Deriving the Community Readiness Index in Facing the Industrial Revolution 4.0 in Indonesia

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Abstract. The demographic dividend that is being experienced by Indonesia is an opportunity to increase the economic growth rate. At the same time, Indonesia has enrolled in the revolution era of industry 4.0, which can provide benefits and boost the Indonesian economy. However, this can negatively impact if the community is not ready, such as increased unemployment due to disruption and job automation. This study examines how ready the Indonesian people are to face the industry 4.0 related to education and the use of information and communication technology (ICT) by forming an index utilizing the factor analysis and then grouping districts based on the index formed. The data used comes from the National Socio-Economic Survey (SUSENAS) 2018 by the Statistics Indonesia (BPS). The results show that there are differences in community readiness based on the groupings formed. This research also shows that in general, Papua and East Nusa Tenggara are not ready to face this era. Therefore, policies are necessitated following each region's conditions to improve education and ICT, especially Papua and East Nusa Tenggara, which require more attention.

Introduction

Indonesia is undergoing a demographic dividend that is expected to peak in 2025 [32]. The demographic dividend is the potential economic growth generated when the dependency ratio is low [34]. At this peak, Indonesia's dependency ratio is estimated to reach 44.2 [32]; this means that two to three productive people will bear every one unproductive people.

On the other hand, Indonesia has just launched the fourth industrial revolution (industry 4.0) policy in 2018, particularly Making Indonesia 4.0 [24]. The fourth industrial revolution is an extension of the third industrial revolution marked by the emergence of technological breakthroughs in some fields such as artificial intelligence, robotics, and the internet of things [31].

Technological advances in this era can threaten some jobs, especially for low-skilled and repetitive jobs (WEF & ADB, 2017). It is estimated that 56% of jobs in Indonesia are at high risk of experiencing automation, 35% are at moderate risk, and 9% are at low risk [9]; this can be a threat to Indonesia as a country with a relatively high workforce and unemployment rate [29].

Concerning the industry 4.0, the World Economic Forum (WEF) has established an index called the Networked Readiness Index (NRI). NRI is a measure that reveals how ready each country is to reap the benefits in the transition of industry 4.0 [8]. According to research by Baller et al [4], Indonesia has low
readiness regarding digital infrastructure. It is also estimated that only one-third of Indonesia's population has access to the internet (WEF & ADB, 2017). On the other hand, Indonesian workers' education is still relatively low, while the education has a negative correlation with job automation [9].

To face this era, the workforce and technology must be prepared [15]. Thus, in supporting the Making Indonesia 4.0, readiness is required, especially from the community. However, the existing measures cannot explain the community readiness down to the district level. Therefore, this research was conducted to measure the community readiness in facing the era of the industry 4.0 at district level. However, considering the limited availability of the data, the community readiness is observed only in terms of education and ICT use.

**Research Methods**

The data used in this study are from the National Socio-Economic Survey (SUSENAS) March 2018 by the Statistics Indonesia (BPS). The survey was conducted in all districts in Indonesia (514 districts) using the sampling method of two stages with the usual household as the unit analysis and household members as respondents [33].

In Da Silva et al [10], human resources related to data and digital literacy and connections from all members in an organization indicate readiness to face this era. Also, Schumacher et al [30] explained that employee competence related to the use of ICT and employee openness to new technology, as well as the existence of modern ICT and the utilization of mobile devices, including indicators covered in the maturity model to assess the readiness of industry 4.0. In relation to this, education influences industrialization; this happens since education is the key in absorbing new technologies and adapting to change [6]. Furthermore, higher education plays a crucial role in shaping the social transitions demanded to make adjustments to industry 4.0 [12].

Furthermore, ICT is a vector of economic and social transformation. By increasing access to services, increasing connectivity, creating business and job opportunities, changing the way we communicate and interact, ICT can prompt world change [11]. Although ICT availability is increasing, the question of access to ICT and its application still plays an important role, especially for developing countries [7]. Therefore, the ICT use is considered in measuring the community readiness. Thus, the following variables are utilized as indicators of the readiness.

