9th International Scientific Conference EMAN 2025 – Selected Papers
https://doi.org/10.31410/EMAN.S.P.2025.71

Impact of Cloud Computing on Sustainability of SMEs: A Systematic Literature Review

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Received: April 30, 2025
Accepted: October 3, 2025
Published: February 28, 2026

Keywords:
Cloud computing;
Sustainability;
Triple Bottom Line (TBL);
Small and medium-sized enterprises (SMEs);
Systematic Literature Review (SLR)

Abstract: *The adoption of cloud computing in small and medium-sized enterprises (SMEs) is well known, but its impact on triple bottom line (TBL) has not yet been sufficiently researched.*

This study fills this gap by analyzing the extent to which the adoption of cloud computing contributes to or detracts from the environmental, economic and social sustainability of SMEs. This question was analyzed by using a systematic literature review (SLR) of peer-reviewed literature from 2015 to 2025 in the SCOPUS and Web of Science databases and was guided by the SALSA framework and PRISMA guidelines. From the initial pool of over two hundred publications, inclusion and exclusion criteria were used to identify papers that linked cloud adoption to SME sustainability, resulting in a core group of studies that were used for detailed analysis.

The results of the study also include an unbalanced weighting of the TBL pillars. Economic aspects of sustainability dominate the current discussion, while the environmental and social aspects are comparatively undervalued.

This SLR provides a basis for understanding the TBL impact of cloud adoption in SMEs. It also emphasizes the importance of additional research questions that focus on the less considered environmental and social dimensions - without losing sight of the economic direction - to ensure a comprehensive pursuit of sustainability in each of the three dimensions.

1. INTRODUCTION

Around 99% of all companies in the EU are small and medium-sized enterprises (SMEs) (European Commission, n.d.). Defined as companies with fewer than 250 employees, SMEs contribute significantly to value creation and employment (OECD, 2022). Therefore, their sustainable orientation is of great importance. Sustainability is often defined as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). It includes ecological, social and economic dimensions, which are collectively referred to as the Triple Bottom Line (TBL) (Elkington, 2004). SMEs often face significant obstacles due to their typically owner-managed structures, informal organizational processes and limited financial and human resources. However, due to their agility and proximity to customers, SMEs can also react flexibly to sustainability trends and introduce innovations more quickly than larger companies (Martins et al., 2022). Technological advancements associated with Industry 4.0 (I4.0), such as cloud computing (Guo et al., 2023), present promising opportunities to support sustainability efforts. Cloud computing provides location-independent and on-demand access via the internet to a shared inventory of customizable IT resources, including computing capacity, storage and software applications, via the Internet (Alshareef, 2023; Attaran, 2017; Mell & Grance, 2011). This is technically enabled through the virtualization of hardware resources, automated provisioning processes, and service-oriented architectures offering models such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) (Botta et al., 2016).

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In recent years, this model has matured into an established technology that gives SMEs in particular access to scalable digital services without high investments.

In the context of increasing sustainability pressures and rapid technological developments, it is important to understand how technologies such as cloud computing can be utilized to promote sustainability goals in SMEs. Although sustainability in SMEs and the adoption of I4.0-technologies have both been extensively studied, there is a lack of systematic analyses that explicitly examine the intersection of cloud computing and the three dimensions of sustainability in the context of SMEs.

This gap emphasizes the need for a systematic literature review that critically assesses the existing research and provides a comprehensive understanding of how cloud computing impacts sustainable business development in SMEs. Accordingly, this study addresses the following research question:

What are the effects of cloud computing adoption on the ecological, economic, and social sustainability of SMEs?

2. METHODOLOGY

The purpose of a systematic literature review is to cover a research topic comprehensively and comprehensibly. To achieve objectivity, traceability and reproducibility, methodological standards such as the PRISMA guideline were applied in the study. This ensures that all steps - from the search strategy to the documentation - are reported transparently and completely (Page et al., 2021).

