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Editorial

SUPPORTING THE CIRCULAR ECONOMY TRANSITION USING THE EMERGENT ROLE OF THE INTERNET OF THINGS

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1. Introduction

In the 1970s, the concept of circular economy emerged in economic literature, and it has started to receive more attention in the last few years (Campbell-Johnston et al., 2020; García-Quevedo et al., 2020; Rajput & Singh, 2019; Shen et al., 2020). This popularity was partly because of the dearth of available natural resources in the environment and significant alterations that have occurred gradually to customers' behaviours (Gallagher et al., 2019). The circular economy model is mainly aimed at decoupling economic development from the consumption of limited resources. This economic model discusses retaining products' components and reserving their materials at their highest value and utility. The circular economy has provided a remarkable opportunity for companies to achieve additional value from their products while taking into consideration resource limitations and price volatility. In this system, manufacturers reuse the materials and resources at the beginning of the same process following a production process (Genovese et al., 2017; Merli et al., 2018). Such a circular system has a significant effect on decreasing both cost and waste. It attempts to promote the recycling of materials and will have a positive contribution to the higher acceptability of the company image.

Industry 4.0 plays a crucial role in moving from a linear to a circular economy (Chiappetta Jabbour et al., 2020; Mohelska & Sokolova, 2018; Ślusarczyk et al., 2020; Sözbilir, 2021). It introduces innovative technologies like the IoT with the aim of supporting the efficiency enhancement and automation of the processes that happen in the industry. In comparison, the circular economy can be considered an essential alternative to the current linear economy model; on the other hand, Industry 4.0 technologically enables users to bring process innovation into the industrial domain. There is a need for novel economic models capable of reducing material inputs and waste generation leveraging on eco-design, recycling and reusing of products, new technologies, and new business models. Some of the most industry

4.0 technologies (Aslanertik & Yardımcı, 2019; Sony & Naik, 2019) (e.g., IoT) have shown the potential required for leveraging the acceptance of circular economy concepts and processes by companies in a way to bring it in an extensive level to our daily life.

In the context of Industry 4.0, IoT has the capacity to support the circular economy paradigms by developing a place to well connect sellers and buyers of manufacturing products/services and raw materials in a way to build global supply chains (Garrido-Hidalgo et al., 2020; Mboli et al., 2022; Nobre & Tavares, 2017). The value drivers of the circular economy build "looping assets" and reuse natural resources in order to make use of them with higher efficiency; this way, they can extend the useful lifetime of such resources and maximize their utilization while the IoT value drivers attempt to organize knowledge in regard to asset quality, locations, conditions, and performance in real-time, which helps to realize novel breeds of circular economic. IoT has been proven to have the capacity to solve the resource-related problems that distress circular economy innovators (Pejic-Bach et al., 2020; Rajput & Singh, 2019).

As a result, researchers interested in this subject need to understand the status quo of the research carried out across the world in order to build a general picture representing the whole subject. Through breaking down structural barriers that have been formed over time between the production process and consumption of products and services, an IoT-enabled circular economy will be able to offer significant opportunities for several sectors, e.g., manufacturing, built environment, and infrastructure, energy, and utilities, waste management, logistics, fishing, and agriculture. Nowadays, both officeholders and disruptive innovators are rethinking their value chains and proposed models, considering that the digital revolution actually underpins a new economy rather than just a niche market. Therefore, in this special issue, an attempt has been made to present the state of the art for leveraging the IoT for circular economy conceptualization. In this regard, we have published some papers in this SI.

In the first paper, Liu and Mishra (2024) presented a comprehensive framework to identify the challenges of G-IoT. The research utilized a survey approach, combining literature review and expert opinions. A total of 23 challenges were evaluated to facilitate the implementation of G-IoT technologies and achieve sustainable development goals (SDGs). The main objective of this article was to rank and assess these challenges in implementing G-IoT for SDGs. An integrated approach incorporating stepwise weight assessment ratio analysis (SWARA) and additive ratio assessment (ARAS) under Pythagorean fuzzy sets was proposed to achieve this. The findings revealed that the machine-to-machine (M2M) standardization protocol obtained the highest rank with a weight value of 0.0508, followed by adaptation to natural energy sources with a weight value of 0.0479. Information security and privacy protection held a weight value of 0.0469, and internet protocol version-6 (IPv6) for low-end devices obtained a weight value of 0.0467.

In the second paper, Hu et al. (2024) evaluated and ranked the risks associated with Internet of Things (IoT) in the context of Supply Chain Management (SCM). To achieve this, "Stepwise Weight Assessment Ratio Analysis (SWARA)" and "Additive Ratio Assessment (ARAS)" methods are applied under the framework of "q-Rung Orthopair Fuzzy Sets (q-ROFSs)". A case study is presented to investigate the IoT risks specifically for SCM within the q-ROFSs framework. Additionally, the obtained results are compared to existing methods used in the literature. The findings of the study reveal that security and privacy risks, with a weight value of 0.0572, emerge as the primary IoT risk factor for SCM. Furthermore, organization-I, with a utility degree of 0.8208, is identified as the best option considering the diverse IoT risks associated with SCM.