**Table 1. Variables**

| Variable | Explanation |
|----------|-------------|
| $X_1$ | Literacy rate |
| $X_2$ | Secondary gross enrollment rate |
| $X_3$ | Tertiary gross enrollment rate |
| $X_4$ | Percentage of population using cell phones |
| $X_5$ | Percentage of population who own cell phones |
| $X_6$ | Percentage of population using PC/laptop |
| $X_7$ | Percentage of population accessing the internet |
| $X_8$ | Percentage of households that own a PC/laptop |
| $X_9$ | Percentage of households with electric lighting as the main source of energy |

The literacy rate is the proportion of the population aged 15 years and above who can read and write simple sentences in alphabets, Arabic letters, and other letters to the population aged 15 years and above. Secondary enrollment rate is the proportion of students in Jr. High School/equivalent and Sr. High School/equivalent to the population aged 13-18 years. Tertiary gross enrollment rate is the proportion...
of students at the tertiary level/equivalent (undergraduate) to the population aged 19-24 years. The percentage of the population using cell phones is the proportion of people aged five years and above who have used cell phones in the last three months, not necessarily have to be personally owned cell phones or purchased/paid for by individuals who use them.

The percentage of the population owning/controlling cell phones is the proportion of the population aged five years and above who owns/controls cell phones with at least one active SIM card. The percentage of the population using a PC/laptop is the proportion of the population aged five years and above who used a PC/laptop in the last three months, not necessarily their own PC/laptop. The percentage of households owning a PC/laptop is the proportion of households that own a PC/laptop. The percentage of households with electric lighting as the main source of energy is the proportion of households that use electric lighting as the main source of energy.

Then, the community readiness index is formed from these variables using the factor analysis method with principal component extraction. Based on Johnson & Wichern [16], the following is a model of the factor analysis.

\[ X_{(p \times 1)} = \mu_{(p \times 1)} + L_{(p \times m)}F_{(m \times 1)} + \epsilon_{(p \times 1)} \]  

(1)

In accomplishing a factor analysis, it is necessary to examine the correlation matrix and identify the sampling adequacy of the data set [3]. The correlation matrix test is observed in equation 2 [5], while the KMO and measures of sampling adequacy (MSA) are in equations 3 and 4 [20]. In facilitating the interpretation of the resulting loading factors, varimax rotation was utilized where the transformation angle used was based on the maximized variance value, as in equation 5 [18].

\[ \chi^2_{obs} = -\left[ n - 1 - \frac{1}{6}(2p + 5) \right] \ln|R| \]  

(2)

\[ \text{KMO} = \frac{\sum_{k=1}^{p} \Sigma_{i=1}^{p} r_{ik}^2}{\sum_{k=1}^{p} \Sigma_{i=1}^{p} \Sigma_{k=1}^{p} 1 - r_{ik}^2} \text{, } i \neq k \]  

(3)

\[ \text{MSA}_i = \frac{\Sigma_{k=1}^{p} r_{ik}^2}{\Sigma_{k=1}^{p} 1 - r_{ik}^2} \text{, } k \neq i \]  

(4)

\[ \Psi = \frac{1}{4} \arctan \frac{2[p \Sigma u_i v_i - \Sigma u_i \Sigma v_i]}{p \Sigma u_i^2 - \Sigma v_i^2 - (\Sigma u_i)^2 + (\Sigma v_i)^2} \]  

(5)

The weighting for each indicator was calculated by referring to one of the methods recommended by the JRC-European Commission [17] in compiling the composite index. This weighting method is also used in calculating the Village Development Index (IPD) of 2014 [25]. The calculation consists of two stages as follows.

\[ \text{weight}_i = \frac{\text{Loading factor}_i \times \% \text{ of variance}}{\sum \text{Loading factor}_i} \]  

(6)

\[ \text{Standard weight}_i = \frac{\text{weight}_i}{\sum \text{weight}_i} \]  

(7)

Furthermore, the standard weight is used for each variable. Therefore, the following is the readiness index in question.

\[ I = \sum_i \text{standard weight}_i x_i \]  

(8)

The resulting index score ranges from 0 to 100, where the closer to 100 indicates better readiness. After that, the districts were grouped based on the standard deviation of the index scores as follows.
Table 2. Group classification

| Groups | Cut off Value                  |
|--------|-------------------------------|
| 1      | $I > \bar{X} + 1.5 S$         |
| 2      | $\bar{X} + 0.5 S < I \leq \bar{X} + 1.5 S$ |
| 3      | $\bar{X} - 0.5 S < I \leq \bar{X} + 0.5 S$ |
| 4      | $\bar{X} - 1.5 S < I \leq \bar{X} - 0.5 S$ |
| 5      | $I \leq \bar{X} - 1.5 S$      |

Table 2 describes the classification of district groups based on the standard deviation of the index scores where $\bar{X}$ is the mean of the scores, and $S$ is the standard deviation. An index score greater than $\bar{X} + 1.5 S$ indicates high readiness, while an index score less than $\bar{X} - 1.5 S$ indicates low readiness. From the grouping results, one-way MANOVA was performed to test the differences between the five groups.

