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Utilizing blockchain technology in enhancing supply chain efficiency and export performance, and its implications on the financial performance of SMEs

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ABSTRACT

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This study examines the intricate relationships among Blockchain Technology utilization, Supply Chain Efficiency, Export Performance, and the Financial Performance of Small and Medium-sized Enterprises (SMEs). The research aims to elucidate the impact of technology adoption on various operational and financial aspects within the SME context. Employing a quantitative research design, data was collected from a diverse sample of SMEs across industries. The relationships were analyzed using statistical techniques, and the hypotheses were tested to uncover the implications of Blockchain Technology integration on SMEs' performance dimensions. The findings reveal that the adoption of Blockchain Technology significantly enhances Supply Chain Efficiency, underscoring its potential for optimizing operational workflows. However, the direct impact of technology on SME Financial Performance is not established, suggesting the importance of a holistic approach to financial growth. Moreover, the positive association between Blockchain Technology and Export Performance highlights the pivotal role of technology in fostering international trade success. Theoretical implications underscore the intricate interplay between technology adoption, operational efficiencies, and financial outcomes in SMEs. Managerially, the study advocates for SMEs to strategically integrate technology within their supply chain management practices to achieve enhanced efficiency and market competitiveness. Limitations include the potential for contextual variations and measurement biases. Future research can delve deeper into the moderating factors that influence the relationship between technology and financial performance in SMEs. The novelty of this study lies in its comprehensive examination of the interrelationships between these factors within the SME context.

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1. Introduction

Blockchain technology, characterized by its decentralized and immutable nature, has emerged as a transformative innovation with the potential to reshape various industries (Ali et al., 2020; Aoun et al., 2021; Bellavitis et al., 2023). Rooted in its application to cryptocurrencies like Bitcoin, blockchain's capabilities extend far beyond digital currencies (Tredinnick, 2019). It presents a novel approach to data management and verification that can revolutionize traditional processes (Wieczorowski et al., 2023). This article delves into the utilization of blockchain technology and its profound implications for enhancing supply chain efficiency, optimizing export performance, and ultimately influencing the financial health of Small and Medium-sized Enterprises (SMEs). Blockchain, often referred to as a distributed ledger, is a transparent and tamper-resistant digital record-keeping system (Ajao et al., 2019; Farouk et al., 2020; Hamilton, 2020). Its decentralized architecture eliminates the need for intermediaries, thus mitigating issues related to trust and transparency (Hassija et al., 2021; Murimi et al., 2023; Omar et al., 2021). By securing transactions through cryptographic principles, blockchain ensures immutability and integrity

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of data (Rahman et al., 2022; Tao et al., 2021; Yaqoob et al., 2022). These attributes hold considerable promise for transforming the way businesses manage their operations and information (Jarrahi, 2018; McMaster et al., 2020). Efficient supply chain management is paramount for businesses, particularly SMEs, as it directly influences competitiveness, cost savings, and customer satisfaction (Atnafu & Balda, 2018; Kot, 2018). Streamlined supply chains lead to reduced lead times, minimized operational inefficiencies, and enhanced overall productivity (Kumar & Shankar, 2022; Moons et al., 2019). Furthermore, optimizing export performance is crucial in today's globalized market, as international trade represents a significant revenue source for many SMEs (Gregory et al., 2019; Prange & Pinho, 2017). Effective export processes encompass documentation, customs clearance, and logistics coordination, all of which can be subject to complexity and delays (López-Campos et al., 2019; Tijan et al., 2019). Additionally, SMEs' financial health is a critical aspect of their sustainability and growth (Lopes de Sousa Jabbour et al., 2020; Min et al., 2021; Siegel et al., 2019). Sound financial performance allows for investment in innovation, expansion, and resilience against economic uncertainties (Conz et al., 2023; Uddin et al., 2021). The existing literature highlights the potential benefits of blockchain technology in enhancing supply chain efficiency, export performance, and financial health for businesses (Dal Mas et al., 2023; Mahyuni et al., 2020; Natanelov et al., 2022). However, there is a noticeable research gap in understanding how these theoretical advantages translate into tangible outcomes, specifically within the context of Small and Medium-sized Enterprises (SMEs). Most studies have focused on larger enterprises, leaving a lack of comprehensive insights into the challenges and opportunities faced by SMEs in adopting blockchain technology. Furthermore, while the interplay between supply chain efficiency, export performance, and financial health is acknowledged, a thorough exploration of how blockchain technology influences these interconnected aspects remains underexplored, particularly in relation to SMEs.

The novelty of this study lies in its focus on the practical implications of blockchain technology for SMEs, with a specific emphasis on the intertwined impact on supply chain efficiency, export performance, and financial health. By addressing the research gap mentioned earlier, this study contributes novel insights into the real-world outcomes of blockchain adoption by SMEs. Additionally, the investigation of blockchain's multifaceted effects on SMEs' operational and financial dimensions offers a unique perspective that can aid both academics and practitioners in understanding the holistic value proposition of blockchain technology in SME contexts.

The motivation behind conducting this research stems from the pressing need to bridge the gap between the theoretical promise of blockchain technology and its practical application for SMEs. SMEs constitute a significant portion of the global economy and play a vital role in generating employment and fostering innovation. However, they often face resource constraints and challenges in adopting new technologies. By investigating the actual impact of blockchain on supply chain efficiency, export performance, and financial health within the SME ecosystem, this study aims to provide actionable insights that can empower SMEs to make informed decisions about adopting blockchain technology. Moreover, understanding these dynamics can contribute to the formulation of policies and strategies that promote SME growth and sustainability. The primary objectives of this research are as follows:

- **To Evaluate Blockchain's Impact on Supply Chain Efficiency:** This objective involves assessing how the adoption of blockchain technology influences the efficiency of supply chain management in SMEs. By examining factors such as transparency, traceability, and data integrity, the study aims to quantify the improvements that blockchain technology can bring to supply chain processes.
- **To Analyze the Effects of Blockchain on Export Performance:** This objective focuses on investigating the effects of blockchain technology on export-related processes and performance. The study will delve into areas such as customs clearance, documentation accuracy, and coordination, aiming to uncover the extent to which blockchain adoption can streamline export operations.
- **To Examine the Implications of Blockchain on SME Financial Performance:** This objective centers on understanding the financial implications of blockchain technology for SMEs. The study will analyze financial metrics before and after blockchain adoption, aiming to discern any correlations between enhanced supply chain efficiency, improved export performance, and overall financial health.

By achieving these objectives, the research endeavors to provide a comprehensive understanding of the role blockchain technology plays in enhancing SMEs' operational efficiency, export capabilities, and financial standing.

