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State of Digital Economy in Asia-Pacific Region:
Delineating the Role of Digital Skill

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ABSTRACT

The paper seeks to examine the cross-country variation in the state of digital economy in Asia-Pacific region. In addition, this paper also identifies the role played by the digital skill in fostering the development of the digital economy in the Asia-Pacific region using secondary data of 43 Asia-Pacific countries over 2012 to 2017. K-means clustering approach and panel regression method were used for the purpose of analysis of data. The outcome of the study revealed stark variations in use, access, and overall digital economy amongst the Asia-Pacific countries signifying the prevalence of digital inequality. The findings of the study highlighted that secondary and tertiary education as the proxies of digital skill exerted significant positive effect on the development of digital economy. However, the effect of tertiary education was found to be stronger than that of the secondary education. The outcome of the study also identified income level to be affecting the development digital economy.

KEYWORDS

Access, Asia-Pacific, Digital Economy, Digital Inequality, Digital Skill, Use

INTRODUCTION

Today, we are living in a knowledge economy and in such economy, knowledge is considered to be the prime driver of growth and development. In the context of the present knowledge economy, the role of Information, Communication and Technology (ICT) in fostering the digital economy can never be undermined (Sharma et al., 2016). The presence of ICT can be felt everywhere in different forms and it has become a prerequisite of human progress (Lee et al., 2017). In fact, digital economy has altered the economic processes, systems, industries, consumer behaviour, business interactions and business models in the present scenario (Bukht & Heeks, 2017). To many, digital economy is also known as 'new economy', 'internet economy' or 'information economy' (L'Hoest, 2001). By whatever name it may be called, it is truly representing a wide idea as it includes e-commerce, e-governance, e-payment system, e-banking, e-knowledge processing, internet banking, mobile banking, payment

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wallets etc. (Quah, 2003; Chakravorti et al, 2016). Digital economy through its spill-over effect promotes economic growth and it also has the ability of lowering non-accelerant inflation rate of unemployment[1] (L'Hoest, 2001; Kamel, 2005). In addition to these, digital economy equilibrates inflation and unemployment in short run, introduces innovative as well as quality products and services, dampens the business cycle (which allows the economy to operate at full capacity), allows the control of corruption and generates employment directly and indirectly (Atkinson & McKay, 2007; Howard et al., 2010; Saxena, 2018). As a matter of fact World Bank (2016) in its *'World Development Report on Digital Dividends'* unequivocally reiterates the role that the digital technology can play in promoting growth and development through inclusion, efficiency and innovation. Owing to its tremendous potential, the digital economy is growing at a very rapid pace across the globe and it is even growing at a faster rate (15-25 percentage) in the developing countries (Bukht & Heeks, 2017).

However, the transformation into the digital economy is to a great extent conditioned upon the state of the digital skill in an economy (Servon & Kaestner, 2008; Aikins, 2019) as it is very much true that the benefits of digital economy can only be harnessed by economies with strong fundamentals (World Bank, 2016). The importance of digital skill can be understood from its linkage with Sustainable Development Goal 4[2] in general and its linkage with SDG Target 4.4[3] alongside Target Indicator 4.4.1[4] in particular (World Bank, 2016). In fact, the ability to use ICT is regarded as the essential life skill to be acquired by everyone (Montoya, 2018[5]). Like reading and writing, digital literacy has also emerged as one of the most important generic skills in modern life (World Bank, 2016). The global pandemic of COVID-19 (Corona Virus) has further reiterated the importance of digital economy and digital skill in our lives at a time when majority of the countries in the world are under lock down[6]. The changed socio-economic order due to the outbreak of COVID-19 and subsequently lock down has also altered human behaviour towards digital technology towards great extent. A large number of people who used to consider the use of technology and internet a remote possibility are also increasingly using the digital mediums to carry out normal day to day functions (Guitton, 2020). However, digital inequality can act as a potential threat in exploiting the advantages of digital economy. Mitigation strategies are to be developed to overcome digital inequalities to enable the people in combating COVID-19 crisis by leveraging the power of digital economy (Beaunoyer et al., 2020).

Asia-Pacific region is important from the view point of the world as majority of the population[7] (4.3 billion i.e. 60% of global population) lives in this region and it includes China and India, two most populous countries. This region contributes approximately 30% [8] of the GDP of the world. This region is also the home of a number of emerging economies of the world. The pace at which this region is growing, increasing population and urbanization are making this region critical for overall growth and development of the world as a whole.

In this backdrop this paper examines the cross-country variation in the state of digital economy in Asia-Pacific region. In addition, this paper identifies the role played by the digital skill in fostering the development of the digital economy in this Asia-Pacific region.

