

# Exploring Technology-Organization-Environment Research Trends in Small and Medium-sized Enterprises (SMEs): A Scientometric Review

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## **Abstract**

**Purpose:** This study aims to analyze published articles on the Technology-Organization-Environment (TOE) framework in SMEs to identify prominent research areas and the interrelationship among various disciplines.

**Design/methodology/approach:** A substantial corpus of 968 studies published between 1991 and 2022 in Social Science Citation Index (SSCI) and Science Citation Index Expanded (SCIE) journals was collected through a meticulous search on the Web of Science database.

**Findings:** The findings reveal "Sustainability" as the most productive journal, with Oliveira T. emerging as the most prolific author. Notably, Universiti Teknologi Malaysia and Universiti Sains Malaysia are among the leading institutions in this research area. Silhouette scores identify 10 key topic clusters, showcasing strong interconnections among various themes, with scores ranging from 0.632 to 0.994. Furthermore, recent keyword analysis highlights a surge in "computing adoption" research, boasting remarkable strength score of 3.92 over the past four years.

**Research limitations/implications:** The data up to 2022, is possibly missing recent developments. The selection of articles and keywords may introduce some bias, and the exclusion of non-English publications due to language limitations is acknowledged.

**Originality:** This study focuses on identifying and elucidating prominent research areas within the TOE framework. By employing advanced analysis techniques to uncover 10 key clusters of topics and their interconnections, this study not only highlights the diversity of research

themes but also provides a nuanced understanding of how various disciplines intersect within the SME context. This aspect of the study offers a novel perspective that can guide future research and decision-making in academia and industry.

**Keywords:** Document Citation Analysis, Network Analysis, Research Trends, Scientometric Analysis, Small and Medium-size Enterprises (SMEs), TOE Framework

### **Introduction**

The Technology-Organization-Environment (TOE) framework, introduced by Tornatzky et al. (1990), explains innovation adoption at the firm level by considering three main contextual groups: technology, organization, and environment. It reflects the impacts of internal and external factors on adoption decisions. The technology context examines existing and new relevant technologies; the organizational context considers firm characteristics like scope, size, and resources; while the environmental context encompasses industry, competitors, and government aspects. This framework provides a robust tool for understanding innovation adoption in firms.

The adoption of the TOE framework by Small and Medium-sized Enterprises (SMEs) has been observed to lag its adoption by large companies, mainly due to several key factors. Firstly, SMEs often face resource constraints, possessing limited financial and human resources (Galanaki et al., 2015; Iborra et al., 2020; Osei & Zhuang, 2020; Rahayu & Day, 2015; Saffu et al., 2008) compared to larger companies. The implementation of frameworks like TOE requires investments in research, data collection, and analysis, which can be challenging for SMEs operating with tight budgets. Secondly, lack of awareness is a significant issue. Many SMEs may not be fully aware of the existence or benefits of utilizing the TOE framework (Ifinedo, 2011; Mujahed et al., 2022). In contrast, larger companies often have better access to academic resources, industry networks, and consultants, which increases their exposure to and understanding of such frameworks (Rahayu & Day, 2015). Moreover, many SMEs lack the specialized knowledge and skills required to effectively apply the TOE framework. This is in contrast to larger companies that often have dedicated research and development teams, as well as access to external consultants who can help them navigate and implement complex frameworks successfully (Iborra et al., 2020).

The potential future of the TOE framework for SMEs holds significant implications for their competitiveness and growth in the ever-evolving business landscape. Firstly, the structured approach offered by the TOE framework for technology adoption and innovation presents SMEs with a means to effectively integrate new technologies into their operations, thereby fostering innovation within their respective industries (Feibert & Jacobsen, 2019; Nguyen et al., 2022). Secondly, the framework's emphasis on analyzing and responding to the dynamic external environment equips SMEs with the tools to adapt to changing market conditions and regulatory landscapes, facilitating informed decision-making and enhancing their long-term sustainability (Eze et al., 2021; Iborra et al., 2020; Nguyen et al., 2022). Lastly, the TOE framework's potential to promote cross-disciplinary integration allows SMEs to approach challenges and opportunities holistically, encouraging collaboration and networking among stakeholders (Mendoza-Silva, 2021; Mujahed et al., 2022). This can lead to knowledge sharing and strategic partnerships, contributing further to SMEs' resilience and sustainable growth prospects.

Prior studies examining the TOE framework in the context of SMEs have been conducted across various research fields, as evidenced by works from Eze et al. (2021), Gangwar et al. (2015), Gómez et al. (2022), Mahakittikun et al. (2021), Nguyen et al. (2022), Rahayu and Day (2015), Rahman et al. (2022), and Singeh et al. (2020). However, it is worth noting the absence

of a comprehensive global statistical analysis of bibliometric reviews, specifically in the domain of scientometric-based studies concerning the TOE framework's application in SMEs. Scientometric analysis, serving as a visualized statistical approach to scrutinizing published literature, stands as one of the extensively utilized methods for identifying prevailing trends and potential research gaps within a given database. The application of this analysis encompasses diverse software tools such as CiteSpace, VOSviewer, ScientoPia, and HistCite. By employing scientometric analysis, readers are afforded the opportunity to delve into the historical progressions of research endeavors and discern the future directions that research trends may pursue. The research is guided by the following fundamental questions:

1. What are the prevailing publication output trends for applying the TOE framework in SMEs?
2. How does research on the TOE framework for SMEs relate to other research fields in the Web of Science?
3. Which publications and keywords have shown significant impact or bursts of research activity in the domain of the TOE framework for SMEs?
4. What insights can be gained from the content and themes characterizing the primary research trends on applying the TOE framework in SMEs research?

This study aims to explore and understand how the TOE framework is being applied within SMEs, shedding light on important patterns and potential areas of impact. By examining the relationship between technology, organizational dynamics, and the environment in SMEs, this research provides valuable insights for researchers, practitioners, and policymakers involved in supporting and studying small and medium-sized enterprises.

### **Methodology**

A scientometric analysis was conducted on the recent scientific production (i.e., published papers over the last thirty-two years). The research framework used in this study is shown in Figure 1.

