Internet Penetration as a Driver for Village's Business-Economics Activities

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***Abstract*—Around 80% of Indonesian villages are categorized as rural villages, and the Indonesian government has committed rural village development as a priority. Literature indicates that ICT, especially Internet access, becomes a driver for economic growth at the country level, regions, and rural villages. However, limited studies were investigating the relationship between Internet penetration and economic activities in rural areas. This study aims to characterize Indonesian provinces based on internet penetration and the village's business-economic activities. The result should assist the government in rural development planning. This research adopted a data mining approach, implemented by the CRISP-DM process framework and Knime Analytical Platform. Secondary data was gathered from the Central Bureau of Statistics (BPS). The object of analysis is 27 provinces outside Java and Bali. The cluster analysis identifies two clusters consisting of 12 and 15 provinces. The finding indicates that the internet penetration rate is positively associated with four aspects of the village's business-economics activities: the micro-small enterprises, trading businesses, shopping facilities, and leisure facilities. Provinces with low internet penetration rates and business-economics activities, such as Papua and East Nusa Tenggara, require more intervention. The implementation of the predictive model revealed that Central Kalimantan shifted its position in the cluster membership between data 2014 and 2018. This study suggests the government improve the facilitation of business-economic activities together with internet access. Moreover, business-related mobile apps need to be promoted to make internet access significantly impact businesses.**

Keywords—Internet penetration, ICT, rural, Indonesia, data mining, CRISP-DM

I. INTRODUCTION

Indonesia President Joko Widodo has a vision for rural development expressed by "Building Indonesia from the periphery by strengthening regions and villages within the framework of a unitary state, from Java-centric to Indonesian-centric development." This statement belongs to the third goal of the nine priority-development goals, known as Nawacita. This dream becomes a foundation for rural village development. The constitution (UU) no. 6 the year 2014 about village supporting the vision by declaring that (1) Villages have the right to access information through the village information system developed by the district/city local government; (2) The government and local governments are required to develop a village information system, and rural area development; and (3) The Village Information System includes hardware and software facilities, networks, and human resources. Therefore, developing information and communication technology (ICT) for rural areas is critical and expected to foster business-economic activities.

ICT development could cover computer technology, cell phones, landlines, and internet access. Nevertheless, the ICT penetration mainly relates to the percentage of the population use the internet and mobile phone. Both indicators belong to social and economic measures. The internet penetration rate becomes a globally accepted indicator of ICT penetration within a country and its regions. The Internet World Stats (internetworldstats.com) has continuously published internet penetration among nations. The level of internet penetration among countries is related to a country's wealth, telecommunication infrastructure, urbanization, and government stability [1]. Internet users in Indonesia were around 212 million by June 2021, representing a penetration rate of 76.8%, as reported by the Internet World Stats [2]. The geography of Indonesia as an archipelago with an unevenly distributed population becomes a challenging condition to enhance the ICT penetration.

ICT has brought a fundamental change in how individuals live, the organization operates, and governments serve the public. While the transformation is apparent, the economic impact of ICT has been debatable, as signaled by the "ICT productivity paradox" issue [3], [4]. Nevertheless, in later years, some studies have proved the positive impact of ICT on economic growth [5]. Like the effect of ICT on economic development, several studies investigated the impact of internet penetration. For example, a study examining internet penetration and its correlation to GDP per capita for Nordic countries revealed a positive correlation [3]. A similar analysis found a correlation between Internet penetration and GDP per capita in Indonesia, using data years 1996-2014 [6].

As most of Indonesia's area is a rural region, some studies have been conducted. A review paper of ICT development in Indonesian rural areas categorized 37 articles into four: the evaluation of ICT development, the impact of ICT, proposed model for ICT development, and ICT implementation [7]. None of the studies reviewed in that paper investigating the relationship between Internet penetration and economic activities in rural areas. The understanding of empirical evidence will be helpful for better ICT policy formulation for effective rural development.

This study addresses the research question: Does internet penetration associate with the business-economic activities at rural villages? The specific objectives are (1) to characterize Internet penetration and village's business-economic activities, (2) to characterize provinces based on Internet penetration and village's business-economic activities.

The rest of this paper has four parts. First, it reviews the extant literature on the impact of internet penetration on business and economy in regions. Then research approach, data source, and research framework are discussed. Next, the result of the analysis is presented. Then, the discussion part interprets the result. Finally, the paper ends by offering the conclusions of the study.

