

A Survey of Students' ICT Competencies for Developing Industry-Based Curriculum: An Empirical Study of Papuan Higher Education Students

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ABSTRACT

In the context of the Fourth Industrial Revolution, the Internet of Things (IoT) has become a hot topic (Industry 4.0). ICT proficiency is crucial in the Internet of Things paradigm. Furthermore, in the 21st-century learning paradigm, digital competency is regarded one of the fundamental talents. This research intends to provide an overview of digital proficiency among Papuan higher education students. This study employs a survey strategy with descriptive statistic analysis. The questionnaire on digital competency measurement was presented to 200 students from the engineering faculty. The finding of this study demonstrates that Papua higher education students have a moderate level of digital competence ($\times 3.1$), Hardware and software mastery, self-competence, digital security, classroom collaboration, and digital development mastery are all included. Furthermore, the findings of this study can be utilized to the next stage of developing a learning curriculum to improve ICT capabilities in order to better prepare students for IoT knowledge and practical skills.

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1. INTRODUCTION

The evolution of the industrial sector has brought about changes, particularly in the manufacturing sector. The transition from the second to third industrial eras saw the production process shift from a reliance on water and steam to a reliance on mass power, which eventually led to the usage of electricity (Lukač, 2015). Known as Industry 4.0 in Germany, the industrial period was transitioned in 2011. The industrial world relies on the Cyber-Physical System (CPS) to enable automation, increase industrial efficiency, and encourage productivity while maintaining safety and transparency. (Boyes et al., 2018). CPS cannot function in isolation and needs a haven to function in the Industry 4.0 age. When it comes to the fulfilment of Industry 4.0, the Internet of Things (IoT) has emerged as a critical cornerstone. Since the introduction of the Internet of Things (IoT) in 1999 (Rose et al., 2015), it has continued to facilitate

the establishment of connections between devices owned by consumers and has infiltrated the trade and industrial sectors (Darmois & Elloumi, 2012). The advancement of the industrial period, along with technical advancements such as the Internet of Things (IoT), has resulted in significant changes in the industrial sector, culminating in the creation of the Industrial Internet of Things (IIoT) (IIoT).

Simply put, the industrial use of IoT has resulted in the creation of a new concept called as the Industrial Internet of Things (IIoT). The Industrial Internet of Things (IIoT) refers to the application of certain technologies in the form of IoT in the industrial sector to achieve specific goals in the industrial world. (Boyes et al., 2018). IIoT is a subset of the Internet of Things (IoT). The link between industrial machine sensors and administrators who use the internet to do local processing. (Leber, 2012) is one of the most important Industrial Internet of Things components. The internet properties in the industrial sector are distinct from those of the internet owned by consumers. When it comes to consumer / social internet services, the difference is how they are treated and how much value is created, as most of the value is created through advertising (Floyer, 2013). The industrial application of IoT needs the mastery of suitable skills during production processes. Because of the IIoT, prospective personnel, including students, are expected to have digital competency that can be utilized in the workplace.

Before entering the manufacturing industry, students must demonstrate a thorough understanding of digital competencies. It is expected that individuals will be better equipped to operate effectively and efficiently due to their digital competence to contribute to economic progress both regionally and globally (Ananiadou & Claro, 2009). Individuals who wish to be mainly applied to the manufacturing industry must possess exceptional skills in order to compete in a tight labour market. Digital competence is inextricably linked to information and communications technology (ICT) deployment because it is required by practically all sectors, from private businesses to government organizations (Colmenero & Gutiérrez, 2015). The importance of education is widely acknowledged as being critical in providing students with appropriate information and practical ability. Furthermore, educational institutions are agents that are required to encourage and facilitate the development of individuals' professional abilities for them to meet the demands of a rapidly increasing industry (Casillas et al., 2017).

In order to provide students with digital competencies, the education industry relies on a 21st-century learning framework, which the government supports. Students must be able to adapt to new forms of information and knowledge on their own in order to succeed in 21st-century learning (Baş et al., 2016). A new paradigm that fosters the development of abilities suited to society's needs, particularly the manufacturing industry, must be provided to students as well (Martix & Hodson, 2014; Yunis et al., 2017). Educators must expose students to information and communications technology (ICT) in the classroom as soon as possible. Students are expected to get more experience with information and communications technology (ICT) and to be able to modify it to be used in a variety of professional settings (Yunis et al., 2017). Recent technological advancements have implemented the Industrial Internet of Things (IIoT) in the industrial sector. Previous studies (van Deursen et al., 2021) have established a taxonomy framework for the Internet of Things. Previous research has also highlighted the relevance of regulating the Internet of Things in manufacturing (Ng & Wakenshaw, 2017; L.A. Prihandoko, 2021; Sezer et al., 2017). In addition, students' ability to use the information and communications technology (ICT) is critical before entering the industrial manufacturing field (Motyl et al., 2017; L.A. Prihandoko, 2021; Sejati et al., 2019; Utami & Latiana, 2018).