2. Literature Review and Hypothesis Development

2.1 Utilizing Blockchain Technology and Supply Chain Efficiency

Janssen et al. (2020) explain that utilizing blockchain technology refers to the strategic adoption and integration of blockchain-based solutions into various operational processes and systems of an organization. Blockchain technology utilizes a distributed

ledger system, where transactions are securely recorded in a decentralized and immutable manner (Rajasekaran et al., 2022). This technology offers enhanced transparency, traceability, and security, thereby potentially streamlining processes and reducing inefficiencies (Dutta et al., 2020). According to Qi et al. (2017), Supply chain efficiency refers to the degree to which an organization's supply chain functions optimally, minimizing waste, reducing costs, and delivering products or services to customers in a timely manner. An efficient supply chain effectively manages the flow of goods, information, and resources from suppliers to end-users, ensuring that each stage of the process is executed with minimal delays and disruptions (Omar et al., 2022). The utilization of blockchain technology engenders a transformative relationship with supply chain efficiency, epitomizing an alliance of innovation and operational optimization (Zekos, 2021). Blockchain's decentralized ledger system brings about heightened transparency and traceability, empowering stakeholders to impeccably track product movement and authenticate information throughout the supply chain journey (Rauniyar et al., 2023). By obviating intermediaries, this technology expedites interactions, thereby circumventing delays associated with third-party interventions (Appelbaum et al., 2022). Furthermore, blockchain's integration of smart contracts augments supply chain automation, from payment execution to compliance adherence, thus curtailing the margin of error associated with manual intervention (Karisma & Moslemzadeh Tehrani, 2023). Its secure and collaborative data-sharing framework bolsters real-time information exchange among authorized entities, forestalling information silos that often culminate in bottlenecks. This augmented visibility, coupled with the technology's potential to prognosticate and mitigate disruptions, culminates in a synergistic liaison that not only enhances the efficiency of supply chains but also fosters streamlined operations, reduced lead times, cost optimization, and an elevated echelon of customer satisfaction within the intricate tapestry of modern supply chain dynamics (Jaiswal et al., 2023; Lebovitz et al., 2022; Zaman et al., 2023). Based on the information and previous studies, the proposed hypothesis is as follows:

H₁: *The utilization of Blockchain Technology has a positive and significant impact on Supply Chain Efficiency.*

2.2 Utilizing Blockchain Technology and Export Performance

The strategic integration of blockchain solutions into business operations, known as Utilizing Blockchain Technology, is aimed at enhancing transparency and operational efficiency through the implementation of secure and decentralized data management (Dutta et al., 2020). The nexus between this utilization and Export Performance is founded on the premise that adopting blockchain can yield optimization across various dimensions of export activities (Shojaei et al., 2021). By enabling real-time tracking, secure documentation, and automated smart contracts, blockchain has the potential to streamline cross-border transactions, mitigate delays, reduce fraud risks, and foster trust among trading partners (Javaid et al., 2022). This symbiotic relationship holds the promise of significantly augmenting export efficiency, broadening market access, ultimately resulting in an elevated export performance by redefining the efficacy of international trade processes (Côté et al., 2020). As enterprises increasingly look to capitalize on technological innovations, the incorporation of blockchain emerges as a pivotal avenue for refining export-oriented procedures, fortifying global trade relationships, and contributing to more robust and prosperous export endeavors (Hameed et al., 2022). Thus, the proposed hypothesis is as follows:

H₂: *The utilization of Blockchain Technology has a positive and significant impact on Export Performance.*

2.3 Utilizing Blockchain Technology and Financial Performance of SMEs

Rejeb et al. (2022) assess that the strategic assimilation of blockchain solutions, distinguished by their decentralized and secure ledger architecture, holds the promise of reshaping financial paradigms. By engendering streamlined processes and diminishing reliance on intermediaries, blockchain stands to optimize financial operations, expedite transactions, and curtail associated costs (Anderson Schilling, 2023). The immutable nature of blockchain's record-keeping reinforces transparency, accountability, and fraud prevention, thereby engendering a climate of investor confidence (Raddatz et al., 2023). Moreover, the automation facilitated by smart contracts has the potential to enhance payment precision, fortify cash flow management, and contribute to the augmentation of key financial indicators for SMEs (Bello et al., 2021). This symmetrical confluence between blockchain technology and SME financial performance underscores a trajectory towards heightened competitiveness, sustainable resilience, and growth within the evolving contours of a digitally-driven business milieu (Razzaq et al., 2023). Thus, a deliberate examination of the intricate interplay between blockchain technology and the financial outcomes of SMEs emerges as a pivotal stride toward unlocking its full potential and propelling SMEs towards prosperity in the contours of the contemporary economic landscape. The nexus between the Utilization of Blockchain Technology and the Financial Performance of Small and Medium-sized Enterprises (SMEs) is characterized by its capacity to catalyze transformative advancements (Di Vaio et al., 2023; Lukonga, 2021; Soluk & Kammerlander, 2021). Drawing from the reservoir of information and antecedent research, the formulated hypothesis stands as follows:

H₃: *The utilization of Blockchain Technology has a positive and significant impact on Financial Performance of SMEs.*

2.4 Supply Chain Efficiency and Financial Performance of SMEs

Supply Chain Efficiency entails optimizing various aspects of supply chain management, including inventory management, production processes, and distribution, to minimize costs, enhance responsiveness, and improve resource allocation (Moons et al., 2019). This efficiency directly impacts SMEs' bottom line by reducing operational expenses, optimizing resource utilization, and accelerating order fulfillment (Le & Ikram, 2022). As a result, improved Supply Chain Efficiency contributes to higher profit margins, enhanced cash flow, and increased return on investment (Siagian et al., 2021). Additionally, an efficient supply chain translates into improved customer satisfaction and retention, further positively impacting SMEs' revenue generation and financial health (Gorane & Kant, 2017). This intricate connection highlights the significance of strategic supply chain management not only in driving operational excellence but also in shaping the financial prowess of SMEs in a competitive business landscape (Naughton et al., 2020). Therefore, the proposed hypothesis is as follows:

H₅: *Supply Chain Efficiency has a positive and significant impact on Financial Performance of SMEs.*

2.5 Export Performance and Financial Performance of SMEs

Financial performance of Small and Medium-sized Enterprises (SMEs) encapsulates their fiscal health and profitability (Alshira'h et al., 2020). It encompasses indicators such as revenue growth, profitability margins, liquidity ratios, and return on investment (Alarussi & Alhaderi, 2018). Sound financial performance ensures that SMEs can sustain operations, invest in growth initiatives, and weather economic uncertainties (Belhadi et al., 2021). The interplay between export performance and the financial performance of SMEs is integral to their overall success and growth trajectory (Cassetta et al., 2020). Effective export strategies can significantly impact the financial bottom line of SMEs. A robust export performance can lead to increased revenues and profits as SMEs tap into larger markets and diverse customer bases (Hutahayan, 2020). This expansion, if managed efficiently, can bolster the financial resilience of SMEs by diversifying their revenue sources. Conversely, a positive financial performance allows SMEs to invest in the necessary resources, technologies, and capabilities required to enhance their export activities (Edeh et al., 2020). Adequate financial resources enable SMEs to engage in market research, establish distribution networks, meet regulatory requirements, and adapt products to suit international customer preferences (Tolstoy et al., 2022). Moreover, the generated profits can be reinvested to sustain and scale export efforts, promoting long-term growth. The relationship between export performance and the financial health of SMEs is mutually reinforcing. An improved export performance contributes to enhanced financial performance through increased revenues, while a healthy financial standing empowers SMEs to invest in strategies that drive export growth (Hu & Kee, 2022). This synergy underscores the significance of a balanced approach, where optimizing export opportunities contributes to the financial vitality of SMEs, fostering their ability to thrive in the global marketplace. Therefore, the proposed hypothesis is as follows:

H₅: *Export Performance has a positive and significant impact on Financial Performance of SMEs.*