II. THEORY

This section briefly examines existing studies about the impact of ICT on economic growth and the effect of internet access on rural areas. Then, the review becomes a basis for formulating a proposition for this study.

The impact of ICT on a country's economic growth (GDP growth) is indisputable. A meta-analysis study found the positive effect of ICT (landlines, computers, mobile phones, internet access) on economic development among countries [8]. The positive impact becomes a foundation for country governments and local authorities to foster ICT adoption to stimulate economic growth [9], [10]. Among various types of ICT, internet access or internet penetration becomes a widely accepted indicator for ICT development in a country or region. Therefore, the effect of the internet on economic growth has become a prevalent issue for academics and policymakers.

An investigation of cross-country panel data found a positive impact of internet use on economic growth and a positive effect of internet use on trade [11]. Furthermore, a study in South Asian countries revealed a long-run positive relationship between ICT (Internet and phone) penetration and economic growth [12]. A recent study analyzing 123 countries found that high-income countries receive more advantages from the internet than the others [13]. However, while other studies support those findings, the correlation between internet usage and economic growth remains inconclusive [14]. This inconclusive condition suggests the practitioners optimize the ICT use for business-related activities.

The evidence and logical assertion about the impact of the internet on economic growth at a country level becomes a basis for governments to focus on rural regions. As a part of a country region, the rural area has no GDP as an economic growth measure. Therefore, the impact of the internet is linked to, for example, household income. A study in China indicated a positive relationship between Internet usage and household income and expenditure in rural areas monthly [15]. Further investigation in Indonesia also found that the promotion of internet infrastructure density positively impacts household income [16]. Therefore, the positive relationship becomes a logical affirmation for policymakers to increase internet penetration in rural areas to advance economic activities. Nevertheless, it should be noted that internet penetration is only one among the indicators affecting economic growth [6].

ICT or internet infrastructure in a rural area is generally less in density or sophistication than in an urban area. Some drawbacks happened in the ICT development in rural regions: lack of infrastructure, territory-and-culture problems, low ICT literacy, and public awareness issue [7]. Moreover, while the ICT infrastructure has been available in a rural area, its adoption still depends on some factors such as individuals, social, culture, economic, and information. Therefore, an intervention to enlarge the ICT or internet adoption is also required. For example, a successful case in Iran showed that the availability of ICT centers in rural areas increased the adoption [17].

The impact of internet access on household income in rural areas has been evidence. Nevertheless, it has a lack of logical reason for how the internet could increase household income. First, the internet should contribute to improving business and economic activities. Then, better business and economic activities will improve financial performance. Subsequently, it will improve household income. Thus, it seems reasonable to formulate a proposition for this study:

> "The level of internet penetration relates to business and economic activities at rural villages."

Rural areas are defined officially by BPS. It defines rural and urban areas as an administrative area at the village level, covering the total score of three indicators: population density, percentage of agricultural households, and access to public facilities (e.g., education, health, economic facilities). Based on the classification of the year 2010 (the latest report and still is used) for villages of all provinces, the average percentage of rural villages is 80% (61.340 rural villages divided by 77.126 whole villages). However, the classification of each village as rural or urban is not published.

III. METHODS

This study is secondary research with numeric data analysis. The unit of analysis is the Indonesian province. Among 34 provinces, seven provinces in Java and Bali are excluded from the study because of a relatively lower percentage of rural villages than those in other provinces. Accordingly, the internet penetration rate of rural villages for 27 provinces becomes 88%. Table I presents the list of those provinces with their codes.

Data was taken from the official site of BPS (bps.go.id). Yearly data of the proportion of individuals using the internet by province was collected. The data represents a variable for the Internet penetration rate. Furthermore, a set of files within the village potential category in the BPS site were acquired. The datasets are available for 2014 and 2018, which is the latest data by the time this paper is written. The data specify the number of villages in each province which having various: (a) production-based micro-small enterprises, (b) trading businesses, (c) shopping facilities, and (d) leisure facilities. These four represent four variables of the village's business-economic activities. Each variable comprises several data shown in Table II. For example, the micro-small enterprises (MSEs) include eight industrial sectors, trading businesses by four business types, shopping facilities by three types of facility, and leisure by four. Data were downloaded in Excel format, then cleaned and formatted. Furthermore, an average value of each village's business-economic activity was calculated. Then, the average is divided by the number of villages in the province for the respective years 2014 and 2018.

