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ARTIFICIAL INTELLIGENCE, CYBER SECURITY MEASURES AND SME'S E-OPERATIONAL EFFICIENCY: MODERATING ROLE OF EMPLOYEES PERCEPTION OF AI USEFULNESS

Wael Sh. Basri[1*]

[1]College of Business Administration, Northern Border University, ArAr. Saudi Arabia.

Research Paper

Abstract: This study endeavours to elucidate the influence of artificial intelligence (AI) adoption on enterprise packages within small and medium-sized enterprises (SMEs) while delineating the factors that contribute to e-operational performance. A cohort of 235 employees was selected from a range of SMEs engaged in active E-business endeavours. Utilizing statistical analyses such as regression analysis and moderation assessment, the study seeks to examine the interrelationships among these variables and assess the anticipated moderating effects. The study's findings unveil substantial associations between AI adoption, employee readiness, cybersecurity measures, technological infrastructure, and E-operational efficiency within SMEs. Firstly, there exists a robust correlation between AI adoption and E-operational performance, signifying that SMEs integrating AI technologies witness enhancements in operational effectiveness. Secondly, the proficiency of employees in utilizing AI tools plays a pivotal role in augmenting E-operational efficiency, indicating that adeptness in AI application among employees contributes significantly to the efficacy of AI implementation. Thirdly, cybersecurity measures and technological infrastructure exhibit positive impacts on E-operational efficiency, underscoring the pivotal role of robust security protocols and state-of-the-art technology infrastructure in enhancing operational effectiveness. Furthermore, the study identifies the moderating influence of employee perceptions regarding the utility of AI on these relationships, emphasizing the significance of organizational culture and employee attitudes towards AI adoption. This research offers empirical evidence supporting the favourable impact of AI adoption on e-operational efficiency within SMEs. It underscores the importance of considering employee readiness, cybersecurity measures, and technology infrastructure in the successful integration of AI technologies. Moreover, the findings highlight the necessity of cultivating a supportive organizational culture that fosters positive perceptions of AI usefulness among employees.

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*Corresponding Author: wael.basri@nbu.edu (W. S. Basri)

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Keywords: AI Adoption, SMEs, E-Operational Efficiency, Employee AI Readiness, Cybersecurity Measures, Technology Infrastructure, Decision Making.

1. Introduction

E-operational efficiency pertains to the digitization of operational procedures in the provisioning of e-services and products, employing electronic means to reduce expenses, streamline workflows, and enhance productivity. This entails automating routine tasks, digitizing documentation and processes, integrating electronic systems, and continuously refining operations through business intelligence. The implementation of such applications, including Groupware, Supply Chain Management (SCM), and Business Intelligence (BI), is underscored as significant by both (Shin, 2006) and (Qushem et al., 2017) for enhancing SME performance. Additionally, Makar (2023) and Schönberger (2023) extend the discourse on AI interventions in operational efficacy and competitiveness within micro and small enterprises (MSEs). Makar elucidates the accessibility of AI for small and medium-sized enterprises preceding (Schönberger, 2023), who identifies key AI applications such as virtual assistance, recommendation systems, and machine learning, highlighting benefits like heightened efficiency and productivity. However, both studies also acknowledge challenges associated with AI adoption, including privacy concerns and the need for specialized skills. Moreover, the digitization process necessitates cybersecurity measures to safeguard electronic assets and facilitate convenient access to mobile services for remote operations.

E-operational efficiency stands as a critical determinant for enterprises striving to maintain competitiveness in the digital era, realized through the optimization of electronic workflows and resources. The integration of AI within SMEs holds significant potential for enhancing operational efficiency and competitiveness (Enshassi et al., 2024). Nonetheless, SMEs commonly encounter challenges associated with AI implementation, notably resource constraints and difficulties in securing up-to-date expertise (Tominc et al., 2024). In pursuit of addressing these challenges, an AI orchestration framework grounded in decentralization, emphasizing transparency and explain ability, is proposed, offering potential applicability in facilitating trade financing and supply chain operations (Alirezaie et al., 2024). Such frameworks also extend their utility to areas like Robotics, AI in Digital Marketing, and FinTech, thereby enhancing business operations and profitability (Enshassi et al., 2024). Consequently, the adoption of AI empowers SMEs to manage burgeoning workloads at reduced costs, leading to heightened efficiencies and competitive advantages (Yang, 2023). The integration of AI-based platforms equips SMEs to automate menial tasks, analyse vast datasets to inform strategic decisions, and tailor services to meet customer demands. For instance, AI-driven chatbots can handle initial customer inquiries, while human resources intervene in more complex matters. Concurrently, machine learning systems contribute to optimizing supply chain management, inventory forecasting, and resource allocation precision, resulting in cost reduction and enhanced operational efficiency.

While attitudes among employees regarding the utility of artificial intelligence applications in SMEs may vary, some perceive it as a valuable asset capable of

executing tasks and providing valuable insights, while others express concerns regarding job security, privacy, and ethical implications. These concerns underscore the necessity for transparent communication, comprehensive training, and inclusion in decision-making processes to ensure successful AI adoption within organizations. Studies examining the impact of AI on firm performance, particularly for SMEs, highlight its utility in supporting business activities, enhancing customer service, and bolstering competitiveness (Kumar & Kalse, 2021; Wamba-Taguimdje et al., 2020) This underscores the imperative for a reassessment of the future of work alongside analytics, as some experts warn of job displacement and changes in human-machine interaction (Howard, 2019). Addressing these concerns necessitates an examination of factors shaping AI adoption in SMEs, including job fit, complexity, long-term implications, attitudes toward usage, social influences, and facilitating conditions (Grover et al., 2022). These factors, notably perceptions and the establishment of AI usefulness, play a crucial role in ensuring the successful integration of AI within SMEs. However, while AI-based chatbots deployed during the employee recruitment process are generally viewed positively, with individuals perceiving them as beneficial (Balcıoğlu & Artar, 2024), others remain unconvinced, citing a lack of relevance to their work due to limited exposure to technology or minimal impact on their tasks. Additionally, some express apprehension, viewing AI adoption as a significant risk potentially leading to job loss, thereby raising concerns about data security and AI strategies.

