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Investigating and Impact of the Supply Chain Effective Parameters on the Digitalization and Success of Businesses in Terms of Innovation

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Abstract

The process of digitalization, also known as Industry 4.0, is affecting industries worldwide. It involves integrating manufacturing processes both vertically and horizontally. Digital platforms (DPs) are an example of digital technology that enables information integration, supports decision-making, and provides interoperability between various software and technologies while also enhancing visibility. This study suggests that the influence of digital platforms on organizations is tied to their digital culture. The data was gathered from 194 manufacturing companies, and structural equation modeling was utilized to test the hypotheses. Furthermore, it was discovered that Big Data Analytics (BDA) can enhance supply chain performance, but its lack of transparency can have various negative impacts. The research investigated the managerial aspects of BDA and focused on organizational capabilities, rather than technical or engineering ones. The objective was to determine how BDA capabilities can strengthen supply chain resilience and innovation, thus improving supply chain performance. The findings indicate that digital platforms have a positive and significant impact on supply chain capability. In addition, supply chain capability plays a key role in connecting digital platforms with operational performance. Furthermore, this study emphasizes the importance of digital culture as a contextual factor that helps explain the varying effects of digital platforms on firm performance. The study also found that BDA capabilities enhance supply chain performance by promoting resilience and innovation within the supply chain.

Keywords: digitalization, supply chain, digital culture, big data, innovation, Operational performance.

1- Introduction

The fast pace of digitalization has altered the competitive logic of the industries, the value chains [1-2], and firms' internal and inter-organization processes [3]. Firms adopt digital technologies to manage their operations, supply chain activities, and real-time visibility [4]); hence, businesses are increasingly connected [5]. This phenomenon encompasses industries globally and is sometimes also referred to as Industry 4 [6-8]. Digital technologies such as digital platforms (DPs) offer information integration [9-10], support visibility and decision-making [11], and provide interoperability between different software and technologies [2]. Thus, they are seen as an enabler of more digitalized supply chains [12]. Digital platforms, as a form of integration software, offer an opportunity for seamless information flow, communication, and connectivity in firms and in supply chains [13&10]. In addition, the contingency perspective of the resource-based view is adopted in this study and argued that

complementary organizational aspects might explain the differential result of using digital technology [14-15]. This study also investigates the moderating role of digital culture, referring to the openness and acceptance of digitalization-related technology [16]. Digital culture, like organizational culture, is identified as one of the causes preventing the change needed to become more digitalized [17-18]. The empirical research on digital culture is limited and has focused on the data-driven culture [19], the use of IT [20], and the intention to adopt internet-enabled supply chain management systems [21], big data analytics [22], and digital organizational culture [23]. Nevertheless, organizational digital cultural attributes are an underdeveloped aspect of digitalization research [24]. E-commerce is intertwined with information flow integrated within supply chain processes [25-26]. Developing a better understanding of how big data analytics (BDA) can add value to the organizational supply chain is of interest [27]. BDA enables organizations to improve the SC performance components of responsiveness, reliability, and customer service [28]. In this regard, [8] concluded that BDA could undoubtedly help improve SC performance. According to the United Nations Conference on Trade and Development (UNCTAD), the e-commerce sector witnessed a substantial rise in its share of all retail sales, from 16 percent to 19 percent in 2020 [29]. Furthermore, propelled by the unprecedented circumstances of the recent COVID-19 lockdowns, businesses have turned to e-commerce to stay financially viable, increasing final [29]. According to recent studies [30], it is suggested that Additive Manufacturing (AM) can greatly change the responsibilities of suppliers and manufacturers.

Tuire Hautala-Kankaanpaa, (2022) focuses on the impact of digital platforms and supply chain capability on operational performance and tests the mediation effect of supply chain capability. Further, the purpose is to examine the moderating effect of digital culture and sharpen our knowledge of how organizational culture as a contextual factor affects the firm's digitalization and their results showed that, digital platforms positively and significantly affect supply chain capability. Moreover, supply chain capability mediates the relation between digital platforms and operational performance. Further, this study confirms that digital culture is a contextual factor that explains the differences in the effects of digital platforms on firm performance [31].

