Financial Innovation

RESEARCH

Open Access

# Fintech adoption for SMEs in different socioeconomic contexts: evidence from Hungary and Indonesia

Adrián Szilárd Nagy[1*], Fitty Valdi Arie[2], Octavia Diana Monica Tuegeh[3], Beáta Bittner[1] and Johan Reineer Tumiwa[2]

*Correspondence:
nagy.adrian@econ.unideb.hu

[1] Faculty of Economics and Business, University of Debrecen, Debrecen, Hungary
[2] Faculty of Economics and Business, Sam Ratulangi University, Manado, Indonesia
[3] Faculty of Economics and Business, Manado State University, Manado, Indonesia

## Abstract

The incorporation of financial technology (FinTech) into contemporary business development has emerged as a critical factor for small medium enterprises (SMEs), which contribute to their viability. In light of the significant collaboration between Hungary and Indonesia, this research endeavors to delve into unexplored dimensions pertaining to the potential of fintech in bolstering the operational resilience of SMEs within the contexts of these developed and developing economies, using the technology-organization-environment (TOE) framework. Specifically, this study aims to investigate how the adoption of digital financial services can facilitate inclusive economic growth and foster entrepreneurial activities in both Hungary and Indonesia. The research adopts a quantitative methodology, employing statistical hypothesis testing and regression analysis to achieve its objectives. A sample of 349 participants, with 164 representing Hungary and 185 representing Indonesia, was purposively selected by scientific criteria to examine the patterns of FinTech adoption within the SME industry. The results show that when partial least squares–structural equation modeling (PLS-SEM) is used to examine the direct effect of TOE on fintech adoption, technological factors and environmental factors have a significant effect on fintech adoption, whereas organizational factors have no significant effect on fintech adoption. Further results from the PLS-MGA method used to investigate group differences show that Hungary–Indonesia significantly differ in terms of the impact of technological factors on fintech adoption; in the organizational context of fintech adoption, Indonesia has a stronger relationship than Hungary does, and in terms of environmental factors, Indonesia has a stronger relationship because, compared with Hungary, Indonesia has a higher level of trust in the government. The findings of this research are highly important, serving as a noteworthy reference point for assessing the collaborative efforts between the two countries in enhancing SMEs through the adoption of fintech.

**Keywords:** FinTech, SMEs, Business development, TOE framework, Operational resilience, Comparative study

**JEL Classification:** Q55, O57

## Introduction

In today's interconnected world, the advancement of technology has facilitated greater collaboration and mutual benefits among nations. FinTech stands for "financial technology", which refers to an industry that combines technology with financial services to improve efficiency, accessibility and innovation in various aspects of finance and significantly changes the landscape of the financial industry by providing more innovative, efficient and affordable services than other conventional financial services do (Chen and Yuan 2021). This perspective is supported by Puschmann (2017), who categorized fintech innovation into three dimensions. First, innovations impact different types of FinTech objects. Second, most FinTech innovations are concentrated on incremental improvements such as mobile payment solutions based on "mature technologies". Third, the scope of innovation includes intraorganizational issues and interorganizational microeconomic and macroeconomic impacts. This is particularly relevant for SMEs, which often rely on these innovations to enhance their financial operations and access to new markets. In other words, Puschmann's (2017) findings support that the adoption of fintech by SMEs plays an important role in increasing financial inclusion, as it provides easier, faster, and more affordable access to financial services that were previously out of reach for SMEs. As countries seek to strengthen their economic ties and foster innovation, exploring the comparison between different nations' approaches to technology, organization, the environment, and fintech is becoming increasingly important (Vergara and Agudo 2021). In general, countries with high adoption rates of digital technology tend to have more tools and solutions to increase operational resilience. However, differences in terms of conservatism toward digital technology between SMEs in Hungary and Indonesia include the company's ability to continue operating and maintain business continuity in the face of various challenges, including changes in the business environment and operational risks. According to Zavolokina et al. (2016), digitalization has had a significant impact on the financial industry, as evidenced by the emergence of "FinTech" (a combination of "finance" and "information technology"), which opens up opportunities for the creation of new services and business models while posing challenges to traditional financial service providers.

This research aims to shed light on the collaboration between Hungary and Indonesia in these areas, as they jointly navigate the challenges and opportunities presented by the digital era. This research highlights the empirical background that Hungary and Indonesia, despite being geographically distant, have recognized the potential benefits of joining forces to enhance their technological capabilities and create a conducive environment for sustainable economic growth and support export and import activity at the microscale level of business (Añón Higón and Bonvin 2023). Thus, exploring the comparison analysis between Hungary and Indonesia concerning how TOE influences their respective FinTech landscapes is essential, as it offers insights into the potential for cross-border collaboration in addressing shared challenges and embracing technological advancements. Figure 1 presents transaction values by segment in trillions of USD from 2017 to 2023, highlighting the rapid growth and significance of fintech development. Digital payments have experienced substantial growth, rising from 3.36 trillion USD in 2017 to 14.78 trillion USD in 2027. As fintech advances, its impact on SMEs becomes even more crucial. Figure 1 also shows that there has been a continuous upward trend

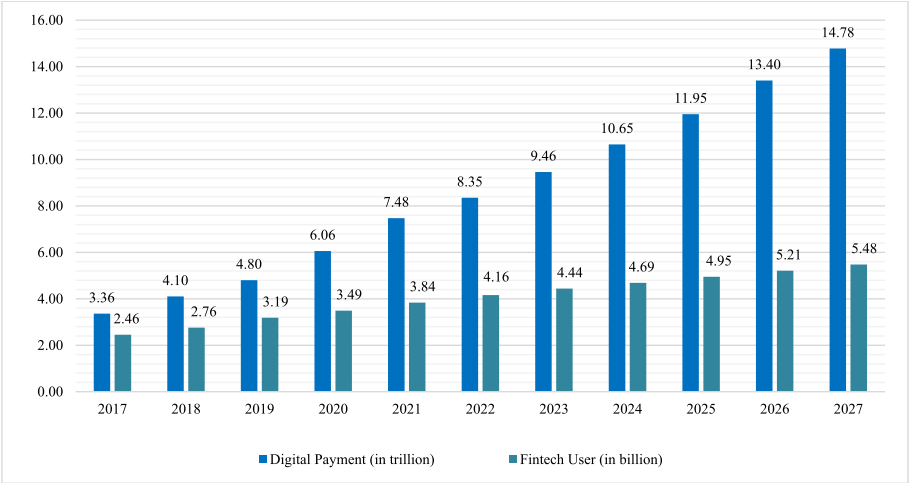



**Fig. 1** Fintech transaction value

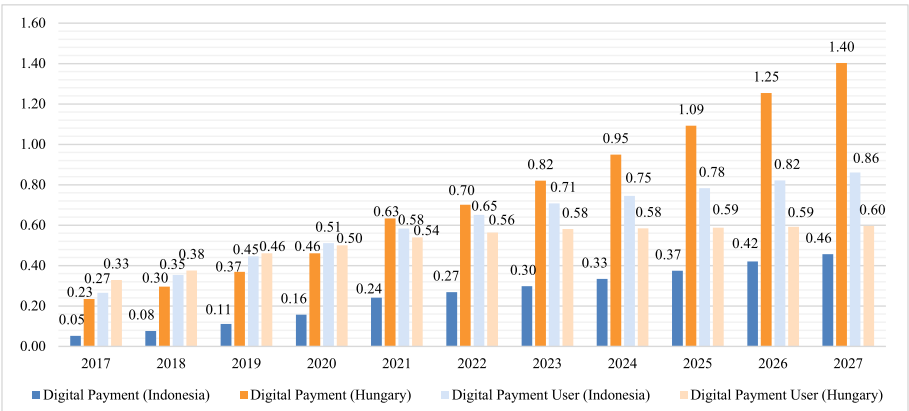



**Fig. 2** Comparison of Fintech transactions per capita

in the number of users embracing FinTech services, with the number of users reaching a significant milestone of 5.48 billion in 2023. With the continued growth of fintech, it is foreseeable that the amount of tangible cash circulating will significantly decrease as more individuals and businesses embrace digital financial solutions for their everyday transactions, thereby revolutionizing the global financial landscape. The rapid growth and significance of fintech development profoundly impact SMEs, as shown in Fig. 1, with rising transaction values in digital payments indicating a transformative shift in the global financial landscape.

Building on this, we make a comparison in Fig. 2, which presents fintech transactions (digital payments) per capita predictions in Hungary and Indonesia from 2017 to 2027. This comparison reveals a significant disparity in the adoption of FinTech services between the two countries. Indonesia shows a gradual increase in fintech transactions per capita, with an estimated value of 0.05 million USD in 2017 and reaching 0.46 million USD in 2027, and Indonesia has 0.27 million fintech users, which steadily increased to an estimated 0.86 million in 2027. Hungary's per capita fintech transactions

are projected to start at 0.23 million USD in 2017 and surge to 1.40 million USD by 2027, with 0.33 million fintech users in 2017, and are projected to reach 0.60 million users by 2027. While Hungary exhibits higher fintech transactions per capita and a more stable number of users, Indonesia shows promising growth in both fintech transactions and user adoption. As fintech continues to evolve and gain traction, it will likely play a pivotal role in fostering financial inclusion, promoting economic growth, and enabling SMEs to access a broader range of financial services efficiently and securely.

The increase in financial and technological innovations has led to growing scientific interest today. Technological innovation is one of the efforts to manage the financial sector efficiently as an effort to continue making economic improvements (Panizzolo 1998); however, if technological innovation cannot be maximized and managed properly, it will trigger risks such as money laundering, cyber fraud, and data breaches (Brychko et al. 2021); however, given the risks commonly associated with the FinTech industry, an investigation of its market size and market potential is highly important (Dorfleitner et al. 2017). The contribution of this article is that we have examined the issue of the effects of fintech development on sustainable economic development in response to digitalization pressures in the e-commerce sector. In line with the research of (Jourdan et al. 2023), a good understanding of fintech literacy is needed for the future development of SMEs to continue to exist and be able to synergize with economic development.

To date, no prior studies have investigated the associations between countries in terms of the TOE framework and FinTech concerning SMEs in the literature. TOE highlights the importance of the relationships among the technological, organizational, and environmental dimensions that interconnect and influence each other in the technology adoption process. The TOE framework helps understand how SMEs adopt financial technology by evaluating the availability and suitability of technologies such as mobile banking and blockchain (Technology), examining internal factors such as structure and readiness (Organization), and considering external influences such as market trends and regulations (Environment). By analyzing these dimensions, the TOE framework offers a comprehensive view of the factors affecting financial technology adoption by SMEs, promoting financial inclusion and business growth. According to (Hornuf and Haddad 2019), fintech is a new challenge for countries that are developing SMEs based on start-ups that can grow economically well supported by secure internet servers, mobile subtelephones that are described, also supported by a qualified workforce, but the gap regarding the continued growth of SMEs based on start-up business is still a challenge. Notably, although Indonesia has a large population and rapid economic growth, technology infrastructure and internet connectivity are still challenging in some areas, particularly in rural areas, whereas Hungary has better technology infrastructure and wider internet access than Indonesia, where internet connections are more stable and faster in general across the country. In organizational contexts such as government regulations and policies, there are still challenges in enforcing regulations and complying with data security and privacy standards in Indonesia, whereas in Hungary, the government has provided active support for financial technology innovation, and cooperation among the private sector, government and financial institutions has helped develop a stronger FinTech ecosystem. The technological environment in Indonesia is characterized by low levels

of trust in digital financial services in some segments of society, mostly among the elderly and in rural areas, whereas Hungarians are generally more open to new technologies, including fintech.

FinTech is growing rapidly in response to changes in technology and market needs. One of the main factors driving the development of fintech is the advancement of digital technology, such as the internet, cloud computing, and mobile devices. FinTech is also emerging as an alternative to traditional financial institutions, which are often less flexible and difficult to access, specifically for SMEs, which are affiliated with services such as E-Wallet, QR code payments, P2P (peer-to-peer) payments, payments via NFC (near-field communication) and international payments and remittance.

