

Technological Capability, Micro-Enterprises?: A Bibliometric Analysis

Zulkieflimansyah¹, Muammar Khadafie² and Dzulfikar Ahmad Furqon³

Abstract

This study analyzed the growth of research publications concerning technological capabilities in micro-enterprises. Bibliometric analysis was conducted on 122 articles from the Scopus citation index. The analysis revealed a shift in the current literature towards examining the impact of technological capabilities on micro-enterprises. This suggests an increasing scientific interest in this area, despite the limited number of studies available. Additionally, the findings highlight untapped potential for researchers to further explore technological capabilities in micro-enterprises, including their applications and impact on business outcomes, indicating ongoing progress in the field. The study also identifies a gap in comprehensive research on technological capabilities in micro-enterprises, offering an opportunity for future researchers to contribute new insights.

Keywords: *Technological Capability, Micro-Enterprises*

INTRODUCTION

Technological capability encompasses a diverse array of elements: active principles, knowledge, experiences, structures, and institutional connections. These components are crucial for initiating and managing technological change processes (Fagerberg et al., 2010). This capability manifests in the ability to outperform competitors in transformation processes (Coombs & III, 2006), and in the capacity to choose, incorporate, modify, or develop new technologies, processes, and products (Ahmad et al., 2014). Given its significance, technological capability has emerged as a strategic tool for both nations (Dutrénit et al., 2018) and businesses (Tsai, 2004) in their pursuit of competitive advantage. It serves as a catalyst for innovation (Verona, 1999), leading to the creation of products and services that offer enhanced value to consumers in the market. In essence, technological capability is a multifaceted concept that drives progress, fosters competitiveness, and fuels innovation across various levels of economic and industrial landscapes.

The accumulation of technological capability can occur through various means, particularly in the context of developing nations. Two primary approaches have been identified: the importation of technology (Kim, 1980) and technological learning (Lall, 1992). While these methods necessitate distinct strategies, they share a common thread in their connection to learning processes, knowledge accumulation, and established routines (Lestari & Ardianti, 2019). These approaches are particularly relevant for firms in developing countries as they strive to enhance their technological prowess (M[^]onica Fitz-Oliveira, 2022) and (Adomako et al., 2022). Whether through technology importation or indigenous learning, the ultimate goal remains the same: to foster technological development and improve competitive standing in the global marketplace. This perspective underscores the importance of adaptable strategies in building technological capabilities, recognizing that different paths can lead to similar outcomes in terms of technological advancement and economic growth for developing nations and their enterprises.

The relationship between technological capability and performance has been a subject of investigation across various contexts. Research has explored this connection in both developed and developing nations, providing insights into how these variables interact in different economic environments. In the context of

¹ Sumbawa University of Technology, Innovation Management study programme , Olat Maras Sumbawa, West Nusa Tenggara, Indonesia E-mail: zulkieflimansyah@uts.ac.id

²Sumbawa University of Technology, Communication Sciences study programme, Olat Maras Sumbawa, West Nusa Tenggara, Indonesia E-mail: muammar.khadafie@uts.ac.id

³Sumbawa University of Technology, entrepreneurship study programme, Olat Maras Sumbawa, West Nusa Tenggara, Indonesia, E-mail: dzulfikar.ahmad.furqon@uts.ac.id

developed countries, studies such as those by (Ruiz Ortega, 2010) and (Hsu et al., 2014) have examined this relationship, offering valuable perspectives on how technological capabilities influence performance in advanced economies. Similarly, research focused on developing countries, including works by (Bag et al., 2020) and (Reichert & Zawislak, 2014), has also contributed to this field of study. Notably, both sets of studies - those in developed and developing nations - suggest a positive correlation between technological capability and performance. However, it's important to note that the primary focus of the current study is on developing countries. As such, the literature review and theoretical framework lean more heavily towards research that specifically examines the interplay between technological capability and performance within the context of emerging economies. This targeted approach allows for a more nuanced understanding of how technological capabilities impact performance in environments where resources and technological infrastructure may be less advanced or readily available compared to developed nations.

Technological capability serves as a catalyst for innovation, which in turn propels productivity growth. This chain reaction underscores the importance for nations, particularly developing ones, to prioritize the accumulation of technological capabilities within their business sectors to enhance competitiveness, productivity, and overall economic growth. In the context of developing countries, industry reports have highlighted a noteworthy trend: micro, small, and medium sized enterprises (MSMEs) are demonstrating innovative practices. This collective innovation indicates the presence of certain levels of technological capabilities within these smaller business entities (Sobanke et al., 2014). The process of industrialization is fundamentally driven by the development of technological capabilities. These capabilities play a crucial strategic role in fostering competitiveness not just at the firm level, but also across entire industries and countries. With the advent of the digital age, a new dimension has been added to technological capabilities. The proliferation of digitally enabled technologies has shifted the focus towards specific abilities. These include the capacity to search for, recognize, develop, adopt, modify, and disseminate new technologies. Such skills are becoming increasingly critical, particularly in the service industry, as highlighted by recent research (Qiu et al., 2022). This evolving landscape emphasizes the need for businesses and nations, especially in developing economies, to continuously adapt and enhance their technological capabilities to remain competitive in the global market.

The development of technological capabilities in micro enterprises is emerging as a crucial factor driving economic advancement in developing nations. This phenomenon opens up new avenues for economic growth and injects vitality into markets (Dey et al., 2020). The adoption of advanced technologies empowers countries to compete on a global scale (L. rong Wu & Chen, 2023). Cutting edge technologies, particularly in the high-tech sector, are reshaping the economic landscapes of nations. High-tech industries play a pivotal role in industrial restructuring and economic transformation (Pham et al., 2021). Their growth is essential for countries aiming to overcome the middle-income trap and establish themselves as modern, powerful economies. The participation of high-tech industries in global value chains (GVCs) significantly influences a country's international standing. Consequently, many regions are strategically focusing on accelerating industrial development towards the middle and high-end segments of GVCs (Tu et al., 2023). This shift underscores the increasing importance of technological capabilities and high-tech industries in shaping economic competitiveness and global positioning, particularly for developing nations seeking to advance their economic status and influence on the world stage.

Since the 1980s, the research landscape on technological capability in developing countries has expanded to encompass various new approaches. These include studies focusing on technological capability in relation to: (1) Technological change (Figueiredo, 2016), (Jian & Hongxia, 2023). (2) Technological innovation (Capozza & Divella, 2018), (Fitz-Oliveira & Tello-Gamarra, 2022), (Coombs & III, 2006). (3) Firm performance (Lestari & Ardianti, 2019). These diverse research streams underscore the growing recognition of technological capability as a crucial factor in enhancing the competitiveness and sustainability of businesses, particularly in the small business sector facing global market competition (Wang et al., 2023). However, the full potential of technological capabilities is yet to be realized in many contexts. This underutilization can be attributed to several factors, with suboptimal technology transfer being a significant barrier. Moreover, there's a notable gap in recent research: studies examining technological capabilities

specifically in the context of micro enterprises have been relatively scarce over the past five years. This highlights an area ripe for further investigation, given the importance of micro enterprises in many developing economies and the potential impact of improved technological capabilities on their performance and growth. This evolving research landscape reflects the complex and multifaceted nature of technological capability, its varied applications, and the ongoing challenges in fully leveraging its potential, particularly in smaller business entities in developing countries.

To advance the understanding of technological capabilities in micro enterprises, this paper employs a comprehensive and objective approach through bibliometric analyses. This method utilizes scientific mapping to illustrate the intellectual landscape and dynamic themes within this research domain (Cobo et al., 2011). Bibliometric analysis offers a quantitative and objective way to analyze and visualize the interconnections among various elements such as documents, cited references, keywords, and authors (Zupic & Čater, 2015). By examining citation data, this approach allows researchers to identify the relative influence of different documents and how they are linked and grouped in networks. This methodology is particularly valuable in revealing the underlying knowledge base and "invisible colleges" within the field of technological capabilities related to micro-enterprises (Vogel et al., 2021). While bibliometric reviews do involve some subjective critical evaluation of key content, this evaluation is primarily guided by research clusters or themes that are generated objectively through scientific mapping (Jiang et al., 2023). One of the key advantages of this approach is its reduced susceptibility to potential biases associated with researchers' subjectivity. Moreover, it often uncovers research themes that might be misinterpreted or overlooked by conventional qualitative reviews (Markoulli et al., 2017). By employing this method, the current paper aims to provide a more comprehensive and objective overview of the literature on technological capabilities in micro enterprises. This approach not only helps in understanding the current state of research but also in identifying potential gaps and future directions in this important field of study.

This review employs two distinct bibliometric analyses to address two fundamental questions: (1) What constitutes the knowledge base or intellectual structure underpinning research in technological capability as it relates to micro enterprises?. (2) What are the key research fronts or emerging themes that are shaping the future trajectory of this research domain?. Building upon these bibliometric analyses, this paper also proposes a forward-looking research agenda. This agenda aims to advance scholarly knowledge in the field of technological capability within the context of micro enterprises. While seasoned researchers might find some results of bibliometric analyses intuitive, these analyses often generate broader insights. These insights help researchers develop a comprehensive understanding of the factors that have shaped the current state of a knowledge domain and how it is evolving (Vogel et al., 2021). This review serves two primary audiences: (1) Emerging researchers focusing on technological capabilities in micro enterprises: It provides a holistic understanding of the field and helps formulate ideas for future research. (2) Established researchers: It offers an opportunity to expand their knowledge boundaries in this area. By providing a comprehensive overview of the field's intellectual structure, emerging themes, and potential future directions, this review aims to be a valuable resource for both newcomers and experienced scholars in the domain of technological capabilities in micro enterprises. It not only summarizes the current state of knowledge but also points towards promising avenues for future research, thereby contributing to the continued growth and development of this important field of study.