Resistance to change can exacerbate perceptions contrary to the concept, necessitating visible communication, training, involvement in decision-making processes, and elucidation of AI benefits to mitigate this challenge and foster a positive attitude towards integration. Conducting research on employees' perceptions of AI in the workplace reveals a nuanced landscape. While AI is formally acknowledged as highly significant and beneficial, criticisms regarding its impact on employment persist (Weiss et al., 2022). Employees themselves express a desire for AI systems characterized by explainable AI, addressing concerns about transparency and comprehensibility (Weitz et al., 2022). However, individuals tend to exhibit a bias towards optimism regarding AI's impact on their own businesses while adopting a more pessimistic view of its effects on others (Weber, 2023), a common phenomenon. Despite the existence of these concerns, AI, particularly in the form of chatbots, is recognized for redefining job roles, with employee trust emerging as a crucial factor facilitating innovation in AI utilization (WANG et al., 2022).

The aims and objectives of investigating the adoption of AI within business applications in SMEs encompass multifaceted considerations: The study seeks to assess the present status of AI integration within SMEs' business frameworks, encompassing both the existing AI applications deployed within these entities and the factors influencing the facilitation or hindrance of AI adoption. It is imperative to gauge the proficiency of SME employees in adopting AI technology. This necessitates an evaluation of their comprehension and familiarity with AI systems, their skill sets, and a cost-benefit analysis aimed at identifying training requirements and resistance to change. Given the escalating reliance on digital innovations, including AI, there arises a pressing need to address cybersecurity concerns within SMEs. This entails, among other aspects, evaluating the efficacy of current security protocols in safeguarding AI systems and data from cyber threats, encompassing vulnerabilities

and potential breaches. The research objectives also entail an assessment of the technological infrastructure of SMEs, which serves as the foundation for AI implementation. This examination encompasses various facets such as the availability of computational resources, the quality of data storage facilities, and the feasibility of integrating AI systems within existing frameworks.

In this context, the primary aim of exploring AI integration in SME applications is to acquire insights into how these enterprises employ AI to enhance operational efficiency, streamline decision-making processes, and gain a competitive edge within their respective industries. This research scrutinizes AI adoption, employee readiness, cybersecurity measures, and technological infrastructure within SMEs with the objective of offering recommendations on prudent AI technology adoption strategies. The goal is to enable SMEs to capitalize on the advantages of AI while effectively managing associated risks.

2. Literature Review

AI technologies have demonstrated their capacity to enhance e-operational efficiency across various industries, optimizing processes and driving productivity. This enhancement encompasses improved data analysis, predictive capabilities, and asset optimization, resulting in cost savings and a strengthened competitive edge. The integration of AI within e-operational contexts facilitates organizational performance improvement, enabling more efficient operations in the digital era. Research indicates that AI implementation has notably elevated e-operational efficiency across diverse sectors (Makar, 2023), particularly in conjunction with IoT and operations management, leveraging coordinated deployment of these technologies (Rocha & Kissimoto, 2022). Key drivers of AI for achieving operational excellence include leveraging data-driven AI capabilities and deep learning methodologies (Tariq et al., 2021). Furthermore, AI implementation in management information systems has enhanced organizational efficiency through automation and predictive insights (Bhima et al., 2023). AI-powered automation not only reduces IT costs but also enhances operational efficiency and garners positive customer feedback (Turchin, 2020).

H1 *AI adoption positively influence E-operational efficiency.*

The high readiness of employees for AI technologies significantly contributes to the positive trends in e-operational efficiency. Well-trained employees equipped with the requisite skills to utilize AI tools and platforms can effectively automate processes, explore opportunities, and make data-driven decisions. Moreover, the presence of cutting-edge technologies fosters an innovation culture that promotes continuous improvement within the organization, leading to enhanced efficiency across various operational areas such as customer service, supply chain management, and product development. Employees who embrace AI can collaborate seamlessly with AI systems to address complex issues and adapt to evolving business conditions, thereby facilitating sustainable growth and competitiveness in the ever-changing digital landscape. While Ahmed et al. (2018) and Gautam and Devarakonda (2022) underscore the positive impacts of AI on productivity and technology acceptance among employees, they also acknowledge the technological barriers and ethical

challenges associated with AI systems. Trust, as emphasized by Lai et al. (2013), plays a pivotal role in e-business satisfaction and is a key driver of operational efficiency. Furthermore, as Tabatabaei et al. (2013) asserts, emotional intelligence is essential for improving job performance, and self-efficacy serves as a significant factor in e-operational success. In conclusion, employees' acceptance of AI usage and their emotional intelligence can have a positive impact on electronic operations.

H2 *Employees AI readiness positively influence E-operational Efficiency.*

Cybersecurity measures play a pivotal role in enhancing e-operational efficiency by safeguarding digital assets, mitigating risks, and ensuring uninterrupted business operations. With appropriate cybersecurity measures in place, organizations can navigate the digital landscape securely and focus on core activities without fear of cyber threats. Effective cybersecurity measures prevent data breaches, minimize downtime resulting from cyberattacks, and mitigate financial losses associated with cyber incidents. This stability significantly enhances overall production efficiency by preserving the quality, continuity, and confidentiality of critical systems and data. Research, such as that conducted by (Prentice & Nguyen, 2020), underscores the profound positive impact of cybersecurity measures on e-operational efficiency. Additionally, studies by Geleta (2018) emphasize the need for cybersecurity metrics to serve as performance indicators in e-business, while (Alqahtani & Braun, 2021) highlights the importance of technical controls, accountability, and monitoring for compliance in cybersecurity, thus enhancing business efficiency. A comprehensive approach to cybersecurity, especially in critical infrastructure sectors like electric utilities, is essential, as noted by (Aitel, 2013).

H3 *Cyber Security Measures positively influence E-operational Efficiency.*

The optimal technology infrastructure forms the bedrock for enhancing e-operational efficiency through its attributes of scalability, reliability, and flexibility. Enhanced performance optimization facilitates accelerated processes, while stringent security measures mitigate cyber threats, emphasizing the importance of compliance and uninterrupted operations. This eradicates data transfer obstacles, fostering streamlined data exchanges and minimizing operational complexities. Acting as a foundational support, technology infrastructure facilitates the flow of digital processes and activities. In essence, measuring e-operational efficiency hinges on designing and nurturing technology infrastructure, which serves as the cornerstone of organizational success, enabling the utilization of digital capabilities, adaptability to business needs, and strategic alignment in the digital sphere. A plethora of research underscores the positive impact of technological infrastructure on operational efficiency. For instance, Widajanti and Ratnawati (2020) study demonstrated how information and communication technology systems minimized production costs and increased productivity at PT TASPEN. Additionally, Ali et al. (2014) highlighted the pivotal role of cloud computing in enhancing e-government operations. Similarly, Shamshoian et al. (2005) and Kounetas and Tsekouras (2010) emphasized the capability of certain technological infrastructures, such as energy-efficient technologies, to enhance operational efficiency across high-tech industries and manufacturing sectors.

