

The Consequences of Digitalization of the Labor Market in Developing Countries: Case Study in Indonesia

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ABSTRACT

Digitalization has positive and negative impacts on labor productivity and labor market. Nonetheless, digitalization era created fear on the labor market in developing countries, especially in Indonesia, which has a bonus demographic. This problem raised this study aims to identify the impact of digitalization on the labor market and labor productivity in Indonesia and understanding the readiness of Indonesia in the digital era. By using panel data from Statistics Indonesia 2012-2017 and research method is panel regression analysis. The results indicate that digitalization era can replace labor in Indonesia despite having a profound influence. Whereas digitalization has a higher effect on reducing labor productivity in Indonesia. As a result, to prevent the big wave of a new era of technology, the Indonesia government should renew the education system as a consequence of digitalization era and the changing of labor structure.

Keywords: Digitalization, Technological change, Labor productivity, Employment, Job creation, Job destruction, Labor market.

1. INTRODUCTION

Nowadays, technological developments are leading us to the era of digitalization, where things are faster and more efficient. The creation of digital technology and its derived technologies (such as computers, smartphones, and the internet) affects several aspects such as computerization of production, private spheres, and delivery services. Meanwhile, the development of connectivity also leads to a new dimension, where electronic devices connect people to each other, workers with machines, and machines with machines. Thus, we can call that one of the characteristics of digitalization is the information and communication technology (ICT) revolution. Blix [1] described that digitalization progress is the third industrial revolution and Jalava and Pohjola [2] called as "Digital Economy" or "New Economy" and also as a pioneer of automation era or fourth industrial.

In the new economy, technological innovation is considered a new way of production, which has the capability to increase output without increasing input. As a result, since the beginning of the industrial revolution, technological advancement plays an essential role in the process of economic growth. Neoclassical economists,

such as Solow, Ramor, and others, also assume that technological advancements are accelerating economic growth and productivity, leading to structural change and also a net positive impact on employment [3-4]. Moreover, Zeira [5] explained that the issue of technology diffusion and adoption are less attention. Since most countries in the world adopt and use technologies, rather than invent them, and occurs the different of their economic growth. Sabbagh, et al. [6] pointed out that the existence of digitalization is a crucial driver of economic growth and facilitates employment creation. Several empirical studies [7-9] explained ICT use and investment improves firm productivity and the efficiency of all stages of the production process. The primary influence of ICT, according to Zeira [5] and Bartel [10], is the reduction in setup time, which not only make it less costly of shifting production from one product to another but also it supports the changes in business strategy into more customized production. Furthermore, technological advancement leads to decreasing aggregate labor hours in the future, while total demand increases [11-12].

Efficiency and low costs created from technological progress will improve the productivity and output of the

firm. However, this situation has opposing effects on labor markets. On the one hand, countries that are dealing with population aging phenomena (such as Japan, Singapore, or Germany) will have other problems regarding the labor market. On the other hand, a country such as Indonesia, which have a demographic bonus, will have many issues, especially the labor market. Moreover, the impact of technological developments on the labor market in developing countries such as Indonesia raises several questions. These issues include increased labor productivity, job creation, job destruction, job shifts, education adequacy, and skill-biased technical change. Therefore, this study aims to understand Indonesia's readiness in the face of the digital era and some jobs that will create and destruct. Additionally, it is also necessary to understand the impact of digitalization and education on labor productivity and labor markets in Indonesia.

2. LITERATURE REVIEW

During the 1990s, new economic theory and model have been created to measure the impact of technology change to economic growth, as a result of the increasing investment on technology in the USA and other developing countries. Kraemer and Dedrick [13] defined "New Economy" as non-inflation association in which sustained economic is produced with high investment in technology and economy restructuring due to new ICT innovation used, such as supply chain management, e-commerce, and internet. Further, Jalava and Pohjola [2] pointed out that "Digital Economy" or "New Economy" refers to the pressures of globalization and the technological revolution, especially ICT, resulting from the emergence of the power of superior economic structures.