REVIEW OF LITERATURE

Growing importance of digital economy has attracted the attention of the scholars across the globe to delve into this relatively new domain of research especially in last two decades. Majority of the research studies tried to explore the determinants of the digital divide especially in the context of Asian countries (Wong, 2001; Kiiski & Pohjola, 2001; Quibria et al. 2002; Ono, 2005) and America (Chinn & Fairlie, 2006). For example, Wong (2001) carried out a study to examine the state of digital economy in the Asian countries vis-à-vis other countries in rest of the world. The outcome of the study marked disproportionate variation in the digital economy amongst the Asian countries. Japan, Hong Kong, Korea, Singapore and Taiwan outperformed rest of the Asian countries in ICT diffusion. Similar kind of observations was also made by Vu (2017) in respect of the ASEAN countries. The

outcome of the study showed that level of ICT diffusion is at different levels amongst the ten ASEAN countries. On the other hand, the performance of Asia as a whole in ICT diffusion was found to be poor in comparison to OECD and other Non-Asian groups. The outcome of the study also revealed that level of development of the country and the competitiveness were found to be the major driving force in ICT diffusion for the Asian countries, whereas the per-capita GDP and cost of internet services were found to be relevant in explaining internet diffusion in OECD countries (Kiiski & Pohjola, 2001). However, the study carried out by Hoang (2017) showed that human development index to be the most important determinant of overall ICT penetration amongst the Asia-Pacific countries during 2014 to 2017.

Quibria et al. (2002) conducted a study to identify the determinants of digital divide across Asian countries where they have identified stark differences in ICT diffusion amongst the Asian countries. Size of the countries as indicated by the level of population and level of income were found to be significant factors affecting the use of cellular phone, fax machine, internet, personal computer, telephone main line, television. Moreover, level of education was found to be the major factor explaining the use of internet, personal computer and telephone main line use alongside income of the people. The study concluded that promotion of education, creation of adequate infrastructure and enabling institutions, international cooperation and appreciating institutional innovation were the critical factors in narrowing the prevalent digital divide.

In a different study Ono (2005) using the survey data for Singapore, Korea and Japan suggested that ICT diffusion in these three countries were much higher although digital divide was prevalent amongst the different demographic groups in these countries. On an aggregate level the income, education and gender were found to be the instrumental factors affecting the ICT diffusing in these there Asian countries. Privatisation, development of telecommunication sector and the competition within, world system of capitalist development along with per capita GDP as the control variable were found to be the major determinants of global digital divide in a study carried out by Gillian and Suarez (2005).

In a study carried out by Dewan et al., (2005), telecom infrastructure, per capita GDP, years of schooling and openness of the economy were found to be exerting significant positive effect in reducing inequality in global digital access. However, the outcome of the study revealed that the effect of urban population was found to be negative in narrowing the digital divide. Yartey (2006) carried out a study to examine the effect of financial and capital market development on the global digital divide using panel data of 76 countries over 1990 to 2003. The result of the study suggested that lagged ICT diffusion, FDI, trade openness, credit and stock market development, per capita GDP and financial development were found to be the major determinants of telephone mainline, mobile, internet and personal computer usage during the period of study.

Another cross-country study (161 countries) was conducted by Chinn and Fairlie (2006) where effort was made to explore the factors affecting the computer and internet penetration for the period 1999 - 2001. The outcome of the study revealed that internet penetration was found to be highest in North America and lowest in South Asian countries. In addition to it, income per capita, years of schooling, literacy level, youth, urbanization rate, telephone density, electricity consumption and regulatory quality were found to be the major determinants of computer and internet penetration. Using the data for 66 developing and 23 developed countries for the period 1991 to 2002, Shchetinin and Baptiste (2008) suggested lagged internet diffusion, FDI and literacy rate were found to be positive determinants of the internet diffusion for developing countries only. The significant negative sign associated with the level of income was explained using 'Resource Curse Theory[9]' by the authors.

In a similar kind of study in a cross-country framework for the year 2003, Murthy and Nath (2009) observed economic freedom, trade openness and credit market development exacerbating significant positive impact on the digital access, whereas Gini index (of Gini coefficient-a measure of inequality) was found to be adversely affecting the digital access. Using 18 years data from 1994 to 2011 for Malaysia, Indonesia, Philippines and Thailand, Nipo et al. (2014) found out that per-capita

GDP of these countries was the principal factor affecting the ICT development. In addition to it, foreign direct investment, trade openness, stock market and credit market development, population and infrastructure were also found to be important under different model specifications and assumptions. In fact, the social development is considered to be the significant determinants of ICT diffusion in the developing economies (Lechman & Kaur, 2016). In China, the digital outcome inequality was noticed to be far more than inequalities in digital access and use and such digital inequality is primarily affected by socio-economic factors (urban residential income, secondary gross enrolment ratio and rural residential income) rather than institutional or innovation factors (Song et al., 2020).

One of the most comprehensive reports in this regard is the World Development Report on Digital Dividends (World Bank, 2016). The report highlights the rapid spread digital technology throughout the world and how it has promoted growth and development by amplifying opportunities and ameliorating service delivery. However, the reports also points out the presence of stark first (access dimension) and second (use dimension) order digital divide within and across the different countries. Institutional interventions such as infrastructure development, reform to promote competition in the telecommunication market, adoption of PPP model and better regulatory environment can help economies to bridge the first order digital divide whereas investment in public education and health, better business climate and good governance are of paramount importance to reap the fruits of digital economy (World Bank, 2016).