Digital competence, on the other hand, is viewed as a necessary attribute that students must grasp in order to be able to meet the demands of the industry (Casillas et al., 2017; Guillén-Gámez et al., 2020). Research on digital competence in Indonesia has been limited to schooling (Atzori, 2010; Betaubun, 2020; Santucci & Lange, 2008), and insufficient studies are examining In the production context, digital competence is a skill that must be mastered. Exploration of students' digital capabilities is necessary to guarantee that the educational curriculum is matched with industrial needs.

During college, students must gain a thorough understanding of digital competencies in order to equip themselves with skills that are by industry standards (Betaubun & Nasrawati, 2020). The transition to a digital society necessitates the acquisition of digital abilities in order to be successful.

Because of the rapid changes in conditions, particularly in the social and manufacturing spheres, students will continue to be left behind (Motyl et al., 2017), especially in the 21st century. As a consequence of this investigation, educational institutions can utilize the findings as a guide in establishing a curriculum that pays attention to students' digital competencies and can help them better meet the needs of the workplace.

Technically speaking, the Internet of Things (IoT) is a network that connects numerous physical items and facilitates the exchange of data both internally and externally (Lorenz et al., 2015). The Internet of Things is also reliant on the "worldwide web" to provide device connectivity through the use of certain communication standard protocols (Rizal et al., 2019). To sum up, the Internet of Things paradigm has three linkages that incorporate aspects of the internet, objects, and semantics (Aisyah & Susanty, 2017), each of which is discussed in detail below. The Internet of Things (IoT) integration with the world of industry happens due to the requirements for the development of online-based technology that is long-lasting. The Internet of Things (IoT) has the potential to ensure the long-term viability of the industry by providing a variety of help in connecting people wherever and whenever they desire.

The use of IIoT necessitates a thorough understanding of information and communications technology (ICT) in the context of industrial processes. In order to keep up with technological improvements, Industry 4.0, which spans everything from big data to system integration to IIoT to cloud computing to augmented reality, necessitates the implementation of ICT. (Atoy Jr et al., 2020). Industry 4.0 brought about a shift in information and communications technology (ICT), which substantially impacted workers' types of occupations and capacities in the industrial sector (Sejati et al., 2019). For this reason, students must learn new skills and talents tailored to global advances, automation, and networking in the industrial sector (Wong, 2013). In order to fulfill the needs of an ever-changing industrial world, students must be able to adapt and be adaptable. ICT (information and communication technology) can assist them in their endeavor. The idea of establishing new types of jobs that are influenced by market needs for products and services is being studied as a result of how industrial 4.0 is being implemented. (Zaslavsky et al., 2013).

A critical aspect in developing students' ICT skills is the development of their digital competencies. In particular, earlier studies conducted outside of Indonesia have discovered a link between digital competencies and motivation in using information and communication technologies (Motyl et al., 2017). In addition, age and gender play an important impact in developing digital talents (Balta & Duran, 2015). Furthermore, digital skills serve as a component of operational capabilities, which are critical in preparing academics for the changes that will occur in the world in the coming years (Guillén-Gámez et al., 2020). On the other hand, the prior study focuses on themes that are only relevant to educators who have not looked into the perspectives of learners.

In comparison to past research in Indonesia, the current study, particularly in terms of the ability of students to demonstrate digital competence, is still in its early stages. Previously published research analyzes digital abilities that focus on digital literacy areas with limited topics, especially the teacher (İlkan et al., 2017). In addition, additional research investigates pre-service teachers' restricted digital competencies, with particular attention paid to features of the native digital level of instruction. Furthermore, according to a small study conducted on employees in telecommunications businesses, there is a performance discrepancy (Esteve-Mon et al., 2020). More specifically, there is no attempt to investigate students' digital competencies associated with the IIoT who live in rural locations. This study aims to provide a fresh view of exploration conducted on students, particularly in distant regions, by providing them with a new perspective on exploration. Gender and differences between ethnic Papuans and non-Papuans will be included in this study, which will widen the area of factors studied. This study's findings would surely differ from those of prior studies conducted in Indonesia, which focused on a narrow subject area only in western Indonesia. The findings of this study are expected to give policymakers new insights that will allow them to take more proactive steps to improve education in eastern Indonesia.

