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Review Article

The Impact of Environmental Factors and Cloud Computing Adoption

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Abstract *- This meta-analysis aimed to establish, using evidence from recently published quantitative studies, whether factors in the external business environment significantly influence SMEs' adoption of cloud computing. Despite several studies examining the role of environmental factors in cloud computing adoption, there remains a lack of consolidated evidence, particularly in SMEs. This study's novelty lies in synthesizing evidence from recent (2020-2025) quantitative studies, providing an up-to-date understanding of how external factors influence cloud computing adoption in SMEs. This area has seen mixed findings in prior studies. A meta-analysis was conducted to determine whether the pooled effect of different environmental factors is significant. Findings revealed that environmental factors may significantly influence SMEs' adoption of cloud computing. However, due to significant heterogeneity among studies included in the overall model, a subgroup analysis was conducted. The subgroups included seven specific environmental factors: social influence, customer satisfaction, competitive pressure, government policies, political issues, supplier support, and general environmental factors. Only two factors – supplier support and political issues – had statistically insignificant effects. The remaining factors – government policies, customer satisfaction, social influence, general environmental factors, and competitive pressure – significantly positively affected cloud computing adoption. These findings provide clearer insights into the role of environmental factors, offering more robust evidence compared to previous studies with mixed findings*.

Keywords *- Cloud computing, Environmental factors, SMEs, Technology adoption, TOE framework.*

1. Introduction

As technology advances, organizations are experiencing a myriad of challenges that, if left unaddressed, may undermine their survivability and competitiveness (Saarikko et al., 2020). Mishrif and Khan (2023) noted that for many organizations, skills gaps, complex regulatory environments, evolving customer needs and expectations, and cybersecurity threats are some of the challenges that must be overcome. Since the 1990s, organizations and businesses have used cloud computing systems and services to mitigate some of the aforementioned challenges (Al Hadwer et al., 2021). Despite its small-scale adoption, cloud computing services have offered organizations and businesses secure, flexible, and cost-effective services (Hadwer et al., 2021). Cloud computing provides numerous advantages, including improved productivity, security, scalability, and performance (Aligarh et al., 2023). Public cloud computing has grown in the last two decades, with expenditure increasing from $270 billion in 2020 to $332.3 billion in 2021 and expected to reach $397.5 billion in 2022 (Sumina, 2022). However, many organizations, including small and medium-sized enterprises (SMEs), remain concerned about implementing cloud computing (Akbar et al., 2023). Despite numerous studies investigating the influence of environmental factors on the implementation of cloud computing, there is insufficient consolidation of evidence, particularly in the context of SMEs (Ahmed, 2020; Karagozlu et al., 2020). Despite the growing interest in cloud computing, the relationship between external business environmental factors and SME adoption remains underexplored, and findings across studies have been mixed. This meta-analysis aimed to address this gap by consolidating evidence from recently published quantitative studies to determine whether factors in the external business environment significantly influence SMEs' adoption of cloud computing. Only recent studies, those published between 2020 and 2025, were used to ensure the evidence obtained is applicable in the current temporal context.

2. The Technology-Organization-Environment Framework

The technology acceptance and enterprise (TOE) framework offers a comprehensive approach to cloud computing adoption decisions, categorized into organizational, environmental, and technological factors (Low et al., 2011; Perçin, 2008). Drawing from Depietro et al.'s (1990) work, thousands of studies have utilized this

integrative multifaceted framework, providing a broad strategy and guidance for adopting technology. Despite the development of several other frameworks, the TOE framework remains the most widely used (Alkhalil et al., 2017).

Numerous researchers have used the TOE to study the impact of various adoptions of information technology. For instance, Bhattacharya and Wamba (2018) adopted the TOE framework to investigate factors influencing RFID adoption in retail. Poba-Nzaou et al. (2016) also employed the framework to examine challenges in social media adoption. In another study, de Oliveira et al. (2014) used TOE as the theoretical framework to assess factors influencing cloud adoption. Al-Hujran et al. (2018) used TOE to determine the challenges in developing countries. Wang and Wang (2016) modelled factors facilitating and inhibiting knowledge management systems implementation using the TOE framework. Gangwar et al. (2015) adopted the TOE framework to understand cloud computing adoption at the organizational level. While the framework identifies three key aspects, this study focused on the external business environmental aspect alone.

3. Review of Literature

3.1. Cloud Computing Adoption in SMEs: Key Drivers and Barriers

Cloud computing emerged as an innovative technology that is gradually becoming more commonplace in companies looking for better ways to manage their resources and achieve economies of scale. In the last two decades, cloud computing has been adopted as a standard business tool across all types of ventures to minimize expenses and enhance the availability of data and services (Akbar et al., 2023). SMEs are the two primary user categories that have exhibited major shifts as more companies seek cloud services because of resource limitations and contend with other companies that offer similar services in the current digitally influenced market (Sumina, 2022). The increase was demonstrated most evidently in public cloud-computing expenditure, partly due to enhanced cloud technology appreciation (Sumina, 2022). The flexibility, relatively low cost, and the ability to access resources anywhere and anytime have made clouds appealing to SMEs. However, cloud computing adoption in SMEs targets is not general due to more factors in which they are, for instance, limited resources, inadequate regulatory support, and resistance to change (Ahmed, 2020; Karagozlu et al., 2020).

Unlike larger organizations, SMEs encounter specific environmental factors that may encourage or hinder cloud computing adoption and its subsequent success, including regulatory policy competition and social factors in the external environment (Tornatzky & Fleischer, 1990). Although there has been an increase in technology adoption, few studies focus on how environmental factors influence the integration of cloud computing in SMEs, and some provide contradictory data. According to some scholars, the emerging facility of favorable government incentives and policies (Qatawneh, 2024; Salim & Ali, 2020); others highlighted the challenges posed by competitive pressure and the lack of adequate infrastructure (Golightly et al., 2022). Some researchers focus on consumer-related pressures (Salim & Ali, 2020), while others stress competitive pressure and insufficient facilities (Golightly et al., 2022; Hadwer et al., 2021). Other external and internal facilitating factors include the social influence of different businesses and the adoption of similar behaviors by peer professional organizations (Alighar et al., 2023; Jennice, 2024).

