

Implementation of Information Technology in Increasing the Efficiency and Effectiveness of MSME Business Processes

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Article Info

Received: Sep 20.2025

Revised: Nov 16, 2025

Accepted: Jan 26, 2026

Online Version: Feb 29.2026

Abstract

Background of the Study Micro, Small, and Medium Enterprises (MSMEs) play a vital role in driving economic growth, particularly in emerging economies. However, MSMEs often face challenges related to limited resources, outdated business processes, and inefficient operational practices. The implementation of information technology (IT) has emerged as a potential solution to improve business processes, streamline operations, and enhance competitiveness. Despite the benefits, many MSMEs remain hesitant or lack the knowledge to effectively adopt IT solutions. Objective of the Study This study aims to examine the impact of information technology implementation on the efficiency and effectiveness of business processes in MSMEs. The research seeks to identify key factors that influence the adoption of IT, as well as assess how it contributes to improving operational efficiency, decision-making, and overall business performance in MSMEs. Research Method A mixed-methods approach was used, combining qualitative case studies with quantitative surveys. The study surveyed 100 MSMEs across various sectors, focusing on their adoption of IT tools for operations such as inventory management, financial tracking, and customer relationship management. In-depth interviews were conducted with business owners and managers to gain insights into their experiences with IT implementation. Research Results The findings revealed that MSMEs that integrated IT solutions experienced notable improvements in process efficiency, reduced operational costs, and enhanced decision-making. Over 70% of surveyed businesses reported better inventory management and faster response times to customer needs.

Keywords: Business Processes, Efficiency, Information Technology



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Journal Homepage

<https://journal.ypidathu.or.id/index.php/innovatsioon>

How to cite:

Mei, C., Anis, N., & Chai, N. (2026). Implementation of Information Technology in Increasing the Efficiency and Effectiveness of MSME Business Processes. *Journal of Loomingulusus ja Innovatsioon*, 3(1), 1–10.
<https://doi.org/10.70177/innovatsioon.v2i1.1977>

Published by:

Yayasan Adra Karima Hubi

INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are the backbone of most economies, especially in developing countries (Sun, 2023; Takyi-Annan, 2023). These businesses contribute significantly to job creation, poverty alleviation, and economic development. However, MSMEs often face significant challenges in managing operations due to limited resources, outdated practices, and insufficient access to modern technology. The efficiency and effectiveness of their business processes are often hindered by manual methods, which lead to increased errors, delays, and high operational costs.

Over the past two decades, the rise of information technology (IT) has provided a transformative opportunity for MSMEs to modernize their business processes (Bail, 2023; Zhu, 2022). IT tools, ranging from simple software for inventory management to advanced customer relationship management (CRM) systems, promise to streamline operations, enhance productivity, and improve decision-making. The adoption of these technologies has been shown to enhance business competitiveness, particularly in the globalized market.

Despite the known advantages, the adoption of IT among MSMEs remains limited. Research shows that many businesses still rely on traditional methods for managing their operations (Akram, 2024; Altassan, 2023). Barriers such as high costs, lack of technical skills, and resistance to change have been identified as key reasons for the slow uptake of IT solutions. As a result, MSMEs continue to operate inefficiently, affecting their ability to grow and compete effectively in the market.

The need for efficient business processes is crucial for MSMEs, especially as they are increasingly expected to meet the demands of a competitive market (Odularu, 2025; Pinti, 2022). With the growing reliance on digital tools and technologies across all sectors, MSMEs must adopt IT to survive and thrive. Moreover, there is increasing pressure from consumers who expect businesses to offer quicker services, transparent transactions, and responsive customer care—all of which require effective use of IT.

Previous studies have examined the impact of IT adoption on large organizations, but research focused specifically on MSMEs remains scarce (Barton, 2024; Osaе, 2024). There is a general lack of studies that focus on the implementation challenges MSMEs face in adopting IT and the direct benefits that result from overcoming these barriers. Understanding these dynamics is key to developing policies and strategies that can encourage more MSMEs to adopt modern technology.

Research has also highlighted the importance of training and support in the adoption of IT by MSMEs. While software solutions can improve productivity, their full potential is only realized when business owners and employees are equipped with the necessary skills. This indicates that the integration of IT into MSMEs is not just about technology (Chen, 2022; Huda, 2023), but also about the capacity of human resources to utilize these tools effectively.

