



## Digital Connectivity Bridging Digital ASEAN

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### ABSTRACT

The world is changing rapidly with the adoption of sophisticated digital technology. The foremost tool for digital technology operation is digital connectivity infrastructure. To unleash the potential of the digital economy in ASEAN countries, the foundation is upgrading its digital connection, which is a key part of making digitalization feasible. This study identified five factors that contributed to the digital connectivity of ten ASEAN countries and used them to calculate the overall score of each country to show its performance in terms of digital connectivity. The competitive analysis results of the five digital connectivity enablers in each country show their respective strengths and shortcomings. Myanmar made the greatest progress in overall digital connectivity, due to its engaging in national regulatory reforms and focusing connectivity developments after realizing the need to improve their ICT infrastructure. There is still much room for improvement in the network performance of ASEAN countries; among all ten countries, only Singapore has reached a very satisfactory level. Striving to narrow the digital connectivity development gap would be an important agenda item for all ASEAN countries.

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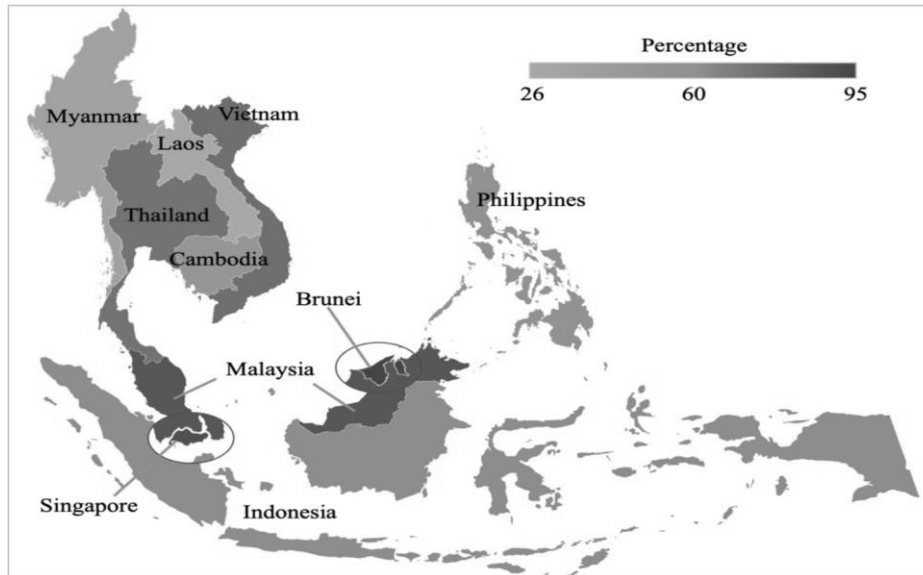
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## INTRODUCTION

In the digital age, the enabling power of information and technology has made almost anything possible. Digital evolution, transition, and transformation have thus far brought a digital economy that is intangible, but still real and existing. According to Google and Temasek Holdings (2017), Southeast Asia (SEA) as the world's fastest growing Internet region has a massive opportunity to leapfrog into the vanguard and could potentially rank in the top five digital economies in the world by 2025. Home to 655 million people, ASEAN countries' gross domestic product (GDP) in 2019 hit US\$ 3.1 trillion (ASEAN Statistics Division, 2020). From the "e-Conomy SEA 2019" report released by Google in collaboration with Temasek Holdings and the global consultancy firm Bain & Company (2019), SEA's internet economy with a base of 360 million Internet users soared to US\$100 billion in 2019 (3% of regional GDP), the first time in the history of the region. The surge is unprecedented, and such a pace of growth is even expected to continue, potentially reaching \$300 billion by 2025. Figure 1 illustrates the percentage of the population using the Internet in ASEAN countries in 2019.

