

Article

Digitalization for a Sustainable Performance: Dual-Study Analysis of Digital Leadership, Circular Economy, and Technological Innovation

Asfand Yar Khan ^{1,*} , Maria Akhtar ^{2,*}  and Azmat Yar Khan ²

¹ School of Business, Shandong Normal University, Jinan 250014, China

² School of Management Science and Engineering, Zhengzhou University, Zhengzhou 450001, China; azmijadoon94@gmail.com

* Correspondence: asfandyarkhan2071988@gmail.com (A.Y.K.); mariaakhtar954@gmail.com (M.A.)

Abstract: This research investigates the impact of digital leadership on organizational performance using a mediating role of circular economy practices. Moreover, this research also examines the moderating role of technological innovation in the relationship between circular economy and organizational performance. This research is based on two independent studies in two different economy manufacturing sectors including textile and automobiles in East Southern China. In study 1, the data were collected from 282 respondents including employees and supervisors in textile manufacturing organizations from Henan, China. In study 2, the data were collected from 256 employees and supervisors from automobile manufacturing in Hefei, China. We employed a cross-sectional design in study 1 and a time-lag design in study 2 by using systematic random sampling techniques in both studies. The findings of study 1 indicate that digital leadership has a significant impact on circular economy practices and that circular economy practices have a positive impact on organization performance. The findings also indicate that circular economy practices significantly mediate the association between digital leadership and organizational performance. The findings of study 2 show that technological innovation positively moderates the relationship between circular economy practices and organizational performance and that as the influence of technological innovation increases, this relationship becomes stronger. This research also provides useful insights for scholars and policy makers to reform manufacturing processes to encourage circular economy practices.

Keywords: digital leadership; circular economy practices; organizational performance; technological innovation



Citation: Khan, A.Y.; Akhtar, M.; Khan, A.Y. Digitalization for a Sustainable Performance: Dual-Study Analysis of Digital Leadership, Circular Economy, and Technological Innovation. *Sustainability* **2024**, *16*, 10465. <https://doi.org/10.3390/su162310465>

Academic Editors: Estrela Ferreira Cruz and António Miguel Rosado da Cruz

Received: 29 October 2024

Revised: 24 November 2024

Accepted: 27 November 2024

Published: 29 November 2024



Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The Industrial Revolution, which began in the 18th century, has led to an increase in global competition focused on satisfying market needs and enhancing profitability [1]. This industrial expansion caused several socio-environmental issues to emerge globally [2], particularly concerning environmental degradation and the scarcity of resources [3]. Resource scarcity is the core concept of economics but we have always taken it for granted [4]. It includes the issue of resource scarcity in the pricing process, such that increasing demand corresponds with higher scarcity, leading to a spike in prices [5]. Large amounts of waste generated due to industrial production and resource scarcity have always remained the central issue [6]. The world typically uses a linear economic model that includes produce, use, and disposal [7,8]. The circular economy concept was introduced, and resource scarcity is currently being addressed in an incredibly novel approach. A cyclic approach to the production process including, make, use, dispose, recycle, and remanufacture (RR), is known as the circular economy practices [9]. The three Rs, recycle, reduce, and reuse, are

usually regarded as the main components of a circular economy [10]. Implementing circular economy practices serves as a crucial metric for improving organizational performance [11].

The circular economy is a system of regeneration that manages production cycles and energy to reduce issues like resource waste, toxic emissions, and energy leaks [12]. It focuses on a high standard of material and product functioning through recycling, reusing, refurbishing, repairing, and maintenance [6]. Circular economy practice is a process of transition holding a lot of potential for sustainability and minimizing waste [13]. It also emerges that it can lead to the reduced use of natural resources while not affecting consumption. However, the monitoring of a product lifecycle through the value network process is essential for effective operation of the circular economy practices [14,15]. Globally, authorities and businesses want to know how the product life cycle reuse points can be traced, in addition to implementing the circular economy system for sustainability purposes, as identified by [16].

Modern technologies are important in facilitating a circular economy as they are endowed with technological innovation regarding the industrial supply chain [17]. The design of technology is essential for achieving the goals of the circular economy, as it allows for the production of durable goods and services using state-of-the-art manufacturing processes with fewer resources [17]. Sustainable practices are meant to enhance product durability and, consequently, increase its utility. There is a need to shift from a linear economy to a circular system through the development of a new manufacturing system and business models. This shift could equally serve technological innovation by aggregating, assessing, and incorporating data. Thus, the investigation is established on understanding how technological innovation can integrate circular economy practices for increased organizational performance.

Global digitalization continues to progress steadily, but relatively little is known about the role of digital leadership in promoting and facilitating a circular economy in China. Currently, the Chinese manufacturing organizations have some issues regarding resource consumption and waste management; hence, the importance of digital leadership for circularity is not well understood yet. Circular economy practices are slowly emerging in China, especially encouraged by programs such as Made in China 2025 [18]. However, research associating circular economy activities to real organizational results is scarce; the studies that exist were mostly dedicated to the environmental domain [19,20]. This research could explore how circular economy practices in specific sectors yield improvements in overall performance and measure the degree to which such endeavors are economically sustainable. There is scarce research about technological innovation in China, such as AI, IoT, and automation, but it is relevant to know how these developments affect the circular economy practices in terms of the legal framework and competition inside China to design further policies and business strategies [21,22]. However, previous studies have paid less attention to exploring a direct relationship between digital leadership and circular economy practices and an indirect relationship between circular economy practices and organizational performance.

This research seeks to examine the relationship between digital leadership and circular economy practices and the moderating effect of technological innovation. Digital leadership provides flexibility and data management to help monitor products' life cycles along with supporting approaches to circular economy. This paper seeks to fill the research gap by focusing on the following questions: How does digital leadership impact organizational performance through circular economy practices and to what extent does technological innovation intensify the relationship between circular economy practice and organizational performance? Considering the identified research gap, this study intends to examine the following research objectives: (1) to investigate the direct impact of digital leadership on circular economy practices, (2) to determine the impact of circular economy practices on organizational performance, (3) to examine the mediating role of circular economy practices in the association between digital leadership and organizational performance, and (4) to explore the moderating effect of technological innovation on the linkage between circular

economy practices and the organizational performance of two different manufacturing organizations (textile and automobile).

The findings of this study yield several significant contributions. Firstly, it establishes that digital leadership plays a crucial role in advancing circular economy practices. Moreover, the research reveals that when the mediating effects of these practices are taken into account, there is a positive correlation between digital leadership and organizational performance. By framing digital leadership as a key driver and investigating the mediating influence of circular economy practices, this article provides an innovative perspective on the connections between corporate sustainability initiatives and their performance metrics. Second, the role of technological innovation as a moderating factor offers a compelling perspective, revealing how advanced technologies can significantly improve the effectiveness of circular economy practices in enhancing organizational performance [23]. Third, the practice-based view (PBV) serves as a theoretical foundation for our analysis of circular economy practices and organizational performance amid environmental uncertainties. Consequently, this article reinforces the relevance of PBV theory as a valuable lens for examining the relationship between digital leadership and circular economy practices. Forth, the proposed framework offers actionable insights for enterprises seeking to elevate their performance through the adoption of circular economy practices, supported by robust digital leadership. Lastly, this model is aligned with global sustainability initiatives, as it synthesizes leadership, innovation, and performance. It advances the literature on the triple bottom line, comprising economic, social, and environmental dimensions by demonstrating the potential of circular practices to achieve a sustainable balance.

2. Theory and Hypothesis

The theoretical framework of the present study was provided by the practice-based view theory. According to the PBV theory, many organizational practices affect organizational performance [24]. The PBV theory was proposed by [25] and states that taking organizational context into consideration, a practice has been significantly correlated with organizational performance. In this context, “practices” refers to a collection of various interconnected acts (circular economy practices and technological innovation) that affect organizational performance and decision making [26]. The PBV has become a prominent theory assisting in the comprehension of different operational prospects for efficient decision making to enhance organizational performance [22]. The PVB theory highlighted organizational resources such as digital leadership and technological innovation and how organizational processes play a crucial role to effectively adopt emerging practices (circular economy practices) in a fast-evolving marketplace.

Ref. [27] states that digital leadership is essential when allocating resources for upholding business. Managers who are skilled with digital technologies encourage their employees to use innovative methods, which increases their enthusiasm and productivity. Furthermore, digital leaders ought to be flexible with their leadership style and capable of embracing new technologies such as technological innovation in order to persuade their employees to adopt modern practices like circular economy practices [28]. Ref. [10] also demonstrated that a PBV explains the variations in organizations’ performance caused by the usage of unique and transferable business processes. Processes are defined as “an established practice or set of various practices that different organizations may execute” [25]. The PBV theory proposes a set of integrated and transferable activities as explanatory variables, with organizational performance as the outcome variable [26]. In the light of the PBV theory, the present study suggested digital leadership, circular economy practice, and technological innovation as set of integrated activities, with organizational performance as an outcome variable, as shown in Figure 1.