As part of the revolution of digitalization—i.e. personal computer, internet, mobile phone and other IT devices—increasing productivity in ICT-producing and manufacturing sectors has a direct effect on aggregate productivity and economic growth [14-15]. As stated by Galindo-Martín, et al. [16] that digital transformation and innovation are conducted a value creation and stimulate entrepreneurial activity and generate beneficial effects on society. Unremarkable that digitalization through ICT has the potential to result in increased productivity in the entire economy [3-4]. According to Biagi [17] economic improvement occurs because of the abundance effects associated with it, namely: 1) vertical spillovers between ICT-producing sectors and specific productive sectors in which ICT are applying, 2) horizontal spillovers between the various sectors in which ICTs are.

The progress of digitalization makes the employee learning process constant and flexible. Coreynen, et al. [18] pointed out that human productivity in the industry has achieved an effective 40% increase in the firm's output. Zeira [5], Heeks [19] and Parviainen [20] explained that the process of digitalization could lead to

better firm operation from manual to automatic. Hence, the digitalization will drive the increases productivity in general and labor productivity in particular [3]. Also, digitalization has enhanced the employment conditions of each business sector because of the automation of routine work and freeing time to develop new skills [19],[21-22]. Titan, et al. [23] and Jacob, et al. [24] assessing the potential of technological innovations promoting equality and ease in education such as virtual schools. It means the industries are now capable of performing their business activities with higher efficiency caused they may get high skill employment.

The emergence of high efficiency and the current era could change the relationship between technology and labor. As long as, the development of technology is not only oriented to jobs that use muscles, but also to jobs that use the brain. The development of this technology also shifts the conventional way of working with a large number of human resources, and self-owned is no longer valid. This development will significantly encourage cost efficiency and changing the labor structure. Following Keynes' statement that there would be technological unemployment [4],[25]. Where this occurs as a result of firms findings on how to economizing the use of labor beyond the pace at which firms can find new methods for employment [5]. Tinbergen assumed that technological developments tend to increase the demand for a more educated workforce and as a signal for changes in the wage structure as a race between technological progress and access to education [4],[23]. Besides, Degryse [26] states that the digitalization revolution will have a significant impact on the labor market. Nerhus [11], Degryse [26] and Vermeulen, et al. [27] provide a general description of the various fields of impact as follows:

1. Job creation: new sectors, new products, new services;
2. Job changes: digitization, intelligent human/machine interface, new forms of management;
3. Job destruction: automation, robotization;
4. Shift work: digital platform, crowd source, 'sharing' economy.

The four effects of digitalization will have an impact on the macroeconomic side such as development in labor market, wages, social inequality, the new quality of work that has just created, changed, or 'shifted', etc. Developing countries can be hammered so hard by the influence of digitalization. This circumstance due to the low readiness of the population on facing the change of technology. In carrying out this digital era, education reform is needed to meet the demands of the workforce with new skills. Therefore, workers who can update their skills and keep up with current technology developments will not be easily eliminated from their position and also in line with their wages.

In addition, Walwei [3] and de Groen, et al. [12] agreed that the combination of digitalization and globalization could increase competition and fewer restrictions on trade and the availability of information at any point and at any time that could encourage the national economy to be more specialized. Meanwhile, developing countries, which have low human capital and level of readiness to technological progress, are threatened unable to compete in the global market with countries that have advanced technology. Due to developing countries will have low productivity compared with developed countries, and they are problematic to fulfill global market demand. The position of these countries becomes exacerbated by the fewness of restriction that occurs between these countries and also threatens their country's sovereignty.

Additionally, Frey and Osborne [25] also state that the era of digitalization and computerization will have an impact on the labor market, especially work that can be replaced by computers and machines. In addition, Balsmeier and Woeter [28] view the existence of technological advances lead to job destruction because the majority of modern jobs requires higher skills than many jobs in the past. This situation is contrary to a second industrial revolution which did not cause mass unemployment because the capacity and quality of the education sector can rapidly meet the labor demand at that time. Thus, in the current era, workers are demanded with higher skills.

