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Bibliographic Coupling Analysis IR4.0: Challenges and Opportunities in Southeast Asia

Abstract: - The fourth industrial revolution, known as Industry 4.0 or IR4.0, has garnered global attention for its transformative potential in revolutionizing manufacturing and industrial processes. This research conducts a bibliometric analysis using data from the Scopus database and the VOSviewer application to explore the current research landscape of IR4.0 in Southeast Asia. Findings reveal seven thematic clusters representing various aspects of IR4.0 integration and performance in the region. These clusters highlight the challenges, opportunities, and emerging themes surrounding IR4.0 adoption and implementation. Additionally, the study underscores the significance of Southeast Asian countries, particularly developing nations, in driving economic development through IR4.0 technologies. Insights from this study can inform business owners, policymakers, and academia about the evolving landscape of IR4.0 in Southeast Asia, aiding in strategic decision-making and technology adoption. Furthermore, the study suggests that the future of IR4.0 in the region hinges on the development of effective strategies, models, and technologies to enhance its implementation and impact.

Keywords: IR4.0, Southeast Asia, digital transformation, Scopus, Bibliometric analysis, Bibliographic Coupling.

I. INTRODUCTION

Industry 4.0 or IR4.0, has attracted significant attention worldwide since 2011 due to its transformative potential in revolutionizing manufacturing and industrial processes [1]. This paradigm shift is driven by advancements in digital technologies such as the Internet of Things (IoT), big data analytics, additive manufacturing, artificial intelligence, and robotics. While the discourse surrounding IR4.0 has primarily focused on its implications in developed economies, its relevance and impact in emerging regions, particularly Southeast Asia, cannot be overlooked.

Southeast Asia region (Figure 1), comprising countries such as Malaysia, Indonesia, Singapore, Brunei, Philippines, Thailand, Cambodia, East Timor (Timor-Leste), Laos, Myanmar, and Vietnam, presents a diverse and dynamic landscape characterized by varying levels of economic development, technological infrastructure, and industrial capabilities. Against this backdrop, understanding the adoption, challenges, and opportunities associated with IR4.0 in each of these countries is crucial for navigating the region's industrial transformation and fostering sustainable development. As a developing region with a growing manufacturing sector and is rapidly embracing digital technologies, Southeast Asia stands poised to benefit immensely from the adoption of IR4.0 technologies. Countries like Singapore and Malaysia have already embarked on ambitious initiatives to position themselves as regional hubs for advanced manufacturing and innovation, leveraging IR4.0 to enhance productivity, efficiency, and competitiveness [2-3]. However, other nations in the region, such as Cambodia, Laos, and Myanmar, face significant challenges related to infrastructure, human capital, and regulatory frameworks, which may impede their ability to fully embrace IR4.0 [4]. Moreover, the COVID-19 pandemic has underscored the importance of digitalization and resilience in mitigating disruptions to supply chains and sustaining economic activities. In

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response, Southeast Asian countries are increasingly prioritizing digital transformation and IR4.0 as key pillars of their post-pandemic recovery and long-term economic resilience strategies [5-6].

Figure 1. Southeast Asia Region

IR4.0 revolutionizes manufacturing and industrial processes by integrating various technologies and components. For instance, the application of IR4.0 operates through mobile devices with IoT platforms to detect the location and advanced human-machine interfaces that are used in daily lives. Smart sensors, authentication, fraud detection systems, big data analytics, augmented reality, and data visualization tools are the technologies that are currently applied in the industry. Mainly, these technologies can be summarized into four major components that define the term IR4.0 or smart factory: IoT, on-demand availability of computer system resources (e.g., cloud computing), cyber-physical systems and cognitive computing [7-8]. However, the main pillars and technologies that underpin IR4.0 are big data; autonomous robots; simulation; horizontal and vertical system integration; industrial IoT; cloud computing; additive manufacturing; augmented reality; and cybersecurity (Table I).

