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Benchmarking the Innovation Performance of the ASEAN-5: Fostering Science, Technology, and Innovation

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Abstract:

This study assesses the scientific, technological, and innovative performance of the member countries of the Association of South-east Asian Nations (ASEAN)-5. The term "ASEAN-5" is used to denote the initial five member countries of the Association of South-east Asian Nations (ASEAN), namely Indonesia, Malaysia, Philippines, Singapore, and Thailand. This study aims to reassess extensive datasets from various countries by encompassing multiple dimensions of indicators to evaluate the performance and growth of science, technology, and innovation (STI) through regression analysis. This study also compares the previous findings regarding the science, technology, and innovation (STI) policy in ASEAN countries. The result of this study identified that human resources, especially number of researchers in ASEAN-5 countries is the most significant factors to effect STI performance. Other than that, intellectual properties also somehow can affect STI performance of ASEAN-5 countries. The discovery of this study can also serve as an assessment tool for monitoring progress in the implementation of 'Vision 2025'.

Keyword: innovation performance, ASEAN-5, science, technology, and innovation

1. Introduction:

In commemoration of nearly three decades since its inception, the Association of South-east Asian Nations (ASEAN), established on 8 August 1967, witnessed the participation of the founding members, now recognised as the ASEAN-5 countries, in the inaugural ASEAN declaration, commonly referred to as the Bangkok Declaration, held in Bangkok, Thailand. The primary objectives of the establishment of ASEAN were to establish a union that encompasses both political and economic aspects, with a specific focus on facilitating the economic growth, social advancement, and cultural development of South-east Asia (Aisyah and Saputra, 2021). Additionally, ASEAN aimed to promote peace and security within the region (ASEAN, 1997). The Kuala Lumpur Declaration of 1971 introduced a new direction towards the year 2020, commonly referred to as 'Vision 2020' (ASEAN, 1997). According to the ASEAN Vision 2020, the objective of the South-east Asian nations is to achieve a state of peace and stability by addressing the underlying factors that may lead to conflicts. This includes a steadfast commitment to upholding justice and the rule of law, as well as strengthening both national and regional resilience (ASEAN, 1997; Jintana *et al.*, 2020).

Moreover, the Vision 2020 also outlined a vision for dynamic development by promoting strategic partnerships among ASEAN members to facilitate economic integration (Degelsegger-Márquez *et al.*, 2018). Additionally, it emphasised the need to expedite sustainable and equitable economic growth within the South-east Asian region (Aisyah and Saputra, 2021). Therefore, it has been argued that the promotion of science, technology, and innovation is a crucial factor in fostering economic growth and prosperity (ASEAN, 1997). Rodriguez and Seoparwata (2012), conducted a study that aimed to evaluate the performance of ASEAN countries in the domains of science, technology, and innovation (STI) as outlined in the 'Vision 2020' initiative. The findings of the study revealed variations in the performance patterns among these nations, with their growth patterns displaying a skewed distribution. The author posits that the influence of national STI policies on STI performance is not the sole determining factor. The development stage and historical context, including colonial influence, of ASEAN member states also play a significant role. Based on the presented data, it can be inferred that the ASEAN countries underwent a period of economic expansion from 1999 to 2009 (Rodriguez and Soeparwata, 2012). Nevertheless, the region failed to adequately advance its position in the value chain and enhance its dependence on productivity-boosting innovations founded on science and

technology (S&T) as a primary driver of economic growth despite the efforts made by ASEAN countries to establish goals related to science, technology, and innovation (STI). In light of the constraints and the subjective nature of the previous research, the author proposes a subsequent investigation employing a similar methodology, with a time span of 10 years, encompassing the period from 2010 to 2020. Alternatively, the author recommends incorporating supplementary indicators to provide a more comprehensive assessment of science, technology, and innovation (STI) performance in the Association of South-east Asian Nations (ASEAN) region.