Today, e-Commerce, e-Learning, e-Health, and so on have become an indispensable part of netizens' lives. With the outbreak of the COVID-19 pandemic since December 2019, the performance of the digital-technology-related sector solely stands out in unfortunate times. This is because technology can help to reduce the spread of the virus while digital-adopting businesses remain open and keep society functional during social distancing norms, quarantines, and nationwide lockdowns. At a fundamental level, digital tools function on the basis of digital connectivity. Digital development and performance require a fast, secure and stable Internet, so a simple Internet connection is no longer sufficient to support the demand for high efficiency. Digital connectivity is essential for the proper functioning of the digital ecosystem. Owing to this fact, Chen and Ruddy (2020) from the Economic Research Institute for ASEAN and East Asia highlighted a policy agenda to prioritize and improve digital connectivity to facilitate digital transformation and overall economic performance in ASEAN countries.



Source: Authors' own elaboration based on the latest statistics released in 2020 by International Telecommunications Union (ITU) in their ICT Portal.

Figure 1 Penetration of Internet Users among Population in ASEAN Countries (2019)

Decades ago, connectivity infrastructure mainly referred to road conditions, power or electricity supply, water supply and so on—that is, the physical connections between people. The advent of the digital age has given us a new component of connectivity. The connectivity that people think of now is communication, Internet, Wi-Fi, network speed, network performance, etc., are almost all digital and intangible, which now are more commonly known as digital connectivity. Due to the fact that digital connectivity is the basic requirement for other parts of digital technology to function properly and smoothly, this strongly moves the present study to highlight the performance of digital connectivity infrastructure quantitatively in ASEAN

countries. In simple words, we propose calculating a value or score to evaluate and represent the level of digital connectivity, rather than just saying that it is doing well, poorly, strong, moderate or weak. Several enablers that are parts of connectivity infrastructure and indicators affecting each enabler have been identified and cautiously selected in order to present actual digital connectivity performance. The forthcoming part will further detail the previous literature in Section 2, the methods used and discussion on findings in Section 3, results and discussions on findings in Section 4, and Section 5 concludes the study.

## REVIEW OF LITERATURE

The subject topic of technological advancement in research work is always fascinating. As it was claimed that less attention had been paid to developing and less-developed countries, Wang and Chien (2007) developed a framework to examine the impact of technological development on economic performance in ASEAN countries. On the same target countries of the study, the research done by Bhattacharyay (2010) focused more on physical infrastructures of connectivity and integration. Abdullaev et al. (2019) pointed out that digital technology is becoming more and more popular in all aspects of human life, and more and more people require fast but low-cost reception of information. As in firm-level of studies, Olurinola et al. (2021) realised the unleashing of ICT digitalisation is a key driver of firm's innovation in Nigeria. Trinugroho et al. (2021) paid attention to Indonesia's micro and small businesses in their level of adoption of digital technologies. Since we are now in the digital era, these studies have greatly inspired and encouraged us to focus research attention on ASEAN countries as well, but this time to shed the light particularly on digital connectivity.

Research on digital connectivity has grown in recent years. Given the geographical immobility issue unavoidably faced by certain migrants, Leurs (2014) presented a qualitative case study on Somali migrants in Ethiopia to show how digital connectivity eased their transnational communication. Invisible connections bring people closer, and digital connectivity definitely can do more beyond this. Graham et al. (2017) recognised the rapid change brought about by digital connectivity that connects millions of sub-Saharan African citizens to the digital economy, but found that it has a greater impact in high-income countries than in low-income countries. Instead of showing impacts on countries at different income levels, this study reveals the performance of their digital connectedness despite income level differences.

Researchers have also paid attention to ASEAN countries to discuss and address digital connectivity as a critical digital agenda item in order to progress better in terms of digital development in the region, such as Chapman (2018), Anuar (2019), Chen (2020), and Chen and Kimura (2020). These studies are focused on discussion and policy priorities that remind, inform, and emphasise the issues, challenges, and potentials of digital connectivity infrastructure. Different from these studies, our research examines the level of digital connectedness quantitatively, so that each ASEAN country has its own score to show its actual performance in digital connectivity over the years.