Further, Galindo-Martín et al. [16] explain the consequence of digital transformation impact to an economic expansion results in higher employment levels and growth and, therefore, greater well-being. Walwei [3], Bühner and Hagist [4], and Degryse [26], also described the interaction between digitalization and demography, because demographic changes and the potential for labor shortages may be compensating by technological advances (e.g. labor-saving machines). Conversely, countries with a demographic bonus may face problems with the abundant compensatory labor with technology, namely technological unemployment. However, if the abundance of employment does not have sufficient human capital to compete in the digital era, which increases competition both individually and in the business world, it can become a burden and increase the problem of unemployment in a country that has a dividend demographic such as Indonesia. On the other hand, the abundance of human resources with adequate human capital enables the development of new startups, job creation, and economic improvement in developing countries such as Indonesia like the prediction of Galindo-Martín, et al [16].

3. RESEARCH METHODOLOGY

This paper use Statistics Indonesian (Badan Pusat Statistik-BPS), which is a panel of data with the research

object consisting of 33 provinces in Indonesia and the period of 2012 to 2017. The research period based on the availability of ICT data owned by BPS in Indonesia, and another reason was in 2012, Indonesia Connected project has started to develop rapidly and give a significant influence on the labor in the formal sector and economic development in general and the development of human resources in particular.

According to Frey and Osborne [25] predicted that the era of digitalization and computerization would impact several jobs which could be replaced by them. The other researchers such as Nerhus [11], Acemoglu and Restrepo [22], and Degryse [26] adding that revolution of digitalization would have a major impact on employment and the labor market structure. According to Bühner and Hagist [4], Titan, et al. [23], and Balsmeier and Woeter [28], the demands of labor with high skill is increasing, especially in dealing with the digital revolution. Therefore, from previous studies, we could form several variables with OLS to find out the relationship of the digitalization and the labor market as follows:

$$E_{it} = \alpha_{0,i} + \beta_1 IP_ICT_{it} + \beta_2 X_{it} + \varepsilon_{it} \quad (1)$$

E_{it} is the employment rate in each province and each year. IP_ICT_{it} is representing the digital revolution. Based on BPS, IP_ICT is a proxy for measuring the growth of ICT development, digitalization development, and the potential for ICT development in Indonesia. This proxy is a composite index that combines 11 (eleven) indicators into a standard measure of ICT development. The X_{it} is mean years of schooling (MYS) as explanatory variables. MYS indicates the level of education that has been/is being pursued by someone. The higher number of MYS means the longer/higher of the level of education they have completed. Accordingly, MYS is reflecting the average educational level of Indonesia population and as the human capital of employee.

Meanwhile, Walwei [3] also explained that the digitalization would drive the increases labor productivity. According to Mankiw ([29], p. 213), labor productivity (LP) indicated by output per worker.

$$LP = output/worker = Y/L \quad (2)$$

Assuming that we combine remark of Walwei, Mankiw's explanation (equation 2) and the previous variables from equation (1), then we may form the new formula to knowing how the correlation between labor production and digitalization as follows:

$$LP_{it} = \alpha_{0,i} + \beta_1 IP_ICT_{it} + \beta_2 X_{it} + \varepsilon_{it} \quad (3)$$

