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Adoption of Digitalization in SMEs Using the TOE Framework and Advanced Analyses

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A B S T R A C T

Objective: The objective of this study is to investigate the influencing factors that lead to the adoption of digitalization in small and medium-sized enterprises (SMEs), taking into account the interaction of technological, organizational, environmental, and outside market dimensions based on the Technology-Organization-Environment (TOE) framework.
Method: A quantitative approach was adopted that included using a structured survey to gather data from 200 SME managers from three main industries: manufacturing, services, and retail. For testing the relationships of TOE dimensions and digitalization adoption and the moderating effect of technological readiness, data were analyzed using Structural Equation Modeling (SEM).
Results: It finds that all three dimensions of the TOE model, i.e., technological, organizational, and environmental, have a significan positive effects on SMEs' digital technology adoption. The study further establishes external market forces as a key mediator between the relationship of the dimensions and digitalization. It was discovered that the technological preparation level moderates the adoption phase, adding to the agility with which SMEs embody digital technologies.
Originality: The significance of this research lies in the fact that it uses empirical evidence to exhibit how external market factors mediate the relationship between TOE dimensions and digitalization adoption. It emphasises the role of technological readiness and market forces in informing SMEs' digital transformation strategies, which has been largely overlooked in prior research.
Implications: These findings hold significant implications for SMEs and policymakers alike. SMEs investment on in-house Technological Readiness enable digitalization, while innovative Digital Technologies adoption by SMEs would need favorable exogenous Environmental Mullions alignment from the Government Policymakers Future research can also consider more moderating variables and use longitudinal designs to capture the changing nature of digitalization in SMEs.

1. Introduction

The growing need for resilience and intelligence in enterprises, especially in SMEs, resulted in digital transformation as a critical link in the chain of recovery. The use of digital technologies of SMEs around the world is increasing due to the need to deal with challenges like COVID-19 pandemic, changing consumer behavior, and growing global competition. Battistoni et al. (2023), Liu et al. (2022) emphasizes, digital solution adoption among SMEs leads to operational efficiency and customer engagement improvement. The digital economy in Indonesia grows exponentially, with SMEs making an impact on the nation's GDP as the biggest contributor (Karim et al., 2022; Kurniawan et al., 2022). However, there are still considerable gaps in the regions in technological capability (Kebebe, 2019; Rodríguez-Pose, 2020), and infrastructure. Thus, it is pertinent to comprehend the adjacency of digital adoption in SMEs to ensure sustainable economic development.

Although there has been a lot of documentation on how beneficial digital transformation can be, SMEs encounter a myriad of challenges when it comes to the adoption and integration of digital technologies. There are also major barriers such as lack of access

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to funding, poor digital skills and resistance to change (Kumar et al., 2021). Herein we use the Technological-Organizational-Environmental (TOE) framework to look at these barriers, as it captures the fundamental dimensions driving technology adoption. Hussain & Papastathopoulos (2022), Zhang et al. (2020), technological infrastructure, organizational readiness, and environmental pressures that influenced digital adoption decisions (N'Dri & Su, 2024; Su et al., 2023). However, in Indonesia, systemic and cultural constraints often prevent SMEs from being able to align these dimensions (Raya et al., 2021; Widiastuti et al., 2024). This contextual understanding is critical so that we can address these challenges with specific interventions that contribute to the digital transformation process.

The technology-organization-environment (TOE) framework introduced by Tornatzky et al. (1939), is one of the most pioneering models to analyze technology adoption. The framework postulates that a three distinct factor domain define the decision to adopt: technological, organizational, and environmental. Furthermore, research has begun to extend this framework to include mediating and moderating factors such as market forces and technological readiness to create more nuanced perspectives on digital adoption (Baker et al., 2022)). For example, a significant moderator in the relationship between TOE dimensions and digital adoption outcomes is technological readiness an organization's ability to implement and use technology (Jing et al., 2024). The relevance of TOE framework in the context of Indonesia SMEs is substantial as it provides insight into how these factors interact to influence the digital transformation in this region.

Thus far, researchers have documented the phenomenon of digital adoption, but the existing literature base still presents many significant gaps, especially in terms of the nuanced experiences of SMEs in developing economies like Indonesia. While existing studies yield mixed results, some documenting the beneficial effects of digital adoption on performance and innovation Blichfeldt & Faullant (2021), Liu et al. (2023), others signal challenges such as increased implementation costs and organizational inertia (Rosenbloom et al., 2019; Sarkar & Osiyevskyy, 2018). Basarir et al. (2023), Cruz et al. (2021), Sadeghi et al. (2021), found a strong positive association between technological readiness and digital adoption, while Chen & Filieri (2024), Du et al. (2024), found that environmental pressures tend to restrict adoption in technological laggards. We're motived by the gap solution in the ecommerce level in Indonesian SMEs, with this research novelty focusing on external market forces as mediating factors along with technological readiness as moderating factor to see how powerful the relationship on this research chain is the phenomenon in TOE framework research model through comprehensive research in Indonesian SMEs. This study fills knowledge gaps and enhances understanding of how SMEs leverage digitalization for sustainable growth, despite various barriers.