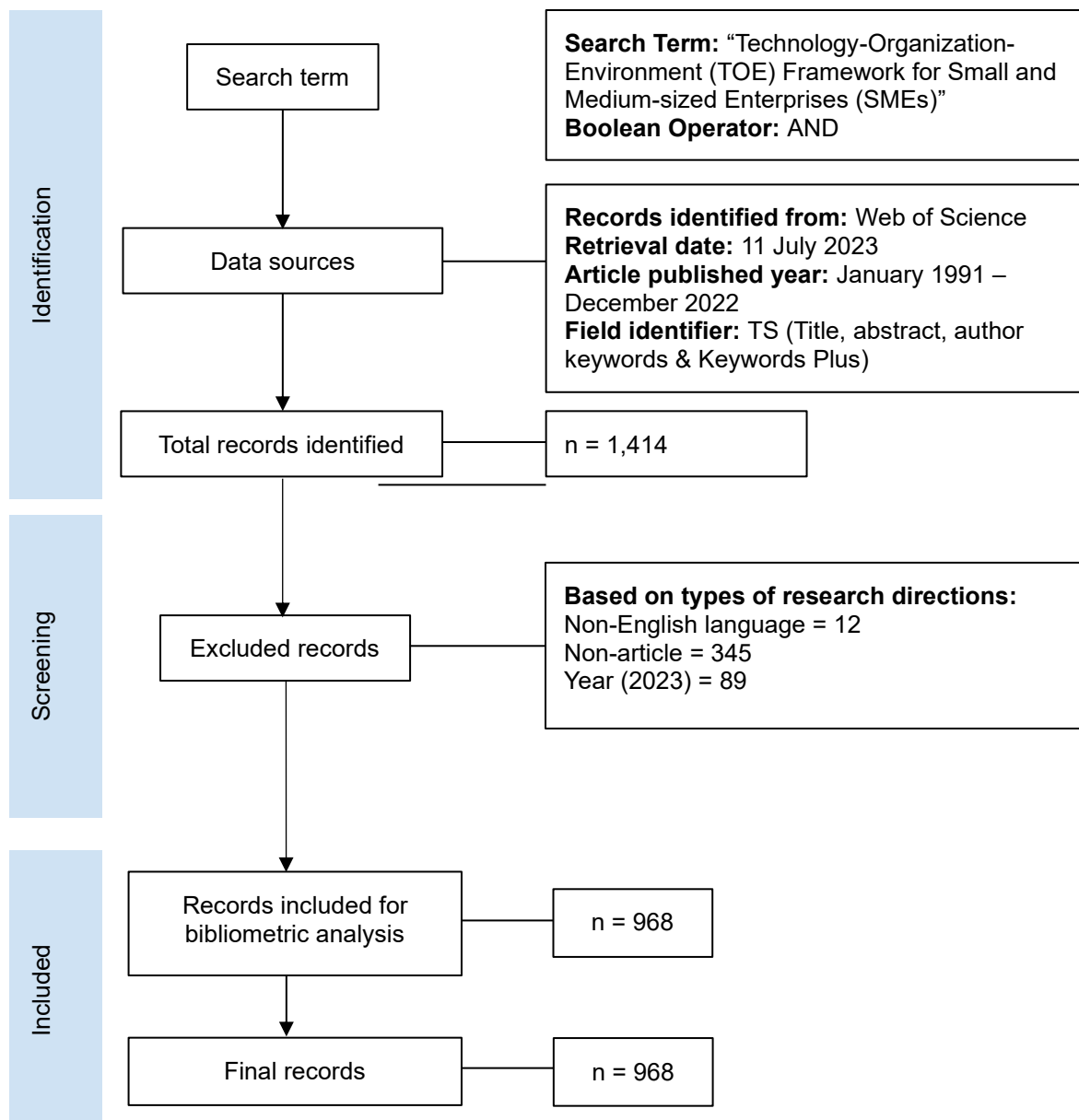


Figure 1: Methodological framework for the current study

### Article Search

The present study drew upon the extensive Web of Science database encompassing a substantial collection of over 22,000 scholarly journals derived from reputable publishers, including prominent entities such as Elsevier, Springer, Wiley, and Taylor and Francis. The utilization of this database facilitated a comprehensive search for articles pertaining to TOE framework for SMEs. To ensure robust coverage of relevant publications, the search action was conducted on 11 July 2023 using selected search term to represent a broad spectrum of TOE framework for SMEs. The keywords had to be in the article’s title, keywords, or abstract to specify the search stream. The Boolean search string used is presented below:

TS= (((("Small Medium Enterprise") Or ("SME") Or ("SMEs") Or ("Entrepreneurship") Or ("Entrepreneur") Or ("Entrepreneurs") Or ("Small Business") Or ("Business") Or ("Businesses") Or ("Start-Up") Or ("Enterprise") Or ("Enterprises") Or ("Venture Capital") Or ("Business Venture") Or (Organization) Or (Organisation) Or (Entrepreneurial) Or

("Entrepreneurial Enterprises") Or ("Self-Employment") Or ("Small Enterprise") Or ("Medium Firm") Or ("Medium Business") Or (Medium Enterprise") Or (Small And Medium-Sized Enterprise") Or ("Small And Medium-Sized Business")) AND (("Technology-Organization-Environment") OR ("Technological-Organizational-Environmental") OR ("TOE") OR ("TOE framework")))

### ***Eligibility/Inclusion Criteria***

Our subsequent analyses exclusively encompassed articles that were published in peer-reviewed journals within the Web of Science database and were authored in the English language.

### ***Exclusion Criteria***

In our research endeavor (Figure 1), we implemented strict criteria for the inclusion of articles in our analysis. Specifically, we excluded any article that did not meet the standards of original research, was not published in an English-language publication, or had not undergone the rigorous process of peer review.

Consequently, we eliminated research materials such as proceedings papers, reviews, book reviews, abstracts, editorial materials, letters, and news articles from our investigation. By applying these criteria, we ensured that our analysis comprised only high-quality, peer-reviewed, and original research articles from reputable academic sources within the domain of interest.

Since we are currently in the year 2023, it might not be possible to obtain a complete dataset for all the articles published within this year. Waiting for the entire year's data to become available and verified can introduce delays in conducting the analysis. Therefore, we also excluded the data for the year 2023.

### ***Data Analysis***

The present study employed CiteSpace, a widely used tool for data mining and visual summarization of research data from the Web of Science. CiteSpace V version 6.2.R4, Advanced, designed for the 64-bit Windows operating system, was utilized along with Microsoft Office Professional Plus 2019, including Excel, for data organization and analysis. CiteSpace is a versatile and widely used analysis tool in various research domains, including bibliometrics (Li et al., 2019, Zupic & Cater, 2015), health care (Li & Lu, 2019), migration studies (Hu et al., 2019) and management (Chen, 2006), supporting its suitability for the data analysis carried out in this research.

Co-citation analysis, a quantitative method for mapping scientific knowledge, was employed to identify research connections and trends on specific topics, research centers, and research links. Co-citation occurs when two sources are frequently cited together in other documents. Papers with more co-citations are considered to be semantically connected. Degree, centrality, and sigma values were used to appraise the quality of variables.

Citation burstiness was employed to identify prominent keywords related to the research area. This technique detects sudden surges in citation frequency for specific articles, represented visually by red rings in the network diagram. Detecting citation bursts offers insights into temporal dynamics and increased scholarly attention surrounding certain articles. This approach helps identify influential contributions and noteworthy topics with significant citation activity.

To address the research questions, descriptive analyses for publication trends, productive authors, top institutions, productive journals, and regional contributions were visualized using Excel. A dual-map overlay displaying inter-domain specialty and specialty trends was used to

link research areas. Additionally, the burstiness metric was utilized to identify influential publications, top keywords, and major research trends. Overall, this analytical approach provides researchers with a deeper understanding of key areas, research focuses, and influential articles that have made notable impacts in scholarly discourse.

## Results

### Descriptive Analysis

#### Publication Trends

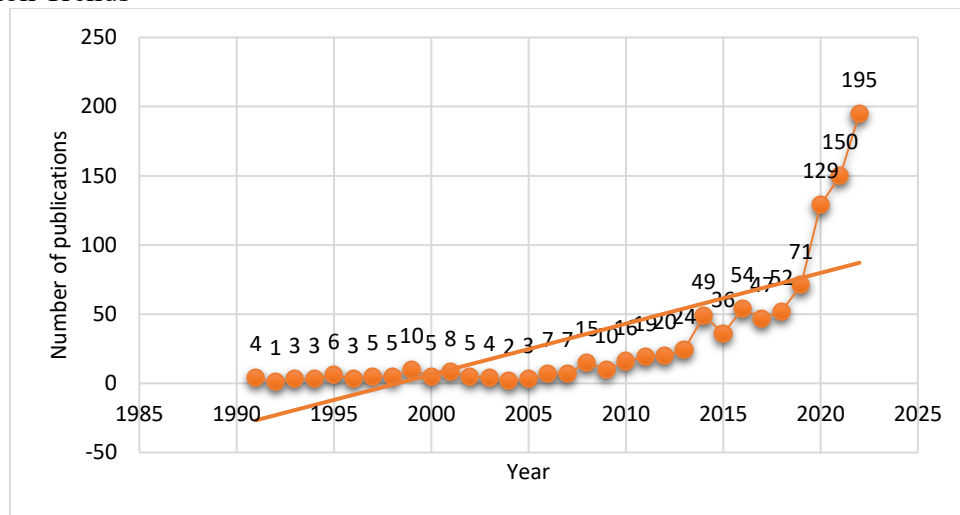


Figure 2: Number of research articles published annually since 1991

Figure 2 displays the number of documents related to TOE framework in the SMEs setting published between 1991 and 2022, sourced from the Web of Science Core Collection database. A total of 968 publications were recorded, with a consistent increase in the number of publications over time. In 1991, only four articles were published and less than 20 publications were recorded until 2011. However, starting in 2012, the number of publications began to rise steadily. The average number of publications per year was 6.71 from 1991 to 2011 and 80.7 from 2012 to 2022. The highest number of articles, 195, was published in 2022. These findings reflect the growing interest and research in the field of TOE framework within the SMEs setting.

