Big Data and ICT Readiness Index for ASEAN Economic Community

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ABSTRACT

ASEAN is undergoing a paradigm shift from Government-to-Government (G2G) to Community-to-Community (C2C) relationships with the emphasis on integration and collaboration. The relatively recent developments of Information and Communication Technology (ICT), especially Social Networks, Web 2.0, mobile technology, big data and its related technologies have become the main drivers of this paradigm shift. Big data optimizes capabilities process, high growth and diversified data that create value and knowledge for community within ASEAN in facing ASEAN Economic Community. This study assesses the ICT readiness of each of the ASEAN members to take advantage of the ICT development to build C2C integration and collaboration in facing big data era. The study reveals the score value of each country member to portray ICT readiness for the components of infrastructure development, human capital, people empowerment, innovation, and economic transformation. The paper shows the stages in ICT initiatives in the context of ASEAN and recommend ICT development for each country to eliminate the digital gap between members. It also proposes model of big data for ASEAN member country in supporting economic transformation.

INTRODUCTION

The advancement of Information and Communication Technology (ICT) and the widespread adoption of mobile technology continue in all regions including the Association of Southeast Asian Nation (ASEAN) countries. Traditionally the paradigm of ASEAN ICT initiatives is solely conducted through Government-to-Government (G2G) interaction. This implies there is minimal or no participation from citizens or community. The aim of C2C collaboration and integration is to empower ASEAN's communities to take an active role in the economic transformation of their regions. The challenge of C2C for integration and collaboration is to minimize the digital gap between ASEAN members. To realize the importance and the potential high returns that ICT can offer in transforming a progressive ASEAN economy requires accessing ICT readiness to ensure the sharing and efficient use of resources through ICT. In 2010, 78% of people in ASEAN were using ICT in various aspects of living (ITU, 2014). ICT penetration uses indicators such as the number of mobile phone subscriptions, individuals using the Internet, households with a personal computer (PC) and Internet access, mobile broadband subscriptions, the use of social networks, and big data application.

Big data is a new generation of managing strategies, technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data by enabling high-velocity capture, discovery, and/or analysis (Anshari & Alas, 2012). There are three main characteristics of big data: the data itself, the analytics of the data, and the presentation of the results of the analytics (Gantz & Reinsel, 2012). Big data is defined as an extremely large volume of data that are analyzed with technology to show the patterns of human development or anything related to the society since big data leads to more precise analysis thus helps to bring more accurate decision making and more efficient work. The massive of data is growing quickly, it is expected that by 2020 there will be more than 16 zettabytes of useful data (16 Trillion GB), which implies growth of 236% per year from 2013 to 2020 (Turner et al, 2014). Big data in ASEAN can contribute to economic transformation in adopting a pervasive knowledge-based economy. A knowledge-based economy depends on community literacy, community empowerment and collaboration, integration systems, and knowledge sharing as competitive advantages (Low & Anshari, 2013). Therefore, big data application can contribute in the concept of Community-to-Community (C2C) collaboration and integration in ASEAN.

This study assesses the components of ICT readiness for each ASEAN country. The components comprise ICT infrastructure development,

human capital development, people empowerment and engagement, innovation, and economic transformation. We use the Network Readiness Index (NRI) to assess infrastructure development, Human Capital Index (CHI), e-government index for people empowerment and engagement, the number of H index publications to measure innovation, and GDP for economic performance. The analysis reveals a score index showing the relative position of ICT readiness for each ASEAN country. The study also proposes a framework of ICT initiatives and development and big data's model to provide direction in measuring ICT readiness and assisting ASEAN member countries to focus of components in big data application. In the next section, we present a literature review on related work and Section 3 contains the methodology of our study. Section 4 discusses the issues, and big data and ICT readiness are in Section 5. Finally Section 6 presents the conclusions.

LITERATURE REVIEW

Goods and services are expected to move more easily across borders because of the reduction in transaction time, costs and technical barriers to trade, benefiting business to business (B2B) activities, enhancing trade facilitation and removing tariffs within ASEAN through commitment to a Common Effective Preferential Tariff (CEPT) (ASEAN, 2014). Community to Community (C2C) is closely related to the participation level of individuals in a community, which, in turn, is affected by the level of literacy. Thus, the foundation of C2C integration and collaboration for ASEAN ICT initiatives is driven by many factors such as ICT literacy, infrastructure availability, and affordability. ICT literacy is defined as the degree to which an individual has the capacity to obtain, process, and understand basic information processing to make appropriate decisions.

ASEAN ICT initiatives should encourage the skills of citizens seeking information and services. Citizens are expected to understand the new roles in seeking information, understanding basic information, and making decisions for themselves. Citizens with appropriate information literacy levels have abilities that range from reading instructions for public services and administration, interpreting instructions, public promotion brochures, or public alerts. In addition, information literacy indicates the ability to read information, and is a learning process, which will improve as citizens become familiar with it. It requires reading, listening, analytical and decision-making skills, and the ability to act on instructions (Nutbeam, 2008). Poor information literacy is common among racial and ethnic minorities, and elderly persons, particularly in public-sector settings, because of limited access to the service, facilities, and information (Schillinger et al., 2002).

Literacy involves a complex set of abilities to comprehend and use the dominant symbol system of a culture for personal and community development. The need and demand for these abilities vary in different societies. In a technological society, the concept is expanding to include the media and electronic text, in addition to alphabets and numbers. Individuals must be given life-long learning opportunities to move along a continuum that includes reading, writing, critical understanding and the decision-making abilities they need in their communities. People with low literacy skills are most likely to incur higher costs (CHCS, 2011). Traditional citizen education relies heavily on writing material, management, and instructions (Williams et al., 1995). Despite the availability of extensive education materials with relatively consistent content, many are written at a high level so that citizens with low literacy have difficulty in comprehending essential points. Thus, citizens with inadequate literacy may not benefit from such educational efforts.