In some of the very recent studies too, GDP per capita, level of education, digital literacy, urban population, cost of internet, economic freedom, privatisation, age of the population, gender, access to electricity, rural income, working age population were found to be the instrumental factors in explaining digital divide (Billon et al., 2016; Nishijima et al., 2017; Hoang, 2017; Vu, 2017; Zhang, 2017; Waters, 2017; Pachis, 2018; Cruz-Jesus, 2018; Aikins, 2019; Fang et al., 2019; Otioma et al., 2019; Song et al., 2020; Huxhold et al., 2020).

The review of the existing literature suggests that although there are studies at the global level which has tried to examine the digital divide or inequality and its determinants, there are dearth of studies which have tried to focus on the clustering of countries in terms of the state of the digital economy and the intermediating role played by the digital skill in fostering digital economy especially in the context of Asia Pacific region. As mentioned earlier, one relevant study in the context of Asia-Pacific countries was conducted by Hoang (2017), in order to examine the socio-political factors affecting ICT penetration. The independent factors taken into consideration in that study were Global Peace Index, Human Development Index and Freedom status. However, the research work suffers from number of limitations. First of all, the study only concentrated on socio-political issues whereas there are number of other factors which have been found to be important in explaining ICT penetration vis-à-vis digital divide. Such limitation is also getting reflected in the result of the study, where none of the socio-political variables (except Human Development Index score) was found to be significant. Secondly, the sample size (24 countries) of the study was so little that no conclusive generalizations could be made on the Asia-Pacific region as a whole.

Therefore, this paper tries to address the existing gap in the literature. Specifically, this paper intends to explore the cross-country variation (by clustering the countries) in terms of the state of digital economy in the Asia-Pacific region. More importantly, this paper specifically identifies the intermediating role of digital skill in promoting digital economy in Asia-Pacific region.

DATA AND METHODOLOGY

This study is pre-dominantly analytical in nature. For the purpose of the study, relevant data were collected from various secondary sources. A total of 43 countries from the Asia-Pacific region were selected for the purpose of the study. The time period of the study period was 2012 to 2017 which was purely based on the availability of the secondary data. The gathering of the data and construction of various parameters such as ICT use and ICT access, Digital Skill and Digital Economy were entirely

guided by the ITU methodology. At the very outset it must be mentioned that unavailability of the secondary data is regarded as one of the major challenges associated with digital economy related research (Vicente & Lopez, 2011; Song et al., 2020).

Measuring Digital Economy

For the purpose of measuring the digital economy, ICT use and ICT access dimensions were taken into account. ICT access dimension is a composite indicator comprising of fixed-telephone subscriptions per 100 inhabitants, mobile-cellular telephone subscriptions per 100 inhabitants, international internet bandwidth (bit/s) per internet user and percentage of households with a computer. In a similar way the ICT use is determined by taking into consideration percentage of individuals using the internet, fixed-broadband subscriptions per 100 inhabitants and active mobile-broadband subscriptions per 100 inhabitants. The composite data on ICT use and ICT access dimensions were directly obtained from International Telecommunication Union (ITU) which is specialised United Nations agency for promoting and monitoring ICT development throughout the world. The process of considering both ICT use and ICT access dimensions for evaluating the state of digital economy is in fact similar to the methodology employed by Song et al. (2020) to measure 'Digital Development Index'.

Measuring Digital Skill

Measurement of digital/ICT skill is a tedious task. While evaluating the achievement with respect to SDG target indicator 4.4.1 i.e. ICT skill, the parameters incorporates the ability to move a file or folder in a PC, ability to copy and paste, ability to send e-mails with attachments, ability of using excel formula, ability of connecting and installing additional devices to PC (such as modem, camera), ability to find, download, install and configure software, ability to prepare presentations in electronic forms such as power point presentations, ability to transfer files between PCs and other devices and ability to write computer programmes. However, these are often self reported by the respondents which suffer from under or over rating due to their subjective bias and such self-evaluation seldom truly represent the true level proficiency (Montoya, 2018). Therefore, there exist significant challenges in measuring digital literacy of the people of a country. Fortunately, ITU is the UN custodian agency responsible for developing the methodology and leading the data collection to produce SDG Indicator 4.4.1 (Montoya, 2017[10]).

Like ICT use and ICT access, ITU considers digital skill to be a composite factor which incorporates mean years of schooling, secondary gross enrolment ratio and tertiary gross enrolment ratio. The composite value of all these three factors is regarded as the proxy of digital literacy as presumed in computing ICT Development Index (IDI) by ITU. Although, utilization of ICT related skills as used in measuring the SDG Indicator 4.4.1 would have been more appropriate but unavailability of such data for the Asia-Pacific countries prompted the use of methodology as used by ITU to gauge digital skill data as a surrogate. Therefore, ITU methodology for measuring digital skill (while computing IDI) was used as a proxy of digital skill for the purpose of this study. However, in order to unearth the effects of mean years of schooling, secondary gross enrolment ratio and tertiary gross enrolment ratio, these three components were used individually rather than as a composite factor. Due to the non-availability of some of the data points on individual digital skill dimensions, ultimately number of data points was limited to 72 observations during the specific time period across Asia-Pacific countries in case of panel regression analysis.

