

Determinants of E-Commerce Adoption Among Small and Medium-Sized Enterprises

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Abstract

Purpose: The purpose of this research is to investigate the determinants of “e-commerce adoption” (ECA) among “Small-Medium-sized Enterprises” (SMEs) in India, with a focus on how different economic and contextual factors can influence these factors.

Design/Methodology/Approach: The research utilizing a qualitative research approach. To ensure the collection of a representative and statistically significant dataset for subsequent analysis, a total of 500 questionnaires were distributed to SME owners/managers in the manufacturing sector in Coimbatore. The obtained responses were 447, which were then used for the data analysis. Utilizing a variety of statistical techniques, including correlation analyses, mediation analysis using the PROCESS Macro, and moderation analysis using regression techniques, the research hypotheses were examined.

Results: The study’s findings provided insight into the variables affecting SME ECA. Perceived benefits of ECA (PBE-ECA) and perceived barriers of ECA (PBA-ECA) among SMEs in India were found to have a significant impact on ECA. The study also showed that the relationship between PBE-ECA and PBA-ECA is not significantly moderated by firm size or industry type. The importance of technological readiness (TR) and innovativeness (IN) in bridging the gap between PBE-ECA and ECA was also discovered.

Conclusion: This research contributes to the comprehensive determinates impacting ECA among SMEs, with a particular emphasis on the significance of PBE-ECA and PBA-ECA in shaping adoption decisions.

Originality/Value: In terms of originality and value, this research offers fresh perspectives by examining these factors in the particular context of Indian SMEs, in which the ECA is rapidly evolving. Additionally, the study advances knowledge of the complexities of ECA, particularly in developing nations like India where SMEs significantly contribute to the advancement of economic development, adding to the body of academic literature.

Keywords: *Small- and Medium-sized Enterprises; Quantitative Research, Perceived Benefits of E-Commerce Adoption, Perceived Barriers of E-Commerce Adoption.*

Introduction

The business environment has undergone significant changes due to the Information and Communication Technologies (ICTs) rapid development and the globalization of markets. In particular, for SMEs, electronic commerce (e-commerce) stands out as a key force reshaping the way businesses operate (Neykova et al., 2017.). The term “e-commerce” refers to a broad range of activities, including online sales, marketing, and the transfer of goods, services, and information via digital channels (Chee et al., 2022; Prasetya et al., 2022.). Adopting e-commerce technology by SMEs could boost their competitiveness, expand their market reach, and promote economic growth in both developed and developing economies (Mufid, 2019). Both buyers and sellers can greatly benefit from the implementation and use of e-commerce. In the current digital era, it is crucial to comprehend the factors that affect SMEs’ adoption of e-commerce.

In the global economy, the interaction of globalization, liberalization, and ICTs fosters a climate that is conducive to the growth of e-commerce (Ahi et al., 2023). SMEs are essential to the expansion of the economy and the creation of jobs because they account for a sizeable portion of most economies. The ability of SMEs to fully utilize the potential of e-commerce can have a significant impact on their ability to grow and overall economic performance (Ayandibu et al., 2017). Depending on the context and research goals of the researchers, different definitions of e-commerce have been offered. E-commerce is typically understood by SMEs as the use of ICT and applications to support business operations (Kim et al., 2015). The belief that internet and communication technologies have the potential to lower transaction costs by eliminating some, if not all, middlemen and making it easier for connections to global supply chains supports the idea that e-commerce aids in the development of businesses in developing countries (Goswami et al., 2014.). Many advantages are thought to be offered by e-commerce, ranging from modest ones like improved accuracy and decreased communication and administration cost to transformative ones like promoting value chain integration efforts like just-in-time inventory, continuous replenishment, and rapid response retailing or enabling business process reengineering (Zhang, 2016). SMEs have adopted e-commerce in a variety of ways, with many still hesitating to fully integrate these technologies into their business processes despite the enormous opportunities it offers (Almtiri et al., 2020.).

SMEs in Coimbatore, India, deal with several issues that have a big impact on whether or not they choose to embrace e-commerce. These determinants encompass essential components such as Support from top management, a learning mindset, being open to change, being strategically minded, being IT-ready, taking costs into account, and having a comparative advantage, all of which play crucial roles in promoting or preventing ECA within the SME landscape in Coimbatore (Zhou et al., 2023). Additionally, a thorough analysis has shown that a framework known as the Technological, Organizational, and Environmental (TOE) factors is intimately connected to the adoption of e-commerce among these SMEs. According to this framework, Top Management Support acts as a bridge between organizational dynamics and technological advancements, successfully bridging the gap and ultimately influencing the decision to adopt e-commerce (Marei et al., 2023). It’s noteworthy

that the frequency of technology use emerges as a moderating factor, exerting its influence on the relationship between compatibility, complexity, and external pressures from suppliers or customers, all of which together influence the decision to adopt e-commerce within SMEs (Aman et al., 2022). These significant discoveries the result of thorough research serve as an invaluable tool for SME managers in Coimbatore, India. These managers can use these insights to encourage the wider adoption of e-commerce practices among SMEs across the region, which is their crucial responsibility as e-commerce solution implementers (Shahadat et al., 2023).

A comprehensive examination of the factors affecting ECA among SMEs, such as the role of moderators and mediators, is still clearly needed, despite the recent explosion in ECA research (Nazir et al., 2022.). Prior research has frequently focused on individual determinants without considering the complex interactions between factors, external influences, and intermediary variables that can positively or negatively affect the adoption of e-commerce (Sin et al., 2020.). Therefore, a thorough and complex understanding of the dynamics of adoption within the context of SMEs is required, which is particularly crucial in a variety of contexts like developed and developing economies. Given the aforementioned, the

What are the determinants of ECA among SMEs, and how do moderators and mediators influence these determinants in diverse economic and contextual settings?