Brunei Darussalam

Brunei is a small country of 5769 square kilometres located on the northwest end of the island of Borneo. The population of Brunei is 415,717, with 76% in urban and 24% in rural areas, with an average growth of 2.2% per year. The population of Brunei Darussalam is 53% male and 47% female and is 73.8% Malay, 14.8% Chinese, and 11.4% other (AITI, 2010; Anshari & Alas, 2015a). The statistics on Brunei Internet users from 2006 to 2009 show an increase in the penetration of Internet usage to 78.5% according to the report on Brunei by the Oxford Business Group in 2010 (AITI, 2010). In the near future Brunei's network infrastructure will be upgraded to an ultra-broadband service connection through fibre optics (Almunawar & Anshari, 2014). The high-speed broadband will have a maximum data transfer rate of 150 Mbps, a more stable and better network coverage, and consistent Internet experience (Abubakar, 2011). Internet Literacy in Brunei is high (Anshari, Alas & Guan, 2015a), with more than two thirds of the population gaining access to the Internet, there is a very narrow digital divide in Brunei (AITI, 2010; Anshari & Alas, 2015b). With the increasing presence of smartphones in Brunei, agencies (government and NGO) have initiatives to improve ICT to support it (Anshari, Alas & Guan, 2015b). In 2000, the government expressed a wish to see Brunei implementing e-government and e-business initiatives through global information technology as a way to encourage economic development, which includes the use of smartphones (Kifle & Cheng, 2009).

Cambodia

The number of mobile subscriptions in Cambodia currently exceeds the population. In 2012, Internet usage increased by almost 60%, jumping from 1.7 million to 2.7 million users. The increase in mobile and Internet users

in Cambodia means there is enormous potential for business growth and employment opportunities in the technology sector (Todd, 2013). In 2014, the population of 15,205,539 was 20% urban and 80% rural. There was 5% Internet penetration with 8% active Facebook users, and 126% mobile subscriptions. Ninety-five percent of mobile subscriptions were pre-paid, and 5% were post-paid. Eleven percent of mobile subscriptions were 3G connections (GSMA Intelligence, 2014).

Indonesia

Internet penetration is expected to rise significantly in the years to come as technology becomes more affordable. Social media are normally used for sharing and bonding (Thia, 2011). Indonesia has the 4th-highest number of Twitter users worldwide. As of January 2011, there were more than 4 million Twitter accounts established by Indonesian users. Almost 20.8% of online users visited Twitter.com in June 2010 (Comscore, 2010). Currently, there are 44 million Facebook users, which makes it number 4 in the ranking of all Facebook statistics by country. Facebook penetration was 18.21% of the population and 147.45% of Internet users (Socialbakers, 2012). In 2014, the population of 251,160,124 was 51% in urban and 49% rural. There was 29% Internet penetration with 25% active Facebook users, and 112% mobile subscription penetration. The average time users spent on the Internet each day through a desktop or laptop was 5 hours 27 minutes. There was 14% mobile internet penetration and the average time users spent on the Internet daily was 2 hours 30 minutes (GlobalWebIndex; 2014). Social media penetration was 15% of the population, with 2 hours 54 minutes per day on average spent on social media. Seventy-four per cent of mobile users used social media apps on their phone and 32% used location based facilities (GlobalWebIndex, 2014).

Lao PDR

In 2014, the population of 6,695,166 was 34% urban and 66% rural. Internet penetration of 1% included 6% active Facebook users, and 97% mobile subscriptions. Ninety eight percent of mobile subscriptions were pre-paid, and 2% post-paid, and 11% were 3G connections (GSMA Intelligence, 2014). There were 54,000 active mobile broadband subscriptions, or 0.8% of the total population. The 360,000 active social media users accessing social media on mobile devices were a 5.4% penetration of the mobile social sector (US Census Bureau, 2014; InternetWorldStats, 2014; Facebook, 2014; ITU, 2014).

Malaysia

Malaysia is stable and the highest ranked economy in developing Asia. Business usage is strong, as firms invest to adopt new technologies and strive

to become increasingly innovative. In 2014, the population of 29,628,392 was 73% urban and 27% rural. There was 65% Internet penetration with 53% active Facebook users, and 139% mobile subscriptions. Internet users spent on average 5 hours 36 minutes using the Internet each day through a desktop or laptop. Mobile Internet penetration was 58% and mobile Internet users spent on average 3 hours 3 minutes per day using mobile Internet (GlobalWebIndex; 2014). Social media penetration was 64% of the population and users spent on average 3 hours and 17 minutes on social media. Fifty eight per cent of mobile users used social media apps on their phone and 28% location based facilities (GlobalWebIndex, 2014).

Myanmar
In 2014, the population of 55,167,330 was 33% urban and 67% rural. Internet penetration was 1% with 2% active Facebook users, and a 10% mobile subscription penetration. Ninety-nine percent of mobile subscriptions were pre-paid, 1% post-paid, and 14% were 3G connections (GSMA Intelligence, 2014). There was no information on the number of active mobile broadband users. There were 1.1M active social media users accessing social media on mobile devices or a 2.0% penetration of the mobile social sector (US Census Bureau, 2014; InternetWorldStats, 2014; Facebook, 2014; ITU, 2014).

Philippines
The Philippines improved the most in ICT readiness. In 2014, the population of 105,720,644 was 49% urban and 51% rural. Internet penetration was 36% with 32% active Facebook users, and a 101% mobile subscription penetration. Internet users spent on average 6 hours 12 minutes per day on the Internet through a desktop or laptop. Mobile Internet penetration was 31% and users spent on average 2 hours 48 minutes per day on mobile Internet (GlobalWebIndex; 2014). Social media penetration was 35% of the population with an average 4 hours and 1 minute per day spent by users. Social media apps were used by 62% on their phones while 29% used location based facilities (GlobalWebIndex, 2014). The role of ICTs in fostering innovation by creating new products and services ranked 42nd and the organizational model ranking at 28th was confirmed, contributing to this promising result.