Mohammad Bahrami et al, (2022) focus on big data analytics (BDA) capabilities can affect supply chain performance in several ways. This study was to understand how BDA capabilities could affect supply chain performance through supply chain resilience and supply chain innovation and their results showed that, BDA capabilities improve supply chain performance through resilience and innovation of the supply chain. The present study also contributed to the existing literature by demonstrating the mediating role of supply chain resilience and supply chain innovation between BDA capabilities and supply chain performance [33].

Banu Yetkin Ekren et al, (2023) focus on establishing utilization policies for AM in a supply chain network so that companies can simultaneously improve their total network cost and response time performance metrics. They propose three different utilization policies, i.e. reactive, proactive – both with 3D printing support – and a policy excluding AM usage in the system. A simulation optimization process for 136 experiments under various input design factors for an (s, S) inventory control policy is carried out. they also completed a statistical analysis to identify significant factors (i.e. AM, holding cost, lead time, response time, demand amount, etc.) affecting the performance of the studied retailer supply chain, and their results showed that utilizing AM in such a network can prove beneficial, and where the reactive policy contributes significantly to the network performance metrics. Practically, this work has important managerial implications in defining the most appropriate policies to achieve optimization of supply network operations and resilience with the aid of AM, especially in times of turbulence and uncertainty [34].

In this article, we examine the Impact of digital transformation through e-commerce on supply chain stages. Moreover, Effective Parameters on the Digitalization and Success of Businesses in terms of Innovation. Such as big data analytics, and digital culture. Statistical results showed that almost all dimensions (management, infrastructure, and personnel expertise capabilities)

were equally important in building BDA capabilities. However, it also comes with some disadvantages, such as slow processing as well as high production costs. Further, digital culture is a contextual factor that explains the differences in the effects of digital platforms on firm performance.

2- Methodology

Different companies have varying levels of success when it comes to utilizing digital technologies [23]. It is believed that simply having access to digital resources does not significantly improve a company's performance and that organizational factors such as culture are necessary for significant improvement [15]. In addition, [32] argues that the interaction between organizational culture and IT is crucial in generating value. In the context of digitalization, a company's digital culture refers to its willingness to embrace and utilize digital technologies [16], and an openness to new ways of thinking is a fundamental requirement for embracing digital technologies [33]. As a result, the advantages gained from digital culture may be limited. Digital culture is considered to be a factor that can impact the effectiveness of digital platforms. Previous studies have shown that a data-driven culture can moderate the impact of big data analytics on supply chain finance [34]. Additionally, digital organizational culture can indirectly influence operational performance [23]. Culture also affects the utilization and adoption of digital technologies [20-21]. We gathered data from manufacturing companies between December 2019 and April 2020. Even though one company's turnover was below the threshold of EUR 0.9 million, we still included their data in our analysis. To invite companies to participate, we used a mixed-methods approach involving both email invitations and direct calling. We contacted 800 companies, with 414 of them contacted by phone. Eventually, we received 194 acceptable responses, which was suitable for SEM according to research by Wolf et al. (2013) and Sideridis et al. (2014). Most responses came from the phone calls, with only 21 firms responding to the email. The overall response rate was 17%, with the majority of respondents holding managerial positions like CEO (83%) and CFO (13%). Most companies operated in the metal industry (32%), while others were in electric or electronic machinery (22.7%), food manufacturing (9.8%), leather, stone, clay, and glass production (3.6%), wood, furniture, and paper manufacturing (9.3%), and other manufacturing sectors (8.8%). You can find the sample demographics in Table 1. Sample demographics.