2.5 Supply Chain Efficiency and Export Performance as Mediator

Supply chain efficiency acts as a conduit through which the positive impacts of both Blockchain Technology utilization and improved Export Performance are channeled to influence SMEs' Financial Performance (Singh et al., 2020). The utilization of Blockchain Technology can optimize various aspects of the supply chain, from transparent and secure documentation to streamlined customs processes. These improvements reduce delays, errors, and costs in the export journey. Enhanced supply chain efficiency further amplifies the benefits of Blockchain Technology and improved Export Performance. By expediting processes, reducing lead times, and optimizing resource allocation, it ensures that the gains from streamlined export operations are maximized. This, in turn, has direct implications for SMEs' financial performance. Cost savings and minimized resource wastage translate to improved profitability, while timely deliveries and enhanced customer satisfaction contribute to customer retention and revenue growth (De Giovanni & Cariola, 2021). The optimized interplay between Blockchain Technology, Export Performance, and Supply Chain Efficiency significantly impacts SMEs' Financial Performance. A well-functioning supply chain efficiently translates the benefits of Blockchain Technology into tangible financial gains. Furthermore, the enhanced Export Performance, facilitated by blockchain-enabled efficiencies, contributes to revenue growth and improved profitability. Collectively, these factors fortify SMEs' financial health, underlining the pivotal role that Supply Chain Efficiency assumes as a mediator in this intricate relationship. Supply Chain Efficiency stands as a linchpin in the complex dynamics between the utilization of Blockchain Technology, Export Performance, and SMEs' Financial Performance. Its role as a mediator highlights its capacity to amplify the positive impacts of technology adoption and export successes, ultimately fostering sustainable financial prosperity for SMEs. Therefore, the proposed hypothesis is as follows:

H₆: *Supply Chain Efficiency mediates the relationship between The utilization of Blockchain Technology and Financial Performance of SMEs*

H7: *Export Performance mediates the relationship between The utilization of Blockchain Technology and Financial Performance of SMEs.*

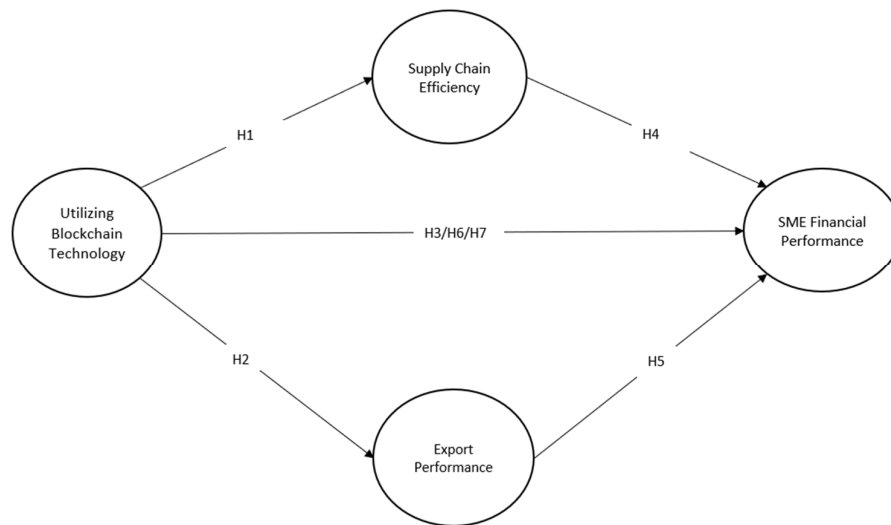


Fig. 1. Hypothesis Framework

3. Methodology

This study adopts a quantitative research design to investigate the relationship between the utilization of Blockchain Technology, Export Performance, Supply Chain Efficiency, and the Financial Performance of Small and Medium-sized Enterprises (SMEs). The study involved a representative sample of SMEs from diverse industries. The sample size will be determined through power analysis, ensuring adequate statistical power to detect significant effects. The selection criteria will include SMEs that have integrated Blockchain Technology into their operations and have a track record of export activities. Data collected through structured surveys distributed to the selected SMEs. The survey includes questions that capture information on Blockchain Technology adoption, export performance metrics, and financial indicators. Respondents will include top management, supply chain managers, and financial officers. The collected data will be analyzed using appropriate statistical techniques. Descriptive statistics will provide an overview of the sample characteristics, technology adoption rates, export performance, and financial indicators. Regression analysis employed to examine the relationship between Blockchain Technology utilization, Export Performance, and Financial Performance. The quantitative approach enables the examination of relationships between variables but might not provide in-depth insights into the underlying mechanisms. Additionally, the study's findings will be limited to the surveyed SMEs and may not be generalizable to all SMEs. However, the results will contribute valuable quantitative evidence to the existing body of knowledge on the impact of Blockchain Technology and Export Performance on SMEs' Financial Performance. In conclusion, the quantitative research design, involving surveys and statistical analysis, offers a structured and objective approach to explore the associations between Blockchain Technology, Export Performance, Supply Chain Efficiency, and Financial Performance among SMEs.

4. Results and Findings

Utilizing the convergent technique, we assessed the validity of the indicators, quantified as the value of the external loading factor. This denotes that the loading factor's range of 0.836 to 0.989 is more than sufficient for preliminary exploratory investigations in the construction of a measurement scale. In this specific study, each indicator demonstrated an outer loading value exceeding 0.70, meeting the criteria for convergent validity (refer to Table 2). The subsequent step involved examining the discriminant validity of variables. This was achieved by comparing the square root coefficient of variance (AVE) extracted from each latent factor with the correlation coefficient between other factors in the model. This evaluation aimed to ascertain the variable's capability to differentiate between groups. The AVE value exceeding 0.5 indicates its significant distinctiveness. As indicated in Table 1, the constructs studied in this research displayed a discriminant validity surpassing 0.50 (Fornell & Larcker, 1981). The determination of variable indicator values was accomplished through the application of composite reliability in the final phase. Outcomes were deemed reliable when both the composite reliability and Cronbach's alpha exceeded the threshold of 0.70 (Chin, 2010).