Exploring Hungary–Indonesia economic cooperation through events such as the Joint Commission on Economic Cooperation and the "Hun-IndoTech" business forum highlights the potential for leveraging mutual strengths. Indonesia's market diversity and Hungary's technological advancements pave the way for strategic partnerships that foster shared knowledge and growth. Moreover, aligning strategic IT, focusing on market orientation, and forming business partnerships significantly enhance SME performance indirectly by bolstering e-business capabilities, demonstrating the multifaceted benefits of international collaboration (Bi et al. 2017). Thus, this research provides practical benefits for policymakers, businesses, and academics concerning the understanding of the approaches and strategies of these countries to identify best practices, draw inspiration, foster meaningful partnerships that contribute to global technological advancement and economic prosperity, and develop a strategy to build SME engagement with the internet (Dholakia and Kshetri 2004). From an academic perspective, research on FinTech adoption in SMEs via the TOE framework has a broad and deep impact on business development, SME competitiveness, and economic policy. This study uses the technology-organization-environment (TOE) framework to show how technological and environmental factors play a significant role in driving fintech adoption, whereas organizational factors have less influence. In addition, this research reveals important differences in the dynamics of FinTech adoption in developed and developing countries, which provides new insights into digital SME transformation in different economic contexts. Comparative studies between developed and developing countries also provide useful insights for the adaptation of strategies and policies to suit local contexts. These impacts include improved efficiency, access to finance, product innovation, and financial inclusion, all of which contribute to the sustainability and growth of SMEs in the digital age. While there are few comparative studies specifically addressing FinTech adoption in both Hungary and Indonesia, we recognize the importance of grounding our research in the literature. According to research by Vijayagopal et al. (2024), this research provides an important foundation for understanding the differences between developing and developed countries in terms of fintech regulation and adoption, which was the initiation and starting point for the development of this article. Thus, this article bridges research and offers broader insight into the FinTech phenomenon in different social and economic contexts. Given these implications, academia can play an important role in supporting the development and application of FinTech for SMEs and ensuring that the benefits are widely felt by society as part of social and economic policies that support the development of an inclusive and sustainable FinTech ecosystem.

## Literature review

### TOE framework

The recent research on the TOE framework introduced by Gupta et al. (2022) is relevant for analyzing technology adoption at the organizational level, which bridges the theoretical gap by exploring process-related indicators of FinTech applications and their impact on sustainable performance outcomes, including efficiency, environmental considerations, sustainable technology orientation, and organizational value creation. The TOE framework, which is distinct from TAM and DOI, adopts a holistic view of technology adoption (Tolić et al. 2022). It evaluates the technical, organizational, and environmental factors critical for the integration of new technologies, offering a broader perspective for understanding and implementing innovation. In the socioeconomic context of small and medium–sized enterprises (SMSs), there is a close correlation between the innovation process and the technology-organization-environment (TOE) framework. For SMSs, the innovation process is often key to remaining competitive in a rapidly changing marketplace. TOE provides a systematic understanding of how technological, organizational and environmental factors interact and influence an organization's ability to innovate.

The TOE framework provides a valuable theoretical perspective for investigating FinTech adoption, encapsulating technological, organizational, and environmental indicators (Mahakittikun et al. 2021). Technological factors, such as relative advantages, compatibility, trialability, complexity, and observability, influence the decision to adopt financial technology (Awa et al. 2017; Qalati et al. 2020; Rahayu and Day 2015; Wibowo et al. 2022). There are many concepts about TOE, but on the basis of the theory of company evolution, an innovation that is both inbound and outbound in the company's organizational structure, including formalization, specialization, and centralization, has a positive relationship with the development of SMEs in the future (Gentile-Lüdecke et al. 2020). Organizational factors, including innovativeness, mobile payment knowledge, the IT infrastructure, organizational readiness, and top management support, play crucial roles in the adoption of social media-based fintech (Dadhich and Hiran 2022; Gupta et al. 2022; Lai 2012; Mahakittikun et al. 2021). With respect to environmental factors, government support involves regulations and policies influencing technological innovation adoption, whereas competitive pressure considers market demands and competitors' impact on FinTech adoption (Effendi et al. 2020). Market dynamics assess the complexity of financial markets in specific contexts, affecting FinTech adoption (Awa et al. 2017; Wibowo et al. 2022). The influence of industry structure on fintech adoption within the TOE framework is analyzed, and the organizational dogmatic environment impacts fintech adoption decisions (Moreira-Santos et al. 2022).

### FinTech

FinTech uses algorithm-based software technology to manage operational activities and financial systems efficiently (Berman et al. 2022). This digital financial technology addresses financial sector challenges, provides innovative solutions and enhances financial services (Tran et al. 2022). FinTech integrates digital economic business models and services across regions, promoting efficiency and accessibility (Varga 2017). Payment technologies such as debit cards and mobile money enable precise financial transactions

for consumers and retail companies (Agarwal et al. 2020). The magnitude of externalities resulting from FinTech adoption, particularly their effects on the technology threshold and network dynamics, presents challenges in measurement and analysis (Higgins 2020). While fintech technologies occasionally face technical challenges, their integration into business operations predominantly enhances efficiency and risk management. By comprehensively understanding and addressing potential risks, businesses can significantly mitigate them, improving overall fintech innovation (Li et al. 2022a, b). Strategically utilizing data assets enables these firms to improve risk evaluations, streamline operations, interact with clients effectively, and foster transparency. This strategic approach involves refining risk evaluations across different business domains, minimizing adverse selection, and enhancing general operational effectiveness (Bonvino and Giorgino 2024). Furthermore, in certain instances, its adoption can decrease human involvement in financial processes and business transactions, thereby reducing the risk of collusion or bribery, as evidenced by research indicating its potential to curb credit corruption (Su and Xu 2023). In the future, its application within SMEs can notably contribute to fostering green innovation and cultivating a positive corporate environment (Li et al. 2022a, b). A solid grasp of financial literacy enables individuals to comprehend the benefits and risks associated with these products and services (Gallego-Losada et al. 2021). With enhanced understanding, consumers, especially within the SME sector, are more inclined to explore and adopt financial technology solutions.

#### Hypothesis development

According to the previous literature, technological factors have significantly driven the increased adoption of digital financial technology. Previous studies conducted by Mahakittikun et al. (Mahakittikun et al. 2021) emphasized the relative advantages of technological factors, which was further supported by Nguyen et al. (Nguyen et al. 2022), who highlighted compatibility as a critical factor influencing adoption. Arifin and Frmanzah (Arifin and Frmanzah 2015) discussed the increasing complexity of technological innovations, offering sophisticated solutions to financial challenges. The focus on SMEs underscores how technological factors empower businesses and promote economic development, which aligns with the TOE framework's application in this research, reinforcing its scientific basis. Therefore, this research proposes the following hypotheses:

$H_1$ There is a significant effect of technological factors on the FinTech adoption of SMEs

The research also aims to reveal how organizational factors significantly affect fintech adoption. Previous studies have emphasized the importance of organizational factors in adopting financial technology. Gupta et al. (2022) used top management support, technological competence, and financial readiness indicators to assess FinTech adoption. These organizational factors play crucial roles in driving the adoption of FinTech solutions, especially among SMEs in both countries. The application of the TOE framework provides a solid theoretical basis, further supporting the following hypotheses:

$H_2$ Organizational factors have a significant effect on SMEs' fintech adoption.

The extant literature posits that environmental factors within the TOE framework exert a substantial influence on FinTech adoption. Rahayu and Day (2015) underscore the pivotal role of government support, competitive pressure, and market dynamics in shaping the adoption of technological innovations in the SME sector, improving the information available on the security of digital payment solutions, building public confidence in new features, and developing and implementing programs to improve the financial and digital skills of the population (Farkas et al. 2022). Government regulations can act as enablers or deterrents to FinTech adoption (Effendi et al. 2020). The significance of market dynamics is further corroborated (Ta and Lin 2023), elucidating the perpetual transformation of highly competitive and intricate markets. As such, this research aims to empirically investigate the following research hypotheses:

$H_3$ There is a significant effect of environmental factors on the FinTech adoption of SMEs.

The preceding literature highlights various aspects relevant to the comparative analysis of the geographical location of FinTech adoption. It stems from investigations into fintech adoption, which have focused predominantly on specific fintech sectors, such as crowdlending, and analyzes aspects such as investor behavior, loan default likelihood, and privacy preferences (Firmansyah et al. 2022; Urumsah et al. 2022; Utami et al. 2021; Varma 2019). The rise of technological advancements, peculiarly in mobile and smartphone usage, has revolutionized access to financial services, particularly in emerging economies. From a technological perspective, Hungary and Indonesia have experienced significant growth in information and communications technology (ICT) infrastructure, including the development of digital banking applications, financial technology platforms and solutions that have driven fintech growth through financial inclusion policies, support for technological innovation and collaboration with the private sector. This is evident through the innovation of mobile money services and the growing knowledge surrounding mobile payments (Hornuf and Haddad 2019). Furthermore, the growth of mobile payment services and the disruptive potential of fintech startups have been associated with technological advancements (Dorfleitner et al. 2017; Mariano et al. 2003). Amidst these transformative shifts, SMEs' adoption of the internet and ICTs has gained substantial momentum. Various factors, including firm characteristics, attitudes, past experiences, and external influences, have been identified as critical determinants shaping decisions, constituting a significant component of the organizational factor (Christian et al. 2020; Dholakia and Kshetri 2004; Mertzanis 2023; Siu 2001). This study customized the indicators representing the organizational factor to precisely correspond with the unique attributes of the SME research subjects Hungary and Indonesia. Both governments have taken steps to create a conducive business environment for fintech growth, introducing proinnovation policies, tax incentives and technology training. A stable economic and regulatory environment, as well as access to the European Union market, has driven the growth of fintech in Hungary, while the Indonesian government has also introduced

regulations that support fintech innovation and protect consumers covering digital payment services, peer-to-peer lending and block chain technology for business model sustainability in optimizing production and supply chains after COVID-19 (Guaita Martínez et al. 2022). This customization serves to unveil potential discrepancies in technological advancement between these two countries, which may influence fintech adoption rates (Bhutto et al. 2023). FinTech provides easier and more affordable access to financing for SMEs in both countries, enabling them to obtain funding, make payments and manage their finances more efficiently. Through a combination of fintech initiatives supported by the TOE framework and cross-border collaboration, the two countries can accelerate financial inclusion, strengthen SMEs and accelerate overall economic growth. Other previous studies, which concentrated on SMEs in Hungary and Indonesia, emphasized the importance of comprehending how environmental factors influence fintech adoption within the context of SMEs. This enhanced understanding substantially contributes to both economic expansion and the promotion of financial inclusion (Abbasi et al. 2021; Moreira-Santos et al. 2022). This collective body of research lays a robust foundation for the following hypotheses:

$H_4$ There is a significant difference in the effects of technological factors on FinTech adoption between SMEs in Hungary and Indonesia.

$H_5$ There is a significant difference in the effect of organizational factors on FinTech adoption between SMEs in Hungary and Indonesia.

$H_6$ There is a significant difference in the effects of environmental factors on FinTech adoption between SMEs in Hungary and Indonesia.

Drawing from the literature, a research framework is introduced to elucidate the connection between each dimension of the TOE framework and financial technology factors in both Hungary and Indonesia. Consequently, the conceptual model and research hypotheses framework depicted in Fig. 3 are developed to guide this study.

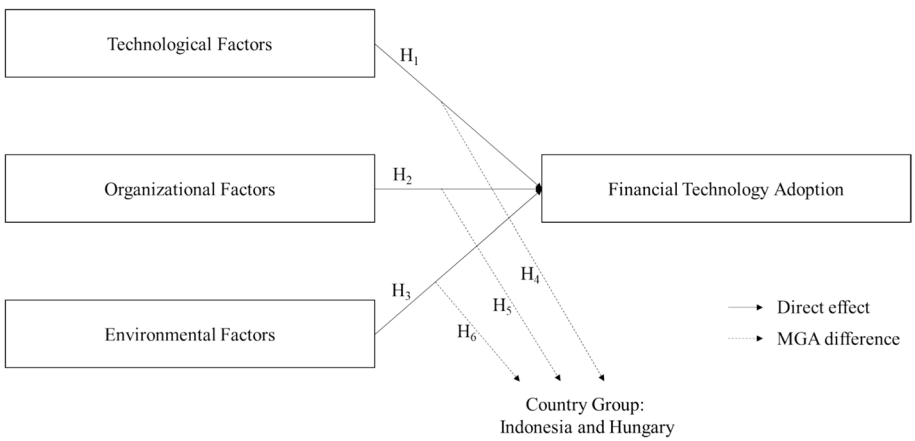



**Fig. 3** Research framework

## Methodology

### Research approach

We use a quantitative study for this research on fintech adoption by SMEs in Hungary and Indonesia, which is grounded in the need to systematically investigate the relationships among various factors influencing technology adoption. Quantitative methods allow for the objective measurement and analysis of data from a substantial sample size, ensuring the generalizability of the findings. In this research, we utilize the precise measurement of variables covered by quantitative methods to ensure objective and accurate measurement. This precision is crucial for testing hypotheses about the impact of these TOE factors on FinTech adoption. Another purpose of using a quantitative approach is statistical rigor. Since we use statistical hypothesis testing, the quantitative approach provides robust evidence of the relationships between variables to draw reliable conclusions about the determinants of FinTech adoption and the differences between Hungary and Indonesia. Finally, we use comparative analysis to compare FinTech adoption in two distinct socioeconomic contexts. Quantitative methods facilitate this by allowing for the systematic collection and comparison of data from SMEs in both countries on how different environments influence technology adoption (Datsii et al. 2021; Nguyen Phuc Hien et al. 2023). Quantitative methodologies enable researchers to systematically gather data on the utilization of digital financial technology in both Hungary and Indonesia in an impartial and quantifiable manner. This facilitates the identification of disparities in adoption trends, influencing factors, and their ramifications for the financial and economic sectors across the two countries. Quantitative approaches are widely regarded for their heightened validity and reliability in scientific inquiry. Through the implementation of structured research protocols and suitable measurement instruments, researchers can ensure the accuracy and dependability of the collected data. Such rigor is crucial within comparative analyses such as this, where the precision of data from both countries is essential for attaining a comprehensive understanding of the observed phenomena.