#### Productive Journals

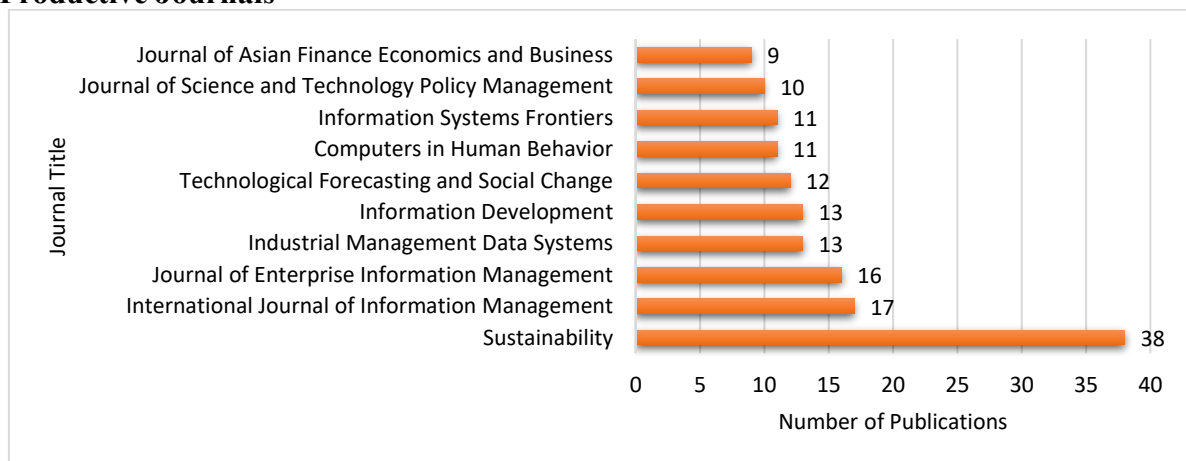


Figure 3: The number of publications published between 1991 and 2022 from the top ten journals

The top 10 journals by number of publications are shown in Figure 3. In total, we identified eligible articles from 493 journals. Among these, Sustainability emerged as the journal with the highest publication count, featuring 38 articles. The International Journal of Information Management secured the second position with 17 articles, while the Journal of Enterprise Information Management claimed the third spot with 16 articles. This ranking showcases the notable contributions of these journals in disseminating research pertaining to the field of TOE framework in the SMEs setting.

### Productive Authors

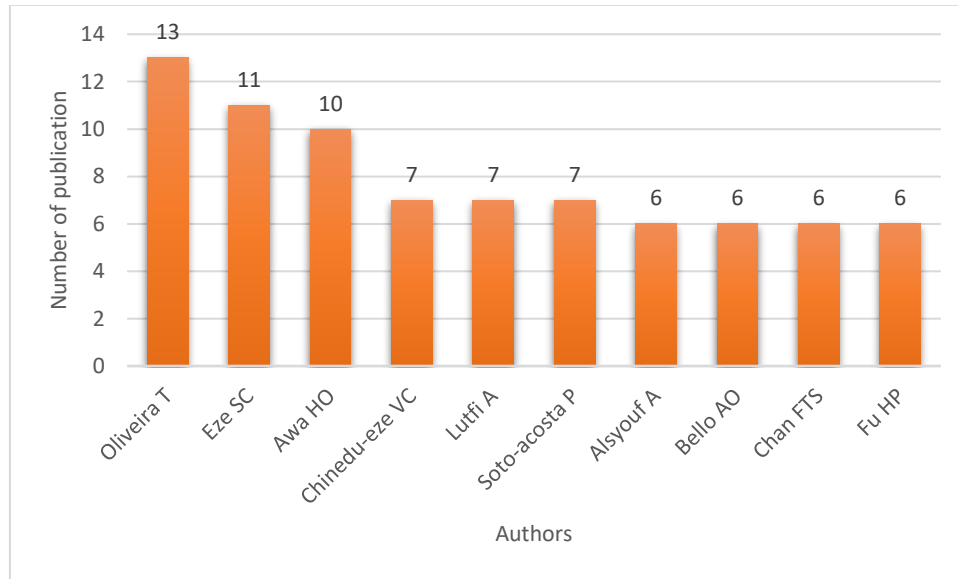


Figure 4: Top ten most productive authors for the period of 1991 to 2022

In Figure 4, we observed the top 10 authors who have made significant contributions to the field of TOE framework in the SMEs setting. From a total of 2,858 authors, a modest proportion of 310 authors (10.8%) have published more than one article in this domain. Topping the list is Oliveira T. who has authored the highest number of publications with 13 articles. Following closely are Eze S. C. and Awa H. O. who have contributed 11 and 10 articles, respectively. These authors have demonstrated a consistent commitment in producing valuable research output in the TOE-SMEs field.

### Highly Cited Publication Journals

Table 1 provides a compilation of the 10 most prominent articles derived from a comprehensive collection of 968 publications obtained from the Web of Science database. Spanning the period from 1991 to 2022, these articles have garnered substantial attention within the academic community. Notably, the article "The Internationalization and Performance of SMEs" authored by Lu and Beamish (2001) and published in the Strategic Management Journal secures the top position. With an impressive citation count of 1168, this article reflects its wide-reaching influence and recognition within the field.

Table 1: Top ten articles published between 1992 and 2022 with more than 300 citations.

Authors	Total Citations	DOI
Lu & Beamish (2001)	1168	10.1002/smj.184.abs
Kuan & Chau (2001)	622	10.1016/S0378-7206(01)00073-8
Oliveira, Thomas & Espadanal (2014)	552	10.1016/j.im.2014.03.006
Zhu, Kraemer & Xu (2003)	524	10.1057/palgrave.ejis.3000475
Pai & Patton (1997)	496	10.1016/S0021-9290(96)00165-0
Roeder, Kokini, Sturgis, Robinson, & Voytik-Harbin (2002)	485	10.1115/1.1449904
Yue & Cole (1992)	418	10.1152/jn.1992.67.5.1114
Zhu, Kraemer, Xu, & Dedrick (2004)	412	10.1080/07421222.2004.11045797
Wang, Wang, & Yang (2014)	402	10.1016/j.techfore.2010.03.006
Pan, Cai, & Quacquarelli, (2016)	367	10.1038/nmeth.3964

The second most cited article, titled "A Perception-Based Model for EDI Adoption in Small Businesses Using a Technology-Organization-Environment Framework" authored by Kuan and Chau (2001) and published in the Information and Management journal, has accumulated 622 citations. Following closely is the article titled "Assessing the Determinants of Cloud Computing Adoption: An Analysis of the Manufacturing and Services Sectors" by Oliveira, Thomas, and Espadanal (2014), which was published in the Information and Management journal and has amassed 552 citations.

### Top Institutions

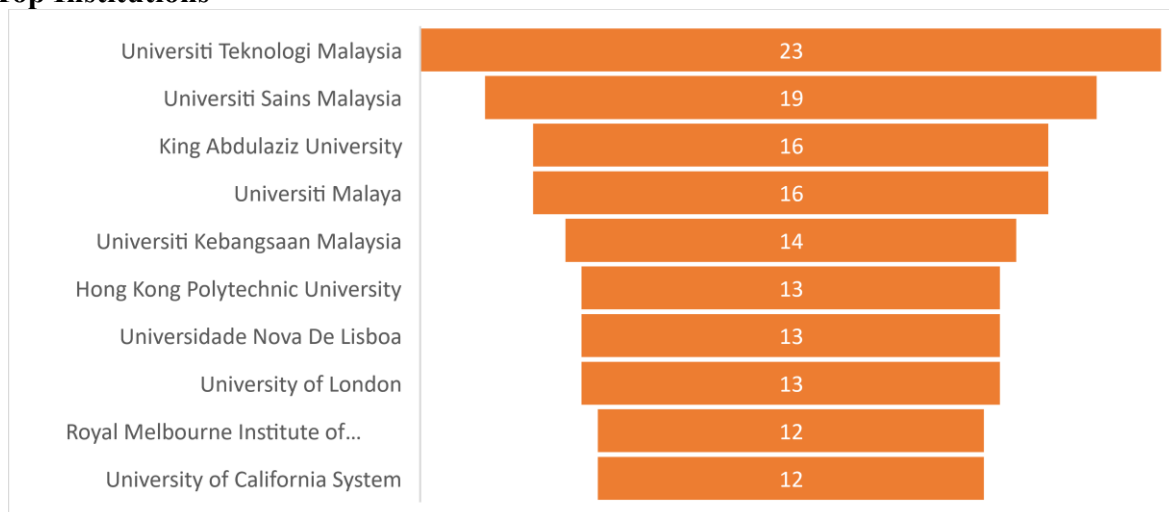


Figure 5: The number of publications from the top ten institutions

Figure 5 presents the ranking of 1320 institutions based on their total number of publications, highlighting the top 10 performers. Notably, the institution that secured the leading position was Universiti Teknologi Malaysia, demonstrating a commendable output of 23 publications. Following closely is Universiti Sains Malaysia, which claimed the second position with a respectable count of 19 publications. Another notable mention is King Abdulaziz University, securing the third rank with a noteworthy contribution of 16 publications.