Based on this, this study aims to discover the adoption of digitalization in Indonesian SMEs using the TOE framework. In particular, it examines how technological, organizational, and environmental dimensions, as well as external market forces and technological readiness influence digital adoption outcomes. In addition, this study aims to offer practical implications to both policy-makers and business practitioners, suggesting strategic recommendations to improve SMEs success in embracing digital solutions to secure sustainable growth in this more digital economy.

2. Critical Review

2.1 Theoretical research innovation

The Technological-Organizational-Environmental (TOE) framework is the bulk framework on which much of the theoretical foundation around digital adoption is built in SMEs as it provides a multidimensional view of the technology adoption process. The technological-organizational-environmental (TOE) framework is a model for understanding the factors that influence the adoption of new technologies in organizations, originally proposed by Tornatzky and Fleischer in 1990. Recent works go even further in editing the framework and incorporating various additional factors of mediation and moderation to tackle the complexity of modern digital habitats. For example, Baker et al. MALIK et al. (2021) elaborated on the role of technological readiness, defined as the sum of an organization's infrastructure, skills and resources, which might moderate the relationship between the TOE

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dimensions and the successful adoption of technology at the enterprise level. Similarly, Wang et al. (2023) highlight external market forces as a crucial mediating factor that links organizational strategies with technological innovation. Furthermore, Gupta et al. Authors [42] acknowledge the impact of environmental variables such as competitive pressure and government policies on the digital transformation of SMEs. Specially, by extending the TOE framework, this study reveals fresh insights about how external forces, as well as internal factors regarding technological readiness, play a role alongside traditional dimensions in digital adoption, contributing to the underdeveloped theoretical aspects in the current literature in this domain. This adaption is crucial for emerging economies like Indonesia, where the particularities of systemic challenges and opportunities inform SMEs technology development pathways.

2.2Impact of the technological dimension (TD) on digitalisation adoption (DA)

The technological dimension (TD) encompasses all internal and external technological aspects that affect a business's ability to embrace and implement digital solutions. This includes aspects such as technological infrastructure, system integration, and perceived benefits of technology adoption. Hypothesis H1: The technological dimension has a positive effect on digitalization adoption was supported strongly by the literature. Studies by Baker et al. (2021) and Chong et al. According to Nambisan et al. (2020), firms with strong technology foundations, better access to advanced digital infrastructure, and more sophisticated IT tools are more likely to pursue digital transformation initiatives. In general, technological readiness leads to lower costs and operational efficiencies and this facilitates digital uptake for SMEs (Li et al., 2021). Moreover, Gupta et al. As stressed by Pan et al. (2020): perceived benefits, like improved customer satisfaction and market accessibility, encourage SMEs to adopt digital technologies. Technological complexity and resource restrictions hamper adoption, particularly in developing economies like Indonesia, which continue to grapples with disparate digital infrastructure (Sun et al., 2019). 2 Wang et al. 3 also raise the concern that the findings might not be applicable to tissue donors in general. (2023), emphasize the importance of technological compatibility and access to scalable solutions in creating an enabling environment for digital adoption. It is in itself a fundamental concept to understand how technological matters can be optimized to narrow down adoption gaps, and push SMEs towards a continued pathway of digital transformation.

H1: The technological dimension is positively associated with digitalisation adoption (DA).

2.3Effect of the organisational dimension (OD) on digitalisation adoption (DA)

The O in this model stands for the organizational dimension (OD), which refers to internal variables specific to an enterprise that enable digital technology adoption and implementation. These factors comprise culture within the organization, support afforded by leadership, competency among employees and access to resources. That organizational dimension has a positive impact on the digitalization adoption is well supported by empirical research (H2). Studies by Chong et al. (2021) and Gupta et al. According to Martens et al. (2020), leadership is paramount to set a strategic vision while creating an atmosphere conducive to technology adoption. Active support from management for the process of digital transformation leads to fewer employees who are afraid of losing their jobs, and leads to a better matching of factors like management and organizational goals with technical capabilities. Additionally, Baker et al. (2021) findings show that the more prepared employees are in terms of their digital skills and adaptability, the better an organization directly performs around integrating technology. A further essential consideration, as Wamba et al. (2020). Tajudeen et al. [8] conducted a study of Indonesian SMEs. The next enabler discovered in Singh et al. Improving internal capabilities and building an active

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organizational atmosphere are key to reaping the positive sets of organizational dimension on digital adoption results.

H2: The organisational dimension is positively associated with digitalisation adoption (DA).