Table 1- Sample demographics

	n	%
Industry		
Chemicals, petroleum, rubber and plastic	27	13.9
Food manufacturing	19	9.8
Industrial, electric and electronic machinery	44	22.7
Leather, stone, clay and glass products	7	3.6
Metals and metal products	62	32
Wood, furniture and paper manufacturing	18	9.3
Other manufacturing	17	8.8
Number of employees		
<15	34	17.5
16–29	72	37.1
30–45	30	15.5
46–60	19	9.8
61–99	26	13.4
100–291	13	6.7
Turnover (thousand euros)		
<5	80	41.2
5–9.9	51	26.3
10–24.9	52	26.8
25–50	11	5.7
Firm age (years)		
<5	5	2.6
5–10	36	18.6
11–25	58	29.9
26–50		41.2
<50	15	7.7

A confirmatory factor analysis was used to test the validity of the scales. The reliability measures average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha (α) were tested, and the results are reported in Appendix. All the scales were measured with a 7-point Likert-type scale anchored with completely disagree (1) and completely agree (7) and were estimated through the respondent's perceptual evaluation. All these scales were considered reflective constructs.

The use of big data has brought about a significant revolution in supply chain management (SCM). With the incorporation of complex factors, big data has facilitated the development of a robust supply chain network, as noted by [13]. Furthermore, [9] found that the combination of e-commerce and big data benefits significantly improves the performance of demand chain management compared to traditional SCM practices. Finally, [13] conducted an analysis of supply chain analytics' impact on logistics and SCM through the application of big data strategies according to [38], big data can be a powerful tool in improving the efficiency of e-commerce supply chain management. The insights gained from big data enable businesses to increase productivity, collaboration, speed, and visibility, while also improving interactions with supply chain partners. By integrating big data analytics into their operations and supply chains, companies can better understand their customers, reduce service costs, manage risks effectively, and discover new revenue streams [39]. Argue that big data and analytics are essential drivers of supply chain and organizational performance, and [8] have identified BDA as a potential game-changer in supply chain management. Studies show that BDA capabilities can enhance supply chain efficiency by boosting operational efficiency, cutting costs, and increasing profitability [28 & 40]. Despite the considerable attention given to this issue by researchers, the impact of BDA on supply chain performance remains unclear and requires further investigation.

Based on the conceptual model that was created in Fig.1. The conceptual model, digital organizational culture can indirectly influence operational performance. Culture also affects the utilization and adoption of digital technologies. This research proposes that the impact of digital platforms is connected to the digital culture within organizations. Therefore, we have formulated the following hypotheses:

H1a. SC has a positive effect on operational performance

H2a. Digital platforms have a positive effect on SCC

H3a. Digital culture moderates the relationship between DPs and SCC

H3b. Digital culture moderates the relationship between the DPs and operational performance

BDA has been found to have a positive impact on supply chain performance, but it lacks transparency and can affect supply chain performance in multiple ways. This study examined the managerial aspect of big data and focused on organizational capabilities, rather than technical or engineering ones. The aim was to determine how BDA capabilities can boost supply chain performance by strengthening supply chain resilience and innovation. To ensure the required face and content validity, the survey instrument scales were adopted from previous scientific research. The survey consisted of a total of 31 items, including a 10-item scale adapted from [40] to evaluate BDA capabilities and an 11-item scale adapted from [41] to measure SC performance. Dwayne [42] developed some items to comprehensively study SC performance. The SC resilience was also assessed using 4 items developed by [43] based on the effect of BDA capabilities on SC resilience and competitive advantage in firms. [44] Developed the items after analyzing the speed with which businesses recover from disruptions for SC resilience. The [45] scales (6 items) were utilized to evaluate supply chain innovation in a study on the relationship between risk management capabilities, supply chain innovation, and competitive advantage in global supply chains. All constructs were reflectively considered, and the whole scales were provided in a 7-point Likert-type format ranging from strongly disagree to strongly agree. To test our research models, we utilized Smart PLS 3.0 software which employs partial least squares structural equation modeling (PLS-SEM). With PLS-SEM, complex models can be analyzed with fewer sample sizes and exogenous variables' predictive

potential can be assessed. This variance-based method can handle both measurement and structural models. According to the [46] proposed model, a suitable sample size is "ten times the largest number of formative indicators used for measuring one construct" and "ten times the largest number of structural paths directed at a specific latent construct in the structural model." Based on this model, 187 replies seem to be an adequate sample size. (see table.2. Respondent characteristics)