A research framework was developed as a basis for data analysis, shown in Fig. 1. The basic argument is that the Internet penetration rate is related to the village's business-economic activities, which cover the availability of micro-small enterprises, trading businesses, shopping facilities, and leisure facilities.

This study adopts a data mining approach to reveal the hidden information from a dataset. Data mining should be implemented through a standardized methodology. One of the prominent process frameworks used by practitioners and academics is the Cross-Industry Standard Process for Data Mining (CRISP-DM) [18]. It consists of six steps: Research understanding (initially business understanding), Data understanding, Data preparation, Modelling, Evaluation, and Deployment. This study implements data mining using an open-source software Knime Analytics Platform.

TABLE I. LIST OF PROVINCES

AC-Aceh	KR-Riau Islands	ST-Central Sulawesi
SU-North Sumatra	NB-West Nusa Teng.	SN-South Sulawesi
SB-West Sumatra	NT-East Nusa Teng.	SG-Southeast Sulaw.
RI-Riau	KB-West Kalimantan	GO-Gorontalo
JA-Jambi	KT-Central Kalimantan	SR-West Sulawesi
SS-South Sumatra	KS-South Kalimantan	MA-Maluku
BE-Bengkulu	KI-East Kalimantan	MU-North Maluku
LA-Lampung	KU-North Kalimantan	PB-West Papua
BB-Bangka Bel.	SA-North Sulawesi	PA-Papua

TABLE II. VILLAGE'S BUSINESS-ECONOMIC ACTIVITIES

Micro-Small Enterprises		**Trading facilities**
Clothes	Wood	Mini Market
Metal	Ceramic	Restaurant / Food Stall
Leather	Woven Product	Food and Beverage Store
Food Beverage	Other	Shop / Grocery Store
Shopping facilities		**Leisure facilities**
Shopping Complex		Open Public Space
Market in Building		Theatre
Market Without Building		Discotheque / Karaoke
		Fitness Centre

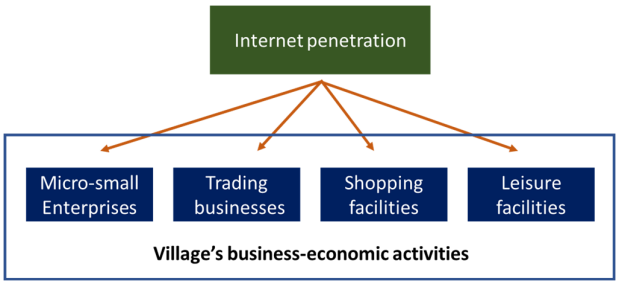

Fig. 1. Research framework.

IV. RESULTS

A Knime's workflow was created by combining nodes, as shown in Fig. 2. The workflow performs three purposes as indicated by boxes: plotting, clustering, model deployment.

A. *Descriptive characteristics*

Table III presents the descriptive statistics of the five variables, with mean, standard deviation, minimum, and maximum scores. The four variables of the village's business-economic activities are composite measures. Therefore, the score must be interpreted carefully. As an illustration, a province has a trading business score of 0.5, informing the maximum 50% of villages has at least one type of trading business, such as a minimarket. Therefore, if a village has minimarket and grocery stores, the actual number should be less than 50%. The table shows the increase of score from the year 2014 to 2018, except for the shopping facilities variable.

The line plot of all variables was investigated to understand the pattern of data. Figure 3 shows the line plot of all five variables, presented by ascending order of the internet penetration rate. Both random variation and increasing trend of four variables over internet penetration rate appear from the graph. The three provinces with the lowest internet penetration are Papua (PA), East Nusa Tenggara (NT), and North Maluku (MU), and the top three are Riau Island (KR), East Kalimantan (KI), and North Kalimantan (KU). Next, Table IV shows the descriptive comparison of the highest and lowest score of five variables between the data years 2014 and 2018. It appears that Papua and West Papua had the lowest score of all five variables in 2014. However, their position did not change much in 2018.