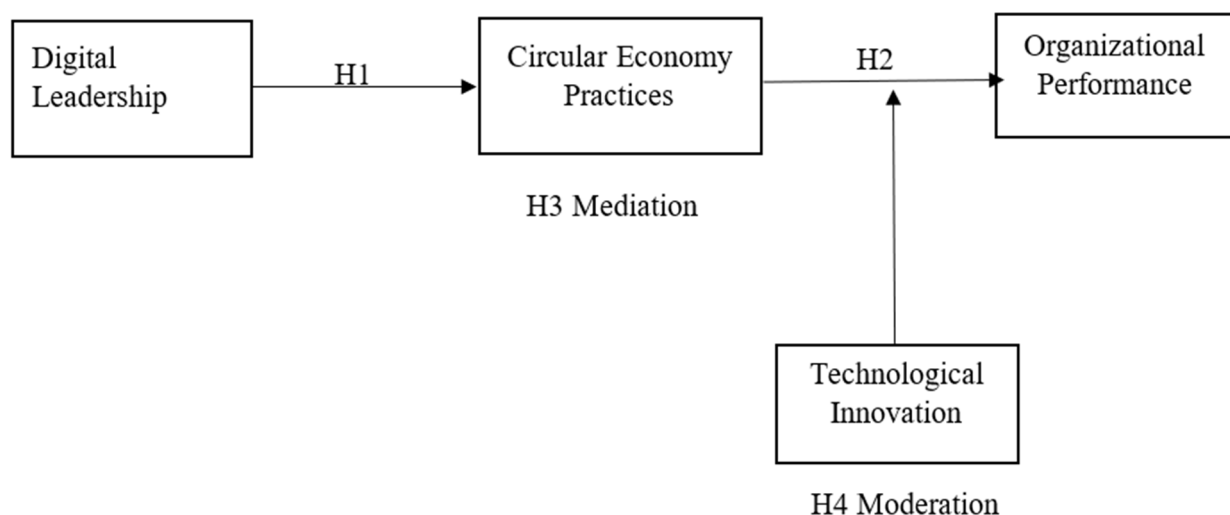


Figure 1. Conceptual framework.

2.1. Digital Leadership and Circular Economy Practices

Digital transformation is crucial for organizational success, and leaders with digital leadership competencies are essential. Digital leadership involves integrating technology with leadership abilities to achieve objectives [29]. Digital leadership also plays a significant role in adopting circular economy practices, which reduce waste, encourage resource efficiency, and regenerate natural systems [30]. However, the impact of digital leadership on circular economy practices is often overlooked.

The practice-based view theory has supported the importance of digital leadership in the practical application of circular economy practices within the manufacturing organizations. This leadership encourages the use of digital technology within the circular economy, which leads to innovation and sustainable economic development [31,32]. The applicability of this approach is especially observed in Industry 4.0, which emphasizes the use of digital technologies in using resources and promoting sustainable practices in recycling and remanufacturing [33]. Several scholars have confirmed the positive relationship between digital business performance and circular economy practices. Such digital transformation strategies may also help to strengthen the impact of circular economy practices on organizations' performance, including in terms of resource efficiency. This view agrees with the practice-based view of organizational routines and capabilities. Ref. [20] stated that digital transformation has positive impact on the adoption of circular economy practices through the lens of the institutional theory perspective at an organizational level. Moreover, [34] highlighted the importance of digital manufacturing by adopting circular economy practices. However, further investigation is needed to fully understand the relationship between digital leadership and circular economy practices in the manufacturing organizations. So, on the basis of the above stated literature, we formulated the following hypothesis:

H1. *Digital leadership has positively influenced circular economy practices.*

2.2. Circular Economy Practices and Organizational Performance

According to [35], the circular economy strives to increase capital through resource retention; these practices significantly impact organizational performance [36]. Circular economy practices involve resource management, innovative business models, and design techniques; these methods enhance organizational performance as well as promoting sustainability [11]. Implementing circular economy techniques can lower operational risks and improve the resilience of the supply chain. Organizations may mitigate the effects of resource scarcity and price volatility by integrating recycled products into their supply chains and diversifying their procurement alternatives [37].

Extensive evidence has been stacked to support the positive influence of circular economy practices on organizational performance. In [11,38] studies, there is sufficient support for the evidence suggesting that resource minimization and recycling through circular economy practices is helpful in enhancing profitability and increasing organizational efficiency. This is also in line with [39], which found that some organizational factors such as communication methods and measures of performance might also lead to more circular economy practices. Ref. [36] proposed a comprehensive formal mediation model and statistical reasoning that provides substantial evidence about circular economy activities leading to substantial financial performance that makes a significant difference in organizations' performance. Implementing circular economy practices can lead to cost savings and optimal resource utilization [40], for example, by reprocessing materials and products, organizations can lower their demand for raw materials, which may be very costly to extract and process. Thus, based on previous studies, we formulated the following hypothesis:

H2. *Circular economy practices have a positive impact on organizational performance.*

2.3. Mediating Role of Circular Economy Practices

In accordance with [37], the connection between digital leadership and organizational performance can be mediated by the use of circular economy practices. Studies shows that the concept of digital leadership positively influences the implementation of circular economy practices and, thus, improves organizational performance [41]. Digital leadership supports circular economy thinking through the enabling of digital technologies and the implementation of appropriate business models. For instance, [42] have argued that digital technologies are instrumental in helping companies adopt the circular economy model, particularly in the construction industry. The circular economy practices have a favorable impact on better resource utilization that, in turn, enhances the organizational operation [43]. This leads to greater circularity and, with the help of proper digital leadership, can lead to enhanced organizational performance. Ref. [43] described circular economy practices such as reuse, recycling, and remaking to sustain material capabilities to attain optimum use and value before disposal.

Action and production diversity as part of the circular economy offers a balanced solution for leadership and organizational performance [36,44]. The study by [45] showed that there is a mediating effect of circular economy practices on the links between eco-control systems and environmental and economic performance. This emphasizes the need for circular economy practices and highlights a significant mediation effect [46,47]. Ref. [48] also recently established that the circular economy fully mediates the relationship between green management strategy and green business success. Prior research has examined various forms of leadership and the moderating influence of circular economy activities; however, the concept of digital leadership has not been explored adequately. The purpose of this study is to establish the mediating impact of circular economy practices on the relationship between digital leadership and organizational performance. Thus, we formulated the following hypothesis:

H3. *Circular economy practices significantly mediate the association between digital leadership and organizational performance.*

2.4. Moderating Effect of Technological Innovation

The role of technologies cannot be ruled out when it comes to enhancing organizational performance since they support technology advancement in manufacturing and deployment technologies within production and consumption networks [49]. This involves the attempt to identify new opportunities that are likely to develop in future, how to allocate available resources and how to handle risks that may exist [50]. Technological innovation is particularly vital for new product development in business-to-business marketing,

production, and supply chain settings [51–53]. It enables the manufacturers to acquire better practices in the utilization of resources, waste minimization, and specification of the product. Advanced technologies such as sensors, big data, and predictive algorithms are, today, greatly helping in improving production rates [54–56].

Technological innovation is a crucial element in this dynamic, as the integration of circular economy thinking agreement (CETA) moderates the relationship between big data-driven supply chain management (BDSCM) and sustainable supply chain management (SSCM), resulting in enhanced corporate performance [57]. Energy and material usage are monitored in real-time through the use of smart sensors, thereby conserving energy and material [58]. The block chain technology enhances transparency in supply chains, whereas chemical recycling has advantages in terms of both the environment and economy [59]. The consumers who are more conscious about environmental issues can be attracted by those companies that employed advanced tracking technology. IoT technology provides the real-time tracking of resources; therefore, organizations can adjust their circular activities based on surrounding conditions [60]. These innovations contribute to a more sustainable and efficient business environment. Moreover, the combination of green technological innovation with circular economy practices significantly elevates both the environmental and economic performance of businesses. Ref. [61] confirmed the moderation effect of technological innovation and added more insight to the leading role of technology innovation in achieving sustainability goals by aligning natural resources usage, economic growth, and transport energy consumption with the sustainable development goals. On the basis of present study's contextual framework, technological innovation serves as a moderator of the linkage between circular economy practices and organizational performance. Moreover, technological innovation plays a crucial role; however, we decided not to include it as a moderating factor in the relationship between digital leadership and circular economy practice. This decision was informed by our specific aim to investigate the direct effects of digital leadership on circular economy practices, without the complicating effects of additional moderators. The present study aimed to prioritize digital leadership as the key driver, rather than to explore the full range of potential moderating variables at this stage of our investigation. So, we formulated the following hypothesis:

H4. *Technological innovation positively moderates the association between circular economy practices and organizational performance in the way that as the use of technological innovation increases, this association becomes stronger.*

3. Methodology

We carried out two separate sample studies in China, in order to assess our hypotheses. In recent decades, China, the largest economy in Asia, has experienced significant changes in the realms of society, economy, and the environment [62]. The present study collected data from two different manufacturing sectors, textile and automobile, in South East China to verify the proposed hypotheses. The current study proposed that H1, H2, and H3 be tested on the employees and supervisor working in manufacturing organizations. To verify and extend the findings of study, we tested H4 from the automobile sector by using a time-lagged approach. We employed two independent studies by employing distinct strategies for both the cross-sectional research approach and the time-lagged approach. The present study did not compare two different organizational sectors in this study; instead, we aim to assess the direct and mediation effect in study 1 and the moderation effect in study 2.

Each study leverages specific measurement tools and methodologies that are tailored to its distinct focus. This enables more accurate data collection and analysis, thereby enhancing the validity of the findings related to each hypothesis. Conducting two separate studies enables the cross-validation of findings, allowing the results from study 1 to be interpreted within the context of study 2, which strengthens the overall robustness and dependability of the research outcomes. Furthermore, these two studies contribute cumulatively to the

comprehension of the overarching research theme. Study 1 established a foundational understanding by identifying the mediating influence of circular economy practices, while study 2 enriches this understanding by exploring the moderating effects of technological innovation on this relationship. Collectively, they provide a more comprehensive perspective on the dynamics influencing organizational performance. Study design for both studies are presented in Figure 2.

