WORKING PAPER

State of Digitalization in the Southeast Asia Region

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Abstract
The digital revolution is reshaping global economies and societies, and Southeast Asia is no exception. This paper presents a bibliometric analysis of the state of digitalization in Southeast Asia, focusing on the period from 2018 to 2023. By leveraging the Scopus database, we conducted a comprehensive review of literature in the digital domain, identifying key trends, regional disparities, and thematic focuses within the ASEAN nations. Our analysis reveals significant strides in digitalization, marked by increased scholarly attention and publication output, particularly from countries like Indonesia, Malaysia, Singapore, and Thailand. The study also highlights a stark digital divide within the region, with countries like Laos, Cambodia, and Myanmar lagging in digital infrastructure and literacy. We analyzed 5058 articles from the last five years, applying a bibliometric approach to assess publication patterns, author affiliations, and emerging research themes. The results indicate a diversified research landscape, with significant contributions in areas such as digital governance, economy, infrastructure, and societal impacts. The paper also discusses the role of digitalization in

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economic growth, social inclusion, and sustainable development within the region. Our findings underscore the importance of regional collaborations and targeted policies to bridge the digital divide. We emphasize the necessity of inclusive digital strategies that consider the unique socio-economic and cultural contexts of each ASEAN country. The study provides valuable insights for policymakers, academicians, and industry stakeholders, guiding future research agendas and digital initiatives in Southeast Asia. The bibliometric analysis not only maps the scholarly terrain but also offers actionable intelligence for decision-makers in navigating the digitalization landscape across this dynamic and diverse region.

Keywords: digitalization, digital divide, Southeast Asia, bibliometric analysis

1. Introduction

Digitalization refers to the integration of digital technologies into organizational and operational environments, transforming both society and business (Parviainen et al., 2017). This process strengthens connectivity, communication, services, and trade, as institutions adopt internet-connected digital technologies and applications (Linkov et al., 2018). Digitalization has significant impacts on B2B exchanges, facilitating activity links, resource ties, and actor bonds (Pagani & Pardo, 2017). As a transformative process, digitalization enables businesses to address economic and environmental challenges, contributing to the UN Sustainable Development Goals (Bican & Brem, 2020). Key features of digitalization include IoT technologies, intensive data exchange, and predictive analytics, which revolutionize industrial business models and support sustainability (Parida, Sjödin & Reim, 2019). Additionally, digitalization enables the emergence of new digital products and services that emphasize flexibility, promoting innovative work practices while heightening the importance of cybersecurity and privacy (Almeida, Duarte Santos & Augusto Monteiro, 2020).

In the current societal landscape, particularly at regional and country levels, digitalization is a pivotal force by fundamentally transforming firms' organizations for value creation, delivery, and capture, bolstering their resilience to global disruptions (Autio, Mudambi & Yoo, 2021). Digitalization catalyzes a new technological revolution and induces profound structural changes in a country's economy, reshaping its technology base and facilitating structure, public policy, and environment (Strohmaier, Schuetz & Vannuccini, 2019). Its significance is further underscored in streamlining innovative services and introducing new products, altering how citizens and stakeholders live, work, collaborate, and communicate (Anthony Jnr, 2021). The COVID-19 pandemic accentuated digitalization's critical role in enabling businesses and individuals to adapt to the new normal, ensuring their survival and adaptation (Layman, Sihombing & Handoko, 2023). In the post-pandemic era, Information Technology will continue to escalate as a vital tool for competitive advantage and agility, advancing sustainability through digital transformation (Ben-Zvi & Luftman, 2022). While digitalization significantly influences economies and the Sustainable Development Goals (SDGs) by diminishing poverty and fostering social equality and ecological balance, it also presents challenges like exacerbating social inequality and straining regulatory capacities (Maltsev & Maltseva, 2020).

In the digital age, embracing technology is crucial for economic growth. The Association of Southeast Asian Nations (ASEAN) recognizes this and promotes digitalization through collaborations and partnerships (Haini & Wei Loon, 2022). However, there is a

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significant digital divide between member countries. This digital divide poses a challenge to achieving economic integration and inclusive growth within ASEAN. To address this, various strategies and policies have been implemented to enhance economic integration through automation and digitalization (Baki et al., 2023). Digitalization is seen as a key driver for economic growth and integration within ASEAN (Hidayat & Musari, 2022).

Southeast Asia faces a significant challenge in bridging the digital divide, which is characterized by unequal access to and utilization of information and communication technologies (ICTs). The region's rapid economic growth and technological progress are hampered by this disparity, which is not just about connectivity, but also encompasses access, usage, and skills divides. While countries like Singapore and Malaysia have made significant strides in bridging this divide, with high levels of internet penetration and digital literacy, other nations such as Laos, Cambodia, and Myanmar still struggle with limited internet access and low digital skills. Furthermore, there is a stark contrast between urban and rural areas regarding digital technology access within these countries.

To address the digital divide, it is crucial to understand that it is not solely dictated by economic factors. Education, infrastructure, and cultural contexts also play critical roles. Limited internet connectivity, high costs of software and internet bandwidth, lack of multilingual supportive services, and inadequate levels of digital literacy and skills are the root causes of this divide. A multi-faceted approach is necessary to tackle these issues, emphasizing targeted investments in internet infrastructure to enhance connectivity, particularly in underserved rural and remote areas. Policies aimed at making digital technologies more affordable and accessible are also crucial, as well as providing comprehensive digital literacy training programs that cater to diverse communities across the region.

Achieving digital inclusion in Southeast Asia requires collaborative efforts between governments, private sector entities, and civil society organizations. Partnerships are vital in driving investments in digital infrastructure, including broadband connectivity and mobile networks, to expand internet access. Only through these concerted efforts can Southeast Asia overcome the digital divide's challenges and harness its digital economy's full potential, ensuring inclusive and equitable growth for all its citizens.

Understanding the concept of the digital divide in Southeast Asia requires a thorough examination of the digitization processes, their outcomes, and the specific issues and problems they create. This approach will help identify and develop frameworks and policies to address the pressing issue of digital gaps and ensure sustainable development. Our goal is to provide an up-to-date literature review of research conducted on digitalization issues in Southeast Asian countries, focusing on the Association of Southeast Asian Nations (ASEAN) region.

Our paper presents a bibliometric analysis with two primary objectives. Firstly, we investigate the key characteristics of research conducted on digitalization between 2018 and 2023. We present these characteristics considering the year of publication, spatial distribution of research, university affiliation, and emerging publication patterns. Secondly, we examine the focus of the research, the main issues addressed, and how they have evolved over time. This analysis will allow us to formulate conclusions on the scope and nature of digitalization research in Southeast Asian countries.

Our review is particularly crucial as digitization continues to advance, influencing the evolving concept of the digital divide, its causes, manifestations, and implications. By identifying the most prominent and recent areas of digitalization research, our review contributes to the literature and informs the development of more effective strategies and policies to bridge the gap.

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2. Theoretical background

2.1. The role of digitalization in economic and social development

Digitalization can play a significant role in economic and social development by increasing productivity and benefiting local and global economies. The growth of a digital economy can create new jobs, promote innovation, and improve business operations and management. Additionally, digitalization can enhance communication, services, and trade between people, organizations, and things, creating unique opportunities to enhance social and environmental well-being and improve global living standards while preserving and improving environmental health for future generations. However, policymakers must also consider potential sustainability challenges and threats, including the carbon footprint associated with digital technologies and the rise of economic disparity (Linkov et al., 2018). Digital technologies are becoming indispensable for participating in the economy and engaging in society and sustained digital divides amplify marginalization. Digital resources such as big data and business analytics are key enablers of sustainable value creation within societies. However, the availability of digital solutions does not always facilitate the resolution of long-standing problems for those less well-off in our societies. Bridging digital divides is critical for sustainable digitalized societies. Therefore, addressing digital inequalities and ensuring fairness and inclusiveness in the digital era is important (Vassilakopoulou & Hustad, 2023).

Digitalization can bring benefits such as increased efficiency, productivity, and innovation, leading to economic growth and development. It can also create new job opportunities and improve access to education, healthcare, and other services. However, beyond the positive effects, digitalization can lead to growing inequalities and threaten the availability of adequate employment opportunities (Piroșcă et al., 2021).