Table I: Indicates the summary of the concepts of IR4.0.

The Concepts	The definitions	Examples of the concepts in the industry
Big data	Large, complex datasets.	Big Data assists manufacturers by predicting maintenance needs, preventing downtime, and creating a safe and secure work environment.
Autonomous robots	Intelligent machines that can perform tasks and operate in an environment independently, without human control or intervention.	A collaborative robot, also known as a 'cobot', is an industrial robot that can safely operate alongside humans in a shared workspace.
Simulation	Mathematical modelling, algorithms that optimize the process.	Simulation software enables users to mimic the behaviour of real-world systems.
Horizontal and vertical system integration	Integration of the inside of the factory and supply chains.	Smart factory (technological advancements that enable digitalization and integration of intelligent systems automation).
IoT	Connection of the physical objects and systems.	Smart network, connected manufacturing equipment.
Cloud computing	Shared platforms that serve multiple users	The vehicle manufacturer implemented cloud manufacturing to revolutionize its production operations.

Additive manufacturing	3D printing technology, producing in mass customization.	3D printers to produce smartphones.
Augmented reality	An interactive experience that combines the real world and computer-generated content.	Design and prototyping phase of automotive manufacturing.
Cybersecurity	Application of technologies, processes, and controls to protect systems, networks, programs, devices, and data from cyber-attacks.	Cyber-physical systems (CPS) refer to a modern manufacturing system that offers an information-transparent environment to facilitate asset management, provide reconfigurability, and maintain productivity.

Source: Adapted from Eboz [7].

IR4.0 builds upon earlier industrial revolutions, incorporating advancements in cyber-physical systems, the IoT, artificial intelligence (AI), big data analytics, and additive manufacturing [8-9]. At its core, IR4.0 seeks to create "smart factories" where machines, systems, and humans communicate seamlessly, leading to increased efficiency, flexibility, and customization in manufacturing processes.

This study's motivation is twofold—first, the importance of IR4.0 towards national development. IR4.0 comprises sophisticated and advanced technologies that can improve performance and efficiency. Despite such challenges, the Southeast Asia region is the primary actor in the country's economic growth [10]. The technologies positively influence Southeast Asia region by improving their supply chains, gaining throughout the value chains and preparing for disruptive technologies worldwide [11]. Apart from the economic view, The Southeast Asia region needs to adopt IR4.0, as advanced technologies require companies to embrace the triple bottom line of sustainability. This expansion in meaning is crucial for transformation and competitiveness in the challenging business market [12]. Thus, determining the predictors and determinants for this region's adoption of IR4.0 based on the past literature would assist in IR4.0 adoption and implementation.

Secondly, there have been no studies that apply the science mapping technique to uncover the knowledge structure of IR4.0 in the Southeast Asia region. Many studies have reviewed IR4.0 adoption in Southeast Asian countries from different perspectives. Adnan et al. [13] reviewed the IoT implementation framework in IR4.0 in Malaysia. Rodzalan et al. [14] performed a systematic review based on IR4.0 has brought significant changes in the requirement of skills and qualifications. Similarly, Nasreen et al. [15] conducted a systematic literature review within 2017-2021 focusing on unemployment among university students with special reference to relevant employability skills for IR4.0. In another study, Adam et al. [16] performed a systematic literature review based on the manufacturing sector in Singapore and several countries including China, the United Kingdom, the United States, and the European Union which reveals the rapid growth and the effect of IR4.0. In a much closer approach to science mapping, Khan & Qureshi [17] reviewed the work on ASEAN country's sustainable manufacturing growth research, however, the study only focused on hybrid processes and IR4.0 for establishing sustainable manufacturing procedures in the ASEAN member countries.