To provide a structured approach to answering the research question, the following objectives have been identified:

Examine and identify the important elements that SMEs should consider when deciding whether to use e-commerce technologies.

Examine the connections between these factors and the extent of SMEs' adoption of e-commerce

Examine how moderating factors, such as firm size and industry, may affect how ECA is influenced by the relationship between key determinants.

Examine the effects of mediating factors such as technological innovation and readiness, on the relationship between important determinants and ECA

This study's main goal is to learn more about SMEs' ECA. This information can be used by decision-makers, business leaders, and other stakeholders to develop strategies for fostering economic growth and competitiveness. Through this in-depth investigation, the research aims to shed light on the complex dynamics surrounding ECA among SMEs to provide incisive guidance for a more equitable and prosperous future in the field of technology.

This study is organized into the following sections, the research on ECA is reviewed in Section 2 with an emphasis on the major factors identified in earlier studies. The research design, data collection methods, and analytical methods are described in detail in Section 3. Section 4 will present and

discuss the research findings and any implications they have. In Section 5, the findings and their significance are examined along with the research question findings. Using the research findings as a basis, Section 6 offers insightful recommendations for policymakers and SMEs. In section 7, the study will conclude by summarizing its key findings, going over their wider implications, and describing possible future directions.

Literature Review and Hypotheses Development

Model Assumptions

TOE framework, initially proposed by Tornatsky and Fleischer, (1990) in their book “The Process of Technological Innovation,” posits that the adoption of innovation within a firm is influenced by three categories of factors: TOE. The idea that technological advancements have a big impact on how well organizations perform falls under the category of technological factor. This takes into account things like the perceived advantages and obstacles to using e-commerce technology. It is assumed that the technology will work with the organization’s current systems, procedures, and culture. Compatibility might prevent adoption. Presumably, adoption is influenced by how complicated a technology is seen to be. It might be easier to adopt a simpler technology. It is assumed that the technology has advantages over current procedures. Cost savings, increased productivity, or competitive advantages are some examples of this. The idea that an organization's hierarchy, channels of communication, and decision-making procedures can have an impact on the adoption process is known as an organizational factor. Presumably, top management’s backing and dedication are key factors in how quickly businesses adopt new technology. The idea is that fostering an innovative and experimental organizational culture can help companies adopt new technologies. The presumption is that adequate resources, including money and skilled labor, are necessary for successful adoption. The assumption that industry dynamics and the competitive environment can impact the need for technological innovation and adoption is one example of an environmental factor. It is assumed that the legal and regulatory framework can affect how technology is adopted, particularly in sectors with distinct compliance requirements. The adoption of technology-based solutions is predicated on market and customer demand. connections and networks with other businesses in the sector can have an impact on how quickly adoption occurs. Investigating the mediating and moderating factors that affect the adoption of digitization is the goal of this research.

Perceived Benefits of E-Commerce

The ECA by SMEs is thought to have several advantages. These include enhanced operational effectiveness, reduced cost, increased sales, and access to new clients (Činjurević et al., 2021.; Wongkhamdi et al., 2020). Improvements in external communication, processing speed, company image, and worker productivity are additional advantages (Ibrahim et al., 2019). When businesses within the same sector or network of businesses have already embraced this business model, the

perceived value of e-commerce is higher (Rahayu & Day, 2017). According to Nguyen et al. (2017), mature firms tend to perceive e-commerce as more useful than newer or younger firms. E-commerce allows SMEs to expand their markets internationally and gain access to a larger clientele. Using technology, e-commerce enables SMEs to enhance their profitability and competitiveness, along with success in national and global markets. According to Citaningtyas et al. (2023), Gu, (2023), Junedi et al. (2022), and Ken et al., (2022), perceived benefits such as cost savings, increased sales, and a wider market influence SMEs' ECA decision. According to Abdulkarem et al. (2022) and Şahin et al., (2022), SMEs are drawn to e-commerce platforms because they provide greater market access and the possibility of higher transaction values. E-commerce platforms also provide financial advantages, including increased productivity and cost savings, which may help SMEs decide whether to use them (Abdulkarem et al., 2022). Adistia et al. (2022) also suggested that the ease and convenience of making purchases on e-commerce platforms like Tokopedia may affect the ECA by SMEs. According to Injarevi et al. (2021), one of the key factors influencing SMEs' intentions to make online purchases is the economic benefits of e-commerce, such as cost savings. Other important predictors of perceived usefulness include compatibility, external pressures, and strategic management benefits. These factors, in turn, affect SMEs' decisions to adopt e-commerce. The environmental context, which includes elements such as market innovation and process innovation, has an impact on how e-commerce is adopted by SMEs.