3.2. Environmental Factors and Cloud Computing Adoption

The TOE framework categorizes the different aspects that impact organizational adoption and use of technology. According to Tornatzky and Fleischer (1990), environmental factors are external factors that may dictate an organization's decision to adopt and use a particular technology. When creating the TOE framework, Tornatzky and Fleischer (1990) stated that the key environmental factors that impacted the organization's adoption and use of technology included, but were not limited to, regulatory requirements, customer satisfaction, social influence, and competitive pressures.

3.2.1. Government Policies

Government policies can be major factors that may trigger the integration of cloud computing in SMEs in the United States. Research indicates that local and state governments may offer financial incentives and invest in technology infrastructure that may enable SMEs to make informed decisions to implement diverse advanced technologies, such as cloud-based services, to improve their services (Salim & Ali, 2020). According to a study (Qatawneh, 2024), most SMEs lack adequate resources to adopt the needed technologies for cloud computing. When the government offers such resources, they are highly likely to integrate cloud computing into their transactions and overall operations. The government can develop policies to regulate cloud-based service providers to ensure that they adhere to the data and protection laws and standards to prevent SMEs' data loss (Banimfreg, 2023; Belgaum et al., 2021). Other researchers have demonstrated that both local and state governments play vital roles in ensuring some effective policies and guidelines offer regulations and standards for adopting technology-related services in organizations, including data protection laws and cybersecurity laws that govern how organizations should conduct cloud-based services (Satish, 2024; Zamani, 2022).

Specific to cloud computing services, state and federal governments have passed laws that require businesses and organizations to protect their clients' information. For instance, Ibrahim et al. (2023) explained that the cloud regulatory framework provides a practical and unified approach to accessing, using, and managing information for

decision-making. Ali and Osmanaj (2020) examined the extent of governmental regulation concerning the integration of cloud computing. The results indicated that developing regulations would help governments and organizations to integrate and utilize cloud computing services. In the USA, for instance, several laws exist. Financial institutions were required to respect consumers' privacy in pursuance of the Gramm-Leach-Bliley Act (GLBA) proactively implemented by the Federal Trade Commission (FTC). Therefore, while there is little empirical knowledge on how and to what extent environmental factors affect the adoption and usage of technology or New Innovation, there is a gap reviewed in the literature on the antecedents and effects of environmental factors in SMEs use of cloud services (Hadwer et al., 2021; Meryeme et al., 2025).

3.2.2. Competitive Pressure

Competitive pressure is also an external environmental factor affecting cloud computing adoption. In the existing empirical literature, scholars suggested that other government policies and competitive pressure are some of the variables that may force SMEs to adopt competitive pressure in investing in cloud computing, with the pressure to perform better than large organizations being most effective (Aligarh et al., 2023; Faiz et al., 2024). According to Golightly et al. (2022), it is clear that organizations offering innovative products and services get more traffic from clients, and this may lead SMEs to use cloud-based services to adapt to the dynamic face of business activities practised in the sector. These findings show that competitive pressure significantly affects the integration of cloud computing in SMEs. Unlike larger organizations, SMEs require enormous spending on technological infrastructure to be at par with the current changes in the business landscape (Hadwer et al., 2021; Vărzaru & Bocean, 2024; Qatawneh,2024).

3.2.3. Social Influence

Social influence has a significant influence on the integration of cloud computing in SMEs. Various scholars have provided different results concerning the impact of the social aspect on the acceptance of cloud-based technology services, suggesting that competition from other SME business partners can be a key factor that affects the use of cloud computing (Alighar et al., 2023; Islam et al., 2023). For instance, Alighar et al. (2023) indicated that when business partners adopt advanced technology, such as cloud-based services, SMEs adopt cloud computing to compete with their competitors. On the other hand, some studies indicated that social interaction with different professionals may influence SMEs to implement cloud-based services as these professionals are highly likely to advise these businesses to adopt the advanced technology for effective operations and customer satisfaction (Jennice, 2024; Yaseen et al., 2023). A similar agreement was reported in a quantitative study conducted by Satish (2024), who noted that engaging with different professionals, particularly technology professionals, may prompt SME leaders to embrace cloud computing as these experts are more likely to offer technical advice for the leaders to adopt in the business operations including cloud computing.

3.2.4. Customer Satisfaction

Customer satisfaction is another factor that may influence the integration of cloud computing technologies in SMEs. As reported in the previous literature, most businesses fail because they do not meet customer needs and satisfaction, leading to losing clients to their competitors (Vinoth et al., 2022). As a result, clients have different perspectives regarding the use of technology in delivering their services and products, and this is more likely to influence how SMEs decide to embrace cloud computing technologies (Vinoth et al., 2022). Consistent results to Vinoth et al. (2022) were also reported in a study by Skafi et al. (2020). According to Bradač Hojnik and Huđek (2023), satisfied customers may affect how SMEs operate and decide on integrating cloud computing technologies in their business operations and transactions. However, Li et al. (2021) established that customers of SME organizations with technology skills are more likely to demand the implementation of cloud computing services for effective service delivery.

3.3. Justification for Meta-Analysis

Despite the rising awareness of cloud computing, scholars in previous studies have not fully addressed the influence of external environment factors in SMEs' adoption of cloud computing. Most studies on the environmental impact of technology adoption hinge on a few factors or have restricted sample size, thus entailing contradictory and inconsistent conclusions at times (Hadwer et al., 2021; Meryeme et al., 2025). Scholars focused on large companies, while the challenges of SMEs were investigated insufficiently (Hadwer et al., 2021; Qatawneh, 2024). Although there is an increasing complexity of technologies and advanced usage of the internet, there is a dearth of literature on how different external factors, including competitive pressures, social influence, and customer satisfaction within SMEs, are considered within the adoption of cloud computing among SMEs (Aligarh et al., 2023; Golightly et al., 2022). In this meta-analysis, the authors addressed the gaps by systematically reviewing recent quantitative research published between 2020 and 2025, providing a more contemporary perspective of how government factors, competition pressure, social pressure, and customer satisfaction influence cloud computing in SMEs.

