable shortcoming on under-researched phenomenon of AI and circular economy in existing literature. We analyzed 105 peer-reviewed journal articles by using Web of Science database. Authors conducted data analysis by using VoSviewer software. The results revealed an interesting insight such as *Cluster1: Circular Economy a pathway towards sustainable business management*. This cluster stressed upon sustainable business management is possible by implementing circular business models in the industries. The *Cluster 2: Leveraging big data models to enhance CE outcomes*. This cluster encouraged companies to adopt big data analytics by mitigating technological barriers and improve their decision-making capabilities by using big data models. The third *Cluster 3: Impact of IR4.0 and digital technologies on the Future of Circular Economy*. This cluster shows businesses are realizing the importance of industry 4.0 technologies such as AI, IoT, VR and digital twin and their potential benefits for transition towards circular economy by

considering these technologies as an opportunity rather than cost. The fourth *Cluster 4: Digitalized Supply chains, A way to foster CE and Sustainable development*. This cluster seems to be crucial as digital supply chains increase the profits of companies and improve the customer satisfaction by supplying products on timely-manner with the help of technologies. The main contribution of this review is to advances our understanding on emerging domains e.g. AI and circular economy in the existing literature due to less focus by prior scholars. Notably, another theoretical contribution of this review is to shift the focus to technological perspective within circular economy, diverging from traditional linear model based on economic views.

6. Limitations and Future Agenda

This review has few limitations. We selected single technology such as AI of Industry 4.0. Future scholars may explore several technologies of industry 4.0 such as IoT, VR, Additive Manufacturing, Digital Twin, AI as to see comprehensive reflection of these technologies for CE transition. We selected only journal articles. Future scholars may also use review articles, book chapters, early access and journal articles. We used single Web of Science database. While Web of Science is an extensive and trustworthy academic database, it might miss some publications that are relevant to the study. Future studies may use combination of databases e.g. Scopus, Web of Science, IEEE explore respectively. This review focused on CE transition. Hence, future researchers may examine CE ecosystem to get better understanding on how multi-stakeholders' expectations and interests. This review selected selective period for data collection such as 2019 to 2025 due to ongoing digital and circular transformation. Future scholars may use data from 1990 to 2025 for comprehensive picture on this phenomenon. This review provides an important future research questions as a notable avenue for future scholars to highlight and contribute for scientific progress. Table 1 illustrates several notable shortcomings.

Table 1: Future Research Agenda

Clusters	Future Research Questions
Cluster 1*:* Circular Economy a pathway towards sustainable business management	*RQ1.* How businesses can redesign their linear models into circular for sustainable future? *RQ2.* What is role of Business, Management and Organizational Scholars in addressing climate change issues for circularity? *RQ3.* What is role of multi-stakeholders in achieving circular economy goals for sustainability?
Cluster 2*:* Leveraging big data models to enhance CE outcomes	*RQ1.* Does big data analytics contribute to CE transition in manufacturing and service industries? *RQ2.* How big data analytics achieve organizational performance by considering circularity goals? *RQ3.* How businesses can tackle technological barriers for fulfilling both economic and environmental goals?
Cluster 3*:* Impact of IR4.0 and digital technologies on the Future of Circular Economy	*RQ1.* How AI dynamic capabilities assists firms for circularity and sustainability? *RQ2.* What is role of internet of things technology for sustainable manufacturing? *RQ3.* How virtual reality helps businesses into their training programs, health and safety for transformation towards CE? *RQ4.* Does digital twin contribute in adopting circular business model for sustainable future CE? *RQ5.* How AI changes the future of work in large companies? *RQ6.* Does AI provide potential benefits of future of circular economy?
Cluster 4*:* Digitalized Supply chains, A way to foster CE and Sustainable development	*RQ1.* How digital supply chains improve firm's circularity for sustainable development? *RQ2.* What is role of CE and sustainable development? *RQ3.* How stakeholders respond adopting digital supply chains in business environment? *RQ4.* Do digital supply chains seem to be challenge or opportunity for companies? *RQ5.* How regulatory bodies deal with firm while implementing digital

Clusters	Future Research Questions
	supply chains? *RQ6.* Do digital supply chains create new ecosystem for multistakeholders? *RQ7.* How digital supply chains enhance customer experience especially following sustainable development goals?

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Ethics Declaration: Ethical clearance was not required for the research because this research was based on review method so authors used secondary data accessed from Web of Science Database.

AI Declaration: Authors declare here they have not used AI tool, technologies or softwares for development of this paper.

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