H4 *Technology Infrastructure positively influence E-operational Efficiency.*

Artificial Intelligence, Cyber Security Measures and SME's E-operational Efficiency: Moderating Role of Employees Perception of AI Usefulness

Employee perceptions of the usefulness of AI act as a significant moderator in the relationship between AI adoption and e-operational performance. When employees perceive AI as highly beneficial, its adoption tends to positively impact e-operational performance. Conversely, if employees perceive AI as less beneficial or are resistant to its adoption, the potential benefits to e-operational efficiency may be limited. Organizational and management support greatly influence employees' perceptions of AI usefulness and their intention to use it. Additionally, employees' perception of AI usefulness is closely linked to workplace well-being. However, perceived complexity limits AI adoption in employee recruitment, while technology competence and regulatory support encourage its use. Factors such as organizational culture, habit, job insecurity, self-image, and perceived usefulness also influence employees' intention to use AI. These findings highlight the critical role of employees' perception of AI usefulness in moderating the relationship between AI adoption and e-operational performance. Notably, studies by Prentice and Nguyen (2020) emphasize the preference for human interactions over AI in customer service, while (Bhardwaj et al., 2020) highlight the positive relationship between AI and HR functions, particularly when moderated by innovativeness and ease of use.

H5 *Employee perception of AI usefulness moderates relationship between AI adoption and E-operational efficiency.*

Representatives' perceptions regarding the utility of AI influence the relationship between their AI readiness and e-operational efficiency. When employees are more inclined to embrace AI technologies, their positive perception enhances the impact of AI on e-operational efficiency. Conversely, if employees exhibit reluctance or resistance towards AI, their readiness level may not translate effectively into improvements in e-operational efficiency. Thus, employees' perception of AI utility acts as a critical factor shaping the effectiveness of AI adoption initiatives in driving e-operational efficiency within organizations. Chien and Hu (2009) and Erdogmus and Esen (2014) both underscore the significance of individual perceptions regarding technology. Chien's focus on ERP effectiveness highlights the role of employee computer self-efficacy in moderating the relationship between ERP proficiency and effectiveness. These findings are consistent with Esen's research on technology readiness and acceptance, which emphasizes the influence of individual readiness on perceived utility. The link between employees' AI readiness and e-operational efficiency is influenced by their perception of AI utility (Damerji & Salimi, 2021). This perception is further shaped by AI decision transparency, which affects employees' trust in AI (Yu & Li, 2022). The integration of AI in HR functions can enhance operational performance, with this relationship being moderated by innovation and usability (Bhardwaj et al., 2020).

H6 *Employee perception of AI usefulness moderates relationship between* Employees AI Readiness *and E-operational efficiency.*

Employees' belief that AI can enhance cybersecurity technologies through automation rather than replace human labour is a magnifying factor in the relationship between cybersecurity measures and electronic operations. When AI is deployed for cybersecurity, employees who perceive AI as valuable for enhancing cybersecurity are more inclined to utilize such measures, leading to greater improvements in e-operational efficiency compared to scenarios where employees

are hesitant to adopt such measures. Conversely, if employees harbour doubts or view AI as having limited efficacy in the cybersecurity domain, the effectiveness of e-operational efficiency diminishes. Thus, it is the perceptions of AI usefulness among employees that determine the extent to which cybersecurity support enhances e-operational efficiency within the organization. Alrfai et al. (2023) and Onumo et al. (2021) suggest that by moderating cybersecurity through the use of AI, there is an increase in operational efficiency, which is a significant determinant of efficiency and profitability. Alrfai et al. (2023) examines intelligent automation within Accounting Information Systems (AIS) systems, while (Onumo et al., 2021) investigates the role of security technologies in promoting employee compliance with cybersecurity control processes. Therefore, cybersecurity studies demonstrate that implementing these measures can leverage the positive impacts of AI on productivity levels. However, Park and Jung (2020) and Verkijika (2020) emphasize the human factor by highlighting employees' perceptions of automation as a threat to job security and its potential impact on their mental well-being. Verkijika's study also underscores the importance of self-efficacy and psychological ownership in employees' cybersecurity-related behaviours. Alhayani et al. (2021) and Pan et al. (2022) note how AI aids in re-evaluating cybersecurity measures, with Alhayani focusing on the IT industry context and Pan exploring how contextual factors influence AI adoption. Wijayati et al. (2022) investigates how AI assists employees in executing tasks more effectively, not only in the services and banking sectors but also in companies involved in general supply. Flavián et al. (2022) contributes to this by examining the intention to use analytical AI in services, suggesting that customers' technology readiness and awareness can influence their acceptance of AI.

H7 *Employee perception of AI usefulness moderates relationship between* Cyber Security Measures *and E-operational efficiency.*

Employees' attitudes towards AI significantly influence e-operational efficiency, acting as a bridge between technology and operations. When employees perceive AI as highly useful and beneficial for enhancing technological capabilities, the practical implementation of these resources has a stronger potential to ensure effective e-operational efficiency. Conversely, if employees have negative perceptions of AI usefulness and view it as less helpful in utilizing technology infrastructure, the impact of these techniques on e-operational improvements may be less efficient. Thus, employees' attitudes towards AI usefulness play a crucial role in the effectiveness of AI technology infrastructure initiatives in achieving end-to-end e-operational efficiency within the organization. Studies by Zhu et al. (2022) highlight the importance of executives' cognitive structures in digital transformation and various AI applications in the workplace. Verma and Singh (2022) investigates the impacts of employees on AI, considering factors like perceived usefulness, enjoyment, and cost. Tannady and Dewi (2024) extends this by examining technological factors such as performance expectancy and perceived risk that influence behavioural intention towards workplace AI utilization. Alshumaimeri and Alshememry (2023) explores the correlation of AI in EFL education and its potential applications in office jobs. Nurhakim and Lestari (2023) emphasizes the positive role of AI and IT in enhancing employee well-being and organizational effectiveness, while Nekonge discusses digital technology governance and ethical issues for future research. These findings underscore the importance of employees' perceptions of AI and IT as essential tools in

their work, impacting technology infrastructure efficiency and e-operational effectiveness. Studies by Asiimwe et al. (2023) validate this concept, emphasizing the role of cybersecurity and IT alignment in improving employee efficiency and AIS. In summary, employees' perceptions of AI and IT usefulness significantly influence the effectiveness of technology infrastructure in achieving e-operational efficiency.