2.4Effect of the environmental dimension (ED) on digitalisation adoption (DA)

The environmental dimension (ED) refers to the external environment that comprises market competition, regulatory frameworks, customer expectations, and technological advancements in the broader ecosystem that impact a firm's decision to adopt digital technologies. A plethora of studies support our hypothesis on the positive influence of the environmental dimension on digitalization adoption (H3) [49,56,59]. Competitive pressures, for example, drive firms to adopt innovative technologies in order to preserve or improve their relative positions in their markets. As noted by Sun et al. According to Almohaisen, Ghazal, and Shakshuki (2020), companies in a competitive environment are generally more probable to adopt digital transformation for operational efficiency and customer satisfaction. Governments shape the ecosystem through their regulatory policies; Gupta et al. demonstrate that when governments stimulate digital transformation through incentives and mandates, they create a fertile environment for technology uptake. (2021). Additionally, the increasing self-service demands by customers forces organizations to adopt digital solutions, as stated by Wamba et al. (2020). Environmental factors such as digital infrastructure, market volatility, and institutional support has an evident influence in the case of Indonesian SMEs. Chong et al. (2021) Clements et al. argued that external market conditions greatly impact SMEs' adoption and retention of digitalization. Thus, for small- and medium-sized enterprises (SMEs) who want to flourish in the progressively digitized markets, it is vital that they comprehend and engage in careful strategies to meet environmental pressures.

H3: The environmental dimension is positively associated with Digitalisation Adoption (DA).

2.5 External Market Forces (EMF) on Digitalisation Adoption (DA)

They include customer preferences, suppliers capabilities, competitive aspects and economic factors that shape the organization to adopt the digital technology through External Market Forces (EMF). Firms are therefore driven by the external push of these forces to adopt a digitalisation to be able to be competitive in the market and have access to the latest demands. H4: EMF positively influences adoption of digitalization The fourth hypothesis is supported by several studies. According to Gupta et al. (2021), companies are pressured by customer-focused markets to turn to innovative digital instruments to boost customer satisfaction and loyalty. Similarly, Wamba et al. (2020) pointed out that competitive pressure plays a strong role in maintaining firms' innovations and relevance in the industrial space. But suppliers are also key actors in this process, providing technology-enabled solutions that help organizations to adopt the digital world in a more affordable and accessible way (Wang et al. (2023). External market forces have always played a crucial role for SMEs, especially in Indonesia. The market volatility paired with the high desire of consumers for online platforms has resulted in the speeding up of digital transformation initiatives among SMEs (Sun et al., 2020). In addition, institutional support including government subsidies for SMEs and partnership with technology solution providers enhances the ability for SMEs to adopt and leverage digital technologies (Chong et al. 2021). Thus, as SMEs encounter market complexities and leverage the benefits of digitalization, comprehending and adapting to EMF is crucial for them.

H4: External Market Forces is positively associated with Digitalisation Adoption (DA).

2.6 *Hypothesis development Mediating Effect of External Market Forces (EMF)*

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The techno-logical dimension that includes innovation, usability, and compatibility is essential for the adoption of digitalization. Nevertheless, this dimension is significantly influenced by the dynamics of the external market forces, which mediate the relationship between technical capabilities and adoption outcomes. Studies like Wang et al. External market forces such as customer demand for digital services force business to adapt (2023). Similarly, Gupta et al. (2021) found that techno-business readiness set the stage for digital adoption, while a market-driven approach provides kinetic energy for technology implementation. External market forces represent a mediator for Indonesian SMEs, since this factor further drives the urgency to adopt advanced technologies to respond to evolving consumer preferences.

Organizational factors Leadership commitment, employee readiness, and resource allocation constitute among others organization-specific aspects that have considerable impact on digitalization efforts. This is mediated by external forces in the market that create urgency and assist with providing a shared alignment of priorities for the organization to have deliverables. According to Wamba et al. (2020) under competitive pressures – this is especially true for businesses. Signing up for Schumpeter privilege Chong et al. (2021). The push for QP is often driven by market forces, and organizations are willing to spend investments in upskilling employees and overhauling processes to address the problem Amid high levels of competition in the digital market, SMEs in Indonesia generally look to external cues before deciding what organizational changes to prioritize and implement to enable successful digital adoption.

Data on the environmental dimension such as regulatory frameworks, industry standards or socio-cultural factors had a considerable impact on digital adoption. External market forces facilitate this relationship, framing environmental pressures in ways that businesses can translate into practice. For instance, Sun et al. Eastin (2020) found that firms in high regulation industries are more responsive to digital tools to meet environmental regulations. Moreover, organizational proactivity towards adapting to environmental challenges using digital solutions is often incentivized by market dynamics (Li et al., 2021). Taking Indonesia as a case study, the vast range of public policies and cultural situations across SMEs and medium-decile sectors demand external-based market forces, which can be a driving factor for positioning in the face of the environmental challenge and mastering digitalization.