In order to explore the effect of digital skill on the state of digital economy, three important control variables such as level of income, urbanization and proportion of aged population were also considered for the purpose of the study. The detailed description and the sources of the variables used in the study are presented in Table 1.

On the basis of 43 individual country performances, a natural grouping of countries in the Asia-Pacific region was made by using clustering technique -a widely used data mining method (Ramachandran et al., 2018). Selection of 43 countries was solely based on the availability of

Table 1. List of variables and its data sources

Variables	Abbreviation	Description	Source
Access of digital services	ACCESS	Fixed-telephone subscriptions per 100 inhabitants, mobile-cellular telephone subscriptions per 100 inhabitants, international internet bandwidth (bit/s) per internet user and percentage of households with a computer	International Telecommunication Union
Usage of digital services	USE	Percentage of individuals using the internet, fixed-broadband subscriptions per 100 inhabitants and active mobile-broadband subscriptions per 100 inhabitants	
State of digital economy	DE	State of Digital Economy as represented by (0.50 × ICT Access+ 0.50 × ICT Use)	
Proxy of Digital Skill	YRS	Mean years of schooling	Education Statistics, World Bank
	SEC	Secondary gross enrolment ratio	
	TER	Tertiary gross enrolment ratio	
Per capita national income	INC	Gross National Income (Per Capita)	World Development Indicator, World Bank
Urbanization	UR	Urban population as a percentage of total population)	
Proportion of aged population	OLD	Population ages 65 and above as a percentage of the total population.	
Source: Author's own compilation			

data for all the indicators of access and usage dimensions. A non-hierarchical (e.g. k-means clustering) cluster methods was employed. In k-means cluster method, k is assumed to be three depending on the achievement of countries in the access and usage dimensions: high, medium and low level of development.

To examine the effect of the digital skill on the digital economy of different countries, Panel Data Regression method was used as it helps in dealing with the data spread over time periods and cross-sections. Panel data regression analysis avoids the risk of biased results as it can efficiently take care of the heterogeneity of the time series and the cross sections. Moreover, Panel data regression allows greater variability, reduced collinearity amongst the factors with more degrees of freedom (Baltagi, 2005). The empirical model was specified as:

$$DE_{it} = \alpha + \beta_1 YRS_{it} + \beta_2 SEC_{it} + \beta_3 \mathrm{TER}_{it} + \beta_4 INC_{it} + \beta_5 UR_{it} + \beta_6 OLD_{it} + + u_{it}$$

where $t = 1,2,3,\ldots T$ and $i = 1,2,3,\ldots n$.

DE is the dependent variables in the Model α is the intercept term, β are the $(k \times 1)$ vectors of parameters to be estimated, YRS, SEC, TER, INC, UR, and OLD are the $\left(1 \times k\right)$ number of observations of the independent variables and u_{it} represents the error term. Except YRS, SEC and TER which are the proxies for digital skill, rest of the variables are control variables in the model.

In the panel data regression framework, three empirical models are available: Constant Coefficient Model (CCM), Random Effects Model (REM) and Fixed Effect Model (FEM) (Brooks, 2000). CCM can easily be estimated just by running a pooled regression which will estimate a single equation using the method of Pooled Ordinary Least Square (POLS). The implicit assumption under CCM is that the average relationship between the variables remains unchanged over different time series and cross-sectional units which in reality are not tenable. The difference between the FEM and REM lies in the fact that, FEM permits the intercept to vary with cross-sections but the same remain constant over varying time periods. However the β values remain the same across cross-sections and time series (Brooks, 2008). However it is to be noted that prior to the application of either FEM or REM

it is imperative to know whether the panel data regression framework will be used or the pooled regression i.e. CCM will be applicable. Therefore, at first, Breusch-Pagan (BP) test was applied to ensure the application of FEM or REM instead of CCM. Secondly, Hausman Test was used to ascertain the applicability of either FEM or REM. In Table 2 the hypotheses (as specified by the expected signs of the independent variables) are presented.

Table 2. Expected signs of the independent variables (i.e. testable hypotheses)

Independent Variables	Expected Signs
YRS	+
SEC	+
TER	+
INC	+
UR	+
OLD	−
Source: Authors own compilation	

In empirical estimation, the particular interest is to verify whether the result confirms the expected sign of the parameter or not. All the independent variables were theoretically expected to have positive effect on digital economy as a whole barring aged population above 65 (OLD). The reasons of expected signs of all the independent variables on the dependent variable have been elaborated in the next section (Analysis and Discussions) while comparing the theoretical conviction with the actual outcome.

ANALYSIS AND DISCUSSIONS

Access and Usage of Digital Services: Asia-Pacific Experience

In Table 3 the state of the digital economy amongst the countries in Asia-Pacific region is presented both for 2012 and 2017. From the analysis of Table 3 it is quite clear that Korea, Japan, Singapore, Bahrain and Israel obtained the top five positions in the context of digital economy during both 2012 and 2017. Bangladesh, Myanmar, Afghanistan, India, Lao PDR, Pakistan and Nepal remained as the laggards in this aspect during the period of study. Significant inter-country variation in respect of digital economy was observed during both 2012 and 2017. A very few countries continue to dominate in terms of digital economy during the period of the study which highlights the existing digital inequality prevailing in the region. However, there has been improvement in the state of the digital economy for almost all the sample countries in general during the period of the study.