Some other studies on various topics related to digital connectivity include Pavez et al. (2017), Friederici et al. (2017), Maitland (2018), Oughton et al. (2018), Theo et al. (2018), Gong et al. (2019), and Shi et al. (2020). These studies did not quantify digital connectivity as numbers or scores, but conducted conceptual research and examined the impact of digital connectivity on other aspects. Indeed, digital connectivity will be the trending focus of infrastructure development in the future, as supported by Gabarró (2020). Nevertheless, digital connectivity also brings out digital inequality, and it is definitely a hurdle for countries to propel and achieve digital convergence together. This has been highlighted by Katz and Gonzalez (2016), where digital connectivity is an important element to ameliorate social marginalisation in terms of digital disparities. Vu (2017) addressed the issue of the ICT revolution affecting the development and governance of ASEAN countries through ICT diffusion indicators, and some of the elements they used are referenced and then cautiously selected for the indicator basket of this study.

## RESEARCH METHODOLOGY

As shown in Table 1, five enablers and 18 indicators have been identified that are related to the infrastructure for establishing digital connectivity. These enablers and indicators are selected based on previous research on digital-related indices frameworks by various global organizations. The frameworks of Digital Adoption Index (DAI) by the World Bank (2016), Network Readiness Index (NRI) by Postulans Institute (2019), Mobile Connectivity Index (MCI) by GSMA (2020), and Digital Economy and Society Index (DESI) by the European Commission (2020) are mainly referenced in the present study. The data is collected from sources such as the International Telecommunication Union (ITU), GSMA Intelligence, and the World Bank for the period from 2014 to 2019.

Table 1 Enablers and Indicators of Digital Connectivity Infrastructure

Enabler	Indicator
<i>Subscription</i>	Fixed-telephone subscriptions per 100 inhabitants
	Fixed-broadband subscriptions per 100 inhabitants
	Mobile-cellular telephone subscriptions per 100 inhabitants
	Mobile-broadband subscriptions per 100 inhabitants
<i>Network Coverage</i>	Percentage of population covered by 2G networks
	Percentage of population covered by 3G networks
	Percentage of population covered by 4G networks
<i>Network Performance</i>	Average mobile broadband download speeds
	Average mobile broadband upload speeds
	Average mobile broadband latencies
<i>Affordability</i>	Fixed BB Basket (% of GNI per capita)
	Mobile Cellular Basket (% of GNI per capita)
	Mobile BB Prepaid (% of GNI per capita)
	Mobile BB Postpaid (% of GNI per capita)
<i>Other Enablers</i>	Access to electricity
	International bandwidth per user
	Number of secure internet servers per population
	Number of Internet exchange points (IXPs) per population

When selecting these data, some selection criteria have been strictly followed. For example, the data needs to be updated regularly so that the research generated from these data is always valid and similar research can be continued in the future. Thus, discontinued data series have been filtered out, even though they are relevant to digital connectivity. Different indicators carry varied units of measurement, so the data must be normalized for comparison across countries and years. The min-max method is used to normalise the data chosen. The indexing approaches used to calculate the value for each indicator and enablers until final aggregation into an overall score in these aforementioned indices are mostly similar. This study uses a simple aggregation method to determine average weights for all indicators and enablers until the final score is calculated to represent the digital connectivity performance for all ASEAN countries, which is called the digital connectivity index (DCI). As the five enablers are treated averagely, the maximum score for each enabler is 20, while for the DCI the maximum score is 100. The simple aggregation is as follows:

$$DCI_c = SS_c + NC_c + NP_c + AF_c + OE_c \quad (1)$$

where the abbreviations in brackets each represent the average score of an enabler, i.e., SS - subscription, NC - network coverage, NP - network performance, AF - affordability, and OE - other enablers, whereas c denotes country.

