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Data-driven strategic planning: The mediating role of the Blockchain-based supply chain in enhancing digital logistics performance

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Abstract

This research investigates the influence of data-driven strategic management on the digital logistics performance of Jordanian logistics firms, including SMEs, and especially the mediating influence of Blockchain-based supply chains. Adopting a quantitative methodology, a systematic questionnaire was distributed to 449 managerial respondents. The data were analyzed using Smart PLS4 and Structural Equation Modeling to investigate the relationships between strategic planning, Blockchain adoption, and logistics performance. Findings indicate that Blockchain-enabled data-driven strategic planning has a tremendous impact on optimizing supply chain transparency, operational efficiency, and trust, hence achieving outstanding logistics performance. Findings reiterate how Blockchain-induced digital transformation offers competitiveness to SMEs in the logistics industry. The findings of the study expound on the importance of the integration of Blockchain in strategic planning, highlighting the ability to induce sustainable growth as well as function with excellence. It also underscores the significance of exploiting future technologies to enhance logistical operations. The findings presented provide strategic counsel for policymakers and logistics managers on the implementation of Blockchain technology to render supply chains more efficient and the sector more competitive.

Keywords: Blockchain-based supply chain, Data-driven strategic planning, Digital logistics performance, Logistics companies, SMEs, Smart PLS4, Jordan.

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1. Introduction

In contemporary literature, logistics is increasingly recognized as one of the important drivers of economic growth and a key determinant of an organization's competitive advantage. However, the sector faces serious challenges in integrating operational efficiency with new digital technologies [1]. While continual advancements are being made in the area of digital transformation, many logistics SMEs still find it difficult to take full advantage of data-driven approaches and technologies, such as Blockchain, that can improve supply chain operations [2, 3]. Although there is existing literature investigating the impact of digital tools in supply chain management, there lies a critical gap in understanding the engagement of the technologies with strategic planning in the improvement of logistic performance [4, 5]. Most prominently, much of the current research narrows its focus to isolated implementations of specific technologies without exploring an overall strategic framework necessary for a full deployment of their potential in practice [1, 6].

This gap is particularly large in resource-constrained economies, such as Jordan, where logistics SMEs face unique barriers related to the high cost of implementation, a lack of technical expertise, and fragmented supply chain systems [7, 8]. These constraints limit the large-scale adoption of Blockchain and other digital solutions in enhancing efficiency in logistics and organizational growth due to the features of these platforms [9]. Although Blockchain technology has been widely acknowledged to enhance transparency, security, and operational efficiency, its strategic role in mediating logistics performance remains underexplored [10, 11]. The scarcity of empirical studies on the integration of Blockchain into strategic planning not only limits the theoretical development related to this aspect but also leaves practitioners without clear guidance on how to harness this technology for organizational excellence [12].

This paper, therefore, seeks to fill these gaps by assessing the mediating role of Blockchain-based supply chains in the relationship between data-driven strategic planning and digital logistics performance in Jordanian logistics companies and SMEs. In particular, it tries to answer the question: How does Blockchain technology mediate the relationship between strategic planning and logistics performance in Jordanian SMEs and logistics companies?

In achieving this objective, the study follows a structured approach. First, using a review of existing literature, the theoretical foundations of strategic planning, Blockchain integration, and logistics performance are established. This study then takes a quantitative approach using data collected through a survey via a structured questionnaire to 449 managerial-level respondents. Data analyzed through Smart PLS4, using structural equation modeling, assesses the proposed relationships. Finally, the findings are interpreted to deliver theoretical insights and practical recommendations for logistics managers and policymakers seeking to enhance digital logistics performance through Blockchain-driven strategic planning.

2. Literature Review

2.1. Data-Driven Strategic Planning

Notwithstanding the potential data-driven strategic planning still has a few notable challenges for implementation at SME levels [13]. Firstly, most organizations do not have good-quality data and advanced analytics tools because their decision-making is usually not too informed [14, 15]. Partial deficiency in technical skills also constrains the extent of proper integration of data insights into the strategic framework [16, 17]. The scholars go on to say that other added issues include resistance to change in organizations and a weak understanding of analytics frameworks, further exacerbating this challenge, thus widening the gulf between available data and actionable insight [1].