Singapore
Singapore implemented a 10-year Master Plan for ICT development, namely the Intelligent Nation 2015 (iN2015). The vision of iN2015 extends the city-state to enable innovation in all economic sectors and society, integration in filling the gaps between communities, government and businesses, and, finally internationalisation to gain access to the world's resources (iN2015, 2006). As a city-state, the total population was 5,460,302 with 100% living

in an urban area with 73% Internet penetration and 59% active Facebook users. There were 148% active mobile phones. Users spent on average 5 hours and 16 minutes per day using the Internet through a desktop or laptop. There was a 64% mobile Internet penetration and users spent an average of 1 hour and 57 minutes per day using mobile Internet (GlobalWebIndex; 2014). Seventy percent of the population used social media, spending on average 2 hours and 10 minutes per day per user, with 49% using social media apps on their phone and 18% using location based facilities (GlobalWebIndex, 2014).

Thailand

Thailand, similar to most other ASEAN members, improved its performance this year (2015). In 2014, the population of 67,448,120 was 34% urban and 66% rural. There was a 35% Internet penetration with 36% active Facebook users, and 125% mobile subscriptions. Users spent on average 5 hours and 7 minutes per day on the Internet through a desktop or laptop. There was a 24% mobile Internet penetration and users spent on average 3 hours and 4 minutes per day on mobile Internet (GlobalWebIndex; 2014). Twenty-five percent of the population used social media an average of 3 hours 39 minutes per day, with 50% of mobile users using social media apps on their phone and 36% using location based facilities (GlobalWebIndex, 2014). Individual use of ICT still lags behind, yet it showed a significant improvement, with a good penetration of mobile phones and use of virtual social networks, comparable to advanced economies.

Vietnam

With a stable performance, Vietnam has marginally improved its ICT score. In 2014, the population of 92,477,857 was 31% urban and 69% rural. Internet penetration was 39% with 22% active Facebook users, and a 145% mobile subscription penetration. Users spent on average of 4 hours 37 minutes per day on the Internet through a desktop or laptop, and of the 34% mobile Internet penetration, users spent an average of 1 hour 43 minutes per day using mobile Internet (GlobalWebIndex; 2014). Thirty-eight per cent of the population used the social media on average 2 hours 3 minutes per day, with 58% of mobile users using social media apps on their phones and 25% using location based facilities (GlobalWebIndex, 2014). The use of ICT by individuals, businesses, and government remained stable, with little progress registered since the last assessment.

Big Data & Open Government Data

Big data becomes popular terms in many sectors, especially business organization. Due to its benefits, AEC needs to consider the emerging big data management, analytics, and technologies into their strategic plan for the member countries. Big data is high volume, velocity and variety information

assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision-making (Laney, 2012). Big data sources can be created by people or generated by machines like sensors gathering climate information, satellite images, GPS signals, digital pictures and videos, and transaction records. The growth in big data is not only because a growing number of smartphone users, but also trigger by other smart mobile devices or pervasive computing abilities that is multiplying quickly (Anshari, Alas, Guan, 2015a). For instance, smart meters collect and transmit real-time data on energy usage (OECD, 2012a), and smart automobiles are able to transmit real-time data on the state of the car's components and environment (OECD, 2012b). Many of these smart mobile devices are based on sensor or actuators that sense and able to interact with their users over mobile networks namely pervasive computing. Pervasive computing exchanges data and interact with people or computers and other smart devices. More than 30 million interconnected sensors through pervasive computing are now deployed worldwide, in areas such as security, health care, the environment, transport systems or energy control systems, and their numbers are growing by around 30% a year (MGI, 2011). From the whole data digital universe (more than 13,000 Exabytes), it is predicted there will be one third having big data value if it is analysed. Not all data is useful for big data analytics, however, some data types are important for analysis, such as a surveillance camera, embedded device, pervasive computing, social media, consumer images (IDC, 2012).

Open Government Data (OGD)

One of the most important sources of big data is the Open Government Data (OGD). OGD initiative in ASEAN member countries needs highly consideration in achieving the goal of the AEC 2015. When the society becomes relying on internet, social networks, and mobile technology, then OGD will accelerate the impact of big data for economic growth in the region. Open Knowledge Foundation defines open data includes any type of data that is free to use, re-use and redistribute without any legal, technological or social restrictions (OKFN, 2013). OGD proactively publishes real time data to be used by the public for a tasking, triggering new ideas of business initiative, and improve decision making for corporations and SMEs. Why it is OGD? There is an ongoing paradigm shift on the issue of government data from the perspective of data as as being (secret) assets or proprietary of the government to the paradigm that the government's data as *public goods* that will provide more benefits when they are shared to the public *in real time* so that people gains value from the extracted data. After the financial crisis in 2008, OGD was considered a way to create value from data which can be freely used, reused and distributed by anyone where it gives more value, influence, and more impact when it is shared with the public to the more open

environment (Ritter, 2014). In some extents, open data contributes to the disaster prevention, rapid response, and improve communication between government, universities, business communities, and citizens using OGD platform. There are many benefits from OGD such as transparency and accountability by government been doing, making information available in real time to the public, and improve public services and the ability to provide input and feedback to the public policy delivery process. From perspective people in the business, OGD has been able to boost tremendous economic growth by accelerating business to take a quick decision making since OGD shares a real time data to the public. There are some identified government data includes in OGD initiatives like public services data, research development and innovation, statistics data, socioeconomic indicators, weather and environment data, healthcare monitoring, culture and exhibitions. The value of OGD as part of the big data source will definitely play an important role in driving the success of AEC.
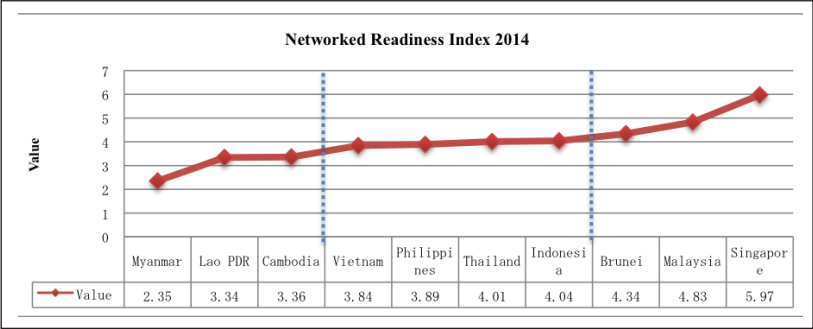
METHODOLOGY

