# BLOCKCHAIN ADOPTION EFFECT ON SUPPLY CHAIN INTEGRATION, INNOVATION MANAGEMENT, AND PERFORMANCE

Nadia Abdelhamid Abdelmegeed Abdelwahed *, Bahadur Ali Soomro **

* *Corresponding author,* Department of Management, College of Business Administration, King Faisal University, Al-Ahsa, Saudi Arabia
Contact details: College of Business Administration, King Faisal University, P. O. Box 400, Al-Ahsa 31982, Saudi Arabia
** Area Study Centre, Far East and Southeast Asia, University of Sindh, Jamshoro, Pakistan

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## Abstract

Developing supply chain performance (SCP) has been a significant challenge in the present era, specifically in manufacturing firms. Hence, implementing blockchain technology within the firms makes it possible to address these challenges. The present study explores the role of blockchain adoption (BA) towards supply chain innovation capabilities (SCICs), competitive performance (CP), SCP, and supply chain integration (SCI) among the managerial-level employees of manufacturing firms in Egypt. The study is quantitative and followed scholars like Jum'a (2023), Wamba et al. (2020), and Sheel and Nath (2019). The study applied convenience sampling techniques and gathered data through a survey tool. The study utilizes 324 valid cases to infer the outcomes. The path analysis suggests a positive impact of BA on SCICs, SCP, CP, and SCI. Besides, the effect of SCICs and CP on SCP appears positive. On the other hand, the study found a negative effect of SCI on SCP among the managerial-level employees of Egyptian manufacturing firms. The company supports manufacturing and small and medium-sized enterprises (SMEs) in enhancing performance by adopting efficient blockchain technology. Moreover, by adopting blockchain technology, the organization would improve its supply chain practices and generate massive productivity and profit.

**Keywords:** Blockchain Adoption, Supply Chain Performance, Supply Chain Innovation Capabilities, Supply Chain Integration, Competitive Performance, Manufacturing Firms

**Authors' individual contribution:** Conceptualization — N.A.A.A.; Methodology — N.A.A.A. and B.A.S.; Validation — N.A.A.A.; Formal Analysis — B.A.S.; Investigation — B.A.S.; Resources — N.A.A.A.; Data Curation — N.A.A.A. and B.A.S.; Writing — N.A.A.A.; Visualization — N.A.A.A. and B.A.S.; Supervision — N.A.A.A.; Project Administration — N.A.A.A.; Funding Acquisition — N.A.A.A.

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## 1. INTRODUCTION

In the present era, blockchain technology is a requirement of every company to enhance their productivity and profit (Hasan et al., 2020). In this way, the different companies hugely invest their resources in blockchain adoption (BA) to reinforce their supply chain practices and channels (Wamba et al., 2020). The BA is a robust and valuable analyst that substantially enhances supply chain performance (SCP), supply chain innovation capabilities (SCICs), competitive performance (CP), and supply chain integration (SCI). With regard to SCP, the BA improves it by developing a strong chain of business and making it easy to deliver products and goods (Jum'a, 2023). Likewise, it helps in developing capabilities and competencies among the firms' employees, thus enhancing the performance and SCP in the organizations (Paul et al., 2021). BA has also great prominence in bringing competition to the organizations' performance, which ultimately enhances and improves the supply chain practices (Li et al., 2021). In organizations, the use of blockchain technology reinforces the organizations in different ways, i.e., it brings efficiency in the organizational processes, develops trust among the customers, data integrity, competition, and security, and makes innovation in the digital economy (Prendi et al., 2023; Akpan & Ukwu, 2023; Chutipat et al., 2023). Moreover, numerous scholars like Paul et al. (2021), Vishwakarma et al. (2023), Sheel and Nath (2019), Gonserkewitz et al. (2022), Tan et al. (2023), Surucu-Balci et al. (2024), Hu et al. (2024), and Mubarik et al. (2020) claimed the massive significance and positive contribution of BA in developing SCP, SCI, CP, and SCICs, etc.

In the domain literature, several factors such as adaptability, SCP agility, sustainability, SCI, BA, traceability, SCICs, customer satisfaction, trust, CP, transparency and market dynamics are found to be the significant predictors of SCP in diverse organizations (Wamba et al., 2020; Surucu-Balci et al., 2024; Hartley et al., 2022; Jum'a, 2023; Mubarik et al., 2020; Khalil et al., 2022; Vishwakarma et al., 2023; Hald & Kinra, 2019; Kamble et al., 2023). However, the investigation BA towards SCICs, CP, SCP, and SCI still needs confirmation in an integrated way. Moreover, contextually, the manufacturing firms of Egypt needs dire need to investigate the role of BA in the supply chain context as these have played a meaningful contribution to the economy of Egypt through enhancing gross domestic product (GDP), employment creation, and export promotion (Salaheldin & Eid, 2007; Abdel-Maksoud, 2011). Furthermore, management staff within these manufacturing firms is eager to make their organization mode successful by improving the supply chain and rational decision-making (Khalaf & El Mokadem, 2019). Thus, the researchers raised the research question:

*RQ1: How does blockchain adoption enhance Egyptian manufacturing firms' supply chain innovation capabilities, competitive performance, supply chain performance, and supply chain integration?*

The study aims to examine BA's impacts on SCI, innovation capabilities, and performance among employees of manufacturing firms in Egypt. The study findings would support organizations in enhancing their performance (especially SCP) and profit through employing the BA. The policymakers and planners of manufacturing firms or small and medium-sized enterprises (SMEs) will promote the culture and modes of technology towards blockchain to improve their supply chain practices. The study would further encourage firms' authorities to provide their employees with basic training regarding blockchain technology to enhance the technological skills of their employees.