2.2. Blockchain-Based Supply Chain

While Blockchain uses excellent transformative possibilities for supply chain exposure as well as performance, numerous challenges hinder the large diffusion of this innovation [1, 6]. High prices of applications as well as the requirement for extremely specialized technological expertise are specifically significant barriers for SMEs in creating economic situations [1, 6]. Concerns about information personal privacy and also scalability even more limit the sensible applicability in intricate logistics networks [1, 6]. Various other research study likewise determines governing unpredictability coupled with a basic absence of standard structures as significant difficulties to attaining traditional Blockchain combination in supply chain systems [1, 6].

2.3. Digital Logistics Performance

However, the best digital logistics performance is usually a persistent challenge, especially in the case of SMEs facing resource constraints [1, 6]. The lack of adequate digital infrastructure, supply chain fragmentation, and low investment in innovation hampers the efficiency and responsiveness of the whole process [1, 6]. Studies show that different businesses are not aligning digital tools with operational processes despite technological advancements [5, 18]. In addition, a shortage of skilled personnel and poor managerial support have weakened initiatives for logistics performance improvement through the implementation of digital transformation initiatives [10].

2.4. Hypotheses Development

2.4.1. Data-driven Strategic Planning and Digital Logistics Performance.

Data-driven strategic planning equips the organization with active insights into logistics operations improvement [1]. Using data analytics, a firm can locate inefficiencies, predict demand patterns, and optimize resource allocation [1, 15]. This hypothesis postulates that integration of such insights into strategic decision-making will enhance the key performance indicators: delivery speed, cost efficiency, and customer satisfaction. Regarding the subject, data-driven approaches enable overcoming resource constraints and increasing the congruence between logistic operations and market demand with competitive advantages in dynamic contexts - [6, 7, 16]. Finally, the study has concluded the hypothesis stated:

H_1: Data-driven strategic planning positively affects digital logistics performance.

2.4.2. Data-Driven Strategic Planning and Blockchain-Based Supply Chain

Data-driven strategic planning empowers Blockchain technology adoption to identify the exact points of inefficiency in supply chains and justify investments in innovative solutions [9, 19]. The conjecture therefore postulates that only those organizations with strong data-driven strategies will be better positioned to implement Blockchain against such challenges as inventory mismanagement, fraud risks, and operational delays [20, 21]. By embedding Blockchain capabilities in the form of real-time tracking and indelible records of transactions, firms will be able to enhance their supply chain processes in line with strategic objectives by engendering more transparency, security, and efficiency [22, 24]. Thus, the hypothesized conclusion from this study will be as follows:

H_2: Data-driven strategic planning positively affects Blockchain-based supply chains.

2.4.3. Blockchain-Based Supply Chain and Digital Logistics Performance

Blockchain technology is expected to improve logistics performance by tackling critical supply chain issues like data transparency, operational inefficiency, and deficits in the trust of stakeholders [1, 6]. This hypothesis states that Blockchain features, such as decentralized ledgers, smart contracts, and secure data sharing, facilitate logistics operations and reduce delays [1, 6]. These advantages involve shipment tracking, fewer paperwork errors, and enhanced collaboration across the supply chain partners for the organizations that adopt Blockchain, according to [1, 6]. Such improvements give a promise of measurable logistics performance enhancement in terms of shorter delivery time, reduced operational costs, and increased customer satisfaction. Therefore, the research hypothesizes as follows:

H_3: Blockchain-based supply chains positively affect digital logistics performance.

2.4.4. Data-Driven Strategic Planning, Blockchain-Based Supply Chain, and Digital Logistics Performance

Such an enabling technology has linked data-driven strategic planning of supply chains and organizational analytics thinking in a relentless pursuit of areas of inefficiency, apart from potential areas of improvement, as the hypothesis has indicated [19]. In any case, without the enabling power of Blockchain technology, such insights are way off directly translating into performance upgrades [9, 19]. By integrating Blockchain, organizations can ensure transparency, security, and real-time tracking, which operationalize the insights gained from strategic planning [20, 21].

It will be used to enhance the inventory management process, reduce waste further, and facilitate on-time deliveries [25]. The recording of immutable records by Blockchain enhances the supply chain procedures concerning trust and accountability [20, 23]. Such accountability ensures that fraud is brought to a minimum while collaboration across stakeholders is effectively driven by the strategic imperatives set up [26, 27]. Thus, Blockchain plays the intermediary agent role in converting strategic intent to tangible operational results, enabling a gap between planning and execution. This hypothesis underlines the interaction between the data-driven insights and the capability of Blockchain, stating that organizations using both will exhibit higher digital logistics performance enhancements than either approach in isolation [5, 11, 17]. Accordingly, the study concludes the following hypothesis:

H_4: Blockchain-based supply chains significantly mediate the relationship between data-driven strategic planning and digital logistics performance.