In performing MANOVA, it is necessary to assume that each group has a multivariate normal distribution and the covariance matrices are equal [16]. In this study, the Henze-Zirkler test was conducted as the multivariate normality test as in equation 9 [14]. The Box-M test was conducted as the covariance matrix homogeneity test as in equation 10 [16]. Meanwhile, Pillai statistic was conducted as the MANOVA test as in equation 11 with an approach to the $F$ distribution as in equation 12 [28]. Pillai statistic was used since it is the most robust of the MANOVA test for dealing with non-normal data and heterogeneous covariance matrices [26]. Furthermore, the Kruskal-Wallis test was performed as a post hoc test of the one-way MANOVA as in equation 13 (Kruskal & Wallis, 1952).

$$T_{n,0}(X_1, ..., X_n) = n(4I_E + D_{n,0}I_E^c)$$

$$C = (1 - U)M$$

$$M = \left[ \sum_{i=1}^{g} (n_i - 1) \right] \ln |S_{\text{pooled}}| - \sum_{i=1}^{g} [(n_i - 1)\ln |S_i|]$$

$$U = \left[ \sum_{i=1}^{g} \frac{1}{n_i - 1} \right] - \frac{1}{\sum_{i=1}^{g} (n_i - 1)} \left[ \frac{2p^2 + 3p - 1}{6(p + 1)(g - 1)} \right]$$

$$V^{(t)} = \text{tr}[(E + H)^{-1}H]$$

$$F = \frac{(2N+t+1)V^{(t)}}{(2z+t+1)(t-V^{(t)})}$$

$$K = \frac{12}{N(N+1)} \sum_{i=1}^{g} \frac{R_i^2}{n_i} - 3(N + 1)$$

Results and Discussion
Descriptive statistics of the variables used are presented in Table 3. Through Table 3; it can be observed that in general, the tertiary gross enrollment rate ($X_3$), the percentage of the population using a PC/laptop ($X_6$), the percentage of the population accessing the internet ($X_7$) and the percentage of households that own PC/laptop ($X_8$) are still low. In this case, the average percentage of the population accessing the internet is 33.38%. It can be stated that only one-third of Indonesia's population has access to the internet; this is in line with WEF & ADB (2017). The percentage of households with electric lighting as
the main source of energy holds the highest average among other variables. However, there are still districts where people do not use electricity as the main source; this shows the gap in Indonesia's infrastructure development.

### Table 3. Descriptive statistics of each variable

| Variable | Mean  | Std   | Min   | Max   |
|----------|-------|-------|-------|-------|
| X₁       | 94.80 | 8.65  | 31.54 | 100.00|
| X₂       | 85.96 | 9.85  | 23.32 | 127.63|
| X₃       | 20.71 | 13.23 | 1.02  | 75.41 |
| X₄       | 71.62 | 13.01 | 3.89  | 92.46 |
| X₅       | 58.75 | 12.86 | 3.09  | 83.23 |
| X₆       | 17.10 | 8.30  | 0.00  | 49.51 |
| X₇       | 33.38 | 14.01 | 0.00  | 73.39 |
| X₈       | 18.67 | 10.19 | 0.00  | 56.47 |
| X₉       | 95.07 | 12.73 | 0.00  | 100.00|

Furthermore, factor analysis was performed using the psych package on R version 4.0.2. The Bartlett test of Sphericity presents a significant result with a p-value of 0.000; this proves that dimensional shrinkage can be achieved on existing data sets. The KMO value is 0.8436 while the MSA value for each variable is presented in table 4 below.

### Table 4. MSA value of each variable

| Variable | MSA  | X₁  | X₂  | X₃  | X₄  | X₅  | X₆  | X₇  | X₈  | X₉  |
|----------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| MSA      | 0.93 | 0.95| 0.90| 0.83| 0.80| 0.81| 0.84| 0.81| 0.88|

A value of more than 0.50 indicates that it is feasible to perform a factor analysis [13]. The next is to determine the number of factors that will be used. This can be done by selecting factors with an eigenvalue of more than 1 [19].