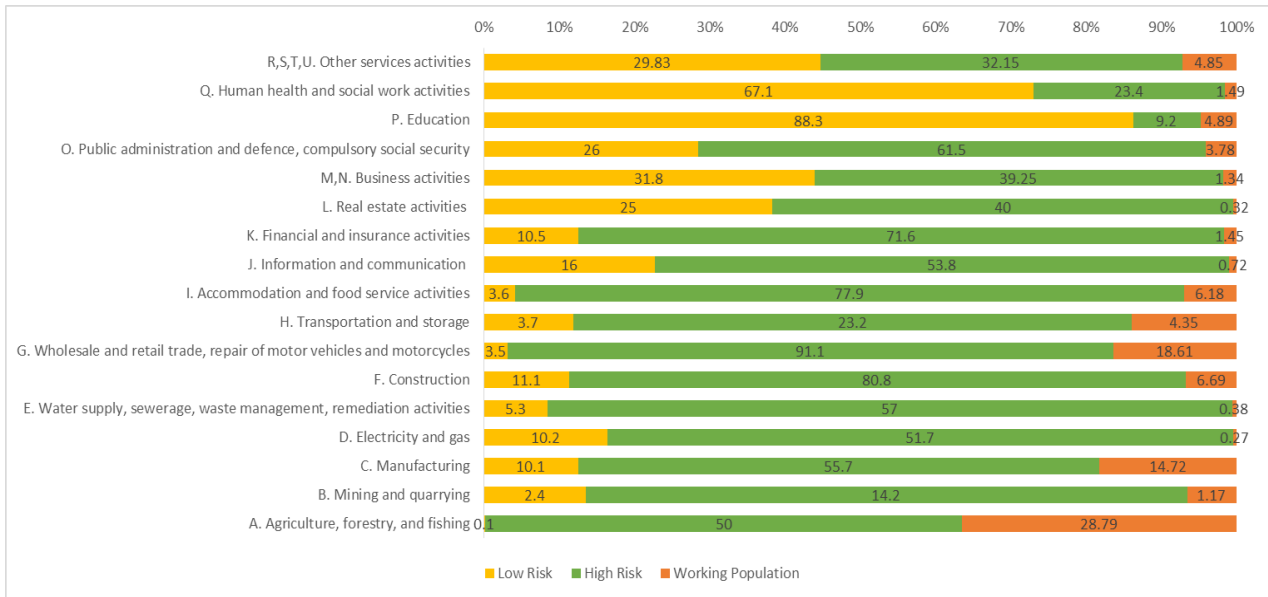


Figure 1 Percentage of Working Population, Low and High Risk¹

Based on the explanations, we formulated two hypotheses 1) there is a negative influence of the digitalization on the employment rate and positive relation between digitalization and labor productivity, 2) the mean years of schooling as a human capital indicator could increase the employment rate and labor productivity.

4. RESULT AND DISCUSSION

4.1. Jobs Shifting in Indonesia

Digitalization could trigger product and process innovations and encourage new products to enter the market. Increased productivity will facilitate lower prices and strengthen the competitiveness of innovators that have an impact on weakening competitor's market position. However, at the same time, increasing productivity with digital technology also led to substitutions for the allocation of labor.

The development of digitalization encouraging the economy based on demand also has implications for the possibility of new forms of employment, e.g. distance work or online and freelancer, they greatly influence how work organized and how the relationship between employers and employees. Another example is low-skilled workers who are quickly replaced by robots, and as a result, the firm needs more skilled workers. This condition shows that work becomes less bound to space

and time and requires high skills and creativity. As reported by pioneer research about future employment from Frey and Osborne [25] estimates that in the next two decades, 47% of jobs in the USA as a developed country run the risk due to automation. Dengler and Matthes [30] also examined the risk of automation in German, and their result is in 2013, approximately 47% of German employees were work in the substitutable occupation. In consequence, it is not new news for developing countries to face the fear of losing their jobs due to the wave of digitalization, as well as in Indonesia.

Labor market condition in Indonesia bearing slow job growth. With a population of over than 265 million people, and in 2018 has 133.94 million people of the total workforce, or have increased by 2.39 million people from 2017. In 2018, 127.07 million people were working while as many as 6.87 million people are unemployed. Compared to a year ago, the working population increased by 2.53 million while unemployment declined by 140 thousand people. This condition indicates an increase in labor supply but is not balanced with the demand for labor and has an impact on the slow pace of job growth.

Three main employment sectors still dominate more than 60% of the structure of the labor market in Indonesia in 2018. Those sectors are Agriculture, Forestry, and Fisheries of 28.79%, Trade of 18.61%, and Processing Industry at 14.72% (see Figure 1). Based on ILO (2016)², 56% of workers in Indonesia at high risk of technology advancement (see Figure 2) and about 1.7 million office clerks are highly vulnerable to automation. According to 17 economic sectors, almost all of them can be replaced with the digitalization and automation at the level of labor

¹ ADB (2016). Retrieved from <https://www.adb.org/sites/default/files/publication/182935/ino-paper-16-2016.pdf>

² ILO (2016). Retrieved from https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---act_emp/documents/publication/wcms_579554.pdf

with low skills and affect the changing of labor market structure.