2.5. Research Model

Hence, Figure 1 illustrates that this research focuses on assessing the influence of data-driven strategic planning on the digital logistics performance in Jordanian companies and SMEs, with a mediating effect of blockchain-based supply chains. This, in turn, serves to measure the impact of blockchain on the dimensions of transparency, efficiency, and trust that characterize logistics operations. In addition, this research seeks to provide practical insights into enhancing logistics performance through strategic and technological integration.

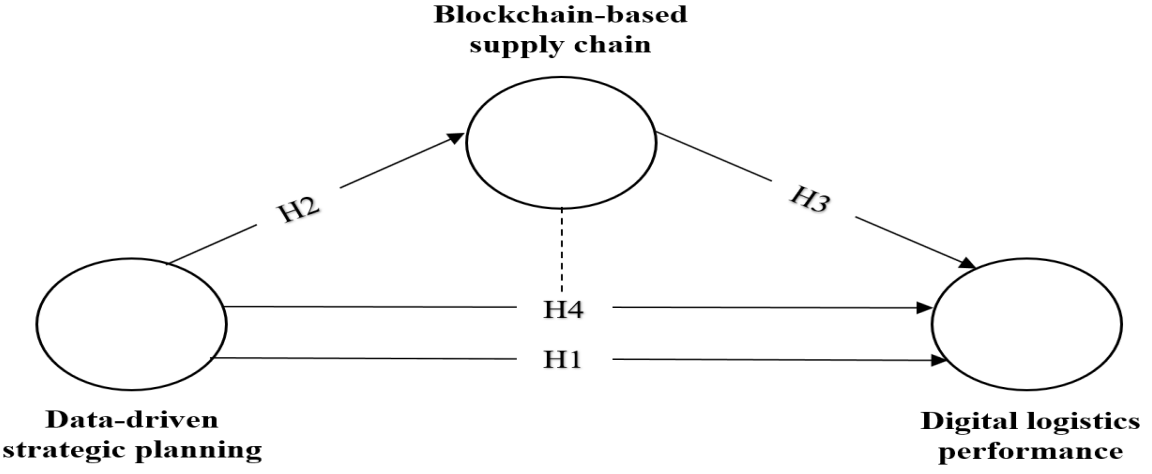

Figure 1.
Conceptual research model.

3. Methodology

3.1. Research Design

The approach adopted in this study was a quantitative descriptive research design with a pre-test. A pre-test represents a small sample for clarity and relevance in the questionnaire. In that respect, full data collection proceeded with a sample from logistics SMEs in Jordan to study the relationship between data-driven strategic planning, Blockchain-based supply chains, and digital logistics performance. Pre-testing of the research instrument was conducted among 25 respondents from the logistics companies to ensure validity. Feedback from this was used to refine the questionnaire for the main study by ensuring that items were clear and relevant, with potential problems identified before full data collection [28].

3.2. Population and Sample

The targeted population in this research consists of Jordanian logistics companies and SMEs engaged in the application of data-driven strategic planning and the use of Blockchain technology. Stratified random sampling allows for capturing representatives across the strata of different sizes of companies, logistic functions, and levels of adaptation to Blockchain, providing a less biased and more diversified perspective. In statistical power analysis, 449 respondents will suffice to attain the effect size necessary to achieve the appropriate sample size required for this study [28, 29]. In contrast, the respondents were senior-level managers, logistics coordinators, or executives vested with the responsibility for the overall planning and implementation of Blockchain applications in their respective companies. Such a group ensured that the data reflected informed insights on both digital and Blockchain technologies for logistics.

3.3. Measurement

Data collection was done using a structured Likert-scale questionnaire of 5-point ratings, from 1=Strongly Disagree to 5=Strongly Agree. Major variables in the study include Data-Driven Strategic Planning: the extent to which data analytics is considered and applied in making strategic plans. Sample items included: "Our Company integrates data analytics into its long-term strategic planning" [13, 14, 17].

Blockchain-based Supply Chains: Assessment of how Blockchain would work to ensure transparency and tracking, adding to the efficiency of this chain. Examples include: "Our Company has implemented Blockchain technology to track and verify shipments [9, 30, 31]. Digital Logistics Performance: Improvement in logistics performance due to digital tools. Sample items included "The speed of our deliveries has considerably improved because of digital logistics technologies", based on [5, 10, 32].

