Digital Maturity in Vocational Secondary Schools (SMK)

[1]Edhy Sri Yarmanto, [2]Agus Setiawan*, [3]Iwan Kustiawan

Universitas Pendidikan Indonesia, Indonesia

Email: [1] edhysriy@gmail.com, [2]* agus_setiawan@upi.edu, [3] iwan_kustiawan@upi.edu

* Correspondence author

ARTICLE INFO	ABSTRACT
	Digital transformation has taken place in various sectors of life, and has also penetrated into Vocational Secondary Schools (SMK). Research on digital maturity in vocational schools is still rare. The purpose of this study is to develop a digital maturity model that includes the dimensions and the level of digital maturity, digital maturity measurement instruments, and to measure digital maturity in vocational schools. The instrument developed has met the validity and reliability test and can be used for quantitative research on digital maturity measurement. The dimensions of digital maturity include: management and organization, people and culture, products and services, technology, and organizational operations. Meanwhile, the maturity level consists of 5 levels: not ready, initial readiness, intermediate readiness, mature readiness, and already implemented. The measurement results showed that the vocational school that was the subject of the study was in mature readiness. This study concludes that digital transformation in vocational schools is a necessity. The resulting assessment models and instruments can be used to measure digital maturity in vocational schools. This study was conducted at a vocational school, which opened up space for future study. The form of research can deepen the dimension of digital maturity, or research for high schools, both public or private high schools.

Introduction

Globalization has had a profound impact on all organizations and businesses around the world. The development of digital technology, with its various applications, has been widely used in various sectors of life. The development of public organizations and private organizations was greatly influenced by the importance of the role of digital transformation (Hai et al., 2021). The world economy was greatly affected by digital transformation, especially after the Corona 19 pandemic.

Organizations were utilizing digital technology as a response to the emergency conditions of the Covid-19 pandemic. As a result of the Covid-19 pandemic, the use of the internet, electronic services, and digital devices has increased significantly. A new perspective has emerged that companies/organizations need to integrate digital solutions and the provision of digital services and goods in virtual spaces (Vuţă et al., 2022). Public organizations and private organizations were greatly influenced by the development of emerging digital technologies. (Borda et al., 2022; Hai et al., 2021; Priyono et al., 2020)

The world of education has also utilized digital technology during the pandemic. The shift from the face-to-face teaching process to a remote teaching system or a blended teaching system due to the Covid-19 pandemic crisis situation occurred suddenly and unplanned (Iglesias-Pradas et al., 2021). The idea that the importance of the scope of the effects of digital transformation on educational organizations was not limited to the scope of the classroom, but the impact of digital transformation in educational organizations has extended to various areas of schools such as: equipment and technology, strategy and leadership, organization, employees, and culture (Rauseo et al., 2023). The adoption and integration of digital technologies is essential, not only for communication, administration and management, but also a meaningful asset to support learning and teaching (Ifenthaler & Egloffstein, 2020).

The digital transformation process has provided reasons for every organization to be able to carry out digital transformation effectively, resulting in the development of a digital maturity model. (Awdziej et al., 2023) said that the transition to remote and hybrid learning and teaching was accelerated by the Covid-19 pandemic, and also highlighted the importance of digital maturity for both staff and students. Research on digital maturity in vocational schools has so far focused on the use of information and communication technology, has not covered the organization of vocational schools as a whole, and has not been related to industry.

Problem Formulation

The digital transformation that has occurred in the world of work has had an impact on the world of vocational education (Rauseo et al., 2023). Vocational schools as providers of labor in the industrial world are required to always be adaptive to the demands of the world of work. Vocational schools are required to equip students with special skills that can be applied in the world of work. The link and match program is an effort to relate the relationship between education graduates to suits the demands and needs of the business world and the industrial world (DUDI) in terms of quantity, quality, variety, qualifications and time. The competency needed by the world of work in

the 21st century and the era of the industrial revolution 4.0 is the competence in the use of digital technology. However, the maturity of digital technology for teachers and students of vocational secondary schools is still low (Astuti et al., 2022).

The labor market shows the need for 21st-century skilled workers to be able to think critically, work with digital technology, be able to adapt, adopt technology, have communication skills, cooperative skills, analytical and decision-making skills, be independent, creative, and have curiosity (Kovalchuk et al., 2023; Nurjanah, 2019). (Rauseo et al., 2023) said the impact of the digital transformation process is not limited to classroom activities, but extends to various areas of the school as a whole, such as factors: equipment and technology, strategy and leadership, organization, employees, and culture. Based on the overall scope of the school, they conducted an assessment of vocational schools in Switzerland. Therefore, vocational schools need to carry out a digital transformation process according to the demands of digitalization needs in the world of work. It means that digital transformation in the world of vocational education is not only limited to the classroom, but transformation in the entire scope of schools. Digitalization in vocational schools that has been carried out so far includes online learning systems, online tuition payment systems and others. The Covid 19 pandemic has had a major impact on the digitalization process in vocational schools and the world of education in general.