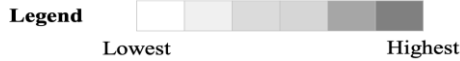
## RESULTS AND DISCUSSIONS

### All enablers are strongly correlated

As a measure of the validity of the index, the correlations across enablers of digital connectivity have been tested, and the results are shown in Table 2. The  $\rho$  values range from 0.509 to 0.931, which indicates that all the enablers are considered to be strongly correlated with each other.

Table 2 Correlation between Digital Connectivity Enablers

Enabler	Subscription	Network Coverage	Network Performance	Affordability	Other Enablers
Subscription	1				
Network Coverage	0.667	1			
Network Performance	0.726	0.672	1		
Affordability	0.820	0.570	0.509	1	
Other Enablers	0.931	0.651	0.765	0.723	1

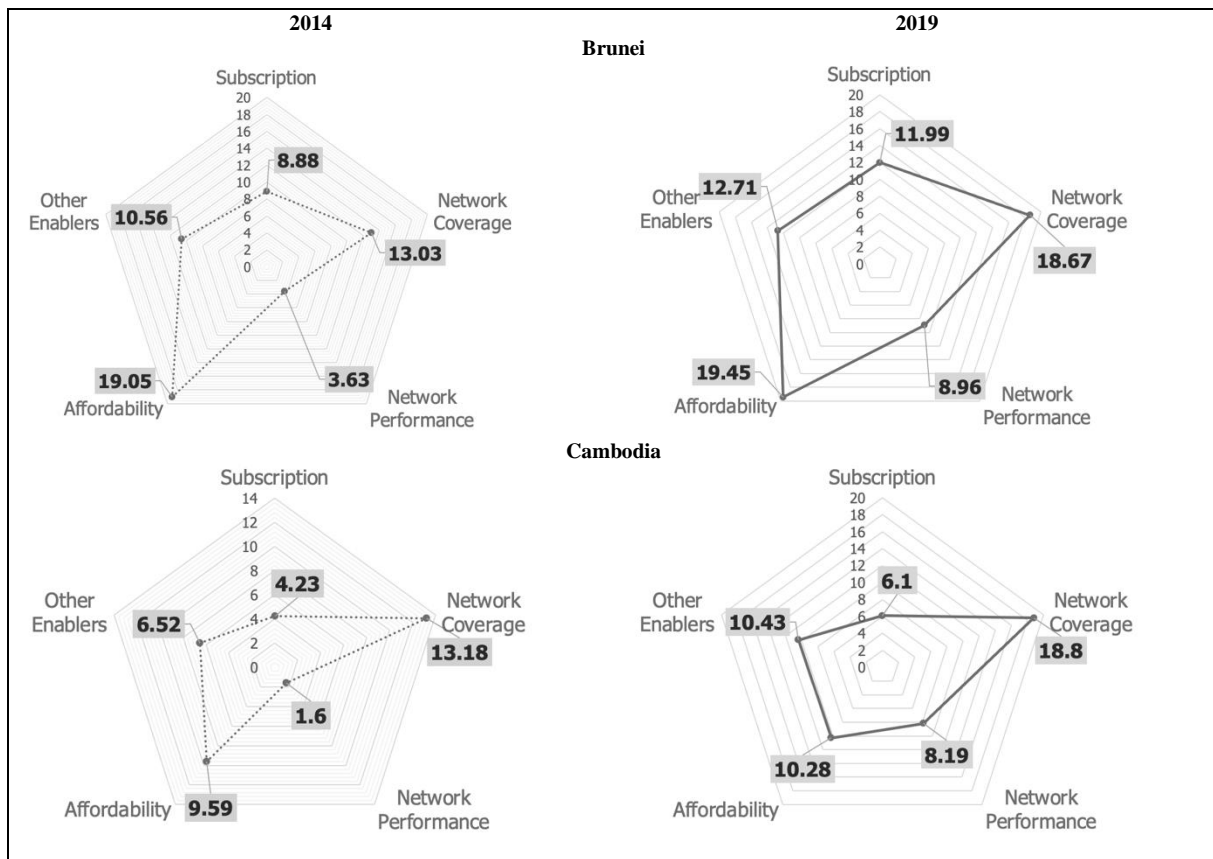


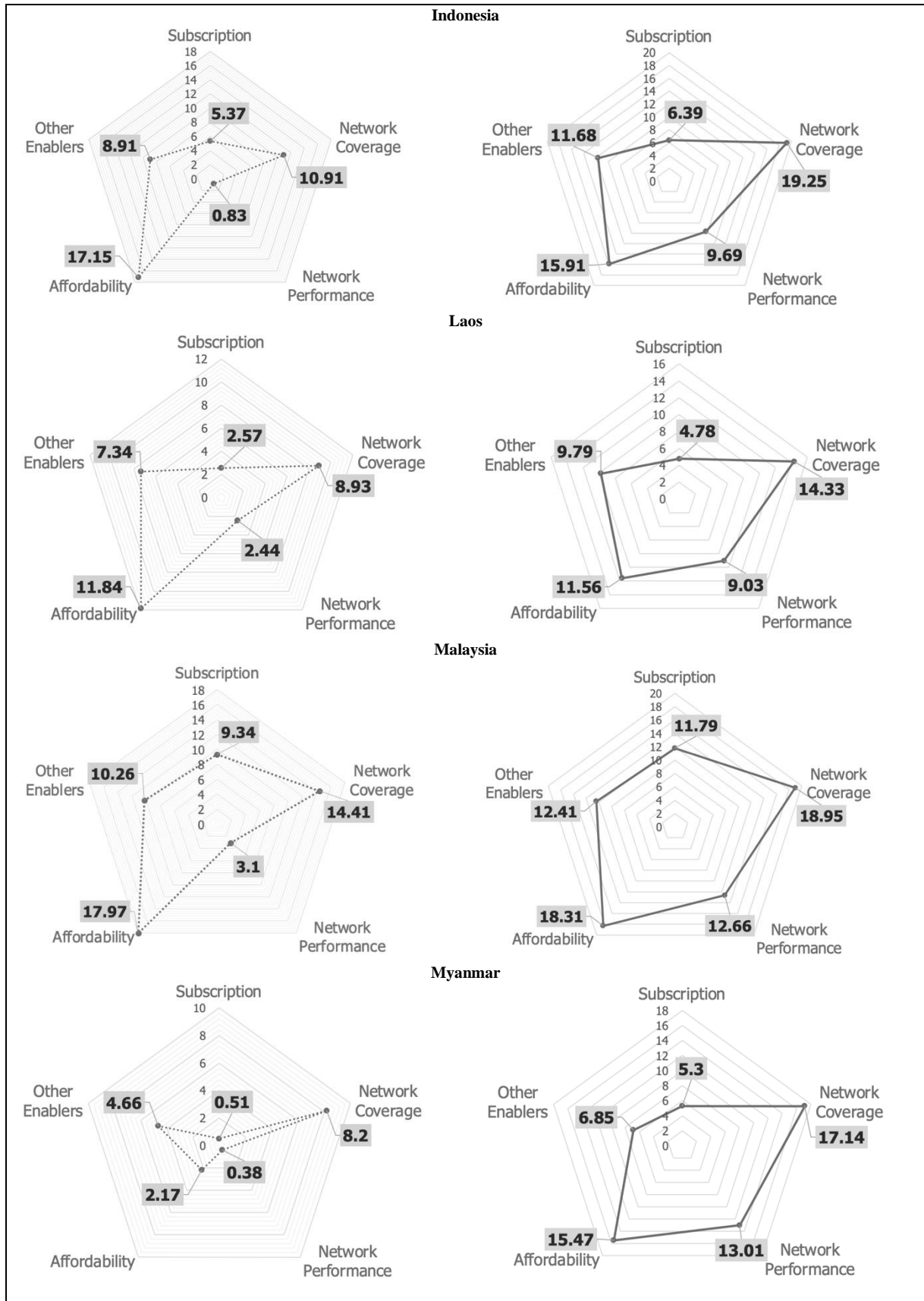
**ASEAN members being more competitive in digital connectivity**