3.4. Data Collection Procedure

Data were collected via an online survey that was distributed to the chosen sample. Participants were invited to respond voluntarily and in a context of confidentiality and anonymity. This format provided an effective method to share and collect data. This research applies structural equation modeling (SEM) with the help of Smart PLS4, a robust method for testing complex relationships and mediating effects. The analysis ensures the reliability and validity of constructs through Cronbach's Alpha for internal consistency and Confirmatory Factor Analysis (CFA) for validation of measurement accuracy. Discriminant validity is checked to establish construct distinctiveness, and path coefficient analysis, along with hypothesis testing, assesses direct relationships among data-driven strategic planning, Blockchain adoption, and logistics performance. Furthermore, the direct, indirect, and total effects are assessed through mediation analysis, elucidating the role of Blockchain as a mediator in strategic planning. The predictive strength and structural integrity of the model are validated using model fit indices. Unlike past studies on isolated Blockchain implementations or single-variable effects, this research takes a strategic perspective by integrating Blockchain within a broader planning framework. This paper provides deeper insights into the transformative impact of Blockchain on logistics performance using SEM and offers a data-driven and strategic approach to digital logistics efficiency [33].

Table 1.
Reliability and validity of constructs.

Constructs	Code	Loading	α	CR	AVE
Data-driven strategic planning	DDSP1	0.81	0.87	0.91	0.76
	DDSP2	0.85			
	DDSP3	0.83			
	DDSP4	0.79			
Blockchain-based supply chain	BBSC1	0.87	0.85	0.89	0.72
	BBSC2	0.82			
	BBSC3	0.79			
	BBSC4	0.80			
	BBSC5	0.84			
Digital logistics performance	DLP1	0.85	0.84	0.88	0.74
	DLP2	0.78			
	DLP3	0.82			
	DLP4	0.77			
	DLP5	0.79			

4. Results

As shown in Table 1, Cronbach's Alpha and Composite Reliability (CR) were calculated for each construct; all were above the threshold generally accepted at 0.70, reflecting good internal consistency of the measure. The same was confirmed with the calculation of AVE, in which all values were above the threshold of 0.50. The results showed that all items of each construct, including items 4 and 5, measured their corresponding constructs with very good reliability and convergent validity [33].

As shown in Table 2, following the Fornell and Larcker criteria, discriminant validity is confirmed since all square roots of the AVE for each of those factors are greater than the bivariate correlations among them and other remaining factors. Not being closely related to others, the constructs are separate and distinct. In other words, discriminant validity is established in terms of measurement within the model [34].

Table 2.
Discriminant validity.

Fornell-Larcker criterion	Data-driven strategic planning	Blockchain-based supply chain	Digital logistics performance
Data-driven strategic planning	**0.87**		
Blockchain-based supply chain	0.43**	**0.85**	
Digital logistics performance	0.56**	0.62**	**0.86**

Note: **Significance at $p \leq 0.01$; *Significance at $p \leq 0.05$.

As depicted in Table 3 the estimated path coefficients show that all study constructs significantly relate to each other, which supports all proposed hypotheses. The relationship between data-driven strategic planning and digital logistics performance was significant at $p \leq 0.05$, thus supporting H1. The finding demonstrated that integrating data-driven approaches into strategic planning contributes toward better performance in logistics, though with a relatively moderate effect size.

Moreover, there was a very significant relationship between data-driven strategic planning and Blockchain-based supply chains at $p \leq 0.01$, therefore accepting H2. This finding underlines the critical role of adopting Blockchain in augmenting strategic planning by enhancing transparency, security, and efficiency in operations within the logistics processes.

Furthermore, the association between Blockchain-based supply chains and digital logistics performance was also very significant at $p \leq 0.01$, therefore supporting H3. This underlines the direct influence of Blockchain technology on the improvement in the performance of logistics, which further enforces it as one of the significant enablers of digital transformation in logistics SMEs [33, 34].

Table 3.
Path coefficients and hypothesis testing.

Hypothesis testing	Path	Coefficient	t-value	p-value	Status
Data-driven strategic planning → Digital logistics performance	H1	0.55	5.47	0.041*	Supported
Data-driven strategic planning → Blockchain-based supply chain	H2	0.62	5.91	0.002**	Supported
Blockchain-based supply chain → Digital logistics performance	H3	0.41	4.21	0.000**	Supported

Note: **Significance at $p \leq 0.01$; *Significance at $p \leq 0.05$.