2. METHODS

According to this research's objectives, a quantitative descriptive study, students' level of digital competence in one of Papua's higher education institutions was investigated. Students from engineering faculties participated in this study, with civil, architectural, mechanical, electrical, informatics, and information majors who answered the survey questions. Data was collected through an online questionnaire created with Google Forms, using a primary random sample method. The link to the questionnaire is sent to students via the WhatsApp group, and the questionnaire filling period is completed in two weeks, from March 2-16, 2021. A total of 200 replies have been received due to the online questionnaire that has been made available to the public.

Several prior studies (Guillén-Gámez et al., 2020; Heemskerk et al., 2005) provided the basis for the 22 items which the variables consist of hardware and software mastery, self-competence, digital security, digital cooperation, and digital development mastery that were included in the online questionnaire distributed to respondents. The questionnaire collects student demographic information, such as gender, ethnicity, and the devices that students own, and a self-assessment of students' digital aptitude through a questionnaire. The questionnaire is offered in Indonesian to make it more convenient for respondents to complete the questionnaire in that language. The reliability and validity of the adapted questionnaire, on the other hand, have been checked using the smartpls application, and the results demonstrate that the questionnaire has a good degree of reliability (> 0.7) and validity (> 0.5) (Kaufmann, 2015).

The information gathered is processed through several processes. The information from the Google form was saved in the format.xls. After that, the students' replies were analysed using IBM SPSS 23 software, which displayed the mean and standard deviation of the responses. The findings of the data processing are then interpreted in accordance with the digital competency framework (Guillén-Gámez et al., 2020), which is as follows: x 0.0-1.7 (low competency), x 1.8-3.7 (moderate competency), and x 3.8-5.0 (high competency) (high competency).

3. FINDINGS AND DISCUSSION

Student self-evaluation findings show the results of the digital competencies assessment. Digital competencies are influenced by a variety of factors, one of which is hardware expertise. Hardware mastery is required for the device to be recognized in terms of its features. As a whole, the amount of expertise over hardware is moderate ($x = 3$), with certain exceptions. According to the findings, the ability to master smartphone usage and connect devices to a WIFI network was determined to be the most accessible hardware mastery for respondents ($x = 3.4$). However, the worldwide mastery of digital devices differs significantly from other indices of hardware mastery ($x = 2.3$), indicating that digital devices are more challenging to master globally.

In addition to mastery of hardware, the capacity to master the software is an essential variable in developing digital competencies. According to the respondents, there is a difference in their level of mastery of hardware and software. On average, respondents' degree of mastery of software outpaces their level of knowledge of hardware ($x = 3.3$), indicating that software is more challenging to master. The critical point to note is that the respondents' use of Microsoft Office ($x = 3.9$) is more intelligent compared to other software mastery. Furthermore, the level of capacity to download and upload is at a moderate level ($x = 3.3$), as is the level of ability to browse the internet. Furthermore, on average, there is no statistically significant difference between mastery of using a browser and mastery of handling digital structures ($x = 3$).

Self-competence becomes a critical variable to master when it comes to digital competencies. Specifically, self-competence is related to the capacity to master the internet, cross-platform navigation, and self-troubleshooting, according to this study. The capacity of respondents to master the internet is at a modest level ($x = 3.1$), according to the survey. The level of expertise in cross-platform navigation and self-troubleshooting is also equal ($x = 3.2$) in terms of difficulty.

Understanding data security is a vital competency that must be learned to be successful in other digital competencies. This expertise is deemed vital because seamless connectivity will also offer several dangers to the network. According to the survey results, the level of respondents' digital security awareness is approximately the same as their level of self-competence ($x=3.2$). Respondents' knowledge of data privacy is moderate ($x = 3.4$), according to the survey. Moreover, respondents' knowledge about the security of the device is at a level that is not significantly different from their understanding of data privacy ($x = 3.1$).

Digital cooperation is a variable that is included in the concept of digital skills. Responses indicate that respondents have a modest level of ability to collaborate with others via cloud computing, video chats, and email usage ($x = 3.1$). The ability of respondents to collaborate through social media is at a modest level ($x = 2.9$), according to the survey. When it came to reading papers online, it was discovered that respondents' digital literacy levels were significantly different from their capacity to use cloud and email computing ($x = 1.8$). However, when compared to other competence variables, the respondent's digital collaboration ability variable ($x = 2.7$) was significantly lower than the other variables.