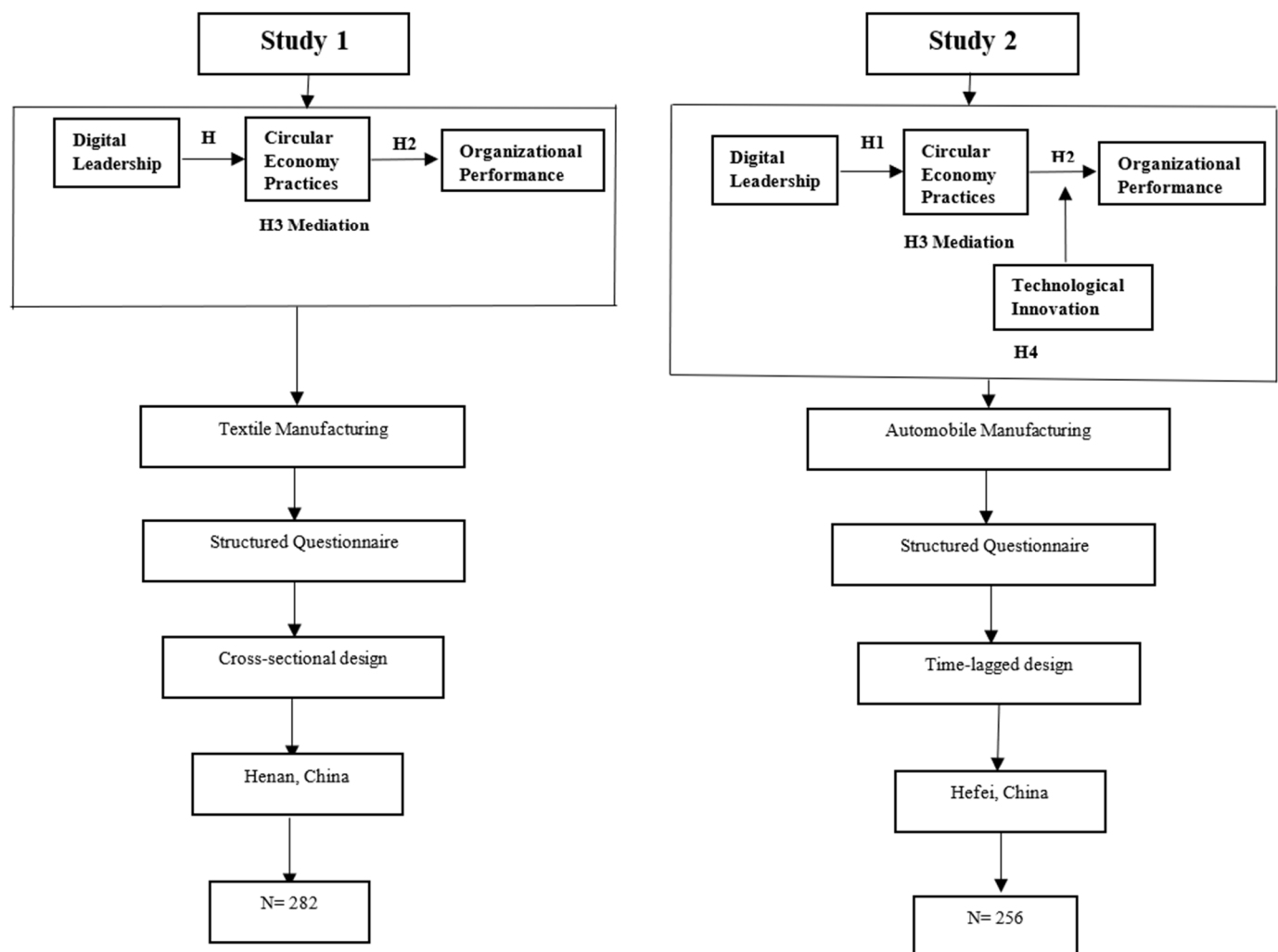


Figure 2. Studies design.

3.1. Data Collection Procedure

In study 1, data were collected from textile manufacturing organizations in Henan, China. We contacted administration and human resource units of the respective organizations to obtain the consent of the supervisors and employees to participate in this study survey. The study implemented a face-to-face approach for distributing questionnaires, which enabled the immediate provision of explanations and clarifications. This method effectively reduced potential misunderstandings and improved the quality of the responses, which greatly enhanced the depth of the study results. Data were collected using a structured questionnaire designed on a five-point Likert scale ranging from 1, denoting strongly disagree, to 5, denoting strongly agree, to record the responses of the study participants. Data collection took place from June to July 2024. The five-point Likert scale was chosen over the seven-point scale due to its ability to reduce complexity for respondents, providing more reliable data and offering a balanced range of responses, allowing respondents to express their opinions without overwhelming them. The survey introduced a brief de-

scription of digital leadership, emphasizing key characteristics and roles. The definition was based on the existing literature and aligned with the study objectives. The survey also asked respondents about their experiences with digital leaders to understand how familiarity might influence their responses. Further details will be provided in the analysis section for transparency and clarity.

Current study employed a cross-section design and collected data from employees and supervisors. The questionnaire was initially designed in English and, later, it was translated into Chinese language using the back translation method adopted by [63]. A total of 410 questionnaires were distributed among willing participants. We received responses from 325 respondents and, after removing incomplete responses, the final study sample was 282. In this study, demographical information on age, gender, qualification, and experience was collected from both supervisors and employees. On the other hand, digital leadership and circular economy practices information was collected from employees and data on employee performance were rated by the respective immediate supervisors. Demographics of the study participants are indicated in Table 1.

Table 1. Demographics.

Demographic Characteristics	Number (N)	Percentage	Number (N)	Percentage
Study 1			Study 2	
Gender				
Male	152	54%	182	71%
Female	130	46%	74	29%
Age				
18–25	65	23%	70	27%
26–35	149	53%	95	37%
36–43	37	13%	56	22%
43 above	31	11%	35	14%
Qualification				
Undergraduate	59	21%	67	27%
Graduate	118	42%	87	34%
Postgraduate	105	37%	102	39%
Experience				
1–5 years	90	32%	59	23%
5–10 years	82	29%	108	42%
10–15 years	62	22%	48	19%
Above 15 years	48	17%	41	16%

N = Study 1—282; Study 2—256.

In study 2, the study implemented a face-to-face approach for distributing questionnaires. Data were collected from automobile manufacturing organizations in Hefei, China. The data were also collected from employees and supervisors by using a time-lag approach in two waves apart from two months. Time lag approach is used to provide different time intervals and different data sources, to provide sufficient time to think, act, and respond to the questions. Wave 1 took place from April to May 2024 and wave 2 took place from August to September 2024. This approach also helps to address the issue of common source and common method bias in the research. The same questionnaires were used that were used in study 1 but with addition information about ‘technological innovation’, with responses provided by the employees. Data were collected on digital leadership, circular economy practices, and organizational performance in the first wave of data collection. The data on organizational performance and technological innovation were collected from supervisors and employees, respectively, in the second wave of data collection. In this study, a structured questionnaire was used and designed on a five-point Likert scale ranging from 1, strongly disagree, to 5, strongly agree. The present study employed a systematic random sampling technique to collect the data, and we gathered lists of the employees of Hefei

automobile manufacturing organizations. We distributed the questionnaire to a sample of 320 respondents who agreed to record their responses after assuring their data privacy and confidentiality. After removing incomplete responses, the final sample was 256, which we used for data analysis. The demographics of the study participants are presented in Table 1.

3.2. Measurements

The present study used the 6 items scales to measure the digital leadership developed by [28]. A sample item is “A digital leader raises awareness of the technologies that can be used to improve organizational processes”. Circular economy practices were measured by the 5-item scale developed by [28]. A sample item includes “Your organization is engaged in reducing resources use in the production, distribution and consumption processes”. The five-item scale was used to measure the organizational performance developed by [28]. A sample item is “Compared with key competitors, our company is more successful”. A total of 16 items used to measure the model in study 1. Moreover, the 8-item scale developed by [64] was used to measure the moderator variable (technological innovation) in study 2 (see Appendix A).

4. Results

In Study 1, participants were predominantly male (54%), with females comprising 46%. The age distribution leaned towards the 26–35 age range (53%), while 23% fell between 18–25 years old. In terms of qualifications, graduate degrees were the most common (42%), followed by postgraduate (37%) and undergraduate (21%) qualifications. When it came to experience, the majority (32%) had 1–5 years of working experience with digital leaders, followed by 29% with 5–10 years, 22% with 10–15 years, and 17% with over 15 years of experience. In study 2, there was a significant skew towards males (71%), with females representing a minority (29%). The age distribution mirrors that of study 1, with the 26–35 age group being the largest (37%), followed by the 18–25 age group (27%). However, qualification shows a slight variation. Here, postgraduate qualifications took the lead (39%), followed by postgraduate degrees (34%) and undergraduate degrees (27%). Experience levels also diverged from those in study 1. The most prominent group had 5–10 years of experience (42%), followed by those with 1–5 years (23%), 10–15 years (19%), and over 15 years (16%).

4.1. Model Fit

Table 2 presents the model fit indices for two studies, evaluating their goodness of fit using various statistical measures. The SRMR (Standardized Root Mean Square Residual) values indicate the difference between observed and predicted correlation matrices, with a good fit of 0.075 for study 1 and 0.065 for study 2 [65]. The d_ULS (Squared Euclidean Distance) values indicate the discrepancy between the empirical and model-implied covariance matrices. Study 1 has a 0.763 value, while study 2 has a higher value of 1.262. The d_G (geodesic distance) values indicate a reasonable fit, with smaller values indicating a better fit. The chi-square test statistic indicates a better fit, with lower values generally indicating a better fit, but this is sensitive to sample size. Study 1 has a chi-square value of 467.087, while study 2 has a higher value of 996.973. The normed fit index (NFI) values indicate a decent fit, with values closer to 1 indicating a better fit [66]. Study 1 demonstrates a slightly superior model fit across most indices, while study 2 exhibits an acceptable fit.

Table 2. Model fit indices.

	SRMR	d_ULS	d_G	Chi-Square	NFI
Study 1	0.075	0.763	0.294	467.087	0.838
Study 2	0.065	1.262	0.721	996.973	0.809

Note: SRMR = Standardized Root Mean Square Residual, NFI = normed fit index, Chi-square = degree of freedom, d_G = geodesic distance, d_ULS = Squared Euclidean Distance. Study 1 (N) = 282; study 2 (N) = 256.