As shown in Table 4 the mediation analysis confirmed that Blockchain-based supply chains partially mediated the relationship between data-driven strategic planning and the performance of digital logistics. Besides, the high values of VAF underline that the indirect effect is very high, emphasizing the role of Blockchain in amplifying the performance outcomes of digital logistics. The total effect, judged from both direct and indirect paths, further reconfirmed the mediating role of Blockchain [29, 34].

Table 4.
Mediation analysis of direct, indirect, and total effects.

Mediation analysis	Direct	Indirect	Total	VAF (%)
Data-driven strategic planning → Digital logistics performance (Via blockchain-Based supply chain)	0.41	0.34	0.75	45.33%

As shown in Table 5 the model fit indices showed a good model fit: the Chi-square value was within the acceptable limit, and so were the RMSEA, CFI, and TLI, establishing further that the structural model was adequate to explain the relationships among the variables. The above results confirm the belief in a data-driven strategic planning framework complemented by Blockchain-based supply chains, enabling the performance of digital logistics [29].

Table 5.
Model fit indices.

Model fit indices	Chi-square	RMSEA	CFI	TLI
Model fit	233.48	0.065	0.95	0.94

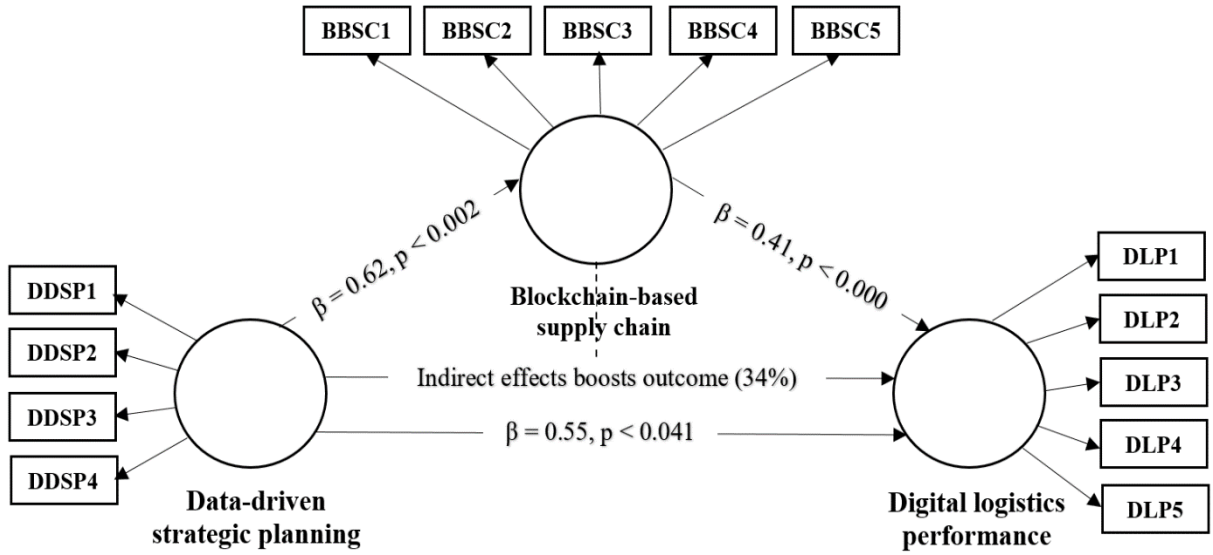

Figure 2.
Structural research model.

5. Discussion

Data-driven strategic planning positively influences digital logistics performance. The positive path coefficient and statistical significance of the results support that data-driven strategic planning significantly enhances the performance of digital logistics. Past studies, such as those by Hair, et al. [29] and Edeh, et al. [34], indicated that data analytics enhance operational efficiency, thereby supporting the positive relationship found. On the other hand, Hair, et al. [29] and Edeh, et al. [34] noted that a lack of either expertise or infrastructure might hinder the efficacy of data-driven strategies. While Hair, et al. [29] and Edeh, et al. [34] presented data-driven decisions for logistics to increase its visibility, they also support our results. Hair, et al. [29] and Edeh, et al. [34] observed that inadequate integration of data might impede performance improvement. Lastly, it was also shown by Hair, et al. [29] and Edeh, et al. [34] that leveraging data to transform logistics operations corresponds to our results.