Asia-Pacific region marked a distinct regional variation in the ICT development, especially in the access and usage of digital services for year 2012 and 2017 (see Appendix Figure 1 and Figure 2). It truly reflects the stark differences in the level of economic development in the region. As far as the access is concerned it was observed that Korea, Japan, Singapore, Israel, Qatar, Bahrain and UAE were at the top during both 2012 and 2017 respectively. Myanmar, Bangladesh, Nepal, Uzbekistan and India were found to be the worst performing countries during 2012 in respect of access dimension whereas in 2017, Afghanistan, Bangladesh, Bhutan, Pakistan and Palestine were

Table 3. State of digital economy in 2012 and 2017

Country	2012	2017	Country	2012	2017
Armenia	4.11	5.47	Malaysia	4.85	6.55
Azerbaijan	4.69	6.06	Maldives	4.09	5.51
Bahrain	7.17	7.84	Mongolia	3.08	4.32
Bangladesh	1.33	2.23	Myanmar	0.88	2.96
Bhutan	2.10	3.15	Nepal	1.61	2.68
Brunei Darussalam	4.88	6.89	Oman	5.05	6.52
Cambodia	2.05	3.36	Pakistan	1.67	2.29
China	3.73	5.43	Palestine	3.20	2.89
Cyprus	5.62	7.74	Philippines	3.15	4.29
Georgia	3.82	5.37	Qatar	6.33	7.49
India	1.73	2.61	Russia	5.85	6.68
Indonesia	2.90	4.02	Saudi Arabia	5.47	6.45
Iran	3.15	5.14	Singapore	7.84	8.03
Israel	6.87	7.76	Korea	8.56	8.78
Japan	8.02	8.48	Sri Lanka	2.41	3.29
Jordan	3.67	5.88	Syria	2.70	3.11
Kazakhstan	5.23	6.62	Thailand	3.16	5.41
Kyrgyzstan	2.71	3.73	Turkey	4.32	5.61
Lao PDR	1.68	2.69	UAE	6.15	7.60
Lebanon	4.91	6.56	Uzbekistan	2.36	4.59
Afghanistan	-	1.47	Timor-Leste	-	3.42
Kuwait	-	6.06	Source: Author's own compilation		

found to be the countries at the bottom of access dimension. Korea was found to be at the top in the use dimension during 2012 followed by Japan, Singapore, Bahrain and Israel respectively whereas Israel lost it position in the top five during 2017 and it was replaced by Cyprus. Myanmar, Bangladesh, Pakistan, Cambodia and Lao P.D.R. were the worst performing countries in terms of use dimension during 2012. However, in 2017 Afghanistan, Pakistan, Bangladesh, Syria and Nepal were found to be at the bottom in the use dimension.

From the change in access dimension, it can be observed that significant improvement was observed in the cases of Uzbekistan, Myanmar, Iran, Nepal and Oman whereas negligible improvement was noticed for Singapore which was found to be amongst the top three in access during the period of study. Surprisingly, negative change was observed in case of Korea which was found to be at the top during the period of study along with Mongolia, Israel and Palestine. There has been a notable improvement in terms of use dimension for most of the Asia-Pacific countries during the study period. Jordan, Brunei Darussalam, Thailand, Cyprus and Malaysia registered remarkable augmentation in the use dimension during the period of study, whereas the improvement was found to be least for countries such as Singapore, Japan and Korea (which were already at the top with respect to use dimension). Therefore, looking at the changes in both use and access it can be observed that the positive change was found to be marginal for the countries which were already highly developed in terms of digital economy and significant positive changes were noticed in case of the countries

where growth possibilities of digital economy were present as they were previously underdeveloped in terms of digital economy.

Regional Groupings: Clustering of Asia-Pacific Countries

An effort was made to simply examine natural groupings of countries in Asia-Pacific region, based on their relative positioning in access and usage of digital services. In k-means cluster, three clusters (i.e. $k = 3$) out of 43 countries were purposively chosen depending on low, medium and high level of development for the beginning (2012) and end of the study period (2017) to underscore the change in the relative position of the countries over the period of study. Country level natural grouping was made for access and usage dimensions separately. In other words, depending on the relative positions of the countries, nine clusters were developed under low access, medium access, high access, low usage, medium usage, and high usage.

In Table 4, an effort was made to highlight the state of the digital economy of Asia-Pacific countries in terms of use and access dimensions for the year 2012. From the analysis of Table 4, it can be seen that 12 countries (Bangladesh, Bhutan, Cambodia, India[11], Kyrgyzstan, Lao PDR, Myanmar, Nepal, Pakistan, Philippines[12], Sri Lanka and Uzbekistan) were found to be in the low access and low use segment which signifies dismal state of digital economy in these countries during 2012. Digital economy of Bahrain, Israel, Japan, Singapore, and Korea were found to be excellent as these countries fall in the high use and high access quadrant.