The meta-analysis is novel since the authors gathered data from various studies on the relationships between external environmental factors. This may have been more precise than previous findings that primarily provided a mixed and conflicting picture of those factors.

This meta-analysis explored current literature concerning the impacts of environmental factors on SME adoption of

cloud-based services. Although different from other research methods, meta-analysis is crucial because it combines data from multiple studies to estimate the pooled effect of environmental factors on cloud computing adoption (Paul & Barari, 2022). Papakostidis and Giannoudis (2023) noted that analyzing the outcomes of different peer-reviewed studies increases the statistical power of the analysis process and the precision of the research findings. Furthermore, meta-analysis creates a robust framework and comprehensive understanding of the research topic (Mengist et al., 2020). Conducting this meta-analysis, the authors analyzed the outcomes of recently published peer-reviewed studies (2020-2025) and, as guided by the TOE framework, identified and described in detail the environmental factors inherent in SMEs' adoption and use of cloud computing services. Therefore, this meta-analysis allowed us to pull and analyze evidence from different quantitative studies to determine whether the pooled effect of environmental factors is statistically significant. Specifically, this article answered the following research question: *Based on evidence from recently published scholarly articles, is there a significant relationship between external business environment factors and cloud computing adoption among SMEs?*

4. Materials and Methods

This meta-analysis aimed to establish, using evidence from recently published quantitative studies, whether factors in the external business environment significantly influence SMEs' adoption of cloud computing. In this section, the authors describe the methods used to identify relevant articles and extract data for meta-analysis.

To identify relevant articles, the authors began by defining the criteria that studies must meet to be eligible for inclusion in this meta-analysis. Only studies focusing on the environmental factors influencing cloud computing adoption were included. The authors only included studies published after 2020 to gather recent evidence. Additionally, only studies authored and published in English were included.

The authors then created a list of keywords that would be used to develop search strings for querying relevant academic databases. The authors created an exhaustive list of keywords related to each key concept in this study: cloud computing, external business environment factors, adoption, and small and medium-sized enterprises (SMEs).

Keywords related to cloud computing were as follows: Cloud storage, cloud migration, cloud services adoption, cloud-based solutions, IaaS (Infrastructure as a Service), SaaS (Software as a Service), and PaaS (Platform as a Service). Keywords related to the concept of technology adoption were as follows: integration, deployment, implementation, and adoption. Keywords related to the concept of environmental factors were as follows: economic conditions, market trends, competition, industry competition, cultural influences, social influences, supply chain, consumer behavior, industry disruptions, legal environment, regulatory environment, government policies, and political climate.

Lastly, keywords related to SMEs were as follows: SMEs, small-scale businesses, small firms, small and medium-sized enterprises, small-sized firms, and medium-sized enterprises. The keywords were then combined using Boolean operators to develop search strings for the literature search. The following search strings were developed:

- Search string 1: ("cloud storage" OR "cloud migration" OR "cloud services adoption" OR "cloud-based solutions" OR IaaS OR "Infrastructure as a Service" OR SaaS OR "Software as a Service" OR PaaS OR "Platform as a Service") AND ("integration" OR "deployment" OR "implementation" OR "adoption") AND ("economic conditions" OR "market trends" OR "competition" OR "industry competition" OR "cultural influences" OR "social influences" OR "supply chain" OR "consumer behavior" OR "industry disruptions" OR "legal environment" OR "regulatory environment" OR "government policies" OR "political climate") AND (SMEs OR "small-scale businesses" OR "small firms" OR "small and medium-sized enterprises" OR "small-sized firms" OR "medium-sized enterprises")
- Search string 2: ("cloud storage" OR "cloud migration" OR "cloud services adoption" OR "cloud-based solutions" OR IaaS OR SaaS OR PaaS) AND ("adoption barriers" OR "adoption drivers" OR "technology adoption challenges" OR "factors influencing cloud adoption") AND ("economic conditions" OR "market trends" OR "industry competition" OR "cultural influences" OR "supply chain" OR "consumer behavior" OR "regulatory environment" OR "government policies") AND (SMEs OR "small firms" OR "small businesses" OR "small and medium-sized enterprises" OR "medium-sized enterprises")

The search strings developed above were then used to query many academic databases believed to contain relevant articles with evidence on the relationship between external business environment factors and cloud computing adoption among SMEs. The specific database queries using the search strings were IEEE Xplore, ScienceDirect, Google Scholar, Scopus, Springer, Sage Journals, Web of Science, and Wiley Online Library.

Figure 1 is a flowchart illustrating the process of identifying and screening studies for inclusion in this meta-analysis. A total of 347 records were identified from various academic databases queried. While this number was initially larger, filters were applied to ensure the databases only returned records published after 2020. This approach effectively reduced the number of records from approximately 10,000 to 347.