These reviews' contribution to IR4.0 adoption in Southeast Asia is fundamental to understanding the role of IR4.0. However, a pertinent gap in the literature must be addressed to comprehend the prevailing issues of IR4.0 in Southeast Asian countries based on the structure of knowledge that links these publications through scientific visualization. Thus, the objective of this study is to determine the current research streams in IR4.0 within the Southeast Asia region its current challenges and opportunities through bibliographic coupling, aiming to identify and analyze prevalent trends and themes. With this objective, the primary focus of this review is to provide an in-depth evaluation of the most crucial themes for researchers and practitioners in the Southeast Asia region to acknowledge the impact of IR4.0 on the overall business market. The first section of this paper presents the role of IR4.0 in Southeast Asia and its importance to economic growth. Section 2 outlined the bibliometric approach applied in this study and the research design performed. Section 3 discusses the findings based on the clusters generated from the bibliographic coupling. Next, section 4 presents the theoretical and managerial implications of IR4.0 in Southeast Asia. Section 5 presents the limitations and suggestions for future works. Finally, section 6 concludes the study.

II. METHODOLOGY

2.1 Bibliometric analysis

According to Donthu et al. [18], the bibliometric approach is a quantitative method that has gained popularity for analyzing large volumes of scientific publications. It was comparing bibliometric analysis with other well-known techniques such as meta-analysis and systematic literature review. According to Zupic & Cater [19], the bibliometric approach presents a measurement of objectivity within the scientific literature by mitigating researcher bias and increasing rigour through the aggregation of multiple scholars working in the same field. In meeting the objectives of this study, bibliographic coupling analysis is used. This analysis is a science mapping technique that assumes two publications with similar references have similar content [20]. The clusters in the network map are formed based on citing publications, thereby highlighting the most recent research publications. This analysis is suitable for assessing the latest developments in current research [18].

2.2 Research Design and Procedures for Data Collection

We used the following search keyword (Table II) to locate relevant publications in the Scopus core collection database. The Scopus is widely regarded as the most authentic database and the largest abstract and citation database of scientific literature globally [21]. This bibliometric review is only limited to journal publications, leaving out books, book chapters, conference proceedings, editorials, white papers and other publication categories. Limiting only journal publication is due to the rigorous peer review process that journals undergo to meet quality criteria for publication [22]. VOSviewer (Version 1.6.18) was used as the software or program for analysis. Compared to other software, VOSviewer can specifically be used for graphical representation in bibliometric analysis. It is open-source software, freely available for constructing network visualizations of scientific maps [23].

Table II: Search keyword in the Scopus database

No	Keywords	Justification
1	"industry 4.0" OR "fourth industrial revolution*" OR "IR4.0" OR "4.0 IR" OR "industrial revolution 4.0"	To identify literature related to IR4.0 and its related terminologies
2	"southeast asia" OR "malaysia" OR "indonesia" OR "brunei" OR "cambodia" OR "east timor" OR " timor-leste" OR "laos" OR "myanmar" OR "burma" OR "philippines" OR "singapore" OR "singapura" OR "thailand" OR "vietnam"	To identify literature on the location of Southeast Asia and its relation to IR4.0, and related terminologies.

III. FINDINGS AND DISCUSSION

The search was performed on 29 February 2024. The initial number of documents retrieved was 1,258. After filtering only journal publications, the finalized number was 672. Figure 2 shows the total number of publications in Southeast Asia and Worldwide on IR4.0. The field is relatively new, with the first publication only emerging in 2011. Since then, it has increased drastically, with more than 3,210 publications in 2023. It is expected that publications in Southern Asia will also continue to rise as technologies in IR4.0 expand worldwide. Meanwhile, Figure 3 shows the total number of publications and citations on IR4.0 in Southeast Asia. Technological innovation, integration, and operation performance will be the main subject of interest in this region.