This study builds on recent reviews of ICT status in ASEAN countries. Searches of Google Scholar and Scopus indexing journals were conducted using keywords 'ICT AND ASEAN, ICT Brunei Darussalam or Cambodia, Indonesia or Laos or Malaysia, or Myanmar, or Philippines, or Singapore, or Thailand and Viet Nam'. We chose only English-language articles published in peer-reviewed journals. After removing duplicates and articles beyond the scope of this study, we selected 50 articles for review to extract the ICT issues in an ASEAN context. We employed a thematic analysis of discussions that most importantly linked papers and articles. We extracted ideas and then applied them in reviewing ICT and the ASEAN environment. We developed the analysis into the proposed model based on the strategic thrust of ICT.

DISCUSSION

4.1   Infrastructure Development

To measure infrastructure development in the ASEAN countries, we used data from the Networked Readiness Index (NRI) of 2014, which was taken in 2013. The ASEAN countries improved their overall scores and the majority also made progress in their rankings, although some continued to be reside at the lower end such as Cambodia (108th), the Lao PDR (109th), and Myanmar (146th) (Bilbao et al, 2014). The World Economic Forum and INSEAD produced the Networked Readiness Index (NRI) which

measures performance in terms of ICT readiness including excellent digital infrastructures, robust innovation systems and universal Internet use. Some features of the NRI are accessibility and usage and it includes the affordability of ICT infrastructures, digital resources, software and Internet literacy. In addition, it covers how using ICT can benefit individuals, communities, businesses, and governments (Bilbao-Osorio, Dutta, & Lanvin, 2014).
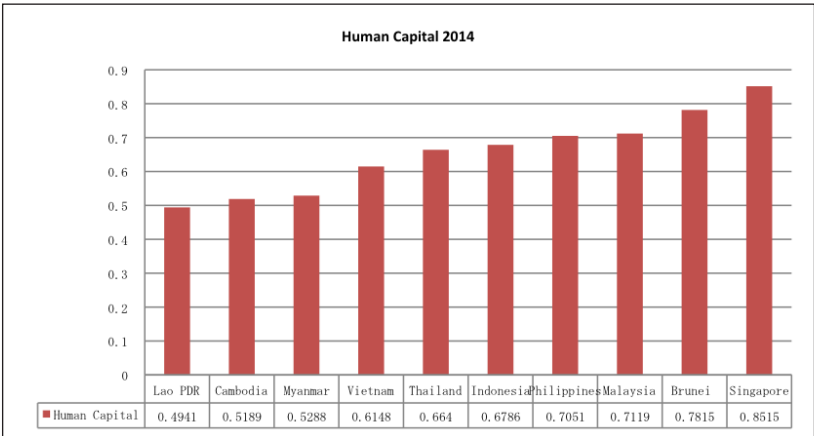

Networked Readiness Index 2014

	Myanmar	Lao PDR	Cambodia	Vietnam	Philippines	Thailand	Indonesia	Brunei	Malaysia	Singapore
Value	2.35	3.34	3.36	3.84	3.89	4.01	4.04	4.34	4.83	5.97

Figure 1: NRI 2014 - Source: Authors' Compilation

Figure 1 shows that Singapore performs very well and ranks second in the world for the most outstanding digital ICT infrastructure that is very supportive for business and provides the best online service in the world. The NRI has provided governments and business makers with a useful conceptual framework to evaluate the impact of ICT at an ASEAN as well as a global level and to benchmark the ICT readiness and usage of their economies (Bilbao et al., 2014). In summary, there are three categories of infrastructure readiness as shown Figure 3. The upper level index includes Brunei, Malaysia, and Singapore. The middle level includes Vietnam, Philippines, Thailand and Indonesia. The lower level includes Myanmar, Laos, and Cambodia.

4.2   *Human Capital Development*

Educational disparity is another contributing factor to the digital divide. A strong correlation exists between education, literacy, and the ability to use ICT. Education is the most important determinant of the intensity of Internet use (UN, 2014). The ASEAN ICT initiatives should encourage the skills of citizens seeking information and services. People in ASEAN are expected to understand new roles in seeking information, understanding basic information, and making decisions for themselves. People with appropriate ICT literacy levels have abilities that include e-learning or mobile learning activities, e-government for public service and administration, and e-business for promotion and transactions. In addition, ICT literacy indicates the ability

to perform online activities, and to enhance skills in analysis and decision-making, and act on preserving morality, responsibility, value, and identity as an ASEAN member.
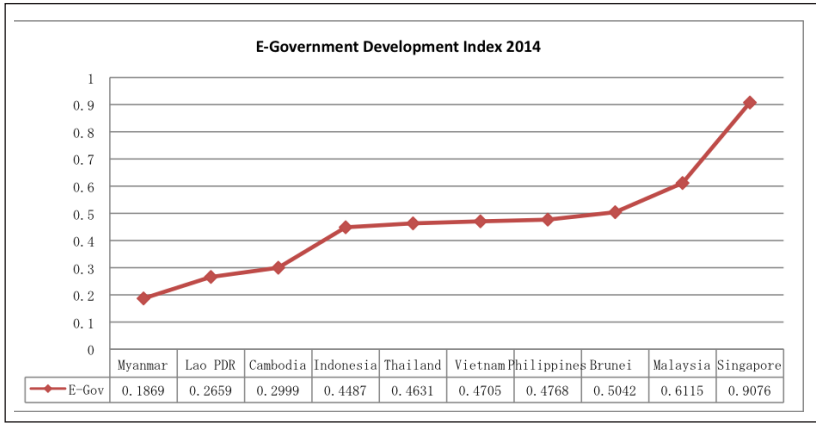
Human Capital 2014