### Population, sample, and control variables

The quantitative survey used in this study made it possible to compare data between different groups systematically. This allows researchers to identify significant differences in behavior, preferences, or views between different groups. The purposive sampling technique was employed, and the survey was distributed both online and offline via the Microsoft Forms platform. Since this research relies on the respondents' perspectives, we incorporate control variables to account for potential confounding factors that might influence FinTech adoption. We made several justifications for the control variable to be used as one of our sampling techniques.

- Firm Size: Recognizing that company size can impact the ability to adopt new technologies, it was controlled to isolate its effect from other variables.
- Industry Sector: Different industry sectors may have varying levels of technology adoption due to specific industry needs and regulatory environments. Thus, the industry sector was included as a control variable.

- Geographical location: To account for regional differences within each country, geographical location was controlled. This helped ensure that the observed differences were not merely due to regional disparities.
- Age of the Firm: Older firms might have different adoption rates than newer firms due to established practices and resistance to change. This variable was included to control for such potential effects.

Therefore, out of 763 responses, only 423 met our criteria. After eliminating outlier data, 349 final responses remained. Upon reanalysis, we found that most respondents were from SMEs. Unlike in Hungary, SMEs are categorized as MSMEs (micro, small-, and medium-sized enterprises) in Indonesia. As a result, most microsized companies were excluded because of the given criteria and the presence of outlier data. Thus, we have a sample of 349 SME participants from various sectors, with 164 respondents from Hungary and 185 from Indonesia from March to June 2023. The data are organized by exploring the data to gain a better understanding of patterns, trends, and relationships between variables and then analyzed via SMART PLS software, including descriptive analysis to summarize data characteristics, inferential analysis to draw conclusions about a population on the basis of a sample, or predictive analysis to build a model that can represent the research objectives. SMEs often depend on seamless access to financial services to manage cash, pay operational costs, and invest in business growth. Therefore, this research involving SMEs from various sectors can provide valuable insights into FinTech adoption in various social and economic contexts. Our study focuses on SMEs integrating financial technology into their operations. The data collection process, including population, sampling, and distribution of questionnaires, was carried out in collaboration with esteemed professional organizations. Specifically, our Hungarian data are informed by insights from the Kft Institute of Nonprofit Agricultural Economics Hungary. These recommendations are grounded in the AKI Institute of Agricultural Economics research findings, leveraging their advanced research methodologies within the EU context. In Indonesia, classifications adhere to the Indonesian Central Statistics Agency's standards and collaborate with Sam Ratulangi University to ensure accurate data concerning SMEs across Indonesia. Our collaboration includes SMEs in sectors such as agriculture, hospitality, manufacturing, health and wellness, transport, and retail, working with associations and research bodies to access and analyze representative samples from both countries. This approach enriches our analysis with comprehensive and relevant data.

#### Rationale of choosing the research subject

Hungary countries and Indonesia have different economic and business contexts. Hungary, as a developed country in Europe, has a more mature fintech infrastructure and higher technology adoption rate than Indonesia, which is still experiencing rapid fintech market growth but may have different infrastructures and access. The technological and financial infrastructure in Hungary and Indonesia may differ significantly in terms of internet access availability, banking penetration, and digital financial services. However, this comparison makes it possible to understand how factors such as technological infrastructure, regulation, and market readiness affect the adoption of FinTech by

SMEs. The research target comprises a population of SMEs in Hungary and Indonesia with prior experience utilizing fintech. The quantitative survey used in this study made it possible to compare data between different groups systematically. This allows researchers to identify significant differences in behavior, preferences, or views between different groups. The purposive sampling technique was employed, and the survey was distributed online via the Microsoft Forms platform.

#### Procedural strategies to mitigate common method bias

We recognize the imperative need to ensure the validity and reliability of our findings, especially in light of common method bias (CMB). To address this concern, we applied integrated strategies both during the data collection phase and in our statistical analysis.

During the data collection, we took considerable steps to mitigate potential biases that could arise from the data-gathering method via the Memon et al. (2023) guidelines. To address CMB during data collection, we employ diverse Likert-type scales (8-scale measurements) and adjust anchors while preserving content validity, which offers a procedural safeguard—balancing item polarity without affecting the scale's conceptual integrity. Despite some debate, we use reverse-coded items as a method to increase participant attention and disrupt bias patterns during the interview, along with temporal, proximal, and psychological separation of variable items, further aiding in eliminating CMB and addressing social desirability bias.

For our statistical analysis, we rigorously applied PLS-SEM, a robust method that not only handles complex models but also facilitates the evaluation of CMB through the analysis of multicollinearity among constructs. Following the guidelines of Kock (2015), Gan and Lau (2024), and Memon et al. (Memon et al. 2023), we carefully reviewed the variance inflation factor (VIF) values within our model, adhering to a threshold of 3.3 or below. Our analysis revealed that the VIF values for the constructs of Environmental Factors (E), Organizational Factors (O), and Technological Factors (TC) to FinTech (Ft) were 2.2, 1.5, and 2.5, respectively—all below the critical threshold. Additionally, in alignment with prior research, we assessed model fit, as detailed in Table 5. This particular approach underscores a model largely unaffected by CMB, thereby reinforcing the credibility of our findings.

Furthermore, this study does not involve human experimentation; instead, it relies solely on the collection of opinions and perceptions about the research variables. Importantly, the data collection process is voluntary, ensuring that respondents provide their input without coercion. Moreover, no financial incentives or gifts are offered in exchange for participation, and all the respondents' explicit consent is diligently obtained before their involvement in the study. To ensure the anonymity and confidentiality of the participants, all participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time. We collected informed consent from all participants, both verbally and in writing. To address the data anonymization, we ensured that the responses were anonymized, ensuring that individual participants could not be linked to their responses. Thus, respondents have the right to refrain from answering questions that involve personal data or are of a personal nature, even if such questions are included in the questionnaire. Furthermore, the data

collected were stored securely on a separate hard drive detached from online access, with access restricted only to the research team.

Table 1 presents the characteristics of the respondents and provides essential information about the participants in the research, such as demographic details such as age, gender, educational background, business type, and country, which may influence the research outcomes.

### Data analysis and variable measurements

This research uses partial least squares structural equation modeling (PLS-SEM), which was originally developed by Herman Wold in (Wold 1963), and has gained widespread application across various disciplines, including psychology, economics, and sociology (Dijkstra 2010). Two common estimation techniques are employed in SEM: covariance-based structural equation modeling (CB-SEM) and PLS-SEM. PLS-SEM offers several advantages over CB-SEM, particularly when dealing with small sample sizes. It demonstrates greater robustness in scenarios with limited data, making it suitable for theory development and predictive analysis while avoiding inadmissible solutions and factor indeterminacy (Hair et al. 2014; Fornell and Larcker 1981; Shmueli et al. 2019). In this study, PLS-SEM via SmartPLS was chosen to analyze the conceptual model, leveraging

**Table 1** Characteristics of the respondents

| | Frequency | (%) |
|---|---|---|
| Country | | |
| Hungary | 164 | 47.0 |
| Indonesia | 185 | 53.0 |
| Gender | | |
| Male | 223 | 63.9 |
| Female | 126 | 36.1 |
| Education | | |
| Under graduates with less than 6 years formal education | 8 | 2.3 |
| Under graduates with more than 6 years formal education | 12 | 3.4 |
| Under graduates with more than 10 years formal education | 70 | 20.1 |
| Graduates | 202 | 57.9 |
| Vocational study | 57 | 16.3 |
| Age | | |
| < 30 years old | 8 | 2.3 |
| 30–35 years old | 5 | 1.4 |
| 36–40 years old | 76 | 21.8 |
| 41–45 years old | 199 | 57.0 |
| 46–50 years old | 45 | 12.9 |
| > 50 years old | 16 | 4.6 |
| Business type | | |
| Hospitality and Tourism | 18 | 5.2 |
| Agriculture and Farming | 183 | 52.4 |
| Manufacturing | 60 | 17.2 |
| Health and Wellness | 18 | 5.2 |
| Transportation and Logistics | 18 | 5.2 |
| Retail and Wholesale | 52 | 14.9 |

*Source*: Author data processing from data tabulation, 2023

its ability to estimate the measurement model and conduct multigroup analysis (MGA) to investigate group differences (Cheah et al. 2023). MGA encompasses advanced techniques commonly used to explore variations between categorical variables, such as gender or country, or continuous variables that have been categorized through dichotomization or cluster analysis (Hair et al. 2019). Within the PLS-SEM framework, PLS-MGA allows researchers to investigate and assess meaningful differences in structural paths across multiple groups (Matthews 2017). The PLS-MGA aligns with the research aiming to gain valuable insights into the impact of the TOE framework on FinTech adoption and to elucidate any significant disparities between Hungary and Indonesia in this regard among SMEs in both countries.

This research employed 4 variables (see Table 2). All scales were measured via an 8-point Likert scale (1 = Strongly Disagree; 8 = Strongly Agree).

## Research findings

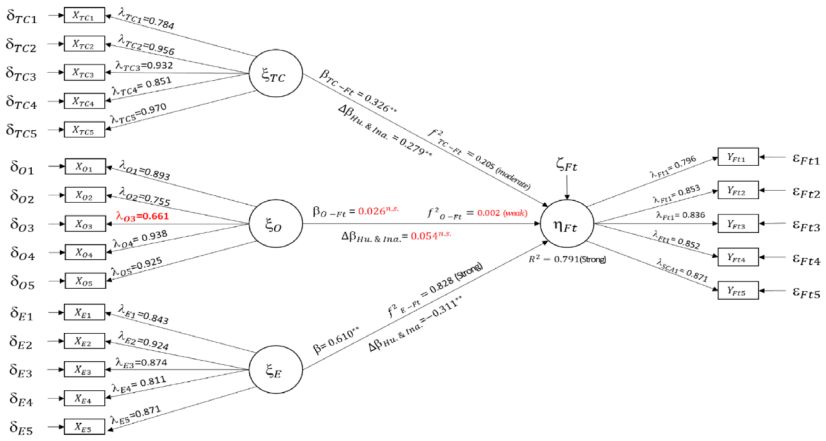
Following the recommendations outlined through research (Malca et al. 2020) and (Ciavolino et al. 2023), this study employs the PLS-MGA approach, which involves the assessment of both the outer model measurement and the inner model evaluation through PLS-MGA analysis. Figure 4 illustrates the application of PLS-SEM with MGA analysis, which employs a reflective indicator model measurement in which variations in the latent construct are presumed to influence changes in the observed indicators.

The interpretation of the measurement evaluation is explained in the following subsections.

**Table 2** Constructs, Indicators, and Factor Loading

| Constructs | Indicators | Items | Factor loading |
|---|---|---|---|
| Technological factors | Relative advantages | TC1 | 0.784 |
| | Compatibility | TC2 | 0.956 |
| | Trialability | TC3 | 0.932 |
| | Complexity | TC4 | 0.851 |
| | Observability | TC5 | 0.97 |
| Organizational factors | Innovativeness | O1 | 0.893 |
| | Mobile payment knowledge | O2 | 0.755 |
| | IT infrastructure | O3 | 0.661 |
| | Organizational readiness | O4 | 0.938 |
| | Top management support | O5 | 0.925 |
| Environmental factors | Government support | E1 | 0.843 |
| | Competitive pressure | E2 | 0.924 |
| | Industry structure | E3 | 0.874 |
| | Competitors | E4 | 0.811 |
| | Market dynamics | E5 | 0.871 |
| FinTech | Software for operational and financial activity | Ft1 | 0.796 |
| | Digital financial technology | Ft2 | 0.853 |
| | Digital economic business models and services | Ft3 | 0.836 |
| | Payment technologies for precise financial transactions for consumers and retail companies | Ft4 | 0.852 |
| | Magnitude of externalities and its effects on business | Ft5 | 0.774 |

*Source*: Author data processing from previous research and data analysis, 2023




*X*: manifest variables for exogenous
λ: lambda
Δ: capital letter delta (represents the difference between groups or the changes in lambda)
η: eta (endogenous variable notation)
ε: epsilon (measurement error for endogenous indicators)

*Y*: manifest variables for exogenous
ξ: ksi (exogenous variable notation)
δ: small letter delta (measurement error for exogenous indicators)
β: path coefficients
ζ: zeta (measurement error for endogenous)

**Fig. 4** Results of the PLS-MGA Model

### Outer model measurement

This research employed outer loading and cross-loading analyses to assess the relationships between the latent constructs and their observed indicators and the relationships between latent constructs and indicators not belonging to them. According to Hair et al. (2019), convergent validity evidence is met with CR values of 0.7 or greater, standard factor loading λ is 0.5 or greater, and AVE values are 0.5 or greater. The findings depicted in Fig. 4 demonstrate that most indicators exhibited satisfactory loadings above 0.7, signifying a strong relationship with their respective constructs. However, one indicator, O3, displayed a loading factor below 0.7, indicating a weak connection with its designated construct. Consequently, this research will exclude indicator O3 from the analysis to maintain the measurement model's reliability and validity, to pay more attention to construct validity in general and to conduct more stringent assessments of construct measurement qualities (Jarvis et al. 2003).