H5: The Role of External Market Forces Mediates the Technology Dimension (TD) on Digitalisation Adoption (DA)
H6: The Role of External Market Forces Mediates the Organisational Dimension (OD) with Digitalisation Adoption (DA)
H7: The role of External Market Forces mediates the environmental dimension (ED) with Digitalisation Adoption (DA).

2.7Hypothesis development for the moderator of technological readiness (TR)

Technological readiness, or an organizations capacity to successfully harness existing and emerging technologies, serves a moderating role between the technological dimension and digitalization adoption. Innovative and compatible technologies are more satisfying if there is a mature technological structure and competent employees, which also encourages further technological acquisition [19]. Wang et al. According to (2023), technically equipped businesses were also able to incorporate innovative solutions in their companies, which led to efficiency and improved customer service. Similarly, Baker et al. as per (2021), technological readiness will overcome barriers of complexity certain to be involved when implementing a system so advanced. Our research contributes to understanding the importance of technological readiness in Indonesian SMEs, it fortifies the relationship between technological variables such as perceived usefulness and the successful implementation of technological solutions for organizational competitiveness in the digital market landscape.

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Organizational factors throughout a firm affect the general ability of a firm to adopt a digitalization strategy, as well as the extent of that strategy, and the firm's technological readiness will (to a significant degree) determine what is possible. Otherwise, organizational commitment leadership support or employee training can translate into successful digital transformation, but a lack of technological readiness can make a profound difference. Studies by Wamba et al. (2020) show that firms having strong technological capabilities are better able to match their organizational strategies to digital initiatives. Moreover, Gupta et al. (2021) highlight that in organizations seeking digitalization, preparedness has a positive impact on the effective allocation of resources and decision-making. Technological readiness in the context of SMEs in Indonesia acts a strong moderating factor providing with some form of resistance to the negative impact of lesser organizational committment on digital adoption enabling enterprises to mitigate internal barriers to digital integration.

Internal and external environmental factors, including regulatory policies, competitive pressures, and socio-cultural dynamics, are key determinants of digital adoption and their impact is moderated by technological readiness. Firms that are technologically ready are better equipped to respond to environmental pressures as they can harness digital tools that respond to regulatory compliance needs and the challenge of competition. Sun et al. Technological readiness provides the tools and competencies organizations must possess to mitigate quickly to environmental changes within their firm (Khan et al., 2020). Similarly, Li et al. (2021), technological readiness improves a firm's capacity to respond proactively to market and regulatory pressures. Indonesia's SMMEs that have a higher technological preparedness are better able to incorporate environmental aspects when adopting its digital strategies resulting in the success of adoption and sustainability.

H8: The effect of technological readiness moderating the technological dimension on digitalisation adoption (DA).

H9: The effect of technological readiness moderating organisational dimension is positively associated with digitalisation adoption (DA).

H10: The effect of technological readiness moderating environmental dimension is positively associated with digitalisation adoption (DA).

3. Method Innovation

3.1 Research design

As this study evaluates the relationship between more than two constructs through the use of statistical analysis, thus a quantitative research design is used which is the most appropriate research design for the said purpose. The research is based on the Technology-Organization-Environment (TOE) theory, extended by the market forces and technology readiness. Through quantitative methods, it is possible to conduct systematic examinations of hypotheses, which makes it possible to quantify relationships and mediating or moderating effects between constructs (or variables). This study takes a cross-sectional survey approach, which means SMEs were sampled at a single point in time. This theoretical approach adds to previous research regarding digitalization adoption (see e.g., Tornatzky and Fleischer 1990; Baker 2012) as it provides the opportunity to acquire insights from the synergistic interplay of technological, organizational, and environmental factors (Davidson, 2008) within the behavioral adoption process. Furthermore, the study utilizes the advanced statistical modeling technique to depict complex relationship, that is, Structural Equation Modeling (SEM) which is suitable for observing interaction and non-try interaction effects; the one that can be employed in testing direct, indirect, and non-linear pathways. This study uses SEM because it can simultaneously evaluate direct, indirect, and interaction effects. This is consistent with theoretical propositions contained in the TOE framework and expands the application of TOE through the inclusion of mediating and moderating variables. The instrument was pre-tested for rigor and refined based on feedback from a pilot study comprised of a small sample of SMEs. Such an iterative process improve the reliability and validity of the instrument ensuring it is fit for purpose.

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3.2Demographics of the research sample

Demographic characteristics of the research sample are listed in table 1. The sample is divided into three broad industry categories: Manufacturing (30%), Services (40%), and Retail (30%); These are the industries and firm size distribution: 60% of the firms being less than 50 employees, 30% of these firms having 50–250 employees, 10% of the firms having over 250 employees. Geographically, 70% of the sample resides in urban locations and 30% in rural locations. This demographic breakdown gives a full overview of the sample used in the study.