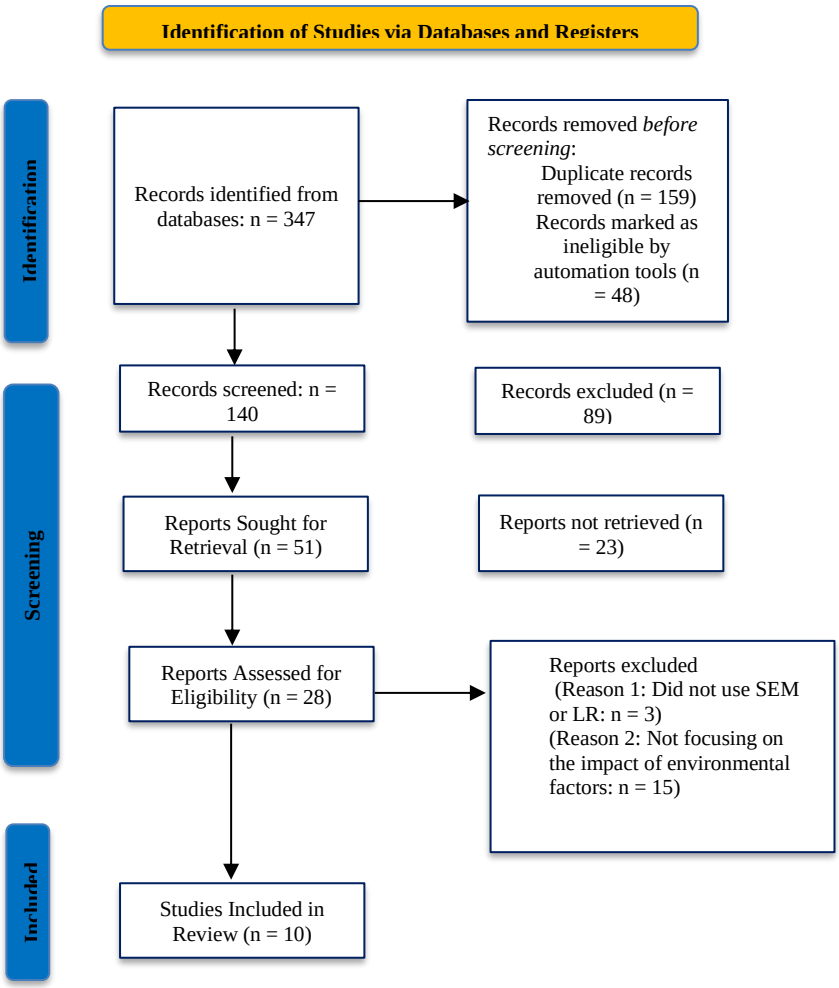

Fig. 1 Flowchart of Study Identification, Retrieval, and Filtering

Before conducting any screening, 159 records were removed since they were duplicates. Automation tools removed a further 48 records. The remaining 140 records were subjected to screening. The screening process involved reviewing each article's title and abstract to determine its relevance. Eighty-nine records were removed as they were deemed irrelevant solely based on their titles and/or abstracts. After eliminating 89 records, the remaining 51 were sought for a full-text review. However, 23 records could not be retrieved. Only abstracts were available for these records. Since the authors could not rely on just the abstracts to gather relevant data, the 23 records were eliminated. The remaining 28 records were subjected to a full-text review. After the full-text review, 15 articles were dropped because their focus was slightly outside the scope of this meta-analysis. Three articles were dropped because they did not employ linear regression or structural equation modelling to estimate the relationship between environmental factors and cloud computing adoption among SMEs. Thus, the total number of articles eligible for inclusion in this meta-analysis was 10. These articles include were as follows: Ali et al. (2020), Al-sharafi et al. (2023), Aligarh et al. (2023), Ayadi (2022), Hussein et al. (2020), Li et al. (2021), Qatawneh (2024), Salim and Ali (2020), Satish (2024), Skafi et al. (2020).

The data collection process involved thoroughly reviewing each article and extracting relevant data, quantifying the relationship between environmental factors and cloud computing adoption among SMEs. Since only studies that employed linear regression or structural equation modelling were included, the data elements of interest included the raw beta coefficient, standard error, and sample size. However, some studies did not report standard errors. In such cases, t-statistics were recorded for later use in calculating standard errors. While only ten studies met the eligibility criteria for inclusion in this meta-analysis, the final dataset contained more than ten rows (n = 19). This is because some studies have reported evidence of multiple environmental factors. For instance, Skafi et al. (2020) reported evidence on political issues, competitive pressures, government initiatives, and supplier support. Table 1 is a snapshot of the process of identifying and screening relevant articles for inclusion in this study:

4.1. Data Analysis

Data analysis was performed using R software. In particular, a meta-analysis was conducted using the R package' meta,' which contains all the functions for estimating various fixed-effects and random-effects meta-analysis models. In this study, the analysis was conducted in two steps. In step 1, a pooled model was used to estimate whether the combined effect of all environmental factors on cloud computing adoption was statistically significant. Both random and fixed-effect models were estimated. However, the random effects model was preferred due to significant heterogeneity caused by fundamental differences across studies.

In step 2, subgroup analysis was performed to estimate the effect of different environmental variables on cloud computing adoption. The authors collapsed different environmental variables into seven categories: social influence, customer satisfaction, political issues, government policies, supplier support, competitive pressures, and general environmental factors.

The authors then estimated the pooled effect of the seven environmental factors on cloud computing adoption. Findings from both steps 1 and 2 are reported under the results section. Table 1 is a snapshot of the final dataset used in the meta-analysis:

Table 1. A Snapshot of the Final Dataset

Author	Predictor	Type	Sample Size	Beta Coefficient	Standard Error
Satish (2024)	Social Influence-related factors	Social Influence	145	0.217	0.093200000
Li et al. (2021)	Customer satisfaction	Customer Satisfaction	357	0.180	0.153000000
Skafi et al. (2020)	Political issues	Political Issues	139	0.845	0.353000000
Skafi et al. (2020)	Government initiatives	Government Initiatives	139	0.130	0.377000000
Skafi et al. (2020)	Competitive Pressure	Competitive pressures	139	0.157	0.330000000
Skafi et al. (2020)	Supplier computing support	Supplier Support	139	-0.212	0.370000000
Ali et al. (2020)	Government Regulations	Government Policies	139	-0.512	0.370000000
Salim & Ali (2020)	Social Influence	Social Influence	139	0.024	0.276000000
Qatawneh (2024)	Environmental related factors	Environmental Factors	373	0.090	0.071000000
Qatawneh (2024)	Government rules and regulations	Government Policies	373	-0.029	0.121000000
Aligarh et al. (2023)	Industry competition	Competitive pressures	373	0.232	0.070000000
Aligarh et al. (2023)	Competitive Pressure	Competitive pressures	197	0.231	0.083000000
Ayadi (2022)	Bandwagon effect	Competitive pressures	139	0.157	0.084000000
Ayadi (2022)	Perceived competitiveness	Competitive pressures	123	0.210	0.158000000
Ayadi (2022)	Government Policy & External Support	Government Policies	139	0.194	0.134000000
Hussein Alghumami et al. (2020)	Regulatory policy	Government Policies	328	0.149	0.058000000
Hussein Alghumami et al. (2020)	Competitive pressure	Competitive pressures	328	0.201	0.055000000
Hussein Alghumami et al. (2020)	Competitive pressure	Competitive pressures	328	-0.060	0.527000000
Al-sharafi et al. (2023)	Government support	Government Policies	415	0.230	0.056000000