The role of digitalization in global society is to create new opportunities for growth and innovation. Digitalization enables the creation of digital network platforms with analytical and predictive functions, which can improve decision-making and increase efficiency in various sectors. It also allows for developing new technologies and industries, such as nano- and biotechnology, new medicine, household appliances, modes of transport and communications, and digital medicine. In addition, digitalization can help bridge the digital divide and promote social inclusion by providing access to information and services to previously excluded people. Digital technologies can help to accelerate progress towards the SDGs by improving access to information and services, promoting social inclusion, and enabling new forms of economic activity. For example, digital technologies can improve healthcare delivery, enhance education and training, increase access to financial services, and support sustainable agriculture and food systems. In addition, digitalization can help to monitor progress towards the SDGs and facilitate data-driven decision-making. However, it is essential to note that digitalization can also create new challenges and risks, such as privacy concerns, cybersecurity threats, and job displacement, which need to be addressed to ensure that the benefits of digitalization are shared by all members of society (Vasilenko, Meshcheryakova & Zotov, 2022).

Digitalization has the potential to create a future sustainable society by uniting the urban and rural worlds under a shared banner of sustainable development, keeping all social elements in the loop. Nations that take a comprehensive strategy will be able to provide equitable growth and an efficient, sustainable, and digital existence for their citizens. As a result, digitization provides better living conditions, active public involvement, clean governance, and transparency in public welfare programs and processes (Xu, She & Liu, 2022).

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2.2. The place of digitalization in policies of countries in South-East Asian Region

Digitalization has emerged as a transformative force in Southeast Asia, revolutionizing industries, reshaping economies, and empowering individuals. Recognizing the immense potential of digital technologies, ASEAN member countries have embarked on a digital transformation journey, implementing policies and initiatives to harness the power of the digital age. ASEAN has been working on digital transformation since 1997, when it adopted ASEAN Vision 2020, which launched an initiative on information and communication technology (ICT) development within the region. The rapid advancement of digital technologies presents opportunities and challenges for the region, and digital integration has become imperative for nations worldwide, including ASEAN. ASEAN has updated its approach to the digital sector over time by launching various initiatives and policies to promote digitalization within the region (Isono & Prilliadi, 2023).

The ASEAN Digital Integration Framework (ASEAN DIF) is a policy proposal developed by the ASEAN Coordinating Committee on Electronic Commerce (ACCEC) to overcome regional digital integration barriers by proposing policies and priority areas. It prioritizes, coordinates, and tracks digital integration efforts across different timelines and objectives. The ASEAN DIF's "6 priority areas" have been translated into the ASEAN Digital Integration Framework Action Plan (DIFAP) 2019-2025, with relevant ASEAN bodies responsible for implementation. The ASEAN DIF serves as a guide to promote digitalization in ASEAN by addressing barriers and accelerating existing plans for digital integration (ACCEC, 2019).

The Consolidated Strategy on the Fourth Industrial Revolution for ASEAN proposes several strategies to address the digital divide in the ASEAN region. These include enhancing digital infrastructure and connectivity to support the development of a Digital ASEAN Community, strengthening digital skills and education to ensure that ASEAN citizens are equipped to participate in the digital economy, promoting innovation and entrepreneurship to drive economic growth and job creation, ensuring that the benefits of the 4IR are shared equitably across ASEAN, and addressing potential risks and challenges associated with the 4IR to ensure that its negative consequences do not outweigh the benefits of the 4IR (The ASEAN Secretariat, 2021).

The ASEAN Agreement on Electronic Commerce (AECA), signed in 2019 and entered into force in 2021, stands as a landmark agreement in fostering e-commerce growth within the Southeast Asian region. This comprehensive accord addresses various aspects of digital commerce, encompassing the elimination of trade barriers, consumer protection, cybersecurity enhancement, e-payment system promotion, and cross-border logistics facilitation. The AECA is poised to revolutionize the digital landscape of Southeast Asia, propelling economic growth, enhancing consumer choice, generating employment opportunities, and broadening access to online information and services (AEC, 2019).

The Bandar Seri Begawan Roadmap is a 5-year plan established in 2021 to accelerate ASEAN's economic recovery and digital economy integration. It is divided into Recovery (2021-2022), Acceleration (2022-2024), and Consolidation (2024-2025) phases, focusing on measures such as enhancing digital infrastructure, promoting digital innovation, and developing digital skills. The roadmap aims to ensure that ASEAN emerges stronger and more resilient from the disruptions of the COVID-19 pandemic (ASEAN, 2021b).

The e-ASEAN Framework Agreement is a key initiative under the Association of Southeast Asian Nations (ASEAN), aimed at fostering the growth of the digital economy within the region. This agreement, signed in November 2000, outlines the collective efforts of ASEAN

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member countries in developing an integrated e-economy. The agreement aims to promote the development of human resources and enhance ASEAN's competitiveness in the global market through the opportunities offered by information and communications technology and electronic commerce (The ASEAN Secretariat, 2012).

The ASEAN Digital Masterplan 2025 aims to make ASEAN a leading digital community and economic bloc powered by secure and transformative digital services, technologies, and ecosystems. It aims to ensure the adoption and use of digital services among ASEAN citizens and drive the region's productivity and economic growth. The plan provides a roadmap for digital transformation and includes initiatives to promote digital literacy and skills development and expand access to digital infrastructure and services (ASEAN, 2021a).

The ASEAN Digital Community 2040 is a vision and a long-term goal for the ASEAN region rather than an official policy. It was established as part of the ASEAN Digital Economy Strategy, which aims to establish an open, secure, interoperable, competitive, and inclusive digital economy within ASEAN. The strategy includes several frameworks and commitments, such as the ASEAN Digital Masterplan 2025, the ASEAN Digital Integration Framework Action Plan (2019–2025), and the ASEAN Agreement on E-Commerce Work Plan (2021–2025). It aims to address the challenges of digital transformation and trade in the region by improving the quality of key digital enablers for digital technology adoption, enhancing countries' preparedness for digital transformation, and improving the quality of privacy and competition laws to address the costs and risks of digital transformation (Ing & Markus, 2023).

In the dynamic landscape of Southeast Asia, digitalization stands as a pivotal force shaping the future of each nation. As we transition from a regional overview of digitalization policies and initiatives to an in-depth examination of country-specific strategies, it is essential to recognize the diversity and complexity of approaches each ASEAN member country has adopted. While the regional frameworks set forth by entities like ASEAN provide a shared vision for digital growth and integration, the actual execution of these strategies is deeply rooted in the specific needs, capacities, and aspirations of each member country. This diversity reflects the unique socio-economic, cultural, and technological landscapes that characterize the nations within this region. The shift from a regional to a country-specific perspective is not merely a change in scale but an essential step in understanding the multifaceted nature of digitalization in Southeast Asia. Regional initiatives, though designed to address common goals such as enhancing connectivity, fostering digital economies, and bridging the digital divide, must be interpreted and applied in the context of national priorities and realities. This approach acknowledges that strategies effective in one country may need significant adaptation to suit the circumstances of another.

As we delve deeper into the digitalization narrative of each country, we discover a range of approaches and stages of digital maturity. These differences are influenced not only by economic and infrastructural factors, but also by varying levels of government commitment, public-private partnerships, and societal readiness to embrace digital transformations. Additionally, cultural norms play a significant role. The degree of public acceptance, level of digital literacy, and societal norms surrounding technology adoption are crucial in determining the effectiveness and acceptance of digital policies. Therefore, this exploration at the country level reveals how each Southeast Asian nation is navigating its own path towards digital advancement, shaped by its unique context.

Indonesia is one of the ASEAN member countries that places significant emphasis on digital transformation. In Indonesia, the National Medium-Term Development Plan (RPJMN) 2021-2024, as interpreted by the Ministry of Communication and Information Technology

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through Ministerial Regulation No. 2 of 2021, identifies four strategic sectors for digitalization: digital infrastructure, digital government, digital economy, and digital society (BAPPENAS, 2020; KOMINFO, 2021). Digital infrastructure through the acceleration of internet distribution with a policy known as the Palapa Ring (Ministry of Law and Human Rights – Republic of Indonesia, 2016), and the development of a national data center through Presidential Regulation No. 39 of 2019 on One Data Indonesia (Ministry of Law and Human Rights – Republic of Indonesia, 2019). Digital government through the simplification of digital-based bureaucracy and the establishment of effective, responsive, and adaptive digital-based governance, as outlined in Presidential Regulation No. 95 of 2018 on the Electronic-Based Government System (SPBE) (Setneg, 2018). Digital economy through various regulations that facilitate digital economy actors (Kemendag, 2020). Digital society with policies aimed at enhancing digital human resources through the provision of Digital Talent Scholarship (DTS), the establishment of Professional Certification Institutions (LSP) in the field of ICT, and the granting of SKKNI certifications in ICT. This is intended to increase the number of human resources with specialized digital competencies (KOMINFO, 2021).