Table 4. Classification of Asia Pacific countries for 2012 in access and usage dimensions

Usage / Access	Cluster 1 (Low usage)	Cluster 2 (Medium usage)	Cluster 3 (High usage)
Cluster 1 (Low access)	Bangladesh,Bhutan, Cambodia, India, Kyrgyzstan, Lao PDR, Myanmar,Nepal, Pakistan,Philippines, Sri Lanka,Uzbekistan		
Cluster 2 (Medium access)	Georgia,Indonesia, Iran, Jordan,Mongolia,Palestine, Syria,Thailand	Armenia, Azerbaijan, China, Lebanon,Maldives, Oman,Turkey	
Cluster 3 (High access)		Brunei Darussalam,Cyprus,Kazakhstan, Malaysia,Qatar, Russia,Saudi Arabia, UAE	Bahrain, Israel, Japan, Singapore, Korea

Source: Author's own compilation

The use and access of ICT was found to be moderate in Armenia, Azerbaijan, China, Lebanon, Maldives, Oman and Turkey. For Brunei Darussalam, Cyprus, Kazakhstan, Malaysia, Qatar, Russia, Saudi Arabia and UAE, although the adequate ICT infrastructure was available but the use by the people of these countries was found to be at medium level during 2012 whereas Georgia, Indonesia, Iran, Jordan, Mongolia, Palestine, Syria and Thailand were observed to be on the medium access and low use during the same period. None of the countries were found in high access medium use, medium access high use, low access medium use and low access high use segments during the year 2012.

In a similar fashion, Table 5 represents the distribution of countries in access and usage dimensions in a bi-matrix for the year 2017. It highlights the fact that majority of the countries lies in diagonal cells: low access-low usage (11 countries), medium access-medium usage (9), and high access-high usage (8) trajectories. It also demonstrates a variation in individual country experiences

Table 5. Classification of Asia Pacific countries for 2017 in access and usage dimensions

Usage / Access	Cluster 1 (Low usage)	Cluster 2 (Medium usage)	Cluster 3 (High usage)
Cluster 1 (Low access)	Afghanistan, **Bangladesh, Bhutan, Cambodia, India, Myanmar, Nepal, Pakistan,** Palestine, Timor-Leste, Lao PDR		
Cluster 2 (Medium access)	**Indonesia,** Philippines, Sri Lanka, **Syria,** Kyrgyzstan	**Armenia, China,** Georgia, Jordan, **Maldives,** Mongolia, Thailand, **Turkey,** Uzbekistan	
Cluster 3 (High access)	Iran	Azerbaijan, **Brunei Darussalam,Kazakhstan,** Kuwait, Lebanon, **Malaysia,** Oman, **Russia, Saudi Arabia**	**Bahrain,** Cyprus, **Israel,Japan,** Qatar, **Singapore,Korea,**UAE

Source: Author's own compilation
Note: Counrties in bold maintained status-quo since 2012.

from this general trend: five countries in medium access-low usage category, and nine countries in high access-medium usage category. Majority of the South Asian countries (except Sri Lanka and Maldives) experienced a similar kind of development in digital economy.

Comparing the relative positions of the countries for 2012 and 2017 reveals that Cyprus, Qatar and UAE which were at high access and medium use segment had made significant advancement in the use dimension and shifted to high access and high use cell during 2017. There has been a notable improvement in the use of digital modes for the countries such as Georgia, Jordan, Mongolia and Thailand which enabled them to excel from medium access low usage segment in 2012 to medium access and medium usage in 2017. Uzbekistan experienced notable improvement in both use and access dimensions during the period of study. The ICT infrastructure of Azerbaijan, Lebanon, Oman, Philippines[13], Sri Lanka and Kyrgyzstan improved in 2017 over 2012. However, the use of such digital infrastructure remained unchanged at low levels for these countries. Bahrain, Israel, Japan, Singapore, and Korea continue to maintain their earlier positions in the high access and use cell. The rest of the Asia-Pacific countries (Bangladesh, Bhutan, Cambodia, India[14], Myanmar, Nepal, Pakistan, Indonesia, Syria, Armenia, China, Maldives, Turkey, Brunei Darussalam, Kazakhstan, Malaysia, Russia and Saudi Arabia) maintained status quo in terms of their earlier access and use status.

Determinants of State of Digital Economy: Role of Digital Skill

For the purpose of investigating the intermediating role of the digital skill in promoting the digital economy, panel data regression method was utilized. As mentioned in the methodology, before applying the panel data regression (i.e. either REM or FEM), it is important to know whether panel data regression is at all applicable or not. The outcome of the Breusch-Pagan test suggested panel

data method was applicable instead of CCM. Further, the result of the Hausman test indicated that fixed effect model is the appropriate model to be used in the study.