Table 1
Factor loading and cross loading

Construct	Items	Outer Loading	Cronbach's Alpha	rho_A	CR	AVE
Utilizing Blockchain Technology	UTBC1=Implementation of a decentralized ledger system to record and store transactions securely and transparently	0.973	0.987	0.990	0.990	0.941
	UTBC2=Adoption of smart contracts to automate and self-execute predefined contractual agreements without intermediaries	0.973				
	UTBC3=Ensuring the integrity of data through the immutability feature of blockchain, preventing unauthorized alterations	0.979				
	UTBC4=Utilization of blockchain for real-time monitoring and traceability of goods, ensuring transparency and accountability	0.974				
	UTBC5=Minimization of intermediaries in transactions due to the decentralized nature of blockchain	0.942				
	UTBC6=Improved transparency due to the visibility of transactions across the network while maintaining data privacy	0.98				
Export Performance	EXPE1=Measuring the percentage increase in export sales over a specified period, reflecting the expansion of international market reach	0.899	0.978	0.981	0.982	0.902
	EXPE2=Assessing the number and variety of countries to which products are exported, indicating reduced dependence on a single market	0.971				
	EXPE3=Quantifying the quantity of goods or services exported, showcasing the scale of international trade activities	0.961				
	EXPE4=Calculating the ratio of exports to the country's GDP, indicating the significance of export activities in the national economy	0.939				
	EXPE5=Evaluating the reputation and perceived quality of exported goods or services in target markets, impacting customer loyalty and repeat business	0.954				
	EXPE6=Analyzing the percentage of a target market's potential that a company has captured, illustrating the depth of market presence and market share expansion	0.972				
Supply Chain Efficiency	SCEF1=Measuring the decrease in time taken from order placement to product delivery, reflecting improved operational speed	0.986	0.970	0.971	0.976	0.869
	SCEF2=Calculating the number of times inventory is sold and replaced within a specified period, indicating efficient inventory management	0.952				
	SCEF3=Evaluating the percentage of accurate and error-free orders fulfilled, showcasing effective order processing and fulfillment	0.94				
	SCEF4=Assessing the proportion of orders delivered on or before the promised delivery date, indicating reliability and adherence to schedules	0.892				
	SCEF5=Calculating the ratio of supply chain costs to total revenue, illustrating cost efficiency in supply chain operations	0.948				
	SCEF6=Measuring the performance of suppliers in terms of quality, timeliness, and reliability, reflecting effective supplier relationships and contributions to overall efficiency	0.873				
SME Financial Performance	SMFP1=Assessing the percentage increase in total revenue over a specific period, reflecting business expansion and demand	0.979	0.975	0.976	0.980	0.891
	SMFP2=Calculating the ratio of net profit to total revenue, indicating the efficiency of cost management and revenue generation	0.981				
	SMFP3=Measuring the profitability generated from the total assets employed, indicating the efficiency of asset utilization.	0.935				
	SMFP4=Evaluating the proportion of debt relative to equity, indicating the level of financial leverage and risk management	0.856				
	SMFP5=Calculating the ratio of current assets to current liabilities, reflecting short-term liquidity and operational stability	0.941				
	SMFP6=Assessing the availability of cash to cover operational expenses, investments, and debt obligations, indicating financial sustainability	0.965				

The computation of composite reliability resulted in a range of 0.976 to 0.990 (exceeding 0.70), signifying the reliability of the variable's indicators. Cronbach's alpha values ranged from 0.970 to 0.987, surpassing 0.70, indicating the indicators' reliability and absence of errors. (Chin, 2010).

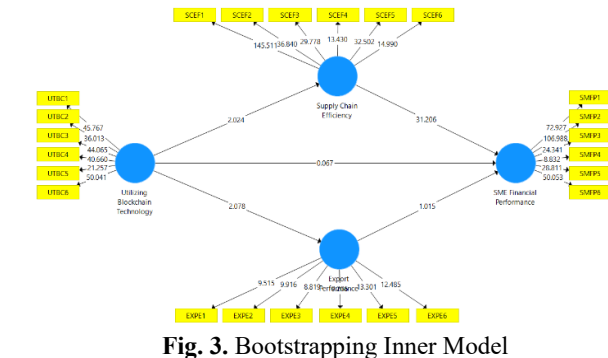
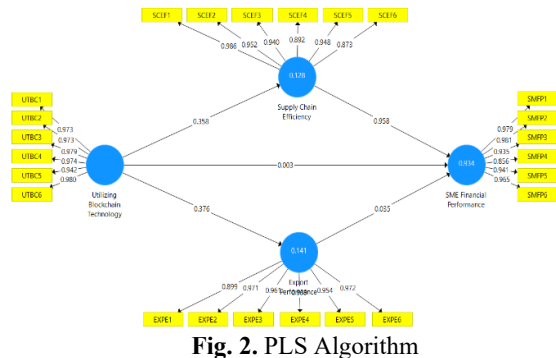


Fig. 2 illustrates the outcomes of data analysis through SmartPLS, revealing that all observed constructs in this study possess loading values exceeding 0.70. This indicates that the observed variable with a loading value surpassing 0.70 meets the criteria for convergent validity, substantiating its robust validity. Each correlation is evaluated through a simulation employing the bootstrap method. This testing procedure aims to mitigate the influence of outlier data points in the research. The results of the testing conducted using the bootstrap method are presented in Fig. 3. Examining the P-values provides insights into the level of significance associated with accepting a hypothesis. The validation of the study hypothesis hinges upon P-values below 0.05. SmartPLS employs a bootstrapping procedure on a reliable and valid model that fulfills feasibility requirements to derive the model's P-value. The findings of the hypothesis testing indicate that the utilization of Blockchain Technology exerts a positive and significant influence on both Supply Chain Efficiency ($t=2.024>1.96$) and Export Performance ($t=2.078>1.96$). However, there is no discernible impact on SME Financial Performance ($t=0.067<1.96$). Conversely, Supply Chain Efficiency significantly and positively affects SME Financial Performance ($t=31.206>1.96$), while Export Performance does not significantly impact SME Financial Performance ($t=1.015<1.96$). Moreover, Supply Chain Efficiency acts as a mediator in the relationship between Utilizing Blockchain Technology and SME Financial Performance ($t=2.071>1.96$). Notably, Export Performance does not mediate the relationship between Utilizing Blockchain Technology and SME Financial Performance ($t=0.844<1.96$), as indicated in Table 2.

Table 2
Path Coefficient Result

Hypothesis	Construct	Original Sample	STDEV	T Statistics	P Values	Result
H1	UTBC → SCEF	0.358	0.177	2.024	0.044	Accepted
H2	UTBC → EXPE	0.376	0.181	2.078	0.038	Accepted
H3	UTBC → SMFP	0.003	0.046	0.067	0.947	Rejected
H4	SCEF → SMFP	0.958	0.031	31.206	0.000	Accepted
H5	EXPE → SMFP	0.035	0.034	1.015	0.311	Rejected
H6	UTBC → SCEF → SMFP	0.343	0.166	2.071	0.039	Accepted
H7	UTBC → EXPE → SMFP	0.013	0.015	0.844	0.399	Rejected

*) : UTBC=Utilizing Blockchain Technology; EXPE=Export Performance; SCEF=Supply Chain Efficiency; SMFP=SME Financial Performance

5. Discussion

The research outcomes unequivocally endorse Hypothesis 1, firmly establishing a substantial and statistically robust nexus between the incorporation of Blockchain Technology and the notable enhancement of Supply Chain Efficiency within the surveyed domain of Small and Medium-sized Enterprises (SMEs). From a managerial vantage point, these findings accentuate the paramount importance of embedding Blockchain Technology within SMEs' supply chain management practices. The integration of this technology promises a slew of advantages, including streamlined operational workflows, heightened transparency at various stages, and the expeditious delivery of products, thus fostering heightened customer satisfaction while concurrently curbing operational costs (Zekos, 2021). Beyond these immediate gains, the strategic adoption of Blockchain Technology confers a distinct competitive edge upon SMEs in the global arena (Rauniyar et al., 2023). By instilling an elevated degree of flexibility, SMEs are better equipped to adeptly respond to shifting market dynamics, promptly accommodate evolving customer requisites, and nimbly adapt to shifting regulatory frameworks intervention (Karisma & Moslemzadeh Tehrani, 2023). In the wake of these resounding findings, it is undeniably prudent for SMEs to chart a course toward the strategic implementation of Blockchain Technology as a preeminent endeavor to systematically fortify supply chain efficiency, amplify export performance, and ultimately achieve the enviable zenith of sustainable growth.