The outer model measurement in the PLS-SEM analysis was assessed via the Fornell–Larcker criterion, as shown in Table 2. The Fornell–Larcker criterion indicates the square root of the average variance extracted (AVE) for each construct along the diagonal and the correlations between the constructs (Fornell and Larcker 1981). The results show that the AVEs for all the constructs of environmental factors (E), fintech (Ft), organizational factors (O), and technological factors (TC) are greater than the interconstruct correlations are, supporting discriminant validity, in line with research (Henseler et al. 2015) highlighting that the Fornell–Larcker criterion is the dominant approach for evaluating discriminant validity. Overall, the results suggest that the measurement model exhibits strong discriminant and convergent validity, indicating that the constructs are distinct and adequately represent their respective indicators.

The Fornell–Larcker method can be used to identify and reduce potential bias in this study by evaluating the discriminant validity between latent variables in the structural

**Table 3** Fornell–Larcker criterion

| Fornell-Larcker criterion | | | | |
|---|---|---|---|---|
| | **E** | **Ft** | **O** | **TC** |
| E | 0.865 | | | |
| Ft | 0.862 | 0.823 | | |
| O | 0.51 | 0.533 | 0.841 | |
| TC | 0.734 | 0.789 | 0.601 | 0.901 |

*Sources*: Data processing, 2023

**Table 4** Hypothesis testing and structural evaluation results

| **Hypothesis** | | **Original sample (O)** | **T Statistics** | **P Values** | $f^2$ | **Decision** |
|---|---|---|---|---|---|---|
| **$H_1$** | **TC–Ft** | **0.610** | **12.463** | **0.00** | **0.205** | **Accepted** |
| $H_2$ | O–Ft | 0.026 | 0.951 | 0.34 | 0.002 | Rejected |
| $H_3$ | E–Ft | 0.326 | 6.081 | 0.00 | 0.828 | Accepted |
| | | | $R^2$ | Ft = | 0.797 | Strong |

*Sources*: Data processing, 2023

model. The discriminant validity value in Table 3, which is greater than 0.7, shows how well the latent variables in the model differ from each other and that the interpretation of the analysis results is more accurate and reliable.

### Structural inner model evaluation

Following the guidelines of previous research, this study evaluates the inner model by analyzing the coefficients of determination ($R^2$), effect sizes ($f^2$), and goodness of fit (GoF), along with tests of significance, to present a more reliable and comprehensive representation of the data. This approach helps to avoid misleading conclusions on the basis of a single fit index and enhances the model's reliability and validity. The results of the inner model evaluation are presented in Table 4.

This study utilizes coefficient determination ($R^2$) and its effect size ($f^2$) to evaluate the practical significance of specific construct relationships. The optimal $R^2$ coefficient value depends on the research domain, with a baseline threshold of 0.10. Values exceeding this threshold fall into distinct categories: weak (0.10–0.19), moderate (0.20–0.33), substantial (0.34–0.67), and strong (0.68–1.00) (Hair et al. 2014; Henseler et al. 2009). Similarly, for $f^2$, prior researchers have suggested that values of 0.02, 0.15, and 0.35 correspond to small, medium, and large effect sizes, respectively (Chin and Newsted 1998; Henseler et al. 2009).

Table 4 portrays the $R^2$ pertaining to the financial technology (Ft) construct within the framework of structural equation modeling. With an $R^2$ value of 0.797, the inference drawn is that approximately 79.7% of the variance counted in the observed indicators, representing the Ft construct, can be elucidated through the underlying latent variables of technological factor (TC), organizational factor (O), and environmental factor (E). While no shared variance exists between O and Ft, the $f^2$ value significantly supports the model evaluation. The $f^2$ between E and Ft is substantial, with a high value of 0.828,

followed by the $f^2$ of TC, and Ft displays a moderate effect size with a value of 0.205. These results implied a substantial predictive ability, indicating that the combined effects of the model's construct significantly elucidate the observed variability. Consequently, this underscores a robust interrelation between the constructs, substantiating the model's commendable alignment with the observed data for the Ft construct.

In addition to the $R^2$ and $f^2$ results, Table 4 provides the outcomes of the hypothesis tests for complete construct relationships. $H_1$, which postulates a relationship between TC and Ft, is supported through a coefficient value of 0.610, accompanied by a statistically significant p value below the threshold of 0.05. Conversely, $H_2$ is not substantiated, given that its p value exceeds 0.05 at 0.34. In contrast, $H_3$ garners acceptance, backed by a coefficient value of 0.326 and a p value below the standard threshold of 0.05. Further comparative analysis using the MGA is described in the following subsection.

To validate the structural model, evaluating the model fit indices for both a saturated and estimated model becomes essential, as depicted in Table 5.

Table 5 presents model fit indices for the saturated model and estimated model. The SRMR (Standardized Root Mean Residual) value of 0.079 indicates a reasonable fit for the model residuals. The d_ULS and d_G indices, which measure model discrepancy, have values of 1.295 and 1.929, respectively, suggesting a moderate level of discrepancy. The chi-square statistic, which is used to assess overall model fit, is 2887.202, whereas the normed fit index (NFI) is 0.673, although it is less than 0.9, still indicating a moderate fit to the data. Additionally, the rms Theta value is 0.247, which reflects the structural model's accuracy. In summary, the model fit indices for the saturated model suggest a reasonable fit in terms of residuals and overall model fit, with a moderate level of discrepancy and acceptable accuracy in representing the data.

### PLS–MGA analysis

Another objective of this research is to analyze and compare the structural paths between Hungary and Indonesia. This analysis seeks to offer insights into the statistical significance of the observed differences between these two groups. Table 6 presents the outcomes of a structural path analysis to signify the relationships between latent constructs and enable the evaluation of the original path coefficients, along with their standard deviations, t values, and p values.

In the context of the interplay between the Environmental Factor (E) and the Financial Technology (Ft) construct, Table 6 shows that the path coefficient for Hungary stands at 0.408, which contrasts with the notably higher coefficient of 0.719

**Table 5** Model fit

| | Saturated model | Estimated model |
|---|---|---|
| SRMR | 0.079 | 0.079 |
| d_ULS | 1.295 | 1.295 |
| d_G | 1.929 | 1.929 |
| Chi-Square | 2887.202 | 2887.202 |
| NFI | 0.673 | 0.673 |
| rms Theta | 0.247 | |

*Sources*: Data processing, 2023

**Table 6** Structural path coefficients for group classification in Hungary and Indonesia

| Group classification | Structural path | Path coefficients original | Path coefficients mean | STDEV | t Value | p Value |
|---|---|---|---|---|---|---|
| Hungary | TC–Ft | 0.519 | 0.518 | 0.066 | 7.877 | 0.000 |
| | O–Ft | 0.041 | 0.045 | 0.035 | 1.159 | 0.247 |
| | E–Ft | 0.408 | 0.408 | 0.063 | 6.508 | 0.000 |
| Indonesia | TC–Ft | 0.240 | 0.251 | 0.073 | 3.294 | 0.001 |
| | O–Ft | − 0.013 | − 0.010 | 0.041 | 0.325 | 0.745 |
| | E–Ft | 0.719 | 0.711 | 0.066 | 10.883 | 0.000 |

*Sources*: Data processing, 2023

for Indonesia. This difference holds statistical significance, evident through t values of 7.877 and 10.883 for Hungary and Indonesia, respectively, both accompanied by p values of 0.000. These results suggest a more robust E-Ft relationship within the Indonesian context. This relationship is relatively similar to the relationship between the technological factor (TC) and Ft, which is significantly different between the two groups, with path coefficients of 0.519 for Hungary and 0.240 for Indonesia. The t values for both comparisons are 7.877 and 3.294, respectively, with p values of 0.000 and 0.001, indicating substantial variations in the strengths of these relationships. Conversely, the relationship between the Organizational Factor (O) and Ft does not demonstrate significant differences between the two groups, as indicated by the t value of 0.325 and the p value of 0.745.

We additionally choose Hungary and Indonesia as control variables to investigate the effects of the technology-organization-environment (TOE) framework on financial technology (Ft) adoption. This selection is not merely geographical but also strategic in terms of the nuanced tapestry of economic, cultural, and regulatory differences that characterize each nation. Hungary, with its European backdrop, offers a context of advanced financial infrastructures, robust regulatory frameworks, and high financial literacy. Conversely, Indonesia represents a contrasting narrative from Southeast Asia, marked by its status as an emerging economy, varying levels of financial literacy, and distinct regulatory and technological landscapes. The rationale behind these choices is to harness these differences, enabling a rich, comparative analysis of how contextual variables shape the adoption of FinTech solutions.

The essence of incorporating Hungary and Indonesia as control variables lies in their potential to elucidate the multifaceted influences on the effectiveness of the TOE framework in predicting FinTech adoption. This decision allows for a nuanced examination of how technological readiness (T), organizational capacities (O), and the external environment (E) interact differently within these distinct contexts to influence FinTech adoption rates (Ft). By analyzing these dynamics, our research uncovers not only the direct effects of TOE variables on FinTech adoption but also how these effects are modulated by the unique characteristics of each control variable, Hungary and Indonesia.

For example, the technological context (TC) in Hungary, evidenced by its significant positive influence on FinTech adoption, mirrors the country's high level of

technological advancement and infrastructure, which likely facilitates a smoother integration of FinTech services. This contrasts with Indonesia, where the positive influence of TCs is markedly weaker, potentially reflecting the challenges and opportunities within an emerging market's evolving technological landscape. This variance in the impact of TCs across the two countries highlights how local technological readiness can amplify or dampen the adoption of financial technologies.

Similarly, both countries' organizational context (O) has a negligible influence on FinTech adoption, suggesting that internal organizational dynamics may play a less critical role in FinTech adoption than may technological and environmental factors. This finding underscores the possibility that, across diverse economies, organizations' internal capabilities or readiness to adopt new technologies might be overshadowed by more pressing technological and environmental considerations.

On the other hand, the environmental context (E) presents a stark difference between the two countries. In Indonesia, E's pronounced positive effect on fintech adoption suggests that external pressures, such as regulatory policies and market demand, are significant drivers in emerging markets. In contrast, the substantial but lesser magnitude of E's influence in Hungary indicates that while external factors are important, their role is modulated by the country's more stable and developed economic environment.

Additionally, to substantiate the outcomes of these comparative results, establishing a structural model comparison between the two countries is imperative. This step is necessary to find statistical evidence to support hypotheses 4, 5, and 6 via multigroup analysis (MGA), as presented in Table 7**.**

Table 7 presents the results of the analysis conducted to examine the differences in structural model assessment between Hungary and Indonesia for the tested hypotheses. In the context of Hypothesis $H_4$, which delves into the impact of TC on Ft, the computed path coefficient difference stands at 0.279. This difference was statistically significant, as indicated by a p value of 0.004. Consequently, since this p value falls below the conventional threshold of 0.05, Hypothesis $H_4$ is supported by the findings of this research. The positive difference indicates that the path coefficient for this relationship is greater in Hungary than in Indonesia, suggesting that Hungary has a more substantial relationship with the effect of the Tc on Ft.

Hypothesis $H_5$ examines the effect of O on Ft. The path coefficient difference is 0.054, and the p value is 0.312. With a positive path coefficient difference, this implies that the relationship between O and Ft is stronger in Hungary than in Indonesia. However, the result is not statistically significant, indicating that this difference is potentially due to random variation. Thus, $H_5$ is rejected.

**Table 7** Multigroup structural analysis via PLS-MGA (cross-country comparison between Hungary and Indonesia)

| Hypothesis | | Path coefficients-difference | p Value |
|---|---|---|---|
| **$H_4$** | **TC–Ft** | **0.279** | **0.004** |
| $H_5$ | O–Ft | 0.054 | 0.312 |
| $H_6$ | E–Ft | − 0.311 | 0.000 |

*Sources*: Data processing, 2023

In the context of Hypothesis $H_6$, which seeks to examine the influence of E on Ft, the calculated path coefficient difference is -0.311. The negative value of the path coefficient difference implies that the relationship between E and Ft is more robust in Indonesia than in Hungary. This outcome suggests that the environmental conditions in Indonesia play a more significant role in driving the adoption of financial technology among SMEs than those in Hungary do. The p value of 0.000 signifies strong statistical support for Hypothesis $H_6$ in this research.