For the research, the databases SCOPUS, Web of Science (WoS) and IEEE Xplore were selected. SCOPUS and WoS are multidisciplinary scientific databases with broad coverage and high data quality (Mongeon & Paul-Hus, 2016), covering technical as well as economic and social science publications, which is essential in the context of cloud computing and sustainability. IEEE Xplore was consulted as this database specializes in engineering and computer science and offers high-quality journals and conference proceedings on cloud computing, Internet of Things (IoT), IT sustainability and digital transformation. The search strategy was designed stringently. Searches were conducted in the fields title, abstract and keywords of the publications. To cover different word endings, truncations (wildcards) were used in SCOPUS and WoS (e.g. * for word stems). Since IEEE Xplore does not allow the use of wildcards, customized search terms were used there. Due to the small number of search results, no exclusions were made regarding the publication date. Document types such as conference reviews were excluded from the outset as exclusion criteria. Furthermore, only articles in English or German were included. The following three search strings show the combined keyword search for economic, ecological and social sustainability aspects (in each case cloud computing + SME + sustainability dimension), with logical operators and wildcards exactly as applied:

General search terms: (“Cloud Computing” OR “Cloud Technology” OR “Cloud Services” OR “Cloud Adoption” OR “Cloud-Based Systems” OR “Cloud Infrastructure”) AND (“SME*” OR “small and medium enterprise*” OR “small business*” OR “medium-sized enterprise*”) AND

Economic Sustainability: (“economic sustainab*” OR “cost efficien*” OR “Cost Reduction” OR “Operational Efficien*” OR “Business Performance” OR “business model innovation” OR “Financial Sustainab*” OR “Financial Impact*” OR “IT Cost Saving*” OR “Economic Impact” OR “Return on Invest*” OR “ROI” OR “Market Competitiveness”)

Environmental Sustainability: ("environmental sustainab*" OR "Energy Efficien*" OR "Carbon Footprint" OR "Green IT" OR "Sustainable IT" OR "Environmental Impact" OR "Eco-Efficiency" OR "Data Center Energy Consumption" OR "resource efficien*")

Social Sustainability: ("Social Sustainab*" OR "Workforce Productivity" OR "Remote Work" OR "Work-Life Balance" OR "IT Skill Development" OR "Employee Satisfaction" OR "Inclusiv*" OR "Stakeholder Engagement" OR "Corporate Social Responsibility")

To ensure a high degree of completeness, replicability and scientific rigor in the methodological approach, the selection of keywords is based on the TBL framework (Elkington, 2004). In addition, relevant studies on cloud technologies and SME sustainability were considered to include common terminology.

3. RESEARCH RESULTS

In a first step, the search was carried out in the three selected databases SCOPUS, WoS and IEEE Xplore using the defined search terms. For analysis purposes, the search was carried out once with and once without the specific restriction to SMEs. The results of these searches are documented in Table 1.

Table 1. Overall Search Results in SCOPUS, WoS and IEEE Explore

	Economic Sustainability, incl. SMEs	**Environmental Sustainability, incl. SMEs**	**Social Sustainability, incl. SMEs**	**Total, after removing Duplicates**
SCOPUS	95	29	6	126
	Economic Sustainability, excl. SMEs	Environmental Sustainability, excl. SMEs	Social Sustainability, excl. SMEs	Total, after removing Duplicates
	3.751	7.024	146	10.806
WoS	Economic Sustainability, incl. SMEs	Environmental Sustainability, incl. SMEs	Social Sustainability, incl. SMEs	Total, after removing Duplicates
	47	10	4	57
	Economic Sustainability, excl. SMEs	Environmental Sustainability, excl. SMEs	Social Sustainability, excl. SMEs	Total, after removing Duplicates
	1.619	4.006	58	150
IEEE Explore	Economic Sustainability, incl. SMEs	Environmental Sustainability, incl. SMEs	Social Sustainability, incl. SMEs	Total, after removing Duplicates
	104	25	6	136
	Economic Sustainability, excl. SMEs	Environmental Sustainability, excl. SMEs	Social Sustainability, excl. SMEs	Total, after removing Duplicates
	2.795	5.626	210	5.780

Source: Own research

After removing duplicates between the three databases and the sustainability dimensions, a total of 247 studies were identified for all three dimensions of sustainability before the content review. After excluding 128 unavailable documents and removing 78 unsuitable articles as part of the abstract analysis and 17 after a subsequent in-depth content analysis, 24 studies were finally included in the Systematic Literature Review (SLR).