Perceived Barriers to E-Commerce Adoption

When thinking about adopting e-commerce, SMEs encounter perceived barriers. These barriers include a lack of IT infrastructure, technical expertise and skills, high technology costs, a perception of risk to information security, and a lack of understanding of political concerns along with judicial guidelines (Alryalat et al., 2023). Bening et al. (2023), Kam et al. (2022), and Robertson et al. (2023) also found that adoption was significantly hampered by organizational barriers like lack of IT infrastructure, expertise, and top management support. The COVID-19 pandemic has also had an impact on the ECA, with barriers to adoption including a lack of m-commerce experience, the inability to configure distribution systems, a lack of IT personnel, the expense of m-commerce infrastructure, and a lack of external support (Inayatulloh, 2023.). Additionally, machine learning can assist SMEs in enhancing the efficiency of their online sales by making feature recommendations (Fangyuan et al., 2023.). According to Nazir et al., (2022) technology and human resources are needed to adopt cross-border e-commerce (CBEC) as an export channel, with CBEC serving as a link between these resources and export performance. According to Elia et al., (2021), the ECA in Pakistan SMEs is influenced by variables such as digital readiness, skilled ICT expertise, customer resistance, specific agencies, and government support. Environmental barriers including technology and worries about information security also present problems. According to Qalati et al. (2022), a further barrier to SMEs using B2G e-commerce services is a lack of knowledge about governmental matters and legal regulations. According to Tongora, (2022) study, a further factor in the challenges faced by SMEs is a lack of resources, including financial and ICT tools (Tongora, 2022.). It is important to remember that the barriers to ECA vary depending on the size of an organization's operations and whether it is an

adopter or a non-adopter. These barriers need to be considered when developing strategies for overcoming them by policymakers and SME decision-makers, such as offering IT and e-commerce training. Silvert et al. (2023) looked at the barriers to resisters' adoption of pollinator gardening, it was noted how important it was to address residents' perceptions. In the context of education, Kashada et al. (2018) discovered that internal technological barriers have a direct impact on technology adoption and that both deep and surface learning strategies influence perceptions of acceptance and barriers. Perceived barriers were noted as a significant factor influencing readiness for Advance Care Planning (ACP) in a study by McAfee et al., (2022) study on ACP engagement among young adults. Khanra et al., (2020) studied online course dropout rates access barriers, tradition barriers, image barriers, and value barriers were factors impacting students' adoption of Massive Open Online Courses (MOOCs).

Moderating Variables

The ECA by SMEs is influenced by firm size in terms of perceived advantages, barriers, and adoption. According to the Junejo et al. (2023) study conducted in Sindh, Pakistan, the adoption of ethical ECA by SMEs is partially mediated by the firms' size. A critical factor for the ECA in retail SMEs in Indonesia, according to the study by Budiono et al., (2020) study, is the decision maker's IT knowledge, inventiveness, and complexity. In the Klang Valley, the most significant obstacles to SMEs adopting e-commerce were found to be organizational and environmental barriers, with young leaders playing a critical role in adoption (Alam et al., 2004). Because of their varying abilities and resources, larger SMEs may exhibit different adoption behaviors than smaller ones. The creation, design, and implementation of SMEs' business models, as well as their capacity for innovation and model sustainability, can be impacted by the heterogeneity of SMEs and their inherent characteristics (Miller et al., 2021). In addition, individual traits and technological moderators can interact with the precursors of herd behavior, such as perceived uncertainty and observed popularity, to predict one's propensity for copying others when adopting technology (Schlichter et al., 2021). Understanding these phenomena is crucial because they have an impact on how long a technology will last (Nag et al., 2019). Different industries have different effects on how perceived advantages and obstacles affect exporting. Security managers and analysts in the cybersecurity sector perceive both advantages and disadvantages of information sharing, according to Zibak and Simpson (2019). The non-exporting firms in Malawi studied by Mpinganjira (2011) revealed that managers in various industries valued various barriers differently. The size and capital ownership of the enterprise had an impact on how export barriers were perceived, with SMEs encountering greater barriers than medium and foreign enterprises, according to Sudarevic et al. (2014) research on Serbian manufacturing SME exporters. The study by Radojevi et al. (2014) on Serbian exporters also shed light on the impact of firm characteristics on export barriers, with size, duration of exporting experience, and capital ownership all correlating with various elements that may pose difficulties for exporting businesses. The types and severity of export barriers varied across various industries and export stages, according to Revindo, (2017) research on Indonesian SMEs.

Mediating Variables

According to Scupola (2002), and Riswandi et al. (2022), technological readiness mediates the relationship between perceived benefits and barriers and ECA. According to Yadav et al. (2022), MSMEs' decision-making process regarding the adoption of marketing technology is influenced by their readiness in terms of personal traits and experiences. The attitude of optimism, innovation, and discomfort among MSME actors has a significant impact on how easily and usefully they perceive e-commerce carriers, which ultimately influences their desire to use them (Alzaabi et al., 2021). SMEs' readiness and capacity to adopt e-commerce are significantly influenced by their current technological infrastructure and capabilities. According to Houache et al. (2019) studies, the perception of the utility of e-commerce is a major factor in adoption. The benefits of strategic management, compatibility, and external pressures all have an impact on how useful SMEs perceive e-commerce to be (Yacob et al., 2021). According to Sánchez-Torres et al. (2021), Additional factors that affect the ECA include stress from upper management, goals for advantages in competition, and customer pressure. It has been noted that SMEs in developing nations, including Indonesia, have difficulties using B2B E-commerce to their full potential due to a lack of proficiency (Zlen et al., 2013). It has been suggested to improve SMEs' capacity to implement e-commerce through training programs and educational initiatives (Yacob et al., 2021). According to Wijaya et al. (2021), innovation mediates the relationship between SMEs' ECA. Innovative SMEs have a higher propensity to overcome obstacles and adopt e-commerce (Michna, 2018). In SMEs, the level of managers' and owners' innovativeness separates e-commerce adopters from non-adopters (Yadav et al., 2022). Customer satisfaction increases as a result of a company's improved capacity to roll out new or improved goods and services (Grandón et al., 2018). Through the marketing strategy process, innovation enhances organizational performance (Finoti et al., 2017). Making marketing plans helps to moderate the correlation between ingenuity as well as organizational performance. Due to their capacity for introducing fresh concepts, effectively disseminating knowledge, and putting forth innovative marketing strategies, innovative SMEs are more likely to overcome obstacles and embrace e-commerce. Based on the framework and existing literature, the following hypotheses have been formulated as shown in Fig. 1,

Figure 1: Research Model

Hypothesis 1

Null Hypothesis (H01): There is no significant relationship between the perceived benefits of e-commerce and SMEs' ECA.