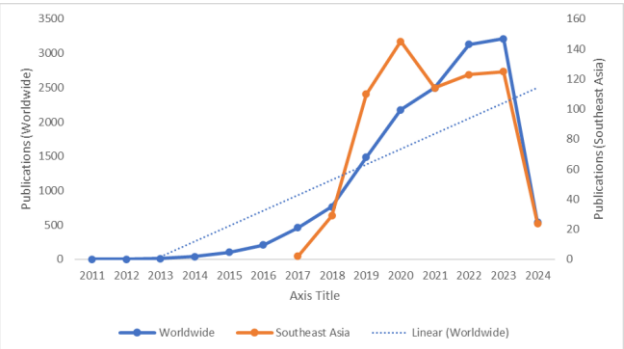

Figure 2. Number of publications on IR4.0 in Southeast Asia and Worldwide. (Source: Scopus)

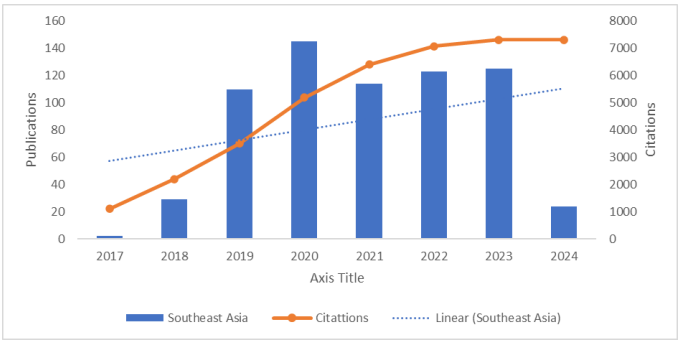

Figure 3. Number of publications and citations on IR4.0 in Southeast Asia (Source: Scopus)

Using metadata retrieved from the Scopus database, it was found that authors from 59 countries have published works on IR4.0 in Southeast Asia. Figure 4 shows the ten countries with the highest number of authors. Malaysia has the most author affiliations, with 271 papers (40.3%), followed by Indonesia with 239 papers (35.6%). Vietnam occupies the third position with 103 papers (15.3%). Thailand with 42 papers (6.3%) and Australia which is a non-Southeast Asia region occupies 18 papers (2.7%). The Philippines occupies the sixth position with 17 papers (2.5%). Japan, Taiwan and the United Kingdom come next, each with 16 papers (each 2.4%), followed by Singapore with 15 papers (2.2%).

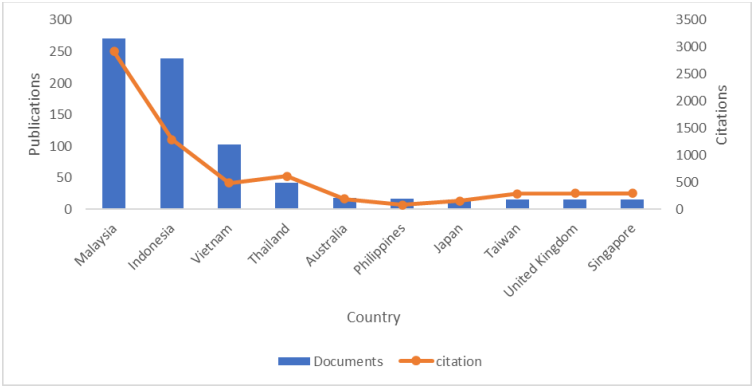

Figure 4. Top 10 countries of origin of authors who papers related to IR4.0 in Southeast Asia

3.1 Bibliographic coupling

From the 465 primary documents in the bibliographic coupling study, 36 documents exceeded the 24-citation criteria, resulting in seven clusters. The threshold was determined through a series of trials until the network visualization achieved the most robust and appropriate number of clusters for further interpretation. The threshold was tested several times with 20, 21, 22, 23 and 25 until the most stable map was produced. The threshold must not be too high or too low, which could lead to over-filtering and under-filtering, respectively. Since bibliographic coupling pays attention to the link of the citing publication, the value of interest is the total link strength (TLS) of the publication. It reflects the coupling strength of the recent relationship of the citing publication on the most influential document. Publications with the highest number of TLS are Kurniawan et al. [24] (21 TLS), Kurniawan et al. [25] (21 TLS) and Ślusarczyk et al. [26] (14 TLS). Of these 36 documents, only 32 were interconnected, producing the network presented in Table III.