Nevertheless, there has been a dearth of scholarly research conducted on the consequences of ASEAN's transition from 'Vision 2020' to 'Vision 2025', particularly from the standpoint of the ASEAN-5 countries. Furthermore, there have been limited research endeavours to empirically investigate STI specifically within the ASEAN-5 countries. Previous studies have predominantly concentrated on utilising larger datasets to analyse STI prevalence across all ASEAN member states. This study posits that it is imperative to focus on the founding members of the Association of South-east Asian Nations (ASEAN) to examine the extent to which ASEAN has influenced the development of the five member countries since its inception. Specifically, the study aims to investigate the effects of ASEAN's establishment on the establishment of a shared vision, the implementation of the Initiative for ASEAN Integration (IAI), and its impact on various interrelated issues. The theory of dynamic capabilities has underscored the importance of organization's capacity to effectively incorporate, construct, and adapt internal and external capabilities in response to dynamic environmental conditions (Zhou and Wu, 2007; Ambrosini and Bowman, 2009; Mwangi, 2012). Based on the information provided by Rodriguez and Seoparwata (2012), it can be inferred that dynamic capabilities are comprised of two distinct components. Firstly, the ability to diffuse technology necessitates a significant level of proficiency on the part of the firm in the selection, utilisation, and advancement of technology. This capability allows firms to effectively gather, integrate, and modify relevant existing technology. Secondly, the concept of creating capability refers to the ability to generate novel technologies through research and development (R&D) efforts, with the aim of establishing a competitive edge as the first entrant in the market. This entails the acquisition of intellectual property rights and the generation of revenue through licensing arrangements, royalty, and sale outright.

Owing to that, in order to assess the growth and performance of science, technology, and innovation (STI), it is recommended to utilise a comprehensive set of indicators. Building upon the research conducted by Rodriguez and Seoparwata (2012), these indicators can be categorised into three main types: enablers, business activities, and economic size. Additionally, the evaluation can be conducted across six dimensions, namely human resources, research systems, funding and support, business research and development (R&D) spending, intellectual assets, and economic size (Veselica, 2019; Jintana *et al.*, 2020). This study expanded the temporal scope from 2016 to 2021, in contrast to the previous study conducted by Rodriguez and Soeparwata (2012), which utilised a distinct time frame spanning from 1999 to 2009. Moreover, this study also has excluded two dimensions which are funding and support, as well as business research and development due to limited data availability which led to missing values during data analysis. This study aims to provide evidence-based policy recommendations that can improve national performance in the field of science, technology, and innovation (STI). This study expands upon the existing scholarly literature on STI in the ASEAN-5 nations by incorporating a broader scope of data and encompassing a longer and recent time.

2. Research Objectives and Hypotheses

This article fulfils two purposes. Firstly, the study presents empirical data on the performance of STI at the national level in the ASEAN-5 nations. Furthermore, this study investigates and compares previous research on STI policies implemented at the national level within the Association of South-east Asian Nations (ASEAN) countries. This article investigates the innovation performance of member countries within the Association of South-east Asian Nations (ASEAN) over a span of seven years, specifically from 2015 to 2021. The selection of this particular time period is based on its alignment with the implementation of the strategic plan known as "Vision 2025," which was introduced in 2015. This study further revealed that the available data is limited to the year 2015. The central focus of this study pertains to the performance of the ASEAN-5 member countries in the context of science, technology, and innovation (STI) during the designated time frame. Consequently, this research put forth two significant hypotheses:

H1: Human resource has a significant relationship with STI performance in ASEAN-5 countries.
Human resources play a pivotal role in assessing the potential expendability of a workforce that possesses advanced education and specialised skills, hence, it's one of the important STI ecosystem (Susanty *et al.*, 2019; Jintana *et al.*, 2020). This involves the assessment of the availability of individuals with scientific, engineering, manufacturing, and construction skills, who have completed tertiary education, as a contributing factor to the innovation process. In certain countries, there may have been a decline in the number of graduates in the fields of science or engineering during the year 2012 (Rodriguez and Soeparwata, 2012). This demonstrates that the proliferation of higher education has resulted in a significant population of students possessing degrees in fields other than science or engineering.