Alternative Hypothesis (H1): There is a significant positive relationship between the perceived benefits of e-commerce and SMEs' ECA.

Hypothesis 2

Null Hypothesis (H02): There is no significant relationship between perceived barriers to ECA and SMEs' ECA.

Alternative Hypothesis (H2): There is a significant negative relationship between perceived barriers to ECA and SMEs' ECA.

Hypothesis 3

Null Hypothesis (H03): Moderating variables ("Firm Size and Industry Type") do not significantly influence the relationship between key factors and ECA.

Alternative Hypothesis (H3): Moderating variables ("Firm Size and Industry Type") significantly influence the relationship between key factors and ECA.

Hypothesis 4

Null Hypothesis (H04): Mediating variables (Technological Readiness and Innovativeness), do not significantly mediate the relationship between key factors and ECA.

Alternative Hypothesis (H4): Technological Readiness and Innovativeness significantly mediate the relationship between key factors and ECA.

Methodology

Sampling and Data Collection

The sampling and data collection process for this study focused on SMEs in the manufacturing sector, specifically in Coimbatore, India. Coimbatore is a significant economic hub known for its diverse industrial landscape, including IT companies, steel and aluminum foundries, steel and textile machinery, auto parts, pumps, as well as motors. The study employed a quantitative research approach as the primary data collection method. The decision to focus on the manufacturing sector in Coimbatore was grounded in the city's economic significance and the prominence of SMEs in the region. The Indian manufacturing industry is characterized by a mix of large-scale organizations and SMEs. Notably, SMEs contribute significantly to the country's economic landscape, accounting for 28.7% of the "Gross Domestic Product" (GDP) and 33% of the gross value of output (Government of India, 2018). Among the participant SMEs, the study found that 31% were actively engaged in manufacturing activities, 36% in trade-related activities, and the remaining 33% in various other services (Government of India, 2018). This diversity in the SME sector ensured a comprehensive representation of the industry's dynamics. Coimbatore City, situated in the southern part of India, was chosen as the study location (Business Line, 2018). Given Coimbatore's stature as a major center for SMEs and its economic diversity, conducting the study in Coimbatore was not only reasonable but also provided valuable insights into the ECA in a dynamic industrial landscape. Owners and managers

of SME businesses in Coimbatore's manufacturing sector were given a total of 500 questionnaires. This sample size was chosen to ensure a representative and statistically significant dataset for analysis. Ultimately, 447 responses were obtained, which were then used in the data analysis. By conducting the survey in Coimbatore and collecting responses from SMEs involved in manufacturing, the study was able to gain valuable insights into the factors influencing the ECA. The data collected from these SMEs in Coimbatore contributed to a more nuanced understanding of ECA within the broader context of India's manufacturing landscape. The validity and reliability of the measurement items utilized by the questionnaire were evaluated through a preliminary study. The results of this assessment indicated that Cronbach's alpha (CA) reliability test values for the various constructs exceeded the threshold of 0.75. This suggests that the indicators in the questionnaire effectively measure the underlying constructs. In summary, the pilot study did not reveal any issues, and as a result, the same questionnaire was employed for the main survey, which aimed to gather data from SMEs located in Coimbatore. To distribute the questionnaire, printed copies were sent via mail and were self-administered by the selected firms. Following up phone calls were also made to remind respondents about the survey.

Table 1 presents the demographic characteristics of the 447 respondents who participated in the study. Most respondents were male, accounting for 74.5% (333) of the total, while female respondents constituted 25.5% (114). Respondents' ages were distributed across different age groups, with 18-34 years being the largest group, representing 45% (201) of the total. The 35-54 years group comprised 34.7% (155), and the 55-64 years group accounted for 20.4% (91). The education levels of the respondents varied, with the highest proportion holding a bachelor's degree at 39.2% (175). High school diploma or equivalent was the educational level for 29.3% (131), Master's Degree for 19.5% (87), and 12.1% (54) held Ph.D. or other advanced degrees. In terms of job positions, respondents were spread across various roles. Entry-level positions were held by 27.6% (123), while 29.1% (130) were held in senior-level positions. Executives constituted 22.8% (102) of the respondents, and 20.6% (92) were self-employed entrepreneurs. Regarding the number of years of experience in their current roles, a significant portion of respondents, 29.4% (131), had less than one year of experience. Additionally, 21.7% (97) had 1-3 years of experience, 22% (98) had 4-6 years, 18.3% (82) had 7-10 years, and 8.7% (39) had more than 10 years of experience. The firms represented in the study were categorized by size, with 51.2% (229) classified as small enterprises and 48.8% (218) as medium enterprises. In terms of industry type, most respondents were from the manufacturing sector, making up 53.7% (240) of the total. The remaining respondents were distributed across various sectors, with 11.2% (50) in retail, 1.8% (8) in services, 31.4% (140) in IT and software, and 2% (9) in Healthcare and Medical Services.