B. *Clustering*

The data of five variables are numeric and unclassified (or unlabelled). Therefore, the machine learning analysis belongs to unsupervised learning. In this unsupervised learning, clustering is selected. Clustering is a data mining technique that groups unclassified data based on their similarities or differences. Among clustering techniques, k-means was chosen because of its simplicity and appropriateness. The likely number of clusters (k) was selected as 2,3,4 by considering the size of objects which is 27 provinces. The best number of k was evaluated using the Silhouette coefficient, which ranges from -1 to 1. Table V displays the mean scores of the Silhouette coefficient for k = 2,3,4. The highest mean score is for k=2; therefore, the cluster size was determined as two.

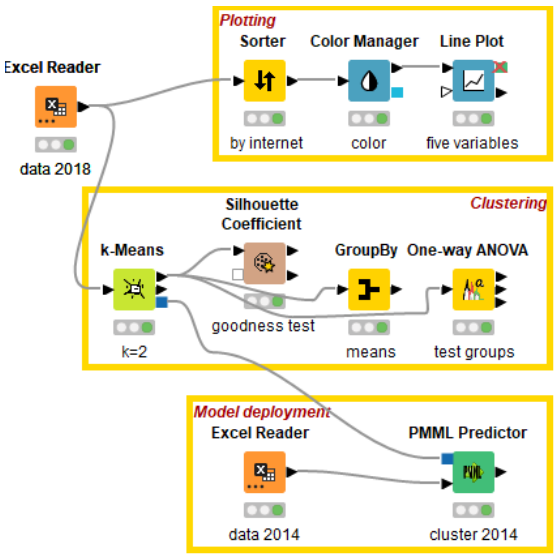

Fig. 2. Knime's workflow.

TABLE III. DESCRIPTIVE STATISTICS OF FIVE VARIABLES

2014	**Mean**	**SD**	**Min.**	**Max.**
internet	18.83	6.17	8.98	37.02
MSE	1.38	0.63	0.29	2.65
trade	0.40	0.12	0.11	0.61
shop	0.13	0.07	0.04	0.26
leisure	0.31	0.14	0.09	0.66
2018				
internet	34.57	7.80	19.59	53.74
MSE	1.51	0.73	0.23	3.06
trade	0.42	0.12	0.13	0.63
shop	0.12	0.06	0.04	0.25
leisure	0.34	0.16	0.10	0.87

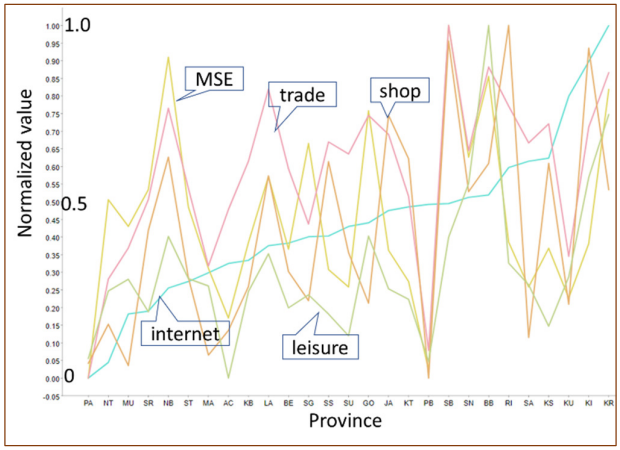

Fig. 3. Line plot

TABLE IV. PROVINCES WITH THE HIGHEST AND LOWEST SCORES

Variable	Highest 2014	Highest 2018
Internet	Riau Islands	Riau Islands
MSE	Bangka Belitung Isl.	West Sumatra
trade	West Sumatra	West Sumatra
shop	Bangka Belitung Isl.	Riau
leisure	Bangka Belitung Isl.	Bangka Belitung Isl.
Variable	**Lowest 2014**	**Lowest 2018**
Internet	Papua	Papua
MSE	Papua	Papua
trade	Papua	Papua
shop	West Papua	West Papua
leisure	Papua	Aceh

TABLE V. EVALUATION OF CLUSTER NUMBER

k	cluster size	Mean Silhouette coef. each cluster	Mean Silhouette coef. Overall
2	12,15	0.23, 0.39	0.317
3	7,7,13	0.09, 0.22, 03	0.221
4	5,6,7,9	0.13, 0.18, 0.28, 0.3	0.234

The implementation of k-means clustering has grouped 27 provinces into two clusters with 12 (cluster-0) and 15 (cluster-1) provinces, as shown in Table VI. The order of province in each cluster follows the descending order of internet penetration rate. Thus, for example, Riau Islands have the highest internet penetration rate in Cluster-0 and North Kalimantan in Cluster-1. Figure 4 shows the scatter plot of trading facilities vs. internet penetration for two clusters of provinces. It appears that cluster-0 is likely to have higher trading facilities and internet penetration than cluster-1. Four provinces in cluster-0 are shown: Riau Islands, Bangka Belitung Islands, East Kalimantan, and West Sumatra. In addition, four in cluster-1 are Papua, East Nusa Tenggara, Maluku, and North Maluku.