4.2. Discriminant Validity (Farnell and Larker Criterion)

Table 3 presents the outcomes of two studies that explore the connections among four variables: circular economy practices (CEP), digital leadership (DL), organizational performance (OP), and technological innovation (TI). The diagonal values in the table indicate the reliability or internal consistency of each construct, with values at or above 0.7 reflecting strong reliability. In the first study, CEP (0.857), DL (0.823), and OP (0.754) demonstrate strong reliability, while TI is excluded. Similarly, study 2 reveals high reliability for CEP (0.879), DL (0.825), OP (0.805), and TI (0.842). The off-diagonal values represent the correlations between the constructs, showing moderate to strong relationships, particularly between OP and both DL (0.539 in study 1 and 0.525 in study 2) and CEP (0.446 in study 1 and 0.441 in study 2). In study 2, the correlations involving TI and the other variables are moderate, especially with DL (0.390) and OP (0.414), indicating a relationship between technological innovation and these factors. Overall, the table reflects positive relationships.

Table 3. Discriminant validity (Fornell–Larker criterion).

	CEP	DL	OP	TI
Study 1				
CEP	0.857			
DL	0.271	0.823		
OP	0.446	0.539	0.754	
Study 2				
CEP	0.879			
DL	0.338	0.825		
OP	0.441	0.525	0.805	
TI	0.225	0.390	0.414	0.842

Note: CEP = circular economy practices, DL = digital leadership, OP = organizational performance, TI = technological innovation. N = Study 1—282; study 2—256.

4.3. Inner Model Evaluation

In the present study, the [67] method was used to measure the discriminant validity. Discriminant validity assesses the measurement validity of model. The average variance extracted is used to assessed the convergent validity [68]. Ref. [69] suggests that the value of AVE should be higher than 0.5. Table 4 presents the results of the inner model evaluation of two studies that focus on the constructs of digital leadership, circular economy practices, organizational performance, and technology innovation.

In study 1, six items of the measurement were used for digital leadership (DL1 to DL6), all of which have loadings indicating satisfactory individual contributions ranging from 0.742 to 0.874. The construct is found to be highly reliable with an alpha coefficient of 0.903, CR of 0.904, and AVE of 0.677, which shows that the scale has high convergent validity. Likewise, circular economy practices (CEP1 to CEP5) also have significant and positive loadings that range from 0.824 to 0.889 and have high reliability, with the alpha, CR, and AVE being 0.910, 0.913, and 0.735, respectively. Meanwhile, organizational performance (OP1 to OP5) has a slightly lower AVE value, 0.568, but the research acceptability of the alpha value, 0.806, and CR, 0.822, prove reliable.

The results of study 2 shows the same pattern for the digital leadership construct with slightly higher loadings and reliability coefficients (alpha = 0.905, CR = 0.927, and AVE = 0.681). In contrast, the circular economy practices demonstrate even greater loadings (from 0.844 to 0.902) and reliability (alpha = 0.926, CR = 0.944, AVE = 0.773). Additionally, organizational performance shows an improvement in reliability (alpha = 0.861, CR = 0.901, AVE = 0.647). A new construct, technological innovation (TI1–TI8), has been introduced, which displays high reliability and validity (alpha = 0.941, CR = 0.951, AVE = 0.709), with loadings ranging from 0.754 to 0.905. This suggests that the technological innovation is effectively represented by its items and significantly enhances the overall evaluation of the model.

Table 4. Inner model evaluation.

Constructs	Items	Loadings	Alpha	CR	AVE
Study 1					
Digital Leadership			0.903	0.904	0.677
DL1	Our digital leader raises the awareness of the employees of the institution about the risks of information technologies	0.769			
DL2	Our digital leader raises awareness of the technologies that can be used to improve organizational processes.	0.742			
DL3	Our digital leader determines the ethical behaviors required for informatics practices together with all its stakeholders.	0.806			
DL4	Our digital leader plays an informative role to reduce resistance to innovations brought by information technologies.	0.865			
DL5	Our digital leader shares his/her own experiences about technological possibilities that help his/her colleagues to learn about the organization's structure.	0.874			
DL6	In order to increase participation in the corporate vision, a digital leader guides the employees of the institution regarding the technological tools that can be used.	0.871			
Circular Economy Practices			0.910	0.913	0.735
CEP1	Our organization is engaged in reducing resources use in the production, distribution, and consumption processes.	0.845			
CEP2	Our organization is engaged in reusing of resources in the production, distribution, and consumption processes.	0.889			
CEP3	Our organization is engaged in recycling of resources in the production, distribution, and consumption processes.	0.879			
CEP4	Our organization is engaged in recovering of resources in the production, distribution, and consumption processes.	0.849			
CEP5	Our organization is engaged in regeneration of resources in the production, distribution, and consumption processes.	0.824			
Organizational Performance			0.806	0.822	0.568
OP1	Compared with key competitors, our company is more successful.	0.797			
OP2	Compared with key competitors, our company has a greater market share.	0.717			
OP3	Compared with key competitors, our company is growing faster.	0.597			
OP4	Compared with key competitors, our company is more profitable.	0.818			
OP5	Compared with key competitors, our company is more innovative.	0.815			

4.4. Hypothesis Testing

The results of the hypothesis testing, as shown in Table 5, highlight important relationships among digital leadership (DL), circular economy practices (CEP), and organizational performance (OP). In study 1, Hypothesis 1 (H1) indicates that DL has a positive effect on CEP, supported by a path coefficient of 0.278, t-value of 4.256, and a *p*-value of 0.000, which provides robust evidence for this relationship. Hypothesis 2 (H2) provides evidence that CEP has an impact on OP, with a path coefficient of 0.453 and t-value of 9.434. In Hypothesis 3 (H3), CEP is posited to mediate the relationship between DL and OP, where it has a path coefficient of 0.127 significant at t-value = 3.318 and *p* < 0.001, which supports the mediating role of the CEP in the relationship between DL and OP.

Table 5. Hypothesis testing.

Structural Path	Proposal Effects	Path Coefficient	Std. Dev.	t-Value	p-Value	Decision
Study 1						
DL→CEP	H1	0.278	0.064	4.256	0.000	Supported
CEP→OP	H2	0.453	0.047	9.434	0.000	Supported
DL→CEP→OP	H3	0.127	0.036	3.318	0.001	Supported
Study 2						
DL→CEP	H1	0.346	0.061	5.528	0.000	Supported
CEP→OP	H2	0.333	0.053	6.259	0.000	Supported
DL→CEP→OP	H3	0.116	0.031	3.639	0.000	Supported
TI*CEP→OP	H4	0.179	0.053	3.379	0.001	Supported

Note(s): DL = digital leadership, CEP = circular economy practices, OP = organizational performance, TI = technological innovation. N = Study 1—282; Study 2—256.

The findings of study 2 are also characterized by the same pattern. Thus, under (H1) hypothesis, circular economy practices (CEP) are positively affected by DL, with the estimated path coefficient of 0.346, a t-value of 5.528, and a p-value of 0.000. Furthermore, CEP has a direct significant and positive relationship with OP, with a path coefficient of 0.333, a t-value of 6.259, and a p-value of 0.000. Additionally, CEP positively influences organizational performance (OP) (H2), as shown by a path coefficient of 0.333, a t-value of 6.259, and a p-value of 0.000. The mediating role of CEP in the relationship between DL and OP (H3) is also validated, with a path coefficient of 0.116, a t-value of 3.639, and a p-value of 0.000. Furthermore, Hypothesis 4 (H4) highlights the moderating effect of technological innovation (TI) on the relationship between CEP and OP, which is supported by a path coefficient of 0.179, a t-value of 3.379, and a p-value of 0.001, indicating that technological innovation significantly bolsters the relationship between CEP and organizational performance.

The findings of both studies confirmed the proposed hypothesis. The combined findings reveal that digital leadership exerts a positive effect on circular economy practices, which, subsequently, contribute positively to organizational performance. Moreover, both studies affirm the mediating role of circular economy practices on the relationship between digital leadership and organizational performance. Additionally, study 2 confirmed that technological innovation significantly strengthens the relationship between circular economy practices and organizational performance. Furthermore, we acknowledge the potential influence of age, size, and enterprise age as control variables, but the present study is not focused on exploring the impact of control variables. The decision to exclude control variables from this study is based on the specific research focus and the context of the study. Including control variables may introduce complexity that could obscure the primary relationships being investigated, especially if these variables are not directly relevant to the hypotheses being tested.

5. Discussion

The finding of two studies presents a similar picture in terms of confirming our hypothesis. The analysis presented above was undertaken to achieve the objectives of our research. It is well established that leaders play a crucial role in influencing circular economy practices. Consequently, we investigated the direct impact of digital leadership on circular economy practices (refer to Figure 3). The results of our analysis indicated a significant positive direct impact of digital leadership on circular economy practices ($\beta = 0.278, 0.346$; $p < 0.000, 0.000$), leading to the acceptance of hypothesis H1. These findings are also consistent with the previous studies [70,71]. The practice-based view theory supports the notion that digital leadership positively influences the implementation of circular economy practices. Leaders are instrumental in fostering the adoption of these practices by promoting innovation, developing critical skills, and leveraging digital technologies [72].