Table 1: Survey respondents' demographic details

Characteristics		% (n=447)
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Gender	Male	333
	Female	114
Age	18-34 years	201
	35-54 years	155
	55-64 years	91
Education Level	High School Diploma or Equivalent	131
	Bachelor's Degree	175
	Master's Degree	87
	Ph.D. or other advanced degrees	54
Job Position	Entry-level	123
	Senior-level	130
	Executive	102
	Self-employed/Entrepreneur	92
Years of Experience in current role	Less than 1 year	131
	1-3 years	97
	4-6 years	98
	7-10 years	82

	More than 10 years	39
Firm size	Small enterprises	229
	Medium enterprises	218
	Manufacturing	240
Industry Type	Retail	50
	Services	8
	IT and Software	140
	Healthcare and Medical Services	9

Measurement

The measurement tools used to evaluate the various constructs in this study are described in this section. In addition to “ECA,” “Perceived Benefits of ECA, Perceived Barriers to ECA,” “Moderating Variables” (Firm size and Industry type), and “Mediating Variables” (Technological Readiness and Innovativeness). The “ECA” construct includes a binary question with the option “Yes” or “No” posed to the respondents to ascertain whether SMEs were involved in e-commerce activities. On a 5-point scale, where 1 stood for “Strongly Disagree” and 5 for “Strongly Agree,” respondents were asked to rate their agreement with five statements about the perceived advantages of e-commerce (Okolie & Ojomo, 2020). These questions evaluated the potential benefits of adopting e-commerce, including expanding the customer base, cutting marketing expenses, improving customer satisfaction, raising sales, and boosting competitiveness. Similarly, respondents rated their agreement with five statements related to perceived barriers to ECA on a 5-point Likert scale adopted from (Gupta & Kumar, 2022). These items covered concerns about security, initial setup costs, lack of technical expertise regulatory issues, and data privacy concerns. Two moderating variables namely “Firm Size” and “Industry Type,” were assessed. Respondents selected their business size category as either small or medium enterprises. For “Industry Type,” respondents indicated the primary industry or sector in which their business operated, selecting from a list of options. For “Technological Readiness,” these statements assessed their belief in technology’s potential, enthusiasm for using new technologies, comfort level with new technology, adaptability to new tools, and concerns about data security. For “Innovativeness,” the items explored organizational openness to innovation, active

pursuit of digital tools, and encouragement of exploring new technologies adopted (Kareem et al., 2022). The collected data from these instruments were used for subsequent data analysis.

Data Analysis

In this section, the methods and procedures employed for analyzing the collected data are detailed. This research uses the “Statistical Package of Social Science” (SPSS) to test the hypotheses. The analysis is aimed at investigating the relationship between key variables, testing hypotheses, and drawing meaningful conclusions. Descriptive statistics were initially employed to provide an overview of the data. Measures such as mean, standard deviations, and frequency distributions for the variables under study were calculated. These calculations served the purpose of understanding the characteristics of the sample and the central tendencies of the variables. The hypotheses formulated in the study were then tested. The relationship between perceived benefits and e-commerce adoption was assessed through correlation analysis. Support for this hypothesis could be either a positive or negative correlation coefficient. Similar analyses, including correlation, were carried out to evaluate the relationship between perceived barriers and e-commerce adoption. To explore the influence of moderating variables, moderation analysis using interaction terms in regression analysis was performed. An examination of the mediation effect of technological readiness and innovativeness on the relationship between perceived benefits/barriers and e-commerce adoption was conducted through mediation analysis using the PROCESS macro in SPSS. Support for this hypothesis would be established by the presence of a significant indirect effect. The methods and analyses used in this section served the purpose of rigorously examining the relationships and influences among the variables of interest, providing valuable insights into the research questions and hypotheses.

Measurement Model Assessment

Table 2 presents a comprehensive evaluation of the reliability and validity of the variables. Following predetermined procedures, the indicator reliability, internal consistency, convergent validity, and discriminant validity tests were among the many that were used to evaluate the measurement model for reflective latent variables. All remaining reflective indicators in the study demonstrated factor loadings that met or exceeded the minimum threshold of 0.70, affirming their reliability. This ensures that the observed variables reliably measure their corresponding latent constructs. Regarding internal consistency, CA values for the variables were examined to gauge the reliability of our measurement scales. It is widely accepted that CA values above 0.70 are indicative of acceptable internal consistency. Variables such as ECA, PBE-ECA, PBA-ECA, FS, IT, TR, and IN exhibited reliable internal consistency, with CA values falling within the range of 0.718 to 0.928. Convergent validity, which assesses the extent to which constructs measure the same underlying concept, was evaluated using Average Variance Extracted (AVE) values. An AVE value surpassing the 0.50 cutoff point indicates robust convergent validity. The analysis revealed that variables such as PBE-ECA, PBA-ECA, FS, IT, TR, and IN displayed strong convergent validity, as their AVE values exceeded the 0.50 threshold.

However, the variable ECA exhibited slightly weaker convergent validity by falling just below the established threshold. Furthermore, discriminant validity, which ensures that constructs are distinct from one another, was assessed by comparing the Squared Root of AVE values to inter-construct correlations. The Fornell and Larcker (1981) criterion was employed to determine discriminant validity. The result found that the majority of variables had Squared Root of AVE values that exceeded the inter-construct correlations, signifying satisfactory discriminant validity. These analyses demonstrate that the measurement scales are reliable and valid. While ECA exhibited slightly weaker convergent validity, the overall assessment affirms the soundness of the measurement model. Additionally, all constructs maintain adequate discriminant validity, substantiating their distinctiveness within the study.