H8 *Employee perception of AI usefulness moderates relationship between* Technology Infrastructure *and E-operational efficiency.*
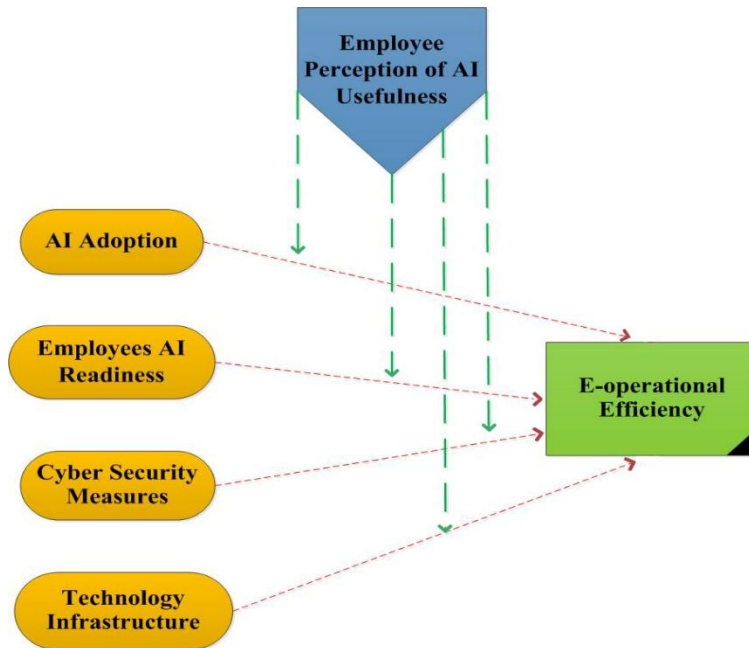

Figure 1: Conceptual Framework.

3. Methodology

3.1 Sampling and Data Collection

The research methodology employed in this study revolves around sampling and data acquisition to investigate the diverse electronic business operations within SMEs. A total of 235 employees were selected from various SMEs actively engaged in e-business operations. Utilizing stratified random sampling, which considers industry sector, company size, and geographic location, the aim was to ensure a valid and representative sample. This approach enabled the researcher to gain a comprehensive understanding of SMEs across different contexts. Data collection was conducted through electronic surveys to gather information quickly and anonymously. Additionally, observational methods were employed to complement the survey, providing a thorough insight into e-business operations within the sampled SMEs. Ultimately, the methodology of this study aimed to acquire a nuanced understanding of e-business practices among SMEs, with the goal of facilitating meaningful analysis

and the development of evidence-based strategies for both practitioners and researchers.

3.2 Descriptive Statistics

Table 1 presents a comprehensive summary of data collected from 235 respondents representing diverse SMEs engaged in E-business operations across multiple companies. Each respondent was surveyed using questionnaire items designed to assess various criteria related to E-business operations, technologies, skills, and strategies. The polar values within the dataset indicate the extent of variability in opinions among participants and facilitate comparison of interactions. The average values provide a measure of central tendency by indicating the mean response for each item within the sample. Additionally, standard deviation (S.D.) values highlight the dispersion of responses or their variability around the mean, indicating the degree of agreement or disagreement among respondents.

Within the realm of descriptive statistics, discernible variations emerge in assessments and attitudes concerning various aspects of E-business operations. For instance, metrics such as "work efficiency" and "timely completion of tasks" yield notably high mean scores, indicating a favourable perception among the majority of the workforce towards these facets of their work environment. Conversely, items such as "Pressure from the IS technology new" exhibit greater dispersion, as evidenced by higher standard deviation values, suggesting that opinions among respondents regarding the challenges posed by information system technology are not uniformly consistent.

Furthermore, certain components, such as "Technical solutions" and "Certification," exhibit lower mean scores and higher variations, suggesting potential areas of concern or ambiguity for SMEs regarding technical competencies and certifications. This underscores the need for researchers to explore these areas further and implement appropriate interventions to foster additional capabilities and organizational confidence in E-business.

In summary, the descriptive scores offer significant insights into the perception regarding the overall operation of E-business among employees in SMEs. These findings will serve as the foundation for subsequent analyses and decision-making processes aimed at identifying strategies and methods to enhance the effectiveness and stability of the E-business environment.

Table 1: Descriptive Statistics of Questionnaire Items

Items	N	Min	Max	Mean	S.D.
Improve firm performance.	235	3	5	3.21	0.56
New technologies.	235	3	5	3.54	0.52
Usage	235	3	5	3.64	0.64
Skills and collaboration	235	3	5	3.01	0.50
Extraversion	235	3	5	3.66	0.69
Efficiency	235	3	5	3.94	0.68
AI technology contributing	235	3	5	3.54	0.70
Timely completion of tasks	235	3	5	3.87	0.71
Strategy for cyber security	235	3	5	3.80	0.58
Managing incidents	235	3	5	3.61	0.66

Trained in cyber security	235	3	5	3.69	0.59
Rules and processes	235	3	5	3.54	0.80
Technical solutions	235	3	5	3.00	0.58
Certification	235	3	5	2.99	0.69
Insurance	235	3	5	3.54	0.58
Cyber incident management exercises	235	3	5	3.79	0.68
Protocols	235	3	5	3.88	0.71
Cyber security Strategy	235	3	5	3.80	0.60
Better vendor	235	3	5	3.49	0.52
Better process improvement	235	3	5	3.64	0.76
Pressure from the new IS technology	235	3	5	3.70	0.95
Technological sophistication	235	3	5	3.80	0.58
Using software	235	3	5	3.94	0.64
Maintaining information systems	235	3	5	3.67	0.52
Better vendor technological support	235	3	5	3.68	0.63
AI as an assistant to humans	235	3	5	3.46	0.65
AI is ultimately beneficial to humanity	235	3	5	3.58	0.66
AI and jobs	235	3	5	3.47	0.68
AI and limitations	235	3	5	3.66	0.56
Reduced costs	235	3	5	3.48	0.55
Deliver faster.	235	3	5	3.10	0.57
Reduced costs in communications	235	3	5	3.28	0.60

3.3 Factor Analysis

Table 2 presents the outcomes of the confirmatory factor analysis conducted on the survey data, highlighting key aspects such as AI implementation, employee readiness, cybersecurity measures, suitable technology infrastructure, employee perception of AI, and the perceived usefulness of AI as a moderator. The reported Cronbach's Alpha coefficients indicate the internal consistency of each factor, providing insight into the reliability of the constituent items. A Cronbach's Alpha value exceeding one signifies greater consensus among respondents regarding a factor, thus indicating higher reliability. Additionally, the percentage of explained variance for each factor is provided to denote both the proportion of total variance in the observed variables and the contribution made by each factor. Higher percentages indicate that the factor explains a substantial portion of the variability in the data, thereby enhancing the comprehension of the construct.