Table 2. Overall radom effect model results

Study	TE	SE	Weight (common)	Weight (random)	Estimate [95% CI]
Satish (2024) – Social Influence-related factors	0.1934	0.0932	2.3%	5.2%	0.19 [0.01; 0.38]
Li et al. (2021) – Customer satisfaction	0.2324	0.0410	12.1%	8.5%	0.23 [0.15; 0.31]
Skafi et al. (2020) – Political issues	0.1345	0.5330	0.9%	1.5%	0.13 [-0.91; 1.18]
Skafi et al. (2020) – Government Initiatives	-0.3309	0.7520	0.6%	1.2%	-0.33 [-1.81; 1.13]
Skafi et al. (2020) – Competitive Pressure	0.1350	0.3300	2.6%	4.3%	0.14 [-0.51; 0.78]
Skafi et al. (2020) – Supplier computing support	0.0925	0.3360	2.5%	4.2%	0.09 [-0.57; 0.75]
Ali et al. (2020) – Government Regulations	-0.0212	0.2045	2.0%	1.6%	-0.02 [-0.44; 0.40]
Salim & Ali (2020) – Social Influence	0.3203	0.0922	2.3%	5.2%	0.32 [0.14; 0.50]
Qatawneh (2024) – Environmental related factors	0.1165	0.0403	12.8%	8.6%	0.12 [0.04; 0.19]
Qatawneh (2024) – Government rules and regulations	0.2332	0.0480	10.1%	6.9%	0.23 [0.14; 0.33]
Qatawneh (2024) – Industry competition	0.1291	0.0653	6.9%	6.0%	0.13 [0.00; 0.26]
Aligarh et al. (2023) – Competitive Pressure	0.2534	0.0802	4.6%	5.9%	0.25 [0.10; 0.41]
Aligarh et al. (2023) – Bandwagon effect	0.1853	0.0984	3.1%	5.5%	0.19 [-0.01; 0.37]
Ayadi (2022) – Perceived competitiveness	0.2036	0.0938	2.5%	5.1%	0.20 [0.02; 0.39]
Ayadi (2022) – Government Policy & External Support	0.1948	0.0863	2.8%	5.4%	0.19 [0.03; 0.37]
Hussein Alghumami et al. (2020) – Regulatory policy	0.1490	0.0548	6.2%	6.9%	0.15 [0.04; 0.25]
Hussein Alghumami et al. (2020) – Competitive Pressure	0.1196	0.0582	6.1%	6.9%	0.12 [0.01; 0.24]
Al-sharafi et al. (2023) – Competitive Pressure	-0.0558	0.3628	2.1%	4.0%	-0.06 [-0.76; 0.65]
Al-sharafi et al. (2023) – Government support	0.2008	0.0562	6.5%	7.5%	0.20 [0.09; 0.31]
Total (common effect, 95% CI)			100%		0.18 [0.16; 0.21]
Total (random effect, 95% CI)				100%	0.16 [0.10; 0.22]
Prediction interval					[-0.05; 0.37]
Heterogeneity: $Tau^2 = 0.0093$; $\chi^2 = 59.71$, df = 18 ($P < 0.01$); $I^2 = 70\%$					

5. Results

5.1. Overall Model

Ten studies met the eligibility criteria. Meta-data extracted from these studies included reported raw beta values, standard errors, and sample sizes. A pooled model was fitted on the data to examine whether external environmental factors significantly influence cloud computing adoption among SMEs. The results of this overall model are shown in Table 2. There was significant heterogeneity among studies, as evidenced by the high I^2 statistic (I^2 = 70%) and significant Chi-square ($p < 0.01$). This result suggests that observed differences across studies in this model resulted from actual differences rather than random chance. Due to the significant heterogeneity, the random effects model was preferred to the fixed-effects model. The pooled effect of environmental factors on cloud computing adoption was positive (B = 0.16) and statistically significant (95% C.I [0.10; 0.22]). This result is consistent with what most of the studies in the model reported. Of the 15 studies in the model, only three reported an adverse standardized beta effect (Ali et al., 2020; Al-Sharafi et al., 20203; Skafi et al., 2020). Even though the beta coefficients reported were negative, none was statistically significant.

5.2. Subgroup Analysis

A subgroup analysis was conducted to explore further the observed differences across studies included in this meta-analysis. The key factors examined in these studies were collapsed into seven categories: social influence, customer satisfaction, political issues, government policies, supplier support, competitive pressures, and general environmental factors. The most examined factors were government policies and competitive pressures. Government policies had six studies reporting evidence of their impact on cloud computing adoption ((Ali et al., 2020; Al-Sharafi et al., 2023; Ayadi, 2022; Hussein Alghushami et al., 2020; Qatawneh, 2024; Skafi et al., 2020). Competitive pressures had six studies reporting evidence of its impact on cloud computing adoption (Aligarh et al., 2023; Al-Sharafi et al., 2023; Ayadi, 2022; Hussein Alghushami et al., 2020; Qatawneh, 2024; Skafi et al., 2020). The impact of social influence was reported in only three studies (Alighar et al., 2023; Salim & Ali, 2020; Satish, 2024). The other factors were supported by evidence from only one study each. In particular, the only evidence on supplier support, customer satisfaction, political issues, and general environmental factors came from Sakfi et al. (2020), Li et al. (2021), Skafi et al. (2020), Skafi et al. (2020), and Qatawneh (2024) respectively.