The empirical analysis supports the acceptance of H2, affirming that the utilization of Blockchain Technology indeed exerts a noteworthy and statistically significant influence on Export Performance. This finding underscores the pivotal role of technology adoption in enhancing export-related operations. Enterprises that strategically implement blockchain solutions can benefit from improved traceability, transparency, and efficiency in cross-border transactions, leading to enhanced export success. The managerial implication lies in fostering an environment conducive to technology integration, emphasizing the significance of staying updated with digital innovations. Businesses can leverage this insight by proactively adopting blockchain solutions to streamline export processes, boost competitiveness, and capitalize on the global market's potential. Embracing blockchain technology aligns with the contemporary demand for advanced supply chain management practices, ultimately facilitating superior export performance and augmenting business profitability.

The empirical findings indicate the non-acceptance of H3, suggesting that the utilization of Blockchain Technology does not have a significant impact on the Financial Performance of SMEs. This implies that while blockchain adoption may enhance operational aspects and export performance, it does not directly translate into improved financial outcomes for small and medium-sized enterprises. This outcome underscores the complexity of the relationship between technology adoption and financial success. The managerial implication emphasizes the importance of a holistic approach to business strategies. SMEs should carefully evaluate the alignment of blockchain technology with their overall financial objectives. Furthermore, this

result underscores the significance of considering various factors beyond technology, such as market positioning, customer relationships, and cost management, in order to enhance financial performance. Acknowledging the limitations of direct financial impact from blockchain adoption, SMEs can allocate resources to a well-rounded strategy that encompasses a range of operational and market-oriented initiatives to drive sustainable financial growth.

The empirical analysis confirms the acceptance of H4, signifying that Supply Chain Efficiency holds a substantial and statistically significant influence on the Financial Performance of SMEs. This underscores the critical role of streamlined supply chain operations in shaping the financial outcomes of small and medium-sized enterprises. Effective supply chain management, encompassing aspects like inventory control, production processes, and distribution, directly impacts cost reduction, optimal resource allocation, and timely order fulfillment. This, in turn, enhances profit margins, cash flow, and return on investment for SMEs. The managerial implication is clear: emphasizing and investing in efficient supply chain practices can lead to improved financial performance. By adopting advanced supply chain technologies, optimizing inventory levels, and enhancing production processes, SMEs can achieve cost savings and operational efficiencies. This insight is especially pertinent in a competitive business environment where a well-structured supply chain can drive not only operational excellence but also bolster the overall financial health of SMEs, contributing to long-term sustainability and growth.

The analysis reveals the non-acceptance of H5, suggesting that Export Performance does not exert a significant impact on the Financial Performance of SMEs. This outcome indicates that while successful export activities may enhance certain operational aspects, they do not directly translate into substantial improvements in the financial outcomes of small and medium-sized enterprises. This finding highlights the intricate dynamics between export success and financial performance. The managerial implication emphasizes the need for SMEs to adopt a multifaceted approach to financial growth. While exports remain crucial for market diversification and growth potential, this result underscores the importance of simultaneously focusing on other elements such as cost management, operational efficiency, and market positioning to enhance financial performance. By recognizing the nuanced nature of the relationship between export activities and financial success, SMEs can fine-tune their strategies to encompass a broader spectrum of factors that contribute to sustained and resilient financial growth.

The comprehensive analysis of this study unequivocally supports the validation of Hypothesis 5, confirming that Supply Chain Efficiency effectively serves as a mediator in the relationship between the utilization of Blockchain Technology and the Financial Performance of Small and Medium-sized Enterprises (SMEs). This substantial finding underscores the crucial role of optimized supply chain operations in translating the benefits of blockchain adoption into enhanced financial outcomes for SMEs. From a managerial standpoint, these outcomes accentuate the strategic significance of strategically aligning blockchain integration with supply chain efficiency enhancements. When blockchain technology is adeptly integrated into supply chain processes, the ensuing efficiencies can substantially streamline operations, reduce costs, and enhance transparency, ultimately resulting in improved financial performance. This mediation highlights the importance of orchestrating a synchronized approach to leverage both technology and operational prowess. Consequently, SMEs are advised to not only adopt blockchain technology but also ensure that the integration is complemented by supply chain optimization, thus holistically harnessing the potential for bolstered financial resilience, growth, and competitive advantage.

The non-acceptance of H7 indicates that Export Performance does not mediate the relationship between the utilization of Blockchain Technology and the Financial Performance of SMEs. This suggests that while the adoption of blockchain technology positively influences export-related operations, it does not indirectly impact the financial performance of small and medium-sized enterprises through the mechanism of enhanced export performance. This finding underscores the complexity of indirect effects within this context. The managerial implication underscores the importance of recognizing that the enhancement of export performance, even when augmented by technological adoption, might not necessarily lead to improved financial outcomes. SMEs should consider a well-rounded approach that encompasses various strategic elements beyond technology, such as cost optimization, market expansion, and operational efficiency, to achieve holistic financial growth. By understanding the limitations of the mediating role of export performance, SMEs can direct their resources towards a comprehensive strategy that encompasses both technology adoption and a broader array of business considerations to enhance their financial standing and overall success.

6. Conclusion

This comprehensive study yields conclusive insights into the complex dynamics governing the relationships among Blockchain Technology utilization, Supply Chain Efficiency, Export Performance, and the Financial Performance of Small and Medium-sized Enterprises (SMEs). The empirical examination of the research hypotheses offers valuable insights for managerial decision-making. The endorsement of Hypothesis 1 emphasizes the profound impact of integrating Blockchain Technology on the enhancement of Supply Chain Efficiency within SMEs. The findings underscore the strategic value of

embracing blockchain for supply chain management. By adopting this technology, SMEs can experience streamlined workflows, heightened transparency, and efficient product delivery, leading to increased customer satisfaction and reduced operational costs. Furthermore, the competitive edge gained through Blockchain Technology can equip SMEs with adaptability and resilience in the face of evolving market dynamics and regulatory changes. Additionally, the acceptance of Hypothesis 2 underscores the pivotal role of technology in fostering Export Performance. This outcome reinforces the necessity of staying abreast of digital advancements and integrating blockchain solutions to elevate export operations. By embracing blockchain, SMEs can enhance traceability, transparency, and efficiency in cross-border transactions, ultimately bolstering export success and market competitiveness.

However, the non-acceptance of Hypotheses 3 and 5 highlights the intricate relationship between Blockchain Technology and Financial Performance, as well as the mediating role of Export Performance. These findings underscore the need for SMEs to adopt a holistic approach to financial growth, considering not only technology but also factors like market positioning, customer relationships, and cost management. This insight advocates for a comprehensive strategy that harmonizes various business considerations to achieve enduring financial success. The validation of Hypothesis 4 accentuates the indispensable link between Supply Chain Efficiency and SME Financial Performance. The result underscores the significance of optimized supply chain operations in shaping SMEs' financial outcomes. The managerial implication is clear: investing in efficient supply chain practices can yield improved financial performance, enhancing profit margins, cash flow, and return on investment. In conclusion, this study reinforces the value of technology adoption, strategic supply chain management, and diversified business strategies for SMEs aiming for sustainable growth. The nuanced insights presented here provide a foundation for SMEs to make informed decisions, harnessing the potential of technology and operational excellence to navigate the complexities of the contemporary business landscape.