The research is structured as follows. Section 2 reviews the relevant literature and develops the hypotheses. Section 3 analyses the methodology used to conduct empirical research on the effects of BA on SCI, innovation capabilities, and performance among employees of manufacturing firms in Egypt. Section 4 shows the results conducted in the study. Section 5 discusses the findings in light of previous studies and also offers the reasons for the existence of relationships in the present study. Finally, Section 6 concludes the study.

## 2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

### 2.1. Blockchain adoption

The BA is a valuable strategic approach involving the investment of resources in blockchain-enabled supply chain applications within a company (Wamba & Guthrie, 2020). It helps in business activities and identifying functional areas that enhance the organization's success (Wamba et al., 2020). The BA is regarded as a competitive guideline and strategy that imitates a commitment to develop blockchain's capabilities to enhance transparency, traceability, and efficiency across different facets of the organization (Sheel & Nath, 2019). BA fulfills the company's basic requirements in terms of financial investments, the allocation of personnel, and the infrastructure to develop and integrate blockchain solutions (Shojaei et al., 2020). By adopting blockchain technology, organizations can improve efficient processes, data integrity, enhanced security, and customer trust, which bring competition and innovation in the digital economy. In the literature, the BA has a significant contribution to enhancing SCICs, CP, SCI, and SCP, etc. (Sheel & Nath, 2019; Mubarik et al., 2020; Paul et al., 2021; Vishwakarma et al., 2023; Tan et al., 2023; Surucu-Balci et al., 2024; Hu et al., 2024).

### 2.2. Supply chain innovation capabilities

The SCICs bring up a company's capacity to increase its performance. These activities comprised, i.e., strategic partnerships, supplier selection with suppliers for continuing innovation, learning new technologies, adapting supply chain processes based on customer demand, and integrating information technology (IT)/information systems (IS) systems to support innovative operations (Fernando et al., 2018). SCICs are regarded as the crucial enabler of performance and SCP. According to Bhatti et al. (2024), data-driven innovation with big data analytics capabilities can reinforce massive innovation and performance. It drives the supply chain networks and helps to improve innovation performance (Wang & Hu, 2020). In manufacturing firms, it also plays a massive contribution to the development of SCP

(Adebanjo et al., 2018). Cheng et al. (2014) confirm the substantial effect of vibrant capabilities in developing innovative performance in supply chains.

### 2.3. Competitive performance

The CP in the context of blockchain can be defined as the capability of a firm to improve its productivity, elevate customer service levels, and reinforce the connection with supply chain partners compared to competitors (Wamba & Guthrie, 2020). It includes the inclusive effectiveness and efficiency with which the firm uses blockchain technology to increase advantages in these critical areas, thus putting itself ahead in the market and improving its competitive advantage (Kant, 2021). CP and competitive supply chain strategies mitigate reservations and enhance firm performance (Duran & Akci, 2015). Karimi and Rafiee (2014) establish that effective supply chain management practices can be enhanced through CP.