Cambodia has established a policy framework known as the Cambodia Digital Government Policy 2022-2025. This policy is centered on establishing a digital government to enhance the quality of life of the people and build trust through improved public service provision. It includes four strategic objectives and ten initiative strategies. The strategic objectives encompass promoting the development of digital government infrastructure, building digital governance and creating digital public services, developing digital capacity and innovation, and promoting cooperation between public and private partnerships. In the economic and social realms, Cambodia has outlined a policy in the Cambodia Digital Economy and Society Policy Framework 2021-2035. This policy focuses on ensuring a strong and crisis-resilient digital ecosystem and agility in addressing digital technology needs. The implementation of this policy is overseen by the Minister of Post and Telecommunications. This ministry plays a pivotal role in leading and coordinating ministries and institutions at both the national and sub-national levels in the digital transformation process (Ministry of Post and Telecommunications, 2022).

Singapore, in 2022 ranked as the highest in the e-government index in Southeast Asia. Its digitalization policy is outlined in the Digital Government Blueprint (DGB), which aims to establish a Singapore government that is "digital to the core and serves with heart." This policy is built on three pillars: Digital Society, Digital Economy, and Digital Government (MCI, 2020). A Digital Society ensures that everyone, regardless of their differences or circumstances, is empowered with an equal opportunity for success. To guarantee that all individuals, young and old, are well-prepared, the government assesses their readiness, which is published in the Digital Readiness Blueprint (MCI, 2018). A Digital Economy utilizes advanced technology to digitalize processes and foster business growth, attracting international investments and creating new jobs and opportunities in Singapore. A Digital Government, with its core digital approach, serves compassionately. Through digitalization, the government is able to provide services that are more empathetic, designing policies and services that are inclusive, seamless, and personalized to meet the needs of all citizens.

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The Philippines is among the countries actively engaged in digital transformation. Through the Digital Cities 2025 policy, the government concentrates on four key areas: talent, infrastructure, cost-effectiveness, and business environment. These elements are implemented across 25 cities. This policy is a continuation of the previous initiative, The Philippine Digital Strategy (PDS) Transformation 2.0: Digitally Empowered Nation, which spanned from 2006-2010 and focused on ICT Infrastructure, cyber services, human capital development, and e-Governance. This was followed by the PDS for 2011-2015, which aimed at enhancing the economy and society (CICT, 2014). Currently, the actions taken by the government encompass: Collaborative efforts through workshops and webinars are part of institutional development efforts to assist stakeholders in contributing to inclusive growth and job creation; Activities for talent development and attraction are designed to encourage careers in the sector, establish extensive training programs for both the workforce and academic institutions, and execute upskilling and reskilling programs for the current workforce and prospective entrants; The infrastructure development is to equip stakeholders with essential tools and resources to maximize the city's capacity for IT expansion; Additionally, to effectively promote the IT sector both domestically and internationally, a well-rounded marketing and communication strategy, along with advocacy initiatives, are crucial for regional areas (DICT, 2021).

The Union of the Republic of Myanmar, in its digitalization efforts, has established the Myanmar e-Governance Master Plan. This policy encompasses administration, social, economic, education, and health sectors managed by the Myanmar government and is implemented through e-Government (MOTC, 2017). In the economic domain, the Myanmar Digital Economy Committee has released the Myanmar Digital Economy Roadmap, which integrates digital transformation, digital government, digital trade, and digital society into a single digital economy (DEDC, 2019). Currently, a draft concerning the Myanmar e-Governance Master Plan 2030 is under discussion. The plan outlines objectives, targets, strategies, and frameworks, along with action plans for both short and long-term execution up to 2030. It includes the development of essential technical infrastructure and the comprehensive drafting of ICT Law, policies, guidelines, and standards.

Brunei has identified regulation and policy as one of its key missions to achieve digital transformation. Additionally, it focuses on developing digital capacity for all stakeholders, fostering the digital industry, and synergizing people, processes, and technology through a policy known as the AITI Strategic Plan 2020-2025 (MTIC, 2019). This is also referred to as the Connected Smart Nation, which is a strategy to achieve the outcomes set in the Digital Economy Masterplan 2025 (DEC, 2020). The policy concentrates on digital government, digital industry, and digital society. In the realm of education, Brunei has published a policy plan focusing on education technology, management technology in educational institutions, and enabling policy and infrastructure, targeted for the period 2023-2027 (MOE, 2022).

Malaysia embarked on its digital transformation journey as early as 1996 with the inception of the Multimedia Super Corridor (MSC). Since then, the Malaysian government has initiated various initiatives focusing on digitalization, technology adoption, and connectivity, targeting all aspects of life. With these substantial efforts, Malaysia ranked 31st in the World Digital Competitiveness Ranking 2022, following Singapore in the Southeast Asia region. The introduction of the Malaysia Digital Economy Blueprint (MyDIGITAL) in 2020 aims to benefit

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every citizen (EPU, 2020). This blueprint outlines plans to position Malaysia as a regional leader in the digital economy within a decade, from 2021 to 2030, through collaboration between the government, private sector, and people. It specifies Six Strategic Thrusts, including (1) driving digital transformation in the public sector, (2) boosting economic competitiveness through digitalization, (3) developing digital infrastructure, (4) building a digitally skilled workforce, (5) creating an inclusive digital society, and (6) establishing a trusted, secure, and ethical digital environment. These strategic thrusts are being implemented in three phases: Phase 1 focuses on laying the digital foundation, Phase 2 on driving digital transformation and inclusion, and Phase 3 on projecting the country as a pioneer in digital content and cybersecurity in the region.

Thailand is currently undergoing a transformation as outlined in their 20-year Thailand Digital Economy and Society Development Plan (Digital Thailand Plan), initiated in 2017. This plan aims to establish Thailand as a digital hub in Southeast Asia and includes six key strategies: (1) building country-wide high-quality digital infrastructure, (2) boosting the economy with digital technology, (3) creating a quality and equitable society, (4) transforming into a digital government, (5) preparing digital talents, and (6) building trust and confidence in the use of digital technology. The plan is divided into four phases, each focusing on a specific aspect of digital development. Phase 1, which began in 2017, laid the foundation of digital technology. Phase 2 ensured that every citizen in Thailand could access and fully utilize digital technology in social and economic areas. Phase 3, currently underway, aims to achieve four-dimensional goals within 10 years, focusing on raising the country's digital competitiveness, creating equal opportunities with information and digital services, developing digital human capital, and revolutionizing government operations. The final phase envisions Thailand as a global leader in the digital economy. A recent effort includes the establishment of the Eastern Economic Corridor (EEC) flagship project, covering three provinces in eastern Thailand (EEC, 2023). This project aims to attract investments in digital technology and is projected to drive digital transformation and workforce development in the near future.

On the other hand, Vietnam has taken significant steps towards digitalization with the National Transformation Program, aiming for key milestones by 2025 and a focus on 2030 (MIC, 2020; LuatVietnam, 2020). Approved in 2020, this program seeks to accelerate digital transformation by experimenting with new technologies and models across government, business, and citizen sectors. It also strives to create a safe, secure, and humane digital environment. The program focuses on eight key sectors: banking, healthcare, education, agriculture, transport, logistics, energy, natural resources, environment, and manufacturing. There are three main pillars: digital government, digital economy, and digital infrastructure (ASEMConnect, 2021). For digital government, objectives include fully digitalizing government services, establishing key economic sector databases, and aiming for a top 50 position in the E-Government Development Index. The digital economy goals include accounting for 30% of GDP from digital sources and ranking in the top 30 of the ICT Development Index (IDI), Global Competitiveness Index (GCI), and Global Innovation Index (GII). Lastly, digital infrastructure development will focus on providing widespread fiber Internet and 5G mobile network services and equipping 80% of the population with electronic payment accounts.

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Overall, digitalization initiatives in Southeast Asia countries are motivated by various factors. The primary aim is to boost economic growth and enhance competitiveness globally. These efforts focus on nurturing digital industries, attracting investments, and creating job opportunities. The countries also recognize the potential for improved public services through streamlined and efficient digital government systems. This approach ensures better access to government services, reduces bureaucratic hurdles, and increases transparency, ultimately leading to a citizen-centric government. Moreover, digital inclusion is a priority, aiming to ensure people of all ages and backgrounds benefit from digitalization. Efforts are directed towards creating a digitally skilled society where everyone can participate in the digital economy. International collaboration is a crucial aspect, with policies designed to attract foreign investments, foster private-sector partnerships, and align with global digital standards. Education and workforce development play integral roles, incorporating training programs, upskilling, and reskilling initiatives to equip individuals with digital skills required by the modern economy. Additionally, investment in digital infrastructure, including broadband networks and data centers, is crucial for widespread adoption of digital technologies. Policymakers also prioritize cybersecurity and data protection measures to ensure the safety and privacy of digital users and their data, considering the increased reliance on digital systems.