6.1 Theoretical and Managerial Implications

The study contributes to existing literature by empirically establishing the complex interconnections between these variables within the SME context. By validating these relationships, the study advances theoretical understanding, offering a foundation for future research endeavors exploring the interplay of technology adoption, export activities, supply chain dynamics, and financial performance. From a managerial perspective, the study underscores the strategic imperatives for SMEs. Integrating Blockchain Technology emerges as a mechanism to optimize supply chain efficiency, foster successful export operations, and enhance financial performance. Recognizing the mediating role of Supply Chain Efficiency highlights the importance of holistic approaches that amalgamate technological advancements and operational enhancements to fortify SMEs' financial resilience, market competitiveness, and sustainable growth prospects.

6.2 Limitations and Recommendations for Future Research

While the study contributes valuable insights, limitations such as sample specificity and cross-sectional design warrant consideration. Future research could delve into longitudinal analyses, encompass broader industries, and employ mixed-method approaches for deeper insights. Exploring additional moderating variables and cross-cultural variations could further enrich the understanding of these intricate relationships. To advance knowledge in this domain, future research endeavors could delve into the contextual nuances that might influence these relationships. Investigating the role of market conditions, regulatory frameworks, and varying export strategies could offer tailored insights. Furthermore, longitudinal studies could capture dynamic effects over time, and qualitative inquiries could provide a deeper understanding of the underlying mechanisms. Expanding the scope to include other technological innovations and their impacts on SMEs' operational and financial aspects could also contribute to a more comprehensive understanding of technology-driven transformations.

References

- Ajao, L. A., Agajo, J., Adedokun, E. A., & Karngong, L. (2019). Crypto Hash Algorithm-Based Blockchain Technology for Managing Decentralized Ledger Database in Oil and Gas Industry. In *Multidisciplinary Scientific Journal*, 2(3), 300–325. <https://doi.org/10.3390/j2030021>
- Alarussi, A. S., & Alhaderi, S. M. (2018). Factors affecting profitability in Malaysia. *Journal of Economic Studies*, 45(3), 442–458. <https://doi.org/10.1108/JES-05-2017-0124>
- Ali, O., Ally, M., Clutterbuck, & Dwivedi, Y. (2020). The state of play of blockchain technology in the financial services sector: A systematic literature review. *International Journal of Information Management*, 54, 102199. <https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2020.102199>
- Alshira'h, A. F., Alsqour, M., Lutfi, A., Alsyuf, A., & Alshirah, M. (2020). A Socio-Economic Model of Sales Tax Compliance. In *Economies* (Vol. 8, Issue 4). <https://doi.org/10.3390/economies8040088>
- Anderson Schillig, M. (2023). 'Lex Cryptographi(c)a,' 'Cloud Crypto Land' or What? – Blockchain Technology on the Legal Hype Cycle. *The Modern Law Review*, 86(1), 31–66. <https://doi.org/https://doi.org/10.1111/1468-2230.12748>
- Aoun, A., Ilinca, A., Ghandour, M., & Ibrahim, H. (2021). A review of Industry 4.0 characteristics and challenges, with potential improvements using blockchain technology. *Computers & Industrial Engineering*, 162, 107746. <https://doi.org/https://doi.org/10.1016/j.cie.2021.107746>

- Appelbaum, D., Cohen, E., Kinory, E., & Stein Smith, S. (2022). Impediments to Blockchain Adoption. *Journal of Emerging Technologies in Accounting*, 19(2), 199–210. <https://doi.org/10.2308/JETA-19-05-14-26>
- Atnafu, D., & Balda, A. (2018). The impact of inventory management practice on firms' competitiveness and organizational performance: Empirical evidence from micro and small enterprises in Ethiopia. *Cogent Business & Management*, 5(1), 1503219. <https://doi.org/10.1080/23311975.2018.1503219>
- Belhadi, A., Kamble, S. S., Mani, V., Benkhathi, I., & Touriki, F. E. (2021). An ensemble machine learning approach for forecasting credit risk of agricultural SMEs' investments in agriculture 4.0 through supply chain finance. *Annals of Operations Research*. <https://doi.org/10.1007/s10479-021-04366-9>
- Bellavitis, C., Fisch, C., & Momtaz, P. P. (2023). The rise of decentralized autonomous organizations (DAOs): a first empirical glimpse. *Venture Capital*, 25(2), 187–203. <https://doi.org/10.1080/13691066.2022.2116797>
- Bello, S. A., Oyedele, L. O., Akinade, O. O., Bilal, M., Davila Delgado, J. M., Akanbi, L. A., Ajayi, A. O., & Owolabi, H. A. (2021). Cloud computing in construction industry: Use cases, benefits and challenges. *Automation in Construction*, 122, 103441. <https://doi.org/https://doi.org/10.1016/j.autcon.2020.103441>
- Cassetta, E., Monarca, U., Dileo, I., Di Bernardino, C., & Pini, M. (2020). The relationship between digital technologies and internationalisation. Evidence from Italian SMEs. *Industry and Innovation*, 27(4), 311–339. <https://doi.org/10.1080/13662716.2019.1696182>
- Chin, W. W. (2010). How to write up and report PLS analyses. In *Handbook of Partial Least Squares* (pp. 188–194). https://doi.org/10.1007/978-3-540-32827-8_29
- Conz, E., Magnani, G., Zucchella, A., & De Massis, A. (2023). Responding to unexpected crises: The roles of slack resources and entrepreneurial attitude to build resilience. *Small Business Economics*. <https://doi.org/10.1007/s11187-022-00718-2>
- Côté, C., Estrin, S., & Shapiro, D. (2020). Expanding the international trade and investment policy agenda: The role of cities and services. *Journal of International Business Policy*, 3(3), 199–223. <https://doi.org/10.1057/s42214-020-00053-x>
- Dal Mas, F., Massaro, M., Ndou, V., & Raguseo, E. (2023). Blockchain technologies for sustainability in the agrifood sector: A literature review of academic research and business perspectives. *Technological Forecasting and Social Change*, 187, 122155. <https://doi.org/https://doi.org/10.1016/j.techfore.2022.122155>
- De Giovanni, P., & Cariola, A. (2021). Process innovation through industry 4.0 technologies, lean practices and green supply chains. *Research in Transportation Economics*, 90, 100869. <https://doi.org/https://doi.org/10.1016/j.retrec.2020.100869>
- Di Vaio, A., Latif, B., Gunarathne, N., Gupta, M., & D'Adamo, I. (2023). Digitalization and artificial knowledge for accountability in SCM: a systematic literature review. *Journal of Enterprise Information Management*, ahead-of-print(ahead-of-print). <https://doi.org/10.1108/JEIM-08-2022-0275>
- Dutta, P., Choi, T.-M., Somani, S., & Butala, R. (2020). Blockchain technology in supply chain operations: Applications, challenges and research opportunities. *Transportation Research Part E: Logistics and Transportation Review*, 142, 102067. <https://doi.org/https://doi.org/10.1016/j.tre.2020.102067>
- Edeh, J. N., Obodoechi, D. N., & Ramos-Hidalgo, E. (2020). Effects of innovation strategies on export performance: New empirical evidence from developing market firms. *Technological Forecasting and Social Change*, 158, 120167. <https://doi.org/https://doi.org/10.1016/j.techfore.2020.120167>
- Farouk, A., Alahmadi, A., Ghose, S., & Mashatan, A. (2020). Blockchain platform for industrial healthcare: Vision and future opportunities. *Computer Communications*, 154, 223–235. <https://doi.org/https://doi.org/10.1016/j.comcom.2020.02.058>
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39–50. <https://doi.org/10.1177/002224378101800104>
- Gorane, S., & Kant, R. (2017). Supply chain practices and organizational performance. *The International Journal of Logistics Management*, 28(1), 75–101. <https://doi.org/10.1108/IJLM-06-2015-0090>
- Gregory, G. D., Ngo, L. V., & Karavdic, M. (2019). Developing e-commerce marketing capabilities and efficiencies for enhanced performance in business-to-business export ventures. *Industrial Marketing Management*, 78, 146–157. <https://doi.org/https://doi.org/10.1016/j.indmarman.2017.03.002>
- Hameed, S., Quamar, M. M., & Kumaraswamy, P. R. (2022). *UAE BT - Persian Gulf 2021–22: India's Relations with the Region* (S. Hameed, M. M. Quamar, & P. R. Kumaraswamy (eds.); pp. 411–474). Springer Nature Singapore. https://doi.org/10.1007/978-981-19-4434-5_9
- Hamilton, M. (2020). Blockchain distributed ledger technology: An introduction and focus on smart contracts. *Journal of Corporate Accounting & Finance*, 31(2), 7–12. <https://doi.org/https://doi.org/10.1002/jcaf.22421>
- Hassija, V., Zeadally, S., Jain, I., Tahiliani, A., Chamola, V., & Gupta, S. (2021). Framework for determining the suitability of blockchain: Criteria and issues to consider. *Transactions on Emerging Telecommunications Technologies*, 32(10), e4334. <https://doi.org/https://doi.org/10.1002/ett.4334>
- Hu, M. K., & Kee, D. M. H. (2022). Fostering sustainability: reinventing SME strategy in the new normal. *Foresight*, 24(3/4), 301–318. <https://doi.org/10.1108/FS-03-2021-0080>
- Hutahayan, B. (2020). The mediating role of human capital and management accounting information system in the relationship between innovation strategy and internal process performance and the impact on corporate financial performance. *Benchmarking*, 27(4), 1289–1318. <https://doi.org/10.1108/BIJ-02-2018-0034>
- Jaiswal, R., Gupta, S., & Tiwari, A. K. (2023). Dissecting the compensation conundrum: a machine learning-based prognostication of key determinants in a complex labor market. *Management Decision*, 61(8), 2322–2353. <https://doi.org/10.1108/MD-07-2022-0976>
- Janssen, M., Weerakkody, V., Ismagilova, E., Sivarajah, U., & Irani, Z. (2020). A framework for analysing blockchain