### 2.4. Supply chain integration

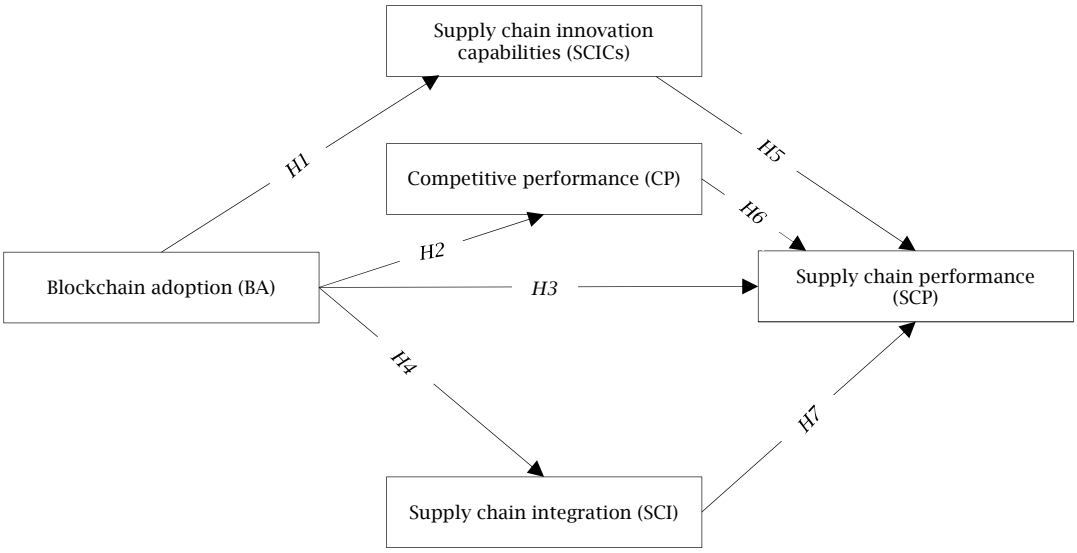
The SCI utilizing blockchain technology is a strategic approach that develops and optimizes several components of a supply chain network. Internally, this integration includes massive blockchain to generate a more cohesive and efficient supply chain function within an organization (Han et al., 2017). Blockchain enables unified data sharing, automation of processes, and better communication among diverse departments, i.e., procurement, production, logistics, and distribution (Lotfi et al., 2013). Besides, blockchain improves interdepartmental integration by breaking down storage towers and allowing better collaboration and decision-making throughout the organization (Tapus & Manolache, 2019). Blockchain delivers a secure and transparent platform for handling contracts, sharing information, tracking transactions, and confirming compliance throughout the supply chain ecosystem (Ahmed et al., 2022). Customer integration is improved through blockchain technology by contributing customers' admittance to real-time information about product origins, quality standards, sustainability practices, and delivery status (Han et al., 2017).

### 2.5. Supply chain performance

The SCP points to a supply chain system's overall efficacy and effectiveness in attaining its objectives and fulfilling customer demands (Wamba & Guthrie, 2020; Wamba et al., 2020). The SCP reduces transaction costs, improves service provision to customers, improves the speed of operations, and enhances value creation through the adoption and integration of blockchain technology (Fernando et al., 2018). The SCP is predicted through various factors such as SCI, BA, SCICs, SCI, innovations, etc. (Queiroz et al., 2020; Mubarik et al., 2020; Khan et al., 2024).

As a result, the literature demonstrates the substantial linkages between BA, traceability, SCICs, transparency, trust, CP, adaptability, SCP agility, market dynamics, sustainability, SCI and customer satisfaction etc. (Hartley et al., 2022; Jum'a, 2023; Kamble et al., 2023; Surucu-Balci et al., 2024; Mubarik et al., 2020; Hu et al., 2024; Sheel & Nath, 2019; Vishwakarma et al., 2023; Hald & Kinra, 2019). However, the domain literature still lacks the gaps that need filling. More specifically, the literature requires an integrated model integrating constructs such as BA, SCICs, CP, and SCI to investigate SCP. Besides, the effects of SCICs, CP, and SCI have not been studied regarding SCP in the presence of BA as the primary predictor. Contextually, this type of investigation is still lacking in the domain literature, which may concentrate on the managerial level employees of Egyptian manufacturing firms. Based on these existing knowledge and contextual gaps, we formulated a model for the confirmation among the managerial level Egyptian manufacturing firms (see Figure 1).

**Figure 1.** Conceptual framework of the study




*Source: Authors' elaboration.*

### 2.6. Blockchain adoption, supply chain innovation capabilities, competitive performance, supply chain performance, and supply chain integration

The BA has great prominence in developing SCICs in the various studies with diverse regions (Sheel & Nath, 2019; Iranmanesh et al., 2023; Jum'a, 2023; Wamba et al., 2020; Surucu-Balci et al., 2024). The literature suggests that blockchain technology enhances supply chain transparency, traceability, and trust, leading to improved adaptability and agility in responding to market dynamics (Sheel & Nath, 2019; Iranmanesh et al., 2023). Blockchain boosts integration and alliance among supply chain actors, resulting in smoother operations, abridged lead times, and greater coordination (Kamble et al., 2023; Surucu-Balci et al., 2024). The empirical evidence from several industries, such as maritime sectors, automotive, and manufacturing, emphasizes the massive and robust contribution of BA in developing SCP, i.e., efficiency, cost savings, customer satisfaction, and sustainability outcomes (Kamble et al., 2023; Jum'a, 2023; Wamba et al., 2020). Nevertheless, challenges, i.e., regulatory concerns, technological complexities, and interoperability issues, can be significantly enhanced by upgrading and boosting blockchain in supply chain management (Hartley et al., 2022; Surucu-Balci et al., 2024).

BA and CP are closely associated (Wamba & Guthrie, 2020). According to Khalil et al. (2022), the CP is positively enhanced by BA. Scholars like Paul et al. (2021) and Wong, Leong, et al. (2020) conducted studies in the supply chain domain and claim that blockchain technology positively improves CP with the support of transparency, traceability, and efficiency. Hu et al. (2024) propose that BA has a massive role in leading to significant benefits and resilience within organizations.