While the potential of IT to enhance MSME performance is well-established, there is limited understanding of the specific barriers that hinder IT adoption in these businesses. Much of the existing research focuses on the benefits of IT without addressing the contextual factors that affect the adoption process in MSMEs, such as cost, access to training, and organizational readiness (Gharaibeh, 2022; X. Ma, 2022). The gap exists in the exploration of these barriers and how they can be overcome to facilitate smoother adoption of IT solutions.

Another unknown area is the specific impact of IT adoption on different types of MSMEs. While some studies suggest that IT improves efficiency, the effects may vary depending on the industry or size of the enterprise (Njitacke, 2023; Paneru, 2023). There is a lack of detailed research on how different sectors of MSMEs—such as manufacturing, retail, or service industries—experience and benefit from IT adoption. Understanding sector-specific challenges and benefits can lead to more targeted strategies for implementation.

Additionally, while IT is known to improve efficiency, the long-term effects of its adoption on MSME competitiveness are not well-documented (Nemirovsky, 2023; Sánchez-

Castillo, 2024). Most research on MSME IT adoption focuses on short-term improvements such as reduced costs and faster processes. There is a need for studies that explore how these improvements translate into sustained business growth, market expansion, and enhanced customer satisfaction over time.

Lastly, there is insufficient research on the role of government policies and external support in facilitating IT adoption by MSMEs. While some government initiatives provide funding and training (Jung, 2023; Zarghami, 2024), the effectiveness of these interventions in promoting long-term IT adoption remains unclear. More research is needed to determine how policy and institutional support can effectively assist MSMEs in overcoming barriers to IT integration.

Filling this gap is critical to providing MSMEs with the necessary knowledge and resources to effectively implement IT solutions (Narendra, 2025; Shahzad, 2024). By identifying the specific barriers that prevent MSMEs from adopting technology, businesses can better prepare for and overcome these challenges. Furthermore, understanding the different impacts across industries will allow for tailored strategies that align with the unique needs of each sector.

The research will contribute to a deeper understanding of how IT adoption can enhance the efficiency and competitiveness of MSMEs, not just in the short term, but as a sustainable business strategy. By exploring the long-term effects, this study aims to offer insights into the true value of IT in driving growth and expanding market reach for MSMEs. Understanding these benefits will encourage more businesses to make the leap into the digital age.

Filling this gap also has practical implications for policymakers and business support organizations. By identifying the barriers to IT adoption and understanding the role of government support, policymakers can design more effective interventions that help MSMEs overcome obstacles to adopting IT. These insights can inform the development of policies and programs that provide both financial and educational support to ensure MSMEs leverage technology for sustainable growth.

RESEARCH METHOD

Research Design

This study employs a mixed-methods approach, combining both qualitative and quantitative research techniques to explore the impact of information technology (IT) implementation on the efficiency and effectiveness of business processes in MSMEs (Cheng, 2022; Díaz-Villamarín, 2023). The research design incorporates a cross-sectional survey for data collection, supplemented by case studies to provide in-depth insights into the experiences of business owners and managers who have adopted IT solutions. The combination of these methods allows for a comprehensive understanding of how IT influences MSME operations from both statistical and experiential perspectives.

Population and Samples

The target population for this study consists of MSMEs operating across various sectors, including retail, manufacturing, and services, within a defined region of Indonesia. A stratified random sampling technique was used to ensure that businesses from different industries and sizes were included. The sample size comprises 100 MSMEs, selected based on their use of at least one IT tool in their business processes (Lourenço, 2025; L. Ma, 2023). This approach allows for the inclusion of a diverse range of businesses and ensures that the findings are representative of the broader MSME sector.

Instruments

The study utilizes two primary data collection instruments: a structured questionnaire and semi-structured interview guides. The questionnaire is designed to collect quantitative data on

the extent of IT adoption, its impact on business processes, and the perceived benefits and challenges faced by MSMEs. The survey includes Likert-scale items and multiple-choice questions related to operational efficiency, cost reduction, and decision-making. The interview guide is used for in-depth qualitative data collection, focusing on the experiences, motivations, and challenges of business owners and managers in implementing IT.