Table 2- Respondent characteristics

Respondents (N = 187)	Frequency (%)
Job title type	
Supply chain manager	45.5
Marketing manager	14.2
Operations manager	7.1
IT manager	33.2
Industry type	
Oil & Gas	11.4
Automotive	13.2
Textiles	4.1
Pharmaceuticals	5.9
Manufacturing	13.4
Electrical equipment	8.2
Transport services	10.6
ICT	11.1
Electrical equipment	8.9
Construction	7.4
Other	5.8
Number of employees	
0–50	22.0
51–100	17.1
101–500	16.4
501–1,000	19.3
1,001–10,000	25.2

H4a. SC resilience mediates the link between BDA capabilities and SC performance.
H5a. SC innovation mediates the link between BDA capabilities and SC performance.
Meeting demands in virtual logistics involves a combination of communication and transportation technologies, big data analytics, and human-machine interaction to provide efficient service to consumers. Digitally-enhanced first-mile e-commerce operations are helping to connect physically remote markets. Data plays a crucial role in the digital transformation of e-commerce supply chains. Over the past few years, technology has radically transformed the supply chain, with the rise of mobile devices, software logs, barcode scans, social platforms, RFID-tagged data, big data analytics, and cloud computing. In this section, we will explore how digital transformation has impacted logistics and supply chains. Our goal is to analyze how digitalization affects business success by examining the role of supply chain capabilities.

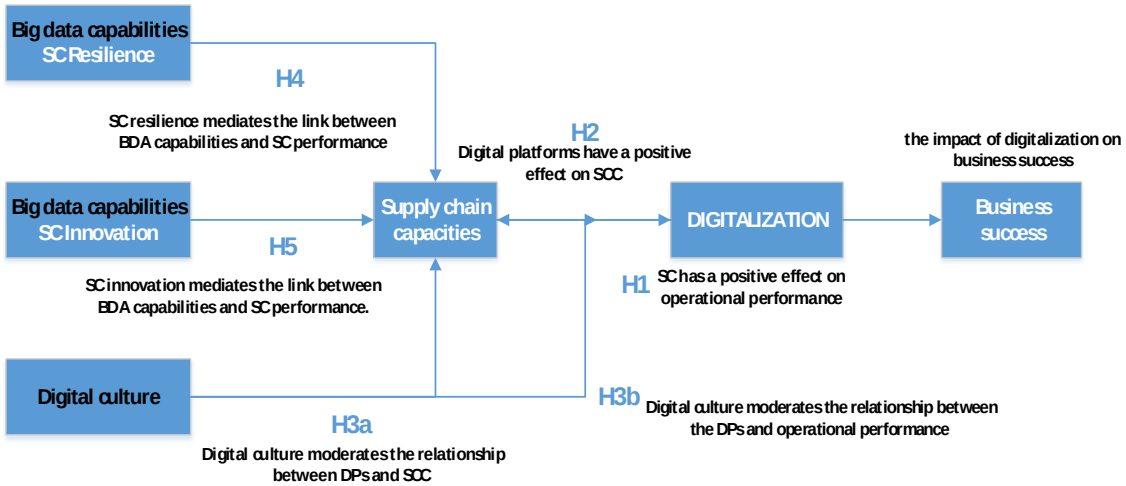


Fig 1- The conceptual model

3- Results and discussion

The test started with the analysis of direct relations. The results show that SCC (β 5 0.397, p < 0.001) has a positive and significant direct effect on the firm's operative performance, thus supporting H1. DPs (β 5 0.267, p < 0.001) directly and positively affect SCC, which supports H2. The control variables, size (β 5 0.105, p 5 0.054), and age (β 5 0.046, p 5 0.400), did not affect operational performance, whereas industry (β 5 0.115, p < 0.05) had a negative and significant effect on operational performance. In addition, the effect of digital culture on operational performance was controlled for, the results showing a significant direct effect of digital culture on operational performance (β 5 0.266, p < 0.001).