![Figure 1. Scree plot.](image-url)
The scree plot in Figure 1 shows that factor 1 and factor 2 have an eigenvalue of more than 1. Thus, this study uses two factors with weights for each variable as follows.

### Table 5. Factors and weight of each variable

| Factor | % of explained variance | Variable | Weight |
|--------|-------------------------|----------|--------|
| 1      | 40.7828                 | X_3      | 0.1219 |
|        |                         | X_6      | 0.1344 |
|        |                         | X_7      | 0.1211 |
|        |                         | X_8      | 0.1374 |
|        |                         | X_1      | 0.1060 |
|        |                         | X_2      | 0.0762 |
| 2      | 38.4409                 | X_4      | 0.1011 |
|        |                         | X_5      | 0.0885 |
|        |                         | X_9      | 0.1134 |
|        |                         |          | 1.0000 |
|        |                         |          | 79.2237 |

Based on Table 5, it can be perceived that the two factors used can explain approximately 79% of the variation of the original data. Factor 1 was identified as a factor in education and the use of ICT in the advanced level. In contrast, factor 2 was identified as a factor in education and the use of ICT in the basic level. Then, using the weight of each variable, the readiness index for each district in Indonesia was obtained. Table 6 presents the five districts in Indonesia whose communities are the readiest to face this era in which the five districts are municipal administrations. Meanwhile, the five districts whose communities are least ready, as displayed in Table 7, are all in Papua Province and constitute regency administrations. The readiest district was Yogyakarta City, with an index score of 77.4, while the least ready was the Puncak Regency with an index score of 8.9. In general, the Indonesian people's readiness, observed from education and the use of ICT in advanced level, is still low.

### Table 6. Districts with the highest index scores

| District       | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 | X_7 | X_8 | X_9 | Index |
|----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| Yogyakarta     | 98.7| 96.3| 75.4| 86.3| 79.7| 49.5| 73.4| 56.5| 100.0| 77.4  |
| Banda Aceh     | 99.7| 118.2| 67.1| 89.7| 82.1| 42.7| 65.0| 55.8| 100.0| 76.7  |
| Padang         | 99.6| 100.4| 75.2| 84.7| 81.2| 37.8| 56.2| 44.7| 99.8 | 72.4  |
| Tangerang Selatan | 99.2| 87.9| 55.0| 85.4| 79.8| 42.5| 72.0| 48.3| 100.0| 72.0  |
| Palu           | 99.7| 102.2| 67.1| 84.9| 77.7| 39.9| 57.1| 43.7| 100.0| 71.6  |

### Table 7. Districts with the lowest index scores

| District       | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 | X_7 | X_8 | X_9 | Index |
|----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| Puncak         | 51.0| 23.3| 3.5 | 7.3 | 5.0 | 0.2 | 0.3 | 0.2 | 0.0 | 8.9   |
| Nduga          | 38.8| 36.8| 4.8 | 5.9 | 5.4 | 0.1 | 0.2 | 0.0 | 0.0 | 11.1  |
| Mamberamo Tengah | 40.6| 69.3| 1.9 | 3.9 | 3.1 | 0.0 | 0.4 | 0.0 | 0.0 | 11.0  |
| Yahukimo       | 64.1| 32.9| 1.0 | 9.5 | 9.0 | 1.2 | 2.4 | 4.2 | 5.5 | 12.8  |
| Dogiyai        | 42.2| 74.0| 5.8 | 14.2| 9.0 | 1.5 | 0.6 | 2.1 | 27.4| 16.7  |
From the index scores, a grouping was formed using the standard deviation scheme. There are 39 districts in the highly ready category, 78 districts are in the ready category, 297 districts are in the moderate category, 77 districts are in the unprepared category, and 23 districts are in the highly unprepared category. Furthermore, to confirm that the five groups formed were different based on the nine sets of variables used, the one-way MANOVA test was performed. Before performing the test, a multivariate normality test was conducted for each group along with covariance matrix homogeneity test. The results using Henze-Zirkler test revealed that only group 1 and group 5 were proven to have a multivariate normal distribution. Also, the Box-M test revealed that the covariance matrices were heterogenous. Therefore, Pillai statistic was utilized as presented in Table 8.