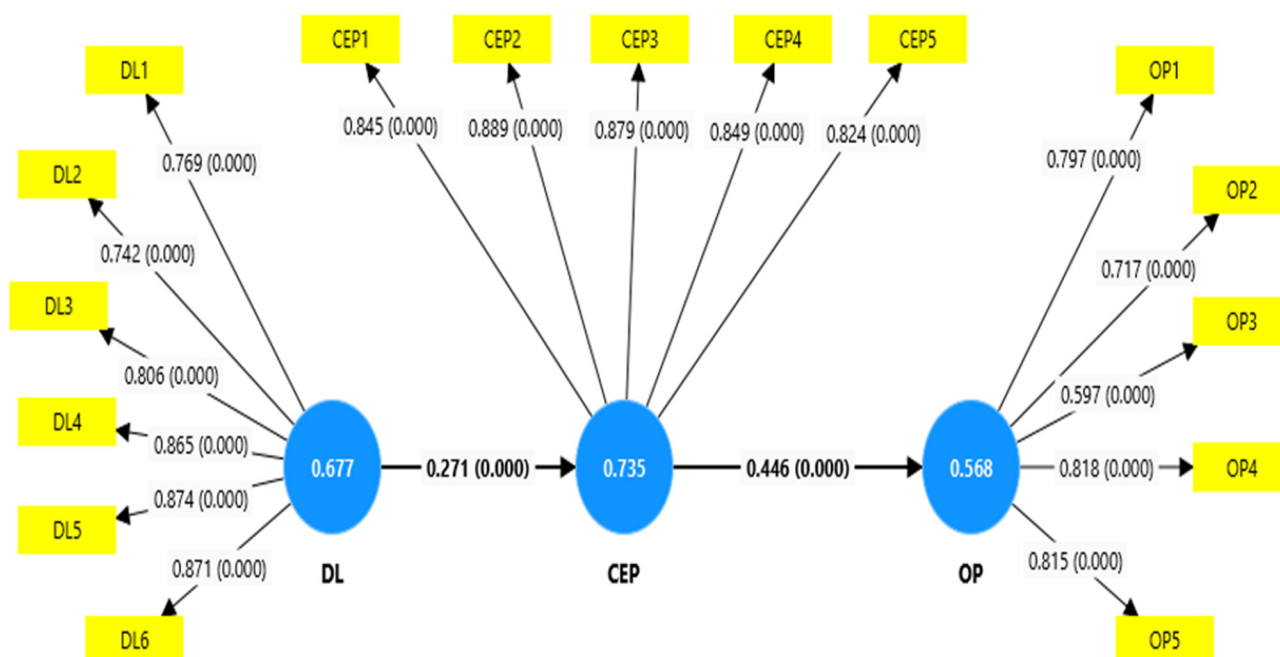


Figure 3. Path analysis (Study 1).

H2 posits that circular economy has a positive and significant influence on performance in organizations. The statistical findings indicate that circular economy practices have a positive and significant impact on organizational performance ($\beta = 0.453, 0.333; p < 0.000, 0.000$), leading to the acceptance of H2. These results are supported by prior studies showing that circular economy strategies have a positive effect on firm performance [73,74]. The practice-based view theory firmly supports the hypothesis that circular economy practices enhance organizational performance and the studies provided evidence that the implementation of circular economy practices has been beneficial in enhancing financial, environmental, and operational performances in different contexts of organizations [75]. The mediating role of circular economy practices was analyzed in the digital leadership and circular economy practices relationship ($\beta = 0.124, 0.116; p < 0.001, 0.000$). Hence, H3 is accepted. Prior studies have supported the present findings concerning the mediation effect, as circular economy practices act as a significant bridge to establish the connection between block chain technology and organizational performance [5]. The practice-based view theory robustly endorses the notion that the implementation of circular economy practices, as developing routines, empower organizations to fully leverage the potential of digital leadership, leading to improved organizational performance [76].

In study 2, Hypothesis 4 was tested. Technological innovation positively moderates the connection between circular economy practices and organizational performance ($\beta = 0.179, p < 0.001$), which leads to the acceptance of H4 (see Figure 4). Technological innovation has already been studied as a moderating factor in various contexts. The findings of present study are also consistent with those of previous studies [3,61]. The PBV theory asserts that technological innovation is fundamental to the execution of circular economy practices [77]. This leads to enhance organizational performance metrics such as cost efficiency, customer loyalty, and market differentiation [78]. However, most of the previous studies were conducted in western countries [79,80]. The current study is conducted in China and in line with the previous studies. Consequently, we conclude that interaction results clearly show that technological innovation strengthens the positive impact of circular economy practices on organizational performance as shown in Figure 5.

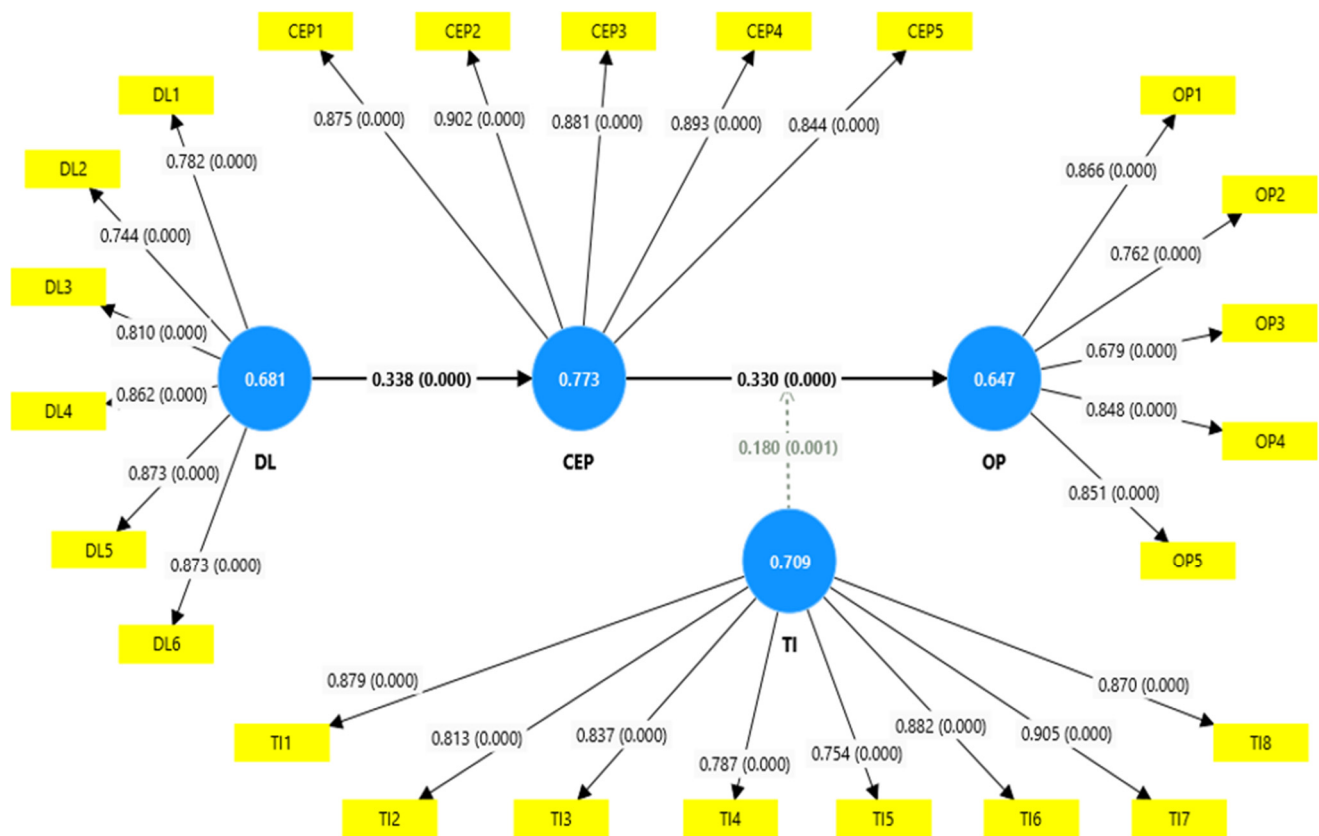


Figure 4. Path analysis (Study 2).

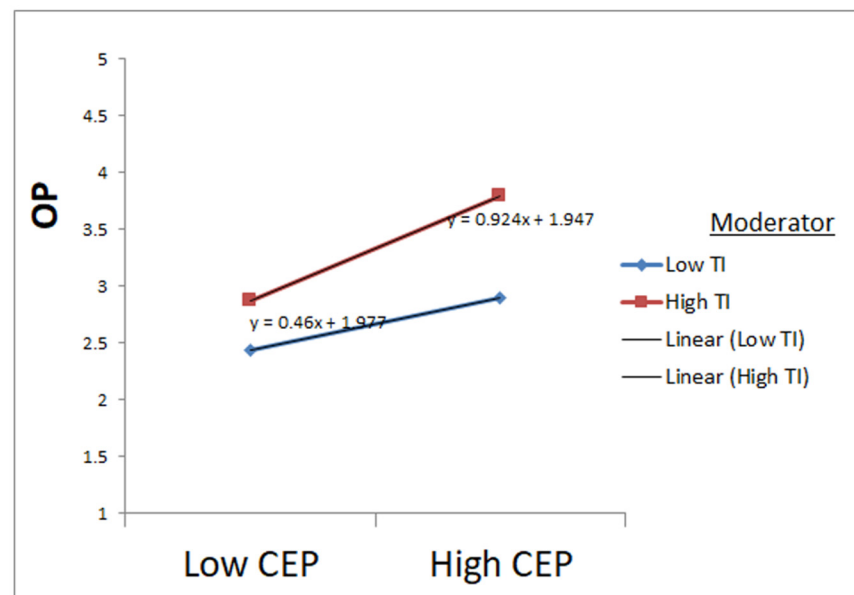


Figure 5. Interaction effect of technological innovation and circular economy practices on organizational performance.

Moreover, extending the conclusions to contexts beyond China or to a wider framework of management science and practice requires careful consideration of the unique cultural, economic, and regulatory factors that influence management practices in those areas. Adapting the findings involves a detailed exploration of local conditions, stakeholder behaviors, and specific challenges within industries. To achieve generalization at a broader

management level, it is important to focus on core principles and frameworks that are universally applicable, while also tailoring strategies to align with the distinct contexts and specific needs of organizations in various regions.

5.1. Theoretical Implications

The present study offers several contributions to the literature. First, this brings to light that from a PBV standpoint, the model implies that an effective integration of digital leadership and circular economy practices is a prerequisite to optimal organizational performance. This suggests that to improve their performance, organizations need to embrace digital technology while simultaneously integrating sustainability and circularity into their leadership strategy.