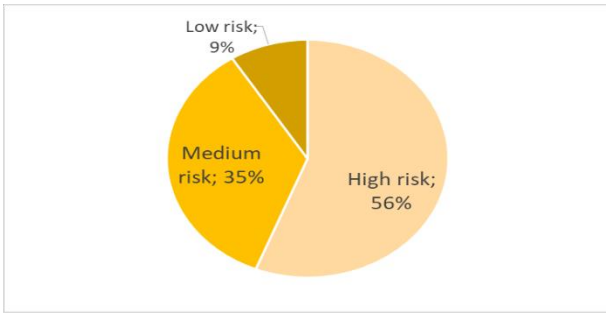


Figure 2 Distribution of employment at risk of automation in Indonesia

The four sectors that are highly threatened by technological advancements include wholesale and retail trade of 91.1%, construction of 80.8%, accommodation and food services of 77.9% and financial and insurance activities of 71.6%. If it is

juxtaposed with the proportion of its workforce, around 33% of the workforce population threatened to replace with machinery and unemployed. Conversely, the four sectors that are low on that are small on the threat of new technologies are education of 88.3%, human health and service work activities of 67.1%, business activities—such as professional and administrative activities—of 31.8% and other activities—such as arts, entertainment and recreation—of 29.83%. The reasons for this condition are

Table 1. Skill levels, education, occupations, and risk of automation in Indonesia

Skill		Education	Risk Level	Occupation
Level	Definition			
I	Simple and routine physical or manual task	Primary	High	Manufacturing industry: machine operators and electricians on automotive and auto parts industry; Industrial sewing machines operators on textiles, clothing and footwear industry; Hotels and restaurants: fast food cooker, receptionist, travel agents; Wholesale and retail trade: cashier, telemarketers; Agriculture labor: gardeners; Construction and Mining workers; Some types of services: welder, postal workers or courier, printing technicians, oil industry operators, housekeeper,
II	Driving vehicles; operating, maintenance and repair of mechanical and electronic equipment; manipulation, ordering and storage of information	Secondary	High	Office clerk (secretaries), typist, driver, dressmaker, sewing machinist, electrician and mechanic, newsstands, book store and library jobs, archivists, accountant, tax form specialists, tax consultancy, electric and electronic assembly line workers, shop salesperson, some aspects of financial services (teller bank), some types of services (translation, guide)
III	Specific knowledge, complex technical and practical	Under-graduate	Middle	Technician, assistant professional, proofread, journalist; Business activities: auditor, real estate agents, marketing and sales jobs, public relation; Some aspects of financial services; Recruitment department; Health service providers; Some types of services: hairdressing, therapist, beauty care
IV	Specific knowledge, complex problem-solving, decision-making and creativity	Post-graduate	High	Education: teachers and scientists; Arts and media: designer, artist, director, choreographer; Professional and ICT: actuarial, manager, engineer, hotelier, systems analysts, app and web developer, digital art; Legal services: lawyer; Health services and social work: doctors, surgeons, nurses, psychologists

the routine tasks are replaceable with machines and non-routine tasks still have metacognitive lags behind of human [11],[30]. So, the jobs which are categorized as non-routine tasks hardly to replace with machines or technology. Furthermore, it can be delineated that 56% of the labor market in Indonesia susceptible by technological advancement and 35% in the middle level, and 9% in the low level (see Figure 2). The high risk of jobs destruction in Indonesia is higher than the estimation of job destruction in the developed countries such as USA and German that reach until 47% due to technology disruption [25],[30].

In addition, Indonesia is one of the largest producers in the automotive and auto parts and textiles, clothing and footwear (TCF) industries in ASEAN. However, both sectors are vulnerable to technological advancements. Nowadays, the leading technology of automotive and auto parts is robotic/automation. This technology becoming more attractive and triggered by spikes in minimum wages cited as the driver to automate. The impact of using robots is increasingly replacing lower-skilled jobs such as assembler, on the other hand, it would be increasing the demand for labor with higher skilled. Such as the result of Dauth et al. [31] that growing industrial robots no effect on total employment, nevertheless adverse effects on manufacturing employment. Additional of one robot leads to two manufacturing jobs working less on average, but it is not happening in the service sector. Likewise, in TFC industry, shifting of leading technology by using Sewbot give the highest risk of displaced workers, especially female workers. Based on ILO (2016), other occupations in Indonesia at high risk include shop salespersons (1.8 million) and tailors (1.1 million). Considering the condition and the level of education in Indonesia or countries with similar characteristic like Indonesia, then occupations with low skills will be replaced easily (see Table 1).