Likewise, the BA plays a protagonist in the development of SCP. The research of Wamba et al. (2020) establishes that the elements of BA significantly impact SCP or positively enhance SCP. BA positively affects supply chain agility, adaptability, alignment, and overall performance, providing evidence of blockchain technology's transformative potential in augmenting various supply chain management features (Sheel & Nath, 2019). An empirical assessment by Vishwakarma et al. (2023) exerts that blockchain-enabled healthcare supply chains can expand sustainability and performance. Nevertheless, Hald and Kinra (2019) restraint that blockchain enables better data security, transparency, and collaboration, but it also poses challenges connected to scalability and regulatory constraints.

BA also has a significant influence on SCI. In the automotive industry, blockchain technology positively affects SCI and sustainable performance (Kamble et al., 2023). In the views of Queiroz et al. (2020), blockchain integration improves supply chain processes across various sectors and has a massive potential to streamline operations and promote integration. In the assessment of Tan et al. (2023), BA positively enhances visibility and performance, and SCI analyses overall performance better, specifically in the era of digital transformation. Likewise, in the manufacturing sector, blockchain nurtures SCI (Mubarik et al., 2020). Similarly, Khan et al. (2024) provide empirical evidence of blockchain's potential impact on integration, agility, and collaboration within supply chains, predominantly in regions like Oman and Pakistan.

Consequently, the above literature demonstrates the positive contribution of BA in developing SCICs, CP, SCP, and SCI mostly in separate models. However, the domain literature still needs to integrate BA, SCICs, CP, SCP, and SCI aspects. Moreover, more evidence of empirical phenomena is needed in the Egyptian manufacturing context, specifically among managerial-level employees. Hence, based on existing connections in the literature and the need to conduct a study among managerial-level employees' of Egyptian manufacturing firms, we expect:

*H1: Blockchain adoption positively predicts supply chain innovation capabilities in Egyptian manufacturing firms.*

*H2: Blockchain adoption positively predicts competitive performance in Egyptian manufacturing firms.*

*H3: Blockchain adoption positively predicts supply chain performance in Egyptian manufacturing firms.*

*H4: Blockchain adoption positively predicts supply chain integration in Egyptian manufacturing firms.*

### 2.7. Supply chain innovation capabilities and supply chain performance

The SCICs are the critical predictors of SCP. Within the supply chain networks, SCICs positively predict innovative performance (Wang & Hu, 2020). Adebanjo et al. (2018) show that supply chain and integration contribute significantly to improved, innovative capabilities and manufacturing performance. Supply chain strategy moderates the connection between SCICs and business performance (Zimmermann et al., 2020). Cheng et al. (2014) proposed a positive contribution of relational governance along with capabilities that substantially predict innovative performance in supply chains. The SCP is enhanced through supply chain innovation and innovation-driven improvements (Wong & Ngai, 2022). Bhatti et al. (2024) investigate and claim the association of data-driven innovation with big data analytics capabilities. In the COVID-19 era, the impact of SCI, responsiveness, and innovation capability on operational performance is positively significant (Siagian & Johono, 2022). According to the empirical insights of Belhadi et al. (2024), there is excellent potential for artificial intelligence-driven innovation to increase supply chain resilience and SCP.

As a result, the literature confirms the positive role of SCICs in predicting SCP in several contexts. However, these confirmations still need to be improved in an Egyptian context, specifically in manufacturing firms. Thus, we suggest:

*H5: Supply chain innovation capabilities positively predict supply chain performance in Egyptian manufacturing firms.*

### 2.8. Competitive performance and supply chain performance

Several scholars have evidence of the relationship between CP and SCP. For example, Hadrawi (2019) confirms the predictive power of CP in achieving CSP. Supply logistics integration, supply performance, and learning processes are essential in enhancing CP within supply chain processes (Prajogo et al., 2016).

In the research of Huo et al. (2014), the competitive environment positively predicts supply chain information sharing and performance in China. Jin et al. (2014) claim the association of capability with CP. Several studies demonstrate a positive impact of CP and blockchain action competencies on CP, which ensures a meaningful and substantial role of CP in developing SCP (Li et al., 2021; Hadrawi, 2019; Prajogo et al., 2016; Huo et al., 2014; Jin et al., 2014). In addition, Duran and Akci (2015) underline the importance of aligning competitive strategies and supply chain strategies to mitigate uncertainties and improve firm performance under environmental uncertainties. Similarly, Salehzadeh et al. (2020) claim the effect of different forecasting methods on firms' CP within supply chains. In a case study by Karimi and Rafiee (2014), effective supply chain management practices aligned with competitive priorities can positively influence organizational performance.

Consequently, the above literature offers positive links between SCI and SCP in various contexts, except for the conduct of study among Egyptian manufacturing firms. Hence, we suggest:

*H6: Competitive performance positively predicts supply chain performance in Egyptian manufacturing firms.*

### 2.9. Supply chain integration and supply chain performance

The SCI construct is a robust indicator of SCP. Factors such as supply chain partnership, collaboration, and integration are pivotal factors that positively influence SCP (Mofokeng & Chinomona, 2019). Sundram et al. (2020) contribute by highlighting the significant impact of IT and information sharing on SCI, SCP, and firm performance. Supporting the same associations, Fabbe-Costes and Jahre's (2008) review consolidates evidence supporting the positive correlation between SCI efforts and SCP improvements. Kim (2013) recognizes the role of SCI and confirms it as a positive enabler of SCP. Providing the mechanism through which SCI enhances information sharing and contributes to improving SCP (Koçoğlu et al., 2011). A meta-analysis of Ataseven and Nair (2017) shows a positive association between SCI and SCP.