3. Methodology

3.1. Method

In conducting our in-depth analysis, we employed a robust bibliometric approach, leveraging the vast resources of the Scopus database. With a detailed search strategy, we focused our inquiry on the dynamic intersection of "digital*" within the expansive landscape of Southeast Asia. Our targeted query spanned across specific countries, encapsulating the diverse technological landscapes of Malaysia, Indonesia, Thailand, Singapore, Vietnam, Cambodia, Philippines, Myanmar, Laos, Brunei, and Timor-Leste.

The search parameters were applied to article titles, abstracts, and keywords, ensuring a comprehensive exploration of the research landscape. By narrowing our focus to these specific regions and employing a sophisticated search strategy, we aimed to examine key trends, emerging themes, and the evolving scientific discourse surrounding digital technologies in Southeast Asia. This methodological precision allows us to deliver insights that transcend traditional boundaries and offer a deeper understanding of the digital landscape within this dynamic and diverse geographical region. The included dataset is available for free download at the Zenodo (Kovac, 2023).

3.2. Sources of data and procedure

This study employs bibliometric analysis to provide a comprehensive overview of the existing literature on the subject. Many researchers have utilized the Scopus database for bibliometric analysis (Abbas et al., 2021). The preference for Scopus is attributed to its extensive range of publications compared to other databases (Sikandar et al., 2021) which led us to choose it as well. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram, depicted in Figure 1, guided the data collection for this systematic literature review, enhancing the review and meta-analysis's reliability.

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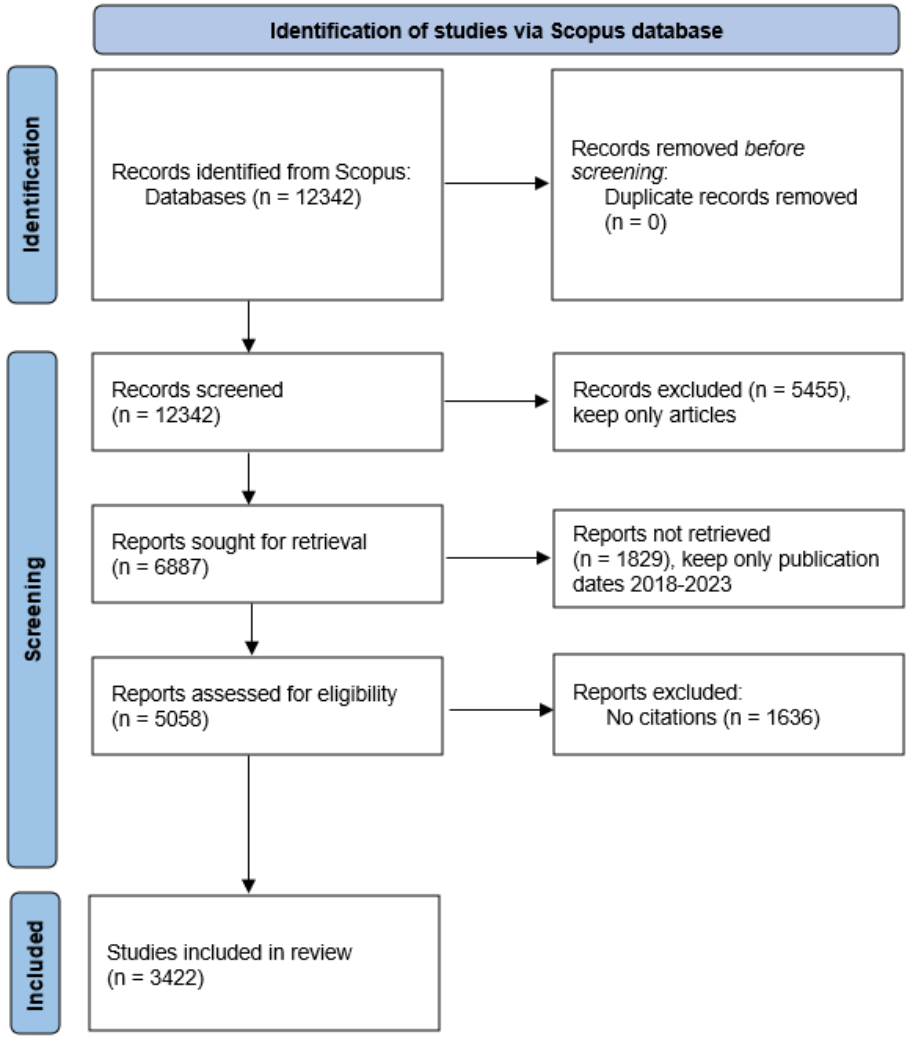

Figure 1. PRISMA flow diagram

The search query based on previously described keywords yielded 12342 articles, dating back to 1964. To ensure study quality, only journal publications were included, excluding conference papers or book chapters, resulting in 6887 articles. For bibliometric analysis, we focused on publications from the last five years (2018-2023), resulting in 5058 articles. Out of these, 3422 articles with more than 5 citations were selected for a systematic review to identify main research themes. The 5-citation limit was set to narrow the research scope to include only significant articles.

4. Results and discussion

The utilization of the PRISMA methodology for bibliometric analysis in the study on digitalization across Southeast Asia from 2018 to 2023 reflects a systematic and comprehensive approach to gather, assess, and categorize relevant scholarly works. The specified query, strategically formulated to encompass a broad spectrum of Southeast Asia countries, ensures inclusivity in the scope of the study, covering Malaysia, Indonesia, Thailand, Singapore, Vietnam, Cambodia, Philippines, Myanmar, Laos, Brunei, and Timor-Leste. This methodological choice is pivotal in capturing the diversity of digitalization efforts and scholarly

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contributions within the Southeast Asian context. The emphasis on the search query, combining "digital*" and specific country names, is a nuanced approach. It not only ensures the inclusivity of studies related to digitalization but also allows for a more tailored examination of the unique initiatives and challenges faced by each Southeast Asian country in their digitalization endeavors.

Moreover, the extraction of data elements such as article titles, abstracts, and keywords through PRISMA facilitates a structured and organized analysis. These elements serve as key indicators to categorize and understand the focus areas, trends, and themes prevalent in the digitalization of literature. The geographical segmentation of the study also enables a more granular examination of regional nuances and disparities in the digitalization landscape. Additionally, the methodology extends its focus beyond the content analysis to identify contributing institutions and journals. This holistic approach not only enriches the bibliometric analysis but also provides insights into the academic landscape and the dissemination channels for digitalization studies in Southeast Asia. In essence, the meticulous application of the PRISMA methodology aligns with best practices in systematic review and bibliometric analysis, ensuring the robustness and reliability of the study's findings.

4.1. Documents by year

Over the years, the number of articles receiving one or more citations has been increasing in the Southeast Asian dataset. In 2018, there were 306 articles meeting this criterion, and this number grew consistently in the following years. The count reached 453 in 2019, 609 in 2020, 775 in 2021, and peaked at 877 in 2022 before dropping slightly to 402 in 2023. This upward trend signifies overall progress in both the influence and recognition of academic publications in the region. The highest point of this trend was attained in 2022, as shown in Figure 2.

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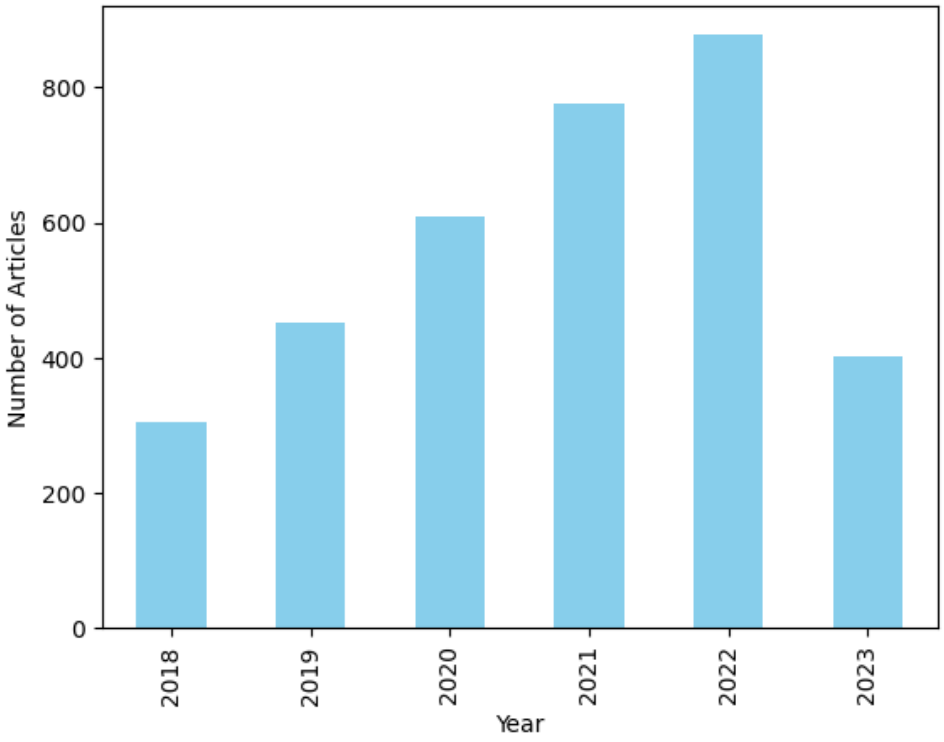