- technology adoption: Integrating institutional, market and technical factors. *International Journal of Information Management*, 50, 302–309. <https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2019.08.012>
- Jarrahi, M. H. (2018). Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. *Business Horizons*, 61(4), 577–586. <https://doi.org/https://doi.org/10.1016/j.bushor.2018.03.007>
- Javaid, M., Haleem, A., Singh, R. P., Suman, R., & Khan, S. (2022). A review of Blockchain Technology applications for financial services. *BenchCouncil Transactions on Benchmarks, Standards and Evaluations*, 2(3), 100073. <https://doi.org/https://doi.org/10.1016/j.tbench.2022.100073>
- Karisma, K., & Moslemzadeh Tehrani, P. (2023). *Blockchain: Legal and Regulatory Issues BT - Sustainable Oil and Gas Using Blockchain* (S. Saraji & S. Chen (eds.); pp. 75–118). Springer International Publishing. https://doi.org/10.1007/978-3-031-30697-6_4
- Kot, S. (2018). Sustainable Supply Chain Management in Small and Medium Enterprises. In *Sustainability* (Vol. 10, Issue 4). <https://doi.org/10.3390/su10041143>
- Kumar, U., & Shankar, R. (2022). Application of Value Stream Mapping for Lean Operation: An Indian Case Study of a Dairy Firm. *Global Business Review*, 09721509221113002. <https://doi.org/10.1177/09721509221113002>
- Le, T. T., & Ikram, M. (2022). Do sustainability innovation and firm competitiveness help improve firm performance? Evidence from the SME sector in vietnam. *Sustainable Production and Consumption*, 29, 588–599. <https://doi.org/https://doi.org/10.1016/j.sp.2021.11.008>
- Lebovitz, S., Lifshitz-Assaf, H., & Levina, N. (2022). To Engage or Not to Engage with AI for Critical Judgments: How Professionals Deal with Opacity When Using AI for Medical Diagnosis. *Organization Science*, 33(1), 126–148. <https://doi.org/10.1287/orsc.2021.1549>
- Lopes de Sousa Jabbour, A. B., Ndubisi, N. O., & Roman Pais Seles, B. M. (2020). Sustainable development in Asian manufacturing SMEs: Progress and directions. *International Journal of Production Economics*, 225, 107567. <https://doi.org/https://doi.org/10.1016/j.ijpe.2019.107567>
- López-Campos, M., González-Ramírez, R. G., Bearzotti, L., & Cannella, S. (2019). *Modelling and Analysis of the Apples Export Supply Chain Business Processes: Experiences from Chile BT - Best Practices in Manufacturing Processes: Experiences from Latin America* (J. L. García Alcaraz, L. Rivera Cadavid, R. G. González-Ramírez, G. Leal Jamil, & M. G. Chong Chong (eds.); pp. 29–52). Springer International Publishing. https://doi.org/10.1007/978-3-319-99190-0_2
- Lukonga, I. (2021). *Fintech and the Real Economy: Lessons from the Middle East, North Africa, Afghanistan, and Pakistan (MENAP) Region BT - The Palgrave Handbook of FinTech and Blockchain* (M. Pompella & R. Matousek (eds.); pp. 187–214). Springer International Publishing. https://doi.org/10.1007/978-3-030-66433-6_8
- Mahyuni, L. P., Adrian, R., Darma, G. S., Krisnawijaya, N. N. K., Dewi, I. G. A. A. P., & Permana, G. P. L. (2020). Mapping the potentials of blockchain in improving supply chain performance. *Cogent Business & Management*, 7(1), 1788329. <https://doi.org/10.1080/23311975.2020.1788329>
- McMaster, M., Nettleton, C., Tom, C., Xu, B., Cao, C., & Qiao, P. (2020). Risk Management: Rethinking Fashion Supply Chain Management for Multinational Corporations in Light of the COVID-19 Outbreak. In *Journal of Risk and Financial Management* (Vol. 13, Issue 8). <https://doi.org/10.3390/jrfm13080173>
- Min, Z., Sawang, S., & Kivits, R. A. (2021). Proposing Circular Economy Ecosystem for Chinese SMEs: A Systematic Review. In *International Journal of Environmental Research and Public Health* (Vol. 18, Issue 5). <https://doi.org/10.3390/ijerph18052395>
- Moons, K., Waeyenbergh, G., & Pintelon, L. (2019). Measuring the logistics performance of internal hospital supply chains – A literature study. *Omega*, 82, 205–217. <https://doi.org/https://doi.org/10.1016/j.omega.2018.01.007>
- Murimi, R., Bell, G., Rasheed, A. A., & Beldona, S. (2023). Blockchains: A review and research agenda for international business. *Research in International Business and Finance*, 66, 102018. <https://doi.org/https://doi.org/10.1016/j.ribaf.2023.102018>
- Natanelov, V., Cao, S., Foth, M., & Dulleck, U. (2022). Blockchain smart contracts for supply chain finance: Mapping the innovation potential in Australia-China beef supply chains. *Journal of Industrial Information Integration*, 30, 100389. <https://doi.org/https://doi.org/10.1016/j.jii.2022.100389>
- Naughton, S., Golgeci, I., & Arslan, A. (2020). Supply chain agility as an acclimatisation process to environmental uncertainty and organisational vulnerabilities: insights from British SMEs. *Production Planning & Control*, 31(14), 1164–1177. <https://doi.org/10.1080/09537287.2019.1701130>
- Omar, I. A., Debe, M., Jayaraman, R., Salah, K., Omar, M., & Arshad, J. (2022). Blockchain-based Supply Chain Traceability for COVID-19 personal protective equipment. *Computers & Industrial Engineering*, 167, 107995. <https://doi.org/https://doi.org/10.1016/j.cie.2022.107995>
- Omar, I. A., Hasan, H. R., Jayaraman, R., Salah, K., & Omar, M. (2021). Implementing decentralized auctions using blockchain smart contracts. *Technological Forecasting and Social Change*, 168, 120786. <https://doi.org/https://doi.org/10.1016/j.techfore.2021.120786>
- Prange, C., & Pinho, J. C. (2017). How personal and organizational drivers impact on SME international performance: The mediating role of organizational innovation. *International Business Review*, 26(6), 1114–1123. <https://doi.org/https://doi.org/10.1016/j.ibusrev.2017.04.004>
- Qi, Y., Huo, B., Wang, Z., & Yeung, H. Y. J. (2017). The impact of operations and supply chain strategies on integration and performance. *International Journal of Production Economics*, 185, 162–174. <https://doi.org/https://doi.org/10.1016/j.ijpe.2016.12.028>