The results of the subgroup analysis are shown in Table 3. Of the seven factors in the subgroup model, only two had a statistically insignificant relationship with cloud computing adoption: political issues (B = 0.13, 95% C.I [-0.91; 1.18]) and supplier support (B = 0.03, 95% C.I [-0.63; 0.69]). Both factors were supported by only one study; hence, heterogeneity statistics could not be computed. The rest of the factors statistically significantly affected cloud computing adoption among SMEs.

Social influence had a statistically significant positive relationship with cloud computing adoption (B = 0.12, 95% C.I [0.01; 0.22]). Heterogeneity was low in this subgroup (I^2 = 16.1%); hence the fixed effects model was preferred. This result indicates that the social environment within which SMEs operate positively influences their decisions to adopt cloud computing. The social influence factor was supported by three studies (Aligarh et al., 2023; Salim & Ali, 2020; Satish, 2024), although only one of them (Satish, 2024) reported a statistically significant effect. The second subgroup consisted of factors related to customer satisfaction. Only one study (Li et al. 2021) reported evidence of the effect of customer satisfaction; hence, heterogeneity could not be computed. As shown in Table 4, customer satisfaction had a statistically significant relationship with cloud computing adoption (B = 0.23, 95% C.I [0.15; 0.13]).

The third subgroup consisted of factors related to government policies. Six studies reported evidence of the effect of government policies. Of the six studies in this subgroup, two reported a negative but statistically insignificant effect, three reported a positive and statistically significant effect, and only one reported a positive but insignificant effect (Table 3). Heterogeneity was low in this subgroup (I^2 = 30.2%); hence the fixed-effects model was preferred. Results indicate a statistically significant relationship between government policies as an external environmental factor and cloud computing adoption (B = 0.26, 95% C.I [0.21; 0.31]).

The fourth subgroup consisted of factors related to competitive pressure. Six studies reported evidence of the impact of competitive pressure, with only one reporting a statistically insignificant adverse effect. The rest of the studies in this subgroup, apart from Qatawneh (2024), reported a statistically significant positive effect of competitive pressure. In their study, Qatawneh (2024) found no significant effect of competitive pressure on cloud computing adoption. Heterogeneity was low (I^2 = 39.4%); hence the fixed-effects model was preferred. The pooled effect of competitive pressures on cloud computing adoption was positive and statistically significant (B = 0.14, 95% C.I [0.03; 0.25]).

Lastly, environmental factors were included as a subgroup since one of the 10 studies reported evidence of its effect. Qatawneh (2024) included environmental factors as a composite variable in their study. No heterogeneity statistics were computed since only one study was included in this subgroup. However, the result suggests that environmental factors positively and significantly affect cloud computing adoption (B = 0.12, 95% C.I [0.04; 0.19]).

Table 3. Subgroup Meta-analysis Results

Study or Subgroup	TE	SE	Weight (common)	Weight (random)	SMD [95% CI]
Type = Social Influence					
Satish (2024)	0.1934	0.0932	2.3%	5.2%	0.19 [0.01; 0.38]
Salim & Ali (2020)	0.0144	0.0879	2.6%	5.4%	0.01 [-0.06; 0.07]
Aligarh et al. (2023)	0.1508	0.0888	2.6%	5.4%	0.15 [0.05; 0.26]
Total (common effect, 95% CI)			7.5%	16.1%	0.12 [0.01; 0.22]
Total (random effect, 95% CI)			7.5%	16.1%	0.12 [0.01; 0.22]
Heterogeneity $Tau^2 = 0.0008$	$Chi^2 = 2.18$, df = 4 (P = 0.34); $I^2 = 8\%$				
Type = Customer Satisfaction					
Li et al. (2021)	0.2324	0.0410	12.1%	8.5%	0.23 [0.15; 0.31]
Total (common effect, 95% CI)			12.1%	8.5%	0.23 [0.15; 0.31]
Total (random effect, 95% CI)			12.1%	8.5%	0.23 [0.15; 0.31]
Type = Political Issues					
Skafi et al. (2020)	0.1345	0.5330	0.1%	0.3%	0.13 [-0.91; 1.18]
Total (common effect, 95% CI)			0.1%	0.3%	0.13 [-0.91; 1.18]
Total (random effect, 95% CI)			0.1%	0.3%	0.13 [-0.91; 1.18]
Type = Government Policies					
Skafi et al. (2020)	-0.3390	0.7520	0.2%	0.4%	-0.34 [-1.18; 1.13]
Ali et al. (2020)	0.0243	0.0793	0.2%	0.3%	0.02 [-0.10; 0.13]
Qatawneh (2024)	0.3883	0.0604	3.4%	5.1%	0.39 [0.13; 0.47]
Ayadi (2022)	0.0293	0.0360	0.3%	0.5%	0.03 [-0.04; 0.11]
Hussein Alghumami et al. (2020)	0.1604	0.0409	6.5%	7.5%	0.16 [0.08; 0.23]
Al-sharafi et al. (2023)	0.0209	0.0405	0.5%	0.8%	0.02 [-0.05; 0.10]
Total (common effect, 95% CI)			27.5%	30.2%	0.20 [-0.12; 0.39]
Total (random effect, 95% CI)			27.5%	30.2%	0.21 [-0.13; 0.54]
Heterogeneity $Tau^2 = 8.77$	$Chi^2 = 2701.03$, df = 6 (P < 0.01); $I^2 = 100\%$				
Type = Competitive Pressures					
Skafi et al. (2020)	0.0439	0.3030	0.2%	0.9%	0.04 [-0.50; 0.58]
Qatawneh (2024)	0.2003	0.1382	2.6%	3.4%	0.15 [-0.06; 0.76]
Aligarh et al. (2023)	0.2203	0.0912	3.4%	4.3%	0.20 [0.05; 0.39]
Ayadi (2022)	0.0534	0.2155	0.4%	2.5%	0.05 [-0.36; 0.43]
Hussein Alghumami et al. (2020)	-0.0558	0.2369	0.1%	1.7%	-0.06 [-0.54; 0.41]
Total (common effect, 95% CI)			9.0%	35.7%	0.10 [-0.13; 0.31]
Total (random effect, 95% CI)			9.0%	35.7%	0.14 [-0.16; 0.39]