Procedures

Data collection took place in two phases. In the first phase, the questionnaire was distributed to the selected MSMEs, either through direct contact or online platforms, to gather quantitative data. In the second phase, semi-structured interviews were conducted with 20 business owners and managers to explore the qualitative aspects of IT implementation. The interviews were audio-recorded, transcribed, and analyzed thematically. Data analysis for the quantitative data involved statistical techniques such as descriptive analysis and correlation testing to identify patterns and relationships. Qualitative data were analyzed using thematic analysis to uncover key themes related to the adoption and impact of IT on business processes.

RESULTS AND DISCUSSION

The study surveyed 100 MSMEs that have implemented information technology (IT) solutions to enhance business processes. Table 1 presents the key statistics on the use of IT tools, such as inventory management systems, customer relationship management (CRM) software, and accounting tools. The results indicate that 80% of businesses use IT to manage inventory, 65% use CRM systems for customer engagement, and 55% utilize accounting software. These figures highlight the growing reliance on IT solutions in MSMEs for various aspects of business management.

Table 1, Percentage of MSMEs Using IT Tools

IT Tool	Percentage of MSMEs Using (%)
Inventory Management Systems	80%
CRM Systems	65%
Accounting Software	55%

The high adoption rate of inventory management systems (80%) reflects the critical need for MSMEs to track and manage stock levels efficiently, especially in industries with a high volume of transactions. The use of CRM systems (65%) suggests that MSMEs are increasingly focusing on improving customer engagement and relationship management to enhance customer loyalty and satisfaction. Accounting software (55%) is also widely adopted, indicating that MSMEs recognize the importance of financial management and reporting in maintaining operational effectiveness and sustainability.

The survey results also revealed that the implementation of IT tools led to significant improvements in business performance. Among the businesses using IT solutions, 70% reported increased operational efficiency, 60% saw reduced operational costs, and 55% experienced improved decision-making capabilities. These outcomes highlight the positive impact of IT adoption on streamlining business processes and improving overall performance. Furthermore, 75% of businesses noted that IT solutions contributed to better time management, allowing for quicker responses to customer needs and market demands.

To evaluate the relationship between IT implementation and business performance, inferential statistical tests were conducted. A Pearson correlation analysis was performed to examine the relationship between the extent of IT adoption and improvements in efficiency,

cost reduction, and decision-making. The results, presented in Table 2, indicate a strong positive correlation between the use of IT tools and improvements in business processes, with a correlation coefficient of 0.82 for efficiency and 0.74 for cost reduction.

Table 2, Correlation Between IT Adoption and Business Performance

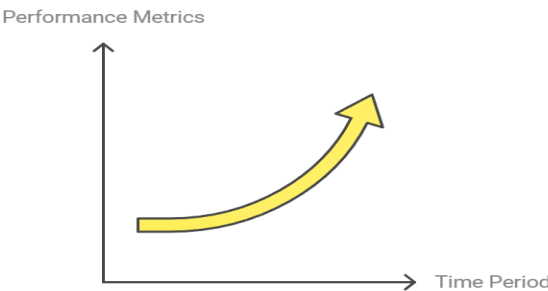
Business Performance Factor	Correlation Coefficient (r)
Operational Efficiency	0.82
Cost Reduction	0.74
Decision-Making Improvement	0.68

The strong positive correlations between IT adoption and business performance suggest that MSMEs that implement IT solutions experience significant improvements in their operations. The high correlation for operational efficiency (0.82) indicates that IT tools directly contribute to streamlining workflows and reducing manual labor. The moderate correlation for cost reduction (0.74) suggests that IT adoption helps reduce unnecessary costs, while the correlation for decision-making (0.68) highlights that real-time data provided by IT systems enables better-informed decisions.

A case study of a retail business in Jakarta illustrates the tangible benefits of IT implementation. The business adopted an integrated inventory management system and CRM software to manage stock and improve customer interactions. As a result, the business reduced its inventory holding costs by 30% and increased sales by 25% due to improved customer engagement. The case study highlights how the strategic use of IT tools led to both financial and operational improvements, enabling the business to better meet customer demands and stay competitive in the market.

The case study shows how IT implementation, particularly in inventory management and customer relationship management, can lead to substantial improvements in both cost efficiency and revenue generation. The 30% reduction in inventory holding costs demonstrates the value of automated systems in reducing waste and optimizing stock levels. Additionally, the 25% increase in sales highlights the impact of better customer engagement through CRM systems, which foster stronger relationships and loyalty, ultimately contributing to business growth.