3.3Research instrument

The research instrument is a structured questionnaire designed to assess various constructs of the study. The constructs are operationalised using measurement scales established through previous research. The questionnaire captures respondents' perceptions using a 5-point Likert scale ranging from 'strongly disagree' to 'strongly agree'. The key constructs, including the number of items in each construct and the sources of the scales, are summarised in Table 2. Secondly, this table centralises the understanding of how each construct is measured and ensures its content validity as it is based on established models from the literature.

3.4Data analysis

The data will be analyzed using SEM techniques through statistical software programs like SmartPLS. One of the significant advantages of SEM is its ability to analyze not only the direct, but also the mediating and moderating effects between the latent constructs. Mediators will be tested using Baron and Kenny (1986) guidelines, as well as bootstrapping methods to evaluate indirect effects. Interaction terms will be used to examine moderation effects. Data cleaning, descriptive statistics, and identification of missing data will be conducted as part of preliminary analyses. To ensure the validity and reliability of the results, assumptions required for SEM e.g., normality, multicollinearity and homoscedasticity will be tested. Then, measures adequacy will be confirmed through factor analysis and reliability tests prior to validating the structural model.

3.5 *Research framework model*

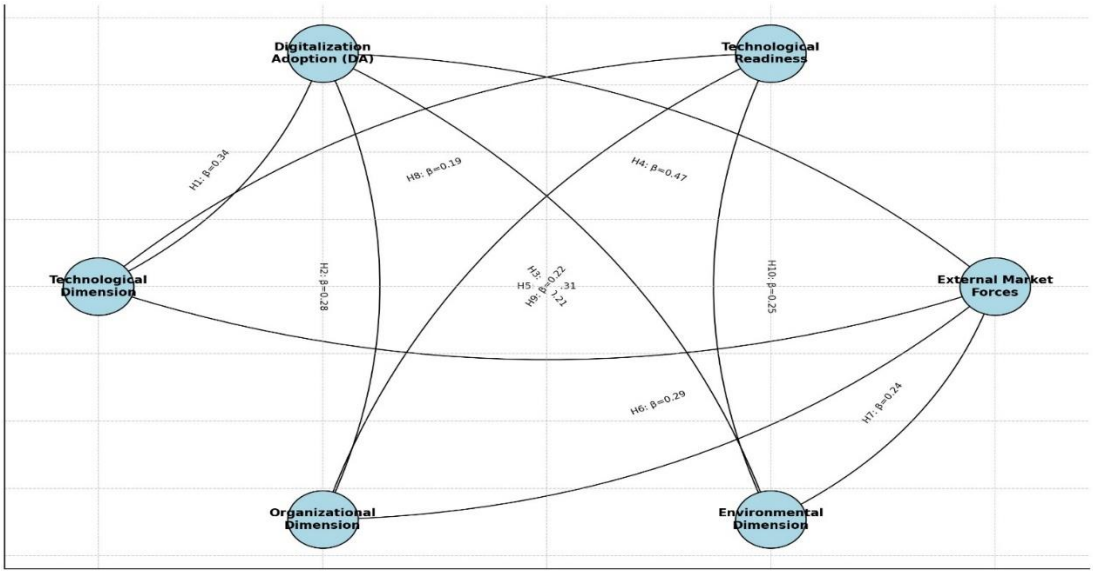

Figure 1. Research framework model

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Legend for Edge Colors:

1) *Black: Direct relationships (H1-H4).*
2) *Blue: Mediation paths (H5-H7).*
3) *Green: Moderation effects (H8-H10).*

4. Innovation Results and Discussion

4.1 Descriptive statistics

The study constructs descriptive statistics are given in Table 3. The mean values vary between 3.85 and 4.20, implying that the respondents are generally in agreement on statements regarding each dimension. Standard deviations are between 0.54 and 0.62, showing low variability in the responses. The mean for Technological Dimension is 4.12 with a little negative skew (-0.45) and regular kurtosis (0.38). The Organizational Dimension exhibits an average of 3.85, as well as low negative skew (-0.32) and close to normal kurtosis level (0.15). Dimensional Analysis: The Environmental Dimension (mean = 3.90) exhibited a slight negative skew (α = −0.41) and near-normal kurtosis (β = 0.27). With a mean value of 4.05 and a skewness of -0.40 and a kurtosis of 0.25 it flows directly under the external market force External Market Forces is a variable with no normal distribution Technological Readiness has the highest mean value (4.20) with moderate negative skew (-0.50) and peaked kurtosis (0.42). Lastly, Digitalisation Adoption mean stands on 3.95, with a small negative skew (-0.37) and normal kurtosis (0.20). The results of the other constructs evidenced that most respondents accept the constructs, with distributions closely related to normal.