### Regional Distribution

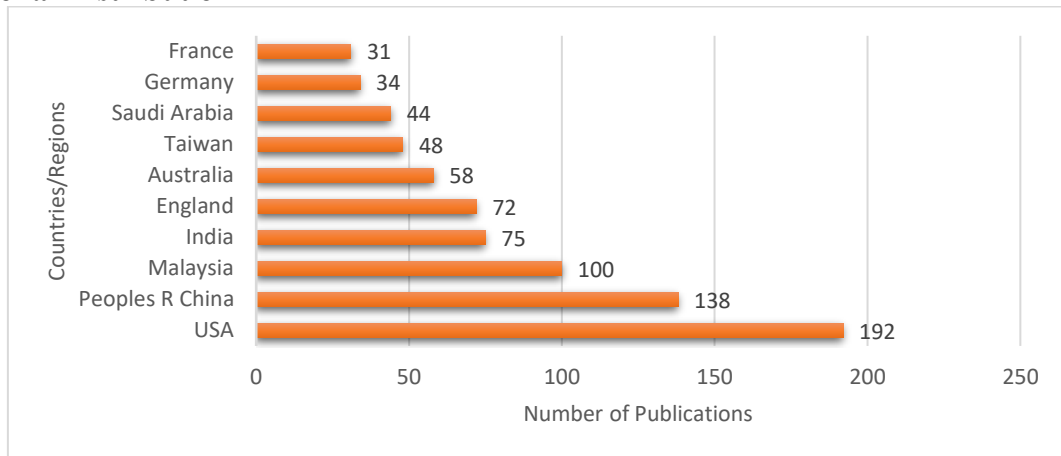


Figure 6: Number of publications published between 1991 and 2022 from the top ten countries/region

Figure 6 depicts the hierarchical arrangement of nations in terms of the dissemination of research on TOE framework in the context of SMEs. Remarkably, the top ten nations collectively contributed 81.8% of the total publications pertaining to this domain, encompassing a vast spectrum of scholarly work across 95 countries. The United States of America (USA) emerged as the frontrunner in this regard, exhibiting the highest volume of 192 publications. Following suit, the People's Republic of China secured the second position with a substantial output of 138 publications, while Malaysia attained the third spot with a noteworthy count of 100 publications.

### Scientometric Analysis

#### Dual-Map Overlay

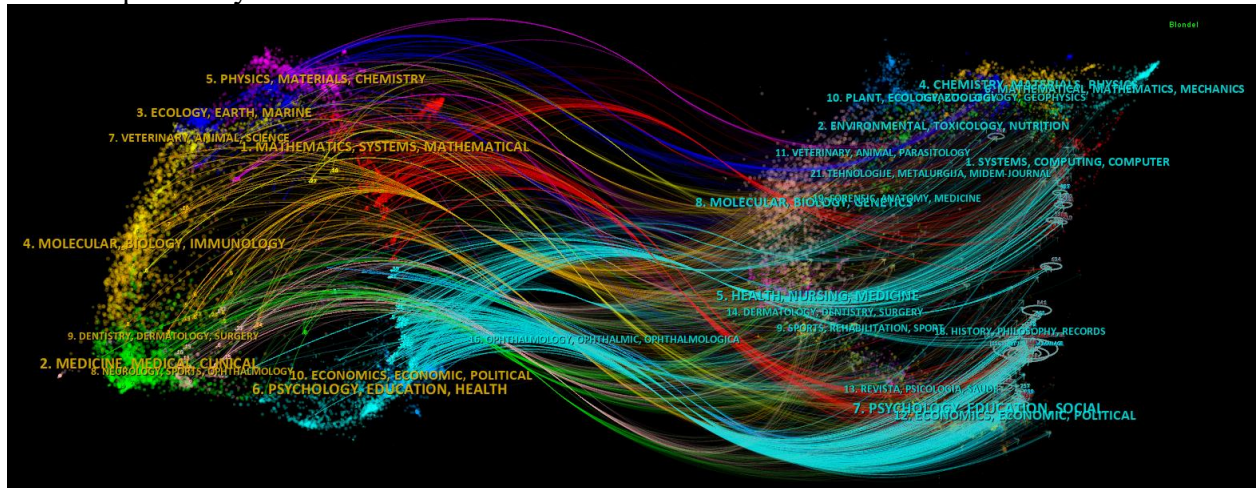


Figure 7: Dual-map overlay on Technology-Organization-Environment and SMEs

Figure 7 presents a dual-map overlay that visually represents the expansive landscape of TOE-related research within the context of SMEs. The left nodes on the map represent individual articles encompassing TOE research in SMEs. Correspondingly, the referenced articles corresponding to these left nodes are displayed on the right side of the map. To visually depict the impact and significance of the articles, the map employs ellipsoids or oval shapes, which reflect the quantities of active citations and specialized journals dedicated to TOE research in

the SMEs setting. The curves observed on the map signify the number of citations received by the articles, with thicker lines indicating a higher volume of citations. Furthermore, the size of the ellipsoids conveys highly active areas within the field of TOE-related research, specifically within the context of SMEs.

The findings of this analysis highlight that the circle of study within TOE focuses on a diverse range of disciplines, including Mathematics, Systems, Economics, Political Science, Psychology, Education, and Health (as depicted in Figure 7). Conversely, the cited articles predominantly encompass fields such as Systems, Computing, Political Science, Health, Nursing, Medicine, History, Philosophy, Education, Psychology, Social Sciences, and Economics. These observations shed light on the interdisciplinary nature of TOE research within the SMEs context and its interconnectedness with various academic disciplines. Overall, Figure 7 provides a comprehensive visual representation of the scholarly landscape in the field of TOE framework in the SMEs setting, facilitating a deeper understanding of the prominent subfields, citation patterns, and interdisciplinary connections within the field.

### Co-Citation Analysis

#### *Author Co-Citation Analysis*

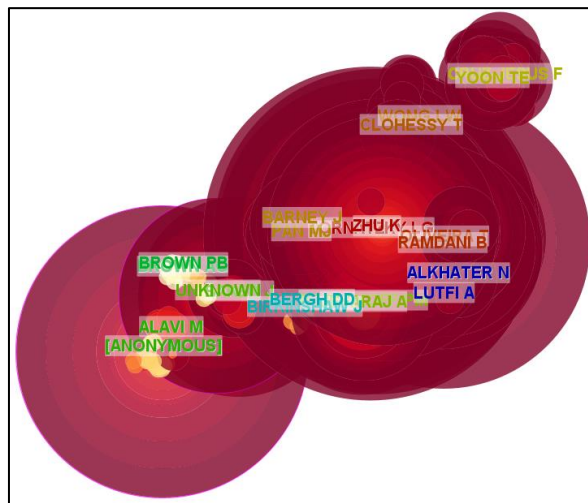


Figure 8: The knowledge maps for the author co-citation analysis

Table 2: Top ten most influential authors in the field of Technology-Organization-Environment and SMEs research based on sigma scores, with the highest at the top.

Authors	Degree	Centrality	Sigma
Chwelos P.	40	0.04	1.52
Grover V.	40	0.04	1.51
Kuan K. K. Y.	35	0.02	1.36
Hong W. Y.	33	0.03	1.32
Cooper R. B.	35	0.03	1.31
Raymond L.	49	0.02	1.29
Fichman R. G.	33	0.02	1.29
Porter M. E.	32	0.05	1.24
Moore G. C.	29	0.04	1.22
Barua A.	55	0.02	1.2

The authors' co-citation network had 1191 nodes, 5777 connections, and a density of 0.0082. Figure 8 and Table 2 show the top 10 authors in the field of TOE framework in SMEs research based on the sigma score. Chwelos P. from the University of British Columbia, USA emerged as the most influential author in this field with a sigma score of 1.52. The second and third influential authors in the field of TOE framework in SMEs research are Grover V. and Kuan K. K. Y. with the sigma scores of 1.51 and 1.36, respectively.