The structure of the remaining paper is as follows: (1) Methodology Overview: The paper begins with a comprehensive explanation of the bibliometric method employed. This section includes a detailed description of the sampling process and the criteria used for including documents in the review. (2) Bibliometric Analyses: The paper then delves into the specific procedures and findings of two key bibliometric analyses: a) Document co-citation analysis b) Bibliographic coupling analysis. These analyses form the core of the paper's analytical approach, providing insights into the intellectual structure and emerging themes in the field of technological capability related to micro enterprises. (3) Future Research Roadmap: The final section of the paper presents a roadmap for future research. This roadmap offers targeted suggestions and directions for advancing scholarly knowledge in the domain of technological capability as it pertains to micro-enterprises. By structuring the paper in this manner, the authors aim to

provide a comprehensive overview of the current state of research, followed by a data-driven analysis of the field's intellectual landscape, and concluding with forward looking recommendations. This approach ensures that readers gain a thorough understanding of the existing body of knowledge while also being equipped with insights to guide future research efforts in this important area of study.

LITERATURE REVIEW

Technological Capability

A nation's economic growth and global competitiveness are significantly influenced by its technological capability, particularly in innovation. This is especially crucial for developing countries, where building these capabilities is viewed as a learning process that requires absorptive capacity. (Sobanke et al., 2014) define absorptive capacity as the ability to learn and solve problems, enabling the absorption of existing knowledge, its assimilation, and the subsequent creation of new knowledge (Choi, 2007).. This concept highlights the critical role of learning as a precursor to innovation (Jerez-Gómez et al., 2005) and (Akhtar et al., 2021). (Sobanke et al., 2014) further describe learning capability as the assets that allow firms to transform and utilize their resources for product or process innovations. Drawing from various studies (Adquisiciones et al., 2019), (Sobanke et al., 2014) and (Choi, 2007), researchers have identified five key learning modes: (1) Learning by searching, (2) Learning by training, (3) Learning by using, (4) Learning by doing, (5) Learning by interacting. Each of these modes plays a significant role in accumulating technological capability within an organization. The factors that influence this learning process can be broadly categorized as either internal or external to the firm.

The high-end equipment manufacturing sector serves as a primary catalyst for technological advancement. For Chinese companies in particular, the specialized technological resources that emerge from this industry play a crucial role in determining their strategies for entering new markets. When viewed through the lens of technological capability, these resources are considered assets that have a direct impact on transaction costs, as noted by (Anderson & Sutherland, 2015). This perspective aligns with the transaction cost theory in international business. On the other hand, the Resource-Based View (RBV) approach offers a different interpretation. According to (Kogut & Zander, 2003) these technological capabilities represent valuable knowledge that is inherently difficult to codify or transfer. This tacit nature of the knowledge makes it a unique and potentially sustainable competitive advantage for firms. By combining these perspectives, we can understand that the technological capabilities developed in the high-end equipment manufacturing industry not only affect the costs associated with international expansion but also form a core part of a firm's unique resource base, influencing their choice of entry mode into foreign markets.

The influence of shifting trade conditions on a company's choice of market entry strategy is significantly moderated by its own technological capabilities. Companies with lower technical proficiency face greater challenges in conducting independent research and development. As a result, these firms experience a heightened need and urgency to acquire external technology. Consequently, such companies tend to favor entry modes that involve higher levels of resource commitment and control. These strategies typically offer easier access to technological resources and know-how. This preference is driven by the firm's desire to bridge its technological gap and enhance its competitive position in the new market. This relationship between technological capability and entry mode choice has been supported by various studies, including those by (Breznik & Lahovnik, 2016), (WEN et al., 2023), (Jia Nisha Lei Hongzhen, n.d.). These researchers have found that firms with lower technological capabilities are more likely to opt for entry modes that provide greater control and access to technology, even if these modes require more substantial resource investments. In essence, a company's technological prowess not only shapes its ability to innovate independently but also significantly influences its strategic decisions when entering new markets, particularly in response to changes in the trading environment.

Technological capability emerges as a crucial element in establishing and maintaining a competitive edge in international markets. This capability serves as a valuable asset, enabling investors to navigate through non-

structural challenges and manage information overload effectively. As a result, it plays a significant role in mitigating environmental uncertainties that companies often face when expanding into foreign territories. This perspective is reinforced by various research findings. Studies have consistently shown that parent companies with abundant technological resources tend to favor establishing new plants (greenfield investments) over collaborative ventures when entering foreign markets. This preference is primarily driven by two key factors: (1) Minimizing knowledge transfer risks: By setting up wholly-owned subsidiaries, companies can maintain tighter control over their proprietary technologies and processes. (2) Protecting intellectual property rights: Greenfield investments allow firms to implement their own systems and practices from the ground up, reducing the risk of intellectual property infringement. These findings are supported by the works of researchers such as (Balsvik & Haller, 2010), (Klier et al., 2017). Their studies underscore the strategic importance of technological capabilities in shaping a company's foreign market entry decisions, particularly in terms of balancing control, risk, and the protection of valuable technological assets. In essence, a strong technological foundation not only enhances a firm's competitive position but also influences its strategic choices in international expansion, favoring modes that offer greater control and protection of its technological advantages.

As mentioned in this topic, extensive research has been carried out to determine whether technological capability significant benefits in micro enterprises. Despite the considerable evidence available, the field continues to be both popular and promising. However, no published work has yet provided a thorough overview of the diverse theoretical perspectives. Consequently, this paper seeks to synthesize the literature on technological capability and micro enterprises, offering insights into the current landscape and future trends in this area. In this research, we employ bibliometric analysis to identify existing knowledge gaps and propose potential directions for future studies (van Eck & Waltman, 2010a) and (Hollebeek et al., 2021). Our analysis primarily utilizes the Scopus scientific database, widely recognized as the most comprehensive repository of peer-reviewed literature (Norris & Oppenheim, 2007). Scopus is highly regarded for its extensive collection of significant publications from leading journals and renowned researchers (van Eck & Waltman, 2010a). According to Elsevier's website, as of 2023, Scopus encompasses over 26,000 journals, approximately 84 million publications, and more than 1.8 billion citations. When compared to Web of Science (WoS), another popular multidisciplinary database, Scopus offers superior coverage (Srivastava & Sivaramakrishnan, 2022). Furthermore, numerous researchers prefer Scopus for conducting bibliometric analyses (Srivastava & Sivaramakrishnan, 2022) and (Donthu et al., 2021). However, following the approach of previous bibliometric reviews (Baker et al., 2019) and (Rey-Martí et al., 2015), we also incorporated the Web of Science (WoS) database in our literature search. This decision was based on WoS's stringent indexing criteria, which only include journals that adhere to rigorous peer-review processes and maintain higher quality standards compared to other databases. By leveraging both Scopus and Web of Science, our study aims to provide a comprehensive and high-quality bibliometric analysis of the field, ensuring a robust foundation for identifying research gaps and suggesting future research directions.

Our research aimed to identify scholarly articles that specifically address technological capabilities in the context of micro enterprises. To achieve this, we designed our search strategy to locate documents where both key terms ("technological capabilities" and "micro enterprises") appeared simultaneously in the title, abstract, or keywords. For our Scopus database search, we employed the following search string: TITLE-ABS-KEY ("technological capability*" AND "micro enterprises"). The use of an asterisk (*) in our search criteria allowed us to capture variations of the term "technological capabilities," including singular forms or related concepts such as "technology" and "high-tech." We intentionally opted for broader search terms rather than more specific ones. This decision was made to obtain a comprehensive and general overview of the theme, considering that the intersection of technological capabilities and micro enterprises is a relatively new area of study. By using this inclusive search strategy, we aimed to capture a wide range of relevant literature, providing a holistic view of the current state of research in this emerging field. This approach allows us to identify trends, gaps, and potential areas for future research more effectively, given the nascent nature of this specific research intersection.

Our initial search in Scopus, conducted on August 3, 2024, yielded 122 documents before any additional

filtering was applied. To ensure the relevance and quality of our analysis, we implemented a set of inclusion and exclusion criteria to refine our dataset beyond the initial keyword-based search results. The refinement process consisted of several stages: (1) Screening: We limited our selection to studies published between 2006 and 2024, providing a focused timeframe for our analysis. (2) Eligibility: Each article underwent a thorough review to confirm its focus on technological capabilities in the context of micro enterprises. This step was crucial in maintaining the specificity of our research scope. (3) Final Selection: Following the eligibility assessment, 92 documents were excluded as they did not align with our research objectives. As a result of this rigorous filtering process, our final dataset comprised 30 articles that met all criteria and were deemed suitable for in-depth analysis. This methodical approach to document selection ensures that our bibliometric analysis is based on a highly relevant and focused set of publications, enhancing the validity and applicability of our findings in the field of technological capabilities in micro enterprises.

In our study, we employed a dual approach to analyze the collected data. While we utilized the performance analysis tools available within Scopus, we also incorporated VOSviewer for scientific mapping to enhance our bibliometric analysis. VOSviewer, a software tool developed by (van Eck & Waltman, 2010a) was chosen for its specialized capabilities in bibliometric network analysis. This powerful tool enables researchers to create, visualize, and explore complex bibliometric networks with ease. The decision to use VOSviewer was influenced by its growing popularity in the academic community. In recent years, it has become a preferred tool for analyzing and evaluating scholarly work across various scientific disciplines (Markoulli et al., 2017). Its widespread adoption is due to its user friendly interface and robust features that allow for in depth exploration of bibliometric data. By combining Scopus's performance analysis tools with VOSviewer's scientific mapping capabilities, our research aims to provide a comprehensive and multifaceted analysis of the literature on technological capabilities in micro enterprises. This integrated approach allows us to uncover patterns, trends, and relationships within the field that might not be apparent through traditional literature review methods alone.

DISCUSSION OF RESULTS

This section will outline the key results of the bibliometric study. Initially, a performance analysis based on Scopus data will be presented, emphasizing research outcomes related to technological capabilities and research development. This analysis will spotlight the most cited and influential publications, the top authors in these areas, and the journals that publish the majority of these works (Donthu et al., 2021). Following this, the findings from science mapping will be discussed, with an interpretation of bibliometric maps showing shared keywords, co-authorship, and co-citations. Lastly, various network metrics will be introduced.