4. ANALYSIS

The relatively low number of the 24 final matching studies, as well as the significantly higher number of identified scientific articles without specific reference to SMEs, as shown in Table 1, suggests that the research question has been underrepresented in the context of SMEs to date.

The distribution of these publications over time shows increasing attention to the topic in recent years and is shown in Figure 1. Between 2011 and 2020, only eleven relevant contributions were published in total, whereas seven studies were published in 2023 and an additional four studies followed in 2024.

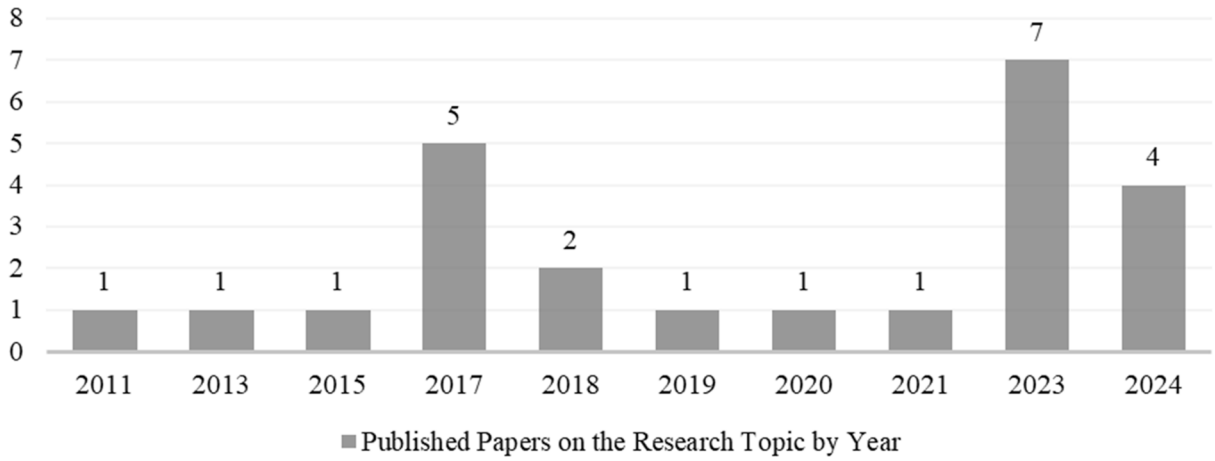

Figure 1. Published Papers on the Research Topic by Year
Source: Own research

This distribution indicates a growing scientific interest, which has likely been driven by both the increasing spread of cloud technologies and the increased importance of sustainability issues in business contexts.

The publication form of the studies identified comprises 13 conference papers, ten journal articles and one book chapter.

The dominance of conference papers shows that the research landscape in this area is highly topical and dynamic, while the relatively high proportion of journal articles also reflects the increasing scientific anchoring of the topic.

Eleven studies relate to the Asian region, with China, Malaysia and Pakistan being represented several times. Africa is represented by two articles, each from Morocco and Kenya, while Europe is represented by one study from the United Kingdom, one from Latvia, one from Norway and one study on European SMEs in general. One study was identified for Australia. Studies that explicitly refer to North and South America are completely absent. Six of the studies analyzed do not follow a specific regional approach but deal with the topic on a general or global level. The regional distribution illustrates the high relevance of cloud computing for SMEs in emerging and developing countries, while research in North and South America seems to be underrepresented in this context. The distribution of the geographical context of the studies is shown in Figure 2:

The existing literature suggests that cloud computing can have a significant impact on the sustainability of SMEs, particularly regarding the economic dimension. These positive effects on economic sustainability are a central finding of the SLR and are supported by all the studies examined.