*Journal Co-Citation Analysis*



Figure 9: The knowledge maps for the journal co-citation analysis

Table 3: Top ten journals in Technology-Organization-Environment and SMEs research based on sigma scores

Publication Titles	Degree	Centrality	Sigma
Journal of Neurophysiology	104	0.14	10.84
Science	59	0.21	2.93
Experimental Brain Research	76	0.06	2.88
International Journal of Electronics and Communications	29	0.05	1.96
Nature	52	0.15	1.89
Brain Research	97	0.04	1.75
Journal of Physiology	57	0.06	1.72
The New England Journal of Medicine	20	0.11	1.72
Communications of the ACM	51	0.03	1.52
Academy of Management Journal	48	0.07	1.5

The co-citation network analysis revealed significant insights into the interconnections among academic journals within the field of TOE framework and SMEs research. The network comprises 1,098 nodes that represent distinct journals, with a total of 5,774 connections illustrating the scholarly relationships between these journals. The density of the network was calculated to be 0.0096, indicating a relatively sparse arrangement of connections among the journals.

The Journal of Neurophysiology (ISSN: 0022-3077) emerged as the most prominent and influential journal within the field. This recognition is supported by its highest journal degree

score of 104, signifying the considerable number of co-citations that it shares with other journals. Furthermore, the centrality score of 0.14 underscores the pivotal position of the Journal of Neurophysiology within the network, where it acts as a key intermediary connecting other journals. Remarkably, the sigma score of 10.84 reaffirms its substantial influence and authoritative status in shaping the discourse of TOE framework and SMEs research.

Following closely behind, Science also holds significant influence within the field with a degree score of 59. Its relatively higher centrality score of 0.21 indicates that Science serves as a vital hub, facilitating substantial connections among other journals. Although its sigma score of 2.93 is lower than that of the Journal of Neurophysiology, it nonetheless highlights the notable impact of Science in the academic community.

Lastly, Experimental Brain Research (ISSN: 0014-4819) secured the third position as an influential journal in TOE-SMEs research. With a degree score of 76, this journal establishes a considerable number of co-citations with other journals, contributing to its recognition. While its centrality score of 0.06 indicates a less central role compared to the top two journals, its sigma score of 2.88 still highlights the journal’s substantive influence and valuable contributions to the research domain.

### Document Co-Citation Analysis

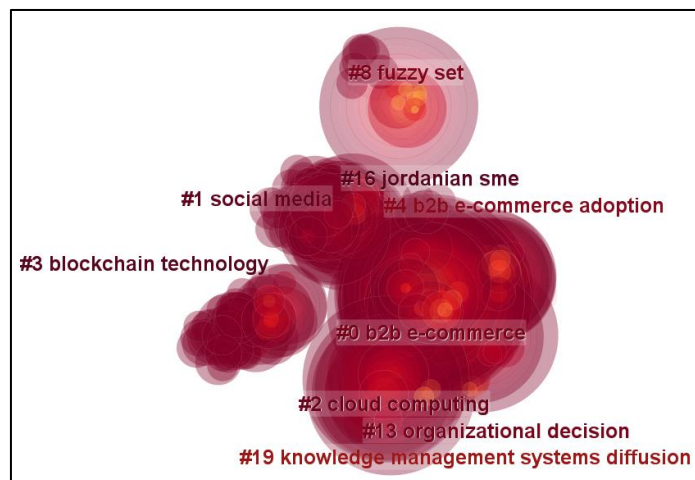


Figure 10: The knowledge maps for the document co-citation analysis

Table 4: Top ten articles in Technology-Organization-Environment and SMEs research based on sigma scores

Labels	Degree	Centrality	Sigma	DOI
Chwelos (2001)	38	0.03	1.37	10.1287/isre.12.3.304.9708
Chau (1997)	39	0.02	1.23	10.2307/249740
Chatterjee (2002)	35	0.02	1.2	10.2307/4132321
Hong (2006)	37	0.02	1.17	10.1016/j.im.2005.06.003
Cooper (1990)	35	0.02	1.17	10.1287/mnsc.36.2.123
Zhu (2004)	35	0.02	1.15	10.1080/07421222.2004.11045797
Teo (2003)	30	0.02	1.14	10.2307/30036518
Grover (1993)	36	0.02	1.13	10.1111/j.1540-5915.1993.tb01295.x
Tornatzky (1990)	25	0.02	1.13	
Grover (1993)	30	0.01	1.11	

Figure 10 presents the results of document co-citation network with 1147 nodes, 5650 connections, and a density of 0.0086. Table 4 illustrates the resulting network diagram, which specifically focuses on articles with sigma scores surpassing 1. From the analysis, 92 articles were selected as their sigma scores met or exceeded the predetermined threshold, signifying their significant impact within the domain of TOE framework and SMEs research. One publication that emerged as the most influential article is “Research Report: Empirical Test of an EDI Adoption Model” authored by Chwelos (2001). This influential work, featured in the Information Systems Research journal, attained a notable sigma score of 1.37. Moreover, it garnered a degree score of 38, indicating a substantial number of co-citations, and a centrality value of 0.03, signifying its pivotal position within the network. Additionally, two other highly influential articles were identified, each with the sigma scores of 1.23 and 1.2, respectively. These articles were published in MIS Quarterly, further emphasizing their significance in the field of the TOE framework and SME research.

### Cluster Analysis

The examination of document clusters yielded noteworthy findings concerning the Modularity Q Index and Mean Silhouette metrics, which displayed values of 0.7224 and 0.7409, respectively. These metrics, surpassing the average thresholds, indicate a high level of reliability and consistency within the network under investigation. The analysis successfully identified and delineated 10 distinct clusters comprising related documents. Figure 11 visually represents these clusters as a horizontal line, accompanied by cluster labels positioned on the right side. The clusters were assigned numbers and arranged in descending order according to their sizes, with the largest cluster designated as #0. The temporal existence of each cluster is represented by a solid yellow line confined within its boundaries. To assign labels to the clusters, a text mining and keyword analysis algorithm within the CiteSpace software was employed, with the labels determined through the utilization of a statistical measure known as log-likelihood ratio (LLR).

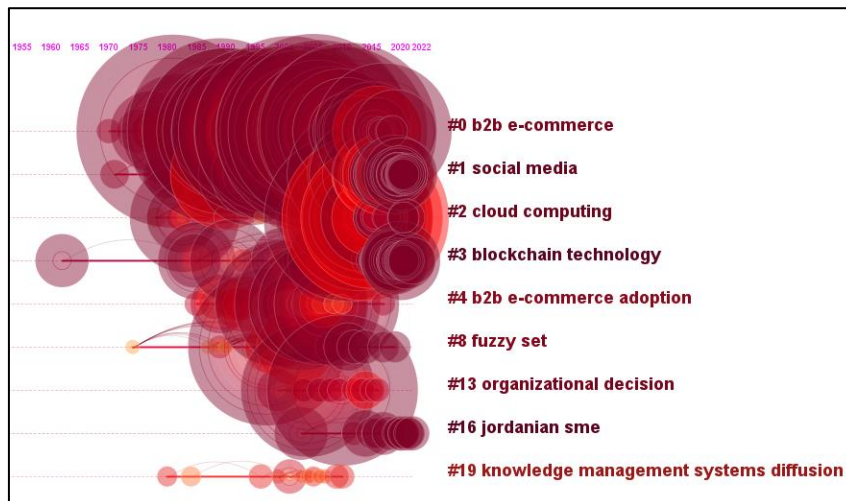


Figure 11: Summary of the identified top 10 document cluster lifetimes (solid lines)

Table 5: Top ten group clusters based on the “Technology-Organization-Environment and SMEs” keyword

Cluster ID	Size	Silhouette	Label (LLR)	Average Year
0	228	0.632	B2B e-commerce	2002
1	203	0.651	Social media	2011
2	75	0.89	Cloud computing	2008
3	63	0.851	Blockchain technology	2012
4	52	0.901	Cloud computing	2001
8	21	0.977	Fuzzy set	1999
13	16	0.99	Organizational decision	2008
16	15	0.959	Jordanian SME	2017
19	14	0.983	Knowledge management systems diffusion	2001
42	4	0.994	Determinant	2003

The most substantial cluster, denoted as Cluster #0, comprises 228 members and exhibits a silhouette value of 0.632. It was characterized by LLR as "b2b e-commerce" while LSI labeled it as "organization-environment framework." Additionally, the fuzzy analytic network process (1.77) by MI is associated with this cluster. A pivotal citing article within this cluster is the work by Awa (2017) titled "Integrated Technology-Organization-Environment (T-O-E) Taxonomies for Technology Adoption" published in the Journal of Enterprise Information Management. Notably, cited members within this cluster include Zhu and Kraemer (2005), Fornell and Larcker (1981), and Kuan (2001).