## Discussion

Hypothesis 1 shows that the technological factor has a significant effect on FinTech adoption. These findings indicate that technological factors, with indicators of relative advantages, compatibility, trialability, complexity, and observability, significantly influence the adoption of FinTech. This research revealed that digital financial technology, driven by its relative advantages and compatibility with existing practices, has transformed the financial sector, leading to increased adoption by financial institutions, consumers, and SMEs, which is in line with previous research (Mahakittikun et al. 2021; Setiyani et al. 2021; Varma 2019). Additionally, this research revealed the importance of the complexity of FinTech solutions, which impacts users' willingness to engage with the technology (Vanninen et al. 2022). Despite efforts, insight into how SMEs respond to fintech opportunities appears to be limited (Sharma et al. 2023), and the results show a robust positive effect of fintech development on firms' innovative activities (Li et al. 2023). From a technological perspective, the role of fintech is very strategic in encouraging the internationalization of entrepreneurship among those countries, with a particular focus on the impact of crowd funding, peer-to-peer lending and online banking (Cumming et al. 2023) and effectively alleviating the financing constraints of SMEs, and this phenomenon is very significant for SMEs (Li et al. 2022a, b).

Contrary to Hypothesis 2, the research findings do not support the hypothesis that organizational factors significantly influence fintech adoption. Previous studies have emphasized the importance of factors such as top management support, organizational readiness, and organizational competencies, which are not consistently significant in this research. Gupta et al. (Gupta et al. 2022) suggested that while top management support can be crucial in driving fintech adoption, its impact can vary depending on the organization's structure and strategic orientation. Extensive experience, the availability of infrastructure, the accumulation of intellectual capital, human resource capabilities, and flexible and agile capabilities with legislation provide ideal conditions for fintech development for SMEs in Hungary, which is in line with prior research (Sharma et al. 2023). In contrast to Hungary, the challenges for fintech adoption in Indonesia include a human resource base that is not fully prepared, lower levels of technological proficiency among the general populace, and a fintech sector that tends to be exclusive. These challenges are highlighted by Kliber et al. (Kliber et al. 2021), who note the uncertainty regarding the future availability of skilled workers and the lack of proper legal frameworks. Mahmud et al. (Mahmud et al. 2023) further underscore the hesitancy among SMEs to adopt FinTech services due to concerns about security, data privacy, insufficient government regulation, and high barriers to intuitive service use. The complexity of the relationship between organizational factors and FinTech adoption is evident from the

fact that their significance can be mitigated by factors such as government regulations and market dynamics, which also shape the adoption landscape (Effendi et al. 2020; Póta and Becsky-Nagy 2022; Qalati et al. 2020; Rahayu and Day 2015; Varma 2019), further supporting Hypothesis 3.

This research also accepts Hypothesis 3 regarding the effect of environmental factors on fintech. The statistical results indicate that environmental factors significantly influence fintech adoption, including government support, competitive pressure, and market dynamics. Government regulations, supportive policies, and competitive pressures impact the decision to adopt technological innovations in the financial sector (Dadhich and Hiran 2022; Effendi et al. 2020). The dynamic nature of financial markets and the regulatory environment shape the FinTech adoption landscape. These findings align with the conceptual framework of the TOE, which includes environmental indicators as essential determinants of technology adoption (Oliveira and Martins 2010). Environmental factors, including government support and eco-friendly regulations, are significant in encouraging FinTech adoption among SMEs, which has been supported by findings from Tian et al. (Tian et al. 2023). Their research demonstrated a positive correlation between FinTech adoption and sustainable innovation among SMEs, suggesting that such technologies can drive policies on energy efficiency and promote sustainable business models. This indicates the broader role of fintech beyond financing, contributing to environmental sustainability goals in both countries.

In Hypothesis 4, a unique Hungary–Indonesia comparison reveals a significant difference in the impact of technological factors on FinTech adoption. Hungary outperforms Indonesia in that it has a stronger relationship between these factors and FinTech adoption. This finding aligns with prior research emphasizing the crucial role of technology in FinTech adoption (Al-Jabri and Sohail 2012; Chiu et al. 2017; Gholami et al. 2018; Lian et al. 2014; Wang et al. 2008). Notably, the rapid growth of mobile payment services highlights the role of technology in enhancing financial accessibility and precision (Agarwal et al. 2020), especially in Hungary and Indonesia (Mahakittikun et al. 2021). Hungary's superior position over Indonesia in terms of the influence of technological factors on fintech adoption is underscored by concrete collaborative initiatives and the evolving technological landscape. A significant stride in Hungary's foreign economic strategy is witnessed through its collaboration with Indonesia, where Indonesia learned the advanced technology of fintech from Hungary, such as collaboration on a groundbreaking electronic road toll system project; the Hungarian–Indonesian state-level cooperation agreement in the domain of blockchain technologies signifies Hungary's proactive engagement with Indonesia's burgeoning technology hub; and many more. Amidst the evolving landscape of technological collaboration and advancements, Hungary's adeptness in technological contributions for pivotal projects and its advantageous position over Indonesia concerning the impact of technological factors on FinTech adoption, as proposed by Hypothesis 4.

Assessing Hypothesis 5, the observed path coefficient difference and corresponding p value suggest that the relationship between organizational factors and FinTech adoption is seemingly stronger in Hungary than in Indonesia. This finding aligns with prior research exploring the influence of organizational factors on technology adoption. For example, studies by Rogers et al. (Rogers et al. 2019) and Bajunaied et al. (Bajunaied et al.

2023) emphasize the importance of organizational factors in adopting new technologies. Additionally, Dholakia and Kshetri (Dholakia and Kshetri 2004) and Singh et al. (Singh et al. 2020) underscore the role of firm characteristics, attitudes, and external influences in shaping technology adoption decisions. However, it is essential to note that the result is not statistically significant (p value = 0.312), which could be attributed to random variability. This nonsignificant result may also be associated with the lack of significance in the corresponding finding in Hypothesis 2, which explores the relationship between organizational and fintech. The insignificant relationship between these two variables contributed to the lack of statistical significance in the observed difference in the relationship between organizational factors and FinTech adoption across Hungary and Indonesia. These findings highlight the complexity of the interplay between various factors and the need for further investigation with a larger sample size to ascertain the significance and consistency of the observed differences, as explored in Hypothesis 5.

The observed dynamics in the influence of environmental factors on fintech adoption, as explored through Hypothesis 6, resonate with existing research that highlights the intricate interplay between contextual conditions, government trust, market competition, and firm structures in shaping technology adoption (Lee and Tan 2019; Odei-Appiah et al. 2022; Singh et al. 2020). In the Indonesian context, where there is a prevalently higher level of trust in the government than in Hungary does, this trusting atmosphere may foster a conducive environment for FinTech adoption, as government support and regulations can play a pivotal role in encouraging SMEs' engagement with technology (Prasanna et al. 2019; Rajala and Hautala-Kankaanpää 2023). Moreover, the relatively easier competition within the Indonesian market might create an environment where SMEs are more willing to embrace FinTech solutions to gain a competitive advantage. The structure of firms in Indonesia, characterized by agility and adaptability, could also amplify the effect of environmental factors on fintech adoption, as these traits enable quicker technology integration (Nugraha et al. 2022; Wahyuni and Sara 2020). This previous research aligns with the negative path coefficient difference, indicating a more robust relationship between environmental factors and FinTech adoption in Indonesia. The p value obtained in this research further substantiates these findings, highlighting the significance of these contextual elements and their influence on FinTech adoption among SMEs in different geographical settings. Thus, this study underscores the need for targeted strategies that consider the unique interplay of environmental factors and trust dynamics within each context to foster successful fintech adoption initiatives.

#### Contribution to the body of knowledge

This study contributes significantly to the existing body of knowledge by employing a comprehensive analysis approach to evaluate the practical significance of construct relationships in the context of FinTech adoption. Using coefficient determination ($R^2$) and effect size ($f^2$) provides a nuanced understanding of the relationships between technological, organizational, and environmental factors and their impact on FinTech adoption. The findings align with previous research, illustrating the pivotal role of technological factors in FinTech adoption (Bo Huang and Philp 2019; Lv et al. 2022; Wong et al. 2020). The minor role of organizational factors highlighted in the current study emphasizes their contextual dependence in influencing fintech adoption (Gupta et al. 2022;

Moreira-Santos et al. 2022). Furthermore, the substantial impact of environmental factors, including government support, competitive pressure, and market dynamics, on FinTech adoption echoes previous research on the interplay between the TOE framework and technology adoption (Firmansyah et al. 2022; Nugraha et al. 2022; Rahayu and Day 2015). Notably, the comparison between Hungary and Indonesia in terms of the technological, organizational, and environmental factors that influence FinTech adoption provides novel insights into the interplay of these factors within distinct socioeconomic and regulatory contexts. The findings highlight the potential influence of trust in the government, market competition, and firm structure on FinTech adoption, aligning with prior research on the impact of these factors on technology adoption (Lee and Tan 2019; Mahmud et al. 2023; Urumsah et al. 2022). Overall, this research enriches the understanding of fintech adoption by considering diverse factors and contextual dynamics, contributing to the formulation of targeted strategies for successful fintech implementation in various environments.

#### Managerial implications

These research findings provide valuable insights for SMEs adopting FinTech solutions in different contexts with significant managerial implications, particularly for SMEs operating within different environments. The findings shed light on the varying strengths of the relationships between environmental factors and FinTech adoption in different regions, specifically Hungary and Indonesia. For SMEs in Hungary, the significantly lower path coefficients between environmental characteristics and FinTech adoption may indicate that the local context has less influence on technology adoption decisions. This condition could be caused by a number of variables, including technological maturity in the financial sector and various market trends. The emphasis is on determining the unique benefits and suitability of FinTech solutions with the current operating framework. Despite the potential lack of effect from environmental variables, SMEs in Hungary should monitor legislative developments and technical advances in the fintech field, as these may present possibilities to improve operational efficiency and consumer engagement. However, for SMEs in Indonesia, the larger path coefficient and strong association between environmental factors and FinTech adoption highlight the importance of contextual conditions in driving technology adoption. Existing trust in the government and somewhat easier competitive conditions in Indonesia can provide a favorable atmosphere for SMEs to use fintech technologies. Government assistance and favorable legislation can instill confidence and incentives in SMEs to use fintech, whereas less intense competition can encourage them to use the technology to achieve a competitive edge. SMEs in Indonesia can take advantage of these advantageous conditions by actively exploring and incorporating FinTech technologies into their operations. This strategy may involve collaboration with fintech companies, participation in government-backed projects, and ongoing monitoring of developments in the fintech landscape. FinTech holds significant promise in fostering an inclusive economy through broadening the reach of financial services, fostering financial innovation, enhancing financial education, mitigating economic disparities, and improving the effectiveness and openness of financial dealings. As technology advances and fintech becomes more prevalent, a greater number of individuals and enterprises can engage in economic

activities, potentially fostering more fair and enduring economic development. Therefore, promoting inclusive economics is crucial for fostering the uptake of FinTech among SMEs in Hungary and Indonesia. An inclusive economy plays a vital role in enhancing the resilience of SMEs, facilitating more equitable and sustainable economic progress. It achieves this goal by enhancing access to financial services, empowering grassroots economies, reducing financial volatility, and fostering innovation through broader financial service offerings, improved efficiency and affordability, tailored product offerings, and enhanced access to financing. These advancements not only benefit consumers and businesses by providing convenient and personalized financial solutions but also promote overall economic advancement and inclusivity.

Furthermore, the findings highlight the importance of technological factors for fintech, highlighting their consistent and substantial impact across both regions. This result implies that regardless of contextual differences, SMEs can significantly benefit from embracing technological advancements in their financial operations. SMEs should actively explore how FinTech solutions can offer advantages such as cost savings, improved accuracy, and enhanced customer experiences. Through this research, academics can provide valuable insights for stakeholders, regulators, and businesses to understand the implications of FinTech adoption by SMEs in Hungary and Indonesia and design appropriate policies and strategies to support the development of an inclusive and sustainable FinTech ecosystem. This involves analyzing the accessibility, sustainability and socioeconomic impact of fintech use in improving access to financial services for small and underserved business segments. Collaborating with technology providers and remaining informed about emerging FinTech trends can position SMEs to harness the benefits of technological innovation.

In contrast, the lack of significant differences in the relationship between organizational factors and FinTech adoption between the two regions suggests that these factors might consistently impact diverse environments. Although the impact of organizational factors might be less context specific, SMEs should recognize their importance. Factors such as top management support, readiness, and competencies can be crucial in successfully implementing FinTech solutions. SMEs should strive to create a supportive organizational culture and build internal capabilities to adopt and integrate FinTech effectively. Thus, the adoption of FinTech by SMEs can significantly support their operational resilience by increasing their operational efficiency, diversifying their land resources, expanding their access to markets, and increasing their management risk.