Furthermore, the Kaiser-Meyer-Olkin (KMO) values are examined to assess the suitability of the questionnaire for factor analysis. KMO values approaching one indicate the dataset's suitability for factor analysis, signifying a sufficient level of relatedness among variables to enable factor extraction. The study's findings reveal high Cronbach's Alpha coefficients for each factor, indicating internal consistency among the items within each factor. Additionally, the variance explained by the factors ranges from 40.25% to 71.34%, suggesting a significant proportion of variability accounted for by the factors. Moreover, distinct KMO statistics were computed for each factor, all exceeding 0.5, indicating adequate sampling adequacy for factor analysis. This suggests that the dataset is conducive to further analysis, and the factors

can be identified through expert interpretation, underscoring the usefulness of the data.

Overall, the results of the CFA provide valuable insights for researchers engaged in factor analysis, as well as for discussions concerning AI adoption, employee preparedness, cybersecurity, technology infrastructure, employee perceptions of AI, and the moderating role of AI usefulness in SMEs involved in e-business operations.

Table 2: Results of CFA of questionnaire data

	Cronbach's Alpha	% of Variance	KMO Statistics
AI Adoption (IV)	0.784	40.25	0.731
Employees AI Readiness (IV)	0.821	49.64	0.841
Cyber Security Measures (IV)	0.808	53.67	0.648
Technology Infrastructure (IV)	0.791	71.34	0.614
Employee Perception of AI	0.764	55.60	0.736
Usefulness (Moderator)	0.792	45.34	0.857

Table 2 presents the interrelations among variables, including AI Adoption (IV), Employee AI Readiness (IV), Cybersecurity Measures (IV), Technology Infrastructure (IV), Employee Perception of AI, and AI Usefulness (Moderator). Significance is observed in numerous correlations reported in the table.

3.4 Correlation Matrix of Questionnaire Data

Table 3 displays the correlation matrix of questionnaire responses, elucidating the associations among variables including AI adoption drivers within SMEs engaged in e-business, employee readiness, cybersecurity measures, technology infrastructure, employee perception of AI, and perceived utility of AI as moderators. The table presents correlation coefficients for each variable pair, indicating the strength and direction of the linear relationship between them.

Upon scrutinizing the existing correlation matrix, notable patterns have emerged. Firstly, significant positive relationships are observed between AI adoption and technology infrastructure (0.394, $p < 0.01$), as well as between employees' AI readiness and technology infrastructure (0.631, $p < 0.01$), indicating low scores. These positive correlations suggest that an increase in AI adoption and employees' AI readiness positively influences the perceived utility of technology within SMEs. Furthermore, a positive correlation is apparent between cyber security measures and employees' AI readiness (0.115, $p < 0.01$), with a robust positive correlation confirmed between the two (0.542, $p < 0.01$), signifying that higher levels of cyber security measures are associated with employees' readiness towards AI.

An additional facet reveals a positive correlation between employees' perception of AI and both AI adoption (0.456, $p < 0.01$) and AI employment readiness (0.480, $p < 0.01$). This suggests that an increase in employees' positive outlook towards AI corresponds to a higher rate of AI adoption and increased AI readiness among employees. Particularly intriguing is the indication of an indirect positive correlation between employees' perception of AI and technology infrastructure ($r = 0.480$, $p < 0.05$), suggesting that a higher perception of AI adequacy is associated with a greater perception of technological infrastructure adequacy.

Artificial Intelligence, Cyber Security Measures and SME's E-operational Efficiency: Moderating Role of Employees Perception of AI Usefulness

There is a growing acknowledgment of the significance of AI usefulness, as evidenced by its positive correlation with AI adoption (r = 0.591, p < 0.01) and cybersecurity preparedness (r = 0.521, p < 0.05). Overall, a correlation matrix serves as a valuable tool for elucidating the interrelations among various factors pertinent to AI adoption within SMEs engaged in electronic business, encompassing factors such as employee readiness, cybersecurity measures, appropriate technology infrastructure, and employees' perceptions of AI. These insights are instrumental for organizational enhancement and strategic decision-making.

Table 3: Correlation Matrix of Questionnaire Data

	AI Adoption (IV)	Employees AI Readiness (IV)	Cyber Security Measures (IV)	Technology Infrastructure (IV)	Employees Perception of AI
AI Adoption (IV)					
Employees AI Readiness (IV)	0.345**				
Cyber Security Measures (IV)	0.247*	0.542			
Technology Infrastructure (IV)	0.394*	0.631*	0.360**		
Employee Perception of AI	0.456	0.480	0.480*	0.550	
Usefulness (Moderator)	0.591**	0.345**	0.521	0.214**	0.460

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

3.5 Multiple-Regression Analysis

This research employed multiple regression analysis to test our hypotheses. The regression test results are presented in Table 5. Table 4 exhibits the outcome of the regression analysis, displaying standardized coefficient values that elucidate the relationships between various independent variables (IVs), including AI adoption, employees' readiness to utilize AI technology, cyber security measures, and the efficacy of technology infrastructure quality, with their positive impact on e-operational efficiency, considered as the dependent variable (DV). The beta values in the standard linear regression model indicate the magnitude and direction of these associations.

Among the independent variables, AI Adoption exerts the most significant influence on E-operational Efficiency, with a Beta coefficient of 0.369. This positive relationship indicates that higher rates of AI adoption in SMEs correspond to improved operational efficiency in E-business operations. The level of significance (p < 0.01) suggests that this connection is not random. Furthermore, the implementation of AI also demonstrates a positive impact on E-operational Efficiency, as evidenced by the workforce's AI Readiness. This underscores the moderating effect of employees' readiness amid incremental digitalization. While the Beta coefficient is slightly lower compared to the former case, at 0.297, its significance level (p = 0.05) should not be overlooked. This highlights the importance of employees' mental preparedness in enhancing operational efficiency within SMEs.