Figure 2. Number of articles on digitalization in Southeast Asia from 2018 to 2023

It is interesting to note that the dataset shows a decrease in the number of articles with more than zero citations in the year 2023, compared to previous years. The analysis covered 10.5 months of 2023, and the trend in the Southeast Asia dataset showed a decline from 877 articles in 2022 to 402 articles in 2023. This decline in 2023 may suggest a unique influence, possibly related to external factors such as the global COVID-19 pandemic. It appears that the years heavily impacted by the pandemic, notably 2020 and 2021, were more productive in terms of research output.

4.2. Documents by country

Figure 3 highlights a significant disparity in the volume of digitalization research across Southeast Asian countries. Timor-Leste, with only one article, along with Laos (six articles), Cambodia (15 articles), Myanmar (19 articles), and Brunei (23 articles), have limited research outputs in the field of digitalization. This suggests that these nations may either be in the nascent stages of developing their research capabilities or have less developed infrastructures supporting such studies. In contrast, Vietnam and the Philippines have contributed more substantially, with 91 and 146 articles respectively. This indicates a stronger research interest and possibly more developed IT infrastructures that facilitate these studies. Singapore and Thailand demonstrate a significant volume of research, with 339 and 404 articles respectively. This reflects robust academic environments and a keen interest in digitalization. Indonesia and Malaysia lead the region in research output, with 1106 and 749 articles respectively. This substantial contribution positions them as frontrunners in digitalization research within Southeast Asia. The high number of publications from these countries implies a more advanced

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state of digitalization research, possibly underpinned by well-developed IT infrastructure and a mature academic landscape that fosters such studies.

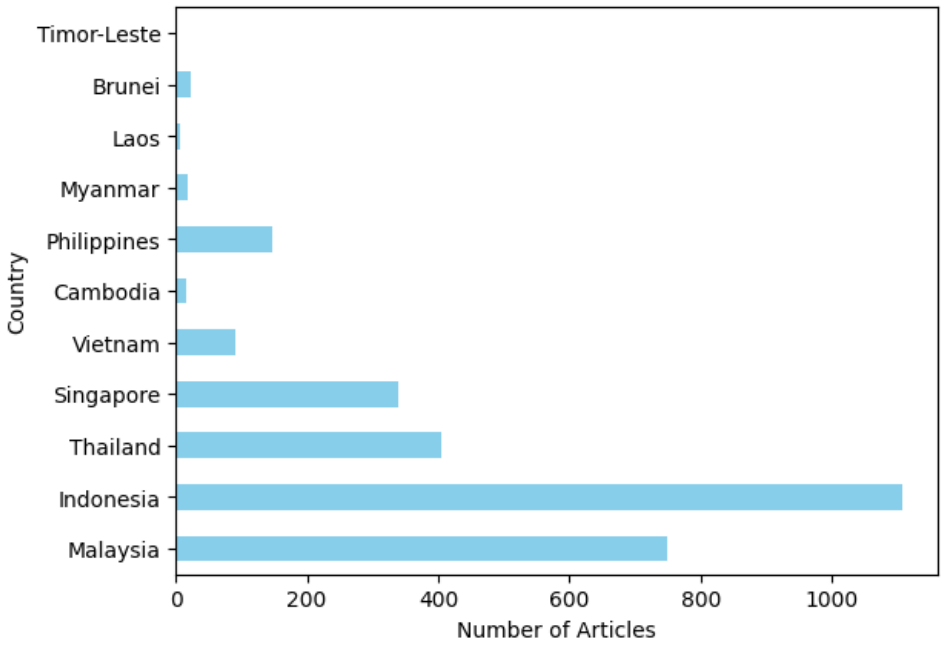

Figure 3. Number of articles on digitalization across Southeast Asia countries

The graph clearly shows the disparity in research output on digitalization among Southeast Asia countries. This could be due to several factors, such as the varying levels of technological advancement, priority given to IT and digital research within each country's academic agendas, or availability of resources dedicated to exploring and addressing digitalization.

4.3. Documents by authors and affiliations

Data regarding authors and their affiliations is illustrated in Figure 4. The distribution shown from the dataset for Southeast Asia indicates that the National University of Singapore has the highest number of articles, totaling 145. The second-largest contributor is Chulalongkorn University in Bangkok Thailand with 122 articles. Following this, Nanyang Technological University in Singapore contributed 113 articles. From Indonesia, Bina Nusantara University contributed 91 articles, followed by the University of Malaya from Malaysia, which contributed 75 articles. Additionally, article contributions in the distribution of authors per affiliation were made by Chiang Mai University of Thailand with 69 articles, Mahidol University of Thailand with 54 articles, Khon Kaen University of Thailand with 44 articles, Kasetsart University of Thailand with 37 articles, and Multimedia University of Malaysia with 34 articles.

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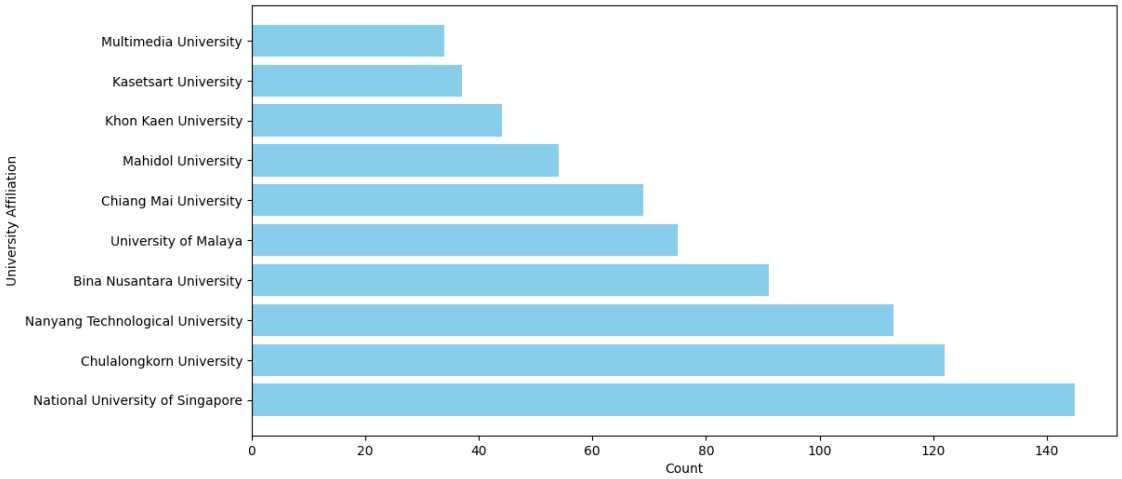

Figure 4. Number of articles by universities in Southeast Asia countries

The Observations made on the distribution of authors per affiliation indicate significant attention from researchers on the theme of digital divide in Southeast Asia. However, in terms of the countries where these universities are located, out of the 11 countries in Southeast Asia, research attention on the digital divide is primarily from universities in Singapore, Indonesia, Malaysia, and Thailand. Meanwhile, affiliations from other Southeast Asian countries such as Vietnam, the Philippines, Brunei, Laos, East Timor, Cambodia, and Myanmar have not yet given significant attention to themes of the digital divide. This situation presents an opportunity for affiliations in less represented regions to engage in and promote the topic of the digital divide as a research subject that needs further exploration.

4.4. Documents by source

The ten journals most frequently publishing articles on the digital divide in Southeast Asia are illustrated in Figure 5. The Scopus dataset reveals that the journal 'Sustainability' from Switzerland has the highest number of articles, totaling 66. In second place is the 'International Journal of Systematic and Evolutionary Microbiology', featuring 43 articles. Following closely in rankings up to the tenth position are: 'International Journal of Interactive Mobile Technologies' with 31 articles, 'Jurnal Komunikasi: Malaysian Journal of Communication' also with 31 articles, 'International Journal of Data and Network Science' with 29 articles, 'Remote Sensing' with 27 articles, 'International Journal of Innovation, Creativity and Change' with 25 articles, 'International Journal of Advanced Computer Science and Applications' with 22 articles, 'International Journal of Environmental Research and Public Health' with 20 articles, and finally, the 'Journal Water' from Switzerland, also with 20 articles.