As a result, the issue of shortages in the fields of science and engineering has been a recurring concern (Veselica, 2019). As a result, the issue of shortages in the fields of science and engineering has been a recurring concern. A shortage can be characterised as a reduction in the overall supply of a nation, specifically referring to a decline in the number of newly graduated individuals in the fields of science and engineering, which is inadequate to compensate for the departure of those leaving the workforce, such as through retirement. The central apprehension pertaining to the dearth of scientists and engineers arises from the acknowledgment that the advancement of our economy is reliant upon allocations towards intellectual capital, thereby necessitating an ample pool of scientific and engineering professionals. In addition to quantifying the quantity of graduates, this study posits that the presence of competent researchers serves as a vital human capital component in facilitating Science, Technology, and Innovation (STI) endeavours. Researchers play a pivotal role in the innovation process due to their profound intellectual expertise and specialised training as university graduates, which equips them for esteemed positions in academia and research (Hartono and Kusumawardhani, 2018). They have successfully attained the second phase of tertiary education, which serves as a steppingstone towards obtaining an advanced research qualification. This notable achievement empowers them to actively participate in the generation and formulation of innovative ideas and concepts.

H2: Research System has a significant relationship with STI performance in ASEAN-5 countries.
The research system in ASEAN-5 countries is considered to be another indicator of STI performance. In business firms, openness and innovation has been proven to be significantly related (Vahter *et al.*, 2014; Lazzarotti *et al.*, 2017) This includes the practice concept of openness, and attractive research system. The degree of receptiveness exhibited by a nation towards international students and experts holds significant importance, as it has the potential to contribute to the advancement of research and development within that country. The presence of international experts, particularly those from developed countries, brings with it a diverse range of cultural, perspective, background, and experiential assets that can positively impact the progress of science, technology, and innovation (STI) in the ASEAN-5 countries, which predominantly consist of developing nations.

H3: Intellectual Properties has a significant relationship with STI performance in ASEAN-5 countries.
The term "intellectual property" as used in this study pertains to the products of human intellect, including inventions, literary and artistic works, designs, and symbols, names, and images employed in commercial activities. The connection between intellectual property and science, technology, and innovation (STI) performance lies in its capacity to gauge the level of effort exerted in the process of innovation (Gangopadhyay and Mondal, 2012; Degelsegger-Márquez *et al.*, 2018). There are many prior research that empirically proved the relationship between intellectual property and innovation (Kalanje, 2006; Bakry *et al.*, 2022; Sharma *et al.*, 2022). The concept of intellectual property encompasses various forms of legal protection, such as patents, copyright, trademarks, industrial designs, trade secrets, and geographical indications. This study utilises economic size as an indicator that is associated with research and innovation performance in order to measure the performance of STIs. According to De Solla Price's research in 1969, it was demonstrated that there exists a positive correlation between the quantity of scientific publications originating from a country and its economic size, as determined by its Gross Domestic Product (GDP) (Rodriguez and Soeparwata, 2012). Furthermore, Narin (1994) on patent bibliometric study discovered that the correlation persists not only in the context of scientific publication, but also in the realm of patenting. In addition to that, the pertinence of employing Gross Domestic Product (GDP) as an indicator is Given that innovation is widely regarded as a primary catalyst for economic advancement, it follows that the trends in a country's GDP per capita serve as a reflection of its economic growth (Rodriguez and Soeparwata, 2012). Consequently, this particular indicator serves to gauge the influence of innovation and, by extension, a nation's aptitude for fostering innovative practises. With that being stated, this study employs GDP per capita at current prices in US dollars as an indicator to assess the performance of Science, Technology, and Innovation (STI) in the ASEAN-5 countries.