## Conclusion

In summary, this study explored the intricate dynamics of the technological, organizational, and environmental factors influencing the adoption of financial technology by SMEs in Hungary and Indonesia. The research findings significantly contribute to understanding the impact of these factors on fintech adoption and underscore the importance of considering contextual nuances when devising adoption strategies. The study emphasizes the critical role of technological variables in both settings, highlighting the universal advantages of leveraging technological advancements in a global economy dominated by multinational corporations. Collaborative efforts with major corporations can enhance market access for SMEs, potentially boosting their income

and diversifying revenue streams, thus enhancing their operational resilience. Consequently, the synergy between major corporations and operational resilience can serve as a catalyst for promoting FinTech adoption among SMEs in Hungary and Indonesia. By fostering collaboration, facilitating knowledge transfer, expanding market access, and providing financial support, major firms can bolster the operational and financial capabilities of SMEs, enabling them to more effectively adopt and utilize FinTech solutions and strengthen their operational resilience over the long term.

Moreover, the study's examination of the impact of environmental factors emphasizes the importance of factors such as trust in government, competitive pressures, and firm structures, which collectively shape the landscape of FinTech adoption in each country. However, the differing degrees of influence observed between environmental factors and FinTech adoption in Hungary and Indonesia highlight the necessity for tailored approaches to technology implementation on the basis of specific contexts. Although less affected by regional differences, organizational factors may still play a crucial role as key determinants of successful fintech adoption across various research contexts and scopes. Despite the valuable insights provided by this study, several limitations should be acknowledged. First, the research focused on a comparative analysis between Hungary and Indonesia, which might only partially represent the broader diversity of global contexts. The findings of this study might need to be more generalizable to other countries or regions with different socioeconomic and regulatory environments. Additionally, the study's reliance on cross-sectional data limits the ability of the analysis to infer causal relationships between factors and FinTech adoption. Longitudinal research designs could provide more robust insights into the temporal dynamics of these relationships. Furthermore, the study's sample size, although appropriate for the analysis conducted, might restrict the generalizability of the findings to the broader population of SMEs. Expanding on the findings of this study regarding FinTech adoption among SMEs in Hungary and Indonesia within the context of the social economy, numerous avenues for further research have emerged. Broadening the analysis to encompass a more diverse array of countries may offer a more nuanced understanding of how contextual variables influence the adoption of FinTech. Longitudinal studies that track the technological adoption trajectories of SMEs over time could yield valuable insights into the evolving dynamics of these relationships within the social economy framework. Additionally, investigating the interaction of factors within various industry sectors may reveal unique sector-specific patterns and obstacles in FinTech adoption. Experimental or quasiexperimental designs could be utilized to establish causal relationships between factors and FinTech adoption outcomes, addressing the inherent limitations of cross-sectional data within the social economy context.

While this study adopts a quantitative approach, future research could benefit from incorporating qualitative methods such as in-depth interviews or case studies. These methods may uncover contextual nuances, behavioral motivations, and stakeholder perspectives that are not easily captured through survey data alone. Integrating qualitative insights could further enrich our understanding of the mechanisms behind FinTech adoption across diverse SME environments.

## Appendix A

Roadmap construction for data collection

Data collection in a comparative study between Hungary and Indonesia on fintech adoption by SMEs (small and medium-sized enterprises) in the agriculture, hospitality and tourism, manufacturing, health and fitness, transportation and logistics, retail and wholesale sectors involved several comprehensive steps. The following is a more in-depth explanation of the data collection process in this context:

1. **Study planning**: The initial stage of data collection is planning by formulating research objectives, research questions, and the conceptual framework that will be used. Researchers consider differences in culture, regulations and business habits between Hungary and Indonesia in the context of fintech adoption by SMEs.
2. **Survey Design**: Researchers chose design survey instruments that suit the research objectives and the established conceptual framework. This instrument should include a relevant socioeconomic context about SMEs' perceptions, experiences and behavior regarding fintech adoption and consider the anonymity and security of data to avoid ***social desirability bias,*** which can affect the validity and reliability of the data in this research.
3. **Adaptation to the Local Context**: Survey instruments need to be adapted to the local context in Hungary and Indonesia. This includes considering the language used, cultural norms, differences in infrastructure and levels of technology penetration in the two countries. For example, in preparing ***questionnaire*** questions, researchers have prepared them in Hungarian and Indonesian but have a standard English format.
4. **Sample Selection**: The researcher selects a representative sample of SMEs in both countries. The sample consisted of 349 SME participants from various sectors, such as agriculture, hospitality and tourism, manufacturing, health and fitness, transportation and logistics, retail and wholesale, consisting of 164 respondents from Hungary and 185 from Indonesia from March–June 2023. This sample should cover a wide range of industry sectors, business sizes, and geographic locations to ensure that the research results are general and relevant.
5. **Survey Implementation**: After sample selection is prepared, researchers need to implement it by collecting data from respondents in Hungary and Indonesia. In this case, researchers use online surveys as a data collection method where respondents are asked to fill out surveys or questionnaires via the internet or online platforms. Surveys were conducted via the online Microsoft platform on respondent preference and availability. Researchers have used online survey distribution channels to reach respondents from various backgrounds. This helps ***reduce bias*** in the sample that may arise from a single distribution channel.
6. **Data analysis**: After the data have been collected, the next step is to analyze the data via appropriate statistical analysis methods. In this case, the researcher used **SMART PLS 4 software with the PLS-MGA method and** the "Likert scale" as a measurement method. This may include descriptive analysis to describe sample characteristics, as well as comparative analysis to compare results between Hungary and Indonesia.

**Table 8** Time table schedule of the research (March–July 2023)

| STEP | Activities | March | | | | April | | | | May | | | | June | | | | July | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st week | 2nd week | 3rd week | 4th week | 1st week | 2nd week | 3rd week | 4th week | 1st week | 2nd week | 3rd week | 4th week | 1st week | 2nd week | 3rd week | 4th week | 1st week | 2nd week |
| 1 | Preliminary Research | | | | | | | | | | | | | | | | | | |
| 2 | Formulation problems and objectives | | | | | | | | | | | | | | | | | | |
| 3 | Research Design and Methodology | | | | | | | | | | | | | | | | | | |
| 4 | Data Collection and Analysis | | | | | | | | | | | | | | | | | | |
| 5 | TOE Framework Construction | | | | | | | | | | | | | | | | | | |
| 6 | Synthesis Analysis | | | | | | | | | | | | | | | | | | |
| 7 | Final Framework Development | | | | | | | | | | | | | | | | | | |
| 8 | Preparing full research result | | | | | | | | | | | | | | | | | | |

7. **Interpretation and conclusions**: The results of the data analysis need to be interpreted carefully to draw valid and relevant conclusions. Researchers consider these findings in the context of existing theory and their practical implications for policy development or business practice, not only from the perspective of Hungary and Indonesia but also from the perspective of other countries globally.
8. **Communication of Results:** Researchers communicated clearly and effectively to stakeholders, including academics, business practitioners, regulators and the general public. This can be accomplished through scientific journal publications, conference presentations, or policy reports. Both existing ones and several references obtained from Financial Innovation Journal reviewers to strengthen the foundation of the methodological construction of this research.

By following these steps, as shown in Table 8 below, researchers can collect relevant and meaningful data in a comparative study between Hungary and Indonesia on fintech adoption by SMEs. This will help in better understanding the factors influencing fintech adoption in both countries and provide valuable insights for future policymakers and business practitioners/researchers.

## Appendix B: Survey questions

Fintech adoption for SMEs in different socioeconomic contexts: evidence from Hungary and Indonesia

Please give your information data below before moving to next part.

### Country

☐ Hungary ☐ Indonesia.

### Gender

☐ Male ☐ Female.

**Ages**

☐ < 30 years old ☐ 30–35 years old ☐ 36–40 years old ☐ 41–45 years old ☐ 46–50 years old ☐ > 50 years old.

**Education**

☐ Under graduates with less than 6 years of formal education.

☐ Under graduates with more than 6 years of formal education.

☐ Under graduates with more than 10 years of formal education.

☐ Graduates.

☐ Vocational study.

**SMEs Name:**

**A. Circle the number according to your business information**

**a. You're business type:**

1. Agriculture.

2. Hospitality/tourism.

3. Manufacturing.

4. Health; fitness,

5. Transportation/logistics,

6. Retail/wholesale.

**b. Sales are made by:**

1. Through stores (physical).

2. Through stores and online.

**c. Use of payment technology:**

1. QR code mobile banking.

2. Mobile wallet QR code.

3. EDC Devices.

4. Mobile POS.

5. P2P (peer-to-peer) payment.

6. Payment via NFC.

Other:…….

**d. Experience using fintech:**

1. Less than 6 months

2.6–12 Months.

3.1–3 years.

4. More than 3 years

**e. Business Status**

1. Individual.

2. Company limitations.

3. Partnership limited.

**f. Average selling price (in Rupiah\ HUF)**

1. Less than 1 million

2.1–5 million.

3.5–10 million.

4.10–50 million.

5.50 million and above

Other:…….

**g. Monthly income (in Rupiah\ HUF)**

1. Less than 5 million.

2. 5–10 million.

3. 10–50 million.

4. 50–100 million.

5. 100 million and above

Other:…….

**h. Number of employees**

1. No employee.

2. Less than 10.

3.10–50 People.

4. More than 50 people

Other:…….

**B. Please tick (√) for each statement below**

1. Strongly Disagree.

2. Disagree.

3. Somewhat disagree.

4. Neutral.

5. Somewhat Agree.

6. Agree.

7. Strongly Agree.

8. In total, Agree.

| Construct | Indicator | References | Statement | Scale |
|---|---|---|---|---|
| TECHNOLOGICAL | Relative Advantage | (Nguyen et al. 2022; Varma 2019) | Fintech makes it easier for us to access financial services than traditional methods | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Compability | (Awa et al. 2017; Nguyen et al. 2022) | The fintech system or application that our business adopt is easy to implement in the company's daily operations | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Trialability | (Awa et al. 2017; Firmansyah et al. 2022) | Fintech platforms have the flexibility to allow our business to customize my settings and business needs | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Complexity | (Setiyani et al. 2021; Varma 2019) | Using a fintech platform feels complicated and takes quite a long time to understand its functionality | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Observability | (Awa et al. 2017) | The benefits and advantages of using fintech in our business can be clearly observed by parties involved in business operations, including employees and business owners | 1 (Strongly Disagree) to 8 (Totally Agree) |
| ORGANIZATIONAL | Innovativeness | (Chiu et al. 2017; Ta and Lin 2023) | Our business believe that the use of fintech is an innovative effort to answer the challenges and opportunities faced by our business | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Mobile payment knowledge | (Mahakittikun et al. 2021; Nguyen et al. 2022) | The use of mobile payments in our business is driven by a strong understanding of the benefits of fintech in increasing the speed and efficiency of transactions | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | IT infrastructure | (Awa et al. 2017; Varma 2019) | Our business IT infrastructure has sufficient capabilities to support the implementation and integration of fintech solutions | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Organizational readiness | (Nugraha et al. 2022; Rahayu and Day 2015) | Our management has a strong commitment to integrating fintech solutions as part of our growth and business transformation strategy | 1 (Strongly Disagree) to 8 (Totally Agree) |

| Construct | Indicator | References | Statement | Scale |
|---|---|---|---|---|
| | Top management support | (Agarwal et al. 2020; Awa et al. 2017) | Our management regularly provides direction and guidance to staff regarding the use and benefits of adopted fintech solutions | 1 (Strongly Disagree) to 8 (Totally Agree) |
| ENVIRONMENTAL | Government Support | (Higgins 2020; Setiyani et al. 2021) | Training and education programs organized by the government help improve our business understanding of fintech solutions and how to use them | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Competitive pressure | (Dholakia and Kshetri 2004; Nguyen et al. 2022) | Increased fintech penetration can accelerate the pace of innovation in products and services offered by competitors, increasing competitive pressure for our SMEs business to continuously adapt | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Industry structure | (Gupta et al. 2022) | The structure of the fintech industry influences the accessibility and availability of fintech solutions for SMEs in various industry sectors | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Competitors | (Awa et al. 2017; Firmansyah et al. 2022) | Competition from competitors in the fintech industry significantly influences strategic decision-making in your SMEs | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Market Dynamics | (Chiu et al. 2017; Mahakittikun et al. 2021) | The contribution of fintech is significantly influencing the dynamics of the SMEs market at the local and regional level | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Software for operational and financial activity | (Gupta et al. 2022; Nguyen et al. 2022) | The fintech software and application is very effective in helping run your SME's operational and financial activities | 1 (Strongly Disagree) to 8 (Totally Agree) |
| FINTECH | Digital financial technology | (Chiu et al. 2017; Effendi et al. 2020; Mahakittikun et al. 2021; Nguyen et al. 2022) | The use of digital financial technology has increased our business accessibility to previously hard-to-reach financial services | 1 (Strongly Disagree) to 8 (Totally Agree) |

| Construct | Indicator | References | Statement | Scale |
|---|---|---|---|---|
| | Digital economic business models and services | (Awa et al. 2017; Firmansyah et al. 2022; Setiyani et al. 2021) | The future use of fintech business models or services in supporting the growth and sustainability of our SME businesses as a representative of digital economy services | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Payment technologies | (Christian et al. 2020; Firmansyah et al. 2022; Nguyen et al. 2022; Setiyani et al. 2021) | The use of fintech payment technology has improved the customer experience in transacting with our customers, suppliers or business partners | 1 (Strongly Disagree) to 8 (Totally Agree) |
| | Magnitude of externalities and its effects on business | (Firmansyah et al. 2022; Nguyen et al. 2022; Varma 2019) | The adoption of fintech technology has brought more positive external impacts than negative ones in our SEMs business ecosystem | 1 (Strongly Disagree) to 8 (Totally Agree) |