The constructs for digital culture and DP were multiplied to provide an interaction term to measure the effect of digital culture as a moderator [47]. The interaction term was treated as an independent variable in the model. The results show that digital culture does not moderate the relation between the DP and SCC (β 5 0.088 p 5 0.162), thus rejecting H3a. Instead, the digital culture significantly and positively moderates the relationship between a BPMJ 28,8 98DP and operational performance (β 5 0.223, p < 0.001), which supports H3b. The results are presented in Fig.2. Structural model results.

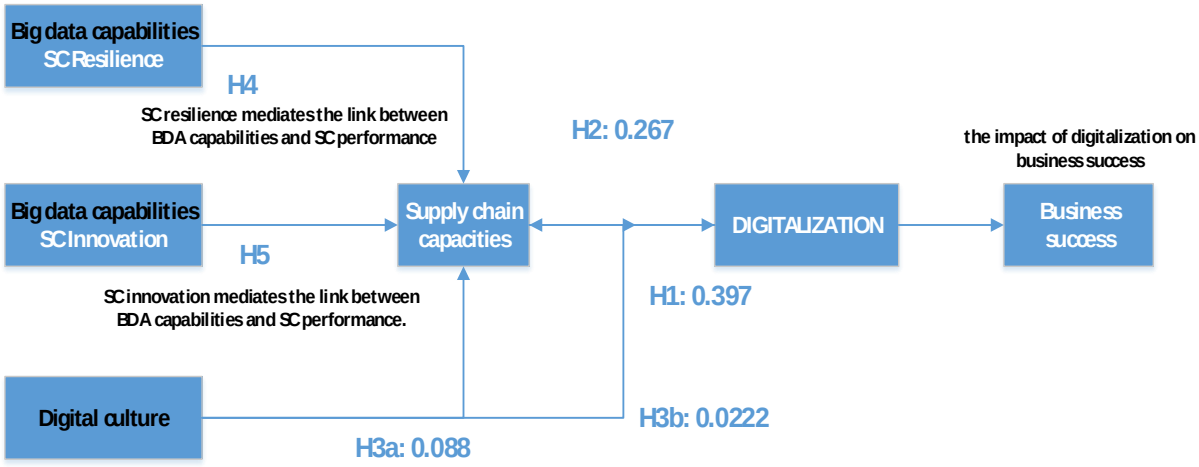


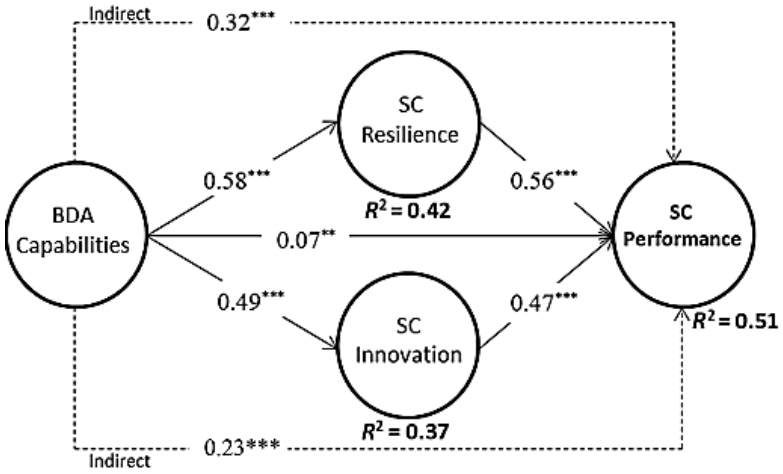
Fig 2- Structural model results

This research confirms that digital platforms (DPs) alone do not have a positive impact on firm performance. However, when combined with supply chain collaboration (SCC), they can lead to better performance. Additionally, SCC acts as a mediator between DPs and operational performance, further enhancing the positive effects. These findings align with previous studies by [48-51], and [19]. This study adds new insights into the performance effects of DPs, suggesting that firms should prioritize establishing processes and capabilities to derive value from them. Ultimately, DPs should be considered fundamental resources that can positively impact firm performance when integrated into their processes. This research explored the significance of a digital culture that embraces and supports digital technologies. It discovered that digital culture plays a key role in moderating the relationship between a firm's digitalization efforts and its operational performance. A company that lacks a supportive digital culture may be vulnerable in the digital age. These findings build on previous studies by [15] and [52], demonstrating that digital culture as an organizational factor is crucial in a firm's digitalization and digital capabilities. This study established a link between a company's digital culture and its digitalization efforts, specifically its use of digital platforms. It also provided possible reasons for the differential performance effects of digitalization that have been observed recently (e.g. [53-55]). It addressed the need identified in [56] research to enhance our understanding of digital resources and their role in a company's successful digital journey. This study filled that gap by demonstrating the impact of digital platforms and, more importantly, the significance of a supportive digital culture in achieving performance gains. It explained why a digital culture is essential to a firm's operations and performance.