The earliest of these articles was published in 1990 (Suzuki, 1990). One of the studies explored whether the framework for analyzing technological capabilities and the conditions necessary to sustain them required large-scale demonstration projects. The findings indicated that such projects are not essential for maintaining technological capabilities. However, research specifically addressing the relationship between technological capability and small businesses only emerged in 2022. This study, titled "Technological Capabilities, Entrepreneurship, and Innovation of Technology-Based Start-Ups: The Resource-Based View," statistically confirmed the impact of technological capabilities and entrepreneurship on technological innovation. The research found that the technological capabilities of start-ups, as measured by patents and technological competitiveness, have a significant positive effect on technological innovation (Ahn et al., 2022).

Table 1 below highlights several studies on technological capability, with the most cited work being the research by (Y. Wu et al., 2020), which has garnered 98 citations. This study, titled "Technological Capability, Eco-Innovation Performance, and Cooperative R&D Strategy in the New Energy Vehicle Industry: Evidence from Chinese Listed Companies," examines how a firm's technological capability (measured by R&D expenditure) influences eco-innovation performance (measured by eco-innovation patents). It also considers the moderating effects of ownership and government support (such as subsidies). Additionally, the study explores the relationship between a firm's technological capabilities and its R&D strategy, whether internal or cooperative. The analysis is based on a unique panel dataset of 127 listed firms in the Chinese automotive industry, covering the period from 2009 to 2018. The empirical results demonstrate that firm-level

technological capability is positively associated with green innovation performance, and this positive relationship is strengthened by state ownership. However, this study does not focus on technological capability in micro enterprises.

Research on technological capabilities in micro-enterprises gained traction in 2021 with the study titled "Technological Capabilities, Open Innovation, and Eco-Innovation: Dynamic Capabilities to Increase Corporate Performance of SMEs" (Valdez-Juárez & Castillo-Vergara, 2021a). This study highlights that small and medium-sized enterprises (SMEs) now play a critical role in the global economy, driving them to seek technological competitiveness and enhance their innovation activities. In this context, open innovation and green innovation are key elements for achieving these goals. The study aimed to analyze the relationship between technological capability, open innovation, and green innovation in firm performance by testing structural equation models using SmartPLS on a sample of 684 SMEs in Mexico. The findings reveal that technological capabilities significantly influence open innovation and green innovation practices. While these capabilities do not directly impact firm performance, they do so indirectly through open or green innovation. The study also confirms that both green and open innovation positively affect the performance of SMEs. These findings have significant implications for the literature on dynamic capabilities, offering new insights that had not been tested before. For firms and decision-makers, the study underscores the importance of promoting these practices in small and medium-sized enterprises.

Table.1 Most cited articles in the field of technological capability

Title of Article	Journal	TC	Findings	Ref
Technological capability, eco-innovation performance, and cooperative R&D strategy in new energy vehicle industry: Evidence from listed companies in China	Journal of Cleaner Production	96	In present study, we investigate how firm-level technological capability (measured by R&D expenditure) affects its eco-innovation performance (measured by eco-innovation patents), as well as the moderating impacts of ownership and governmental support (i.e., subsidy). Further, we explore the correlation between firm's technological capability and its R&D strategy (i.e., internal R&D or cooperative R&D). Our investigation is based on a unique set of panel data from 127 listed companies in the Chinese automotive industry, spanning from 2009 to 2018. The empirical findings demonstrate that firm-level technological capability is positively related to eco-innovation performance, and state ownership intensifies this positive relationship.	(Y. Wu et al., 2020)
The moderated mediating effect of international diversification, technological capability, and market orientation on emerging market firms' new product performance	Journal of Business Research	60	This study proposes a moderated mediating framework to describe the relationships among international diversification, technological capability, market orientation and emerging market multinational enterprises' new product performance. Within this framework, emerging market multinational enterprises' technological capabilities mediate the impact of internationalization on new product performance. This mediating effect is more salient for firms entering more developed markets than those entering less developed markets. Analysis of a sample of Chinese multinationals' internationalization process supports these relationships.	(J. Wu et al., 2019)
Evaluating high-tech industries' technological innovation capability and spatial pattern evolution characteristics: Evidence	Journal of Innovation & Knowledge	20	The development of high-tech industries in an open economy has become an inevitable requirement for all countries to enhance their competitive advantages and overall national strength. Technological	(Tu et al., 2023)

<p>from China</p>			<p>innovation is a direct driving force for promoting high-tech industries' development. The technological innovation capability of China's high-tech industries over 2010–2019 was measured using factor analysis. Moreover, the spatial pattern and evolution characteristics of the technological innovation capability of high-tech industries were analyzed using the Moran index. The empirical results demonstrate that: (1) during the research period, the technological innovation capability of China's high-tech industries rose, but regional development was uncoordinated. Input-output and transformation guarantee capacities were the main factors influencing technological innovation. (2) Improvements in the technological innovation capability of China's high-tech industries were spread over the southeast coast to the central and southwest regions. The technological innovation capabilities of high-tech industries in different regions exhibited an evident spatial correlation. The spatial agglomeration distribution is relatively stable, mainly characterized by "Low-Low" (L-L) agglomeration. This study offers managerial enlightenment for improving the technological innovation capability of high-tech industries to accelerate industrial development to the middle and high end of the global value chain.</p>	
<p>Determinants of Technological Capability of Firms in a Developing Country</p>	<p>Procedia Engineering</p>	<p>31</p>	<p>This paper examined the factors associated with the accumulation of technological capability among metalworking firms in Nigeria. The empirical evidence suggests that prior work experience of the entrepreneur, in-house training of technical staff and networking with the industry association had significant and positive influence on the accumulation of firm-level technological capability.</p>	<p>(Sobanke et al., 2014)</p>
<p>Geographically Dispersed Technological Capability Building and MNC Innovative Performance: The Role of Intra-firm Flows of Newly Absorbed Knowledge</p>	<p>Journal of International Management</p>	<p>34</p>	<p>This study identifies the key mechanisms linking multinationality to multinational firms' knowledge advantage using Technological Capability.</p>	<p>(Zhang et al., 2019)</p>
<p>Explaining the expansion performance in technological capability of participants in megaprojects: A configurational approach</p>	<p>Technological Forecasting & Social Change</p>	<p>57</p>	<p>This study enhances the theoretical understanding of the process of megaprojects promoting participants' growth, and offers new insights into the complex causality of performance differences in technological capability</p>	<p>(Jin et al., 2022)</p>
<p>Evolution of state clusters related with technological capability in Mexico: Application of a multivariate statistical analysis of cluster</p>	<p>Contaduría y Administración</p>	<p>6</p>	<p>The objective of this work is to analyze how the technological capability is distributed between the Mexican states and to examine their evolution. The results show the existence of 7 groups of states characterized by different levels of technological capability. Furthermore, 3 entities that evolved into a more advanced conglomerate –</p>	<p>(Pérez Hernández et al., 2017)</p>

<p>Can standard cooperation enhance enterprises' standardization capability: The moderating role of technological capability</p>	<p>Journal of Engineering and Technology Management journal</p>	<p>34</p>	<p>regarding absorption and innovation capability, as well as infrastructure technological capability – are also detected.</p>	<p>(Yu et al., 2024)</p>
<p>A Study on Technology Development Performance and Technology Commercialization Performance According to the Technology Development Capability of SMEs Focusing on a Comparative Analysis of Technology Business Groups</p>	<p>Journal of Open Innovation: Technology, Market, and Complexity</p>	<p>15</p>	<p>This article investigates whether and how standard cooperation affects enterprises' standardization capability. Using the survey data of 165 enterprises in the ICT industry, the study reveals the effectiveness of standard cooperation in promoting enterprises' standardization capability. In particular, it examines the positive impact of standard cooperation depth and breadth on standardization capability. In addition, technological capability significantly enhances the positive impact of standard cooperation depth on enterprises' standardization capability rather than that of standard cooperation breadth. Therefore, it is suggested that enterprises should optimize their standard cooperation network relationships, choose different partners according to their technological capabilities, and formulate differentiated standard competition strategies.</p>	<p>(Kim et al., 2019)</p>
			<p>the objective of this research was to investigate the influential factors on performance by suggesting technological development results and technology commercialization as the outcome of technological development capability and to identify the capability required for successful technological development performance and technology commercialization for companies through previous academic research. Moreover, the study aimed to investigate performance differences according to technology business groups by dividing the groups into high-technology companies, medium-technology companies, and low-technology companies. As a result of the analysis, among the indicators constituting technological development capability, manpower in technological development and technological development-specialized research centers had a positive influence on the product competitiveness of technological development performance. Also, technological development expenses and technology skill levels were verified to have positive impacts on the technology competitiveness of technological development performance. As for technology commercialization performance, the more manpower that is in research and development, the higher the sales amounts by technological development; also, the higher the technology skill levels, the higher the export amounts by technological development. Moreover, technology business groups had differences in performance. This research has significance in focusing on the influence of the technological development capability of companies on technological development performance and</p>	