**C. Our business adopts financial technology to achieve the following goals: (answers may be more than 1 (√)**

1. Increase in sales transactions
2. Increase in the number of customers
3. Improved brand visibility
4. Service quality improvement
5. Operational improvement
6. Transition from traditional to modern technology
7. Expanding digitalization literacy and fintech innovation

**Acknowledgements**
The authors would like to express their sincere appreciation to the University of Debrecen (UNIDEB) and the Institute for Research and Community Service (LPPM), Sam Ratulangi University (UNSRAT) for their support in covering the article processing charge (APC) and for providing additional non-financial assistance. This study was conducted as a collaborative effort between UNIDEB and UNSRAT, whose cooperation and support greatly contributed to the successful completion of this work.

**Author contributions**
Adrian Nagy conducted the preliminary study, led the literature review, was responsible for data collection, and contributed to the discussion. Fitty Valdi Arie participated in the preliminary study, contributed to the literature review, and assisted in data collection, also in data analysis and discussion. Octavia Tuegeh focused on the literature review and conducted data analysis. Beata Bittner provided the conceptual idea in the introduction, contributed to the literature review, and conducted data analysis. Johan Tumiwa played a multifaceted role, including the preliminary study, data collection, data analysis, and discussion, and then to the finalized the manuscript.

**Funding**
This study was conducted without external funding, relying entirely on self-funding from the authors. This approach to financing underscores our dedication to pursuing this research driven by academic and scientific inquiry, free from the influence of funding bodies. It reflects our commitment to maintaining the autonomy of our research direction and findings. We, the authors of the manuscript titled "Fintech Adoption for SMEs in Different Socio-Economic Contexts: Evidence from Hungary and Indonesia," wish to declare that this research was conducted without external funding. We affirm that no financial interests, sponsorships, grants, or other financing forms have influenced the design, execution,

analysis, or interpretation of the research findings presented in this manuscript. Our research is entirely self-funded, and no external parties have provided financial support or resources that could potentially impact this study's objectivity, integrity, or outcomes. We are strongly committed to maintaining transparency and integrity in our scientific endeavors, and we are dedicated to fully disclosing potential conflicts of interest.

**Data availability**

The data supporting this study's findings are available from the authors upon reasonable request. It is crucial to note that the data maintains the confidentiality and anonymity of the respondents. Participants were assured of the voluntary nature of their involvement and were encouraged to provide genuine answers. The comprehensive data collection process, which includes population selection, sampling, and questionnaire distribution, was conducted collaboratively with professional organizations. This was further augmented by the expertise of the Institute of Nonprofit Agricultural Economics public and state, also known as Agrárközgazdasági Intézet Nonprofit Kft (AKI).

## Declarations

**Competing Interests**

The authors declare that they have no competing interests.

Received: 5 October 2023 Accepted: 6 November 2025
Published online: 29 November 2025

**References**

Abbasi K, Alam A, Du M (Anna), Huynh TLD (2021) FinTech, SME efficiency and national culture: evidence from OECD countries. Technol Forecast Soc Change 163(May 2020):120454. https://doi.org/10.1016/j.techfore.2020.120454
Agarwal S, Qian W, Ren Y, Tsai H-T, Yeung BY (2020) The real impact of FinTech: evidence from mobile payment technology. SSRN Electron J. https://doi.org/10.2139/ssrn.3556340
Al-Jabri brahimM, Sohail MS (2012) Mobile banking adoption: application of diffusion of innovation theory. J Electron Commer Res 13(4):379–391
Añón Higón D, Bonvin D (2023) Digitalization and trade participation of SMEs. Small Bus Econ 62(3):0123456789. https://doi.org/10.1007/s11187-023-00799-7
Arifin Z, Frmanzah (2015) The effect of dynamic capability to technology adoption and its determinant factors for improving firm's performance; toward a conceptual model. Procedia Social Behav Sci 207:786–796. https://doi.org/10.1016/j.sbspro.2015.10.168
Awa HO, Ukoha O, Igwe SR (2017) Revisiting technology-organization-environment (T-O-E) theory for enriched applicability. Bottom Line 30(1):2–22. https://doi.org/10.1108/BL-12-2016-0044
Bajunaied K, Hussin N, Kamarudin S (2023) Behavioral intention to adopt FinTech services: an extension of unified theory of acceptance and use of technology. J Open Innovat Technol Market Complex 9(1):100010. https://doi.org/10.1016/j.joitmc.2023.100010
Berman A, Cano-Kollmann M, Mudambi R (2022) Innovation and entrepreneurial ecosystems: fintech in the financial services industry. Rev Manag Sci 16(1):45–64. https://doi.org/10.1007/s11846-020-00435-8
Bhutto SA, Jamal Y, Ullah S (2023) FinTech adoption, HR competency potential, service innovation and firm growth in banking sector. Heliyon 9(3):e13967. https://doi.org/10.1016/j.heliyon.2023.e13967
Bi R, Davison RM, Smyrnios KX (2017) E-business and fast growth SMEs. Small Bus Econ 48(3):559–576. https://doi.org/10.1007/s11187-016-9788-8
Bo H, Philp M (2019) Association for consumer research. Adv Consum Res 36:23–24
Bonvino C, Giorgino M (2024) A valorization framework to strategically manage data for creating competitive value. Int J Prod Econ 269(1):109152. https://doi.org/10.1016/j.ijpe.2024.109152
Brychko M, Bilan Y, Lyeonov S, Mentel G (2021) Trust crisis in the financial sector and macroeconomic stability: a structural equation modelmodelling approach. Econ Res-Ekon Istraz 34(1):828–855. https://doi.org/10.1080/1331677X.2020.1804970
Cheah J-HH, Amaro S, Roldán JL (2023) Multigroup analysis of more than two groups in PLS-SEM: a review, illustration, and recommendations. J Bus Res 156(April 2022):113539. https://doi.org/10.1016/j.jbusres.2022.113539
Chen W, Yuan X (2021) Financial inclusion in China: an overview. Front Bus Res China. https://doi.org/10.1186/s11782-021-00098-6
Chin WW, Newsted PR (1998) The partial least squares approach to structural equation modeling. Modern methods for business research. Statistical Strategies for Small Sample Research, April, pp 295–336.
Chiu C-Y, Chen S, Chen C-L (2017) An integrated perspective of TOE framework and innovation diffusion in broadband mobile applications adoption by enterprises. Int J Manage Econ Soc Sci (IJMESS) 6(1):14–39
Christian S, Wiradinata T, Herdinata C, Setiobudi A (2020) Environmental Factors Affecting the Acceleration of Financial Technology (Fintech) Adoption by SMEs in the East Java Region. In: Conference: 8th International Conference of Entrepreneurship and Business Management Untar (ICEBM 2019), vol 145, pp 380–385. https://doi.org/10.2991/aebmr.k.200626.065
Ciavolino E, Cheah JH, Simonetti B (2023) Introduction to advanced partial least squares path modeling. Qual Quant 57(S4):1–4. https://doi.org/10.1007/s11135-023-01706-8
Cumming D, Johan S, Reardon R (2023) Global fintech trends and their impact on international business: a review. Multinatl Bus Rev 31(3):413–436. https://doi.org/10.1108/MBR-05-2023-0077

Dadhich M, Hiran KK (2022) Empirical investigation of extended TOE model on corporate environment sustainability and dimensions of operating performance of SMEs: a high order PLS-ANN approach. J Clean Prod 363(September 2021):132309. https://doi.org/10.1016/j.jclepro.2022.132309
Datsii O, Datsii N, Zborovska O, Ivashova L, Cherkashyna M, Ingram K (2021) Financing of environmental programs for industrial waste management in times of crisis. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu 1:130–136. https://doi.org/10.33271/nvngu/2021-1/130
Dholakia RR, Kshetri N (2004) Factors impacting the adoption of the Internet among SMEs. Small Bus Econ 23(4):311–322. https://doi.org/10.1023/B:SBEJ.0000032036.90353.1f
Dijkstra TK (2010) Handbook of Partial Least Squares. *January 2010*. https://doi.org/10.1007/978-3-540-32827-8
Dorfleitner G, Hornuf L, Schmitt M, Weber M (2017) FinTech in Germany. In: *FinTech in Germany* (Issue March). https://doi.org/10.1007/978-3-319-54666-7
Effendi MI, Sugandini D, Istanto Y (2020) Social media adoption in SMEs impacted by COVID-19: the TOE model*. J Asian Finance Econ Bus 7(11):915–925. https://doi.org/10.13106/jafeb.2020.vol7.no11.915
Farkas F, Póta CP, Becsky-Nagy P (2022) Changes in payment patterns in Hungary during the pandemic. WSEAS Trans Bus Econ 19:1061–1074. https://doi.org/10.37394/23207.2022.19.93
Firmansyah EA, Masri M, Anshari M, Besar MHA (2022) Factors affecting fintech adoption: a systematic literature review. FinTech 2(1):21–33. https://doi.org/10.3390/fintech2010002
Fornell C, Larcker DF (1981) Evaluating structural equation models with unobservable variables and measurement error. J Mark Res 18(1):39. https://doi.org/10.2307/3151312
Gallego-Losada MJ, Garcia-Abajo ME, Montero-Navarro A, Gallego-Losada R (2021) El reto de la alfabetizacion financiera digital en el ámbito de la fintech (industria 4.0). ESIC Mark 53(1):e277. https://doi.org/10.7200/esicm.53.277
Gan QQ, Lau RYK (2024) Trust in a 'trust-free' system: blockchain acceptance in the banking and finance sector. Technol Forecast Soc Change. https://doi.org/10.1016/j.techfore.2023.123050
Gentile-Lüdecke S, Torres de Oliveira R, Paul J (2020) Does organizational structure facilitate inbound and outbound open innovation in SMEs? Small Bus Econ 55(4):1091–1112. https://doi.org/10.1007/s11187-019-00175-4
Gholami Z, Abdekhoda M, Gavgani VZ (2018) Determinant factors in adopting mobile technology-based services by academic librarians. DESIDOC J Libr Inf Technol 38(4):271–277. https://doi.org/10.14429/djlit.38.4.12676
Guaita Martínez JM, Carracedo P, Gorgues Comas D, Siemens CH (2022) An analysis of the blockchain and COVID-19 research landscape using a bibliometric study. Sustain Technol Entrepreneurship 1(1):1–7. https://doi.org/10.1016/j.stae.2022.100006
Gupta S, Ghardallou W, Pandey DK, Sahu GP (2022) Artificial intelligence adoption in the insurance industry: evidence using the technology–organization–environment framework. Res Int Bus Finance 63(September):101757. https://doi.org/10.1016/j.ribaf.2022.101757
Hair J, Sarstedt M, Hopkins L, Kuppelwieser VG (2014) Partial least squares structural equation modeling (PLS-SEM). Eur Bus Rev 26(2):106–121. https://doi.org/10.1108/EBR-10-2013-0128
Hair JF, Risher JJ, Sarstedt M, Ringle CM (2019) When to use and how to report the results of PLS-SEM. Eur Bus Rev 31(1):2–24. https://doi.org/10.1108/EBR-11-2018-0203
Henseler J, Ringle CM, Sarstedt M (2015) A new criterion for assessing discriminant validity in variance-based structural equation modeling. J Acad Mark Sci 43(1):115–135. https://doi.org/10.1007/s11747-014-0403-8
Henseler J, Ringle CM, Sinkovics RR (2009) The use of partial least squares path modeling in international marketing. Adv Int Market 20(2009):277–319. https://doi.org/10.1108/S1474-7979(2009)0000020014
Hien NP, Huong NT, Xuan Thu NT (2023). Factors affecting the adoption of online marketing channels in smes: an empirical survey in the North of Vietnam. VNU Univ Econ Bus 3(2):79. https://doi.org/10.57110/vnujeb.v3i2.162
Higgins S (2020) Financial Technology Adoption. https://finance.unibocconi.eu/sites/default/files/files/media/attachments/higgins_jmp20200331105434.pdf
Hornuf L, Haddad C (2019) The emergence of the global fintech market: economic and technological determinants Christian Haddad The Emergence of the Global Fintech Market: Economic and Technological Determinants Abstract. Small Bus Econ 53:81–105
Jarvis CB, Mackenzie SB, Podsakoff PM, Giliatt N, Mee JF (2003) A critical review of construct indicators and measurement model misspecification in marketing and consumer research. J Consum Res 30(2):199–218. https://doi.org/10.1086/376806
Jourdan Z, Corley JK, Valentine R, Tran AM (2023) Fintech: a content analysis of the finance and information systems literature. Electron Mark 33(1):1–21. https://doi.org/10.1007/s12525-023-00624-9
Kliber A, Będowska-Sójka B, Rutkowska A, Świerczyńska K (2021) Triggers and obstacles to the development of the fintech sector in Poland. Risks 9(2):1–27. https://doi.org/10.3390/risks9020030
Kock N (2015) Common method bias in PLS-SEM: a full collinearity assessment approach. Int J E-Collabor 11(4):1–10. https://doi.org/10.4018/ijec.2015100101
Lai PMC (2012) Determinants of mobile payments adoption in retail organizations : a multi-perspective study and assessment framework. Doctoral Thesis, City University of Hong Kong http://lbms03.cityu.edu.hk/theses/c_ftt/engd-seem-b42002552f.pdf
Lee JW, Tan WN (2019) Global corporate citizenship: cross-cultural comparison of best practices in the global automotive industry. J Asian Financ Econ Bus 6(1):261–271. https://doi.org/10.13106/jafeb.2019
Li C, He S, Tian Y, Sun S, Ning L (2022a) Does the bank's FinTech innovation reduce its risk-taking? Evidence from China's banking industry. J Innov Knowl. https://doi.org/10.1016/j.jik.2022.100219
Li J, Wei R, Guo Y (2022b) How can the financing constraints of SMEs be eased in China?-effect analysis, heterogeneity test and mechanism identification based on digital inclusive finance. Front Environ Sci 10(July):1–13. https://doi.org/10.3389/fenvs.2022.949164
Li H, Lu Z, Yin Q (2023) The development of Fintech and SME innovation: empirical evidence from China. Sustainability. https://doi.org/10.3390/su15032541
Lian J-W, Yen DC, Wang Y-T (2014) An exploratory study to understand the critical factors affecting the decision to adopt cloud computing in Taiwan hospital. Int J Inf Manage 34(1):28–36. https://doi.org/10.1016/j.ijinfomgt.2013.09.004