However, the negative association of cybersecurity measures with E-operational Efficiency (Beta coefficient of -0.348) indicates a positive relationship. This suggests that higher cybersecurity standards, and consequently, stronger cybersecurity measures, are inversely related to the effectiveness of E-business operations. Nonetheless, the significance level ($p < 0.05$) underscores the importance of prioritizing cybersecurity measures beyond operational efficiency performance.

Moreover, a positive correlation is observed between Technology Infrastructure and E-Operational Effectiveness, with a Beta coefficient of 0.268. This implies that firms engaged in electronic business operations require a robust technological infrastructure to efficiently carry out their operations. Despite the continuous evolution of technology, the statistically significant effect of technology on operational functions underscores the critical role of an effective technological system within an organization's operations department.

In summary, regression analysis revealed that AI integration, employees' AI readiness, and IT infrastructure significantly enhance SMEs' performance in e-business operations. However, cybersecurity measures were found to negatively impact e-business efficiency, although they are not the primary drivers. This underscores the need for strategic initiatives to enhance efficacy and efficiency in the dynamic e-business environment.

Table 4: Regression Results

	Standardized Coefficients	R^2	Adjusted R^2	F
	Beta			
AI Adoption (IV)	.369**	.314	.268	18.67**
Employees AI Readiness (IV)	.297*			
Cyber Security Measures (IV)	.348*			
Technology Infrastructure (IV)	.268*			

a. Dependent Variable: E-operational Efficiency
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

4. Results of Hypothesis Testing

Table 5 presents a summary of the statistical significance regarding the relationship between independent variables (IVs), including AI adoption, employees' AI readiness, cybersecurity measures, and technology infrastructure, and overall satisfaction in SMEs engaged in E-business operations. The hypotheses postulated a linear and positive association between the variables under investigation and overall satisfaction. The p-values reported in the analysis are utilized to assess the validity of these hypotheses.

The findings validate the research hypotheses, highlighting the relationships between the independent variables (IVs) and the overall satisfaction level. AI adoption, employee readiness, cybersecurity measures, and technology infrastructure emerge as significant contributors to satisfaction, as evidenced by their consistently

low p-values (0.05 < p-value < 0.01). This suggests that a higher recognition of AI's impact, employee preparedness for AI integration, active engagement in cybersecurity measures, and a robust technological infrastructure are associated with greater overall satisfaction among SMEs engaged in E-business operations. These results underscore the importance of these factors in enhancing stakeholder satisfaction within organizations.

All proposed hypotheses are corroborated, indicating that SMEs have the potential to enhance overall customer experience by implementing tailored concessions, mindful of investment constraints, and initiating AI integration. Concurrently, adequate preparations for employees impacted by AI adoption are essential. Moreover, bolstering data security through enhanced access control configurations and other pertinent security measures is imperative. Through adept management of these facets, SMEs can elevate the calibre and efficacy of business operations while concurrently enhancing employee morale and stakeholder satisfaction. Consequently, this strategic approach equips SMEs to effectively compete in the online business landscape.

Table 5: Results of Hypothesis Testing

Hypothesis	Relationship with overall satisfaction	Testing result	Hypothesis
AI Adoption (IV)	Positive	Significant (p= 0.014)	Accepted
Employees AI Readiness (IV)	Positive	Significant (p=0.00)	Accepted
Cyber Security Measures (IV)	Positive	Significant (p= 0.00)	Accepted
Technology Infrastructure (IV)	Positive	Significant (p= 0.010)	Accepted

4.1 Moderation Analysis

Table 6 provides a summary of the moderation analysis aimed at investigating the potential impact of Employee Perception of AI on the relationships between AI adoption, employees' AI readiness, security measures, technology infrastructure, and E-operational Efficiency, serving as the dependent variable. Each independent variable is presented along with the analysis outcomes, estimating the influence of Employee Perception of AI on these relationships.

The results indicate that Employee Perception of AI serves as a mediating factor in connecting the two variables related to e-operational efficiency. Particularly noteworthy is the significant influence ($p < 0.01$) of Perceived Employee AI on the relationships with technology infrastructure and AI adoption. Additionally, it plays a notable moderating role ($p < 0.05$) in the relationship between the interconnected variables of employees' AI readiness and their preparedness.

Hence, the pivotal determinant affecting E-operational Efficiency in SMEs engaged in E-business is the appraisal employees attribute to AI, particularly in terms of AI adoption, AI readiness, and control over technology infrastructure. The moderating effect underscores the crucial role of employees' attitudes and preferences towards

automation in shaping the assessment of AI integration for enhancing operational efficiency. Additionally, the R2 values associated with the moderated models indicate the portion of E-operational efficiency variance dependent on the interaction between these factors and future workforce perceptions of AI. The substantial variances of F-values underscore the overall value of the mediation analysis.

The fundamentals underscore the intricate nature of the Employee Perception of AI as a moderator in establishing equilibrium between E-operational Efficiency and its pivotal determinants within small and medium enterprises. It is imperative to comprehend perspectives and mitigate potential resistance among employees toward AI implementation. AI adoption, employee preparedness for AI, and technology infrastructure directly correlate with business operations and organizational performance in the realm of E-business.

Table 6: Testing Moderation

Variable[a]	NFactor	Factor	Factor	Factor	R^2	R^2 F	
Employee Perception of AI	2350.354*	.268**	.248	.267*	.347	.269	8.647**

Dependent Variable: E-operational Efficiency

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

5. Discussion:

The study establishes a connection between AI adoption levels, the preparedness of personnel for AI integration, and the e-operational efficiency of SMEs. This finding aligns with previous research indicating that AI constitutes a transformative element in process optimization and organizational competitiveness (Davenport & Ronanki, 2018). Enhancing AI-related capabilities within SMEs and ensuring that employees are proficient in technological tools can lead to enhanced process efficiency, better decision-making quality, and a competitive advantage in the digital market landscape. However, it is noted that cyber security measures exhibit an inverse relationship with operational efficiency, highlighting the imperative for companies to prioritize security protocols to safeguard organizational assets, even if it may temporarily impede operational efficiency. This juxtaposition underscores the challenge of reconciling security needs with operational effectiveness. SMEs are urged to adopt comprehensive cybersecurity solutions while minimizing disruptions to operational workflows. Additionally, the positive correlation observed between IT infrastructure quality and operational productivity underscores the pivotal role of robust technological infrastructure in supporting e-business operations and facilitating diverse activities (Li & Wei, 2014).