Furthermore, a one-way ANOVA test was performed to evaluate whether both clusters are different for each variable. The F-statistics, the ratio of between-group variability to within-group variability, show significant p-values for five variables (Table VII). Therefore, this ANOVA test justifies the difference between both clusters.

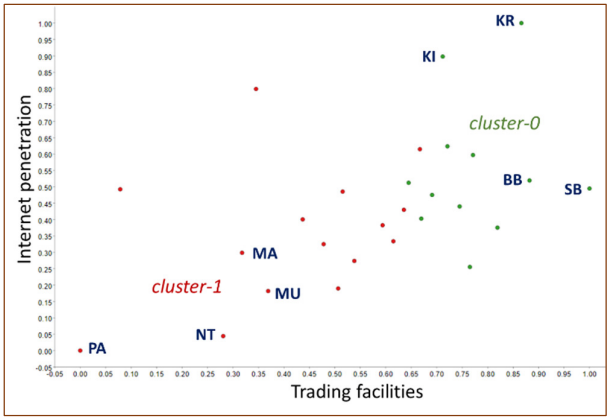

Fig. 4. Cluster members on the Internet vs. Trade

TABLE VI. CLUSTER MEMBERS FOR DATA 2018

Cluster-0		
Riau Islands	Bangka Belitung Isl.	Gorontalo
East Kalimantan	South Sulawesi	South Sumatra
South Kalimantan	West Sumatra	Lampung
Riau	Jambi	West Nusa Tenggara
Cluster-1		
North Kalimantan	South-East Sulawesi	Central Sulawesi
North Sulawesi	Bengkulu	West Sulawesi
West Papua	West Kalimantan	North Maluku
Central Kalimantan	Aceh	East Nusa Tenggara
North Sumatra	Maluku	Papua

TABLE VII. RESULT OF ANOVA

Variable	F-statistics	p-value	Mean cluster-0	Mean cluster-1
internet	6.06	0.021	0.55	0.35
MSE	11.75	0.002	0.61	0.33
trade	30.92	0.000	0.77	0.43
shop	35.95	0.000	0.66	0.21
leisure	13.29	0.001	0.44	0.20

C. Predictive model

One of the data mining advantages is its capability for model prediction, using PMML (Predictive Model Markup Language) format. The cluster analysis using data 2018 produced a predictive model, which was then applied to data 2014. The application of the 2014 dataset to PMML (Fig. 2 above) assigns 13 provinces in cluster-0 and 14 in cluster-1, as presented in Table VIII. The difference in the cluster memberships between 2018 and 2014 is only one province, Central Kalimantan. This province belonged to cluster-0 in 2014 and moved to cluster-1 in 2018. The cluster-0 has higher scores in all five variables than cluster-1, which means Central Kalimantan has moved down.

Finally, Table IX presents the variable means of data 2018 and the percentage change from 2014 to 2018 for four provinces. Papua and East Nusa Tenggara represent the lowest and Riau Island the highest value in the clustering. In addition, Central Kalimantan, which appears from the predictive model, is added.

V. DISCUSSION

This study investigated the relationship between Internet penetration rate and the business-economic activities at rural villages in Indonesia. Its novelty comes from the evidence to consider internet access as a driver for the rural villages to various economic and business activities. The finding has achieved the first objective. The descriptive analysis shows that the average Internet penetration rate among provinces is 34.57%. The number is different from the data published by the Indonesian Internet Providers Association (APJII) or Internet World Stats, in which the penetration rate in 2018 is 64.8% [19]. This substantial discrepancy comes from the difference in methodologies adopted. Internet penetration published by BPS covers data for each province. Therefore, for a study focusing on regions, the BPS data should be used.