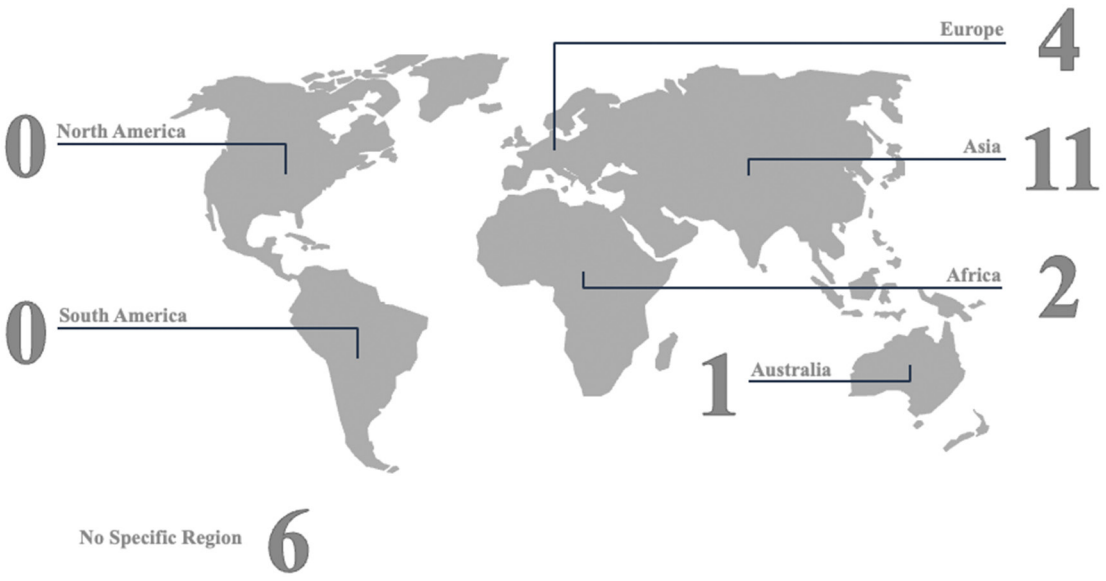

Figure 2. Regional Distribution of Published Papers on the Research Topic
Source: Own research

Several analyzed studies show that the introduction of cloud computing services is associated with a significant reduction in costs, an increase in operational efficiency and an improvement in the competitiveness of SMEs. For example, Al-Mutawa and Mubarak (2023) emphasize that cost reduction, user-friendliness, reliability and the promotion of collaboration in particular are decisive drivers for the sustainable development of SMEs.

Chen (2020) also emphasizes the role of cloud accounting for small and micro enterprises in the context of big data, with a focus on the economic dimension.

The "Function as a Service" (FaaS) model examined by Fahad et al. (2023) also highlights the economic advantages over traditional software development and provision models.

Innovative concepts such as "Everything as a Service" (EaaS), proposed by JosephNg et al. (2016), show how internal resources can be used more efficiently and IT investments optimized through virtualization and grid computing. These approaches make a significant contribution to increasing the flexibility and economic stabilization of SMEs.

Other studies, including the work of Karagozlu et al. (2021) and Khan et al. (2011), also name the economic benefits of cloud-based solutions, whether through cost savings or easier access to business intelligence systems despite limited financial resources.

While many studies primarily address cost-saving effects and productivity increases, Khanyi et al. (2024) also refer to aspects of scalability, risk minimization in the context of cloud-based data networks and APIs.