The research underscores the mediating role played by employees' cognitive perceptions of AI in delineating the relationship between various determinants and E-operational Efficiency. This underscores the critical significance of organizational culture and employees' attitudes toward AI as pivotal factors influencing AI's impact on business operations. To effectively harness AI and foster a supportive environment,

it is imperative to invest in initiatives that enhance SME employees' comprehension of AI, offering guidance on overcoming challenges and fostering a positive attitude toward AI (Gong et al., 2021). Strategies such as training programs, transparent communication channels, and involving employees in AI implementation processes can cultivate a culture conducive to AI-driven innovation and productivity. Overall, the study illuminates the intricacies of E-business operations in SMEs, elucidating the interconnectedness of AI adoption, employee readiness, cyber security, technology infrastructure, and employees' perceptions of AI. By strategically addressing these elements, SMEs can navigate the complexities of the digital landscape, enhancing their operational efficiency and ensuring their sustainability in a fiercely competitive market environment.

H1: This hypothesis posits a discernible trend towards leveraging AI to streamline operational processes, thereby enhancing efficiency. The implementation of AI typically aims to mitigate the need for repetitive tasks through automation, enable large-scale data analysis, and optimize resource allocation. This integration facilitates seamless workflow, mitigates human errors, and expedites data processing. AI algorithms possess the capability to analyse extensive customer data sets and forecast demand patterns, enabling businesses to optimize inventory management and minimize stockouts. Moreover, AI-driven software facilitates predictive maintenance in manufacturing operations, provided it is cost-effective. Importantly, the widespread adoption of artificial intelligence contributes to cost savings, expedited delivery, and heightened customer satisfaction, all indicative of enhanced e-operational efficiency. Validation of this hypothesis would underscore the significant impact of AI utilization on organizational efficiency, highlighting its strategic importance.

H2: This hypothesis posits that the proficiency and preparedness of employees in utilizing AI technologies contribute to enhanced operational efficiency, which holds potential validity. Employees adept at leveraging AI tools through comprehensive training and resources can streamline their tasks and decision-making processes. For example, in customer service operations, operators utilizing AI-powered chatbots could swiftly address routine inquiries, thereby alleviating the workload associated with more complex issues. Moreover, skilled workers, particularly those knowledgeable in AI, may identify process improvements and innovations within their respective domains, thereby fostering a culture of continuous learning and adaptation. By fostering such a culture alongside structured training programs, organizations can effectively integrate AI technologies across various operational domains, thereby optimizing operational efficiency. Empirical support for this hypothesis underscores the imperative of prioritizing the development of well-designed training initiatives to enhance employees' proficiency in AI utilization, thereby bolstering organizational performance.

H3: This hypothesis posits that robust cybersecurity measures are positively associated with heightened e-operational efficiency through the protection of organizational assets and mitigation of disruptions. Effective cybersecurity practices, such as encryption, access controls, and threat detection mechanisms, mitigate the risks of data breaches and cyberattacks, thereby ensuring uninterrupted business operations. For instance, in e-commerce platforms, the implementation of multi-factor authentication and encryption protocols safeguards customer transactions, fostering trust and confidence. Beyond pre-emptively averting the disruptive impacts of cyber

threats, organizations also minimize downtime and enhance operational efficiency by delivering seamless services. Moreover, stakeholders operating within a secure environment are more likely to collaborate effectively, leading to smoother workflows and expedited decision-making processes. Empirical validation of this hypothesis would underscore the critical role of cybersecurity in preserving business continuity. Given the dynamic nature of cyberspace and the proliferation of digital technologies, this assertion holds increasing relevance in contemporary contexts.

H4: This hypothesis posits that sophisticated technological infrastructure enables organizations to achieve heightened performance across diverse operational domains. Contemporary information technology frameworks encompass both physical and logical components, including hardware, software, and networking elements, alongside scalable cloud platforms conducive to deploying such functionalities. The integration of ICTs, particularly in conjunction with high-speed internet connectivity and scalable cloud infrastructure, has revolutionized organizational operations by facilitating the seamless deployment and integration of AI-driven applications for task automation and real-time data analysis. Additionally, intelligently designed communication technologies facilitate prompt connectivity and collaboration among dispersed teams, thereby enhancing organizational agility and responsiveness. Through continuous system refinement and optimization efforts, enterprises can effectively address evolving corporate demands and maintain a competitive edge in the contemporary digital landscape. Empirical validation of these findings would underscore the imperative of strategic IT investments in enhancing organizational efficiency and competitiveness, particularly in industries reliant on digital information technologies for daily operations.

H5: The hypothesis posits that the efficacy of AI solutions in business operations hinges on employees' perceptions of the utility of the introduced AI technologies. When employees perceive AI as valuable and pertinent, they are more likely to actively engage with AI-driven tools and systems, fostering a dynamic AI environment. Consequently, organizations experience greater enhancements in operational efficiency as employees leverage artificial intelligence to streamline workflows, enhance decision-making processes, and innovate new procedures. Conversely, if employees regard AI as superfluous or distracting, they may resist its adoption, leading to underutilization of AI technology and limited improvements in operational efficiency. Therefore, organizations must address employee perceptions through effective communication, training, and change management initiatives to realize the potential benefits of AI in enhancing operational efficiency. Empirical findings validating this assertion would underscore the importance for organizations to assess and manage employees' attitudes and perceptions as crucial determinants of AI implementation and adoption.

H6: This hypothesis posits that employees' perceptions of the utility of AI technology influence the extent to which their readiness to adopt AI impacts e-operational performance. When employees perceive AI as valuable and pertinent to their roles, they are more inclined to actively develop AI-related competencies and apply them effectively in their daily tasks. Consequently, organizations experience greater enhancements in operational performance as employees leverage their AI readiness to optimize workflows, tackle complex challenges, and foster innovation. Conversely, if employees perceive AI as irrelevant or daunting, they may be less inclined to acquire

AI-related skills, resulting in underutilization of available AI capabilities and limited impact on operational efficiency. Hence, organizations must cultivate a positive perception of AI among employees to maximize the effectiveness of AI readiness initiatives in enhancing operational performance. Empirical findings supporting this hypothesis would underscore the significance of addressing employees' perceptions and attitudes toward AI in promoting successful technology adoption and organizational performance enhancements.

H7: This hypothesis posits that employees' perceptions of AI-driven cybersecurity significantly impact e-business efficiency. When employees trust and value AI-powered security measures, they are more likely to comply with security protocols and adopt safer practices, enhancing organizational productivity and resilience against cyber threats. Conversely, scepticism or distrust among employees can undermine the effectiveness of security measures, leaving the organization more vulnerable to cyber threats and reducing operational performance. Therefore, fostering trust and confidence in AI-driven cybersecurity solutions among employees is crucial for enhancing organizational efficiency and resilience against cyber threats.