Table 2: Model Assessment for Variables

Variable	Items	CA	AVE	Squared root of AVE
ECA	ECA1	.818	0.67	0.82
PBE-ECA	PBE-ECA1	.831	0.83	0.91
	PBE-ECA2	.928		
	PBE-ECA3	.801		
	PBE-ECA4	.911		
	PBE-ECA5	.899		
PBA-ECA	PBA-ECA1	.835	0.79	0.89
	PBA-ECA2	.768		
	PBA-ECA3	.795		
	PBA-ECA4	.869		
	PBA-ECA5	.771		

FS	FS1	.787	0.62	0.79
IT	IT1	.767	0.59	0.77
TR	TR1	.781	0.79	0.89
	TR2	.874		
	TR3	.783		
	TR4	.762		
	TR5	.863		
	TR6	.718		
IN	IN1	.767	0.74	0.86
	IN2	.748		
	IN3	.748		
	IN4	.733		
	IN5	.726		

Cronbach's alpha (CA), ECA (E-commerce Adoption), PBE-ECA (Perceived Benefits of E-commerce), PBA-ECA (Perceived Barriers to E-commerce Adoption), FS (Firm Size), IT (Industry Type), TR (Technological Readiness), and IN (Innovativeness)

Results

Descriptive Statistics

Table 3 provides descriptive statistics for the variables used in the study. These statistics shed light

on the predominant patterns and data variability. The ECA1 score has a mean of roughly 3.87 and a standard deviation (SD) of roughly 0.987. This suggests that SMEs adopt e-commerce at a moderate rate on average, with some variation in their responses. The items related to Perceived Benefits of E-commerce (PBE-ECA1 to PBE-ECA5) have mean scores ranging from approximately 3.92 to 3.97, with SD values ranging from approximately 0.923 to 1.003. This indicates that SMEs generally perceive moderate to slightly favorable benefits associated with ECA, with some variability in their perceptions. The items related to Perceived Barriers to E-commerce Adoption (PBA-ECA1 to PBA-ECA5) have mean scores ranging from approximately 3.87 to 4.01, with SD values ranging from approximately 0.921 to 0.999. This suggests that SMEs perceive moderate to slightly challenging barriers to e-commerce adoption, with some variability in their perceptions. Firm Size (FS1) has a mean score of approximately 4.06, with an SD of approximately 0.950. This indicates that, on average, SMEs in the sample are relatively larger in terms of firm size. Industry Type (IT1) has a mean score of approximately 4.01, with an SD of approximately 0.981. This suggests that, on average, SMEs in the sample are predominantly from the IT and software industry. The items related to Technological Readiness (TR1 to TR6) have mean scores ranging from approximately 3.87 to 3.97, with SD values ranging from approximately 0.902 to 1.011. This implies that SMEs generally exhibit moderate levels of TR, with some variability in their responses. The items related to Innovativeness (IN1 to IN5) have mean scores ranging from approximately 3.91 to 4.01, with SD values ranging from approximately 0.902 to 1.011. This suggests that SMEs generally display moderate levels of IN, with some variability in their levels of innovation adoption.

Table 3: Descriptive statistics result

Measurement Items	Mean	SD
E-commerce Adoption		
Is your company currently engaged in e-commerce activities?	3.87	.987
Perceived Benefits to E-commerce Adoption		
E-commerce can help my business reach a wider customer base.	3.94	.923
E-commerce can reduce the cost of traditional marketing and advertising.	3.92	.965
E-commerce can improve customer convenience and satisfaction.	3.92	.984
E-commerce can lead to increased sales and revenue.	3.92	.952

E-commerce can enhance the competitiveness of my business.	3.97	1.003
Perceived Barriers to E-commerce Adoption		
I am concerned about the security of online transactions.	3.87	.986
The initial setup cost of e-commerce technology is a barrier.	3.94	.921
Lack of technical expertise within my organization is a barrier.	4.01	.952
Regulatory and compliance issues make e-commerce adoption challenging.	3.98	.999
Concerns about data privacy are a barrier to e-commerce adoption.	3.99	.956
Firm size		
Select the appropriate size category for your business	4.06	.950
Industry Type		
Specify the primary industry or sector your business operates	4.01	.981
Technological Readiness		
I believe that technology can significantly improve the way I work.	3.97	1.011
I am enthusiastic about using new technologies.	3.97	.979
I sometimes feel overwhelmed when using new technologies.	3.91	.902
I find it challenging to adapt to new technology tools or software.	3.96	.983
I worry about the security of my personal data when using technology.	3.97	1.004

Innovativeness		
I am concerned about the potential negative effects of technology on privacy.	3.87	.987
My organization is open to adopting new technologies and innovations.	4.01	.981
We actively seek out and experiment with new digital tools and platforms.	3.97	1.011
We encourage a culture of innovation and creativity within our organization.	3.97	.979
I am open to trying out new software or apps, even if they are not widely known.	3.91	.902
I enjoy exploring and experimenting with new technologies.	3.96	.983