As a result, SCI predicts SCP, and SCP predicts SCI. However, in the Egyptian manufacturing context, we expect to confirm the effect of SCI on SCP. Therefore:

*H7: Supply chain integration positively predicts supply chain performance in Egyptian manufacturing firms.*

## 3. RESEARCH METHODOLOGY

### 3.1. Approach and respondents of the study

The researchers applied quantitative methods with a deductive approach to finish the study. Quantitative assessment is the best tool for getting facts from society with the support of numbers and figures (Zhou et al., 2022). It helps researchers protect huge expenses and reduces the time and resources of researchers (Conradie et al., 2018). Due to a famous technique of social, management and business, several researchers of the domain like Wamba et al. (2020), Surucu-Balci et al. (2024), Mubarik et al. (2020), Khalil et al. (2022) and Hu et al. (2024) adopted the same strategy to conduct their studies in the domains of BA, SCP, SCI, etc. The study context is Egyptian manufacturing firms, where the researchers targeted managerial-level employees as the respondents. The Egyptian manufacturing firms have significantly contributed to the country's economic development and global competitiveness (Salaheldin & Eid, 2007). The manufacturing firms of Egypt positively and significantly enhance Egypt's GDP, export diversification, job creation, and technology transfer (Abdel-Maksoud, 2011). The selection of managers within these manufacturing firms is essential for observing and understanding strategic decision-making processes (Khalaf & El Mokadem, 2019). Egyptian manufacturing firms' managers are accountable for circumnavigating operational challenges, enhancing performance, and executing effective managerial practices (Fouad, 2013). Furthermore, managers' experiences deliver valuable knowledge for policy development, knowledge sharing, and performance enhancement policies within the manufacturing sector (Salaheldin & Eid, 2007; Abdel-Maksoud, 2011; Khalaf & El Mokadem, 2019; Fouad, 2013). Thus, empirical indulgence is indispensable for efficiency, innovation, and sustainable growth in Egypt's manufacturing industry.

### 3.2. Common method bias

The researchers ensured common method bias (CMB) through the variance inflation factor (VIF), as a crucial factor for measuring the occurrence of CMB recommended by renowned scholars like Kock and Lynn (2012) and Kock (2015). This strategy is valuable in observing any bias curtailing from using a single-source data assortment technique through a survey or tool. In the present study, the researchers found the value VIF below 3.3, which shows no presence of CMB (see Table 1).

**Table 1.** Analysis of full collinearity

| *Construct* | *VIF* |
|---|---|
| Blockchain adoption (*BA*) | 2.837 |
| Supply chain innovation capabilities (*SCICs*) | 1.783 |
| Supply chain performance (*SCP*) | 2.398 |
| Competitive performance (*CP*) | 2.183 |
| Supply chain integration (*SCI*) | 1.992 |

*Source: Authors' elaboration.*

### 3.3. Data collection methods

The researchers applied a survey tool to gather the cross-sectional data. The survey tool is administered in English. The researchers used both methods of data collection, i.e., online and offline. Non-probability sampling and convenience sampling were adopted to trace the respondents. This technique is more feasible and determines population characteristics in a very smooth way (Malhotra, 2010). We followed the ethical protocols of the participants and warranted their privacy and discretion regarding the data usage. We conveyed to them the aim and objectives of the study and requested their responses voluntarily. After that, we signed a consent form from them and moved for further data collection. Consequently, the researchers gathered 324 valid cases and used them to infer the results.

### 3.4. Measures

The researchers gauged all the scale items from the literature, where four items were applied to assess SCP taken from the investigation of Sheel and Nath (2019). The sample content of the item of SCP is :"*Transaction cost of supply chain operations will be reduced by using blockchain*". Similarly, the BA construct is assessed on three items by Wamba and Guthrie (2020) and Wamba et al. (2020), with a sample content item: "*My company invests resources in blockchain-enabled supply chain applications*". We borrowed six items from Fernando et al. (2018) to assess the SCICs, with a sample content: "*Our firm has embedded continuous innovation in our cross-functional teams which involve supply chain activities*". Besides, we evaluated the SCI construct with for items. These items are borrowed from several scholars like Sheel and Nath (2019), Lotfi et al. (2013), and Han et al. (2017). The sample content of the item for SCI is: "*Supply chain integration among the departments will be improved using blockchain*". In the last, we measured the CP factor with four items adopted by Wamba and Guthrie (2020), with a sample item as: "*After the implementation of blockchain, your firm can improve its ability to achieve higher productivity*". The researchers measured all these items on a five-point Likert, allotting options from strongly agree to strongly disagree.