	Lao PDR	Cambodia	Myanmar	Vietnam	Thailand	Indonesia	Philippines	Malaysia	Brunei	Singapore
Human Capital	0.4941	0.5189	0.5288	0.6148	0.664	0.6786	0.7051	0.7119	0.7815	0.8515

Figure 2: Human Capital Index 2014 - Source: Authors' Compilation

Therefore, it is important to realize that the spectrum of skills and literacy are not narrowed to the technical aspect of ICT but include the whole dimension of social development. We used the Human Capital Index to be part of measuring the ICT readiness of ASEAN countries (Figure 2).

4.3   People Empowerment & Engagement

Measuring ICT readiness in the ASEAN countries should consider citizen empowerment, participation and engagement. Effective e-government service requires a paradigm shift from a traditional perspective where citizens are perceived as recipients of services to being partners in the process of administration and public service decision making which are related to the public interest. Empowerment in E-Government emerges to achieve enduring partnerships with citizens in administration and public service.

E-Government Development Index 2014

|	Myanmar	Lao PDR	Cambodia	Indonesia	Thailand	Vietnam	Philippines	Brunei	Malaysia	Singapore
E-Gov	0.1869	0.2659	0.2999	0.4487	0.4631	0.4705	0.4768	0.5042	0.6115	0.9076

Figure 3: Human E-Government Index 2014 - Source: UN E-Government, 2014

Many governments attempt to empower and engage their citizens and encourage them to participate through ICT mobile devices, because the number of people in ASEAN who own mobile smartphones is growing fast. With mobile devices, people can access e-government systems anywhere at any time. Empowerment and participation of citizens should be incorporated in e-government processes to support good governance. Therefore, we used the E-Government Development Index (EDI) released by UN for the year 2014. As shown in Figure 3, Singapore leads in the EDI followed by Malaysia and Brunei. Philippines, Vietnam, Thailand, and Indonesia stand at the moderate level. Cambodia, Laos and Myanmar need more time to implement E-Government initiatives.

4.4   Innovation

Innovation deals with the contribution to knowledge on a per country basis. Contribution to knowledge can be measured by considering the number of publications in refereed journals. To simplify the ranking, we collected the H index publications data per country from the Scopus indexing website. To reduce the gap, AIM may start with initiatives to create greater access for ICT, provide access for the business sectors, education and knowledge resources, government services, and community, across the region. Furthermore, the ASEAN University Network (AUN) should encourage the formation of research communities and collaboration between ASEAN universities and research centres.
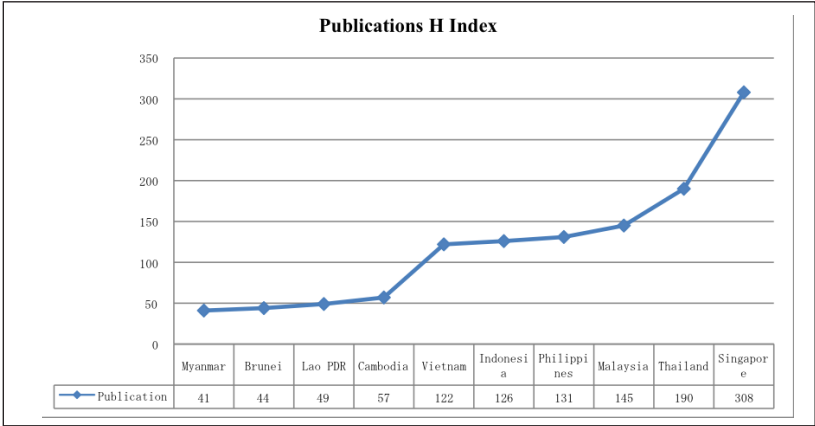
Figure 4: Publication H Index 2014 - Source: Scopus, 2014

Figure 4 shows the distribution of the rate of the contribution of knowledge per country based on the H index level. The figure measures the country's knowledge sharing capacity as well as its overall capacity to innovate, and the production of novel entities measured by the number of Patent Cooperation Treaty (PCT) patent applications and publications. The business-use pillar captures the extent of a country's Internet use as well as the efforts of firms in an economy to integrate ICT into an internal, technology-savvy, innovation-conducive environment that generates productivity gains. It also measures the availability of staff training, which indicates the extent to which management and employees are capable of identifying and developing innovations.

4.5   *Economic Transformation*

Economic transformation is the aim of C2C integration and collaboration. It is the outcome from AIM 2015 that ICT should contribute to economic development and transformation in ASEAN. As discussed before, economic transformation refers to the knowledge-based economy, which depends on the ICT readiness of each community. Therefore, strengthening C2C integration and collaboration can be supported by strengthening ICT development in each ASEAN country. Figure 7 explains the quantitative measure of economic progress of ASEAN members through a GDP indicator comparing 2011 and 2014. GDP is measured by adding total consumer, government and business spending, and the value of net exports. GDP is often used as a way to measure a country's standard of living. We use GDP to find the correlation between the strength of an economy through GDP and other factors such as ICT infrastructure development and the Human Capital Index.
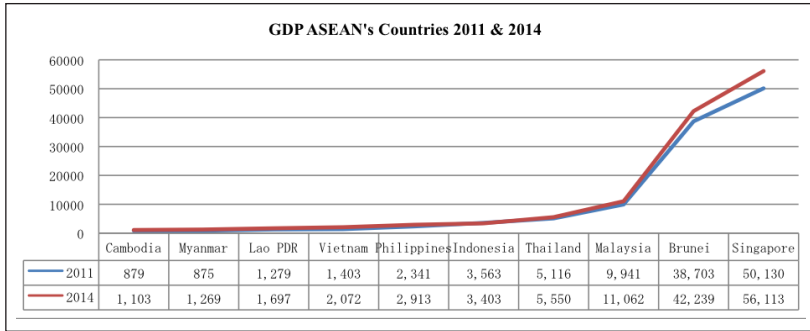
Figure 5: GDP ASEAN Countries 2011 & 2014 (Economy Watch, 2015)

Figure 5 shows that Singapore and Brunei have a greater GDP rate than other ASEAN countries. In the knowledge economy, ICT can contribute to accelerate growth of GDP and vice versa, whereas GDP may support ICT development to make the business process more effective and efficient.