Table III: The bibliographic coupling analysis top 10 documents

Rank	Research paper (Year)	Author(s)	Citation	TLS	Cluster
1.	Strengthening waste recycling industry in Malang (Indonesia): Lessons from waste management in the era of Industry 4.0 (2023).	Kurniawan T.A.; Meidiana C.; Dzarfan Othman M.H.; Goh H.H.; Chew K.W. [24].	**35**	**21**	**3**
2.	Unlocking digital technologies for waste recycling in Industry 4.0 era: A transformation towards a digitalization-	Kurniawan T.A.; Dzarfan Othman M.H.; Hwang G.H.; Gikas P. [25].	75	**21**	**3**

	based circular economy in Indonesia (2022).				
3.	Fourth industrial revolution: A way forward to attain better performance in the textile industry (2019).	Ślusarczyk B.; Haseeb M.; Hussain H.I. [26].	**36**	**14**	**1**
4.	The drivers of Industry 4.0 in a circular economy: The palm oil industry in Malaysia (2021).	Abdul-Hamid A.-Q.; Ali M.H.; Osman L.H.; Tseng M.-L. [27].	38	**11**	**2**
5.	Factors affecting adoption of Industry 4.0 by small-and medium-sized enterprises: A case in Ho Chi Minh City, Vietnam (2020).	Nguyen X.T.; Luu Q.K. [28]	**34**	**11**	**2**
6.	Impeding challenges on industry 4.0 in circular economy: Palm oil industry in Malaysia (2020).	Abdul-Hamid A.-Q.; Ali M.H.; Tseng M.-L.; Lan S.; Kumar M. [29]	90	**10**	**2**
7.	How Industry 4.0 technologies and open innovation can improve green innovation performance? (2021).	Mubarak M.F.; Tiwari S.; Petraite M.; Mubarik M.; Raja Mohd Rasi R.Z. [30]	**68**	**9**	**2**
8.	Future-ready project and facility management graduates in Singapore for Industry 4.0: Transforming mindsets and competencies (2021).	Low S.P.; Gao S.; Ng E.W.L. [31].	32	**9**	**5**
9.	Dynamic capabilities for smart manufacturing transformation by manufacturing enterprises (2020).	Lin T.-C.; Sheng M.L.; Jeng Wang K. [32].	**35**	**9**	**6**
10.	Industry 4.0: A solution towards technology challenges of sustainable business performance (2019).	Haseeb M.; Hussain H.I.; Ślusarczyk B.; Jermsittiparsert K. [33].	322	**9**	**1**

Subsequently, Figure 5 presents the bibliographic coupling network visualization of IR4.0 in Southeast Asia. There are 7 clusters produced from the database, showing seven themes based on the current research front in IR4.0 in Southeast Asia. The following clusters are labelled based on the authors' interpretation of each cluster's publications. Cluster 1 (red) with 9 documents, this cluster is labelled "**IR4.0 Integration and Performance in Southeast Asia.**". This cluster encompasses the various aspects and components related to IR4.0, such as technologies (IoT, smart factory, cloud computing), business aspects (business performance, digital transformation, business model innovation), adoption factors, competencies, quality management, and the overall impact on different types of enterprises (SMEs, manufacturing companies). Additionally, the inclusion of terms like "cyber-physical systems," "smart city," "interoperability," and "smart product" further reinforces the idea of a comprehensive ecosystem surrounding IR4.0 and reflects the focus on integrating IR4.0 technologies and strategies into the Southeast Asia context while addressing challenges and future opportunities in the region.