Regional analyses, such as those by Khouibiri and Farhaoui (2023) on Moroccan SMEs or Korongo et al. (2013) on Kenyan companies, show that cloud computing not only increases local competitiveness but can also provide macroeconomic impetus. In addition to reducing operating costs, increasing efficiency and productivity, increases in turnover, improved competitiveness, and access to new markets are highlighted as key potential benefits.

In China, Li (2017) confirms that the adoption of cloud strategies significantly contributes to cost reduction, improved resource management, and enhanced competitiveness.

Furthermore, the strategic importance of cloud computing for operational agility and scalability is emphasized. Studies such as those by Odukoya (2024) and Uddin et al. (2023) clearly demonstrate that companies that systematically develop their cloud capabilities not only improve their efficiency but also secure their strategic agility and long-term economic sustainability.

Additional sustainability aspects are explored in studies examining hybrid models. Ogunshile (2017) shows that a combination of solar energy and cloud services offers a resource-conserving and cost-efficient alternative for the continuous operation of SMEs.

Syairudin and Nabila (2024) also identify a direct impact on business performance. Based on their findings, the adoption of cloud computing can enhance SME performance, particularly through improved productivity and flexibility.

In further studies, economic sustainability effects emerge as indirect outcomes, as they were not explicitly investigated but merely identified within the context of the overall results.

For example, Attaran and Woods (2018) discuss cloud computing generally as a viable solution for SMEs and confirm that they are adopting this technology to increase their cost and operational efficiency and therefore serve as a competitive advantage, while Ahmad and Mehmood (2015) emphasize the role of cloud technologies as an enabling technology for sustainable enterprise and supply chain systems. Cunha et al. (2018), as well as Kanimozhi Suguna and Nanda Kumar (2019), highlight the combination of cloud computing and IoT as key drivers of sustainable processes in SMEs.

However, these predominantly positive effects on economic sustainability are also accompanied by challenges, which are identified in two studies as barriers.

Research by Machap et al. (2023) examines the obstacles hindering the adoption of IoT and cloud computing technologies within the Malaysian SME sector, finding that limited awareness, cost constraints, and security concerns for the SMEs restrict adoption despite the significant potential for increasing operational efficiency, reducing costs, and expanding market access.

Regional studies, such as that by Vasiljeva et al. (2017) in Latvia, likewise mention the economic benefits associated with the use of cloud computing, but also point to persistent security and privacy concerns as major risks and barriers to adoption.

Only three of the identified studies place a focus on the ecological and social pillars of sustainability as well.

Al-Sharafi et al. (2023) investigate the determinants of cloud computing integration in SMEs and empirically demonstrate that integrating cloud computing services can positively impact not only economic but also ecological and social performance aspects. Examples mentioned in the study are the reduction of energy consumption and the carbon footprint as possible environmental opportunities. Regarding the social dimension of sustainability, the increase in employee satisfaction as well as the increase in public safety was highlighted.

Pathan et al. (2017), alongside economic considerations as the main drivers for cloud adoption among SMEs in Pakistan, indirect ecological benefits such as reduced electricity consumption.

A broader perspective is also provided by the work of Singh et al. (2024), which uses a PEST analysis to examine the effects of cloud computing on various sustainability dimensions and identifies both economic and social benefits, such as cost savings and scalability, as well as job creation and the support of a sustainable future society.

Overall, the literature makes it clear that cloud computing is a key tool for promoting the economic sustainability of SMEs. At the same time, there are regional differences and sector-specific challenges that can influence implementation and the degree of impact.

The study by Vister and David Evans (2017), which examines the role of sustainability in purchasing decisions for cloud services in Norwegian auditing firms, is an important study. Although sustainability was not explicitly mentioned by the respondents as a decision criterion, they reported unintended positive environmental effects, particularly a reduction in paper consumption. This finding could explain and underpin the results of the SLR for the fact that general and economic sustainability benefits of cloud computing for SMEs have primarily been investigated to date, while studies on the ecological or social effects - also in connection with other technologies - have remained comparatively rare.