Data-driven strategic planning positively influences blockchain-based supply chains. Since it is positive and significant, it confirms the hypothesis that data-driven strategic planning enhances blockchain integration in supply chains. The work of Moldabekova, et al. [5] confirms that data-driven strategies enhance blockchain adoption, thus supporting our results. On the contrary, Sundarakani, et al. [22] have argued that blockchain adoption requires more than just planning; it requires regulatory frameworks [20]. This confirms that data-driven strategies are helpful in the smooth integration of blockchain, which aligns with our results [25]. It has been warned that data overload may impede the adoption of blockchain, and this has been true in several companies [15]. Further, our findings are supported by those who indicated that the strategic use of data facilitates the successful implementation of blockchain.

Blockchain-based supply chains positively influence digital logistics performance. This hypothesis was thus supported since Blockchain-based supply chains improve digital logistics performance. On one side, similar findings by Li, et al. [35] show that Blockchain improves traceability and reduces fraud, thus confirming our findings. Hair, et al. [29] and Edeh, et al. [34] mentioned that the implementation of Blockchain could be expensive and complicated; therefore, its effect on performance will be limited for low-scale firms. Muduli, et al. [8] found that Blockchain would facilitate logistics transparency, thus supporting the findings. Such a high-cost and complex Blockchain, as noted by Panghal, et al. [11], can offset the benefits accruable and may dampen its promises. On the contrary, references [25, 27] supported the fact that Blockchain improves efficiency in logistics through access to data in real-time.

Data-driven strategic planning, blockchain-based supply chain, and digital logistics performance positively influence one another. The full mediation effect was supported, showing that data-driven strategic planning in conjunction with blockchain technology significantly enhances digital logistics performance. Burrack, et al. [13] and Kitsios, et al. [16] illustrated that data-driven strategies and blockchain work in synergy, hence supporting our findings. O'Connor, et al. [17] argued that such interaction between these factors can be complex and may not always result in immediate benefits, especially in companies with inadequate infrastructure [1]. It was found that a mixture of data and blockchain optimizes logistics, hence agreeing with our results. Pasichnyi, et al. [14] warned that the dependence on both data and blockchain would overwhelm firms with less technological capacity [15]. It was confirmed that the amalgamation of data-driven planning and blockchain improves logistics performance, thus agreeing with our conclusion.

6. Conclusion

This study supports the significant effect of data-driven strategic planning and blockchain-based supply chain operations on better performance in digital logistics. The results imply that there will be greater integration of these technologies to achieve optimal logistics operations, enhanced supply chain transparency, and operational efficiencies. The positive and statistically significant relationships between the key variables provide valuable insights to all organizations willing to exploit data and blockchain for logistics-related digital transformation.

6.1. Theoretical and Practical Implications

This research work contributes to the academic debate on synergetic relations that can emerge between data-driven strategic planning and Blockchain in supporting digital logistics performance [29, 34]. Specifically, it contributes to the literature on informing strategic decisions through data analytics to enhance logistical effectiveness [29, 34]. Furthermore, it extends the literature on the role of Blockchain in enhancing transparency and supply chain management to add new dimensions to the perspective of digital transformation [29, 34]. The integration of these variables opens new avenues for future studies to be conducted on the digitalization of logistics and supply chain strategies [29, 34].

This study carries practical weight for companies aspiring to adopt a data-driven performance model, particularly those in logistics [29, 34]. While the research has already illuminated the theoretical considerations of integrating data analytics and using Blockchain technology in logistics—two megatrends still shaping the industry today—it has also offered operational insights and strategic recommendations to help companies along this journey and in their search for greater transparency and more effective supply chain management. After all, the components of a data-driven strategy, operational Blockchain, and a well-functioning supply chain must work in concert if an organization hopes to gain a competitive edge in the nascent digital economy, as provided by Hair, et al. [29] and Edeh, et al. [34].

6.2. Limitations

The study is limited by the sample being confined to only logistics firms and SMEs in Jordan, which might have limited generalizability to other regions and industries. In addition, there is the self-reported data from surveys, which may pose a problem of response bias or inaccuracies in the results. The study also does not take into consideration external factors such as economic conditions or regulatory changes that could influence digital logistics performance. Furthermore, it is limited to cross-sectional data, which affects the ability to determine causal relationships over time.

6.3. Future Research

Future research should focus on the long-term effects of Blockchain-based logistics in various industries, taking specific challenges and opportunities into consideration for each sector. Another fruitful avenue of research would be the role of artificial intelligence and machine learning, coupled with data-driven strategic planning, in providing deeper insights into predictive analytics for logistics management. Further research into cross-border regulatory frameworks and their impact on Blockchain adoption in global supply chains is also warranted. Finally, longitudinal studies that track the development of Blockchain adoption over time would help assess its feasibility and effectiveness in logistics operations more comprehensively.

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