Table 8. One-way MANOVA Test

| Pillai | Df | num df | den df | p-value |
|--------|----|--------|--------|---------|
| 1.773  | 4  | 36     | 2016   | 0.000   |

Table 9. Kruskal-Wallis Test

| Variable | Chi Square Value | Df | p-value |
|----------|------------------|----|---------|
| X1       | 125.02           | 4  | 0.000   |
| X2       | 116.14           | 4  | 0.000   |
| X3       | 189.05           | 4  | 0.000   |
| X4       | 292.65           | 4  | 0.000   |
| X5       | 365.67           | 4  | 0.000   |
| X6       | 358.48           | 4  | 0.000   |
| X7       | 367.69           | 4  | 0.000   |
| X8       | 331.18           | 4  | 0.000   |
| X9       | 188.64           | 4  | 0.000   |

Table 8 shows the value of the Pillai statistic and its approach to the F distribution. From these results, it is confirmed that there is at least one pair of different mean matrices. In discovering which mean matrix is different, a further test was performed with the Kruskal-Wallis test, as in table 9. Table 9 presents that at the significance level of 5%, there is sufficient evidence that each group comes from a different population; this means that each mean matrix is significantly different. Thus, these results prove that the grouping differs according to the nine sets of variables used. These results indicate that each category has a different level of readiness, and this can be a reference that each group of districts requires different preparations. For districts in the unprepared and highly unprepared category, it certainly requires more attention from the government to accomplish equitable development.
Figure 2 displays a radar plot comparing the mean of the variables in each group formed. Through this figure, it can be observed that there are gaps between groups, especially for group 5 or highly unprepared districts. Furthermore, Figure 3 presents a thematic map of the Indonesian people's readiness to face the industry 4.0 by district. In general, it shows that Indonesia is in the moderate readiness category; this is per Baller et al [4], where Indonesia's NRI score was in the moderate category. Although there are still some districts in the western part of Indonesia that are in the unprepared category, overall, it can be seen that there is an imbalance in development in terms of education and the use of ICT between western and eastern Indonesia; this is proven where unprepared, and highly unprepared districts are concentrated in eastern Indonesia. Maryati's research [22] also showed an imbalance in development between the western and eastern regions of Indonesia, in which the eastern region of Indonesia was still straggling behind.

In general, it can be observed that East Nusa Tenggara and Papua are respectively in unprepared and highly unprepared group to face the industry 4.0. These results are in line with Kennedy et al [21], that East Nusa Tenggara is lacking in education, including the high dropout rate, low qualifications and competencies of educators and educational personnel, and inadequate educational facilities and
infrastructure. For Papua, Pribadi [27] explained that teaching staff and access to schools were still very minimal. In addition, parents awareness of the importance of education for their children is still lacking.

In terms of the use of ICT, Al-Mursyid [1] explained that East Nusa Tenggara and Papua are provinces that are still lagging and require more attention in ICT development. Research by Ariyanti [2] also noted Papua and East Nusa Tenggara as priorities for ICT infrastructure development and internet operations. It is also suspected that Papua's topography and geographic location make Papua difficult to reach and to build an internet network.

Conclusion
This study examines the readiness of the Indonesian people in facing the industry 4.0 by forming an index in which there are two factors, particularly the factor of education and the use of ICT in advanced level and the factor of education and the use of ICT in basic level. The index results reveal that Yogyakarta City is the district with the most prepared community, while Puncak Regency is the district with the most unprepared community. Meanwhile, in general, the Indonesian people are at moderate level of readiness where improvements are still required in the education and the use of ICT in advanced level, particularly student participation in higher education, utilization of PC/laptop and internet access by individuals, and ownership of PC/laptop by household.

In addition, the grouping with standard deviation scheme of the index scores proves that each group formed is different based on the nine sets of variables. This evidence shows that there are differences in the level of readiness between the groups formed. In this regard, districts in the unprepared and highly unprepared category require more attention to improve educational facilities and infrastructure to support ICT use, both at the basic and advanced levels. According to the results, East Nusa Tenggara and Papua are generally unprepared and highly unprepared. Therefore, the government needs to make these two provinces as the focus and priority in education and ICT infrastructure development, such as improving access to education facilities and building internet networks.

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