5. FUTURE RESEARCH DIRECTIONS

The studies examined as part of the SLR represent a broad spectrum of research work from different geographical regions, technological focuses, and methodological approaches. Although their respective results are context-specific, they largely complement each other and provide a consistent overall picture. Without exception, the studies confirm the economic benefits of cloud use for SMEs, particularly in the form of cost savings and increased flexibility. In contrast, ecological and social sustainability effects have only been investigated to a limited extent to date. Contradictory findings could not be identified.

Future research should specifically address these existing gaps.

Firstly, the ecological and social sustainability effects of cloud use by SMEs need to be investigated in much greater depth in future studies, as primarily economic benefits have been identified to date. In this context, the question of how cloud computing as a complementary technology can support other technologies such as artificial intelligence (AI) and edge computing in promoting sustainability practices should also be investigated in greater depth, especially regarding the creation of integrated digital ecosystems that address environmental, economic and social sustainability goals in equal measure.

Second, a geographical imbalance is evident, as much of the research to date has focused on emerging and developing countries, while systematic research in industrialized regions is largely lacking. Further studies are needed to clarify whether cultural, infrastructural or regulatory differences influence the sustainability effects of cloud use.

Thirdly, there is a lack of long-term analyses that capture the effects of cloud adoption over longer periods of time. Many of the findings to date are based on cross-sectional data, which means that potential long-term effects and rebound effects, for example, through increased resource utilization, cannot yet be adequately assessed. Long-term empirical studies are therefore necessary to enable a reliable assessment of the actual sustainability effects.

Fourthly, it remains unclear to what extent potential negative effects of cloud use occur. Only two of the 23 studies analyzed explicitly mention such effects. Future studies should therefore also

systematically investigate potential risks and undesirable side effects in economic, ecological and social terms.

In addition, new technological developments offer numerous starting points for further research. The integration of AI-based optimizations in cloud environments opens up new opportunities for increasing efficiency, although the actual ecological and social implications for SMEs are still largely unclear. Similarly, the impact of "green" cloud initiatives, such as the increased use of renewable energy in data centers, on the sustainability performance of SMEs needs to be further researched.

Finally, future studies should systematically investigate the influence of changing regulatory frameworks on cloud adoption, such as emissions requirements and sustainability reporting obligations. Interdisciplinary long-term studies that consider ecological, economic and social dimensions in an integrative manner and take regional and sector-specific characteristics into account appear particularly promising in this regard. A stronger integration of technology and management research could also provide valuable insights into how emergent technologies and organizational practices jointly shape the sustainability balance of SMEs.

6. CONCLUSION

This SLR examined the research question: "What are the effects of cloud computing adoption on the ecological, economic, and social sustainability of SMEs?".

The results show that cloud computing can make a significant contribution, particularly in terms of economic sustainability. Cost savings, increased operational efficiency and improved competitiveness are key positive effects that are confirmed in almost all the analyzed studies. In addition, two studies point to ecological benefits such as reduced energy consumption and resource savings, although these effects have so far been largely indirect and rarely systematically quantified. The social dimension also remains largely under-researched, meaning that there is a considerable need for research in this area.

Overall, this work covers a broad spectrum of relevant literature from 2011 to 2024 and offers a well-founded overview of current findings at the interface of cloud technologies, SMEs and sustainability.

However, the analysis also reveals existing research gaps: An uneven treatment of the three pillars of sustainability, a geographical focus on Asian countries and a lack of longitudinal studies limits the generalizability of the findings to date.

In conclusion, cloud computing is an important tool for promoting sustainable business practices in SMEs, but its full potential is not yet fully exploited or understood. Future studies should therefore capture environmental and social impacts more systematically, consider different regional contexts and analyze long-term developments to provide a more comprehensive picture of the sustainable transformation of SMEs through cloud technologies.

In summary, this analysis underlines the need for long-term, interdisciplinary and geographically diversified research approaches to gain a sound and holistic understanding of the sustainable transformation of SMEs through cloud computing.

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