<p>An analysis of grade 12 students' technological capability in learning about electromagnetics through science technology and society approach (STS approach)</p>	<p>Procedia - Social and Behavioral Sciences</p>	<p>35</p>	<p>technology commercialization performance. This study reported Grade 12 students' technological capabilities in teaching and learning about electromagnetics through science technology and society (STS) approach. The participants were 40 Grade 12 students in Pratay, Nakonratchasima, Thailand.</p>	<p>(TucksanunKlahan & Yuenyong, 2012)</p>
<p>An Overview of Technological Innovation on SME Survival: A Conceptual Paper</p>	<p>Procedia - Social and Behavioral Sciences</p>	<p>17</p>	<p>This paper explores the theoretical review of technological innovation on SME survival by looking at literature review with SME studies. Previous reference on survival is still scarce even it is the key benchmark to measure business performance. It has been demonstrated within the literature that the practice of technological innovation is significantly associated with business performance but its effect towards SME survival is underexplored</p>	<p>(Rahman et al., 2016)</p>
<p>Technological innovation toward sustainability in manufacturing organizations: A circular economy perspective</p>	<p>Sustainable Chemistry and Pharmacy</p>	<p>62</p>	<p>the prime purpose of this study, applied to an emerging economy, is to analyze the contributions of technological innovation toward sustainability in manufacturing organizations with a circular economy (CE) perspective. To address this objective, a questionnaire has been developed and conducted, also using the Grey VIKOR method and a sensitivity analysis. The findings from the study illustrate that entrepreneurship direction towards innovation and market direction towards innovation are the two potential factors of technological innovation towards sustainability. The implications highlight that CE, sustainable education and stakeholder engagement solutions can be crucial to the competitiveness of a developing country's manufacturing businesses.</p>	<p>(Dwivedi et al., 2023)</p>
<p>The Analysis Of V.S. Fbr R&D Program Dynamics To Maintain The Technological Capability</p>	<p>IFAC Proceedings Volumes</p>	<p>51</p>	<p>The mechanism to maintain the technological capability of Fast Breeder Reactor (FBR) technologies in the United States, after the cancelation of Clinch River Breeder Reactor (CRBR) project, is analyzed. The analytical framework and the necessary conditions to maintain the technological capability are identified. It is found that a large scale demonstration project is not essential to maintain a technological capability, and despite the steep budget cut in FBR R&D programs, its technological capability has been successfully maintained, The lessons for Japanese FBR program are also discussed.</p>	<p>(Suzuki, 1990)</p>
<p>Technological development of E&P companies in developing countries: An integrative approach to define and prioritize customized elements of technological capability in EOR Sina</p>	<p>Resources Policy</p>	<p>91</p>	<p>The present study focuses on the Technological Capability development of Exploration and Production companies of developing countries in Enhanced Oil Recovery. EOR is one of the most important issues that the Oil industry faces, and improving TC of oil-rich developing countries which have large oil and gas reserves is of great importance to the future of the world's energy. Some new approaches were used in this study to raise the practicality of the research: Elements of TC were extracted in a customized way using Thematic Analysis</p>	<p>(Tarighi & Shavvalpour, 2021)</p>

<p>Technological trajectory based on micro level technological capability: Evidence from the Brazilian rice industry</p>	<p>International Journal of Innovation Studies</p>	<p>40</p>	<p>and integration of TC and EOR functions and then, as for resource constraints of developing countries for managing technological change, the customized elements were prioritized using the fuzzy AHP method. Upstream oil experts of Iran were used since Iran, as a developing oil-producing country with large oil and gas resources and long history in the oil industry, is considered as a perfect case for this research. The priorities showed the following are the most essential elements of improving TC in the EOR sector: training, the expertise of geophysics specialists and reservoir engineers, environmental considerations, R&D in designing the best method of EOR, governmental policies and incentives, linkage with suppliers and global value chain of oil, geological and reservoir data processing ability, suitable seismic equipment, reservoir and production engineering knowledge stock, and inward technology and knowledge transfer</p>	<p>(M[^]onica Fitz-Oliveira, 2022)</p>
<p>Technological capability in the Brazilian naval industry: a metric for offshore support vessels</p>	<p>RAI Revista de Administração e Inovação</p>	<p>10</p>	<p>This study examines technological capability accumulation and the Brazilian rice industry's technological trajectory. Multiple case design was chosen, with an analysis of seven firms involved in the Brazilian rice industry. The results indicate three factors: The first was the identification of technological landmarks for firms in this sector (peeling and polishing, electronic grain selection, electronic packaging, use of forklifts and palletizers, and Industry 4.0). The second is related to the fact that different firms implemented innovative activities and technologies at different speeds, originating from the sector's different technological trajectories. The third is associated with identifying activities within the Brazilian rice industry that can be generalized to other food industries. These results have implications for formulating public policies in the sector, such as creating producer support mechanisms (research and technology transfer institutions), qualification of professionals, and encouragement for economic efficiency and competition.</p> <p>The objective of this study is to present an adapted technological capability metric for the offshore support vessel construction segment. Based on a literature review, a preliminary metric was developed and used to interview a group of researchers, professors, and managers from the naval industry. Through a qualitative approach, the collected empirical evidence was analyzed and organized in an analytical framework. A pilot test of the metric was then carried out at a shipyard in the city of Rio de Janeiro. The study's results indicate that the metric's application can offer firm managers and government policy-makers relevant information for the design and implementation of business and technological strategies for the supply</p>	<p>(Baginski et al., 2017)</p>

<p>Technological and non-technological innovation synergies under the lens of absorptive capacity efficiency</p>	<p>Journal of Business Research journal</p>	<p>17</p>	<p>vessel segment. Our empirical findings suggest that innovation synergies differentially affect firms' absorptive capacity efficiency. Product- marketing innovation synergies positively affect internal knowledge generation, while process-organisational innovation synergies negatively impact in-house Absorptive Capacity efficiency. Both integrated innovations have a positive effect on externally sourced Absorptive Capacity efficiency</p>	<p>(Dimakopoulou et al., 2024)</p>
<p>Technological achievements in regional economic development: An econometrics analysis based on DEA</p>	<p>Heliyon</p>	<p>40</p>	<p>The transformation of university scientific and technological achievements and the coordinated development of regional economy are of great significance to the construction and development of the new paradigm. The transformation ability of scientific and technological achievements in the central and western regions has a big room for improvement. The transformation level of scientific and technological achievements of universities in most provinces is still at a middle level of coordination with the level of regional economic development. In view of the above research conclusions, some countermeasures and suggestions are put forward in order to promote the transformation of scientific and technological achievements and regional economic development can be more coordinated.</p>	<p>(L. rong Wu & Chen, 2023)</p>
<p>Inclusive innovation and the role of technological capability- building: The social business Grameen Danone Foods Limited in Bangladesh</p>	<p>Long Range Planning</p>	<p>57</p>	<p>This article examines how a least developed country-based social business first creates operational capabilities (OCs) and then, over time, builds innovative capabilities (ICs) to fulfil a social need, be self-sustainable and achieve inclusive innovation. This relationship is examined in Bangladesh's Grameen Danone Foods Limited (GDFL) by integrating the technological capability and inclusive innovation theoretical frameworks and by using data gathered through extensive fieldwork. Broadly, our findings show how GDFL built and accumulated basic and intermediate ICs to undertake innovative activities in all areas of operation. Specifically, our findings scrutinize the process in which a social business develops and organizes its resources to initially build OCs and engage in the creation of ICs through various learning mechanisms to deliver inclusive innovation. From this process, we also observe a set of unpredicted positive spillovers to the community, which expands the inclusiveness effect. The findings also suggest that having a social orientation, triggers the use of different resources from within and outside the firm to achieve inclusive innovation. We conclude by discussing the study's implications for scholars, policy-makers and managers of multinational's social businesses. We also highlight future research areas, and crucially those related to key emerging conceptual limitations of inclusive innovation and development.</p>	<p>(Peerally et al., 2019)</p>

<p>The role of competitive advantage in mediating technological capabilities and social media usage on SMEs export performance</p>	<p>Procedia Computer Science</p>	<p>30</p>	<p>This study empirically investigates the relationship between technological capability and social media usage on export performance of garment Small Medium Enterprises (SMEs) in Indonesia, along with the mediating effect of competitive advantage. To analyze This study empirically investigates the relationship between technological capability and social media usage on export performance of garment Small Medium Enterprises (SMEs) in Indonesia, along with the mediating effect of competitive advantage. To analyze questionnaire data from 138 garment SMEs, path analysis was performed. The findings indicate that technological capabilities directly impact export performance, while social media usage does not. However, competitive advantage mediates the relationship questionnaire data from 138 garment SMEs, path analysis was performed. The findings indicate that technological capabilities between these relationships. Finally, this study contributes to filling the gap of previous research by incorporating competitive directly impact export performance, while social media usage does not. However, competitive advantage mediates the relationship between these relationships. Finally, this study contributes to filling the gap of previous research by incorporating competitive advantage as a mediating variable and enhancing the role of Resource Dependence Theory and Social Presence Theory.</p>	<p>(Dju et al., 2024)</p>
<p>The impact of university patenting on the technological specialization of European regions: a technology-level analysis</p>	<p>Technological Forecasting & Social Change</p>	<p>10</p>	<p>We aim to assess the presence of a significant correlation between academic research and technological specialization. The empirical setting is based on a dataset of 846,440 patent families, the output of 256 European regions and 428 local universities. The results of the fixed-effect models indicate a robust and positive relationship between the technological entry of academic institutions and the specialization of the region in the same domain. The technological entry of universities has an additional positive effect for the strong and leading innovators whereas no significant premium or penalty was found for high and low-tech areas. This suggests that the entry of academic institutions into new technology fields occurring in a highly developed innovation ecosystem is more conducive to subsequent industrial specialization thanks to existing collaborations and transmission channels.</p>	<p>(Caviggioli et al., 2023)</p>
<p>Towards a firm-level technological capability framework to endorse and actualize the Fourth Industrial Revolution in developing countries</p>	<p>Research Policy</p>	<p>18</p>	<p>An essential precondition for developing countries to engage in the Fourth Industrial Revolution (4IR) is to accelerate the creation and accumulation of firm-level technological capabilities</p>	<p>(Peerally et al., 2022)</p>

<p>The micro-foundations of a dynamic technological capability in the automotive industry</p>	<p>Technology in Society</p>	<p>11</p>	<p>necessary for digital transformation. Through an analysis of secondary data collected from a systematic review of the 4IR literature, we build on Lall's (1992) and Bell and Pavitt's (1995) frameworks, to develop an updated framework of firm-level technological capabilities which accounts for the refined set of human and organizational activities and resources required by firms for the uptake of 4IR technologies and processes along their digital transformation journey. The framework proposes four levels of increasingly complex technological capabilities across six thematic groups of technological and organizational functions. The framework represents an initial basis for examining the micro-level capabilities required by firms to launch, endorse and actualize the 4IR. Our analysis leads to a definition of 4IR firm-level technological capabilities which better reflects the new realities of this revolution. We discuss the implications of the proposed framework, and we conclude with the contributions of our study from the academic, policy and management perspectives.</p>	<p>(Bağış et al., 2022)</p>
<p></p>	<p></p>	<p></p>	<p>This article seeks insights into how individuals, processes, and structures interact to create the micro-foundations of an operational capability related to production line innovation. Drawing on the literature on the micro-foundations of dynamic capabilities, we develop a model that explains how structures and processes encourage individuals to interact and how organizational routines and production line innovation capabilities emerge through these interactions. We based this study on a single case study design and used the Gioia methodology to analyze the data. The model was developed using 20 interviews with automotive industry suppliers, data collected from participant observations, and data from secondary sources. First, the findings at the individual level show that the mentality and experiences of managers affect macro-level capabilities. Second, social capital and networks, learning and integration capabilities, participatory decision-making and communication, coordination capabilities, and human resources management capabilities influence the development of production line innovation capability by promoting interpersonal interaction. Finally, structural factors such as organizational barriers and processes improve production line innovation capability. This study contributes to the literature on the micro-foundations of dynamic</p>	<p></p>