Second, the relationship between different leadership styles, such as ambidextrous leadership, ethical leadership, adaptive disruptive leadership, and environmental performance, has been analyzed by scholars [4,44,81]. Notably, the study of digital leadership in the context of circular economy practices and its effects on organizational performance is scarce in the literature on leadership and circular economy. Therefore, the present research framework contributes to the comprehension of the factors that forecast organizational performance in Chinese manufacturing organizations, as well as the significance of digital leadership, circular economy practices, and technological innovation in advancing organizational performance.

Third, the present study employed the practice-based view theory, which emphasizes the embeddedness of organizational behavior in the specific social, institutional, and historical contexts under consideration. Hence, the applicability of circular economy practices in boosting organizational performance depends on the degree of their fit not only with growing socio-economic tendencies but also with ongoing regulatory frameworks and business practices. Digital leadership has a huge impact on tackling these contextual factors and providing appropriate circular practices that would be relevant to the specific essence of the business. The present study also emphasized that digital leadership and the circular economy practices, which are interrelated, form an interjoined and cyclical loop for organizational performance. Organizations should be able to swiftly adopt new leadership practices and circular endeavors as their changing technological landscapes and market conditions and improve performance.

Last, the present study underscores the importance of cross-boundary working and harnessing internal capability to enhance organizational performance. From this standpoint, both internal (digital leadership) and external (technological innovation) enablers are essential for the successful implementation of circular economy practices, and digital leadership is essential in order to effectively integrate technology innovation and circular economy practices to enhance organizational performance.

5.2. Practical Implications

The findings of the present study highlighted the significance of digital leadership for organizational leaders to enhance performance in the era of technological advancement. A digital leadership style encourages people to demonstrate positive behavior towards circular economy practices. Ref. [27] also states that digital leadership is essential when allocating resources for upholding business managers who are skilled with digital technologies and encourage their employees to use innovative methods, which increases their enthusiasm and productivity. It is suggested that organizations mold digital leadership abilities in their top executives and managers. This involves supporting capabilities like digital literacy, strategic thinking in a digital environment, and the ability to manage the transformation of digital initiatives.

Second, the organization should appreciate the critical role of circular economy practices and concentrate on embedding circular economy practices into its operational activities. This will be achieved through redesigning products, rethinking production process, and improving waste management, as well as resource utilization to minimize luxury and

intensify the utilization of existing resources. Managers should acknowledge the interdependence of technology innovation, circular economy practices, and digital leadership. Organizations ought to promote internal and external collaboration. This entails exchanging creative solutions, gained experiences, and best practices with academic institutions, government agencies, and organizational peers in order to accelerate the development of high-performing and sustainable business models.

Third, organizations should focus on technology adoption to maximize the efficiency of the circular economy. This may incorporate new technology applications like IoT, block chain, AI, and high-tech analytics to improve resource use efficiency, trace materials through the supply chain, and find solutions that will help create a circular economy. Considering the ever-changing landscape of digital transformation, circular economy practices, and technological innovation. Organizations ought to cultivate a culture of continuous learning and modification; this involves staying updated on market developments, experimenting with new technologies and corporate strategies, and being adaptable when it comes to matching legal and marketplace demands.

Fourth, organizations should set up reliable measures and key performance indicators (KPIs) to assess how technological innovation, circular economy practices, and digital leadership affect overall organizational performance. This entails monitoring metrics including cost reductions, increased resource efficiency, smaller ecological footprint, consumer satisfaction, and overall financial performance. Furthermore, digital leaders ought to be flexible with their leadership style and capable of embracing new technologies such as technological innovation in order to persuade their employees to adopt modern practices such as circular economy practices [28].

5.3. Limitations and Future Research Directions

Despite revealing valuable insights, the study has several limitations and future research directions. First, the study primarily focused on the positive outcomes of digital leadership in circular economy practices and technological innovation on organizational performance. The study does not focus on the privacy, ethical, and financial challenges that are faced by the organization due to the implementation of technology within the organization. Future research should consider these constructs. Second, the present study employed the cross-sectional research approach. Future research should adopt a longitudinal research design to completely understand the impact of technological innovation, as the outcomes over time may provide insights into the long-term effects of technology adoption and provide a comprehensive explanation of its implications for technological innovation. Third, the present study collected data from two different manufacturing sectors and did not focus on the regional differences. Future research should conduct comparative studies across different countries and regions to provide valuable insights into the factors influencing the success of circular economy practice and technological innovation to enhance organizational performance.

Organizational performance can be affected by numerous factors, including both managerial characteristics and firm-specific attributes. The decision to omit control variables in this study is grounded in the particular research focus and context. It is recommended that future studies incorporate these control variables to better understand their effects on organizational performance. We did not compare the average characteristics of employees in the selected organizations in the present study. Future studies should compare these characteristics, as this comparison will help identify any potential self-selection biases in the sample. Finally, these limitations open a path for future research to examine variations in circular economy practices, technological infrastructure, and cultural contexts. Future studies should explore the best practices for the effective use of circular economy practices to improve organizational performance. Additionally, future research should explore the implications of emerging technologies such as block chain, artificial intelligence, and big data analytics on circular economy practices and organizational performance, investigating

how these technologies are effectively integrated and offering valuable insights for policy makers and practitioners.

Author Contributions: Conceptualization, A.Y.K. (Asfand Yar Khan) and M.A.; Software, A.Y.K. (Azmat Yar Khan); Formal analysis, A.Y.K. (Azmat Yar Khan); Investigation, A.Y.K. (Asfand Yar Khan); Resources, M.A.; Writing—original draft, A.Y.K. (Asfand Yar Khan) and M.A.; Writing—review & editing, A.Y.K. (Asfand Yar Khan). All authors have read and agreed to the published version of the manuscript.

Funding: The authors declare they received no funding or financial support for this research, and that no individuals or organizations had any influence over the design, execution, or interpretation of the study findings presented in this manuscript.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Shandong Normal University, Jinan China (protocol code BSSDNU101510 and date of approval 25 March 2024) for studies involving humans.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The authors will make the data and materials used in this study available upon request to qualified researchers for purposes of replication and further analysis, provided that the request complies with applicable laws and regulations.

Conflicts of Interest: The authors declare that they have no conflicts of interest that could influence the interpretation or publication of the research findings presented in this manuscript.

Appendix A. Study 2. Construct Items

Digital Leadership			0.905	0.927	0.681
DL1	Our digital leader raises the awareness of the employees of the institution about the risks of information technologies.	0.782			
DL2	Our digital leader raises awareness of the technologies that can be used to improve organizational processes.	0.744			
DL3	Our digital leader determines the ethical behaviors required for informatics practices together with all its stakeholders.	0.810			
DL4	Our digital leader plays an informative role to reduce resistance to innovations brought by information technologies.	0.862			
DL5	Our digital leader shares his/her own experiences about technological possibilities that help his/her colleagues to learn about the organization's structure.	0.873			
DL6	In order to increase participation in the corporate vision, a digital leader guides the employees of the institution regarding the technological tools that can be used.	0.873			
Circular Economy Practices			0.926	0.944	0.773
CEP1	Our organization is engaged in reducing resources use in the production, distribution, and consumption processes.	0.875			
CEP2	Our organization is engaged in reusing of resources in the production, distribution, and consumption processes.	0.902			
CEP3	Our organization is engaged in recycling of resources in the production, distribution, and consumption processes.	0.881			
CEP4	Our organization is engaged in recovering of resources in the production, distribution, and consumption processes.	0.893			
CEP5	Our organization is engaged in regeneration of resources in the production, distribution, and consumption processes.	0.844			

Organizational Performance		0.861	0.901	0.647
OP1	Compared with key competitors, our company is more successful.	0.866		
OP2	Compared with key competitors, our company has a greater market share.	0.762		
OP3	Compared with key competitors, our company is growing faster.	0.679		
OP4	Compared with key competitors, our company is more profitable.	0.848		
OP5	Compared with key competitors, our company is more innovative.	0.851		
Technological Innovation		0.941	0.951	0.709
TI1	Our organization uses technologies in production processes.	0.879		
TI2	The application of technologies generates information on the production processes.	0.813		
TI3	Having more information contributes to proper decision making.	0.837		
TI4	Artificial intelligence applications help workers' tasks.	0.787		
TI5	The use of software helps the processing of large amounts of data.	0.754		
TI6	Technology allows for the obtaining of reliable information on the production process.	0.882		
TI7	The organization shares information digitally.	0.905		
TI8	The adoption of technology improves the use of resources.	0.870		