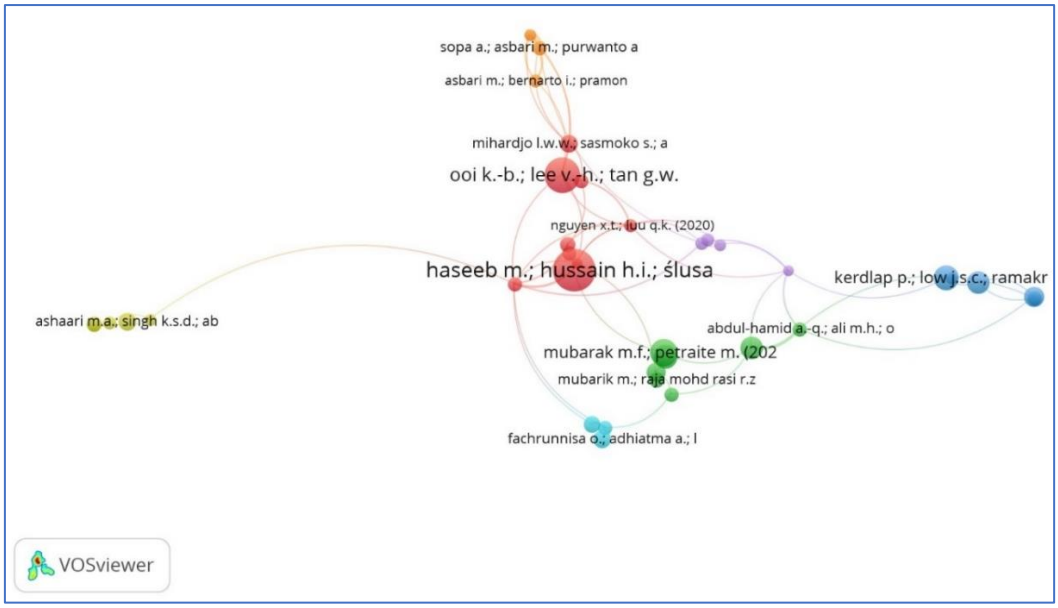

Figure 5 Bibliographic coupling analysis of IR4.0 in Southeast Asia

Cluster 2 (green) is formed by 7 documents labelled " **Innovation Ecosystem for Sustainable Development in Southeast Asia**". This cluster encompasses the themes of innovation management, internationalization of innovations, open innovation, technological orientation, blockchain technology, circular economy, green innovation performance, environmental orientation, artificial intelligence, big data analytics, IoT, supply chain sustainability, and sustainable development. It reflects the focus on fostering an innovation-driven ecosystem that promotes sustainable development within the Southeast Asia region.

Cluster 3 (blue) with 5 documents, this cluster is labelled "**Sustainable Industry Advancement in Southeast Asia**". This cluster encompasses the themes of industrial ecology, industrial symbiosis, sustainable manufacturing, waste management, cleaner production, resource recovery, zero-waste, eco-innovation, CO2 emission reduction, and sustainable development. It reflects the focus on advancing sustainable industrial practices and technologies within the Southeast Asia region.

Cluster 4 (yellow) with 5 documents is labelled as "**Technological Innovation and Adoption in Southeast Asian Industries**". This label encompasses the themes of big data analytics capability, hybrid SEM-neural network method, AI-based chatbots adoption model, fintech adoption, electronic commerce, and their implications for various sectors such as higher education, smart meters, sustainability in banking, and home-based businesses. It reflects the focus on leveraging technological advancements and addressing challenges related to adoption and implementation in the Southeast Asia context.

Cluster 5 (purple) with 4 documents is labeled "**Convergence of Industry and Education in the Era of Digital Transformation**". This cluster encompasses the themes of technology-based learning, big data, emerging economy, human capital, technology readiness, and implementation challenges. It reflects the interconnectedness between industry advancements driven by digital technologies and the evolving landscape of education, workforce development, and societal implications in Southeast Asia.