Also, we began by assessing the relevance of indirect impacts, followed by the direct influence of BDA capabilities on SC performance. Table 3 summarizes the findings of the mediation test using the bootstrapping approach in SmartPLS3 [57]. The indirect effect's significance, as demonstrated in Table 3, qualifies for mediation analysis. Additionally, we estimated variance accounted for (VAF 5 indirect effect/direct effect þ indirect effect) to ascertain the strength of the SC resilience and SC innovation mediating effects. As mentioned by [61], partial mediation is shown when (VAF) surpasses the 0.2 threshold level, and when it exceeds 0.8, full mediation is offered. We used bootstrapping with 5,000 samples to determine the relevance of path coefficients. Based on the obtained statistical results the, H4 (SC resilience →SC performance), and H5 (SC innovation → SC performance) were supported. Path coefficients were shown in Fig.3. Structural model results.

Table 3- Mediation analysis

Mediated path	Support	Indirect effect	VAF	Conclusion
BDA capabilities → SC resilience→ SC performance	YES	0.32***	0.82	Full mediation
BDA capabilities → SC innovation→ SC performance	YES	0.23***	0.76	Partial mediation



Note(s): **Significant at $P < 0.01$
***Significant at $P < 0.001$

Fig 3- Structural model results

The findings indicate that SC resilience entirely mediates the association between BDA capabilities and SC performance, while SC innovations partially mediate the relationship. The purpose of this study was to determine how BDA capabilities could impact SC performance via SC resilience and innovation. To achieve this goal, the concept of BDA capabilities was introduced as a vital capacity that companies should cultivate to reach optimal performance results in the big data age. Statistical results also showed that almost all dimensions (viz. management, infrastructure and personnel expertise capabilities) were equally important in building BDA capabilities. Although no direct association was established between BDA capabilities and SC performance, the empirical findings indicated that BDA capabilities could contribute to SC performance improvement by boosting SC resilience and innovation. In addition, SC resilience as a full mediator and SC innovation as a significant partial mediator seemed to strengthen the association between BDA capabilities and SC performance. The results associated with the effects of BDA capabilities, SC resilience, and SC innovation correspondingly showed an agreement with previous literature and provided new insights into the contribution of all the dimensions to SC performance enhancement. This study's findings demonstrated that BDA capabilities indirectly improve supply chain performance. Accordingly, this study looked at big data from a managerial viewpoint, concentrating on