Internet penetration among 27 provinces indicates the top three of highest internet penetration are Riau Islands, East Kalimantan, and North Kalimantan. Furthermore, the top-bottom three are Papua, East Nusa Tenggara, and North Maluku. A significant digital divide appears between Papua (the lowest), 19.6%, and Riau Islands, 53.7% (the highest). A previous study affirmed that the internet penetration rate is affected by economic rather than social and political factors [20]. From the economic perspective, the gap comes from the demand side (the population needs) and the supply side (the availability of internet networks).

The investigation of the household expenditure data published by BPS indicates that provinces with low internet penetration have low expenditure per capita. Papua and East Nusa Tenggara have the lowest expenditure per capita among provinces. The amount of spending relates to the household income. Subsequently, the household income comes from residents doing business-economic activities. These explain the finding that regions with low internet penetration are likely to have less business-economic activities. It can be interpreted that rural villages in that province will likely have fewer MSEs, fewer stores, fewer markets, and fewer theatres. The amount of expenditure is one among four components of the Human Development Index, which signifies the economic welfare of society. Therefore, the finding indicates that provinces with higher internet penetration rates are likely to have higher economic welfare. The result supports the prior study investigating the impact of the internet on economic welfare in Indonesia's rural area [16] and also in Mexico [21].

The finding has fulfilled the second objective. Clustering has classified provinces into two groups with higher and lower internet penetration and the village's business-economic activities. The Internet penetration rate is positively associated with a higher village's business-economic activities covering the number of micro-small enterprises, trading businesses, shopping facilities, and leisure facilities. Thus, those firms and facilities are likely to support the growth of economic activities. This relationship supports a prior study conducted among Asian countries [12] and rural firms in China [22].

Provinces in the eastern part of Indonesia: Papua, West Papua, Maluku, and Maluku Utara belong to the cluster with low internet access and low business-economic activities (Table IX). Conversely, most provinces in Sumatra, such as Riau Island, Bangka Belitung, and South Sumatra, belong to the cluster with high internet access and high business-economic activities. Thus, the digital divide exists between the western and eastern parts of Indonesia.

TABLE VIII. CLUSTER MEMBERS FOR DATA 2014

Cluster-0		
Riau Islands	Bangka Belitung Isl.	Gorontalo
East Kalimantan	South Sulawesi	South Sumatra
South Kalimantan	West Sumatra	Lampung
Riau	Jambi	West Nusa Tenggara
Central Kalimantan		
Cluster-1		
North Kalimantan	Bengkulu	West Sulawesi
North Sulawesi	West Kalimantan	North Maluku
West Papua	Aceh	East Nusa Tenggara
North Sumatra	Maluku	Papua
South-East Sulawesi	Central Sulawesi	

TABLE IX. COMPARING FOUR PROVINCES

Province	**internet**	**MSE**	**trade**	**shop**	**leisure**
Papua	19.59	0.23	0.13	0.05	0.15
	118%	-22%	18%	-18%	63%
East Nusa Tenggara	21.10	1.66	0.27	0.07	0.29
	111%	31%	13%	-11%	-10%
Riau Islands	53.74	2.55	0.57	0.15	0.68
	45%	30%	2%	-2%	20%
Central Kalimantan	36.17	1.00	0.39	0.17	0.27
	82%	-3%	3%	-9%	-16%

The cluster analysis using data 2018 produced a machine learning predictive model, then applied to data 2014. This predictive model deployment was not intended to predict the future, instead of to observe the shifting of cluster membership. The result revealed that all 27 provinces, except Central Kalimantan, maintained their groups. Central Kalimantan experiences degradation as it moves from the cluster with higher internet penetration and village's business-economic activities to lower ones. Investigating its variable scores indicates a good increase of internet penetration rate from 20% to 36%, however trading businesses only increase by 3%, shopping and leisure facilities decrease by 9% and 16%. Nevertheless, its internet penetration rise seems normal as the national average is about 16% (Table III).

Some findings and lessons learned are as follows:

- Overall, internet penetration rates among provinces are still low (34.6%), and the gaps among them are high. Some regions with the lowest are Papua (19.59%), East Nusa Tenggara (21.1%), and North Maluku (25.8). However, it should be acknowledged that the internet penetration rate for those provinces has a tremendous increase of more than 100% from 2014 to 2018 (Table IX), above the national average.
- Papua and West Papua are some provinces with the lowest business-economic activities in rural villages. Papua, for example, experienced a decrease (22%) from 2014 to 2018 in the number of business sectors (MSEs) per rural village.
- Provinces with lower internet penetration are likely to have lower business activities in rural villages.