Technological capabilities development model in Chinese energy service companies	Journal of Cleaner Production	7	<p>capabilities.</p> <p>This paper investigates the energy service companies (ESCOs) in China from the perspective of technological capability (TC) development. The conventional capability development model of manufacturing in emerging economies has been adapted to examine the four dimensions of TC (investment, production, linkage and innovation) through a qualitative analysis of multiple case studies. Small and medium-sized private ESCOs can perform well based on investment and production capabilities to develop energy management software competence. Large state-owned ESCOs can develop more advanced linkage and innovation capabilities and serve large-scale businesses with more specialist services. For small and medium-sized ESCOs, competitiveness, customers and related business strategy are the primary drivers of TC development. These drivers are essential for large ESCOs, but government support and pressure are also important. The framework developed can be used to research ESCOs and other service providers in other developing countries.</p>	(Qiu et al., 2022)
Technological Capabilities, Entrepreneurship and Innovation of Technology-Based Start-Ups: The Resource-Based View	Journal of Open Innovation: Technology, Market, and Complexity Article	14	<p>This paper analyzes the factors that influence technological innovation in Korean technology-based start-ups based on the resource-based view (RBV). The empirical analysis combines ordinary least squares and ordered probit analysis of data collected from 248 technology-based start-ups in Korea. The analysis results statistically confirm the effects of technological capabilities and entrepreneurship on technological innovation. First, a start-up's technological capabilities measured by patents and technological competitiveness have significant positive effects on technological innovation, while the effect of having an in-house R&D department for technological innovation is not significant. Second, entrepreneurship has a significant positive effect on the technological innovation of a start-up, and this positive effect has a moderating effect that further promotes the positive effect of technological competitiveness on technological innovation.</p>	(Ahn et al., 2022)
Technological capability and performance in developing countries: A meta-analysis	Journal of Engineering and Technology Management	4	<p>There has been an increasing interest in the literature pertaining to the relationship between technological capability and performance in developing countries. However, these studies have generated heterogeneous results. This is the literature gap that this article intends to explore. The goal of this paper is to find the relationship between</p>	(Fitz-Oliveira & Tello-Gamarra, 2022)

<p>Host country's environmental uncertainty, technological capability, and foreign market entry mode: Evidence from high-end equipment manufacturing MNEs in emerging markets</p>	<p>International Business Review</p>	<p>14</p>	<p>technological capability and performance in developing countries. Considering the diversity of quantitative and heterogeneous results in literature, we chose to use the meta-analytic method to achieve the objective of this study. We were able to correlate all of the results from 19 studies regarding more than 6000 firms from developing countries. Due to this study, two results came up. Firstly, we were able to observe that technological capability and performance are positively correlated in developing countries. Secondly, we found that one of the sources of heterogeneity in the results has to do with the existence of different variables used for measuring technological capability and firm performance.</p>	<p>(Li & Xiong, 2022)</p>
<p>Technological capability strength/asymmetry and supply chain process innovation: The contingent roles of institutional environments</p>	<p>Research Policy</p>	<p>8</p>	<p>This study builds on the dyadic capability-based view and institutional theory to investigate how buyer's and supplier's technological capabilities jointly affect supply chain process innovation in China. We differentiate between two distinct dimensions, technological capability strength and technological capability asymmetry, and propose that technological capability strength negatively influences supply chain process innovation whereas technological capability asymmetry promotes such</p>	<p>(Wang et al., 2023)</p>

<p>Technological Capabilities, Open Innovation, and Eco-Innovation: Dynamic Capabilities to Increase Corporate Performance of SMEs</p>	<p>Journal of Open Innovation: Technology, Market, and Complexity Article</p>	<p>84</p>	<p>innovation. We also examine how formal (i.e., government intervention) and informal (i.e., guanxi importance) institutional factors moderate the effects of technological capability strength and asymmetry on supply chain process innovation. Empirical analyses based on 157 buyer–supplier dyads in China offer strong support for our hypotheses, which provide important implications for the supply chain innovation collaboration literature and managerial practice.</p>	<p>(Valdez-Juárez & Castillo-Vergara, 2021b)</p>
<p>Linking technology entrepreneurship to a business model towards the growth of ventures: Lessons from Ethiopian small manufacturing ventures</p>	<p>Social Sciences & Humanities Open</p>	<p>2</p>	<p>this study analyzes the linkage between technology entrepreneurship and the BM toward small venture growth. To achieve this, data were collected using a questionnaire from 335 small manufacturing enterprises selected from Addis Ababa. The result indicates that BM influences venture’s growth indirectly through technology entrepreneurship. To the small businesses facing the problems of resource scarcity and poor strategy development, designing appropriate BM is an opportunity and can be used as an input to the adoption of technology entrepreneurship. Besides, by capturing values from combining the factors of production and technology entrepreneurship, the BM organizes and orchestrates the incumbent assets and other resources that make enterprises grow more than their counterparts. As a result, small enterprises should try to exploit existing technological opportunities by developing technology-oriented BM and integrating with technology entrepreneurship.</p>	<p>(Gebrekidan et al., 2023)</p>

Note: TC = total citations

Figure 1 presents the key mapping topics associated with Technological Capability. To uncover the

conceptual framework within Technological Capability research, a shared word analysis was performed on the authors' keywords. These keywords were then mapped and organized into a word occurrence map. In this map, as illustrated in Figure 1, each node corresponds to a keyword. The mapping data analysis reveals that research on Technological Capability is connected to five primary clusters. The following paragraphs provide a detailed description of the eight clusters identified in the keyword occurrence analysis:

Cluster 1, represented in orange, is the densest of all clusters, containing 60 keywords. The most frequently appearing keywords within this cluster are "Technological Capability," "standard cooperation," and "Technological Capability Firm." An examination of the other keywords in this cluster indicates that it encompasses publications focused on the design and application of technological capabilities to enhance a firm's business performance and drive changes in its outcomes. The technological capabilities discussed in these publications predominantly pertain to large-scale enterprises.

Cluster 2, depicted in green, comprises 31 keywords. The most frequently occurring keyword in this cluster is "manufacturing," with a minor connection to "micro," though research related to "micro" is largely confined to the literature. This cluster primarily contains research that examines the application of Technological Capability specifically within the manufacturing industry.

Cluster 3, represented in navy blue, includes 6 keywords. The most frequently occurring keywords are "digitalization of the ability to use technology in companies," "business sustainability influenced by Technological Capability," "development of Technological Capability in a country," and "innovation management driven by Technological Capability." Research in this cluster indicates that the use of technological capability in small businesses remains an underexplored area.

Cluster 4, shown in yellow, consists of 6 keywords. The most frequently appearing keywords are "ownership," "eco-innovation," and "sustainability." Research within this cluster is centered on how Technological Capability can contribute to business ownership, foster innovation, and promote sustainability within the business.

Cluster 5, represented in purple, contains 5 keywords. The standout keyword in this cluster is "technology entrepreneurship." Research within this cluster has started to explore the relationship between Technological Capability and small businesses. However, studies specifically focusing on Technological Capability in micro-enterprises remain limited, with only 5 articles indexed in Scopus addressing this topic.

Cluster 6, depicted in light blue, groups 5 keywords. The most frequently appearing keywords are "micro enterprise," "new to the market," "organizational character," "process innovation," and "product innovation," with "micro enterprise" being the most prominent among them. However, there remains limited research on the relationship between Technological Capability and micro enterprises, as indicated by the noticeable distance between these terms in the keyword connection network visualized in VOSviewer.

Cluster 7, Red, groups 5 keywords, represented in red, comprises five interconnected keywords. Among these five keywords, the ones most frequently associated with Technological Capability are: business models, multinational enterprises, and emerging industries. This cluster's research primarily explores the interplay between Technological Capability and these three key areas. It examines how Technological Capability relates to and influences business models, how it manifests in multinational enterprises, and its role in shaping emerging industries. Notably, this analysis reveals a gap in the current research landscape. While the cluster focuses on larger business entities and broader industry trends, it appears that studies investigating the relationship between Technological Capability and micro enterprises are currently lacking. This observation suggests an opportunity for future research to explore how Technological Capability applies to and impacts smaller-scale business operations.

Cluster 8, depicted in brown, encompasses four key terms. These keywords are: emerging market multinational, international Technological Capability, market orientation, and SMEs. Within this cluster, the research primarily concentrates on two main areas. First, it explores the concept of emerging market multinationals in relation to Technological Capability. Second, it examines how market orientation is influenced by Technological Capability. It's noteworthy that the relationship between Technological

Capability and micro enterprises has received minimal attention in this cluster. This connection is only briefly touched upon through the link between Technological Capability and SMEs (Small and Medium-sized Enterprises). This observation suggests that while there is some acknowledgment of smaller businesses in the context of Technological Capability, the research in this cluster is still predominantly focused on larger, multinational entities and broader market dynamics. The limited exploration of micro enterprises in relation to Technological Capability indicates a potential area for future research expansion.