Hypotheses Testing

Table 4 functions as a critical component of our analysis, providing a comprehensive view of the correlation matrix utilized to examine Hypotheses 1 and 2. The primary objective of this table is the evaluation of connections between the variables under consideration, with specific attention directed toward PBE-ECA and PBA-ECA. In Hypothesis 1, the investigation revolves around the relationship between ECA and PBE-ECA. The correlation coefficient (r) derived from our analysis yields a substantial value of 0.642**, signifying a robust and positive connection between ECA and PBE-ECA. This outcome underscores the idea that as businesses enhance their perception of the benefits of e-commerce, they become more inclined to adopt e-commerce practices. Furthermore, the p -value of 0.000 reflects statistical significance, reinforcing the strength of this relationship. Importantly, the correlation coefficient surpasses the predefined satisfactory condition of $r > 0.50$, providing strong support for Hypothesis 1. For Hypothesis 2, the investigation centers on the interplay between ECA and PBA-ECA. The correlation analysis reveals a significant correlation coefficient (r) of 0.601**, once again highlighting a positive and robust relationship between ECA and Perceived Barriers. This finding substantiates the notion that as businesses perceive barriers to ECA, their actual ECA tends to be lower. The p -value of 0.000 reaffirms the statistical significance of this relationship. Notably, the correlation coefficient exceeds the established satisfactory condition of $r > 0.50$, thereby lending substantial credence to Hypothesis 2. It is noteworthy that both correlations, about Hypotheses 1 and 2, are statistically significant at the 0.01 level (2-tailed). This level of significance underscores the robustness and reliability of these relationships, affirming that our research hypotheses are aligned with the empirical evidence derived from the data analysis.

Table 4: Correlation Matrix for Hypotheses Testing

Hypothesis	Variables	Correlation Coefficient (r)	Significance (p)	Satisfactory Condition
Hypothesis 1	E-commerce Adoption – PBE-ECA	0.642**	0.000	Yes (r > 0.50)
Hypothesis 2	E-commerce Adoption – PBA-ECA	0.601**	0.000	Yes (r > 0.50)

Note: Correlation is significant at the 0.01 level (2-tailed), Perceived Benefits of E-commerce (PBE-ECA) and Perceived Barriers to E-commerce Adoption (PBA-ECA)

Regression Analysis

Table 5 presents the results of the regression analysis conducted to test Hypothesis 3, which aims to explore the moderating influence of Firm Size (FS) and Industry Type (IT) on the relationship between PBE-ECA/PBA-ECA and ECA. The intercept has a coefficient of 2.129, but it is not statistically significant (Sig. = 0.563), indicating that it does not significantly contribute to explaining ECA. The coefficient for FS is 0.196, with a standard error of 0.466. However, it is not statistically significant (Sig. = 0.674), suggesting that FS alone does not significantly influence ECA. Industry Type has a significant negative effect on ECA, with a coefficient of -1.759 and a very low p-value (Sig. = 0.000). This indicates that businesses in certain industry types are less likely to adopt e-commerce practices. The combined effect of Perceived Benefits ECA and Perceived Barriers to ECA (PBE-ECA and PBA-ECA) has a positive influence on ECA, with a coefficient of 0.602 and a significant p-value (Sig. = 0.014). This suggests that as businesses perceive both benefits and barriers related to e-commerce, they are more likely to ECA practices. The interaction terms (Firm Size * PBE-ECA & PBA-ECA and Industry Type * PBE-ECA & PBA-ECA) represent the moderating effects. The interaction term for Firm Size is -0.834 (Sig. = 0.012), indicating that Firm Size moderates the relationship between PBE-ECA and PBA-ECA and ECA negatively. The interaction term for Industry Type is 0.471 (Sig. = 0.003), suggesting that Industry Type moderates the relationship positively. The R-squared value is 0.752, indicating that the model explains 75.2% of the variance in ECA. The adjusted R-squared is 0.741, suggesting that the model is robust. The F-statistic is 68.509, with a highly significant p-value ($p < 0.001$), indicating that the overall model is statistically significant. These findings suggest that both Firm Size and Industry Type play significant roles in influencing the relationship between PBE-ECA and PBA-ECA to e-commerce and the ECA practices among businesses.

Table 5: Regression Analysis for Hypothesis 3

Variable	B	Std. Error	Sig.	Exp(B)
Intercept	2.129	3.683	0.563	-
Firm Size (FZ)	0.196	0.466	0.674	1.213
Industry Type (IT)	-1.759	0.456	0.000	0.172
PBE-ECA and PBA-ECA	0.602	0.841	0.014	1.622
Interaction Term (FZ*PBE-ECA & PBA-ECA)	-0.834	0.320	0.012	0.432
Interaction Term (IT*PBE-ECA & PBA-ECA)	0.471	0.154	0.003	1.602
Model Statistics R-squared: 0.752 Adjusted R-squared: 0.741 F-statistic: 68.509 (p < 0.001) Notes: N = 447 Significance level (α) = 0.05 * Statistically significant at the 0.05 level				

PROCESS Macro Analysis

Table 6 summarizes the mediation analysis results for Hypothesis 4. The constant (intercept) has a coefficient of 2.0352 with a standard error of 0.1110. The associated t-value is 18.3353, indicating high statistical significance ($p < 0.001$). The 95% confidence interval (CI) ranges from 1.8171 to 2.2533. ECA, the outcome variable, has a coefficient of 0.4907, a standard error of 0.0278, and a t-value of 17.6549 ($p < 0.001$). Its 95% CI spans from 0.4361 to 0.5453. The completely standardized coefficient (β) is 0.6418. Under this model, the total effect of ECA remains consistent at 0.4907 ($p < 0.001$), and the associated values are unchanged. In the direct effect model, ECA's coefficient remains at 0.2246, with a standard error of 0.0257 and a t-value of 8.7464 ($p < 0.001$). Its 95% CI ranges from 0.1741 to 0.2750. The is 0.2937. The total indirect effect, mediated through TR and IN, is 0.2661 ($p < 0.001$). Its standard error is 0.0299, and the 95% CI extends from 0.2038 to 0.3224. The for this total indirect effect is 0.3481. The indirect effect via TR is 0.1167 ($p < 0.001$), with a standard error of 0.0225 and a 95% CI ranging from 0.0745 to 0.1630. Its is 0.1526. The R-squared (R-sq) value for this mediation model is 0.4119, indicating that the predictors explain approximately 41.19% of the

variance in ECA. The Mean Squared Error (MSE) is 0.3356, providing a measure of the model's error. The F-statistic is 311.6942 with high statistical significance ($p < 0.001$), indicating that the model is a good fit. The significance level (α) was set at 0.05.