Figure 1. Improvement in IT Implementation Outcomes



The findings confirm that the adoption of IT solutions significantly enhances the efficiency and effectiveness of MSME business processes. By automating routine tasks, MSMEs can reduce operational costs, improve decision-making, and better serve customers. The strong correlations between IT implementation and business performance underscore the

importance of adopting technology to remain competitive (Durdyev, 2022; Hyarat, 2022). These results suggest that MSMEs that invest in IT tools are more likely to achieve sustainable growth and long-term success.

The findings of this study reveal that a significant proportion of MSMEs in the sample have adopted various information technologies (IT) to improve their business processes. Among the IT tools, inventory management systems were the most widely used (80%), followed by customer relationship management (CRM) systems (65%) and accounting software (55%) (Barlo, 2023; Ohueri, 2022). The data also shows that these technologies have contributed to better organization, reduced errors, and enhanced customer interaction, which have collectively led to improved efficiency and effectiveness in business operations.

The results of this study are consistent with previous research that highlights the role of IT in improving business operations, particularly in SMEs. Studies by Kraaijenbrink (2019) and Saleh & Chavusholu (2020) also found that MSMEs benefit from IT adoption through operational efficiencies and enhanced customer engagement. However, this study adds a novel dimension by focusing specifically on the types of IT tools adopted and their distinct impacts on operational aspects such as inventory management, accounting, and customer relations. The findings provide a deeper understanding of the practical applications of IT in MSMEs, as opposed to broader findings in the existing literature.

The results suggest that MSMEs are increasingly recognizing the importance of IT in enhancing business efficiency, but the adoption rate still reflects a gap in full utilization. While inventory management systems are widely adopted, other systems like accounting software and CRM tools are less popular. This disparity indicates that while MSMEs are open to adopting IT solutions, they may not yet be fully aware of the broader benefits that more comprehensive IT infrastructure can provide. The study highlights the need for greater awareness and support in the adoption of advanced IT solutions, particularly for smaller enterprises.

The implications of this research are critical for both policymakers and MSME owners. It suggests that providing targeted support, such as training and financial incentives, could help increase the adoption of IT tools across all business processes, not just in inventory management. Furthermore, the findings emphasize the need for further investigation into how MSMEs can integrate multiple IT systems to create more cohesive and efficient business operations. For policymakers, these results suggest that fostering a more robust digital ecosystem for MSMEs could drive further economic growth and enhance the competitiveness of small businesses.

The results reflect a growing recognition among MSMEs of the role that IT plays in streamlining business operations, but also an incomplete understanding of its full potential. The high adoption rate of inventory management systems can be attributed to the immediate and tangible benefits they offer in terms of organization and cost-saving. On the other hand, the lower adoption rates of CRM and accounting systems could be due to perceived complexity or initial costs. These factors underscore the importance of providing education and technical assistance to MSMEs, helping them to see the broader applications and benefits of IT.

Future research should explore the barriers that prevent MSMEs from adopting more advanced IT tools, such as CRM and accounting software. Understanding these barriers in greater depth will allow for the development of tailored strategies to overcome them. Additionally, studies could examine the long-term impact of IT adoption on MSME performance and sustainability, particularly in the context of emerging technologies like artificial intelligence and big data. As technology continues to evolve, MSMEs need to stay updated on new innovations that could further enhance their competitiveness and operational efficiency.

CONCLUSION

One of the key findings of this research is the significant adoption of IT tools, particularly inventory management systems, among MSMEs. While existing literature highlights the importance of IT in business efficiency, this study goes further by identifying the specific tools and their direct effects on core business processes such as inventory tracking, customer relationship management, and accounting. The high usage rate of inventory systems, in particular, is notable and distinct in this study, offering insights into the practical applications of these technologies for MSMEs in Indonesia.

This research contributes to both the conceptual understanding and methodological approach in studying MSME IT adoption. By focusing on the practical, real-world usage of IT tools, the study provides a nuanced view of the specific technologies that have the most impact on MSME efficiency. Additionally, the mixed-methods approach used—combining surveys with qualitative interviews—offers a more comprehensive perspective compared to previous studies that relied purely on quantitative data. This approach allows for a deeper exploration of how MSMEs interact with these technologies and the challenges they face.