Heterogeneity Tau² = 0.1771	Chi² = 8.88, df = 5 (P = 0.12); I² = 76%				
Type = Supplier Support					
Skafi et al. (2020)	0.0298	0.3360	0.2%	0.8%	0.03 [-0.63; 0.69]
Total (common effect, 95% CI)			0.2%	0.8%	0.03 [-0.63; 0.69]
Total (random effect, 95% CI)			0.2%	0.8%	0.03 [-0.63; 0.69]
Type = Environmental Factors					
Qatawneh (2024)	0.1165	0.0400	12.8%	8.6%	0.12 [0.04; 0.19]
Total (common effect, 95% CI)			100.0%	100.0%	0.18 [0.16; 0.21]
Total (random effect, 95% CI)			100.0%	100.0%	0.16 [0.10; 0.22]
Prediction Interval					[-0.05; 0.37]
Heterogeneity Tau² = 0.0093	Chi² = 59.71, df = 18 (P < 0.01); I² = 70%				
Test for subgroup differences (common effect)	Chi² = 16.84, df = 6 (P < 0.01)				

5.3. Publication Bias Assessment

Publication bias was assessed using a funnel plot and a formal Egger's test. The funnel plot shown in Figure 2 shows evidence of potential publication bias. The plot appears asymmetrical, with more studies on the right side, suggesting potential publication bias or heterogeneity. There are a few studies with negative effect sizes but fewer on the far left, which may indicate missing studies. However, a statistical test, Egger's test, was used to ascertain evidence of publication bias. The bias estimate was statistically insignificant (Bias Estimate = -0.9150, p = 0.249), suggesting the absence of significant publication bias.

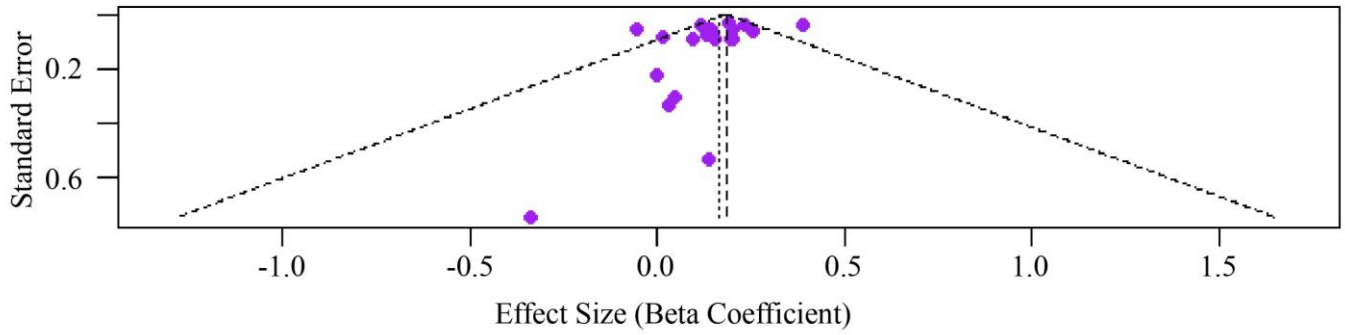

Fig. 2 Funnel Plot for Publication Bias Assessment

6. Discussion

This meta-analysis aimed to establish, using evidence from recently published quantitative studies, whether factors in the external business environment significantly influence SMEs' adoption of cloud computing. In this study, only ten studies met the eligibility criteria. The overall model results showed that the external business environment significantly influences SMEs' adoption of cloud computing. The findings imply that the overall external business environmental factors may influence the implementation of cloud computing among SMEs. The results indicated that out of the seven environmental factors impacting the use of cloud computing in SMEs, only two factors had a statistically insignificant relationship with cloud computing adoption. These factors include political issues and supplier support, which may not significantly impact the intention to adopt cloud computing among SMEs. This could be because political issues and supplier support were only supported by one study each, and political factors may not influence the use of technology in organizations such as SMEs.

However, other external business environment factors significantly influenced the adoption of cloud computing. One such factor was government policies. The analyzed studies showed that external environmental factors, including government policies, are significantly related to cloud computing adoption. The study confirms the existence of government influence on SMEs planning to incorporate cloud

computing technology in their business. The authors argued that only if the government provides incentives such as funding and undertakes the establishment of infrastructure and technologies will SMEs adapt to using cloud computing in their operations. This finding aligns with earlier studies, which stated that local and state governments may, through financial incentives and investing in technological infrastructure, encourage or help SMEs decide to embark on a range of advanced technologies like cloud-based services to enhance their services (Salim & Ali, 2020). To ensure that data is not lost through cloud-based service providers, the government can develop policies that check on the providers to ensure they are observing the data and protection laws and provisions of laws to address this.

Competitive pressure was an external business environmental factor that also affected the implementation of cloud computing in SMEs. The data analysis revealed that the probability of competitive pressures and adoption of cloud computing was statistically significant. These SMEs compete with large organizations that have incorporated various technologies like cloud computing, which puts pressure on the SMEs to adopt cloud computing to compete with the large organizations. The findings are consistent with previous research showing that competitive pressure might affect the adoption of cloud computing services in SMEs, and as such, these organizations continue to incur significant technological capital to ensure they are positioned well to respond to competition pressure (Aligarh et al., 2023; Al-Sharafi et al., 2023; Ayadi, 2022).

From the data analyzed, the study observed that social influence, a factor of the external environment, affected the implementation of cloud computing in SMEs. The study established that social influence significantly and positively correlated with cloud computing implementation. The force may be in the form of demands by their partners, such as customers and suppliers, who might have engaged the business to consider using cloud computing services for the most appropriate service delivery, hence exerting pressure on SMEs to adopt cloud-based services. In addition, since these staff experts are likely to insist on technology as the solution for any solution, there is a higher chance that they will opt for cloud services, hence improving the willingness of SMEs towards cloud computing. The findings concur with Christiansen et al. (2022), who mentioned that when business partners embrace modern technology, SMEs are most likely to embrace cloud computing to counter their competitors.