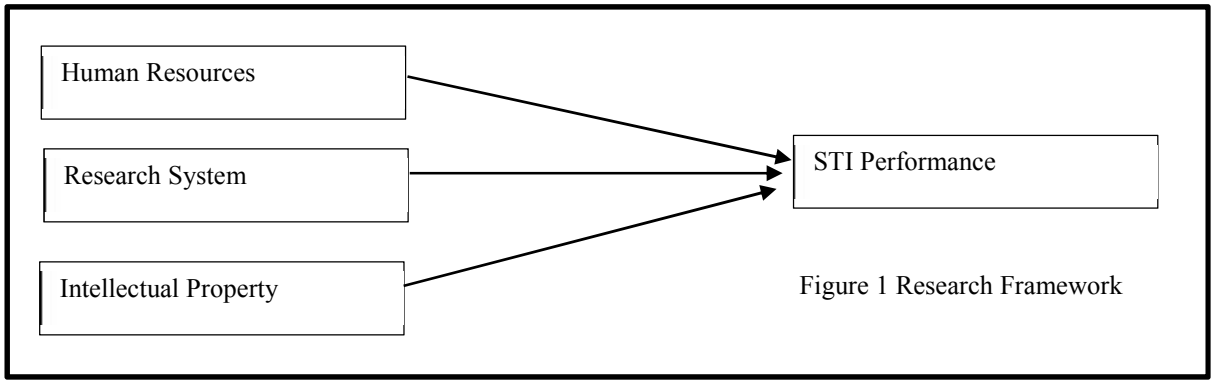

Figure 1 Research Framework

The present article is structured in the following manner. The section titled "ASEAN 2025: Forging Ahead Together" delineates the revised vision formulated by the member states of the Association of South-east Asian Nations (ASEAN) in the year 2015. The section titled “Research Objectives and Hypotheses” outlined the purpose and assumption of this study. The section titled "Methodology" provides a comprehensive explanation of the technique employed for the computation of composite indicators. The section titled "Findings" provides an overview of the research outcomes, analysis, and interpretation of the research findings. The section titled "Conclusion and Future Direction" offers recommendations that are supported by evidence and serves as the concluding part of the article.

3. ASEAN 2025: Forging Ahead Together

During the 27th ASEAN Summit held in Kuala Lumpur, Malaysia, the ASEAN Member States (AMS) effectively formulated the ASEAN community Vision 2025, referred to as ASEAN 2025: Forging Ahead Together (ASEAN, 2015; Aisyah and Saputra, 2021). The Association of Southeast Asian Nations (ASEAN) has revisited its previous vision for the year 2020, which aimed to foster a harmonious and stable community with collective prosperity. This vision was based on various foundational documents, including the Treaty of Amity and Cooperation in Southeast Asia, the ASEAN Vision 2020, the Declaration of ASEAN Concord II, the ASEAN Charter, the Roadmap for an ASEAN Community (2009-2015), and the Bali Declaration on ASEAN Community in a Global Community of Nations (ASEAN, 2015). The assessment of the advancements made by ASEAN countries since 2009 has been described as favourable, particularly in relation to the execution of the ASEAN community's roadmap, which encompasses the ASEAN political security community, ASEAN economic community, and ASEAN socio-cultural community. Additionally, the accomplishments of the strategic framework, work plan, and implementation of the initiative for ASEAN integration (AIA) and the Master Plan on ASEAN connectivity have been acknowledged (ASEAN, 2015).

In order to formulate a comprehensive vision for the year 2025, AMS has undertaken an evaluation of the key achievements in various domains of ASEAN development, including education, health, science, technology and innovation, socio-cultural aspects, and the economy, among others. Therefore, the strategic objective for the year 2025 encompasses the preservation of a tranquil, steadfast, and robust society, along with an augmented ability to adeptly address adversities and cultivate the reputation of ASEAN as an internationally engaged entity, all while upholding the core principles of ASEAN centrality while also promoting creative entrepreneurship to drive competitiveness of ASEAN countries (ASEAN, 2015; Aisyah and Saputra, 2021). With regards to the realm of science, technology, and innovation, the vision for 2025 asserts that ASEAN Member States (AMS) are anticipated to exhibit a high level of integration, cohesiveness, competitiveness, innovation, dynamism, connectivity, and sectoral cooperation. This is aimed at ensuring that ASEAN countries become more resilient, inclusive, and people-oriented within the context of an integrated global economy. ASEAN promotes the adoption of strategies aimed at enhancing competitiveness, fostering innovation, and establishing a dynamic community. This is achieved through the generation and practical application of knowledge, the implementation of supportive policies towards innovation, and the adoption of a science-based approach, particularly in the field of green technology. These efforts are intended to stimulate robust productivity growth within the ASEAN member states (ASEAN, 2015). The Association of Southeast Asian Nations (ASEAN) has recognised the importance of embracing digital technology advancements, promoting transparency and responsive regulations, practising good governance, and enhancing participation in global value-added strategies (ASEAN, 2015).