1.6   C2C Integration and Collaboration

We summarize the findings in Table 1 below. The scope of ICT readiness is divided into ICT infrastructure using the Network Readiness Index (NRI), people literacy using the Human Capital Index (HCI), people empowerment and engagement using the E-Government Development Index (EDI), innovation using the H-index publication, and economic transformation using the Gross Domestic Product (GDP). Each number should be interpreted as the level of readiness for each item. From the standpoint of each country, we sum the individual scores to obtain the total score. We also provide recommendations for each country based on the weakest or strongest points.

Table 1: The Networked Readiness Index 2014 (The World Economic Forum, 2014)
DEVASIA = Developing Asia; ADV = Advanced Economies

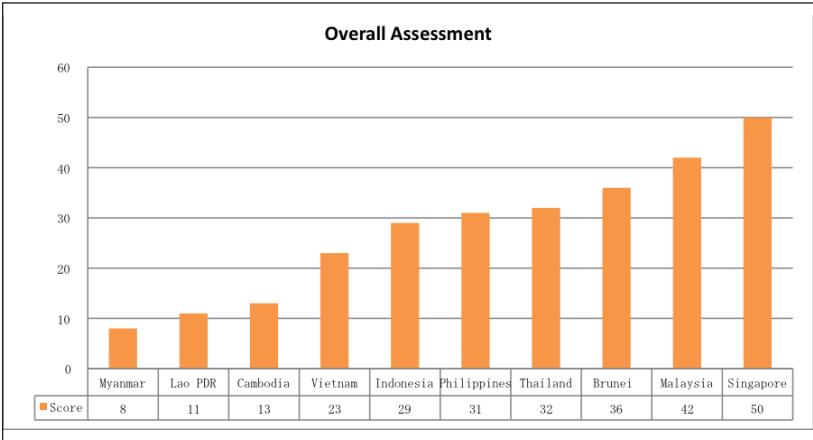| Country	Infrastructure	Human Capital	Engagement	Innovation	Economic	Recommendation
Brunei Score: 36/50	8	9	8	2	9	• Human capital high but innovation low, very few universities (4 only) and research centres • Economic transformation should consider using more from infrastructure & human capital

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Country	Infrastructure	Human Capital	Engagement	Innovation	Economic	Recommendation
Cambodia Score: 13/50	3	2	3	4	1	• Has potential in innovation that must be encouraged and improved further through human capital and ICT infrastructure • Human capital and ICT infrastructure should be made the priority for development to contribute economic transformation
Indonesia Score: 29/50	7	6	4	6	6	• With the large population and many universities in Indonesia, the government should seriously consider developing innovation and human capital • Though the infrastructure of ICT has improved (cheap Internet access), government initiatives should facilitate systems such as the e☐government initiative in all sectors
Lao PDR Score: 11/50	2	1	2	3	3	• The biggest challenge is developing human capital • Empowerment and engagement should follow the government investing more in ICT infrastructure
Malaysia Score: 42/50	9	8	9	8	8	• Human capital is in a good position and it should be improved further • Economic development should improve if innovation and human capital are facilitated further

Country	Infrastructure	Human Capital	Engagement	Innovation	Economic	Recommendation
Myanmar Score: 8/50	1	3	1	1	2	• It should consider investing more in ICT infrastructure to reduce the digital divide within the country • Has potential in human capital but it must have support systems
Philippines Score: 31/50	5	7	7	7	5	• Has a moderate level of ICT infrastructure development • Economic transformation should improve when the government invests more in ICT infrastructure
Singapore Score: 50/50	10	10	10	10	10	• Singapore is considered a developed country where the challenge is to maintain development and encourage continuous innovation • The other challenge is to ensure community does not change in terms of ethics and principles resulting from the advancement of ICT
Thailand Score: 32/50	6	5	5	9	7	• Human capital, ICT system support (e-Govt) and ICT infrastructure need more attention • It has potential in innovation that should support economic transformation if the three factors above are improved
Vietnam Score: 23/50	4	4	6	5	4	• The country has a moderate level of ICT development compared with other ASEAN countries • The government should consider improving infrastructure and human capital, which leads to innovation for better economic transformation

Table 4: Scoring of ICT Readiness and Recommendation - Source: Authors' Compilation

The biggest challenge in the ASEAN ICT initiative is the digital gap between ASEAN members as seen in Figure 6. It needs collective effort from all the ASEAN members to establish synergies so that C2C integration and collaboration can be achieved.