Cluster 6 (light blue) with 3 documents is labelled "**Strategic Digital Transformation in Southeast Asian SMEs**". This cluster encompasses the themes of agile leadership, digital transformation, SMEs, strategic flexibility, workforce transformation, IR4.0, maturity model, self-assessment model, smart manufacturing, and dynamic capabilities. It reflects the focus on enabling SMEs in Southeast Asia to navigate the challenges and seize the opportunities presented by digital transformation and IR4.0 through strategic and agile approaches.

Lastly, cluster 7 (orange) with 3 documents is labelled "**Enhancing Organizational Adaptability in the Era of IR4.0**". This cluster with keywords like employee innovation capability, hard skills, soft skills, organizational learning, explicit knowledge, and tacit knowledge. This cluster label highlights the critical importance of enhancing organizational adaptability in the context of IR4.0. It suggests that organizations need to cultivate innovation capability, leverage knowledge management practices, and prioritize organizational learning to thrive in an era characterized by rapid technological advancements and disruptive changes.

The bibliographic coupling analysis summary for IR4.0 in Southeast Asia is shown in Table IV. Each cluster is presented with its number, colour, label, number of publications and representative publications.

Table IV: Bibliographic coupling analysis on IR4.0 in Southeast Asia

Cluster No and colour	Cluster label	Number of publications	Representative publications
1 (red)	IR4.0 Integration and Performance in Southeast Asia	9	Ooi et al. [34]; Haseeb et al. [33]; Ślusarczyk. et al. [26].
2 (green)	Innovation Ecosystem for Sustainable Development	7	Ali et al. [35]; Mubarak et al. [30]; Akbari. et al. [36].
3 (blue)	Sustainable Industry Advancement	5	Kerdlap et al. [37], Kunkel & Matthess [38], Kurniawan et al. [24],
4 (yellow)	Technological Innovation and Adoption in Southeast Asian Industries	5	Nathan et al. [39]; Alkawsi [40]; Mohd Rahim [41].
5 (purple)	Convergence of Industry and Education in the Era of Digital Transformation	4	Siddoo et al. [42]; Alakrash & Razak [43]; Adebanjo et al. [44].
6 (light blue)	Strategic Digital Transformation in Southeast Asian SMEs	3	Fachrunnisa et al. [45]; Lin et al. [46].
7 (orange)	Enhancing Organizational Adaptability in the Era of IR4.0	3	Sopa et al. [47]; Asbari et al. [48].

IV. IMPLICATIONS

4.1 Theoretical implications

IR4.0 can be studied using several theoretical bases. These theoretical perspectives would drive organizational capabilities in predicting their readiness models to conceptualize readiness for new technology. The theoretical implications for Southeast Asia contexts across various clusters, such as IR4.0 integration, sustainable development, industry advancement, technological innovation, convergence of industry and education. Most of the studies on IR4.0 adoption focus on the Technology-Organization-Environment (TOE). The TOE model identifies factors needed for innovation adoption by considering technological, organizational and environmental elements [49-51]. Another relevant theory is the Resource-based view theory (RBV), which facilitates firms to better grasp the relationships between different resources and how these resources can be integrated to improve supply chain performance [52]. Resources are deemed a crucial driver towards IR4.0. Each country in Southeast Asia must identify their current state and readiness so that manufacturing companies can complement the associated function of the technologies towards their performance. Integrating the many theories would provide a holistic view of technology adoption within companies. For instance, Thuan et al. [53] integrated the TOE, RBV and Diffusion of Innovations theory (DOI) to investigate the factors affecting the application of accounting information systems.

4.2 Managerial Implications

In proper planning, the first action requires evaluating the current state using established and quality tools to highlight areas required for improvement. Naeem and Gorengo [54] suggested that companies must adopt a maturity model to self-evaluate the current state of IR4.0. Technologies of IR4.0 should be embraced within their opportunities rather than barriers. Southeast Asian countries' low application and readiness for IR4.0 signifies an untapped potential in developing business model innovation [55-56]. Fundamentally, SMEs focus more on business operations rather than developing business models. This missed opportunity leads to investment backlogs in identifying new technologies [56]. It was pointed out that countries in Southeast Asia need to pay more attention to the potential of IR4.0 due to excessive concentration on daily operations and perceiving the cost of adopting the technologies outweigh the advantages. It is then recommended to map out the process flow to identify the most suitable and worthy technologies to be adopted.