4. Methodology

In this study, the utilisation of regression analysis is employed to ascertain the causal relationship between the independent variables and the dependent variable. The data analysis was performed using SPSS. Furthermore, this research employs secondary data obtained from various reputable sources such as the UNESCO Institute for Statistics, the Data Centre, the World Intellectual Property Indicators, and the World Bank. The data were obtained from the sources presented in Table 1.

Table 1 Source of data for each indicators from year 2015 to 2020

Indicator	Source	Theme	Year
Percentage of graduates from science, technology, engineering, and mathematics	UNESCO (2023)	Human Resource	2015-2020
Percentage of graduates from tertiary education engineering, manufacturing, constructions	UNESCO (2023)	Human Resource	2015-2020
Percentage of graduates from tertiary education information and communication technologies	UNESCO (2023)	Human Resource	2015-2020
Percentage of graduates from tertiary education Natural sciences, mathematics, and statistics	UNESCO (2023)	Human Resource	2015-2020
Researcher per million (FTE)	UNESCO	Human Resource	2015-2020

	(2023)		
Total patent application	WIPO	Intellectual Property	2015-2020
GDP Per Capita	UNSD	STI Performance	2015-2020

5. Result

The findings from the regression analysis conducted for the years 2016 to 2021 reveal interesting insights into the relationship between various factors and Science, Technology, and Innovation (STI) performance in ASEAN-5 countries. The analysis assessed the correlation and statistical significance of different variables, shedding light on their potential impact on STI performance. In terms of human resource factors, the correlation analysis indicates that there is no consistent significant relationship between the percentage of graduates from different fields (STEM, engineering, manufacturing, constructions, information and communication technologies, and natural sciences, mathematics, and statistics) and STI performance across the years. For instance, percentage of graduates from Science, technology, engineering, and mathematics is not statistically significant ($F = 0.444813$, $p = 0.625544$). Therefore, there is insufficient evidence to conclude that the percentage of graduates from STEM fields has a significant relationship with STI performance in ASEAN-5 countries for the year 2015. Similarly, percentage of graduates from tertiary education engineering, manufacturing, constructions is not statistically significant ($F = 2.723618$, $p = 0.346813$). Thus, there is insufficient evidence to establish a significant relationship between the percentage of graduates from engineering, manufacturing, and construction fields and STI performance in ASEAN-5 countries in 2015.

In the same year, percentage of graduates from tertiary education information and communication technologies is not statistically significant ($F = 7.968442$, $p = 0.216743$). Consequently, there is insufficient evidence to support a significant relationship between the percentage of graduates from information and communication technologies fields and STI performance in ASEAN-5 countries during 2015. The percentage of graduates from tertiary education Natural sciences, mathematics, and statistics also is not statistically significant ($F = 17.72498$, $p = 0.148461$). The insufficient evidence to establish a significant relationship between these indicators also recorded in the year of 2016, 2017, 2019 While some individual years showed a significant correlation such in 2018, percentage of graduates from tertiary education Natural sciences, mathematics, and statistics is statistically significant ($F = 6.916979$, $p = 0.119257$). Therefore, there is some evidence to support a significant relationship between the percentage of graduates from natural sciences, mathematics, and statistics fields and STI performance in ASEAN-5 countries in 2018. The lack of consistency suggests that other factors may be at play. These factors could include the quality of education, the relevance of the curricula to industry needs, and the alignment of skills with market demands. Thus, simply increasing the number of graduates in specific fields may not be sufficient to drive STI performance in the ASEAN-5 countries.