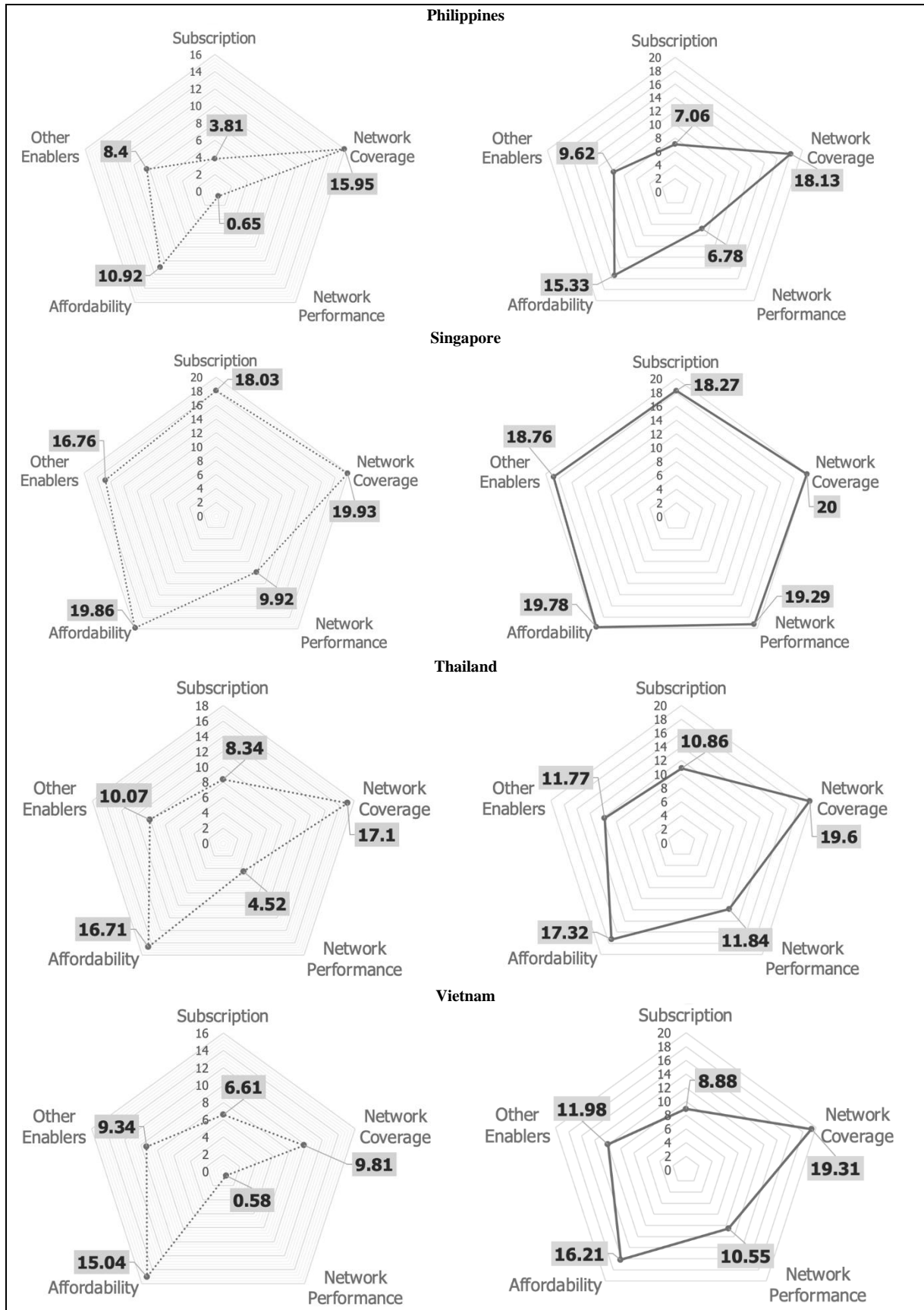
Next, the study performs a competitive analysis of digital connectivity for each ASEAN country. Figure 2 depicts the development and transformation of digital connectivity competitiveness of each ASEAN country from 2014 to 2019. Overall, in the past six years, all ten ASEAN countries have shown improvements and enhancements in terms of Internet subscription, network coverage, network performance, affordability, and other factors that contribute to their digital connection strength.