Based on the findings of this study, it can be inferred that customer satisfaction is one of the environmental factors that has impacted the adoption of cloud computing in SMEs. The findings revealed that customer satisfaction affected cloud computing adoption among SMEs significantly. The authors concluded that perceived competitive advantage and the need to satisfy customers with a view of deploying effective brand loyalty may drive SMEs to adopt cloud computing. With such expectations, the trend of delivering services such as cloud-based services in real-time enhances the SME organizations' efficiency, influencing the adoption of cloud computing services. Confirming current study findings, previous research indicated that satisfied customers may affect how SMEs operate and make decisions regarding adopting cloud computing technologies in their business operations and transactions (Skafi et al., 2020).

6.1. Comparison with Existing Literature and Novel Contributions

This meta-analysis provides a broader perspective of the research on how the external environment influences cloud computing adoption on SMEs by systematizing the findings of recent quantitative studies (2020-2025). Contrary to individual studies, which can be focused on smaller populations or narrower scopes, the meta-analysis combines the results of different research studies, giving a broad and general perspective. Statistically, this study provides a robust understanding because the approach is a mixed model with fixed and random effects, increasing the results' feasibility and accuracy. Specifically, the selection of the findings corrects potential biases in prior research as the authors used recent sources to provide the study's conclusions with particular relevance.

Due to developments in the information technology industries and the flexibility in the cloud computing sphere, previous studies have, in most cases, provided inconclusive or even contradictory findings targeting environmental factors and positive effects on cloud computing. By pooling data from multiple sources, this study quantifies the effect size more accurately and finds the statistical significance of the relationships indicated for government policies, including competitive pressure and customer satisfaction. These findings provide greater support than previous studies that have drawn attention to these factors associated with the outcomes, but statistical measures have not widely supported these comparisons. The authors acknowledge political issues and supplier support as factors with the most significant influence, which caused rather insignificant impacts, although they remained beyond the scope of previous studies. This conception differentiates the focus of this work apart from prior research, which could have exaggerated or understated these considerations.

The findings in this study differ from prior individual studies, which might not have considered the variation in results across different contexts. The authors integrated various studies in the meta-analysis, enabling a more reliable, broader perspective. In this case, the broad scope enables the assessment of various environmental factors, such as social influence vested in the organization, pressures from its competitors, and the satisfaction level of its customers. In combination, the authors established a coherent and richer

understanding of drivers for cloud adoption in SMEs. The results show why this more expansive perspective provides a better understanding, as the previous studies were often conducted within the scope of specific geographical regions, industries, or smaller samples.

7. Limitations and Future Research

There are several limitations associated with this meta-analysis research. This study adopted secondary data sources using meta-analysis to analyze previous studies about the environmental factors influencing the adoption of cloud computing in SMEs. Secondary data sources may include scholarly works whose errors were never addressed, which may affect the validity of the current study findings. The second limitation was about the studies used in this meta-analysis research. The limitation was that only articles published between 2020 and 2025 were included in this study, while those studies or articles published before 2020 were excluded from this research despite having consistent data about cloud computing technology implementation in SMEs. The third limitation was that quantitative studies were included in this research, and qualitative studies with relevant empirical evidence were excluded.

Future research is needed using primary data sources to explore how external environmental factors influence the adoption of cloud computing technologies in SMEs and other contexts. In addition, researchers should consider investigating environmental factors and their relationship with the adoption of cloud computing in SMEs within a specified time as SMEs have evolved in their adoption of cloud-based services.

Finally, since only quantitative studies were included in this research, more research should be conducted using qualitative study designs for enhanced insights concerning the importance of adopting cloud computing in SMEs. Additionally, future research should be conducted to establish the extent to which competitive pressures, government policies, customer satisfaction, and social influence relate to the adoption of cloud computing not only in SMEs but also in large organizations.

8. Implications

Several implications can be derived from the findings of this study. Local and state governments may consider developing policies that favor adopting cloud computing technology in SMEs to enhance investment and innovation. Local and state governments may impose regulatory frameworks and policies that foster or hinder the implementation of cloud computing services in SMEs. The policies developed by government agencies, including regulatory guidelines for data protection, may help SMEs to ensure they adhere to stipulated regulations when adopting cloud computing enhanced operations and overall performance.

Leaders in SMEs should consider diverse factors before deciding to adopt cloud-based services. Thus, they may be required to identify important areas for investments in infrastructure and implement robust measures to address security concerns to enhance customer satisfaction, as customers may influence how they adopt cloud computing. Similarly, tech-savvy professionals in SMEs may use this study's findings to understand the need for a competitive edge over competitors by adapting to the ever-evolving technological development in the business context, such as cloud-based services.

This research's findings may help cloud computing service providers understand various environmental factors they must adhere to, including government policies and competitive pressures that may influence how SMEs adopt cloud computing. Therefore, these providers may need to offer cloud-based systems that are user-friendly and compatible with the existing systems within the SMEs to promote the adoption of cloud computing. The need for SMEs to create a strong competitive advantage for their services and products on the market may pressure them to adopt innovative strategies such as cloud computing for efficient operations to meet the competitive demands in the industry.

9. Conclusion

This research aimed to explore the relationship between external environmental factors and the adoption of cloud computing in SMEs. This study has provided important insights into how external environmental factors influence the acceptance of cloud computing among SMEs. The synthesis of existing empirical literature in this research has provided an understanding of how diverse external environmental factors, including competitive pressures, government policies, customer satisfaction, and social influence, affect the adoption of cloud computing in SMEs. Thus, this meta-analysis research findings indicated significant implications for organizational leaders, local and state governments, policymakers, professionals in cloud-based services, and cloud computing service providers who would need to consider such factors in future decision-making. This research also offers important background and reference for future research on practical strategies and environmental factors to be considered when promoting the adoption of cloud computing within the SME industry. Therefore, the consistent progression and evolution of cloud computing technologies may dictate the necessity to understand numerous external environmental factors that may influence the adoption of cloud computing to promote creativity and innovation in diverse industries such as SME organizations.

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