The analysis also examined the correlation between the number of researchers per million (FTE) and STI performance. The results reveal a mixed pattern, with some years showing a significant positive correlation. This suggests that having a higher number of researchers per million population can contribute to improved STI performance. For instance, the regression analysis suggested that in 2015, Researchers per million (FTE): The regression analysis shows that the model is statistically significant ($F = 56.2401$, $p = 0.01732$). Similarly, in 2016, The regression analysis shows that the model is statistically significant ($F = 54.9198$, $p = 0.005083$). Thus, there is sufficient evidence to support a significant relationship between the number of researchers per million (FTE) and STI performance in ASEAN-5 countries. Different in 2019 and 2020, the regression analysis shows that the model is not statistically significant ($F = 43.11127$, $p = 0.096219$). Thus, there is insufficient evidence to support a significant relationship between the number of researchers per million (FTE) and STI performance in ASEAN-5 countries for the year 2019 and 2020 ($F = 0.037836$, $p = 0.877695$). However, it is worth noting that the correlation coefficients were not consistently strong across all years, indicating that other factors beyond the researcher population should be considered. These factors might include research quality, collaboration networks, and access to funding and resources.

When exploring the research system, the analysis investigated the correlation between the net flow of international students (mobile students) and STI performance. The results suggest that there is no consistent significant relationship between these variables across the years as reported in table 2 below. While international collaboration and knowledge exchange through student mobility are often viewed as important drivers of innovation, the lack of consistent correlation may indicate that the impact of international students on STI performance in ASEAN-5 countries is influenced by other contextual factors. These factors could include the structure of research institutions, the level of industry-academia collaboration, and the effectiveness of knowledge transfer mechanisms.

Table 2 p-Value and Significancy of net flow of international students on STI performance in ASEAN-5 countries from 2016-2020

Year	p-Value	Significancy
2016	0.570669	Not significant
2017	0.565359	Not significant
2018	0.536201	Not significant
2019	0.420981	Not significant
2020	0.377139	Not significant

Lastly, the analysis explored the correlation between intellectual properties, measured by total patent applications, and STI performance. The findings indicate a mixed pattern of correlation across the years . Some years show a significant positive correlation, suggesting that a higher number of patent applications is associated with improved STI performance. However, the correlation coefficients were not consistently strong, emphasizing the need to consider additional factors such as patent quality, patent commercialization, and the overall innovation ecosystem.

Table 3 p-value and significancy of intellectual property on STI performance from 2015 to 2020

Year	p-Value	Significancy
2015	0.23228	Not significant
2016	0.251896	Not significant
2017	0.230404	Not significant
2018	0.171143	Not significant
2019	0.207198	Not significant
2020	0.041	Significant

6. CONCLUSION AND FUTURE DIRECTION

Tran huu et. Al (2022) argues that the quality of graduates to determine the employment especially in Asia, which affects the quality of supply in human resources to the advancement of countries especially in STI performance. It is important to highlight that Tran Huu (2022) reported students from high school and higher education has the fear of unemployment and poor career plans especially for those in major of natural sciences compared to humanities literatures and other social sciences major. This indicates that, these students has low expectations on future job employment when it comes to the sciences fields (Ayob *et al.*, 2023). By having said that, it is important to ensure that the qualified graduates students are given opportunities and platform to be employed based on their qualification especially in the field of science, technology, and engineering (Atkinson and Pennington, 2012). However, the employers argued that lack of opportunities given to graduates is because of the lack in quality of the graduate itself in terms of skills, interest in early career planning and working experiences (Atkinson and Pennington, 2012). Hence, the education institutions needs to develops and improve curricula align with the demands on employers, enhance students understanding about careers, and create networking between students and industries to establish communication, interest in career plannings and also as an effort to motivate students to perform better in academic to overcome the competition for jobs. Furthermore, the education institutions also could prepare the students by getting know to the engineering accreditation boards in order to understand the employers expectation of the current skills that are relevant to the current economy (Kamaruzaman *et al.*, 2019). Furthermore, the ASEAN community, especially the ASEAN