Otherwise eliminating some work, technological advancement drives the demand for a highly skilled workforce. This condition emerges the need for new jobs in the labor market. The future jobs can be divided being two categories top and bottom of the scale. The head of the level is a job with high demand and requires complex skills. While the bottom of the scale is a job with a low requirement (see Table 2). New occupations on top levels that arise due to technological advances conduct the increasing demand for high skill workers, well-educated, and creative. The shifting of the ability of employee is because the vacancy requires workers who can solve the problem that is related to complex issues and create new solutions to make firms survive in the long run. This demanding can also influence the existing wage structure. Additionally, Dammert et al. [33] state that development of technology also helps labor supply met with the labor demand with any requirement.

competence index. This index is a proxy of index growth of citizens' expertise levels in ICT. Based on data of BPS from 2012 to 2015, generally Indonesia at a high and moderate level (see Figure 3). On the other hand, if we observed partially, almost all provinces in Sumatra Island have high and average skill growth rates except South Sumatra, Lampung, Riau Island, and Bangka Belitung. Meanwhile, on the islands of Kalimantan and Sulawesi, only West Kalimantan and West Sulawesi have a low skill index. Similarly, East Java has the lowest competence index on Java, and the other provinces with a low index are NTB, NTT, and Papua. Principally, the readiness of Indonesia to dealing with digitalization era is in moderate level (see Figure 3).The differences that occur in these regions are due to unbalanced economic growth and the concentrated development of Java, Sumatra, and Kalimantan. In more details, the areas that have a high ICT competence index are the economic center region of that island. Another reason for the disparity of this condition is low infrastructure to access information and technology owned by those regions. Therefore, the rest of Indonesia is still struggling to connect. Further, we can recognize those regions that have low levels of digital literacy could not improve their regional economy, particularly they could not create new business opportunities.

Another risk of this lack may affect labor demand in

Table 2. New jobs in the digital economy in Indonesia

New Jobs	
'Top of the scale'	Data analysts, data miners, data architects; Consultant of software and application developers; Specialists in networking, artificial intelligence; Designers and producers of new intelligent machines, robots and 3D printers; Digital marketing and e-commerce specialists; Content creator, web content writer, product designers, SEO and SEM expert, computer and mathematical experts, online editor, influencer, online teacher
'Bottom of the scale'	GoJek/Uber/Grab drivers and services; casual odd-jobbing (repairs, home improvement, pet care, nanny); Data entry, filter workers, mechanical working on the digital platforms, YouTuber

Source. Occupations by author's. The table is constructed by definition of Frey & Osborne [25] and Degryse [26]

Indonesia, especially with Indonesia's bonus demographic. By considering employees who have

digital literacy, i.e. the ability to use the internet by digital media, such as personal computers, smartphones, tablets, and others, will become a fundamental skill required. Afterward, people who have low digital literacy and also have low competitiveness in the labor market. Likewise, the result of Titan et al. [23] research in Romania that there is still a large gap between the needs in the labor market and the digital skills that individuals have so, the labor supply has not yet met with the demand for labor in Romania. This skill-biased technological change boosts the increase of technological unemployment, to prevent it, Titan et al. [24] suggested the reform of the educational system with a purpose to keep up with the change. Hence, this skill is an asset to prepare to enter a shifting jobs landscape driven by innovation in digital technology. Moreover, high digital literacy can encourage people to take advantage in the digital era and encounter hidden inequality that persists in Indonesia.

regression with fixed effect model, the independent variable could explain the employment rate with R-square at 0.877 or 87.7 percent and the labor productivity at 0.989 or 98.9 percent. It can be interpreting that digitalization and education play an essential role in changes in the level of labor and labor productivity. In general, these results are consistent with previous studies which assumed that digitalization and education have a significant influence on the labor market.