From a technological view, system integration is the most influential domain [57]. Several related issues on system integration include the capabilities of integrating IR4.0 technologies with their current system and the feasibility of

the many technologies in a business context. Optimal use of technologies and IT systems is the fundamental basis of IR4.0 integration initiatives [58]. A substantial system integration determines dynamic capabilities, develops top management commitment, integrates IT infrastructure and supply chain, and sustains the triple bottom line. Muller [55] suggests integrating strategies based on business models with IR4.0 to strengthen the building blocks of to face the rapid digital transformation. The business model must consider the many IR4.0 technologies that can help chart the digital roadmap.

Considering the lack of expertise in developing countries, they should engage and appoint consultants to formulate strategies and planning towards IR4.0 [59]. This grafting approach enables them to optimize resources and clarify market demands and requirements. Managers must determine the competencies and skills required for employees to adopt the technologies. Training and continuous programs to support company transformation to gain not only job-related description aspects but also skills that are considered a must in today's digitalized world. These competencies include teamwork, complex decision-making, social skills, critical thinking, effective communication, creativity and social responsibility [60-61].

V. Limitations And Future Research Avenues

The bibliographic coupling analysis conducted in this study is limited to the Scopus database. Scopus is a comprehensive database that offers extensive coverage of scholarly literature; however, it does not encompass all available bibliometric data. Hence, it is conceivable that certain relevant research publications might have been excluded from this analysis. This limitation emphasizes the importance of performing bibliometric analyses across multiple databases to achieve a thorough comprehension of the research field. Whereas, incorporating additional databases such as Web of Science and Google Scholar could provide further insights into the research trends and patterns associated with collaborative governance in forestry matters. Therefore, while this study's bibliometric analysis offers crucial insights into the research field of IR4.0 in Southeast Asia, it's important to note its limitation to the Scopus database. Future researchers could broaden the scope of bibliometric analyses and offer more comprehensive insights by incorporating additional databases. Future studies should look into how companies or SMEs in Southeast Asia adapt to different IR4.0 technologies. Researchers should also comprehend the acceptance of IR4.0 in different industries, as most companies in Southeast Asia industries are manufacturing-oriented [62]. These industries differ in their readiness models, each comprising distinct needs and requirements within domains such as technology, process, and people capability [63].

VI. Conclusion

This study provides an overview of the challenges and opportunities of IR4.0 in Southeast Asia by various authors worldwide. Over the past decade, there has been a notable rise in the quantity of publications within this field that are indexed in Scopus. This indicates that IR4.0 applies to many countries not only in Southeast Asian countries. The existence of 672 documents in the Scopus database suggests that there are many potential areas to explore regarding IR4.0 in this region for further research, the prospect of IR4.0 relies much on the strategies, models and technologies to enhance IR4.0 in this region. Furthermore, this study reveals that Malaysia has the highest number of author affiliations compared to other countries, followed by Indonesia and Vietnam. The research on IR4.0 in Southeast Asia would also represent developing countries, which are an integral component of economic development and growth. The role of The Association of Southeast Asian Nations (ASEAN) is also important in nation-building, as the diffusion of technologies in IR4.0 is inevitable. Business owners, policymakers and academia could benefit from the research streams discovered from the science mapping of this study, particularly on the different functions of technologies. The focal current and emerging themes included challenges and barriers of IR4.0, technological adoption, opportunities and business model innovation. On the other hand, the prospect of IR4.0 relies much on the strategies, models and technologies to enhance IR4.0 among countries in Southeast Asia.

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