The prime concern in this paper is to explore the effect of the individual sub-components of digital skills (i.e. mean years of schooling, gross enrolment in secondary and tertiary education) on the state of the digital economy. From the analysis of the Table 6, it can be observed that the sign associated with two of the sub-components of digital skill (gross enrolment in secondary and tertiary education) were found to be positive and statistically significant. The coefficient associated with the mean years of schooling was also found to be positive but statistically insignificant. As a matter of fact, it can be mentioned that secondary and tertiary education plays a pivotal role in development in digital economy but the effect of tertiary education is normally more robust than that of the secondary education in the early stage of development of digital economy (Song et al., 2020). The outcome of the study clearly signifies that digital skill plays an instrumental role in fostering the digital economy in the Asia-Pacific context.

Table 6. Determinants of digital economy

Variables	Coefficients	Z-Value	p-Value
YRS	0.143	0.53	0.596
SEC	0.018	1.90	0.098
TER	0.037	4.04	0.000
INC	4.172	4.28	0.000
UR	-0.034	-0.55	0.583
OLD	.022	0.17	0.867
Constant	-38.352	-6.15	0.000
$\bar{\chi}^2$ (BP Test)	49.27	p-values	0.000
χ^2 (Hausman Test)	82.25		0.000
F-value	32.69		0.000
Model	FEM	N	72
Source: Authors own calculation			

As far as the level of income is concerned, it is expected that with an increase in the income of a country, there is a positive effect on the use and access dimensions within the digital economy. With higher income, people will tend to get familiar with the digital devices and thereby there will be demand driven improvement in the usage dimensions of digital economy. The outcome of the study corroborates with this theoretical argument. In the empirical model the effect of level of income was found to be positive and statistically significant which is consistent with the findings of Quibria et al. (2002), Chinn and Fairlie (2006) and Mocnik and Sirec (2010). The rest of control demographic variables such as proportion of urban and aged population were found to be statistically insignificant.

CONCLUSION AND POLICY IMPLICATIONS

Going digital is the order of the day. Development of ICT has significant social, political and economic ramifications. In fact, the digital economy along with ICT revolution has transformed the way of living. This paper examined the state of digital economy amongst the Asia-Pacific countries during 2012 to 2017 and at the same time effort was made to evaluate the intermediating role played by the digital skill in fostering the digital economy. The outcome of the study revealed the prevalence of sharp differences amongst the Asia-Pacific countries in terms of digital economy. The presence of digitally advanced nations such as Korea, Singapore, Israel, UAE, Cyprus, Japan and Bahrain making such difference starker. Moreover, the poor state of digital economy of Afghanistan, Bangladesh, Bhutan, Cambodia, India, Myanmar, Nepal, Pakistan, Palestine, Timor-Leste and Lao PDR making the picture even more contrasting. However, there has been improvement in use and access dimensions vis-à-vis digital economy for majority of the Asia-Pacific countries during the period of study. In addition to that, the proxies of digital skill (years of schooling, gross enrolment in secondary and tertiary education) were observed to be exacerbating positive effect on the development of the digital economy amongst the Asia-Pacific countries in general. However, the effect of tertiary education was found to be stronger as compared to the other two proxies. Inclusion of the digital skill components in the determinants of digital economy for the first time in the existing literature warrants an important policy insight. Keeping in mind the paramount importance of digital skill in the overall development of digital economy, the policy makers need to emphasize on digital skill formation in realising a vibrant digital economy in the Asia-Pacific region. In particular, improvement of enrolment in secondary and tertiary education can be seen as an effective strategy to promote digital inclusion among individuals in Asia-Pacific region by reducing barriers related to digital skill formation. The findings of the study showed that level of income was also found to be major determinant of digital economy during the study period in the context of Asia-pacific region.

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ENDNOTES

1 It is that rate of unemployment in the economy which does not allow inflation to accelerate. For details please see Gordon, R. J. (1997). The time-varying NAIRU and its implications for economic policy. *Journal of Economic Perspectives*, *11*(1), 11-32.

2 **"**Inclusive and quality education for all and promote lifelong learning."

3 "By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship."

4 Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill.

5 https://sdg.uis.unesco.org/2018/08/08/meet-the-sdg-4-data-skills-for-a-digital-world/

6 https://www.weforum.org/agenda/2020/04/digital-infrastructure-public-health-crisis-covid-19/

7 https://asiapacific.unfpa.org/en/node/15207

8 https://databank.worldbank.org/reports.aspx?source=world-development-indicators#

9 The richer developing countries are theoretically expected to be resource oriented economies and less democratic. Therefore, there will be more restrictions in use of internet and as a result the internet diffusion will decline as income increases.

1[0] http://uis.unesco.org/en/blog/tracking-literacy-increasingly-digital-world-0

11 In 2012 the position of India in terms of 'Access' (2.89) and 'Use' (0.57) was found to be very poor especially if it is compared with countries like Korea [8.91 (Access) and 8.20 (Use)], Japan [8.26 (Access) and 7.78 (Use)] and Singapore [8.53 (Access) and 7.14 (Use)].Weak performance in both 'Use' and 'Access' dimensions led India to be marked as 'Low-Access and Low Use' cluster country in 2012.