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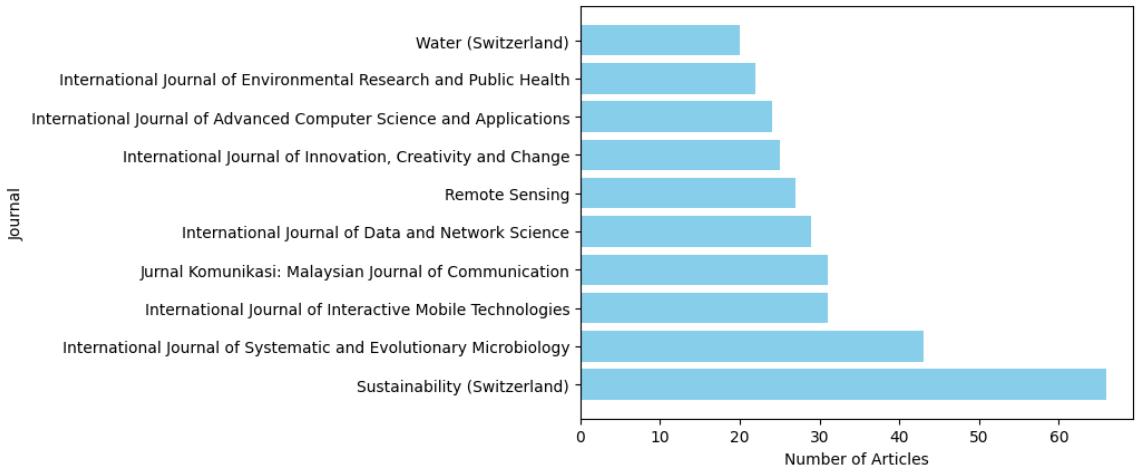

Figure 5. Number of articles in journals

Publication sources reflect the impact of articles within a scholarly community. Based on the sources, issues of the digital divide are featured in journals with impact factors ranging from 0.18 to 1.14, or within Quartiles 1-3. The highest impact factor is 1.14 for 'Remote Sensing' in the cross-disciplinary scholarly community. Out of the 10 sources, two are in Quartile 1, six in Quartile 2, and the remaining two in Quartile 3. This indicates that the majority of articles are published in communities with a good reputation. In terms of scope, four out of these 10 sources fall within the cross-disciplinary scholarly area. This suggests that the issue of the digital divide is not extensively discussed in specific communities but rather in multidisciplinary ones. It can be found in areas such as microbiology, health, communication, information technology, networking, and even environmental studies. Based on these sources, there appears to be opportunities namely to strengthen specific communities related to the digital divide.

4.5. Keywords networks

Figure 6 illustrates a breakdown of various keywords category related to digitalization in Southeast Asia. The most substantial segments attributed to human (10.5%), female (10.2%), and article (10.2%), indicating their significant presence within the database. Next, closely following these are male (8.8%), adult (8.1%), and humans (8.0%) categories. Based on the geographical categories, Indonesia (8.0%), Thailand (7.9%), Malaysia (7.0%), and Singapore (4.3%), pointing to a possible regional aspect of the data. Additionally, digital storage (5.1%) and middle-aged (4.6%) appear as distinct categories that may potentially referencing the age group of subjects and the data storage method used in the study. The smallest segment is controlled study aged at 3.7%, hinting at a specific age-related subset within the research. These keywords effectively convey the proportional relationships between the various categories, suggesting a diverse range of data points and interests represented in the overall dataset.

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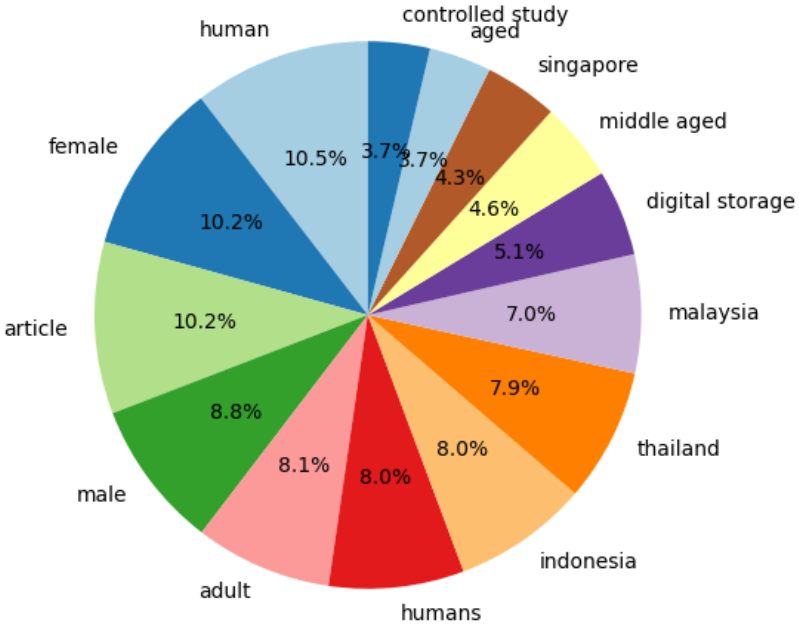

Figure 6. Breakdown of keywords on digitalization

Figure 7 reveals a comprehensive exploration of diverse research fields, emphasizing the multifaceted nature of digitalization. With digital storage commanding a substantial 44.6%, the findings highlight a predominant scholarly focus on efficient and secure data storage—a critical facet in contemporary research and technological progress. The distribution across fields such as droplet digital polymerase chain reaction, digital transformation, digital image, digitization, digital technologies, digital mapping, digital technology, and digital elevation model underscores the interdisciplinary character of the study. For instance, the inclusion of digital transformation (3.3%) suggests a concentration on strategic and organizational dimensions of digital advancements. Furthermore, the notable percentage (20.8%) dedicated to the digital elevation model signals the importance of geospatial and terrain-related research within the digitalization discourse. This diverse array of research areas not only enriches the study but also reflects the varied impacts and applications of digital technologies across scientific domains.

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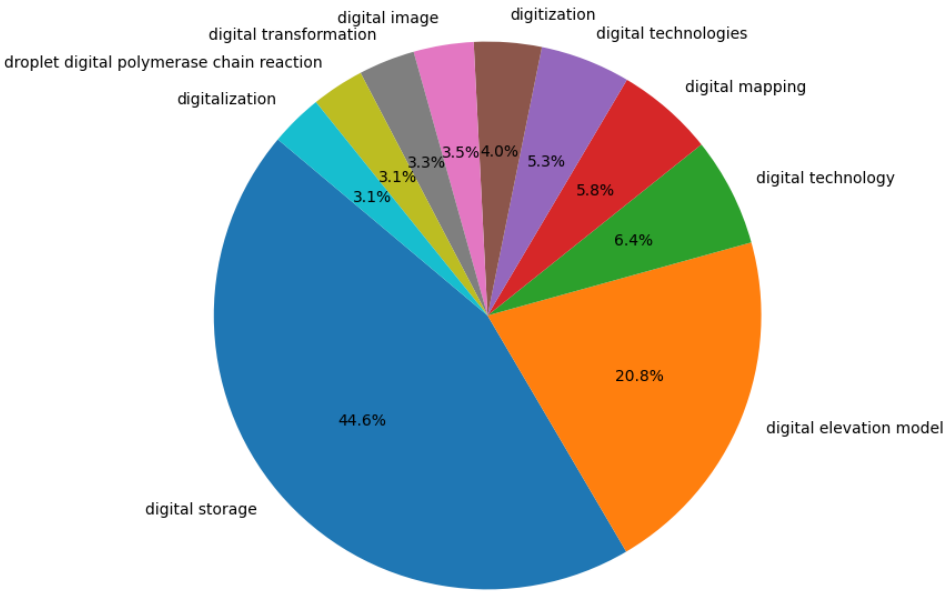

Figure 7. Field of research on digitalization

4.6. Network visualization

The final datasets obtained through the application of the PRISMA selection methodology, were subjected to in-depth analysis using Visualization of Similarities Viewer (VOSviewer) software. The utilization of VOSviewer in this study holds paramount importance for several reasons. VOSviewer provides a powerful tool for visualizing and understanding complex networks of scholarly works, offering a clear and comprehensive overview of the research landscape. The ability to visually represent relationships between keywords and clusters enhances the interpretability of the data, allowing researchers to identify patterns and trends that may not be immediately apparent in traditional analyses.