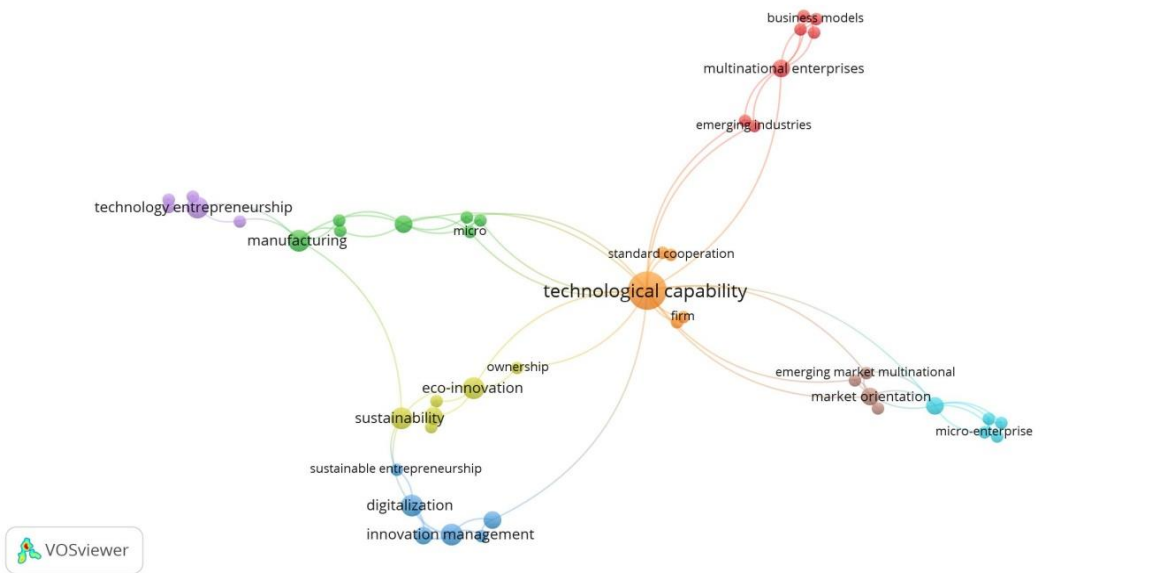


Fig 1. Keywords connection network

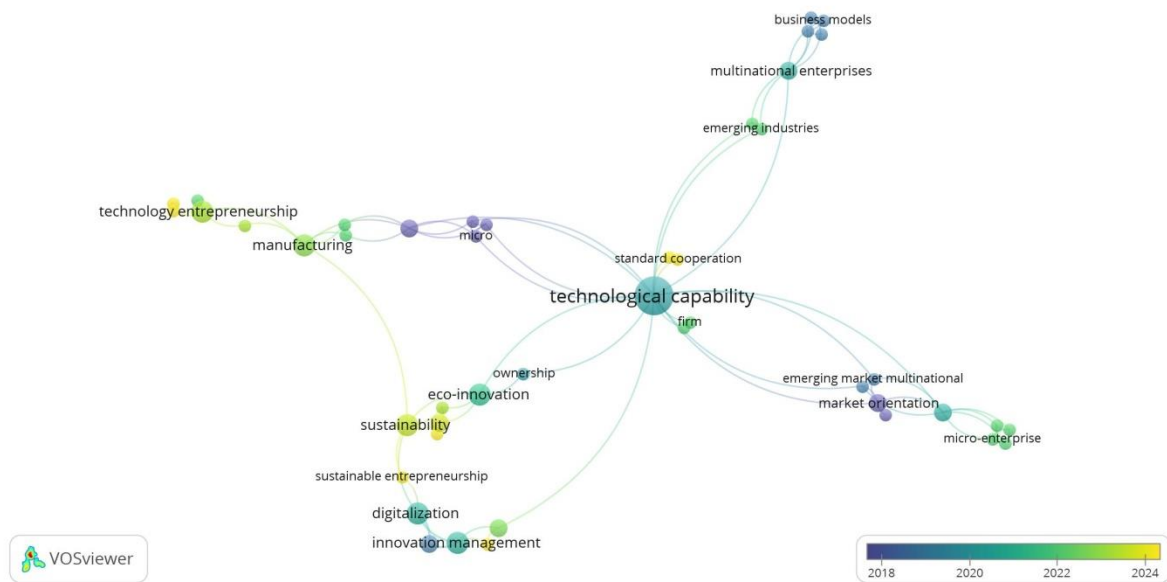


Fig 2. Network visualization map of keywords revolving around the topic Technological Capability and micro enterprises

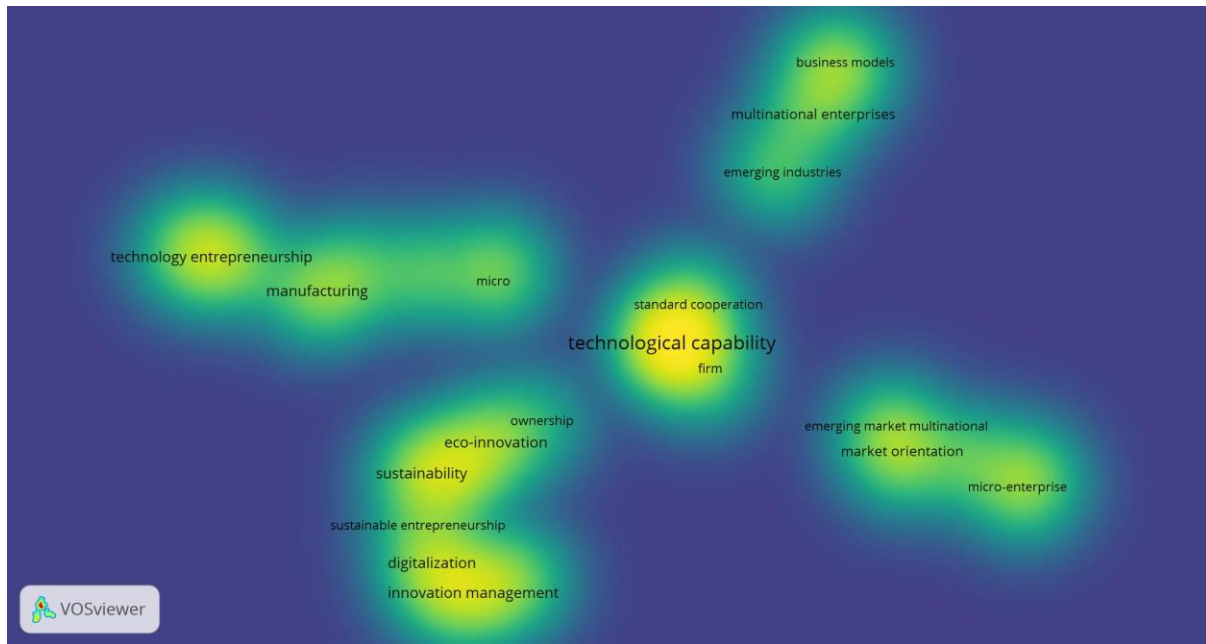


Fig 3. Density Visualization map of keywords revolving around the topic Technological Capability and micro enterprises

Clustering can be performed not only based on keyword relationships but also by considering publication years, resulting in a new visualization (Fig. 2). This figure offers a clearer view of each keyword's usage timeline. The color scheme represents the average publication date of the source documents, with yellow indicating the most recent topics and dark blue representing the oldest (van Eck & Waltman, 2010b). Generally, words from older publications are concentrated in cluster 2, primarily addressing themes related to business capability building using the Technological Capability concept, and small business development in developing countries influenced by Technological Capability. Conversely, the latest keywords are grouped in cluster 3, mostly referring to topics such as innovation management, digitalization, innovation economy, and technological development (Wang et al., 2023). Earlier research attempted to conceptualize Technological Capability within the innovation field, focusing mainly on its implementation in the context of technological development. Initial publications emphasized understanding technological capabilities (e.g., their combination with business models, innovation, business sustainability, innovation management, and capability building) for implementation in technological capability platforms (Zhang et al., 2019) and (Ahn et al., 2022). Current literature is shifting focus towards the impact of implementing technological capabilities on micro enterprises. This indicates a successful expansion of scientific interest in Technological Capability for micro enterprises, although studies in this specific area remain limited. Figure 3 suggests that there's still potential for academics and researchers to explore Technological Capability in micro enterprises, its application, and its effects on business outcomes, signifying progress in the field. Furthermore, yellow-colored terms like "technology entrepreneurship" and "sustainable entrepreneurship" indicate that current research is particularly focused on small enterprises.

The evolution in research focus demonstrates a successful expansion of academic interest in technology entrepreneurship, particularly in relation to micro enterprises. However, this shift also highlights a persistent gap in studies specifically addressing technological capabilities within micro enterprises. The findings from a Systematic Literature Review, which employed Bibliometric Analysis on 122 articles from the Scopus citation index, confirmed this research deficit. This lack of comprehensive studies on technological capabilities in micro enterprises presents an opportunity for future researchers to generate novel insights in this domain.

The use of Bibliometric Analysis methods can be particularly beneficial for future scholars. This approach can help researchers: (1) Identify commonly explored topics in the field. (2) Pinpoint relatively neglected areas of study. (3) Uncover issues that have not been extensively researched. By highlighting these aspects, the Bibliometric Analysis method can guide researchers towards unexplored or under-researched areas, potentially leading to new and valuable contributions to the field of technological capabilities in micro enterprises. This approach not only helps in mapping the current state of research but also in identifying promising directions for future studies, thereby advancing our understanding of how technological capabilities manifest and impact micro enterprises.

CONCLUSION

Our research analyses the evolution of research trends and current research dynamics from multiple perspectives and contributes in various ways. Firstly, it makes a preliminary analysis to track the growth of research publications in the field of technological capability related to micro enterprises. Our analysis primarily utilises the Scopus scientific database, widely recognised as the most comprehensive repository of peer-reviewed literature. Scopus is highly regarded for its extensive collection of significant publications from leading journals and renowned researchers. Our bibliometric analysis found that the literature is now shifting focus towards the impact of implementing technological capabilities on microenterprises. This indicates a successful expansion of scholarly interest in Technological Capabilities for microenterprises, although studies in this specific area are still limited. Figure 3 shows that there is still potential for academics and researchers to explore Technology Capabilities in microenterprises, their application, and their impact on business outcomes, signalling progress in this area. In addition, the yellow coloured terms such as "technology entrepreneurship" and "sustainable entrepreneurship" indicate that current research is specifically focused on small businesses. However, this shift also highlights the continuing gap in research specifically addressing technological capabilities in microenterprises. Findings from the Systematic Literature Review, which utilised Bibliometric Analysis on 122 articles from the Scopus citation index, confirm this research deficiency. The lack of comprehensive studies on technological capabilities in micro enterprises provides an opportunity for future researchers to generate new insights in this domain. Bibliometric Analysis methods can guide researchers towards unexplored or under-researched areas, potentially resulting in new and valuable contributions to the field of technological capabilities in micro enterprises. This approach not only helps in mapping the current state of research, but also in identifying promising directions for future research, thus advancing our understanding of how technological capabilities manifest and impact microenterprises.