**Myanmar shows greatest improvement among ASEAN countries**

Although the current subscription level and other enablers have yet to reach a satisfactory level, Myanmar has shown the greatest progress among ASEAN countries over the past six years. As communication is essential and indispensable for modern life in the digital information age, Myanmar has realized the need to improve its ICT infrastructure and thus established the Ministry of Transport and Communications (MoTC) in 2016. As part of the government’s goal of reforming its telecommunications sector, MoTC subsequently formulated the Universal Service Strategy for Myanmar (2018 to 2022), which aims to expand telecommunications services to more than 90% of its population, making the Internet accessible to at least 85%, and more than 50% can access high-speed Internet. From 2014 to 2019, the increase in competitiveness of Myanmar's digital connectivity shows that the series of policy formulations related to telecommunications have obviously been effective. In fact, digital connections in other countries have also improved over the years, and Myanmar is relatively outstanding overall.







Source: Authors' own elaborations.

Figure 2 Competitive Analysis of Digital Connectivity in ASEAN Countries, 2014 vs 2019

### **Low international bandwidth resulting high Internet transit price and affect Internet subscription**

In terms of interpreting various factors that contribute to digital connectivity, Cambodia and Laos performed just slightly above average to cover the cost of using Internet plans and data usage, which is also reflected in lower subscription levels. This is generally due to lack of sufficient international bandwidth used for Internet traffic, or what is commonly known as data transmission rate, expressed in bits per second. In short, higher data transfer rates also means higher costs. Insufficient international bandwidth would cost higher wholesale prices and thus higher Internet retail prices, consequently affecting Internet affordability. Other factors affecting affordability also include the lack of carrier-neutral IXPs that would otherwise increase the competitiveness of smaller Internet service providers.

### **Coverage of network in ASEAN countries is above satisfactory**

Due to technological changes and the acceleration of digitization, our daily lives are inseparable from wireless connections. The coverage of wireless networks can be quantified by the proportion of the population covered by each type of network, i.e., 2G, 3G, or 4G Long-Term Evolution (LTE). In SEA, countries have different geographic coverage of cellular wireless networks. According to OECD (2019), the 2G coverage rate in 2017 covered more than 95% of the population of each ASEAN country, while the 3G coverage rate varied from 78% to 100% of the population in different countries. However, the deployment of 4G (or LTE) networks in Cambodia, Laos, and Myanmar was still in the early stages. From our findings, over time, network coverage for all ASEAN countries in 2019 was above satisfactory, with a score of at least 14.33 out of the 20 highest scores.