Partially, the statistic significant at the level of 5% and a negative coefficient of IP-ICT, which means that a 1% develop in IP-ICT will fall employment rate by 0.59%. This result showed the inverse relationship between digitalization and workforce. This result contradicts what neoclassical economists assume that technological progress will have a positive impact on labor [3-4]. Nevertheless, in line with Keynes' expectation of technological unemployment would happen, as a result of economizing the use of labor. Likewise, the study of Frey and Osborne proved in Indonesia, that the era of digitalization and computerization would harm the labor market, especially several jobs that could be replaced by computers and machines or called as jobs destruction.

On the other hand, the labor productivity results show that IP-ICT has a negative coefficient, and it means improving 1% of ICT-IP will reduce labor productivity

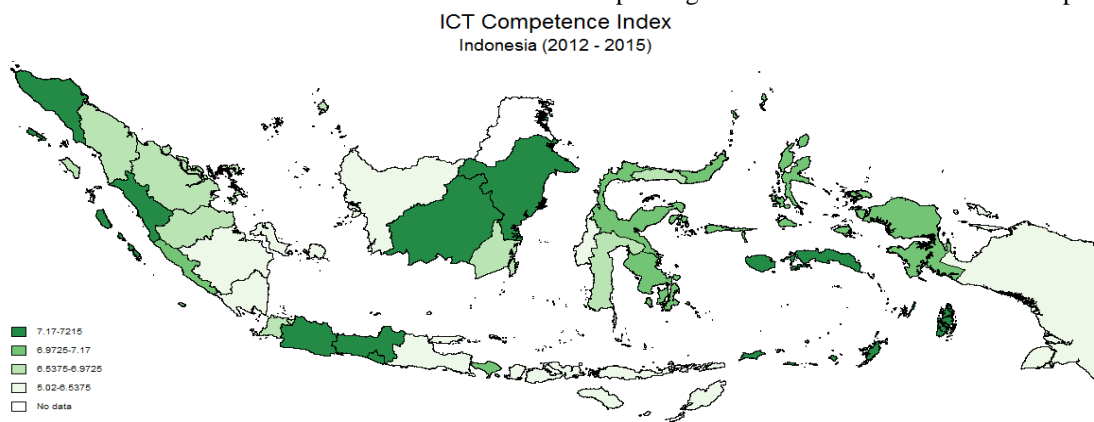


Figure 3 Competence Index in Indonesia 2012-2015³

4.3. Digitalization and the Labor Force in Indonesia

Technological developments in Indonesia are expected to encourage economic sectors and increase the rate of economic growth. The positive economic growth assumed will increase labor productivity. Otherwise, the fear of technological developments in Indonesia also increases because of the negative externalities that might occur, namely eliminating some jobs or jobs destruction and replacing labor with robots. On the results of panel

by 3.62%. It also contradicts the assumed neoclassical that technological progress is accelerating productivity [3-4]. Besides neoclassical, these results are also not in harmony with some previous studies such as Coreynen et al. [18], which states that digitalization makes 40% labor productivity more effective in increasing output. However, there is a possibility that a negative relationship between digitization and labor productivity is caused by a shift in input, which tends to use capital rather than labor. As assumed by Zeira [5] that technology adoption becomes more realistic and results

³ Processed by authors based on BPS data. Retrieved from <https://www.bps.go.id/pressrelease/2018/12/17/1532/indeks->

[pembangunan-teknologi-informasi-dan-komunikasi--ip-tik--indonesia-tahun-2017-sebesar-4-99-pada-skala-0---10.html](https://www.bps.go.id/pressrelease/2018/12/17/1532/indeks-pembangunan-teknologi-informasi-dan-komunikasi--ip-tik--indonesia-tahun-2017-sebesar-4-99-pada-skala-0---10.html)

Table 3. Estimation Result (MYS)

Independent Variable	Dependent Variable: Employment rate						Dependent Variable: Labor Productivity					
	Common Effect Model		Fixed Effect Model		Random Effect Model		Common Effect Model		Fixed Effect Model		Random Effect Model	
	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.
C	101.201	0.000	90.053	0.000	95.222	0.000	-155.283	0.000	-122.464	0.000	-129.267	0.000
IP-ICT	-0.155	0.338	-0.592**	0.001	-0.513**	0.002	32.549***	0.000	-3.618**	0.032	-2.572	0.121
MYS	-0.734***	0.000	0.896*	0.008	0.209	0.414	11.671**	0.012	27.252***	0.000	27.653***	0.000
R-Squared	0.161		0.877		0.048		0.465		0.989		0.305	
Prob (F-stat)	0.000		0.000		0.008		0.000		0.000		0.000	
Note: level significance ***1%, **5%, *10%												

in abandoning the standard assumptions of technical innovation, which reduces all required inputs in

production, and consider instead changes that save labor but use more capital (machines) or other inputs.