Overall Assessment

	Myanmar	Lao PDR	Cambodia	Vietnam	Indonesia	Philippines	Thailand	Brunei	Malaysia	Singapore
Score	8	11	13	23	29	31	32	36	42	50

Figure 6: Overall Assessment of ICT Readiness - Source: Authors' Compilation

I.   ICT Readiness & Big Data Challenges

There are six strategic realities in the ASEAN ICT Masterplan 2015. Because the ICT readiness of each member country differs at various levels, we propose a framework for ICT development in the ASEAN context based on AIM 2015 (see Figure 7). The aim of the framework is to help countries understand their recent status and condition, secondly to assist them to set their respective priorities for ICT initiatives, and finally to set a future direction to eliminate the digital divide and create ICT as a tool for economic transformation. We propose the framework in the form of a pyramid in which each level should be fulfilled before moving to the next level. At the bottom, the ICT initiative should start from developing the ICT infrastructure. We believe that C2C integration and collaboration are difficult to achieve without the support of sufficient ICT infrastructure that is reliable and affordable for the community in the respective country. The second level is development of human capital. Improving human capital will automatically reduce the digital divide within a country and the region. Development of human capital should be at the national level to ensure the ICT literacy of citizens is standardized with other member countries. Thirdly, people empowerment and engagement can only be achieved if the other two foundations have been accomplished, then we should achieve empowerment and engagement. The government plays an important role in people

empowerment and engagement to enhance the well-being of their citizens, in the effort they make to implement their vision for ICT development, and in the number of government services, they provide online.
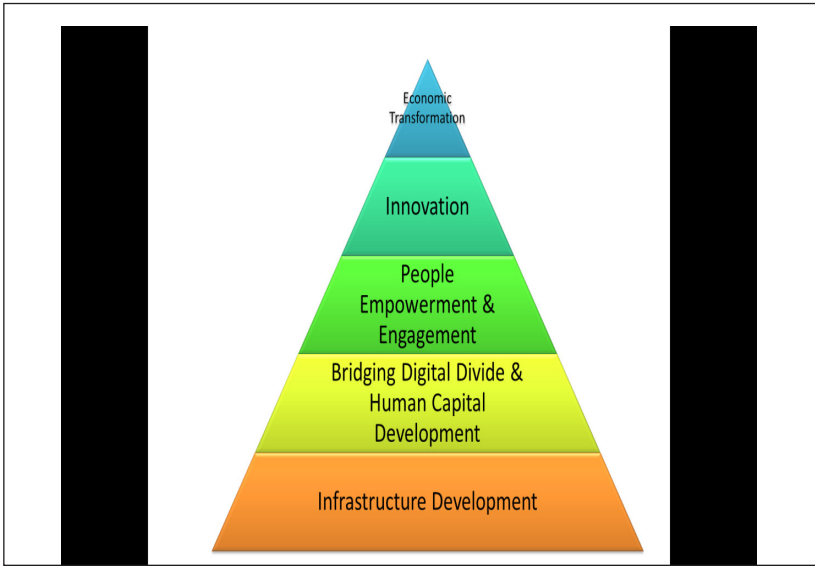
Figure 7: Phase of ICT Initiatives in ASEAN

Fourthly, innovation is about the competitiveness of the community through ICT. Innovation is a competitive advantage and added value that governments place on carrying out government support to encourage citizens to use ICT and human capital as a factor in the competitiveness of the country. Finally, economic transformation is the goal for the ICT initiative in ASEAN, where ICT can contribute to support a knowledge economy and strengthen ASEAN economic competitiveness.

Big Data Challenges in AEC

Goods and services are expected to move more easily across borders because of the reduction in transaction time, costs and technical barriers to trade, benefiting business to business (B2B) activities, enhancing trade facilitation and removing tariffs within ASEAN through commitment to a Common Effective Preferential Tariff (CEPT) (ASEAN, 2014). At the same time, the digital universe will grow to eight zettabytes by 2015 (IDC, 2012) due to data exchange of individual, community, business, and government. Therefore, big data will have a broad impact socially and economically to AEC. ASEAN needs to have a new strategy and business model to exploit

the value of big data by engaging all stakeholders such as governments, corporations, SMEs, institutions, and individual on board. There are some challenges for big data initiatives in AEC.

Big Data Awareness

The first challenge is ASEAN's leaders acknowledging the potential and promise of big data. The ASEAN leaders should realize the value and impact of big data in realizing ASEAN Economic Community 2015. In the simplest scenario, people are producing a huge amount of data every day. However, they are very hard to realize the value of their own data produced to the public. When they are given the tools and mechanism to store, retrieve, explore, and visualize their own data. They can comprehend of the value of data for better decisions such as understanding their own habits, forecasting expenditures, managing their finances effectively. Similarly, it is applied in the context of business and ASEAN that is a vast quantity of data produced can be managed, retrieved, analysed to solve common problems in a region like disaster prevention and response, Centre for Diseases Control and Preventions, regional business trends and forecast, consumers' demand & supply. Leaders in ASEAN must take a necessary step to ensure their country is '*Big Data Enables*'.
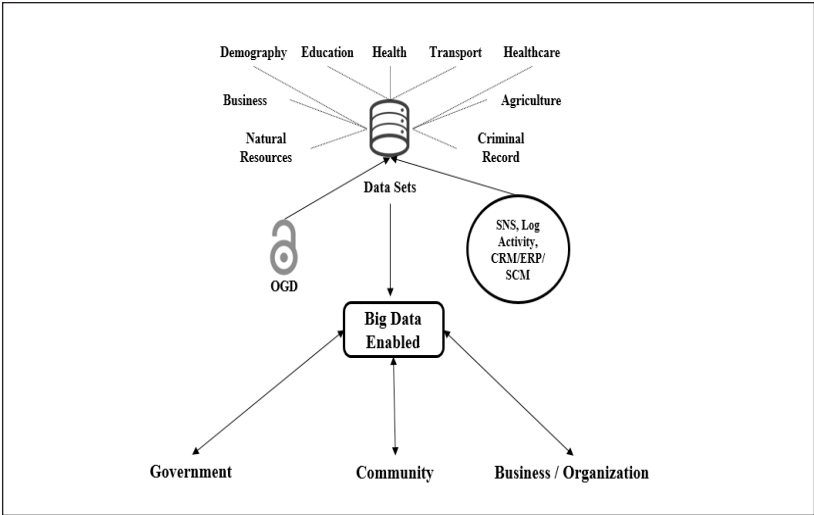
Figure 8: Big Data Enabled Source: Authors' Compilation (2015)

For instance, healthcare is one of the major spending any country in the world (Anshari, et al, 2013a, b). Figure 8 shows the model of big data enabled on, how big data could potentially reduce the budget spending in ASEAN countries. Healthcare centers through OGD in each country release real time

data, how many patients suffer from specific diseases. It gives information on the proportion and forecasting people going to see a doctor. From general public, they generated data from online conversations among people (SNS), interactions between people and systems (e-health & mHeallth), and sensor-enabled machinery (Almunawar & Anshari, 2014a). Lab (Doctor) in each district will analyze and send sample results' subset of their patients to central Healthcare. Data from various sources is retrievable and used by people. Information on disease and prevention are released to public.