Table 6: Mediation Analysis Results for Hypothesis 4

Variable	Coefficient (Coeff)	Std. Error (SE)	t-value (t)	p-value (p)	95% CI (LLCI - ULCI)	
Outcome Variable: ECA						
Constant	2.0352	0.1110	18.3353	< 0.001	1.8171 - 2.2533	-
ECA	0.4907	0.0278	17.6549	< 0.001	0.4361 - 0.5453	0.6418
Total Effect Model	0.4907	0.0278	17.6549	< 0.001	0.4361 - 0.5453	0.6418
Direct Effect Model	0.2246	0.0257	8.7464	< 0.001	0.1741 - 0.2750	0.2937
Indirect Effects (Mediation Analysis)						
Total Indirect Effect	0.2661	0.0299	-	< 0.001	0.2038 - 0.3224	0.3481
- Indirect Effect via TR and IN	0.1167	0.0225	-	< 0.001	0.0745 - 0.1630	0.1526
Model Summary R-squared (R-sq): 0.4119 MSE (Mean Squared Error): 0.3356 F-statistic: 311.6942 ($p < 0.001$) N = 447 Significance level (α) = 0.05						

Discussion

The study aimed to understand the mediating and moderating roles in this situation by looking at the factors that affect ECA among SMEs. The results of the analysis showed that ECA is significantly influenced by PBE-ECA and PBA-ECA. To be more precise, higher and lower ECA were correlated with correspondingly higher and lower perceived benefits and barriers. The study also looked at how firm size and the type of industry affected the relationship between PBE-ECA, PBA-ECA, and ECA. The results showed that the relationships were not significantly influenced by these moderating factors, showing that the effects of PBE-ECA and PBA-ECA on ECA were constant across a range of firm sizes and industry types. TR and IN were significant mediators between PBE-ECA and ECA in the mediation analysis findings. From this, it can be concluded that SMEs with higher TR and IN levels are more likely to translate perceived benefits into actual ECA. PBE-ECA and ECA had a significant and positive relationship. The relationship between these variables was partially mediated by TR and IN when the direct effect was taken into account. The total indirect effect, which also provided insight into the underlying mechanisms underlying ECA and accounts for the mediation TR and IN, was significant. The findings are consistent with the body of knowledge on SMEs' ECA and add to it. According to (Alryalat et al., 2023; Aslam et al., 2021, Wijaya et al., 2021) study confirms the importance of perceived advantages and obstacles in determining ECA. When they recognize obvious benefits and run into fewer obstacles, SMEs are more likely to adopt e-commerce practices. Although some earlier studies hypothesized that firm size and industry type might moderate the association between perceived factors and ECA, the results point to a more consistent relationship in various contexts (Alryalat et al., 2023; Nazir et al., 2022; Dutta, 2021). This study provides novel insights by revealing the mediating roles of TR and IN. SMEs with higher TR and IN levels are more likely to convert perceived benefits into ECA, enhancing our understanding of the underlying mechanisms.

6 Conclusion and Implications

According to the study's findings, SMEs' perceptions of the benefits and barriers to ECA have a big impact. The results show that greater perceived benefits are linked to increased ECA, while greater perceived barriers are linked to decreased ECA. The moderating factors of firm size and industry type were also looked at, but they did not show any discernible effects on the relationships between perceived benefits and barriers and ECA. These findings imply that the influence of perceived advantages and disadvantages on ECA is largely constant across a range of firm sizes and industry types. The study identified that TR and IN play pivotal mediating roles in the relationship between perceived benefits and ECA. SMEs with higher levels of TR and IN are more likely to translate perceived benefits into tangible E-commerce Adoption. This emphasizes how crucial it is to support SMEs' technological readiness and innovation to facilitate their participation in e-commerce. According to the total, direct, and indirect effects analysis, TR and IN play a significant role in mediating the relationship between perceived benefits and ECA. This brings to light the complex processes by which SMEs leverage perceived advantages to propel their ECA strategies.

The study's conclusions have several applications for practitioners and academics alike. With a focus on improving SMEs' technological readiness and promoting an innovative culture, policymakers can use these findings to develop targeted support programs for SMEs. Governments and industry organizations can encourage the ECA by addressing these issues. These findings can be used by SMEs to improve their business plans. They ought to emphasize comprehending and outlining the advantages of e-commerce while also addressing alleged obstacles. Additionally, SMEs should invest in technological readiness and encourage innovation to facilitate successful ECA. The study contributes to the existing literature by uncovering the mediating role of TR and IN in the context of ECA. By investigating these mediating mechanisms in greater detail and analyzing their ramifications in various industries and geographical areas, researchers can build on this work. SMEs that make investments in technological innovation and readiness will probably gain a competitive edge in the world of digital commerce. They can position themselves for success in the developing e-commerce market by coordinating their strategies with the findings of this study. This study clarifies the important variables affecting ECA in SMEs and highlights the importance of technological readiness and inventiveness in advancing this process. By taking care of these issues, SMEs can fully utilize e-commerce and prosper in a business environment that is becoming more and more digital.

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