Cluster #1, the second largest cluster, consists of 203 members and possesses a silhouette value of 0.651. Both LLR and LSI designated this cluster as "social media" while the fuzzy analytic network process (2.45) by MI is also associated with it. The primary citing article for this cluster is Chittipaka's (2022) study titled "Blockchain Technology for Supply Chains Operating in Emerging Markets: An Empirical Examination of Technology-Organization-Environment (Toe) Framework" published in Annals of Operations Research. Highly cited members in this cluster include Ghobakloo (2011), DePietro (1990), and Lin (2014).

The third largest cluster, Cluster #2, comprises 75 members and boasts a silhouette value of 0.89. It is identified as "cloud computing" by both LLR and LSI, with the fuzzy analytic network process (1.33) by MI also associated with it. The major citing article within this cluster aligns with the same work cited in Cluster #1, i.e., "Blockchain Technology for Supply Chains Operating in Emerging Markets: An Empirical Examination of Technology-Organization-Environment (Toe) Framework" from the Annals of Operations Research. Noteworthy, cited members within this cluster include Low (2011), Oliveira (2014), and Alshamaila (2013).

These clusters, distinguished by their member size, semantic associations, and influential citing articles, serve as essential structures for organizing and understanding research trends and knowledge patterns in the respective field of study.

## Burstness Analysis

### Document Burstness Analysis

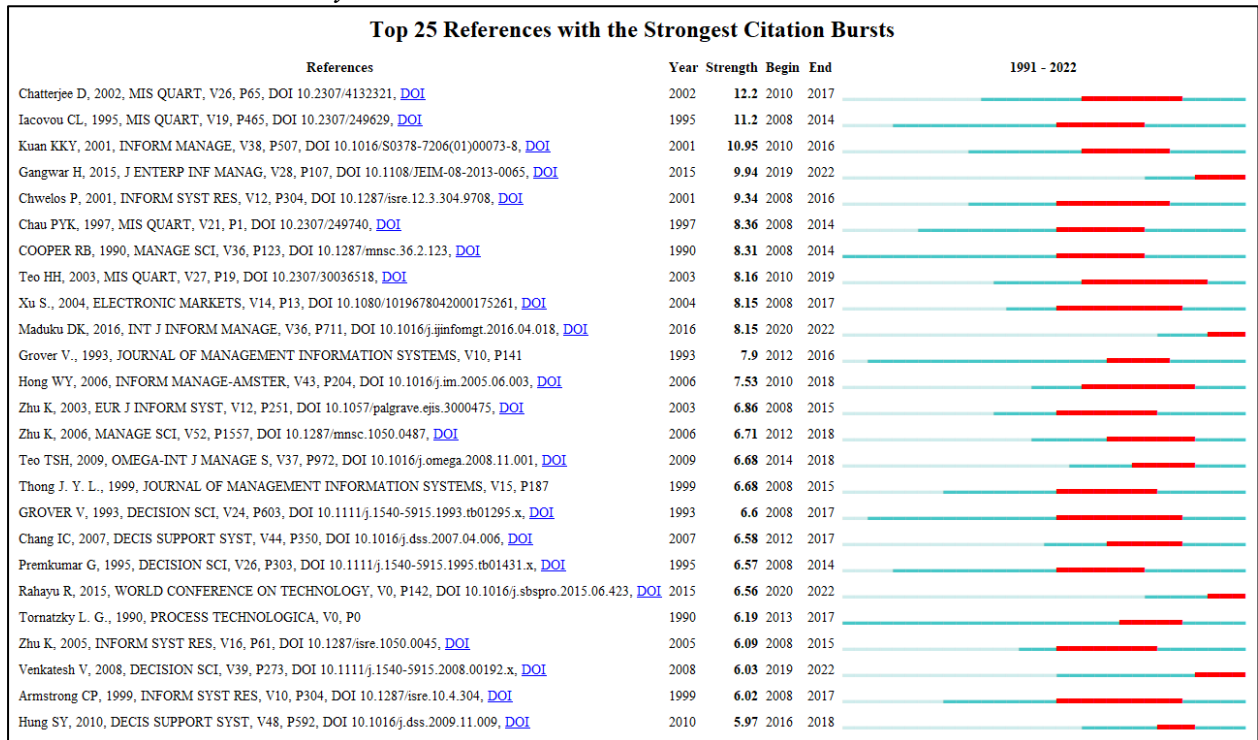


Figure 12: Top 25 references in TOE framework and SMEs research with the strongest citation bursts

Figure 12 provides a valuable snapshot of the ten most influential publications in the research landscape, characterized by their powerful citation bursts and durations. This analysis, spanning from 1991 to 2022, visually showcases the dynamic nature of scholarly discourse over time, with the blue line representing the overall timeline and the red line denoting periods of significant burst activity.

Among these influential publications, four recent articles stand out for their notable impact. The first of these, "Understanding determinants of cloud computing adoption using an integrated TAM-TOE model" by Gangwar et al. (2015), published in the Journal of Enterprise Information Management, exhibited a remarkable burst strength of 9.94. This burst lasted from 2019 to 2022, indicating a sustained and substantial scholarly interest in the integrated model proposed by the authors.

The second article, "Understanding mobile marketing adoption intention by South African SMEs: A multi-perspective framework" authored by Maduku et al. (2016), displayed a strong burst with a strength of 8.15, actively contributing to scholarly discourse from 2020 to 2022. This publication underscores the significance of multi-perspective frameworks in understanding the adoption intentions of SMEs in the context of mobile marketing.

Similarly, the third article, "Determinant Factors of E-commerce Adoption by SMEs in Developing Country: Evidence from Indonesia" by Rahayu and Day (2015), exhibited a burst strength of 6.56 during its active burst period from 2020 to 2022. This research sheds light on the factors influencing e-commerce adoption by SMEs in developing countries, particularly in Indonesia.

Lastly, "Technology Acceptance Model 3 and a Research Agenda on Interventions" by Venkatesh and Bala (2008) displayed a substantial burst strength of 6.03 from 2019 to 2022.

This article has made a notable impact by introducing the Technology Acceptance Model 3 and contributing to discussions on research interventions.

These prominent publications, characterized by their impactful citation bursts, have significantly advanced research in their respective fields. Their ability to attract substantial attention in the academic community during specific timeframes underscores their significance and influence on ongoing scholarly discussions. These articles have not only contributed to the TOE framework but have also shaped the trajectory of research in related areas, making them noteworthy landmarks in the literature.