Education Ministers shall realise the importance to enhance the quality of human resources through enhancing education institutions capacity and strengthen the education system that can be done through strategic process and coordination, funds and supports to increase facilities and access to a better education system by the ASEAN-5 nations, as well as other ASEAN countries members (Ayob *et al.*, 2023). Other than that, ASEAN Education Ministers also shall always keep themselves focus on digital education transformation which has rapidly moving since the COVID-19 pandemic, hence, improving internet infrastructure and access are should be priorities to ensure equality in education system among rural and urban area. These are the effort should be given focus on especially to ensure the ASEAN-5 and other countries as well to improve in STI performance. This study believes that ASEAN committee may want to include the effort of enhancing human supply in the area of science, technology and innovation to polish the STI policy and to ensure the progress of STI performance among ASEAN countries is in positive pattern. This study also believes that enhance human supply, can directly impacting the growth of STI in countries, as evidenced in this study. This is because human supply is considered as intellectual capital on countries technological innovation. Of course, enhancing intellectual capital is not the only factor to contribute to STI, however, the production of intellectual properties are all sourced from the intellectual capital. Therefore a high quality intellectual capital with structured STI policy, sufficient funding and support can increase STI performance in ASEAN-5 countries. Funding and support encompass the provision of governmental assistance programmes for innovation endeavors and financial schemes for innovation initiatives. Moreover, this phenomenon signifies the government's recognition of innovation as a crucial factor in driving economic growth, as well as its readiness and capacity to allocate resources towards fostering the innovation process.

In summary, governments on ASEAN-5 countries must moving towards global market-focused through enhancing the country and states capabilities and capacity to implement the designed policy my ASEAN committee in effort to improve STI performance, to be at par with other developed and developing countries. Prior study also has identified that Singapore, Indonesia, and the Philippines are experiencing a period of technological stagnation, with no significant advancements taking place (Afzal *et al.*, 2019). Investment on education shall not be reduced and education institutions at the same time shall practice openness and involves private and industrial sectors in designing curricula, research activities, policies, and strategies to successfully implement effective and efficient policies. On other perspectives, ASEAN committee also shall find a better system to coordinate ASEAN-5 and other ASEAN countries in STI performance, while also generating a better and new solutions to STI related problems. The ASEAN committee also need to ensure that the STI policy designed by the ASEAN committee shall be translated into national policy, with effective monitoring and evaluation system, open learning system between ASEAN countries and benchmarks to compare the best practice among ASEAN members. Through this process, ASEAN committee may find the best tools and strategy to identify ways to boost their STI performance and reducing the STI gap between ASEAN countries. The recognition of the significant role played by science, technology, and innovation in enhancing the competitiveness of ASEAN countries is imperative. Furthermore, it exerts a substantial impact on the promotion of inclusive development and the growth of national income. Previous research has demonstrated that within the ASEAN region, there exists a notable correlation between innovation and the income group of countries (Veselica, 2019; Aisyah and Saputra, 2021). This suggests that the income of a country has an impact on its level of innovation capabilities, as it provides the means for investment, inclusive development, improvement of the education system, and the cultivation of high-quality human resources through sufficient budget allocation for investment. As reported in 2021, ASEAN's worldwide economic impact is growing. ASEAN accounts for 3.5% of global GDP and 7.2% of commerce. 8.5% of the world is ASEAN. ASEAN FDI is 154.7 billion USD (Jintana *et al.*, 2020), hence, the consistent advancement, particularly in science, technology, and innovation (STI), can have a substantial impact on the Association of Southeast Asian Nations (ASEAN) and its ability to exert a greater influence on global economic growth (Afzal *et al.*, 2019; Ayob *et al.*, 2023).

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