- Raddatz, N., Coyne, J., Menard, P., & Crossler, R. E. (2023). Becoming a blockchain user: understanding consumers' benefits realisation to use blockchain-based applications. *European Journal of Information Systems*, 32(2), 287–314. <https://doi.org/10.1080/0960085X.2021.1944823>
- Rahman, M. S., Chamikara, M. A. P., Khalil, I., & Bouras, A. (2022). Blockchain-of-blockchains: An interoperable blockchain platform for ensuring IoT data integrity in smart city. *Journal of Industrial Information Integration*, 30, 100408. <https://doi.org/https://doi.org/10.1016/j.jii.2022.100408>
- Rajasekaran, A. S., Azees, M., & Al-Turjman, F. (2022). A comprehensive survey on blockchain technology. *Sustainable Energy Technologies and Assessments*, 52, 102039. <https://doi.org/https://doi.org/10.1016/j.seta.2022.102039>
- Rauniyar, K., Wu, X., Gupta, S., Modgil, S., & Kumar, A. (2023). Digitizing global supply chains through blockchain. *Production Planning & Control*, 1–22. <https://doi.org/10.1080/09537287.2023.2189614>
- Razzaq, A., Sharif, A., Ozturk, I., & Skare, M. (2023). Asymmetric influence of digital finance, and renewable energy technology innovation on green growth in China. *Renewable Energy*, 202, 310–319. <https://doi.org/https://doi.org/10.1016/j.renene.2022.11.082>
- Rejeb, A., Rejeb, K., Simske, S. J., & Keogh, J. G. (2022). Blockchain technology in the smart city: a bibliometric review. *Quality & Quantity*, 56(5), 2875–2906. <https://doi.org/10.1007/s11135-021-01251-2>
- Shojaei, A., Ketabi, R., Razkenari, M., Hakim, H., & Wang, J. (2021). Enabling a circular economy in the built environment sector through blockchain technology. *Journal of Cleaner Production*, 294, 126352. <https://doi.org/https://doi.org/10.1016/j.jclepro.2021.126352>
- Siagian, H., Tarigan, Z. J., & Jie, F. (2021). Supply Chain Integration Enables Resilience, Flexibility, and Innovation to Improve Business Performance in COVID-19 Era. In *Sustainability* (Vol. 13, Issue 9). <https://doi.org/10.3390/su13094669>
- Siegel, R., Antony, J., Garza-Reyes, J. A., Cherrafi, A., & Lameijer, B. (2019). Integrated green lean approach and sustainability for SMEs: From literature review to a conceptual framework. *Journal of Cleaner Production*, 240, 118205. <https://doi.org/https://doi.org/10.1016/j.jclepro.2019.118205>
- Singh, R. K., Modgil, S., & Acharya, P. (2020). Identification and causal assessment of supply chain flexibility. *Benchmarking: An International Journal*, 27(2), 517–549. <https://doi.org/10.1108/BIJ-01-2019-0003>
- Soluk, J., & Kammerlander, N. (2021). Digital transformation in family-owned Mittelstand firms: A dynamic capabilities perspective. *European Journal of Information Systems*, 30(6), 676–711. <https://doi.org/10.1080/0960085X.2020.1857666>
- Tao, X., Das, M., Liu, Y., & Cheng, J. C. P. (2021). Distributed common data environment using blockchain and Interplanetary File System for secure BIM-based collaborative design. *Automation in Construction*, 130, 103851. <https://doi.org/https://doi.org/10.1016/j.autcon.2021.103851>
- Tijan, E., Agatić, A., Jović, M., & Aksentijević, S. (2019). Maritime National Single Window—A Prerequisite for Sustainable Seaport Business. In *Sustainability* (Vol. 11, Issue 17). <https://doi.org/10.3390/su11174570>
- Tolstoy, D., Nordman, E. R., & Vu, U. (2022). The indirect effect of online marketing capabilities on the international performance of e-commerce SMEs. *International Business Review*, 31(3), 101946. <https://doi.org/https://doi.org/10.1016/j.ibusrev.2021.101946>
- Tredinnick, L. (2019). Cryptocurrencies and the blockchain. *Business Information Review*, 36(1), 39–44. <https://doi.org/10.1177/0266382119836314>
- Uddin, M., Chowdhury, A., Anderson, K., & Chaudhuri, K. (2021). The effect of COVID – 19 pandemic on global stock market volatility: Can economic strength help to manage the uncertainty? *Journal of Business Research*, 128, 31–44. <https://doi.org/https://doi.org/10.1016/j.jbusres.2021.01.061>
- Wieczorowski, M., Kucharski, D., Sniatala, P., Pawlus, P., Krolczyk, G., & Gapinski, B. (2023). A novel approach to using artificial intelligence in coordinate metrology including nano scale. *Measurement*, 217, 113051. <https://doi.org/https://doi.org/10.1016/j.measurement.2023.113051>
- Yaqoob, I., Salah, K., Jayaraman, R., & Al-Hammadi, Y. (2022). Blockchain for healthcare data management: opportunities, challenges, and future recommendations. *Neural Computing and Applications*, 34(14), 11475–11490. <https://doi.org/10.1007/s00521-020-05519-w>
- Zaman, S. I., Khan, S., Zaman, S. A. A., & Khan, S. A. (2023). A grey decision-making trial and evaluation laboratory model for digital warehouse management in supply chain networks. *Decision Analytics Journal*, 8, 100293. <https://doi.org/https://doi.org/10.1016/j.dajour.2023.100293>
- Zekos, G. I. (2021). *E-Globalization and Digital Economy BT - Economics and Law of Artificial Intelligence: Finance, Economic Impacts, Risk Management and Governance* (G. I. Zekos (ed.); pp. 13–66). Springer International Publishing. https://doi.org/10.1007/978-3-030-64254-9_2