In the next paper, Yang and Shen (2024) examined the correlation between the shadow banking behavior of Chinese listed firms in the Internet of Things industry and their bank connections. The findings indicate that bank connections play a crucial role in reducing information asymmetry between banks and firms. Moreover, a positive relationship is observed between bank connections and firms' long-term debt. As firms' long-term debt increases, their shadow banking behavior also tends to increase. Importantly, this finding demonstrates strong robustness, as the empirical analysis provides substantial evidence of the association between firms' shadow banking behavior and bank connections in the Internet of Things industry. Furthermore, the evidence suggests that the propensity for shadow banking behavior is more prominent among non-state-owned enterprises (NSOEs) than state-owned enterprises (SOEs), as revealed by sub-sample sensitivity analysis.

In another article, Wang et al. (2024b) investigated the role of the Internet of Things in tourism economic data analysis and supply chain modeling. This study aims to reduce costs in Ice-Snow Tourism (IST) Supply Chain enterprises and enhance the intelligence and automation of Supply Chain Management (SCM). Firstly, the economic data of the IST Supply Chain are analyzed based on the spatial-temporal characteristics using the Internet of Things (IoT). Next, the Online Public Attention (OPA) data for IST in various domestic cities and regions are collected on an annual basis. Spatial and temporal characteristics are analyzed using the quarterly concentration index and Gini coefficient. To address data redundancy and enhance information accuracy, improvements are made to the weighted fusion algorithm used for Supply Chain scenario modeling. Finally, a framework for the IST-oriented Supply Chain scenario ontology model is proposed. Experimental results indicate that there has been significant attention from internet users towards IST from 2011 to 2021. OPA to IST initially increased, reached a peak in 2016, and then declined. The final fusion value of the proposed data fusion algorithm is 20.0221, while that of the adaptive Weighted Average Method (WAM) is 20.0724.

In the next article, Wang et al. (2024a) examined the influencing factors of the digital economy and explored the relationships between these factors. By analyzing time-series data from China spanning the years 2002 to 2018, the researchers employed grey correlation analysis to calculate the correlation between these influencing factors and the development of the digital economy. Additionally, the study utilized the Granger causality test and reviewed existing research to assess the interrelationships among various factors. The interpretative structure model was employed to determine the relationship structure of the main factors affecting the development of China's digital economy. The findings revealed that the number of digital talents, the state of the technology market, and the degree of digitalization directly influence the digital economy. These results contribute to a deeper understanding of digital economy development and can inform the implementation of policies aimed at fostering more sustainable cities.

In the next article, Li et al. (2024) employed web crawler technology to gather news pertaining to the fintech innovation of commercial banks from Baidu news. By utilizing a balanced panel data set encompassing 72 banks in China over the period 2010 to 2020, the researchers aimed to examine the impacts and mechanisms of fintech on commercial banks' Total Factor Productivity (TFP). The findings indicate that fintech innovation has a significant and positive effect on TFP, which is confirmed through rigorous robustness tests. Moreover, the study reveals that fintech innovation enhances commercial banks' TFP by fostering financial product innovations, bolstering risk control capabilities, reducing costs, and improving profitability. Additionally, the utility of fintech is more pronounced in banks with greater assets, facilities, and human capital, suggesting the presence of a "bigger is better" mindset driven by fintech innovation. Furthermore, the results from the quantile regression analysis demonstrate that higher levels of fintech innovation correspond to a more substantial increase in TFP, providing further evidence of the existence of a "too big to fail" phenomenon among commercial banks in the era of digitalization.

In the last article, (Gou et al., 2024) employed bibliometric methods to analyze the characteristics of authors, nations/regions, and institutions in the literature on Fuzzy Set Theory (FST) and Circular Economy (CE). Additionally, the study explores collaboration relationships among these entities. The authors summarize the existing literature on fuzzy techniques in the context of CE and identify the specific role that FST can play at each stage of the CE, including the pre-preparation stage, design and production stage, and recycling and reuse stage. Furthermore, the paper investigates the advantages of Industry 4.0 (I4.0) technologies for CE and analyzes the research on the role of fuzzy techniques based on FST, in the context of CE and I4.0 technologies. Lastly, the conclusion of the paper summarizes the insights gained from the bibliometric and content analyses of the literature and suggests future research directions. The research aims to highlight the contribution of FST and encourage further advancements in CE and I4.0 technologies.

2. Conclusions

The concept of a circular economy has gained significant attention in response to the increasing pressure on policymakers and governments to prioritize sustainability, bio-based products, and sustainable processing. As a result, promoting the circular economy has become a crucial policy objective and a normative ideal not only within the European Union but also in other regions. At its core, the circular economy advocates for a shift from linear resource-to-goods-to-waste processes to systems that emphasize the reuse, remanufacture, and recycling of materials. In a similar vein, the circular economy has emerged as a novel industrial paradigm aimed at addressing the negative externalities associated with the linear take-use-discard economy. The IoT is recognized as a key enabling technology with the potential to transform various industries, such as manufacturing, construction, services, and the supply chain and logistics sector. In essence, the IoT constitutes a network that interconnects objects and sensors, allowing for their control, monitoring, and optimization through wired cables, wireless networks, or hybrid systems. Cutting-edge technologies, such as IoT, possess the potential to significantly enhance the adoption of CE concepts by organizations and society, ultimately leading to their integration into our daily lives. Consequently, it is of utmost importance for researchers interested in this field to comprehend the current state of worldwide studies and obtain a comprehensive overview of the subject matter.

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