## 4. RESEARCH RESULTS

### 4.1. Measurement model

We measured the model to confirm the reliability of the item and construct level. Hair et al. (2019) recommend that the measurement model should examine factor loadings, composite reliability (CR), and an average extracted variance (AVE). Regarding factor loadings, the loading values appeared to be greater than 0.70, which is acceptable. However, items such as *SCICs4* and *CP3* were detected to have values of less than 0.70 and were hence removed. Besides, the value of CR is also noted to be above 0.70 for all the constructs along the values of AVE, which is greater than 0.50. These values suggest the acceptable CR (> 0.70) and AVE (> 0.50) (Kline, 2010; Hair et al., 2019). Moreover, internal consistency among the items is ensured through Cronbach alpha, which is found to have fair scores (> 0.70) (Hair et al., 2019) (Table 2). In addition, to measure the degree of the constructs' difference from pragmatic standards, we ensured the discriminant validity (DV) by applying the Fornell and Larcker (1981) test as suggested (Hair et al., 2014). As presented in Table 3, the correlation coefficient among the primary constructs appears to be 0.109–0.576, which is lower than the square root of AVE, which appeared to be from 0.647–0.783.

**Table 2.** Measurement model

| *Construct* | *Code* | *Loadings* | *CR* | *AVE* | *Alpha (α)* |
|---|---|---|---|---|---|
| Blochchian adoption (*BA*) | *BA1* | 0.847 | 0.875 | 0.700 | 0.839 |
| | *BA2* | 0.833 | | | |
| | *BA3* | 0.829 | | | |
| Supply chain innovation capabilities (*SCICs*) | *SCICs1* | 0.890 | 0.935 | 0.743 | 0.868 |
| | *SCICs2* | 0.882 | | | |
| | *SCICs3* | 0.873 | | | |
| | *SCICs5* | 0.863 | | | |
| | *SCICs6* | 0.798 | | | |
| Competitive performance (*CP*) | *CP1* | 0.874 | 0.895 | 0.740 | 0.847 |
| | *CP2* | 0.863 | | | |
| | *CP4* | 0.844 | | | |
| Supply chain integration (*SCI*) | *SCI1* | 0.855 | 0.892 | 0.673 | 0.872 |
| | *SCI2* | 0.836 | | | |
| | *SCI3* | 0.806 | | | |
| | *SCI4* | 0.783 | | | |
| Supply chain performance (*SCP*) | *SCP1* | 0.863 | 0.906 | 0.706 | 0.793 |
| | *SCP2* | 0.846 | | | |
| | *SCP3* | 0.833 | | | |
| | *SCP4* | 0.818 | | | |

*Notes: Deleted items = SCICs4 and CP3.*
*Source: Authors' elaboration.*

**Table 3.** Discriminant validity

| *Construct* | *BA* | *SCICs* | *CP* | *SCI* | *SCP* |
|---|---|---|---|---|---|
| ***BA*** | 0.783 | | | | |
| ***SCICs*** | 0.481 | 0.756 | | | |
| ***CP*** | 0.576 | 0.429 | 0.647 | | |
| ***SCI*** | 0.396 | 0.386 | 0.150 | 0.669 | |
| ***SCP*** | 0.410 | 0.233 | 0.149 | 0.109 | 0.746 |

*Source: Authors' elaboration.*

### 4.2. Structural model

#### *4.2.1. Fitness of the model*

Ensuring model fitness with data is necessary before moving to assess the hypotheses (Byrne, 2001; Hair et al., 2020). In this way, at the initial stage, the researchers noticed CMIN = $x^2$/chi-square to assess the statistical power of the test through insignificant statistics, which confirmed the initial fitness of the model with available data (CMIN = 3.311 or < 5.0). Likewise, the rest of the model fit indicators, i.e., comparative fit index (CFI = 0.922), goodness-of-fit index (GFI = 0.948), adjusted goodness-of-fit index (AGFI = 0.918), normed fit index (NFI = 0.927), and root mean square error of approximation (RMSEA = 0.059), made the researchers ensured the satisfaction of model fitness (Nam et al., 2018) (see Table 4).

**Table 4.** Model fit indices

| *Goodness-of-fit indices* | *Acquired value [level of acceptance]* |
|---|---|
| Chi-square / df | 3.311 [< 5.0] |
| CFI | 0.922 [> 0.90] |
| AGFI | 0.918 [> 0.85] |
| GFI | 0.948 [> 0.90] |
| NFI | 0.927 [> 0.90] |
| RMSEA | 0.059 [< 0.08] |