Lv K, Yu S, Fu D, Wang J, Wang C, Pan J (2022) The impact of financial development and green finance on regional energy intensity: new evidence from 30 Chinese Provinces. Sustainability (Switzerland) 14(15):1–29. https://doi.org/10.3390/su14159207
Mahakittikun T, Suntrayuth S, Bhatiasevi V (2021) The impact of technological-organizational-environmental (TOE) factors on firm performance: merchant's perspective of mobile payment from Thailand's retail and service firms. J Asia Bus Stud 15(2):359–383. https://doi.org/10.1108/JABS-01-2020-0012
Mahmud K, Joarder MMA, Muheymin-Us-Sakib K (2023) Adoption factors of FinTech: evidence from an emerging economy country-wide representative sample. In J Financ Stud 11(1). https://doi.org/10.3390/ijfs11010009
Malca O, Peña-Vinces J, Acedo FJ (2020) Export promotion programmes as export performance catalysts for SMEs: insights from an emerging economy. Small Bus Econ 55(3):831–851. https://doi.org/10.1007/s11187-019-00185-2
Mariano C, Antonella M, Luisa P, Emilio P (2003) Technological and organizational tools for knowledge management: in search of configurations. Small Bus Econ, pp 397–408. https://doi.org/10.1023/A:1026123322900
Matthews L (2017) Applying multigroup analysis in PLS-SEM: a step-by-step process BT—partial least squares path modeling: basic concepts, methodological issues and applications. In: Latan H, Noonan R (eds), pp. 219–243. Springer, Cham. https://doi.org/10.1007/978-3-319-64069-3_10
Memon MA, Thurasamy R, Cheah J-H, Ting H, Chuah F, Cham TH (2023) Addressing common method bias, operationalization, sampling, and data collection issues in quantitative research: review and recommendations. J Appl Struct Equ Model 7(2):1–14. https://doi.org/10.47263/JASEM.7(2)01
Mertzanis C (2023) FinTech finance and social-environmental performance around the world. Fin Res Lett 56:104107. https://doi.org/10.1016/j.frl.2023.104107
Moreira-Santos D, Au-Yong-Oliveira M, Palma-Moreira A (2022) Fintech services and the drivers of their implementation in small and medium enterprises. Information 13(9):409. https://doi.org/10.3390/info13090409
Nguyen TH, Le XC, Vu THL (2022) An extended Technology-Organization-Environment (TOE) framework for online retailing utilization in digital transformation: empirical evidence from Vietnam. J Open Innovat Technol Market Complexity. https://doi.org/10.3390/joitmc8040200
Nugraha DP, Setiawan B, Nathan RJ, Fekete-Farkas M (2022) Fintech adoption drivers for innovation for SMEs in Indonesia. J Open Innovat Technol Market Complexity. https://doi.org/10.3390/joitmc8040208
Odei-Appiah S, Wiredu G, Adjei JK (2022) Fintech use, digital divide and financial inclusion. Digital Policy Regulat Govern 24(5):435–448. https://doi.org/10.1108/DPRG-09-2021-0111
Oliveira T, Martins MF (2010) Information technology adoption models at firm level: review of literature. In: 4th European Conference on Information Management and Evaluation, ECIME 2010, January, pp 312–322.
Panizzolo R (1998) Managing innovation in SMEs: a multiple case analysis of the adoption and implementation of product and process design technologies. Small Bus Econ 11(1):25–42. https://doi.org/10.1023/A:1007941228765
Póta CP, Becsky-Nagy P (2022) Impact of digitalization on the financial sector. Competitio 21:29–42. https://doi.org/10.21845/comp/2022/1-2/6
Prasanna RPIR, Jayasundara JMSB, Gamage SKN, Ekanayake EMS, Rajapakshe PSK, Abeyrathne GAKNJ (2019) Sustainability of SMEs in the competition: a systemic review on technological challenges and SME performance. J Open Innovat Technol Market Complexity 5(4):1–18. https://doi.org/10.3390/joitmc5040100
Puschmann T (2017) Fintech. Bus Inf Syst Eng 59(1):69–76. https://doi.org/10.1007/s12599-017-0464-6
Qalati SA, Li W, Vela EG, Bux A, Barbosa B, Herzallah AM (2020) Effects of technological, organizational, and environmental factors on social media adoption. J Asian Finance Econ Bus 7(10):989–998. https://doi.org/10.13106/jafeb.2020.vol7.no10.989
Rahayu R, Day J (2015) Determinant factors of E-commerce adoption by SMEs in developing country: evidence from Indonesia. Procedia Soc Behav Sci 195:142–150. https://doi.org/10.1016/j.sbspro.2015.06.423
Rajala A, Hautala-Kankaanpää T (2023) Exploring the effects of SMEs' platform-based digital connectivity on firm performance—the moderating role of environmental turbulence. J Bus Ind Mark 38(13):15–30. https://doi.org/10.1108/JBIM-01-2022-0024
Rogers EM, Singhal A, Quinlan MM (2019) Diffusion of innovations. In: An integrated approach to communication theory and research, 3rd edn, *March*, 415–433. https://doi.org/10.4324/9780203710753-35
Setiyani L, Rostiani Y, Rostiani Y (2021) Analysis of e-commerce adoption by SMEs using the Technology-Organization-Environment (TOE) model: a case study in Karawang, Indonesia. Int J Sci Technol Manage 2:1113–1132. https://doi.org/10.46729/ijstm.v2i4.246
Sharma SK, Ilavarasan PV, Karanasios S (2023) Small businesses and FinTech: a systematic review and future directions. Electron Commer Res 24(1):535–575. https://doi.org/10.1007/s10660-023-09705-5
Shmueli G, Sarstedt M, Hair JF, Cheah J-H, Ting H, Vaithilingam S, Ringle CM (2019) Predictive model assessment in PLS-SEM: guidelines for using PLSpredict. Eur J Mark 53(11):2322–2347. https://doi.org/10.1108/EJM-02-2019-0189
Singh S, Sahni MM, Kovid RK (2020) What drives FinTech adoption? A multi-method evaluation using an adapted technology acceptance model. Manag Decis 58(8):1675–1697. https://doi.org/10.1108/MD-09-2019-1318
Siu WS (2001) Small firm marketing in China: a comparative study. Small Bus Econ 16(4):279–292. https://doi.org/10.1023/A:1011179823847
Su F, Xu C (2023) Curbing credit corruption in China: the role of FinTech. J Innov Knowl 8(1):100292. https://doi.org/10.1016/j.jik.2022.100292
Ta VA, Lin CY (2023) Exploring the determinants of digital transformation adoption for SMEs in an emerging economy. Sustainability (Switzerland) 15(9):1–13. https://doi.org/10.3390/su15097093
Tian H, Siddik AB, Pertheban TR, Rahman MN (2023) Does fintech innovation and green transformational leadership improve green innovation and corporate environmental performance? A hybrid SEM–ANN approach. J Innov Knowl. https://doi.org/10.1016/j.jik.2023.100396
Tolić I, Sabljić D, Sabljić T (2022) Innovation as a process. EMC Rev Časopis Za Ekonomiju APEIRON 23(1). https://doi.org/10.7251/emc2201237t
Tran LQT, Phan DT, Herdon M, Kovacs L (2022) Assessing the digital transformation in two banks: case study in Hungary. Agris on-Line Papers Econ Inform 14(2):121–134. https://doi.org/10.7160/aol.2022.140210

Urumsah D, Ispridevi RF, Nurherwening A, Hardinto W (2022) Fintech adoption: its determinants and organizational benefits in Indonesia.J Akuntansi Audit Indonesia 26:88–101. https://doi.org/10.20885/jaai.vol26.iss1.art9
Utami AF, Ekaputra IA, Japutra A (2021) Adoption of FinTech products: a systematic literature review. J Creative Commun 16(3):233–248. https://doi.org/10.1177/09732586211032092
Vanninen H, Keränen J, Kuivalainen O (2022) Becoming a small multinational enterprise: four multinationalization strategies for SMEs. Int Bus Rev. https://doi.org/10.1016/j.ibusrev.2021.101917
Varga D (2017) Fintech, the new era of financial services. Vezetéstudomány/Budapest Manage Rev 48(11):22–32. https://doi.org/10.14267/veztud.2017.11.03
Varma A (2019) Fintech adoption choices of small businesses: a Technology Organization Environment (TOE) framework study. Account Financ Res 8(2):86. https://doi.org/10.5430/afr.v8n2p86
Vergara CC, Agudo LF (2021) Fintech and sustainability: do they affect each other? Sustainability. https://doi.org/10.3390/su13137012
Vijayagopal P, Jain B, Ayinippully Viswanathan S (2024) Regulations and fintech: a comparative study of the developed and developing countries. J Risk Financ Manag. https://doi.org/10.3390/jrfm17080324
Wahyuni NM, Sara IM (2020) Market orientation and innovation performance: mediating effects of customer engagement in SMEs. J Econ Bus Accountancy Ventura 23(1):28–37. https://doi.org/10.14414/jebav.v23i1.2040
Wang Y, Meister D, Wang Y (2008) Relative advantage and perceived usefulness : the adoption of competing ICTs. In: DIGIT 2008 Proceedings—Diffusion Interest Group In Information Technology, pp 1–22.
Wibowo S, Grandhi L, Grandhi S, Wells M (2022) A fuzzy multicriteria group decision making approach for evaluating and selecting fintech projects. Mathematics. https://doi.org/10.3390/math10020225
Wold HOA (1963) On the consistency of least squares regression all use subject to JSTOR terms and conditions on the consistency. Sankhyā Indian J Stat Ser A 25(2):211–215
Wong LW, Leong LY, Hew JJ, Tan GWH, Ooi KB (2020) Time to seize the digital evolution: sdoption of blockchain in operations and supply chain management among Malaysian SMEs. Int J Inf Manage 52(August):101997. https://doi.org/10.1016/j.ijinfomgt.2019.08.005
Zavolokina L, Dolata M, Schwabe G (2016) The fintech phenomenon: antecedents of financial innovation perceived by the popular press. Financ Innov. https://doi.org/10.1186/s40854-016-0036-7

## Publisher's Note