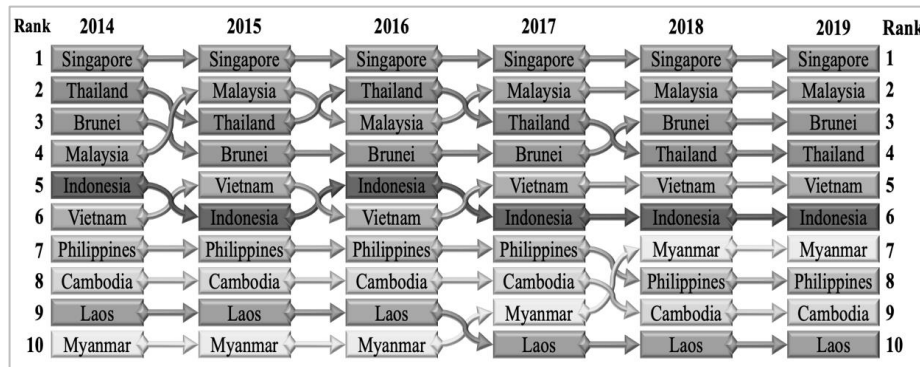
### **Internet speeds in ASEAN countries are below satisfactory except Singapore**

The enabler “network performance: is calculated based on three factors: mobile broadband download speed, upload speed, and network latency. Most people know the meaning of download and upload speeds, as the names imply. In contrast, network latency is relatively unknown in general. It can be defined as the round-trip-time (RTT) for data transmission on a network. In terms of network performance, half of the ASEAN countries, including Brunei, Cambodia, Indonesia, Laos, and the Philippines perform at far from satisfactory levels, with scores all below 10. Only Singapore is exceptionally outstanding, with a score of 19.29 out of 20.

### **Singapore tops in the digital connectivity overall performance across years**

Obviously, only Singapore performs extraordinarily with huge gaps compared to other countries. Attention should be paid to other enablers’ development such as providing sufficient access to electricity and improving construction of secure Internet servers. Most ASEAN countries score only slightly above average in other enabler aspects, except Singapore. From 2014 to 2019, the overall digital connectivity scores for all countries were between 15.93 and 96.10 out of 100 maximum score. Compared with the other nine countries, Singapore is the only developed country in the region, and its digital connectivity scores from 2014 to 2019 have been at the top of the list for six consecutive years. Brunei, Malaysia, and Thailand have consistently competed for the top three spots on the list. From our findings, the digital connectivity performances of these countries have been basically stable and mature since 2018 and have retained the same position in 2019. Figure 3 summarises and depicts the changes of position of all ten countries in terms of their DCI performance from 2014 to 2019.





Source: Authors' own elaboration.

Figure 3 Summary of Changes in Digital Connectivity Performance, 2014 to 2019

## CONCLUSION

As the name implies, the digital economy refers to economic activities based on digital computing technology, which is essential to promoting a country's economic growth. For the digital transformation to be fully realised, digital connectivity is indeed a key part. Therefore, in order to face the infinite demand of millions of Internet users in ASEAN countries, investing and upgrading in digital connection infrastructure is one of the most important agenda items. This foundation can be used to transform the ASEAN economy into a digital economy.

As the main goal of this study is to compare the digital connectivity performance of ASEAN countries to bridging their connectivity development gaps, this study strives to carefully select the consistent components across all ten ASEAN countries from 2014 to 2019. In order to have comparable score across all five enablers for each country, we have used data points that were available consistently from reliable sources, including the World Bank, the GSMA, and the United Nations. From our findings, Singapore's successful and comprehensive development of its digital connectivity is a model for other ASEAN countries to learn from and imitate. As all ten countries are members of the ASEAN bloc, increase of the digital divide would only separate allies from each other and pose an obstacle to the region's top ranking in the world's digital economy.

It is undeniable that level of digital development is not consistent across ASEAN countries. Singapore is the only developed country in the region, while Malaysia, Thailand, Indonesia, the Philippines, and Vietnam are the developing countries, and Myanmar, Cambodia, and Laos are the least developed countries. Different countries are in different stages of development, so this study uses different components in different years for comparison. The transformation of the digital economy is rapid, and it is common to see new components emerge to align with and adapt to the pace of change year by year. But all ASEAN countries have different levels of digital development, so there are different components that can be explained in terms of the country itself. Yet, this issue can be further studied so that different components can be used in different years to better trace the digital transformations of individual countries.

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