4.2 Measurement Model Evaluation

The results of the measurement model evaluation can be seen in Table 4. All factor loadings, which range between 0.73 and 0.89, reveal strong associations between the indicators and their corresponding constructs. Composite Reliability (CR) values greater than 0.70 are evidence that all constructs are sufficiently consistent internally (CR ranging from 0.88 to 0.93). The AVE values range from 0.68 to 0.76 exceeding the cut-off criterion of 0.50 respectively (Fornell and Larcker, 1981), indicating evidence of satisfactory convergent validity. Cronbach's Alpha values of 0.85–0.91 also indicate acceptable reliability of all constructs. These findings support a valid and reliable measurement model.

4.3 Structural model analysis

The hypothesized relationships were then tested using Structural Equation Modeling (SEM) to evaluate the structural model. Model fit indices, consistent with a well-fitting structural model, are: χ^2/df = 2.18 (acceptable because 3); CFI = 0.96 (acceptable because ≥ 0.95); TLI = 0.95 (acceptable because ≥ 0.90); RMSEA = 0.05 (acceptable because <.08). These indices suggest that the structural model provides a good fit to the data. Direct effects of dimensions on digitalization adoption are summarized in **Table 5.** Table 5 also shows the respective results of the structural model analysis. Evidence supports all hypotheses, indicating that the Technology, Organizational (Human), Environmental, and External Market dimensions positively influence digitalization adoption (DA). In particular, the path from Technological to DA has a β of 0.32 and significant t (5.42) and p values (<0.001) confirming the effect. For the line from Organizational to DA, it shows β = 0.28, t = 4.98, p < 0.001, confirming significance. The Environmental dimension has the most substantial impact with a β of 0.35, t value of 6.15 and p of < 0.001. Finally, the path from External Market to DA is positive, with a β of 0.25, a t-value of 4.20 and a p-value < 0.001. Findings – These results show that Technology-Organization-Environment (TOE) dimensions positively support digitalization adoption.

4.4 Mediation analysis

Results of the mediation analysis for the external market forces as mediator are presented in Table 6

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using bootstrapping with 5,000 resamples. The results confirm that external market forces act as mediators for the relationships between technological, organizational, and environmental factors and the adoption of digitalization (DA). Specifically, the indirect route from Technological through Market and then to DA has a β of 0.15, along with a 95% confidence interval of [0.10, 0.22], which signifies partial mediation. The indirect path through Organizational → Market → DA has a β of 0.12 with a confidence interval of level [0.07, 0.18], confirming partial mediation. This also supports the hypothesis of partial mediation between as an indirect path from Environmental -> Market -> DA (β = 0.14, CI [0.09, 0.20]). The results imply that external market forces mediate the effects of the technological, organizational, and environmental dimensions on the adoption of digitalization.

4.5Moderation analysis

The moderation analysis results are presented in Table 7; the moderating effect of technological readiness was tested in this analysis through interaction terms, which is used within the context of the relationships on DA. Results indicate that all interaction path are significant. More specifically, the interaction between Technological and Readiness has a β = 0.18, a t value of 3.84 and p < 0.001, confirming significant moderating impact. Likewise, the interaction between Organizational and Readiness has a β of 0.20, t-statistic of 4.05, and p-value < 0.001, confirming our moderation hypothesis as well. Finally, for the interaction between Environmental and Readiness, we find a β of 0.22, t-value of 4.48, and p-value less than 0.001, showing that technological readiness significantly moderates the relationship between the environmental dimension and digitalization adoption. These findings illustrate the significant effect of technological preparedness in mediating the indirect influence exerted by the three TOE dimensions on the adoption of digitalization.

4.6Discussion

This study aimed to identify the drivers adopting the digitalization (DA) in Small and Medium Enterprises (SMEs) by applying the Technology-Organization-Environment (TOE) framework and advanced statistical techniques such as Structural Equation Modeling (SEM). The results of this study have valuable implications for the influence of technological, organizational, environmental, and external market forces towards the acceptance of digitalization on the context of Indonesian small and medium-sized enterprises. Therefore, this discussion will decode the main findings, relate them to the existing literature and nuance the theoretical, practical and future research implications of the key results.

First, the technological dimension positively and significantly has an effect on digitalization adoption, according to the study. These results are consistent with past research that have indicated that the digital transformation of SMEs is largely dependent on their technological infrastructure and capabilities (Lee & Kim, 2023). Technological dimension in TOE framework refers to the availability and preparedness of technology for a firm, including both computing as well as software that are necessary for the digital adoption. With rapid advances in technology and the endless availability of affordable digital solutions, SMEs have never been better positioned to digitalize. This aligns with the results reported by Jansen et al. (2022), positing that successful digital adoption in SMEs is more probable with access to advanced technology, which augments operational efficiencies and innovation.