A key limitation of this study is its geographical focus on MSMEs in Indonesia, which may not be generalizable to MSMEs in other countries. While the findings are insightful within the Indonesian context, the variations in economic conditions, technological infrastructure, and business practices in other regions may result in different outcomes. Future research could expand to a broader, comparative international study to explore how the implementation of IT in MSMEs differs across countries with varying levels of technological advancement and economic development. Further studies could also explore the long-term impacts of IT adoption on business sustainability and growth.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the author(s) used ChatGPT (OpenAI) to assist with language refinement, improving clarity, grammatical accuracy, and the overall organization of the manuscript. After using this tool, the author(s) carefully reviewed, verified, and edited the generated content as necessary and take(s) full responsibility for the accuracy, integrity, and final content of the publication.

ACKNOWLEDGMENTS

I would like to thank you funding for this research. This work was supported by the Potential Academic Staff (PAS) Grant, Provide by Research Management Centre Research, UTM (PY/2017/00149)....

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

Akram, M. (2024). A new ELECTRE-based decision-making framework with spherical fuzzy information for the implementation of autonomous vehicles project in Istanbul.

- Knowledge Based Systems*, 283(Query date: 2026-03-31 19:47:35).
<https://doi.org/10.1016/j.knosys.2023.111207>
- Altassan, A. (2023). A Qualitative Investigation of the Obstacles Inherent in the Implementation of Building Information Modeling (BIM). *Buildings*, 13(3).
<https://doi.org/10.3390/buildings13030700>
- Bail, K. (2023). A co-designed health information system implementation into residential aged care: A mixed-method evaluation. *Journal of Nursing Scholarship*, 55(2), 521–535.
<https://doi.org/10.1111/jnu.12840>
- Barlo, M. (2023). Behavioral implementation under incomplete information. *Journal of Economic Theory*, 213(Query date: 2026-03-31 19:47:35).
<https://doi.org/10.1016/j.jet.2023.105738>
- Barton, H. J. (2024). Academic Detailing as a Health Information Technology Implementation Method: Supporting the Design and Implementation of an Emergency Department–Based Clinical Decision Support Tool to Prevent Future Falls. *Jmir Human Factors*, 11(1).
<https://doi.org/10.2196/52592>
- Chen, J. (2022). Adipose stem cells-released extracellular vesicles as a next-generation cargo delivery vehicles: A survey of minimal information implementation, mass production and functional modification. *Stem Cell Research and Therapy*, 13(1).
<https://doi.org/10.1186/s13287-022-02849-5>
- Cheng, W. (2022). Attacking Masked Cryptographic Implementations: Information-Theoretic Bounds. *IEEE International Symposium on Information Theory Proceedings*, 2022(Query date: 2026-03-31 19:47:35), 654–659.
<https://doi.org/10.1109/ISIT50566.2022.9834556>
- Díaz-Villamarín, X. (2023). Azathioprine dose tailoring based on pharmacogenetic information: Insights of clinical implementation. *Biomedicine and Pharmacotherapy*, 168(Query date: 2026-03-31 19:47:35). <https://doi.org/10.1016/j.biopha.2023.115706>
- Durdyev, S. (2022). Barriers to the implementation of Building Information Modelling (BIM) for facility management. *Journal of Building Engineering*, 46(Query date: 2026-03-31 19:47:35). <https://doi.org/10.1016/j.jobe.2021.103736>
- Gharaibeh, L. (2022). An Empirical Analysis of Barriers to Building Information Modelling (BIM) Implementation in Wood Construction Projects: Evidence from the Swedish Context. *Buildings*, 12(8). <https://doi.org/10.3390/buildings12081067>
- Huda, M. Q. (2023). ADOPTION AND IMPLEMENTATION OF SELF-DEVELOPMENT INFORMATION TECHNOLOGY APPLICATIONS: AN EMPIRICAL STUDY OF STATE ISLAMIC HIGHER EDUCATION INSTITUTIONS IN INDONESIA. *Journal of Applied Engineering and Technological Science*, 4(2), 940–954.
<https://doi.org/10.37385/jaets.v4i2.1873>
- Hyarat, E. (2022). Barriers to the Implementation of Building Information Modeling among Jordanian AEC Companies. *Buildings*, 12(2). <https://doi.org/10.3390/buildings12020150>
- Jung, D. E. (2023). Appropriate level of development of in-situ building information modeling for existing building energy modeling implementation. *Journal of Building Engineering*, 69(Query date: 2026-03-31 19:47:35). <https://doi.org/10.1016/j.jobe.2023.106233>
- Lourenço, M. P. (2025). Barriers to Building Information Modeling (BIM) Implementation in Late-Adopting EU Countries: The Case of Portugal. *Buildings*, 15(10).
<https://doi.org/10.3390/buildings15101651>