organizational capabilities, rather than a technical or engineering one. The findings indicated that SC resilience and innovation could act as a mediator between BDA capabilities and SC performance, which could serve as a valuable framework for corporate investment allocation. These findings also corroborated the widespread belief that IT may enable businesses to produce value through intermediary organizational capabilities [58]. Like the findings of this study, [59] argue that BDA capabilities can provide a competitive advantage in uncertain circumstances. The use of big data analytics to sustain and increase performance through enhancing supply chain resilience and innovation might be the key to success in unexpected environments and supply chain disruption circumstances. Companies seeking to improve their supply chain visibility can invest in adopting and developing Big Data Analytics (BDA) capabilities. As organizations have gained a better understanding of environmental changes and shifts in supply and demand, utilizing BDA has led to positive performance outcomes ([60]; [22]). BDA enables companies to access data not only from upstream and downstream elements of their supply chain but also from social media and distributed sensors, allowing them to identify changes in the environment and markets.

4- Conclusion

We gathered data from manufacturing firms between December 2019 and April 2020. We randomly selected firms categorized as general manufacturing (C) with a turnover between EUR 1.5 m and EUR 50 m. The DP scale, a 3-item scale, was a new addition. It measures the use of commercial platforms, such as IoT, integrative DP, and supply chain management platforms. IoT supports visibility, data integration, and a constant flow of information. These systems support internal and inter-organizational integration, connectivity, and information and data. To understand the impact of big data on supply chain management, we looked at success elements in growing economies. With the help of the Ministry of Industry database, we selected 367 companies from various industries for a broader perspective on developing BDA capabilities.

- The findings suggest that a combination of DPs and SCC can positively influence firm performance. However, DPs alone do not have a significant impact on firm performance.
- SCC mediates the relationship between DPs and operational performance. Therefore, firms should have processes and capabilities in place to extract value from DPs.
- A supportive digital culture is crucial for firms to fully benefit from digitalization efforts. This study emphasizes the importance of considering organizational aspects, such as digital culture, in digitalization conversations. It offers insights for managers to build a digital culture that supports the use of DPs, ultimately leading to better performance outcomes.
- The study found that BDA capabilities were crucial for companies to achieve optimal results in the big data era. Although there was no direct link between BDA capabilities and SC performance, empirical evidence suggests that BDA capabilities could enhance SC performance by improving SC resilience and innovation.
- According to the study, SC resilience played a complete role in connecting BDA abilities and SC performance, while SC innovation played a partial role in strengthening the connection. These results offer valuable direction for organizations that wish to enhance their supply chain performance by investing in the implementation and growth of BDA skills.
- Businesses can utilize BDA capabilities to collect data from diverse sources, including social media, distributed sensors, and both upstream and downstream components of their supply chain. This aids in gaining a deeper comprehension of shifts in the market and environment, ultimately improving decision-making processes and facilitating the creation of innovative products, services, marketing strategies, and business models. Innovation is vital for companies to stay competitive, adapt to changing market conditions, satisfy customers, and maintain profitability.

- BDA capabilities require significant resource and effort inputs. Therefore, it is important for organizations to broaden relevant knowledge and expertise before making a successful investment in this area. In today's data-driven world and markets, investing in big data technology to increase resilience and innovation may be a wise choice.
- The research showed that the ability to use Big Data Analytics (BDA) had a notable and positive impact on Supply Chain (SC) resilience, innovation, and performance. It was discovered that SC resilience and innovation were the most significant factors in this relationship. Thus, it is highly recommended that corporations focus on enhancing SC resilience and innovation, aided by BDA capabilities, as these are the most influential mediators in driving SC performance.

Further research should investigate how digital culture interacts with other digital resources and capabilities. It would also be beneficial to conduct case studies and surveys to gain a better understanding of how digital culture develops within organizations. In addition, this study's findings are limited by various factors. Firstly, the research was conducted in Iran, so it may not be applicable to other countries with different circumstances. Future studies should be conducted in multiple nations to validate the model's effectiveness. Secondly, the study used a cross-sectional approach, and future researchers should consider longitudinal data to verify the study's results over time.

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