Conversely, those with higher internet penetration are likely to have higher business activities in rural villages. Some provinces experienced a high escalation in internet penetration, but a low or even decrease in business activities. For these, the improvement in internet access might not deliver economic impact.

Provinces with more villages having more MSEs in various industry sectors are associated with higher internet penetration rates. Similarly, provinces with more villages with multiple shopping facilities, trading facilities, and leisure facilities also have higher internet penetration rates. While correlation does not indicate causation, the result demonstrates that internet penetration is a driver for economic-business activities in rural villages. This finding could be considered an argument for the government policy to promote internet penetration in rural areas.

VI. Conclusion

This study has investigated the business and economics activities at rural villages in Indonesia and their association with the Internet penetration rate. The novelty of this study is to provide evidence about the link between Internet penetration and the details of the village's business-economic activities. This study provides academic support to the Ministry of Communication and Informatics to develop internet access in ongoing programs such as Digital Village or Integrated Broadband Village. In addition, the Ministry of Villages, Development of Disadvantaged Regions, and Transmigration in August 2020 decided that the allocated village fund could provide Internet access. Therefore, the village administrators should budget the improvement in internet access in the village development program. More extensive consideration should be given to provinces with low internet penetration and business-economic activities, especially Papua and East Nusa Tenggara. The improvement in internet penetration might not bring effect if there is no improvement in business-economic activities. Therefore, this study suggests that the government improve the facilitation for business-economic activities (MSEs, trading/shopping/leisure facilities) and internet access.

Second, this study suggests that micro-small businesses use appropriate mobile applications (apps) to support business activities. For example, simple online apps for small business accounting, book-keeping, material management, transaction, and marketing. In addition, the use of e-commerce platforms such as Tokopedia.com and Bukalapak.com is essential to promote the products produced by rural villages. Without the help of business-related applications, internet access will be less impact on economic growth. The World Bank reported empirical cases that mobile applications supported rural development; and brought positive effects on the income increase and economic opportunities for people in rural areas [23]. Therefore, government agencies, private sectors, and universities might support the education and promotion for using the appropriate apps-related business to those MSEs.

This study admits limitations. The unit of analysis is a province; therefore, this study could not specify which district/regency or which villages have a high or low score of internet penetration and business-economic activities. If detailed data from BPS is available, more profound and more specific findings could be obtained. Further study, upon the data availability, could focus on a particular province with a district/regency as a unit of analysis to find detailed results.

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Foreword from Conference Chair

It is an honor and privilege to welcome you to the 2021 2nd ICT for Rural Development (IC-ICTRuDev). IC-ICTRuDev is the second international conference on ICT Rural for Development, organized by ICT Research and Human Resource Development Agency, Ministry of Communications and Informatics (Kemkominfo), Republic of Indonesia in collaboration with the IEEE Indonesia Section. The conference's theme, "ICT for Rural Development: Digital Economy and Human Resource Development" invites us to discuss current ideas and issues in rural development, especially the role of information and communication technology in driving development areas, including the economy, digital ecosystem, human resources, social and digital culture. By the end of this conference, we will highlight some recommendations for policy makers at the regional and international levels in addressing ICT for rural development issues.

The international conference on ICT for rural development, is an important forum, not only for researchers and academics but also regulators, industries, and communities to share their studies, ideas, policy outcomes, and best practices that may support ICT ecosystem and digital human resource development particularly in rural areas. The variety of sessions will give you opportunities to connect with friends and colleagues to expand your networks. In this conference, we also encourage all the participants to actively engage for better ICT implementation in driving rural economy, human resource, ecosystem, social and cultural development. This conference is the result of the hard work, support, and dedication of a number of parties. We wish to thank all the committee members who together make the conference possible. The committee has been working throughout the year to propose sessions, review a record number of submissions, answer queries, arrange the schedule, and response to last-minute requests. We also want to thank IEEE Indonesia Section for their contribution to support the conference. For all participants and presenters, we value your presence and participation at the 2021 2nd International Conference ICT for Rural Development (IC-ICT RuDev).

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