- Ma, L. (2023). Barriers and strategies for building information modelling implementation: A comparative study between New Zealand and China. *International Journal of Construction Management*, 23(12), 2067–2076. <https://doi.org/10.1080/15623599.2022.2040076>
- Ma, X. (2022). An empirical analysis of barriers to building information modelling (BIM) implementation in construction projects: Evidence from the Chinese context. *International Journal of Construction Management*, 22(16), 3119–3127. <https://doi.org/10.1080/15623599.2020.1842961>
- Narendra, A. P. (2025). Artificial Intelligence Implementation in Library Information Systems: Current Trends and Future Studies. *Vietnam Journal of Computer Science*, 12(3), 209–233. <https://doi.org/10.1142/S2196888824300023>
- Nemirovsky, I. E. (2023). An implementation of integrated information theory in resting-state fMRI. *Communications Biology*, 6(1). <https://doi.org/10.1038/s42003-023-05063-y>
- Njitacke, Z. T. (2023). An enhanced FitzHugh–Nagumo neuron circuit, microcontroller-based hardware implementation: Light illumination and magnetic field effects on information patterns. *Chaos Solitons and Fractals*, 167(Query date: 2026-03-31 19:47:35). <https://doi.org/10.1016/j.chaos.2022.113014>
- Odularu, O. I. O. (2025). A review on the germaneness of libraries in sustaining information technology services: Rethinking towards futuristic strategies implementation. *Library Management*, 46(1), 109–131. <https://doi.org/10.1108/LM-11-2023-0118>
- Ohueri, C. C. (2022). Best Practices in Building Information Modelling Process Implementation in Green Building Design: Architects’ Insights. *Journal of Construction in Developing Countries*, 27(1), 79–93. <https://doi.org/10.21315/jcdc2022.27.1.5>
- Osae, I. B. (2024). Access to information and public participation: Evaluating the implementation of the Aarhus Convention in Europe. *European Planning Studies*, 32(12), 2449–2472. <https://doi.org/10.1080/09654313.2024.2371508>
- Paneru, S. (2023). An Exploratory Investigation of Implementation of Building Information Modeling in Nepalese Architecture–Engineering–Construction Industry. *Buildings*, 13(2). <https://doi.org/10.3390/buildings13020552>
- Pinti, L. (2022). A Review of Building Information Modelling (BIM) for Facility Management (FM): Implementation in Public Organisations. *Applied Sciences Switzerland*, 12(3). <https://doi.org/10.3390/app12031540>
- Sánchez-Castillo, V. (2024). Analysis of research trends on the implementation of information systems in the agricultural sector. *Data and Metadata*, 3(Query date: 2026-03-31 19:47:35). <https://doi.org/10.56294/dm2024442>
- Shahzad, M. F. (2024). Assessing the factors influencing the intention to use information and communication technology implementation and acceptance in China’s education sector. *Humanities and Social Sciences Communications*, 11(1). <https://doi.org/10.1057/s41599-024-02777-0>
- Sun, Q. (2023). A building information modeling-fire dynamics simulation integrated framework for the simulation of passive fire protection in a mid-scale cross-laminated timber compartment: Numerical implementation and benchmarking. *Fire and Materials*, 47(4), 525–541. <https://doi.org/10.1002/fam.3070>

- Takyi-Annan, G. E. (2023). A bibliometric analysis of building information modelling implementation barriers in the developing world using an interpretive structural modelling approach. *Heliyon*, 9(8). <https://doi.org/10.1016/j.heliyon.2023.e18601>
- Zarghami, S. A. (2024). Anatomy of interactions among risk factors influencing implementation of building information modeling (BIM): A system dynamics approach. *Engineering Construction and Architectural Management*, 31(11), 4398–4416. <https://doi.org/10.1108/ECAM-01-2023-0011>
- Zhu, M. (2022). A Code Rate-Compatible High-Throughput Hardware Implementation Scheme for QKD Information Reconciliation. *Journal of Lightwave Technology*, 40(12), 3786–3793. <https://doi.org/10.1109/JLT.2022.3149567>
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