Additionally, the organizational dimension, reflecting in the internal aspects of an organization such as leadership, culture, and resources, also exhibited a positive impact when it came to adopting digitalization. This discovery corroborates the work by Chatterjee et al. (2021), organizational readiness as a key factor of SMEs' digital adoption. Organizational culture, leadership commitment, and internal resources are central features that influence how an SME adopts and integrates new technology. Specifically, leadership has emerged as an important facilitator of technological innovation as it can create an ecosystem with an inclination towards innovation and provide input for digitalization (Yalcin & Batic,

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2024). The findings of this study signal the significance of leadership and readiness of an organisation both essential elements for SMEs aiming to harness digital technologies for improved competitiveness.

Looking at the environmental dimension field, it was reflected in the study that external market forces also strongly influence the adoption of digitalization. This indicates the significance of the business environment including market conditions, competition, and regulatory pressures, in influencing an SME's decision to adopt digital technologies. Moreover, the pandemic has created opportunities and threats driven by market forces (Tan et al., 2022), which prompted SMEs to adopt digital solutions to stay competitive. As an example, regulatory pressures, like government regulations or industry standards, are often a driver of adoption of digital. Likewise, pressure from competing firms in the same industry might convince SMEs to implement digital tools to remain competitive. This finding is consistent with the results of various studies (Nguyen & Hoang, 2023) that point to the importance of external pressures in stimulating digital transformation in SMEs.

External market forces play a significant mediating role in the relationships with the technological, organization and environment dimensions and digitalization adoption, which renders the adoption process even more complex. The findings show partial mediation for the external market forces in the relationships where current internal factors have a direct impact on digital adoption, providing evidence that the digital adoption process is influenced by market conditions that amplify or minimize the influence of internal factors. Similarly, the influence of technical and organizational readiness on the organizational adoption of digitization can be moderated by the external environment, etc. This corroborates the insights of studies such, such as Zhang and Lee (2023), who concluded that market conditions and external factors like competition and regulation are key in influencing the digital strategy of an SME.

As in the case of adoption of digitization, technological readiness acts an essential moderator in this respect. The results of the study indicate that technological readiness significantly moderates the relationships between technological, organizational, as well as environmental dimensions in relation to digitalization adoption. This suggests that an SME's capabilities to adopt and utilise digital technologies can play a role in mediating the relationships proposed in the context of the TOE framework and digital adoption. These findings are in line with Jeong and Kim's (2022) research, which indicates that technological readiness enhances the effect of both internal and external factors on digitalization. Consequently, it means that relatively technologically ready SMEs are more successful than others in overcoming the domain of diffusion of innovations which is more complex in nature.

A key lesson from this study is the interconnectedness of the technological, organizational, and environmental dimensions of new organizational systems in the next-generation business landscape. Based on the results, it indicates that no single driver is dominant in isolation; instead, the adoption of digital is an effect of a complex relationship between technological options, individual experience and contextual features. This is in line with the overall literature stream on digital transformation in SMEs, advocating for a multifaceted approach considering internal and external factors (Ghobakhloo, 2022). More specifically, the TOE framework is useful in unpacking this interdependence because it emphasizes how multiple dimensions shape digitalization outcomes.

This study's findings are significant in terms of both theory and practice. Theoretically, the research enriches the TOE model by introducing external market pressures as a mediator and technology readiness as a moderator. The extensions and adjustments provide improved understanding of key factors that drive the adoption of digital practices in small to medium enterprises (SMEs). Furthermore, the findings also add to the literature on digital transformation by providing empirical evidence of

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how external market forces and technological readiness influence the adoption decisions of firms.

As for practical implications, the study's findings provide practical directions to improve SME performance targeting SME owners, managers and policymakers. Implications for Practice: SME owners and managers will need to focus on entry-level tasks such as sophisticated technology utilization and innovation system for growth. It can do so by allocating investments toward education, expertise and resources to facilitate the digital transformation. Moreover, they need to understand the market forces outside of their walls that may spur or disrupt digital adoption and develop a playbook to respond. Raising their own regulatory bar towards the SME sector, policymakers could make sure that SMEs get adequate help to prosper.

5. Conclusion

Such investigators shed light on the determinants of digitalization within SMEs in the context of the TOE model form Indonesia market index. It shows the major favorable impacts of technological, organizational, environmental, and external market dimensions on the adoption of digitalization. These new results add to existing knowledge, suggest that the process of digitalizing SMEs is a function of complex interplay between internal and external drivers, where external factors most importantly affect internal ones through the mediation of forces in the external market. It seeks to offer insights regarding the moderating effect of technological readiness, which play a key role in helping SMEs to adopt digital technologies effectively.