H8: This hypothesis posits that employee perceptions regarding the advantages of AI technologies play a significant role in shaping the impact of technological policies on e-business efficiency. When management acknowledges the potential of AI for optimizing technology, they are more inclined to embrace changes and innovations in business processes, thereby boosting productivity. Conversely, if management views AI as unnecessary or disruptive to current operations, they may resist change, hindering the organization's ability to fully leverage technological advancements and realize potential business benefits. Thus, fostering a positive attitude towards AI among employees becomes imperative. Research supporting this hypothesis underscores the importance of aligning management perspectives with organizational goals to maximize the benefits of technology investments, ultimately enhancing productivity and competitiveness.

6. Implications

The findings of this research offer significant theoretical implications that enrich the existing knowledge base concerning e-business operations, organizational methodologies, and technology integration. These implications broaden our comprehension of how AI adoption, employee preparedness, cybersecurity protocols, technology directives, and employee attitudes towards AI collectively influence business efficacy within SMEs. The theoretical insights derived from this study illuminate the intricate interplay among various theoretical frameworks essential for comprehending the intricacies of e-business implementation within SMEs. By amalgamating insights from resource-based theory, technology adoption models, social learning theory, organizational culture, and dynamic capabilities theory, this investigation into AI adoption, employee readiness, cybersecurity and technology policies furnishes a comprehensive framework for scrutinizing the catalysts, outcomes, and management perspectives shaping operational efficiency and organizational performance in the digital era.

The study's practical implications offer actionable insights for SMEs aiming to enhance their e-business performance and overall organizational effectiveness. These findings guide strategic decision-making, resource allocation, and management actions to foster AI adoption, boost employee readiness, fortify cybersecurity policies, and optimize technology strategies. By investing in AI technologies, improving employee readiness, enhancing cybersecurity measures, modernizing technology infrastructure, engaging employees, and embracing a culture of continuous improvement, SMEs can position themselves for success in the evolving digital landscape.

6.1 Limitations

The current study's cross-sectional design poses limitations on establishing causal relationships among variables. Future research employing longitudinal or experimental designs could provide more comprehensive insights into the causal mechanisms underlying the relationships examined in this study. Additionally, the sample predominantly comprises SMEs involved in E-business operations, potentially limiting the generalizability of findings to other industries or organizational contexts. Future studies may benefit from exploring diverse samples to enhance the external validity of findings. Despite efforts to ensure reliability and validity, measurement errors may still persist within the data. Future research could utilize multiple data collection methods and robust measurement techniques to mitigate potential biases and improve data quality.

6.2 Contributions

The study offers a comprehensive understanding of factors impacting operational performance in SMEs involved in E-business operations. By examining the relationships among AI adoption, employee readiness, cybersecurity measures, technology infrastructure, and employee perceptions of AI, the study provides a holistic framework for understanding E-business dynamics. The findings have practical relevance for SMEs navigating the digital landscape, offering actionable insights and recommendations to improve performance and competitiveness in the market.

7. Future Research Directions

Future research could employ longitudinal studies to track AI adoption, employee readiness, and operational efficiency over time, enabling a comprehensive examination of causal relationships and change trajectories. Qualitative methods such as interviews and case studies could offer deeper insights into the nuances of AI adoption, employee perceptions, and organizational practices, capturing rich contextual understanding and complexities of organizational dynamics. Exploring cross-cultural differences in AI adoption, employee attitudes, and operational outcomes could provide valuable insights into cultural influences on organizational practices and strategies, identifying universal principles and culturally contingent practices in AI technology adoption and implementation.

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Appendix 1: Measurement Scales

AI Adoption (IV)	References
My firm is willing to adopt AI to improve firm performance.	(Badghish & Soomro, 2024)
My firm adopts new technologies.	
My firm cannot make use of AI.	

Employees AI Readiness (IV)	
Most of the SMEs demonstrates strong interpersonal skills in team settings, fostering collaboration on AI projects.	(Tountopoulou et al., 2021)
Most of the SMEs effectively showcases extraversion in work, enhancing collaborative efforts on AI projects.	
Most of the SMEs organizes and prioritizes tasks efficiently, especially in fast-paced environments with AI projects.	
Most of the SMEs ensures work efficiency in handling various aspects of AI technology, contributing to successful outcomes.	
Most of the SMEs manages time effectively, ensuring timely completion of tasks, particularly in AI project scenarios.	

Cyber Security Measures (IV)	
Which measures, if any, have your company implemented to improve cyber security?	(Franke & Wernberg, 2020)
The company has strategy for cyber security, either as a separate document or as part of another strategy.	
The company has a continuity plan for managing incidents that entail business interruption or data breach.	
Employees have been trained in cyber security in the past year.	
There are rules and processes for employees, e.g., on password generation, usage of private storage or private digital services, backups, and network access.	
There are technical solutions enforcing, e.g., software updates, backup, communication encryption, and rules for network access.	
The company is certified according to, e.g., the ISO- 27000 series.	
The company has a form of cyber insurance (including cybercrime or data protection	

insurance) that covers, e.g., business interruption, data breach, and incident management support. The company has conducted cyber incident management exercises with respect to accidents and/or attacks. The established company cyber security and incident management protocols are updated at least once a year.

Technology Infrastructure (IV)

Better vendor technological support is an important factor in AI adoption (Shiau et al., 2009)

Better process improvement is an important factor in AI adoption

More pressure from the new IS technology of competitors is an important factor in AI adoption

Technological sophistication in the AI system is an important factor in the AI adoption decision

Using software developed with the latest information technology is an important factor in AI adoption decision

The difficulty of maintaining information systems with resources is an important factor in AI adoption decision in my company

Employee Perception of AI Usefulness (Moderator)

I perceive AI as an assistant to humans or a competitor to humans at work (Ahn & Chen, 2022)

I perceive AI is ultimately beneficial to humanity

The use of AI systems in our organization will displace or create more jobs in organization

The use of AI in our organization for decision-making is likely to limit your (organization and employee's) ability to exercise your judgment/discretion.

E-operational Efficiency (Dependent)

Our e-Business efforts have reduced costs by electronic order taking over the Internet. (Chen et al., 2021)

Our e-Business efforts have made us able to deliver faster.

Our e-Business efforts have reduced costs in communications with suppliers and customers.