*Keyword Burstness Analysis*

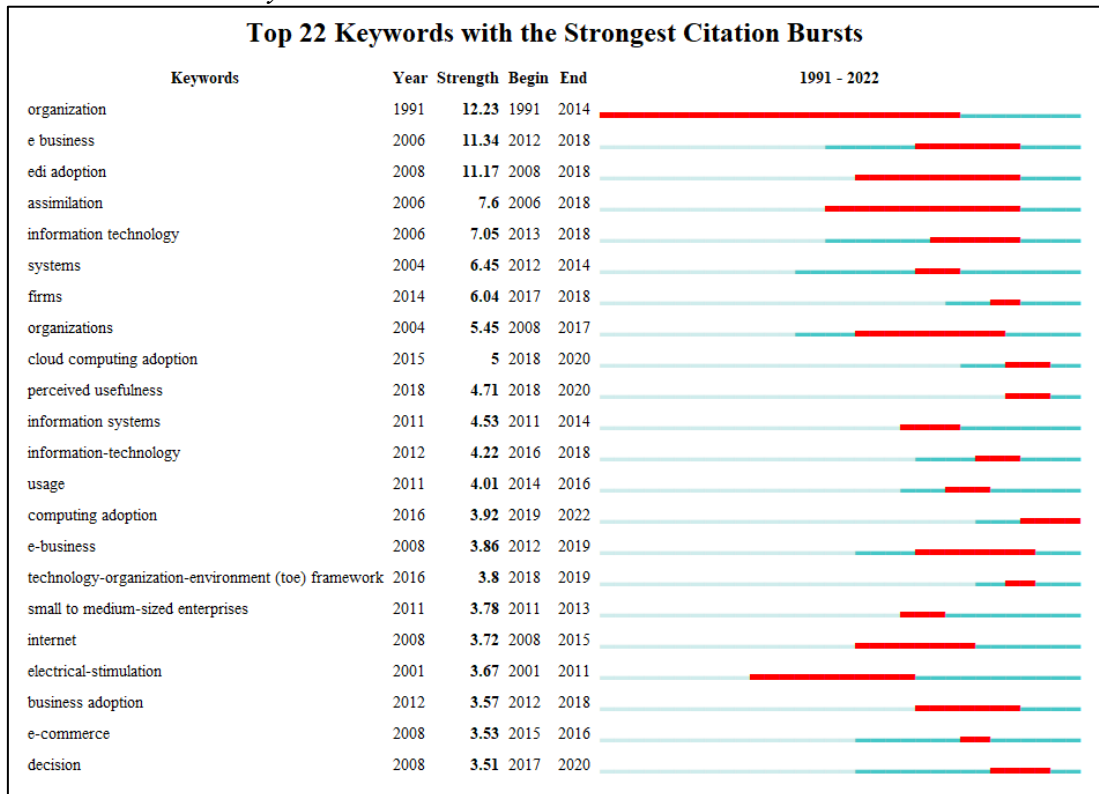


Figure 13: Top 22 keywords in Technology-Organization-Environment and SMEs research with the strongest citation bursts

Figure 13 provides an insightful visualization of the research timeline spanning from 1991 to 2022, with a blue line representing the overall duration and a red line indicating periods of pronounced burstiness. The burst analysis conducted in this study has yielded valuable insights into significant studies and keywords, shedding light on evolving research trends.

One noteworthy finding is the prominent role of the term "organization" in the earlier phase of the timeline, with a strong burst strength of 12.23 observed from 1991 to 2014. This extended period of burst activity signifies a sustained scholarly interest in examining the organizational aspects within the Technology-Organization-Environment (TOE) framework. It suggests that during this time frame, researchers were particularly focused on understanding how organizational factors intersected with technology and the environment in the context of SMEs. In contrast, the recent burst strength of "computing adoption" at 3.92, observed between 2019 and 2022, indicates a surge in research activity and heightened scholarly attention during this specific period. This shift in focus highlights the contemporary relevance of the adoption of computing technologies within SMEs. Researchers are evidently recognizing the increasing



importance of studying how SMEs embrace and leverage computing technologies in response to evolving technological landscapes and market dynamics.

Overall, the burst analysis not only identifies these key shifts in research focus but also underscores the dynamic nature of the TOE framework within SMEs. It demonstrates how research priorities have evolved over time, with a historical emphasis on organizational aspects giving way to a contemporary exploration of computing adoption. These findings provide valuable insights into the changing landscape of SME research and offer researchers and practitioners guidance on where to direct their efforts in the future.

### **Discussion**

The analysis revealed three significant clusters, each characterized by distinct themes and influential publications. The identified clusters encompass themes of "b2b e-commerce", "social media", and "cloud computing", each comprising prominent publications that have significantly impacted the scholarly discourse in their respective fields. These findings provide valuable insights into the underlying patterns and influential works within the studied domain, contributing to a deeper understanding of the evolving trends and dynamics in the literature from 1991 to 2022.

Findings from the document burstness analysis shed light on the most impactful publications and their periods of heightened attention, providing valuable insights into the temporal dynamics and research trends within the studied domain from 1991 to 2022. The identified articles have contributed significantly to scholarly discourse and hold particular significance in the field's development and knowledge dissemination. Moreover, the keywords burstness analysis highlights key shifts in research focus over time, emphasizing the evolving trends and areas of scholarly interest within the studied domain. These findings offer valuable insights into the changing landscape of research and the emergence of significant topics within the field from 1991 to 2022.

The above findings also revealed several potential research areas that are highly relevant to the topic of TOE frameworks in the SMEs setting. Firstly, the investigation of how the TOE framework can contribute to SMEs' resilience and adaptability in the face of multifaceted challenges warrants scholarly attention. SMEs often encounter a myriad of uncertainties, ranging from economic fluctuations and market volatilities to unforeseen disruptions, such as pandemics or natural disasters. The TOE framework offers a comprehensive lens to comprehend the interplay between technological advancements, organizational dynamics, and external environmental factors, thereby elucidating mechanisms through which SMEs can enhance their resilience. Examining the association between SMEs' adoption of innovative technologies with their ability to adapt and withstand turbulent circumstances will allow researchers to provide valuable insights for both academia and practice.

Moreover, the exploration of how the TOE framework can serve as a guiding framework for SMEs' digital transformation endeavors holds significant scholarly merit. Digital transformation is a strategic imperative for SMEs to remain competitive in the fast-paced and technology-driven business landscape. Understanding the interactions between technological innovations, organizational dynamics, and external factors is essential to comprehend the challenges and opportunities faced by SMEs during their digitalization journey. Researchers can undertake empirical studies to identify the critical technological capabilities that SMEs need to develop and the organizational changes required to facilitate successful digital transformation.

Lastly, investigating e-commerce adoption in developing countries is essential to understand how SMEs leverage digital technologies for growth. Future research may compare adoption factors and challenges in several developing nations. Comparative studies across diverse

contexts can reveal commonalities and disparities, considering regulatory frameworks, infrastructure, digital literacy, and cultural attitudes. Tailored policy recommendations can emerge from identifying successful strategies and addressing barriers. Such research provides valuable insights to support SMEs in harnessing e-commerce for sustainable growth and economic development in the developing world.

### **Conclusion**

In conclusion, research on the TOE framework in SMEs holds significant importance in fostering technology adoption, enhancing competitiveness, addressing challenges, and promoting innovation. This study aimed to analyze published articles in the field, identify key research areas, and explore their interrelationships.

The findings have led to the proposition of several promising research areas for future exploration. These include investigating the integration of TOE frameworks with emerging e-commerce trends, harnessing social media adoption within the TOE framework, examining the implications of cloud computing adoption in SMEs, exploring computing adoption in the context of sustainable technology practices, and enhancing the implementation of TOE frameworks in SMEs.

Despite the valuable insights gained, it is essential to acknowledge certain limitations in the research process. The analysis was confined to data available up to 2022, potentially missing recent developments in the field. Additionally, the selection of articles and keywords might have introduced some bias, and language limitations may have excluded non-English publications.

Recognizing these constraints will facilitate further research to advance the understanding and application of the TOE framework in the SMEs setting. By exploring these identified areas and addressing the limitations, researchers can contribute to the growth and competitiveness of SMEs in the technology-driven business landscape.

### **Supplementary Materials**

[https://www-webofscience-com.ezaccess.library.uitm.edu.my/wos/woscc/summary/9380264b-4028-48d0-bad2-6ef0757d5222-9713960e/relevance/1\(overlay:export/exp\)](https://www-webofscience-com.ezaccess.library.uitm.edu.my/wos/woscc/summary/9380264b-4028-48d0-bad2-6ef0757d5222-9713960e/relevance/1(overlay:export/exp))

### **References**

- Alshamaila, Y., Papagiannidis, S. and Li, F. (2013), "Cloud computing adoption by SMEs in the northeast of England: A multi-perspective framework", *Journal of Enterprise Information Management*, 26 (3), pp. 250-275. <https://doi.org/10.1108/17410391311325225>
- Awa, H.O. (2017) Integrated technology-organization-environment (T-O-E) taxonomies for technology adoption. *Journal of Enterprise Information Management*, 30, 29 <http://doi.org.10.1108/JEIM-032016-0079>.
- Chatterjee, D., Grewal, R., & Sambamurthy, V. (2002). Shaping up for e-commerce: Institutional enablers of the organizational assimilation of web technologies. *MIS Quarterly*, 26(2), 65–89. <https://doi.org/10.2307/4132321>
- Chau, P. Y. K., & Tam, K. Y. (1997). Factors affecting the adoption of open systems: An exploratory study. *MIS Quarterly*, 21(1), 1–24. <https://doi.org/10.2307/249740>
- Chen, C. (2006). CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. *Journal of the American Society for Information Science and Technology*, 57(3), 359-377.