References

1. Nara, E.O.B.; da Costa, M.B.; Baierle, I.C.; Schaefer, J.L.; Benitez, G.B.; do Santos, L.M.A.L.; Benitez, L.B. Expected impact of The, industry 4.0 technologies on sustainable development: A study in context of Brazil's plastic industry. *Sustain. Prod. Consum.* **2021**, *25*, 102–122. [\[CrossRef\]](#)
2. Sachs, J.D. *The Age of Sustainable Development*; Columbia Press, University: New York, NY, USA, 2015.
3. Kong, Y.; Agyemang, A.; Alessa, N.; Kongkuah, M. The moderating role of technological innovation on environment, social, and governance (ESG) performance and firm value: Evidence from developing and least-developed countries. *Sustainability* **2023**, *15*, 14240. [\[CrossRef\]](#)
4. Soni, V.; Gnekpe, C.; Roux, M.; Anand, R.; Yaroson, E.V.; Banwet, D.K. Adaptive distributed leadership and circular economy adoption by emerging SMEs. *J. Bus. Res.* **2023**, *156*, 113488. [\[CrossRef\]](#)
5. Rehman Khan, S.A.; Yu, Z.; Sarwat, S.; Godil, D.I.; Amin, S.; Shujaat, S. The role of block chain technology in circular economy practices Logistics, improve organizational performance. *Int. J. Res. Appl.* **2021**, *25*, 605–622. [\[CrossRef\]](#)
6. Ajwani-Ramchandani, R.; Figueira, S.; de Oliveira, R.T.; Jha, S. Importance, Enhancing the circular and modified linear economy: The of blockchain for developing economies. *Resour. Conserv. Recycl.* **2021**, *168*, 105468. [\[CrossRef\]](#)
7. Shojaei, A.; Ketabi, R.; Razkenari, M.; Hakim, H.; Wang, J. Through, Enabling a circular economy in the built environment sector blockchain technology. *J. Clean. Prod.* **2021**, *294*, 126352. [\[CrossRef\]](#)
8. Esposito, M.; Tse, T.; Soufani, K. Introducing a circular economy: New thinking with new managerial and policy implications. *Calif. Manag. Rev.* **2018**, *60*, 5–19. [\[CrossRef\]](#)
9. Botezat, E.A.; Dodescu, A.O.; Văduva, S.; Fotea, S.L. An exploration of circular economy practices and performance among Romanian producers. *Sustainability* **2018**, *10*, 3191. [\[CrossRef\]](#)
10. Khan, S.A.R.; Umar, M.; Asadov, A.; Tanveer, M.; Yu, Z. Technological revolution and circular economy practices: A mechanism of green economy. *Sustainability* **2022**, *14*, 4524. [\[CrossRef\]](#)
11. Kwarteng, A.; Simpson, S.N.Y.; Agyenim-Boateng, C. The effects of circular economy initiative implementation on business performance: The moderating role of organizational culture. *Soc. Responsib. J.* **2022**, *18*, 1311–1341. [\[CrossRef\]](#)
12. Bahadori, N.; Kaymak, T.; Seraj, M. Environmental, social, and governance factors in emerging markets: The impact on firm performance. *Bus. Strateg. Dev.* **2021**, *4*, 411–422. [\[CrossRef\]](#)
13. Hasan, M.N.; Anastasiadis, S.; Spence, L.J.; Uba, C.D. Environmental attitudes of polluting SMEs: Qualitative insights from a low-income developing country. *Bus. Strateg. Dev.* **2020**, *3*, 554–566. [\[CrossRef\]](#)
14. Lewandowski, M. Designing the business models for circular economy—Towards the conceptual framework. *Sustainability* **2016**, *8*, 43. [\[CrossRef\]](#)
15. Korhonen, J.; Honkasalo, A.; Seppälä, J. Circular economy: The concept and its limitations. *Ecol. Econ.* **2018**, *143*, 37–46. [\[CrossRef\]](#)
16. Schroeder, P.; Anggraeni, K.; Weber, U. The relevance of circular economy practices to the sustainable development goals. *J. Ind. Ecol.* **2019**, *23*, 77–95. [\[CrossRef\]](#)
17. Schroeder, P.; Dewick, P.; Kusi-Sarpong, S.; Hofstetter, J.S. Tensions, Circular economy and power relations in global value chains: And trade-offs for lower income countries. *Resour. Conserv. Recycl.* **2018**, *136*, 77–78. [\[CrossRef\]](#)

18. Wang, J.; Wu, H.; Chen, Y. Made in China 2025 and manufacturing strategy decisions with reverse QFD. *Int. J. Prod. Econ.* **2020**, *224*, 107539. [\[CrossRef\]](#)
19. Rodríguez-Espíndola, O.; Cuevas-Romo, A.; Chowdhury, S.; Díaz-Acevedo, N.; Albores, P.; Despoudi, S.; Malesios, C.; Dey, P. The role of circular economy principles and sustainable-oriented innovation to enhance social, economic and environmental performance: Evidence from Mexican SMEs. *Int. J. Prod. Econ.* **2022**, *24*, 108495. [\[CrossRef\]](#)
20. Yin, S.; Jia, F.; Chen, L.; Wang, Q. Circular economy practices and sustainable performance: A meta-analysis. *Resour. Conserv. Recycl.* **2023**, *190*, 106838. [\[CrossRef\]](#)
21. Mantlana, K.B.; Maoela, M.A. Mapping the interlinkages between sustainable development goal 9 and other sustainable development goals: A preliminary exploration. *Bus. Strateg. Dev.* **2020**, *3*, 344–355. [\[CrossRef\]](#)
22. Jabbour, A.B.L.S.; Jabbour, C.J.C.; Godinho Filho, M.; Roubaud, D. Research Industry 4.0 and the circular economy: A proposed Of, agenda and original roadmap for sustainable operations. *Ann. Oper. Res.* **2018**, *270*, 273–286.
23. Todorovic, T.; Medic, N.; Delic, M.; Zivlak, N.; Gracanin, D. Performance implications of organizational and technological innovation: An integrative perspective. *Sustainability* **2022**, *14*, 2836. [\[CrossRef\]](#)
24. Treacy, R.; Humphreys, P.; McIvor, R.; Lo, C. ISO14001 certification and operating performance: A practice-based view. *Int. J. Prod. Econ.* **2019**, *208*, 319–328. [\[CrossRef\]](#)
25. Bromiley, P.; Rau, D. Towards a practice-based view of strategy. *Strateg. Manag. J.* **2014**, *35*, 1249–1256. [\[CrossRef\]](#)
26. Silva, M.E.; Pereira, S.C.; Gold, S. The response of the Brazilian View., cashew nut supply chain to natural disasters: A practice-based. *J. Clean. Prod.* **2018**, *204*, 660–671. [\[CrossRef\]](#)
27. Wasono, L.W.; Furinto, A. The effect of digital leadership and innovation management for incumbent telecommunication company in the digital disruptive era. *Int. J. Eng. Technol.* **2018**, *7*, 125–130. [\[CrossRef\]](#)
28. Erhan, T.; Uzunbacak, H.H.; Aydin, E. From conventional to digital leadership: Exploring digitalization of leadership and innovative work behavior. *Manag. Res. Rev.* **2022**, *45*, 1524–1543. [\[CrossRef\]](#)
29. Öngel, V.; Günsel, A.; Gençer Çelik, G.; Altındağ, E.; Tatlı, H.S. Digital Leadership's Influence on Individual Creativity and Employee Performance: A View through the Generational Lens. *Behav. Sci.* **2023**, *14*, 3. [\[CrossRef\]](#)
30. Khan, S.A.R.; Shah, A.S.A.; Yu, Z.; Tanveer, M. A systematic literature review on circular economy practices: Challenges, opportunities and future trends. *J. Entrep. Emerg. Econ.* **2022**, *14*, 754–795. [\[CrossRef\]](#)
31. Borowska, G. Digital leadership for digital transformation. *Współczesna Gospod.* **2019**, *10*, 11–19.
32. Borah, P.S.; Iqbal, S.; Akhtar, S. Linking social media usage and SME's sustainable performance: The role of digital leadership and innovation capabilities. *Technol. Soc.* **2022**, *68*, 101900. [\[CrossRef\]](#)
33. Calzolari, T.; Genovese, A.; Brint, A. The adoption of circular economy practices in supply chains—An assessment of European Multi-National Enterprises. *J. Clean. Prod.* **2021**, *312*, 127616. [\[CrossRef\]](#)
34. Bag, S.; Dhamija, P.; Bryde, D.J.; Singh, R.K. Effect of ecoinnovation on green supply chain management, circular economy Capability, and performance of small and medium enterprises. *J. Bus. Res.* **2022**, *141*, 60–72. [\[CrossRef\]](#)
35. Khan, A.N.; Khan, N.A. The nexuses between transformational leadership and employee green organisational citizenship behaviour: Role of environmental attitude and green dedication. *Bus. Strateg. Environ.* **2022**, *31*, 921–933. [\[CrossRef\]](#)
36. Feng, X.; Goli, A. Enhancing business performance through circular economy: A comprehensive mathematical model and statistical analysis. *Sustainability* **2023**, *15*, 12631. [\[CrossRef\]](#)
37. Morais, D.O.; Silvestre, B.S. Advancing social sustainability in An, supply chain management: Lessons from multiple case studies in emerging economy. *J. Clean. Prod.* **2018**, *199*, 222–235. [\[CrossRef\]](#)
38. Tahu, G.P.; Yuesti, A.; Verawati, Y. Implications of Circular Economy, Supply Chain Management Innovation and Sustainability on Organisational Performance. *Int. J. Supply Chain Manag.* **2020**, *3*, 23–25.
39. Antonioli, D.; Ghisetti, C.; Pareglio, S.; Quatrosi, M. Innovation, Circular economy practices and organisational settings: Empirical evidence from Italy. 2022. Available online: <https://ssrn.com/abstract=4038174> (accessed on 24 August 2024).
40. Sassanelli, C.; Terzi, S. Circular Economy and Sustainable Business Performance Management. *Sustainability* **2023**, *15*, 8619. [\[CrossRef\]](#)
41. Orellana, L.M.G.; Romero, M.Á.M.; Reyes, G.Y.; Gutierrez, F.S.; Hernández, F.A.H.; Palacios, A.Z.; Carranza, C.P.M. Digital transformation and circular economy in universities. *J. Namibian Stud. Hist. Polit. Cult.* **2023**, *33*, 621–638.
42. Mangla, S.K.; Luthra, S.; Mishra, N.; Singh, A.; Rana, N.P.; Dora, M.; Dwivedi, Y. Barriers to effective circular supply chain management in a developing country context. *Prod. Plan. Control* **2018**, *29*, 551–569. [\[CrossRef\]](#)
43. Sehnem, S.; Jabbour, C.J.C.; Pereira, S.C.F.; Jabbour, d.S. Improving sustainable supply chains performance operational excellence: Circular economy approach. *Resour. Conserv. Recycl.* **2019**, *149*, 236–248. [\[CrossRef\]](#)
44. Katou, A.A.; Kafetzopoulos, D.; Vayona, A. Investigating the serially mediating mechanisms of organizational ambidexterity and the circular economy in the relationship between ambidextrous leadership and sustainability performance. *Sustainability* **2023**, *15*, 7937. [\[CrossRef\]](#)
45. Laguir, I.; Stekelorum, R.; Beysül, A.; Mouadili, O.; Segbotangni, E.A. Eco-control systems and firm performance: Understanding the mediating role of circular economy practices and the moderating role of environmental uncertainty. *J. Clean. Prod.* **2024**, *450*, 141894. [\[CrossRef\]](#)