Meanwhile, the positive and significant coefficient of mean years of schooling (MYS) which means that 1% rise in MYS will increase employment rate by 0.896 % and 27.25% for labor productivity (Table 3). Based on this result, the mean of schooling as human capital more effective to boost labor productivity and employment rate than digital technology. As assumed

Hence, investment in education may be one way to prevent in the digital era. Otherwise, in general, we can conclude this study that digitalization might be replacing employment and not supporting the performance of the employee, while education can encourage these two things.

5. CONCLUSION

Digitalization as a product of technological developments that can increase economic growth through increased productivity. However, this change creates a fear related to the labor market, especially developing countries and countries do not have an edge in technological innovation. The direct impact of digitalization is the shifting of several jobs due to the demands of the situation, the following effect is the requirement for the quality of the labor demanded, especially with high skills and well educated. Therefore, that developing countries will inevitably be forced to improve their education systems and invest in improving the quality of their societies in an effort to keep up the pace of new demand formed of the labor market.

By employing a panel dataset consisting of 33 provinces in Indonesia from 2012-2017, which was a period ICT in Indonesia have started to develop rapidly and give an impact on economic development. According to the outcome in this study, ICT competence index—as a proxy of digital literacy rate—showed that readiness of Indonesia at a moderate level. Therefore, Indonesia's readiness to face the digitalization era must be improved because the pace of technological change indeed prompts. This suggestion supported with the regression outcome that means years of schooling more influence than digital technology. Further, digitalization and employment rates have the opposite relationship, as well as labor productivity.

In general, we can conclude that the wave of digitalization and automation innovation could decrease the employment rate and their productivity, and could change the labor market structure, otherwise create several new occupations. At this point, it is essential to improve Indonesian educational levels to compensate for technological change. The government is necessary to invest in Indonesia's human capital to build the foundation of a more competitive economy in the future. It is needed to be aware of the common weaknesses of automation, and keep in mind that there may be an ultimate goal of automation, where machines could replace labor entirely. Assuming that Indonesia slowly responds to prevent the impact of digitalization, poverty and unemployment will occur, particularly with the bonus demographic conditions that appear.

Then, the reconsideration curricula of education are urgently needed. Notably, enhanced training curricula for workers so that they will have better soft and hard skills. Further, reforming the competency-based of vocational training and apprenticeship programs to prevent substantial employment losses, especially if it turns out

that the observed reduction is stable. In addition, expanded of the qualification, requirement, and the operation of professional certification institutions across the country will give the workers the new value of their profile.

Regardless, the conclusions of this study are not too deep, due to the limited data about digitalization or the use of technology in production activities that can have a vast influence on the labor market and gap in the data year. First of all, while we connected digitalization with the employment rate, unfortunately, we do not observe it at various skill levels. Moreover 'other factors' that contribute to decreasing the employment rate such as the amount of infrastructure of ICT, use of the robot, wage structure and digital literacy rate should be explored since those variables mostly in general aspect.

There may be reasons to believe today may be tremendously different, but the slightly positive net effect that we have identified in this study is mainly related to the impact of education on the labor market. It could consider as one reason to reduce our pessimistic thoughts about changes that will occur and improve the quality of education and prevent the impact of the loss of some jobs. We acknowledge that it is not possible to empirically identify the exact effects without a structural model.

AUTHORS' CONTRIBUTIONS

F.W. conceptualized and designed the research. F.W. also collected and analyzed the data. I.T. supervised, reviewed, commented, and contributed to the final manuscript. All authors discussed the study. Therefore, all authors have read, approved, and have equally contributed to this work.

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