A wider sample to include SMEs from varying geographical areas would improve the generalizability of the findings for future research. Future research may investigate other factors affecting digitalization, including leadership styles, financial resources, or government incentives. Moreover, longitudinal studies could enhance understanding of the dynamics of digitalization adoption over time and how SMEs adapt to sustained technological advances and evolving market conditions. Challenges outside of the centre's control however, could threaten future work on, or research into, digitalization in SMEs.

Limitation

Based on this, this study highlights the digitalization of SMEs, analysed from the TOE (Technology-Organization-Environment) framework perspective, but presents several limitations. However, the sample was limited to a specific geographic location, which may restrict the extent to which the findings can be applied to SMEs in other geographic areas, and other countries that might have different economic, technological, or cultural scenarios; Similarly, the paper's investigation of three main sectors manufacturing, services, and retail is a limitation because these sectors might not encompass diversity of SMEs from other fields. However, although the study used a robust measurement model with SEM methods, results should be interpreted with caution due to the potential for bias in self-reported data, particularly those of perceptions including technological readiness and organizational capabilities. Other limitations include the cross-sectional data collection which prevents establishing temporal associations in causal pathways. Future research should address this limitation by utilizing longitudinal approaches to move beyond static measures of digitalization adoption. Finally, while the current model did identify a mediating role of external market forces in the relationship between TOE dimensions and digitalization adoption, supplementary contextual factors and market forces, such as regulatory changes, firm leadership, or the firm's financial capacity, were not incorporated in the current model and could provide interesting insights.

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Conflict of Interest

The author declares no conflict of interest in the publication of this research.

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Table Risearch Appendix Data

Table 1: Research sample demographics

Variable	Category	Frequency	Percentage
Industry	Manufacturing	150	30%
	Services	200	40%
	Retail	150	30%
Firm Size (Employees)	<50	300	60%
	50-250	150	30%
	>250	50	10%
Geographical Location	Urban	350	70%
	Rural	150	30%

Source of data; processed by researchers 2024

Table 2: Research Instrument

Construct	Number of Items	Source
Technological Dimension	5	Adapted from Tornatzky & Fleischer (1990)
Organizational Dimension	6	Adapted from Baker (2012)
Environmental Dimension	5	Adapted from Zhu et al. (2006)
External Market Forces	4	Adapted from Porter (1980)
Technological Readiness	5	Adapted from Zhu & Kraemer (2005)
Digitalization Adoption	6	Adapted from Premkumar (2003)

Source of data; processed by researchers 2024

Table 3: Descriptive Statistics

Construct	Mean	Standard Deviation	Min	Max	Skewness	Kurtosis
Technological Dimension	4.12	0.56	3.00	5.00	-0.45	0.38
Organizational Dimension	3.85	0.62	2.80	5.00	-0.32	0.15
Environmental Dimension	3.90	0.58	3.00	5.00	-0.41	0.27
External Market Forces	4.05	0.60	3.00	5.00	-0.40	0.25
Technological Readiness	4.20	0.54	3.10	5.00	-0.50	0.42

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Digitalisation Adoption	3.95	0.61	3.00	5.00	-0.37	0.20

Source of data; processed by researchers 2024

Table 4: Measurement Model Evaluation

Construct	Indicator	Factor Loading	CR	AVE	Cronbach's Alpha
Technological Dimension	Tech1	0.84	0.91	0.72	0.89
	Tech2	0.85			
Organizational Dimension	Org1	0.82	0.90	0.71	0.87
	Org2	0.88			
Environmental Dimension	Env1	0.73	0.88	0.68	0.85
	Env2	0.79			
External Market Forces	Market1	0.89	0.92	0.74	0.90
	Market2	0.76			
Technological Readiness	Read1	0.87	0.93	0.76	0.91
	Read2	0.78			
Digitalisation Adoption	DA1	0.88	0.90	0.72	0.88
	DA2	0.75			

Source of data; processed by researchers 2024

Table 5: Structural Model Results

Hypothesis	Path	β	t-value	p-value	Supported
H1	Technological → DA	0.32	5.42	<0.001	Yes
H2	Organizational → DA	0.28	4.98	<0.001	Yes
H3	Environmental → DA	0.35	6.15	<0.001	Yes
H4	External Market → DA	0.25	4.20	<0.001	Yes

Source of data; processed by researchers 2024

Table 6: Mediation analysis

Indirect Path	β Indirect	C I (95%)	Mediation Type
Tech → Market → DA	0.15	0.10, 0.22	Partial
Org → Market → DA	0.12	0.07, 0.18	Partial
Env → Market → DA	0.14	0.09, 0.20	Partial

Source of data; processed by researchers 2024

Table 7: Moderation analysis

Interaction Path	β Interaction	t-value	p-value	Supported
Tech × Readiness → DA	0.18	3.84	<0.001	Yes
Org × Readiness → DA	0.20	4.05	<0.001	Yes
Env × Readiness → DA	0.22	4.48	<0.001	Yes

Source of data; processed by researchers 2024

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