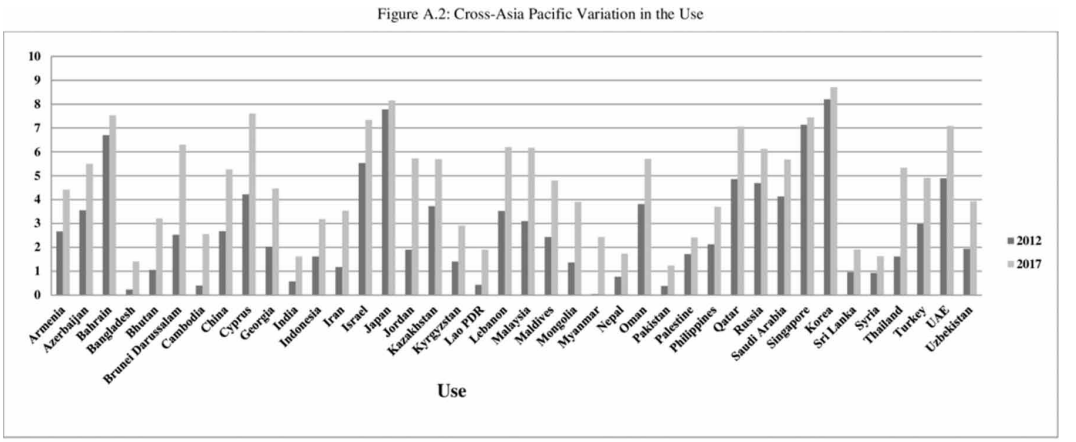
12 The position of Philippines was found to be better in terms of 'Access' (4.17) and 'Use' (2.13) in contrast to India during 2012. However, such performance was found to be dismal as compared to the advanced countries such as like Korea, Japan, Singapore, Israel etc. which led the country to be placed in 'Low-Access and Low Use' cluster.

13 The 'Access' and 'Use' values of Philippines have improved from 4.17 and 2.13 in 2012 to 4.87 and 3.7 in 2017 respectively. Although the country improved its performance over the period of time but if it is compared with other countries including countries like South Korea [8.85 (Access) and 8.71(Use) in 2017], Japan [8.8 (Access) and 8.15 (Use) in 2017], Singapore [8.61 (Access) and 7.45 (Use) in 2017], Israel [8.17 (Access) and 7.34 (Use) in 2017] etc. the performance of Philippines appears weak [ITU, 2018].

[14] Like 2012, India was still lying in the low use and low access cluster even during 2017. The position of India in terms of various components of 'Access' and 'Use' was much below as compared to the Asia-Pacific country averages. For example in 2017, Fixed-telephone subscriptions per 100 inhabitants in India was 1.7 as compared to 9.5 for Asia-Pacific and 13 of World; mobile-cellular telephone subscriptions per 100 inhabitants was 87.3 in contrast to 104 for Asia-pacific. International internet bandwidth (kbit/s) per internet user in India was 25.9 whereas the same was 61.7 and 76.6 for Asia-Pacific and World respectively. Similarly only 16.5% households had access to a computer as compared to 38.9% in Asia-Pacific. As far as the use sub-components were considered there existed a significant difference between the position of India and Asia-Pacific in general. For example fixed-broadband subscriptions per 100 inhabitants was only 1.3 for India as compared to 13 of Asia-Pacific. Similarly, active mobile-broadband subscriptions per 100 inhabitants was only 25.8 as against 60.3 of Asia-Pacific and 61.9 of World. Only 34.5% individuals were observed to be using the internet whereas such number was found to be 44.3% and 48.6% for Asia-pacific and the World respectively (ITU, 2018).

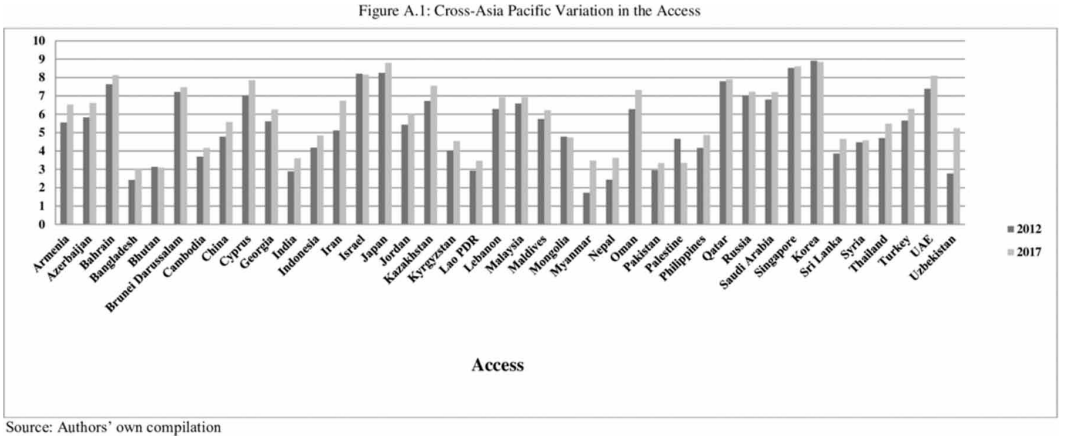
APPENDIX

Figure 1. Cross-Asia pacific variation in the Access



Source: Authors' own compilation

Figure 2. Cross-Asia pacific variation in the use



Source: Authors' own compilation

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