Keeping up with technological developments is essential for developing digital competence. Students must keep up with technological advancements to increase their digital literacy. The ability of respondents to keep up with technological changes is moderate on average ($x = 3.4$). $X = 3.7$ indicates that respondents have an adequate ability to keep up with technological changes. In addition, respondents' mastery and knowledge of new technology are moderate ($x = 3.2$), consistent with previous findings.

After expanding on respondents' digital competency levels based on characteristics, this study broadens the scope of the discussion by integrating additional variables in the form of gender and ethnicity. Regarding the gender variable, males have a more excellent grasp of digital competence than females on average ($x = 3.4$). Furthermore, when it comes to the average distribution of each variable, there is no statistically significant difference in the digital capabilities of men and women, as previously stated. On the other hand, ethnicity data reveal significant differences between Papuans and non-Papuans ethnic groups. The degree of digital skills among Papuan ethnic groups is lower than that of non-Papuans ($x = 2.8$) compared to non-Papuans. In general, the distribution of digital capabilities does not differ significantly depending on ethnicity, except hardware ($x=2.1$), which does differ significantly. This finding is in line with other previous research (Betaubun, 2020)

With the help of self-assessment, the researchers hope to estimate digital competency among higher education students in Papua. According to the survey, the average degree of digital aptitude among respondents is modest. According to the assumption, respondents' degree of digital competency is expected to influence their access to digital equipment and internet access facilities. Furthermore, characteristics of motivation contribute to the mastery of information and communication technologies (Motyl et al., 2017). It is important to remember that human resources also play an important role in the Industrial Revolution. Furthermore, the industry needs significant assistance from various industries, particularly the digital sector.

Furthermore, ICT competence combined with the knowledge of IoT plays a role in managing large amounts of data, which will then be evaluated to draw conclusions based on the data that has been acquired (Rose et al., 2015). Furthermore, the administrator's function continues to be critical. Human personnel is still required to override maintenance or troubleshooting activities when the automation element is in place. In order to be adaptive to the requirements of the industry, students are required to have the necessary ICT competency. In addition, IoT and network systems are at the heart of Industry 4.0 (Sejati et al., 2019), which is growing in popularity, with applications spanning a wide range of industries, from transportation to health (Ng & Wakenshaw, 2017).

Other findings from this study are likewise related to the previous study, which found that gender impacts the mastery of digital competencies, as previously reported by the researchers. Gender characteristics have an impact on digital competencies, according to the findings of this study, which are consistent with the findings of other prior studies (Balta & Duran, 2015). Following the findings of previous studies (van Deursen et al., 2021), ethnicity, on the other hand, has been shown to contribute

to the mastery of digital abilities as well. Gender and ethnicity should be taken into consideration by educators when establishing learning methodologies to prepare students for entering the ever-changing world of industry.

The expansion of the industrial world through the IoT has altered the old industrial pattern, which is heavily reliant on labour-intensive processes that require decent ICT competence. It has been demonstrated that the implementation of IoT technology is not limited to manufacturing automation but can also provide real-time information to system users (Motyl et al., 2017). It is critical to consider curriculum development by incorporating the framework of IoT as this framework is essential for enabling the connectivity of numerous objects through software, which is responsible for obtaining data, monitoring, analyzing, and automatically reacting to specific patterns. On the other hand, the IoT framework refers to a number of components, which include the following: the industry, connectivity, and use; devices, which include the location, characteristics, and technology employed; and services. Users are a critical component of the IoT, which underlines the importance of human resources in the process. In order to play a part in the IoT, users must have excellent ICT competency.

4. CONCLUSION

According to the findings of this survey, students' self-assessment of their ICT competence at one of the tertiary institutions is at a moderate level of proficiency. This study has limitations by employing a small proportion of Papua students. In addition, the exploration is limited to the ICT competence topic. However, the finding of these studies can be valuable information to develop further policies. Further policies should be developed in response to these findings in order to be able to improve the ICT competence of students. This policy is prepared in order to prepare them for a career in the industrial world, which is continuing to alter as a result of the IoT. Additionally, this study's findings imply that various gender and ethnic groups require greater attention in order to increase digital competency. In the form of matriculation, action through policy is required to correct the existing disparities. An increase in digital competence is predicted to create opportunities for students to meet the needs of professional competencies in the industrial sector due to increased digital competence. It is suggested that the researcher interested in this topic could expand the research by taking wider respondents of higher education students in Indonesia.

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