*Source: Authors' elaboration.*

### *4.2.2. Hypotheses confirmation*

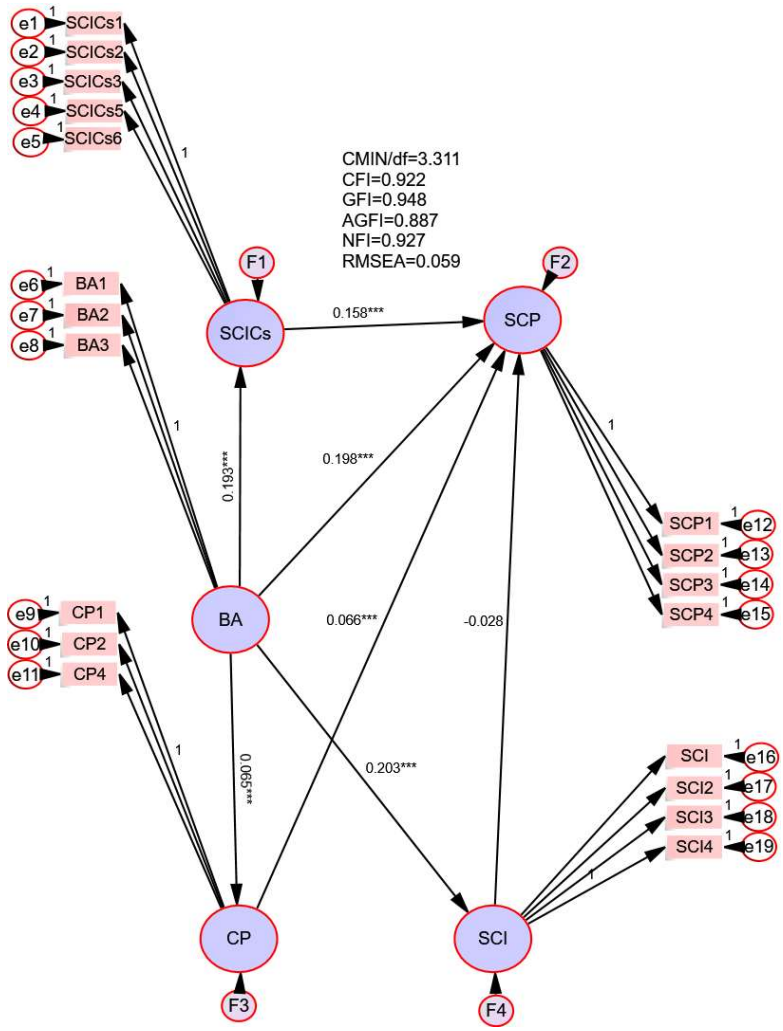
The researchers applied path analysis as the best technique to confirm the expected connections (Hair et al., 2020). As presented in Table 5 and Figure 2, the effect of BA on SCICs is found to be positive ($\beta = 0.193$; $p < 0.01$), which supported the *H1*. The investigation established a positive impact of BA with CP ($\beta = 0.198$; $p < 0.01$), hence *H2* is supported. BA's effect on SCP also appeared to be significant and positive, which supported the *H3* ($\beta = 0.065$; $p < 0.01$). Concerning *H4*, it is supported by showing the positive effect of BA on SCI ($\beta = 0.203$; $p < 0.01$). Moreover, the impact of SCICs and CP is positive on SCP ($\beta = 0.158$; $p < 0.01$), ($\beta = 0.066$; $p < 0.01$). Hence, *H5–H6* is supported. On the other hand, the analysis results appeared to have a negative impact of SCI on SCP, which rejected the *H7* ($\beta = -0.028$; $p > 0.01$).

**Table 5.** Hypotheses testing weights

| *No.* | *Proposed paths* | *Estimate* | *Std. error* | *Critical ratio* | *p-value* | *Decision* |
|---|---|---|---|---|---|---|
| *H1* | *BA → SCICs* | 0.193 | 0.037 | 5.272 | 0.000 | Accepted |
| *H2* | *BA → CP* | 0.198 | 0.044 | 4.531 | 0.000 | Accepted |
| *H3* | *BA → SCP* | 0.065 | 0.019 | 3.492 | 0.000 | Accepted |
| *H4* | *BA → SCI* | 0.203 | 0.045 | 4.566 | 0.000 | Accepted |
| *H5* | *SCICs → SCP* | 0.158 | 0.041 | 3.866 | 0.000 | Accepted |
| *H6* | *CP → SCP* | 0.066 | 0.020 | 3.388 | 0.001 | Accepted |
| *H7* | *SCI → SCP* | -0.028 | 0.028 | 1.010 | 0.313 | Rejected |

*Note: *** p < 0.05.*
*Source: Authors' elaboration.*

**Figure 2.** Path analysis




*Note: *** p <0.05.*
*Source: Authors' elaboration.*

## 5. DISCUSSION

In the present study, the effect of BA on SCI, SCICIs, and SCP in Egypt's manufacturing firms was investigated. The study employed path analysis to examine the relationships. The results of the study suggest a positive influence of BA on SCICs. These consequences are consistent with earlier studies like Sheel and Nath (2019), Iranmanesh et al. (2023), Kamble et al. (2023), Wamba et al. (2020), and Surucu-Balci et al. (2024) who claimed the positive effect of BA on SCICs. These results reflect that Egypt's manufacturing firms are making continuous innovations, where their team is deeply involved in supply chain activities. The innovation system through BA enables the firms to find suitable suppliers. They adopt and develop longstanding strategic cooperation with suppliers to follow incessant innovation in the supply chain practice, specifically logistics, buying and return management, etc. The firm's management staff can learn about the latest technology and move toward innovative technology. Besides, they can reconfigure their supply chain innovation consistent with customer needs.