Business Process with Big Data Enabled
Secondly, ASEAN community is challenged to come up with the initiative to provide Enterprise Resources (ER) solutions (ERP, SCM, and CRM) with the capability of 'Big Data Enabled'. Big data is in early stage in the cycle that needs to address technical and infrastructure challenges, and it will expand to non-technical audience. It will be the next generation of ER solutions with the new features of feature of big data enabled. Therefore, universities and research centers across ASEAN should be encouraged to extend their research scope to come up with the new ER business solution with big data enabled. We predict that there will be a new evolution of the ER business solution introduced to the market soon that will embed big data enabled in their ER solution. For instance, a new generation of CRM will be empowered with mining a real time all of customer data, the interactions of the sales force with them, and combines the results with external datasets on industry and news, social networks of the customers, geographic and demographic patterns, to determine which forecasts are the most likely to make a transaction in the near future. We also will witness more Web technology adopts big data enabled that can detect patterns of users based on their clicks, visiting a web page, and even social media conversation. In those scenarios, the third challenges for AEC is developing 'Big Data Hub' for each country.

Big Data Hub
Within the implementation level, each member country should develop a big data hub that acts as a proxy for ASEAN big data integration. This will enable data sharing any clusters of data sources such as social networks, weather update, business trends, OGD. People across the region will rely on big data hub to get specific information from various sources in single and standardize platform. Data hub in each country must be integrated and managed into single ASEAN entity. It needs to develop a big data hub for each country where the hubs will be connected as a single networked entity. For instance, business from Thailand can access big data hub to understand customers' trends and understanding of customer behavior in Indonesia, which often provides opportunities for commerce due to accurate decision,

create better customer service and retention plans that are aligned with a customer's value to the ASEAN community. Furthermore, big data hub can escalate new and innovative products or services across ASEAN that enables advanced analytics leading to better business outcomes. When each member country has implemented big data enabled, then each big data center will create a big data hub for the purpose of AEC. We can see the benefits and potential beneath. For instance, in the case of disease prevention, how much saving can be made when all research centers and universities in ASEAN are able to use the big data hub to combat the specific disease problem in the region? It will prevent repetitive work of research because the progress is shared in the big data hub. Furthermore, it will make the process of efficient, effective, and quick.

Big Data Manpower
The era of big data is coming to bring new opportunities for discovering new values. In the big data era, reliable system of big data analysis is critical to provide reliable value. Demand for big data skills will significantly improve until 2020. There are no specific data were shared for ASEAN, however the demand is expected to grow by 160 per cent in the United Kingdom alone (de Waal-Montgomery, 2015). One type of analysis is the social media analytics. To illustrate above statement: Starbucks has used social media, such as blogs, twitter and niche forum, to analyze the costumers' on the new product being introduced. This is much quicker as compared to using a periodical method, waiting for the sale's reports to come in and evaluate its performances.

Big Data and Big Gap
Finally, the biggest challenge in gaining value for big data in regard to AEC is the digital gap between ASEAN members as seen in Table 2. It needs collective effort from all the ASEAN members to establish synergies so that integration and collaboration can be achieved. The gap resides in the domain of infrastructure and human capital readiness. In terms of infrastructure readiness, AEC could maximize the efforts to the cloud computing since big data reside increasingly in a computing cloud, above vast hardware, data centers linked to billions of distributed devices, all governed by increasingly intelligent software. In fact, by 2020, nearly cloud computing providers will manage 40% of the information in the digital universe (IDC, 2012). Cloud computing accelerates the potential for flexibility, efficiencies for managing data and scalable analytic solutions (Anshari, Alas, & Guan, 2015b). The big data hub can be developed through cloud computing. In addition, the availability of high-speed broadband access, especially mobile broadband access, has significantly facilitated the collection, transport and use of data in the economy (Almunawar & Anshari, 2014). It is estimated that households across the ASEAN connected with smart devices. Mobile networks are

best geared to geographically mobile and dispersed AEC who want to be connected everywhere and anytime. However, a major barrier for the people in rural areas is the lack of access when a few mobile network providers have been chosen that affects to less competitive broadband services and prices. The solution should be for *government policy and regulations* to allow mobile network providers in ASEAN countries to share the services for the community within ASEAN.

Legal Aspects, Privacy and Security
Ensure legal frameworks and policies are big data friendly. When a value and volume of data increases, so does the risk of data breaches. In fact, the major crime problem for global companies has recently been losses of intangible assets, such as electronic data, which is higher as compared to tangible assets (Masters & Menn, 2010; Kroll, 2012). As data, usage requires information systems and networks to be more organizations that are open, are encouraged to adjust their security policy to the more dynamic environment in which data are widely exchanged and used (OECD, 2013).

CONCLUSION

ICT has become pervasive and transforming in the multi sector relationships across ASEAN countries. By looking into the data analysis above, some ASEAN countries are very resilient and great adopters of the Internet and mobile technology, which promises further innovation in terms of Internet services. However, there are gaps in terms of ICT initiative amongst the members, but opportunities for collaboration, sharing knowledge and ICT infrastructures by those who are already strong in ICT initiatives with those developing, thus reducing the impact of the digital divide. Furthermore, AIM 2015 will contribute to economic transformation, but further investment in infrastructure, digital content, e-government systems, human capital, and innovation are needed to ease access and foster even better economic and social impacts.

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