- Chittipaka, V (2022) “Blockchain technology for supply chains operating in emerging markets: an empirical examination of technology-organization-environment (TOE) framework”. *Annals of Operations Research*. <http://doi.org.10.1007/S10479-022-04801-5>.
- Chwelos, P., Benbasat, I., Dexter, A.S. (2001) Research report: empirical test of an EDI adoption model. *Information Systems Research*. 12(3), 304-321. <https://doi.org/10.1287/isre.12.3.304.9708>
- DePietro, R., Wiarda, E., and Fleisher, M. (1990) “The context for change: Organization, technology and environment: The processes of technological innovation”, in Tornatzky, L. G. and Fleischer, M. (eds.), Lexington Books: Massachusetts, U.S. A. p.151–175.
- Eze, S. C., Chinedu-Eze, V. C., & Bello, A. O. (2021). Some antecedent factors that shape SMEs adoption of social media marketing applications: a hybrid approach. *Journal of Science and Technology Policy Management*, 12(1), 41–61. <https://doi.org/10.1108/JSTPM-06-2019-0063>
- Feibert, D. C., & Jacobsen, P. (2019). Factors impacting technology adoption in hospital bed logistics. *International Journal of Logistics Management*, 30(1), 195–230. <https://doi.org/10.1108/IJLM-02-2017-0043>
- Fornell, C. Larcker, D.F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*. 18, 39-50. <http://doi.org.10.2307/3151312>.
- Galanaki, E., Papalexandris, N., Halikias, J., Galanaki, E., Papalexandris, N., Halikias, J., Burke, S., Collins, K. M., Brandt, T., & Laiho, M. (2015). A gendered lens on entrepreneurship: women entrepreneurship in Turkey. *Gender in Management: An International Journal*, 30(4), 312–331.
- Gangwar, H., Date, H., & Ramaswamy, R. (2015). Understanding determinants of cloud computing adoption using an integrated TAM-TOE model. *Journal of Enterprise Information Management*, 28(1), 107–130. <https://doi.org/10.1108/JEIM-08-2013-0065>.
- Ghobakhloo, M., Arias-Aranda, D. and Benitez-Amado, J. (2011), Adoption of e-commerce applications in SMEs. *Industrial Management & Data Systems*, 111(8), 1238-1269. <https://doi.org/10.1108/02635571111170785>.
- Gómez, J., Salazar, I., & Vargas, P. (2022). Production outsourcing, technological cooperation and E-business adoption by Spanish manufacturing firms. *Journal of Engineering and Technology Management - JET-M*, 63(May 2020), 0–2. <https://doi.org/10.1016/j.jengtecman.2022.101677>
- Hu, X., Rousseau, R., & Chen, J. (2019). Emigration of Chinese scientists: Case of the United States. *Journal of Informetrics*, 13(4), 1141-1153.
- Iborra, M., Safón, V., & Dolz, C. (2020). What explains the resilience of SMEs? Ambidexterity capability and strategic consistency. *Long Range Planning*, 53(6), 101947. <https://doi.org/10.1016/j.lrp.2019.101947>
- Ifinedo, P. (2011). Internet/e-business technologies acceptance in Canada’s SMEs: an exploratory investigation. *Internet Research*. 21(3). <https://doi.org/10.1108/10662241111139309>
- Kuan, K.K.Y, Chau, P.Y.K. (2001). A perception-based model for EDI adoption in small businesses using a technology-organization-environment framework. *Information and Management*. 38, 507–521. <https://doi.org/10.1016/S0378->
- Li, J., & Lu, X. (2019). Mapping the landscape of artificial intelligence applications in diabetes research. *Diabetes Research and Clinical Practice*, 149, 15-25.
- Li, J., Li, X., Qian, S., & Xie, F. (2019). Mapping the knowledge structure and trends of big data research in healthcare: A bibliometric analysis. *PeerJ*, 7, e5997.

- Lin, H.F. (2014). Understanding the determinants of electronic supply chain management system adoption: Using the technology–organization–environment framework. *Technological Forecasting and Social Change*.  
<https://doi.org/10.1016/j.techfore.2013.09.001>
- Low, C., Chen, Y. and Wu, M. (2011). Understanding the determinants of cloud computing adoption, *Industrial Management & Data Systems*, 111 (7), 1006-1023.  
<https://doi.org/10.1108/02635571111161262>
- Maduku, D.K., Mpinganjira, M., Duh, H. (2016). Understanding mobile marketing adoption intention by South African SMEs: A multi-perspective framework. *International Journal of Information Management*, 36(5), 711-723.  
<https://doi.org/10.1016/j.ijinfomgt.2016.04.018>
- Mahakittikun, T., Suntrayuth, S., & Bhatiasevi, V. (2021). The impact of technological-organizational-environmental (TOE) factors on firm performance: merchant’s perspective of mobile payment from Thailand’s retail and service firms. *Journal of Asia Business Studies*, 15(2), 359–383. <https://doi.org/10.1108/JABS-01-2020-0012>
- Mendoza-Silva, A. (2021). Innovation capability: A sociometric approach. *Social Networks*, 64, 72–82. <https://doi.org/10.1016/j.socnet.2020.08.004>
- Mujahed, H. M. H., Musa Ahmed, E., & Samikon, S. A. (2022). Factors influencing Palestinian small and medium enterprises intention to adopt mobile banking. *Journal of Science and Technology Policy Management*, 13(3), 561–584. <https://doi.org/10.1108/JSTPM-05-2020-0090>
- Nguyen, T. H., Le, X. C., & Vu, T. H. L. (2022). An extended technology-organization-environment (TOE) framework for online retailing utilization in digital transformation: empirical evidence from Vietnam. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(4), 200. <https://doi.org/10.3390/joitmc8040200>
- Oliveira, T., Thomas, M., Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: an analysis of the manufacturing and services sectors. *Information and Management*. 51(5), 497–510.  
<https://doi.org/10.1016/j.im.2014.03.006>
- Osei, C. D., & Zhuang, J. (2020). Rural poverty alleviation strategies and social capital link: the mediation role of women entrepreneurship and social innovation. *SAGE Open*, 10(2).  
<https://doi.org/10.1177/2158244020925504>
- Rahayu, R., & Day, J. (2015). Determinant factors of e-commerce adoption by SMEs in developing country: evidence from Indonesia. *Procedia - Social and Behavioral Sciences*, 195, 142–150. <https://doi.org/10.1016/j.sbspro.2015.06.423>
- Rahman, M., Ismail, I., Bahri, S., & Rahman, M. K. (2022). An empirical analysis of cashless payment systems for business transactions. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(4), 213. <https://doi.org/10.3390/joitmc8040213>
- Saffu, K., Walker, J. H., & Hinson, R. (2008). Strategic value and electronic commerce adoption among small and medium-sized enterprises in a transitional economy. *Journal of Business and Industrial Marketing*, 23(6), 395–404.  
<https://doi.org/10.1108/08858620810894445>
- Singeh, F. W., Abrizah, A., & Kiran, K. (2020). Bringing the digital library success factors into the realm of the technology-organization-environment framework. *Electronic Library*, 38(3), 659–675. <https://doi.org/10.1108/EL-08-2019-0187>
- Tornatzky, L.G.M.; Tchell, F.; Alok, K.C. *The Process of Technological Innovation*; Lexington Books; The Free Press: Cochranton, PA, USA, 1990

- Venkatesh, V., Bala, H. (2008). Technology Acceptance Model 3 and a research agenda on interventions. *Decision Sciences*, 39(2), 273-315. <https://doi.org/10.1111/j.15405915.2008.00192.x>
- Zhu, K., Kraemer, K.L. (2005). Post-adoption variations in usage and value of e-business by organizations: cross-country evidence from the retail industry. *Information Systems Research*, 16(1) 61-84. <https://doi.org/10.1287/isre.1050.0045>
- Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, 18(3), 429-472.