REFERENCES

- Adomako, S., Donbesuur, F., Ahsan, M., Danso, A., & Uddin, M. (2022). Strategic Agility of SMEs in Emerging Economies: Antecedents, Consequences and Boundary Conditions. *International Business Review*, 31. <https://doi.org/10.1016/j.ibusrev.2022.102032>
- Adquisiciones, L. E. Y. D. E., Vigente, T., Frampton, P., Azar, S., Jacobson, S., Perrelli, T. J., Washington, B. L. L. P., No, Ars, P. R. D. a T. a W., Kibbe, L., Golbère, B., Nystrom, J., Tobey, R., Conner, P., King, C., Heller, P. B., Torras, A. I. V., To-, I. N. O., Frederickson, H. G., ... SOUTHEASTERN, H. (2019). PERSEPSI MASYARAKAT TERHADAP BANK SYARIAH (Studi Pada Masyarakat Desa Bakti Kecamatan Ponrang Selatan Kabupaten Luwu). *Duke Law Journal*, 1(1).
- Ahmad, N., Othman, S., & Lazim, H. (2014). A Review of Technological Capability and Performance Relationship in Manufacturing Companies. In *ISTMET 2014 - 1st International Symposium on Technology Management and Emerging Technologies, Proceedings*. <https://doi.org/10.1109/ISTMET.2014.6936505>
- Ahn, S., Kim, K. S., & Lee, K. H. (2022). Technological Capabilities, Entrepreneurship and Innovation of Technology-Based Start-Ups: The Resource-Based View. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(3), 156. <https://doi.org/10.3390/joitmc8030156>
- Akhtar, S., Hongyun, T., Iqbal, S., Ashraf, S., & Bashir, I. (2021). Impact of Organization Learning Capability on Performance Innovation: Mediating role of Information Technology. *The Journal of Educational Paradigms*, 3, 146–150. <https://doi.org/10.47609/0301012021>
- Anderson, J., & Sutherland, D. (2015). Entry mode and emerging market MNEs: An analysis of Chinese greenfield and acquisition FDI in the United States. *Research in International Business and Finance*, 18. <https://doi.org/10.1016/j.ribaf.2015.03.008>

- Bag, S., Gupta, S., & Luo, S. (2020). Examining the Role of Logistics 4.0 Enabled Dynamic Capabilities on Firm Performance. *The International Journal of Logistics Management*. <https://doi.org/10.1108/IJLM-11-2019-0311>
- Baginski, L., Pitassi, C., & Barbosa, J. G. P. (2017). Technological capability in the Brazilian naval industry: a metric for offshore support vessels. *RAI Revista de Administração e Inovação*, 14(2), 109–118. <https://doi.org/10.1016/j.rai.2017.03.002>
- Bağış, M., Kryeziu, L., Akbaba, Y., Ramadani, V., Karagüzel, E. S., & Krasniqi, B. A. (2022). The micro-foundations of a dynamic technological capability in the automotive industry. *Technology in Society*, 70(July). <https://doi.org/10.1016/j.techsoc.2022.102060>
- Baker, H., Pandey, N., Kumar, S., & Haldar, A. (2019). A Bibliometric Analysis on Board Diversity: Current Status, Development, and Future Research Directions. *Journal of Business Research*, 108, 232–246. <https://doi.org/10.1016/j.jbusres.2019.11.025>
- Balsvik, R., & Haller, S. (2010). Picking “Lemons” or Picking “Cherries”? Domestic and Foreign Acquisitions in Norwegian Manufacturing. *Scandinavian Journal of Economics*, 112, 361–387. <https://doi.org/10.1111/j.1467-9442.2010.01606.x>
- Breznik, L., & Lahovnik, M. (2016). Dynamic capabilities and competitive advantage: Findings from case studies. *Management : Journal of Contemporary Management Issues*, 21, 167–186.
- Capozza, C., & Divella, M. (2018). Human capital and firms’ innovation: evidence from emerging economies. *Economics of Innovation and New Technology*, 28, 1–17. <https://doi.org/10.1080/10438599.2018.1557426>
- Cavaggioli, F., Colombelli, A., De Marco, A., Scellato, G., & Ughetto, E. (2023). The impact of university patenting on the technological specialization of European regions: a technology-level analysis. *Technological Forecasting and Social Change*, 188(November 2022), 122216. <https://doi.org/10.1016/j.techfore.2022.122216>
- Choi, H. (2007). On Linsu Kim’s Imitation to Innovation: The Dynamics of Korea’s Technological Learning. *East Asian Science Technology and Society an International Journal*, 1, 259–261. <https://doi.org/10.1007/s12280-007-9017-2>
- Cobo, M., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). Science Mapping Software Tools: Review, Analysis, and Cooperative Study Among Tools. *Journal of the American Society for Information Science and Technology*, 62, 1382–1402. <https://doi.org/10.1002/asi.21525>
- Coombs, J., & III, P. (2006). Measuring technological capability and performance. *R&D Management*, 36, 421–438. <https://doi.org/10.1111/j.1467-9310.2006.00444.x>
- Dey, B., Mohiuddin Babu, M., Alwi, S., Roy, S., Kamal, M., & Mizan, R. (2020). Value co-creation through social innovation: A study of sustainable strategic alliance in telecommunication and financial services sectors in Bangladesh. *Industrial Marketing Management*, 89, 27. <https://doi.org/10.1016/j.indmarman.2020.06.003>
- Dimakopoulou, A. G., Gkypali, A., & Tsekouras, K. (2024). Technological and non-technological innovation synergies under the lens of absorptive capacity efficiency. *Journal of Business Research*, 176(February), 114593. <https://doi.org/10.1016/j.jbusres.2024.114593>
- Djiu, N., Kong, N. V., & Saputra, D. (2024). The role of competitive advantage in mediating technological capabilities and social media usage on SMEs export performance. *Procedia Computer Science*, 234(2023), 756–763. <https://doi.org/10.1016/j.procs.2024.03.062>
- Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133. <https://doi.org/10.1016/j.jbusres.2021.04.070>
- Dutrénit, G., Natera, J. M., Puchet Anyul, M., & Vera-Cruz, A. (2018). Development profiles and accumulation of technological capabilities in Latin America. *Technological Forecasting and Social Change*, 145. <https://doi.org/10.1016/j.techfore.2018.03.026>
- Dwivedi, A., Sassanelli, C., Agrawal, D., Gonzalez, E. S., & D’Adamo, I. (2023). Technological innovation toward sustainability in manufacturing organizations: A circular economy perspective. *Sustainable Chemistry and Pharmacy*, 35(April), 101211. <https://doi.org/10.1016/j.scp.2023.101211>
- Fagerberg, J., Verspagen, B., & Srholec, M. (2010). Innovation and Economic Development. In *Handbook of the Economics of Innovation* (Vol. 2, pp. 833–872). [https://doi.org/10.1016/S0169-7218\(10\)02004-6](https://doi.org/10.1016/S0169-7218(10)02004-6)
- Figueiredo, P. (2016). Evolution of the short-fiber technological trajectory in Brazil’s pulp and paper industry: The role of firm-level innovative capability-building and indigenous institutions. *Forest Policy and Economics*, 64, 1–14. <https://doi.org/10.1016/j.forpol.2015.12.008>
- Fitz-Oliveira, M., & Tello-Gamarra, J. (2022). Technological trajectory based on micro level technological capability: Evidence from the Brazilian rice industry. *International Journal of Innovation Studies*, 6(3), 196–215. <https://doi.org/https://doi.org/10.1016/j.ijis.2022.07.001>
- Gebrekidan, T. H., Chebo, A. K., Wubetie, Y. F., & Dhliwayo, S. (2023). Linking technology entrepreneurship to a business model towards the growth of ventures: Lessons from Ethiopian small manufacturing ventures. *Social Sciences and Humanities Open*, 8(1), 100506. <https://doi.org/10.1016/j.ssaho.2023.100506>
- Hollebeek, L., Das, K., & Shukla, Y. (2021). Game On! How Gamified Loyalty Programs Boost Customer Engagement Value.
- Hsu, T. T., Tsai, K., Hsieh, M. H., & Wang, W. (2014). Strategic orientation and new product performance: The roles of technological capability. *Canadian Journal of Administrative Sciences / Revue Canadienne Des Sciences de l’Administration*, 31. <https://doi.org/10.1002/cjas.1274>