46. de Andrade Júnior, H.; de Andrade, T.P.; Rosinha, A.P. Sustainable Leadership as a Vector of the Circular Economy. In *Handbook of Research on Creating Sustainable Value in the Global Economy*; de Andrade Júnior, H., de Andrade, T.P., Rosinha, A.P., Eds.; IGI Global: Hershey, PA, USA, 2020; pp. 165–180.
47. Villet, H.J. Promoting Circularity Through Sustainable Leadership. In *Human Resource Management Practices for Promoting Sustainability*; IGI Global: Hershey, PA, USA, 2021; pp. 197–211.
48. Manzar, M.S.; Ali, S.; Anwar, J.; Bilal, M.; Hassan, R.M. Unveiling the Pathway Toward Green Management Strategies to Green Building Success: The Mediating Role of Circular Economy Practices. *Bull. Bus. Econ.* **2024**, *13*, 908–917. [\[CrossRef\]](#)
49. Godin, B. *The Idea of Technological Innovation: A Brief Alternative History*; Edward Elgar Publishing: Cheltenham, UK, 2020.
50. Archibugi, D.; Iammarino, S. The globalization of technological innovation: Definition and evidence. *Rev. Int. Polit. Econ.* **2002**, *9*, 98–122. [\[CrossRef\]](#)
51. Ali, O.; Osmanaj, V.; Alryalat, M.; Chimhundu, R.; Dwivedi, Y.K. The impact of technological innovation on marketing: Individuals, organizations and environment: A systematic review. *Econ. Res. Istraživanja* **2023**, *36*, 2210661. [\[CrossRef\]](#)
52. Getor, R.Y.; Mishra, N.; Ramudhin, A. The role of technological innovation in plastic production within a circular economy framework. *Resour. Conserv. Recycl.* **2020**, *163*, 105094. [\[CrossRef\]](#)
53. Anser, M.K.; Khan, M.A.; Awan, U.; Batool, R.; Zaman, K.; Imran, M.; Sasmoko Indrianti, Y.; Khan, A.; Bakar, Z.A. The role of technological innovation in a dynamic model of the environmental supply chain curve: Evidence from a panel of 102 countries. *Processes* **2020**, *8*, 1033. [\[CrossRef\]](#)
54. Del Giudice, M.; Chierici, R.; Mazzucchelli, A.; Fiano, F. Supply chain management in the era of circular economy: The moderating effect of big data. *Int. J. Logist. Manag.* **2021**, *32*, 337–356. [\[CrossRef\]](#)
55. Magrini, C.; Nicolas, J.; Berg, H.; Bellini, A.; Paolini, E.; Vincenti, N.; Campadello, L.; Bonoli, A. Using internet of things and distributed ledger technology for digital circular economy enablement: The case of electronic equipment. *Sustainability* **2021**, *13*, 4982. [\[CrossRef\]](#)
56. Noman, A.A.; Akter, U.H.; Pranto, T.H.; Haque, A.K.M. Machine learning and artificial intelligence in circular economy: A bibliometric analysis and systematic literature review. *Ann. Emerg. Technol. Comput.* **2022**, *6*, 13–40. [\[CrossRef\]](#)
57. Yunis, M.; Tarhini, A.; Kassab, A. The role of ICT and innovation in enhancing organizational performance: The catalysing effect of corporate entrepreneurship. *J. Bus. Res.* **2018**, *88*, 344–356. [\[CrossRef\]](#)
58. Nižetić, S.; Djilali, N.; Papadopoulos, A.; Rodrigues, J.J. Smart technologies for promotion of energy efficiency, utilization of sustainable resources and waste management. *J. Clean. Prod.* **2019**, *231*, 565–591. [\[CrossRef\]](#)
59. Centobelli, P.; Cerchione, R.; Del Vecchio, P.; Oropallo, E.; Secundo, G. Blockchain technology for bridging trust, traceability and transparency in circular supply chain. *Inf. Manag.* **2022**, *59*, 103508. [\[CrossRef\]](#)
60. Bressanelli, G.; Adrodegari, F.; Perona, M.; Saccani, N. Exploring how usage-focused business models enable circular economy through digital technologies. *Sustainability* **2018**, *10*, 639. [\[CrossRef\]](#)
61. Satrovic, E.; Cetindas, A.; Akben, I.; Damrah, S. Do natural resource dependence, economic growth and transport energy consumption accelerate ecological footprint in the most innovative countries? The moderating role of technological innovation. *Gondwana Res.* **2024**, *127*, 116–130. [\[CrossRef\]](#)
62. Kanwal, S.; Pitafi, A.H.; Ahmad, M.; Khan, N.A.; Ali, S.M.; Surahio, M.K. Corridor Cross-border analysis of China–Pakistan Economic development project and local residence quality of life. *J. Public Aff.* **2020**, *20*, e2022. [\[CrossRef\]](#)
63. Brislin, R.W. Back-translation for cross-cultural research. *J. Cross. Cult. Psychol.* **1970**, *1*, 185–216. [\[CrossRef\]](#)
64. Khan, S.A.R.; Ponce, P.; Tanveer, M.; Aguirre-Padilla, N.; Mahmood, H.; Shah, S.A.A. Technological innovation and circular economy practices: Business strategies to mitigate the effects of COVID-19. *Sustainability* **2021**, *13*, 8479. [\[CrossRef\]](#)
65. Hu, L.T.; Bentler, P.M. Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychol. Methods* **1998**, *3*, 424. [\[CrossRef\]](#)
66. Schuberth, F.; Rademaker, M.E.; Henseler, J. Assessing the Overall Fit of Composite Models Estimated by Partial Least Squares Path Modeling. *Eur. J. Mark.* **2023**, *57*, 1678–1702. [\[CrossRef\]](#)
67. Fornell, C.; Larcker, D.F. Evaluating structural equation models with unobservable variables and measurement error. *J. Mark. Res.* **1981**, *18*, 39–50. [\[CrossRef\]](#)
68. Ringle, C.M.; Sarstedt, M.; Mitchell, R.; Gudergan, S.P. Partial least squares structural equation modeling in HRM research. *Int. J. Hum. Resour. Manag.* **2018**, *31*, 1617–1643. [\[CrossRef\]](#)
69. Hair, J.F.J.; Hult, G.T.M.; Ringle, C.M.; Sarstedt, M. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 2nd ed.; SAGE Publications: New York, NY, USA, 2016.
70. Ordóñez de Pablos, P. *Handbook of Research on Developing Circular, Digital, and Green Economies in Asia*; IGI Global: Hershey, PA, USA, 2021.
71. Metcalf, M.; Hinske, C. 10 Circular economy leadership. In *The Impossibilities of the Circular Economy*; Routledge: London, UK, 2022; p. 103.
72. Chowdhury, S.; Dey, P.K.; Rodríguez-Espíndola, O.; Parkes, G.; Tuyet, N.T.A.; Long, D.D.; Ha, T.P. Impact of organisational factors on the circular economy practices and sustainable performance of small and medium-sized enterprises in Vietnam. *J. Bus. Res.* **2022**, *147*, 362–378. [\[CrossRef\]](#)
73. Khan, S.A.R.; Zia-ul-haq, H.M.; Umar, M.; Yu, Z. Digital technology and circular economy practices: An strategy to improve organizational performance. *Bus. Strateg. Dev.* **2021**, *4*, 482–490. [\[CrossRef\]](#)

74. Liu, J.; Quddoos, M.U.; Akhtar, M.H.; Amin, M.S.; Tariq, M.; Lamar, A. Digital technologies and circular economy in supply chain management: In the era of COVID-19 pandemic. *Oper. Manag. Res.* **2022**, *15*, 326–341. [[CrossRef](#)]
75. Farooque, M.; Zhang, A.; Choi, T.M.; Hartley, J.L.; Liu, Y. Antecedents and performance outcomes of circular procurement: An empirical study in China. *J. Purch. Supply Manag.* **2024**, *30*, 100882. [[CrossRef](#)]
76. Cai, X.; Khan, N.A.; Egorova, O. Transactional leadership And, matters in green creative behaviour through workplace learning Network, green knowledge management: Moderating role of social sites use. *Pers. Rev.* **2023**, *53*, 317–335. [[CrossRef](#)]
77. Khan, S.A.R.; Tabish, M.; Zhang, Y. Embracement of industry 4.0 and sustainable supply chain practices under the shadow of practice-based view theory: Ensuring environmental sustainability in corporate sector. *J. Clean. Prod.* **2023**, *398*, 136609. [[CrossRef](#)]
78. Khan, S.A.R.; Ahmad, Z.; Sheikh, A.A.; Yu, Z. Green technology adoption paving the way toward sustainable performance in circular economy: A case of Pakistani small and medium enterprises. *Int. J. Innov. Sci.* **2023**; ahead-of-print.
79. Yuan, X.; Liu, M.; Yuan, Q.; Fan, X.; Teng, Y.; Fu, J.; Ma, Q.; Wang, Q.; Zuo, J. Transitioning China to a circular economy through remanufacturing: A comprehensive review of the management institutions and policy system. *Resour. Conserv. Recycl.* **2020**, *161*, 104920.
80. Walker, A.M.; Opferkuch, K.; Lindgreen, E.R.; Simboli, A.; Vermeulen, W.J.; Raggi, A. Assessing the social sustainability of circular economy practices: Industry perspectives from Italy and the Netherlands. *Sustain. Prod. Consum.* **2021**, *27*, 831–844. [[CrossRef](#)]
81. Cheffi, W.; Zahir-ul-Hassan, M.K.; Farooq, M.O.; Baqrain, A.; Mansour, M.M.H. Ethical leadership, management control systems and circular economy in SMEs in an emerging economy, the UAE. *J. Bus. Res.* **2023**, *156*, 113513. [[CrossRef](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.