VOSviewer also aids in uncovering thematic and conceptual structures within the vast body of scholarly literature, particularly in the context of digitalization in Southeast Asia. By clustering related keywords, the tool enables the identification of key themes and topics, contributing to a deeper understanding of the research landscape. Thirdly, the visual representation of keyword clusters, such as those identified in European and Southeast Asian studies, facilitates cross-regional comparisons. This visual approach is crucial in highlighting linguistic and thematic differences, providing researchers with insights into the diverse nature of research dissemination dynamics across regions.

Overall, VOSviewer serves as an indispensable instrument for researchers conducting bibliometric analyses, offering a visually intuitive means to explore, interpret, and communicate complex relationships within scholarly literature. In the context of this study, the tool has played a crucial role in uncovering the nuanced patterns and thematic distinctions in the field of digitalization in Southeast Asia.

The conclusive datasets underwent thorough analysis using VOSviewer, employing the entire spectrum of keywords as defined by the authors. A minimum keyword occurrence threshold of 15 was employed, leading to 320 keywords meeting the threshold out of the initial 19743 keywords. This carefully chosen threshold ensures a focused and meaningful exploration

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of the keyword co-occurrence patterns within the datasets. Thirty keywords were identified as disconnected and subsequently eliminated from the analysis. The excluded words or phrases included rna, dna, fatty acid, phospholipid, nucleic acid, streptomyces, vitamin k 2. Consequently, 295 connected keywords were selected for further exploration.

As shown in Figure 8, a total of 295 keywords have been categorized into 5 clusters, with the largest cluster comprising 96 keywords. This prominent cluster is centered around key themes such as Indonesia, Malaysia, COVID-19, social media, e-learning and digital literacy. The cohesiveness of these keywords within a substantial cluster suggests a significant focus on developing digital competencies in the context of the pandemia crisis.

The visualization presented in Figure 8 shows clusters derived from the analysis using VOSviewer, offering insights into the thematic distribution of studies related to digitalization in Southeast Asia. The second cluster, consisting of 76 items, highlights keywords such as digital storage, remote sensing, and digital elevation model, with specific focuses on Vietnam and the Philippines. This suggests a substantial body of research in these countries concerning storage technologies and spatial data. In the third cluster, encompassing 46 items, keywords like human, female, male, adult, article, controlled study, major clinical study, and aged indicate a cluster primarily related to demographic and clinical aspects. The fourth cluster, with 46 items, centers around Singapore, addressing topics such as pandemics, coronavirus disease, psychology, mental health, and cross-sectional studies, shedding light on the psychological and health dimensions of digitalization during the pandemic. Lastly, the fifth cluster, comprising 31 items, revolves around Thailand, emphasizing areas like genetics, nonhuman chemistry, phylogeny, bacterium identification, and bacterial typing techniques, showcasing the molecular and biological facets of digitalization research in Thailand. This nuanced analysis provides a comprehensive overview of the diverse themes and geographical focuses within the digitalization discourse in Southeast Asia.

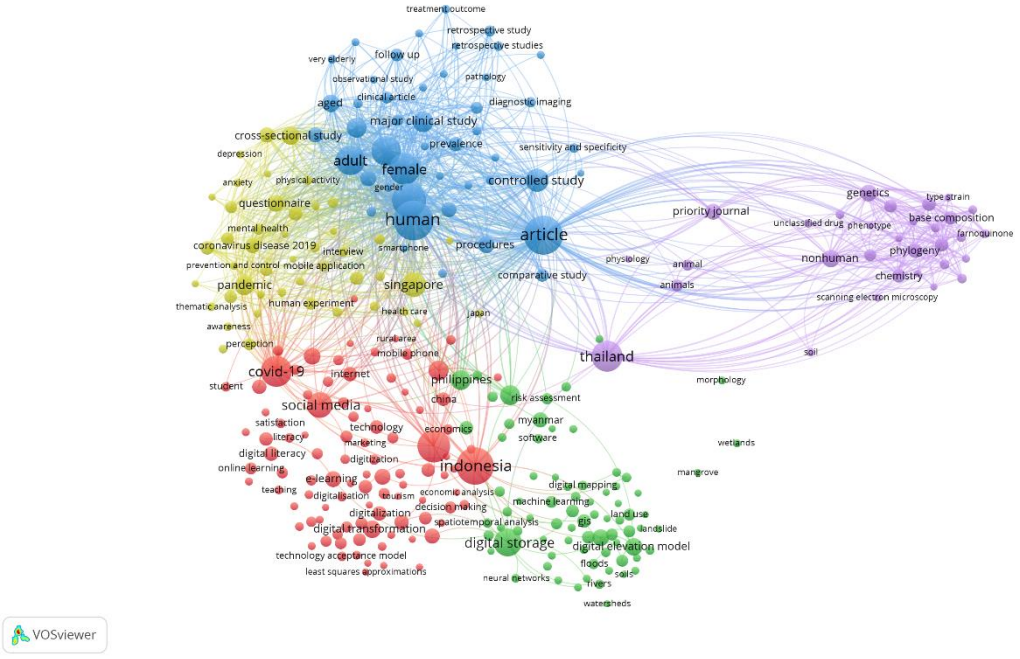

Figure 8. Keyword co-occurrence

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In contrast to the concentrated network visualization focused on Europe, the analysis of keywords defined by authors using VOSviewer reveals a more dispersed pattern. European studies, while sharing similar clusters, exhibit lower contributions within each cluster. This discrepancy may be attributed to the likelihood that many European publications are distributed across diverse languages, unlike studies in Southeast Asian countries, which are predominantly published in English. For instance, in the European context, Cluster 1 exhibits 310 total link strength with 17 items, encompassing keywords like human, male, female, and risk factors. In contrast, Cluster 2 revolves around Southeastern, Asia, Malaysia, Thailand, and environmental monitoring, with a total link strength of 138 and 16 items. The third cluster, comprising 8 items, includes keywords such as air pollutants, air pollution, ASEAN, and Covid-19. Cluster 4, with a total of 5 items, covers topics like animals, malaria, phylogeny, and Vietnam. Lastly, Cluster 5, totaling 2 items, focuses on asia/southeast asia and health policy. This nuanced analysis underscores the distinct linguistic and thematic characteristics between European and Southeast Asian publications, shedding light on the diverse research landscape across regions. The comparative analysis suggests that studies on the digital divide in Europe may lean towards demographic and clinical aspects, while Southeast Asian studies exhibit a broader thematic spectrum, including technological, environmental, and regional dimensions.

4.6. Overlay visualization

The study's findings on the overlay visualization based on Figure 9 correspond with various fields of research, particularly those conducted between 2020 and 2021. This visualization effectively captures the trends in studies during the contemporary period. Notably, recent research on the digital divide in Southeast Asian countries is prominently linked to the ongoing pandemic, specifically addressing COVID-19-related challenges. This trend underscores the dynamic nature of academic discourse, with scholars adapting their focus to the current socio-economic and public health landscape. In contrast, older studies on the digital divide in Southeast Asian countries featured keywords such as priority journals, pathology, biological marker, adolescence, and middle age. This juxtaposition highlights the evolving research priorities over time, showcasing the responsiveness of scholarly endeavors to the prevailing societal context and emphasizing the intersection of digitalization research with broader global issues.

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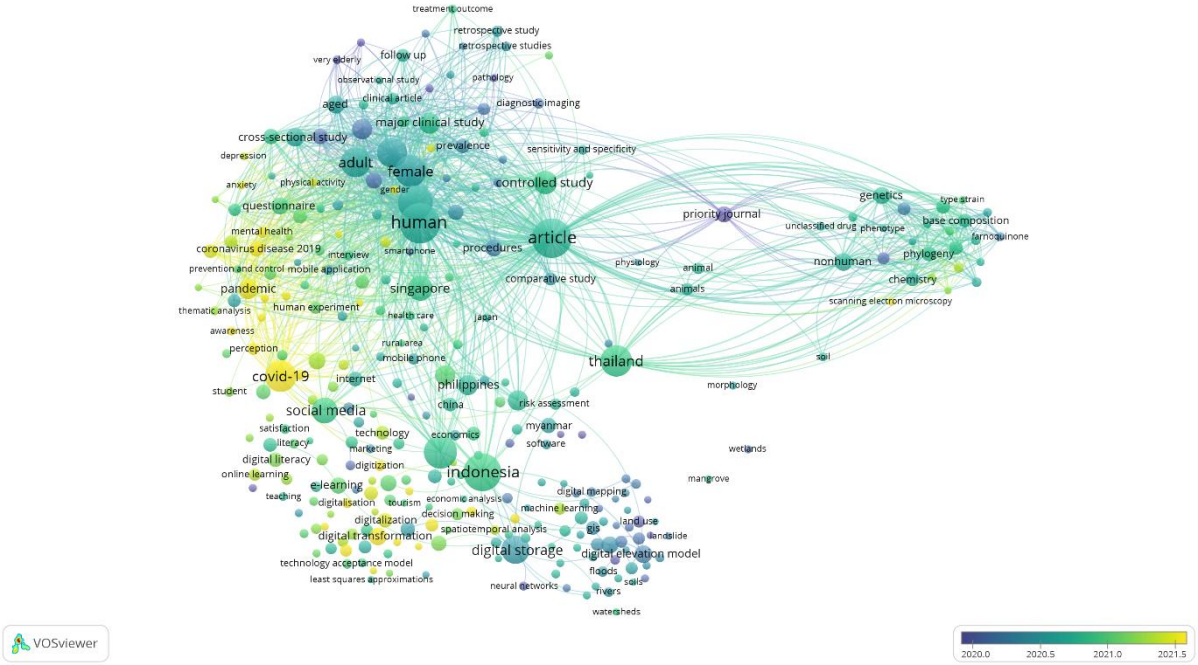