- Jerez-Gómez, P., Cespedes-Lorente, J., & Valle, R. (2005). Organizational learning and compensation strategies: Evidence from the Spanish chemical industry. *Human Resource Management*, 44, 279–299. <https://doi.org/10.1002/hrm.20071>
- Jia Nisha Lei Hongzhen, H. Y. (n.d.). A research on the innovation effect of China's outward foreign direct investment. In *Science Research Management* (Vol. 41, Issue 5, pp. 122–130).
- Jian, Z., & Hongxia, L. (2023). Business models and the performance of Chinese high-tech service firms: the role of the technological innovation mode and technological regimes. *Heliyon*, 9(7), e17797. <https://doi.org/10.1016/j.heliyon.2023.e17797>
- Jiang, Z., Wang, Y. (Lena), Li, W., Peng, Z., & Wu, C.-H. (2023). Career Proactivity: A Bibliometric Literature Review and A Future Research Agenda. *Applied Psychology*, 72, 144–184. <https://doi.org/10.1111/apps.12442>
- Jin, Z., Zeng, S., Chen, H., & Shi, J. J. (2022). Explaining the expansion performance in technological capability of participants in megaprojects: A configurational approach. *Technological Forecasting and Social Change*, 181(May), 121747. <https://doi.org/10.1016/j.techfore.2022.121747>
- Kim, H., Park, S. Y., & Joh, W. IL. (2019). A study on technology development performance and technology commercialization performance according to the technology development capability of SMEs focusing on a comparative analysis of technology business groups. *Journal of Open Innovation: Technology, Market, and Complexity*, 5(3), 65. <https://doi.org/10.3390/joitmc5030065>
- Klier, H., Schwens, C., Zapkau, F. B., & Dikova, D. (2017). Which Resources Matter How and Where? A Meta-Analysis on Firms' Foreign Establishment Mode Choice. *Journal of Management Studies*, 54(3), 304–339. <https://doi.org/https://doi.org/10.1111/joms.12220>
- Kogut, B., & Zander, U. (2003). Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation. *Journal of International Business Studies*, 34, 516–529. <https://doi.org/10.1057/palgrave.jibs.8400058>
- Lall, S. (1992). Technological capabilities and industrialization. *World Development*, 20(2), 165–186. [https://doi.org/https://doi.org/10.1016/0305-750X\(92\)90097-F](https://doi.org/https://doi.org/10.1016/0305-750X(92)90097-F)
- Lestari, E., & Ardianti, F. (2019). Technological capability and business success: The mediating role of innovation. *IOP Conference Series: Earth and Environmental Science*, 250, 12039. <https://doi.org/10.1088/1755-1315/250/1/012039>
- Li, K. S., & Xiong, Y. Q. (2022). Host country's environmental uncertainty, technological capability, and foreign market entry mode: Evidence from high-end equipment manufacturing MNEs in emerging markets. *International Business Review*, 31(1), 101900. <https://doi.org/10.1016/j.ibusrev.2021.101900>
- Mônica Fitz-Oliveira, J. T.-G. (2022). Technological trajectory based on micro level technological capability: Evidence from the Brazilian rice industry. *International Journal of Innovation Studies*, 6(3), 196–215. <https://doi.org/10.1016/j.ijis.2022.07.001>
- Markoulli, M., Lee, C., Byington, E., & Felps, W. (2017). Mapping Human Resource Management: Reviewing the field and charting future directions. *Human Resource Management Review*, 27, 367–396. <https://doi.org/10.1016/j.hrmr.2016.10.001>
- Norris, M., & Oppenheim, C. (2007). Comparing Alternatives to the Web of Science for Coverage of the Social Sciences' Literature. *J. Informetrics*, 1, 161–169. <https://doi.org/10.1016/j.joi.2006.12.001>
- Peerally, J. A., De Fuentes, C., & Figueiredo, P. N. (2019). Inclusive innovation and the role of technological capability-building: The social business Grameen Danone Foods Limited in Bangladesh. *Long Range Planning*, 52(6), 101843. <https://doi.org/10.1016/j.lrp.2018.04.005>
- Peerally, J. A., Santiago, F., De Fuentes, C., & Moghavvemi, S. (2022). Towards a firm-level technological capability framework to endorse and actualize the Fourth Industrial Revolution in developing countries. *Research Policy*, 51(10), 104563. <https://doi.org/10.1016/j.respol.2022.104563>
- Pérez Hernández, C. C., Lara Gómez, G., & Gómez Hernández, D. (2017). Evolución de la capacidad tecnológica en México. Aplicación del análisis estadístico multivariante de clúster. *Contaduría y Administración*, 62(2), 528–555. <https://doi.org/10.1016/j.cya.2017.02.003>
- Pham, T. T. T., Nguyen, K. S., Nguyen, H. H., Nguyen, L. T., & Vo, V. X. (2021). Dynamic entrepreneurship, planned innovation, and firm profitability: evidence from a Southeast Asian country. *Heliyon*, 7(7), e07599. <https://doi.org/10.1016/j.heliyon.2021.e07599>
- Qiu, P., Nunes, B., Vaidya, K., van de Kaa, G., & Greeven, M. (2022). Technological capabilities development model in Chinese energy service companies. *Journal of Cleaner Production*, 330(October 2021), 129551. <https://doi.org/10.1016/j.jclepro.2021.129551>
- Rahman, N. A., Yaacob, Z., & Radzi, R. M. (2016). An Overview of Technological Innovation on SME Survival: A Conceptual Paper. *Procedia - Social and Behavioral Sciences*, 224(August 2015), 508–515. <https://doi.org/10.1016/j.sbspro.2016.05.427>
- Reichert, F., & Zawislak, P. (2014). Technological Capability and Firm Performance. *Journal of Technology Management & Innovation*, 9, 20–35. <https://doi.org/10.4067/S0718-27242014000400002>
- Rey-Martí, A., Ribeiro-Soriano, D., & Palacios-Marqués, D. (2015). A bibliometric analysis of social entrepreneurship. *Journal of Business Research*, 69. <https://doi.org/10.1016/j.jbusres.2015.10.033>
- Ruiz Ortega, M. (2010). Competitive strategies and firm performance: Technological capabilities' moderating roles. *Journal of Business Research*, 63, 1273–1281. <https://doi.org/10.1016/j.jbusres.2009.09.007>

- Sobanke, V., Adegbite, S., Ilori, M., & Egbetokun, A. (2014). Determinants of technological capability of firms in a developing country. *Procedia Engineering*, 69, 991–1000. <https://doi.org/10.1016/j.proeng.2014.03.081>
- Srivastava, M., & Sivaramakrishnan, S. (2022). A bibliometric analysis of the structure and trends of customer engagement in the context of international marketing. *International Marketing Review*, ahead-of-p. <https://doi.org/10.1108/IMR-06-2021-0204>
- Suzuki, T. (1990). Analysis of U.S. FBR R&D program dynamics to maintain the technological capability. *IFAC Proceedings Series*, 22(14), 429–434. [https://doi.org/10.1016/s1474-6670\(17\)52966-3](https://doi.org/10.1016/s1474-6670(17)52966-3)
- Tarighi, S., & Shavvalpour, S. (2021). Technological development of E&P companies in developing countries: An integrative approach to define and prioritize customized elements of technological capability in EOR. *Resources Policy*, 72(October 2020), 102051. <https://doi.org/10.1016/j.resourpol.2021.102051>
- Tsai, K.-H. (2004). The Impact of Technological Capability on Firm Performance in Taiwan's Electronics Industry. *The Journal of High Technology Management Research*, 15, 183–195. <https://doi.org/10.1016/j.hitech.2004.03.002>
- Tu, W., Zhang, L., Sun, D., & Mao, W. (2023). Evaluating high-tech industries' technological innovation capability and spatial pattern evolution characteristics: Evidence from China. *Journal of Innovation and Knowledge*, 8(1). <https://doi.org/10.1016/j.jik.2022.100287>
- TucksanunKlahan, & Yuenyong, C. (2012). An Analysis of Grade 12 Students' Technological Capability in Learning About Electromagnetics Through Science Technology and Society Approach (STS Approach). *Procedia - Social and Behavioral Sciences*, 46, 5085–5093. <https://doi.org/10.1016/j.sbspro.2012.06.390>
- Valdez-Juárez, L. E., & Castillo-Vergara, M. (2021a). Technological capabilities, open innovation, and eco-innovation: Dynamic capabilities to increase corporate performance of smes. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(1), 1–19. <https://doi.org/10.3390/joitmc7010008>
- Valdez-Juárez, L. E., & Castillo-Vergara, M. (2021b). Technological Capabilities, Open Innovation, and Eco-Innovation: Dynamic Capabilities to Increase Corporate Performance of SMEs. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(1), 8. <https://doi.org/https://doi.org/10.3390/joitmc7010008>
- van Eck, N. J., & Waltman, L. (2010a). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 84, 523–538. <https://doi.org/10.1007/s11192-009-0146-3>
- van Eck, N. J., & Waltman, L. (2010b). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2), 523–538. <https://doi.org/10.1007/s11192-009-0146-3>
- Wang, L., Jin, J. L., & Zhou, K. Z. (2023). Technological capability strength/asymmetry and supply chain process innovation: The contingent roles of institutional environments. *Research Policy*, 52(4), 104724. <https://doi.org/10.1016/j.respol.2023.104724>
- WEN, Y., WEN, S., & Yin, M. (2023). The impact of innovation capability on enterprises' upgrading on the global value chain in underdeveloped areas: A resource orchestration perspective. *Resources Science*, 45(9), 1710–1722. <https://doi.org/10.18402/resci.2023.09.02>
- Wu, J., Ma, Z., & Liu, Z. (2019). The moderated mediating effect of international diversification, technological capability, and market orientation on emerging market firms' new product performance. *Journal of Business Research*, 99(100), 524–533. <https://doi.org/10.1016/j.jbusres.2018.03.025>
- Wu, L. rong, & Chen, W. (2023). Technological achievements in regional economic development: An econometrics analysis based on DEA. *Heliyon*, 9(6), e17023. <https://doi.org/10.1016/j.heliyon.2023.e17023>
- Wu, Y., Gu, F., Ji, Y., Guo, J., & Fan, Y. (2020). Technological capability, eco-innovation performance, and cooperative R&D strategy in new energy vehicle industry: Evidence from listed companies in China. *Journal of Cleaner Production*, 261. <https://doi.org/10.1016/j.jclepro.2020.121157>
- Yu, X., Li, S., Shan, J., & Xu, Q. (2024). Can standard cooperation enhance enterprises' standardization capability: The moderating role of technological capability. *Journal of Engineering and Technology Management - JET-M*, 73(258), 101828. <https://doi.org/10.1016/j.jengtecman.2024.101828>
- Zhang, F., Jiang, G., & Cantwell, J. A. (2019). Geographically Dispersed Technological Capability Building and MNC Innovative Performance: The Role of Intra-firm Flows of Newly Absorbed Knowledge. *Journal of International Management*, 25(3), 100669. <https://doi.org/10.1016/j.intman.2019.04.002>
- Zupic, I., & Čater, T. (2015). Bibliometric Methods in Management and Organization. *Organizational Research Methods*, 18, 429–472. <https://doi.org/10.1177/1094428114562629>