The study exerts a positive impact of BA on CP, which is conferred with domain literature (Wamba & Guthrie, 2020; Khalil et al., 2022; Paul et al., 2021; Wong, Tan, et al., 2020). These results suggest that manufacturing firms have improved their ability, capacity, and productivity after the implementation of blockchain technology within the firms. It took a very short time to achieve this milestone. They positively and massively developed their customers' trust and satisfaction with the firms' services. Finally, these firms also attained the capability of creating their relationships with other supply chain associates after the implementation of blockchain technology in the firms.

Moreover, the results confirmed BA's positive effect on SCP and SCI. These effects are also in line with several scholars like Wamba et al. (2020), Sheel and Nath (2019), Vishwakarma et al. (2023), Tan et al. (2023), Mubarik et al. (2020) and Khan et al. (2024), who confirmed the same outcomes earlier. These results demonstrate that the transaction cost of supply chain processes is eliminated by using blockchain. Using blockchain, the level of service, speed of supply chain operations, and value creation can be improved. The respondents suggested that the supply chain function is more integrated among several departments, which positively improved through blockchain. This system's integration helps develop more integration or relationships with other stakeholders, suppliers, and customers.

Moreover, the analysis confirmed a significant positive contribution of SCICs and CPs in developing the SCP. These results are in line with various scholars who demonstrated the same results (Zimmermann et al., 2020; Cheng et al., 2014; Wong & Ngai, 2022; Bhatti et al., 2024; Hadrawi, 2019; Prajogo et al., 2016; Huo et al., 2014). These results suggest that SCP is improved by developing the firms' innovative capabilities. Continuing creative activities helps firms achieve innovation targets and enhance supply chain activities. The SCICs also support fulfilling the demands of customers.

Moreover, the implementation of blockchain technology improves supply chain activities and helps in developing relationships with customers. On the other hand, the results demonstrated that SCI has no contribution to attaining SCP, which is in contradiction with several studies like Kim (2013), Koçoğlu et al. (2011), and Ataseven and Nair (2017), who suggested the positive role in developing SCP. These results indicate that integrating blockchain technology did not improve the SCP. The integration of the industry in firms did not provide enough support to improve SCP. Finally, it also does not provide any assistance in the development of connections with customers.

## 6. CONCLUSION

The study's inclusive findings suggest a positive influence of BA on SCICs, CP, SCP, and SCI. Moreover, the impact of SCICs and CP on SCP is also positive. On the other hand, SCI is a negative predictor of SCP among the managerial-level employees of manufacturing firms in Egypt. The study offers potential practical and theoretical implications in light of these findings.

The study's findings support the enhancement of SCP in firms by developing an effective BA. These initiatives would reduce transaction costs and enhance the swiftness of supply chain actions and value creation by adopting blockchain technology. The findings provide guidelines for companies to invest their resources in blockchain technology, which enhances business activities and smoothly generates productivity and profit. This will also support organizations in continuing their innovation and ability to produce good productivity, develop strategic partnerships, and fulfill customer demands. The study would help improve CP and the firms' productivity by developing their ability through BA. Egyptian manufacturing firms may benefit from blockchain technology to enhance their innovative capabilities, competitive positioning, and overall supply chain competence.

With regard to the theoretical implications of the study, the study provides valuable insights into developing a robust framework that integrates diverse constructs such as BA, SCI, SCICs, SCP, and CP. The study provides empirical insights from the manufacturing firms of Egypt. This would further encourage the domain researchers to survey diverse sectors and regions. Moreover, outcomes of the study would contribute to accepting the contribution of unsettling technologies in driving organizational innovation and competitiveness, accentuating the need for a stable approach that integrates technology adoption with strategic management practices for optimal supply chain consequences.

The study has several limitations as it was finished in a developing context. It is limited to quantitative methods, where cross-sectional data were collected. The study used only a single source of data collection (i.e., a questionnaire). The respondents were only managerial-level employees. The study is restricted as it did not use any relevant theory to support the conceptual framework of the study. Lastly, the conclusions of the study are based on only 324 samples.

In light of limitations, future investigations must use alternative methods, such as mixed methods, qualitative, and longitudinal studies, to validate the results. These investigations will provide

a more comprehensive insight into the impacts of BA on SCP. The domain theories must be applied to underpin the conceptual framework of future studies. Other sectors and organizations with different employees may be focused on conducting future investigations. This will assist in determining the generalizability of our findings. This can reveal sector-specific dynamics and countenance for developing more patronage blockchain implementation strategies. Lastly, the sample size must be more effective to get more suitable outcomes for future studies. The large sample size will enhance the outcomes' robustness as large participants will upsurge the statistical power of the studies, leading to more reliable and widely applicable conclusions.

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