Figure 9. Network map of trending topics in digitalization

4.7. Density visualization

The review of data regarding keyword analysis using VOSviewer as illustrated in Figure 10 reveals intriguing patterns in the prioritization of terms within the scholarly landscape. Notably, high-frequency terms such as "Human," "Indonesia," "Female," and "Covid-19" emerge as central themes, indicating a significant focus on human-centric aspects and the impact of the COVID-19 pandemic, especially within the Indonesian context. On the other hand, less frequently used keywords, including "genetics," "nonhuman chemistry," "phylogeny," "bacterium identification," and "bacterial typing techniques," suggest a relatively lower emphasis on these specific scientific domains. One might assume that the prominence of terms like "Covid-19" reflects the urgent need for research addressing the ongoing global health crisis. Meanwhile, the lower frequency of terms related to genetics and bacterial studies could indicate a potential gap or lesser emphasis in the current discourse on these intricate scientific domains within the Southeast Asian context. This assumption highlights the dynamic nature of research priorities, influenced by societal needs and emerging challenges.

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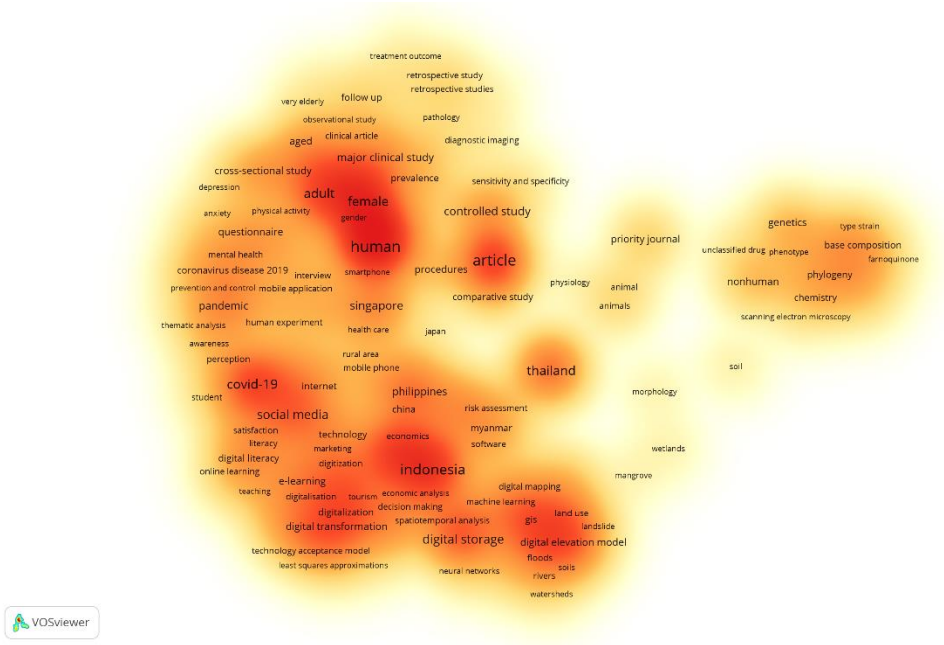

Figure 10. VOSviewer density visualization of the keywords on digitalization

The exploration of the relationship between National Intellectual Capital (NIC) and digital transformation in European countries provides valuable insights applicable to the study of the digital divide in Southeast Asian nations. Similar to Europe, Southeast Asian countries may witness geographical divisions in NIC assets, influenced by historical and regional factors. The correlation between higher NIC scores and enhanced readiness for digital transformation in Europe underscores the significance of education and workforce development, offering pertinent lessons for Southeast Asian nations. Human and social capital, particularly working skills, emerge as pivotal predictors for Digital Transformation Readiness in both regions, emphasizing shared priorities in developing essential capabilities. The existence of a digital divide among EU member states highlights the need for targeted interventions, relevant to Southeast Asian countries grappling with digital disparities. Although structural capital may not significantly predict overall digital readiness in Europe, its role in the first-level digital divide suggests potential implications for Southeast Asian nations addressing infrastructure challenges. Social capital stands out as a critical factor in both regions, emphasizing its pivotal role in fostering digital inclusion. These findings underscore the importance of a skilled workforce and offer actionable policy insights for Southeast Asian nations navigating the digital landscape (Švarc, Lažnjak & Dabić, 2021).

Furthermore, the conclusions drawn from the scoping review on the digital divide in Europe resonate with potential themes and recommendations for studies on the digital divide in Southeast Asian countries. Both underscore the dual focus on access and use, recognizing the pivotal role of public authorities in policy design and implementation. There is a shared acknowledgment of the importance of addressing local specifics and collaborating with stakeholders, such as supplier companies and social agents. The emphasis on empowering rural populations and overcoming resistance to technology finds common ground in both contexts, reflecting the global challenge of digital inclusion (Esteban-Navarro et al., 2020).

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Similarly, the specific recommendations for impactful change, such as linking improved connectivity to new business models, ensuring coherence in initiatives, and prioritizing the rapid implementation of advanced technologies, are applicable in the Southeast Asian context. The call to leverage niche providers, design flexible training for teachers, optimize resource use in rural libraries, and plan initiatives for vulnerable groups aligns with the broader goals of narrowing the digital divide. However, the applicability and effectiveness of these recommendations may vary based on the unique socio-economic, cultural, and infrastructural landscapes of Southeast Asian countries. Therefore, while the overarching themes are relevant, a nuanced approach that considers regional specificities will be crucial for effective policy implementation and research in the Southeast Asian context.

5. Conclusions

Bibliometrics analysis serves as a powerful tool in unveiling key trends and dynamics in the realm of digitalization across Southeast Asia. The breakdown of keywords provides valuable insights into the focal points of research, illuminating the diverse aspects of digitalization that scholars in the region find relevant. This understanding aids in shaping future research agendas, allowing for targeted investigations into specific dimensions of digital transformation. The field of studies on digitalization, as identified through bibliometrics, reflects the interdisciplinary nature of the subject. From digital storage and digital mapping to digital technologies and transformation, the breadth of research signifies the multifaceted impact and applications of digitalization in Southeast Asia. The data on the number of published articles and journals along with university-specific contributions provides an overview of the scholarly landscape. Identifying prolific institutions sheds light on hubs of expertise, potentially guiding collaborative efforts and knowledge-sharing initiatives. Furthermore, the geographical distribution of articles across Southeast Asia countries underscores regional nuances and differences in the digitalization discourse.

From a managerial standpoint, these insights can inform policymakers, industry leaders, and academia about the areas of focus, emerging trends, and collaborative opportunities. The data from 2018 to 2023 adds a temporal dimension, allowing for the assessment of evolving research trajectories and aligning managerial strategies with current and future research priorities. The bibliometrics analysis for this study not only maps the scholarly terrain but also offers actionable intelligence for decision-makers in navigating the digitalization landscape across Southeast Asia.

Limitations

This research presents a comprehensive bibliometric study of scholarly works from Southeast Asia, covering a diverse range of research themes, including those focused on the digitalization domain. The study aims to remain objective and all-encompassing, but it recognizes certain limitations. The most notable limitation is the exclusion of non-English publications from the Scopus database, which could potentially narrow the scope of analysis. Furthermore, bibliometric data is dynamic, and the study's conclusions may shift as new information becomes available. Therefore, we recommend regular updates to maintain the study's relevance. Additionally, it's important to note that bibliometric analysis may not accurately reflect current trends, especially in regard to recently published works that have yet to receive significant citations. As a result, emerging trends and the long-term impact of these publications may not be fully represented.

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