Research on digital maturity in the world of education, including vocational education, is still lacking. Research on digital maturity in higher education was conducted by (Alenezi, 2021; Cardoso & Su, 2022; Fernández et al., 2023). Research on digital maturity was mostly carried out to identify the elements of the use of Information and Communication Technology (Begicevic Redjep et al., 2021). (Rujira et al., 2020) has synthesized the digital transformation framework in vocational schools and established five pillars of digital transformation, consisting of Policy, Process, People, Stakeholders, and Infrastructure.

This study is an effort to fill the research gap on digital maturity in vocational secondary schools, which is a secondary level education that aims to prepare their graduates to become medium-skilled personnel who have the ability in certain fields to be able to work immediately and meet job needs. The important role of vocational education is to transform new competencies (Astuti et al., 2022). Low level of relevance and low quality of graduates are the challenges of vocational education today (Marliyah et al., 2018)

The purpose of this study is to develop a model and measure the digital maturity of vocational schools. The digital maturity model of vocational schools that is created must match or approach

digital maturity in the industry. The SMK digital maturity model is a novelty of this study, namely digital maturity seen from the scope of institutions/organizations that have not been widely developed or made so far. The synthesis of high school digital maturity and industrial digital maturity needs to be carried out to produce vocational school digital maturity that meets industry needs. The study addresses the following research questions:

RQ1: What are the relevant dimensions to assess the digital maturity of vocational schools?

RQ2: What is the instrument for assessing the digital maturity of vocational schools?

RQ3: How is the validity and reliability of the digital maturity instrument developed?

RQ4: How is the digital maturity of vocational schools?

Digital Transformation

Conceptually, (Vial, 2019) defined digital transformation as a process that aims to improve entities by triggering real changes through a combination of information technology, computing, communication, and connectivity. What is meant by digital transformation is the use of new technology, where services or products can be transmitted online or offline. There are also those who call it a way to build a new business by using new technology to meet customer needs (Mergel et al., 2019). Meanwhile (Nadkarni & Prügl, 2021) have provided a definition of digital transformation as a process that guides new technologies with organizational transformation in the form of capabilities, structures, processes, and components of the business model. Digital transformation is the development of new digital business models to create and adjust more value for companies (Verhoef et al., 2021). The digital transformation process will involve three stages consisting of digitization, digitalization, and digital transformation (Verhoef et al., 2021). The initial stage, namely digitization, is the act of converting analog information into digital information in digit format (Bit/binary digits). The second stage is the digitalization process, which is the application of digital technology with the aim of optimizing existing business processes. Process optimization can be in the form of efficiency between processes and creating added value for customers. The last stage is digital transformation which describes the development of the business model after the change occurs throughout the company.

Digital Maturity Model

Lately, there has been more and more discussion about digital maturity. The status quo of organizational digitalization is assessed to refer to the digital maturity model, and further determine measures to increase its digital maturity level (Thordsen & Bick, 2023). Initially, the maturity model started from the field of information systems. Software development requires a quality management

framework (Castelo-Branco et al., 2022; Wendler, 2012). This digital maturity model is synonymous with the digital readiness model, which aims to describe the starting point and initiation of the development process (Schumacher et al., 2016). A maturity model is a tool for a business or software development team to measure how a business or project is progressing and how they can make continuous improvements.

Method

The subject of this study is the phenomenon of applying new technology within the scope of Vocational Secondary Schools (SMK). There are still many who do not understand the stages of the digital transformation process, or how to start the application of digital technology. Research on digital transformation in vocational schools is still very little, so there is a desire to know what dimensions need to be taken into account in digital maturity, what is the measuring tool and how to measure digital maturity in vocational schools. The next step is to develop a digital maturity model, develop a digital maturity measurement and assessment tool, followed by conducting a digital maturity assessment at vocational schools. This study utilizes a quantitative data approach.

This research instrument is developed with the following steps:

Determination of the purpose of the preparation of the instrument

The research instrument is made to be a tool used to obtain digital maturity data at vocational schools.

The study of literature relevant to the research topic.

Theories relevant to the research topic are studied, so that constructions, indicators and variables can be made. In this study, the theories studied are research on existing digital maturity models, both digital maturity models in the education sector and in the industrial sector. Digital maturity in the field of education takes *the* Maturity Model for Educational Qrganitation (MMEO) (Ifenthaler & Egloffstein, 2020) and *the* Model Framework for Digital Mature Schools (FDMS) (Balaban et al., 2018) as references. Meanwhile, the digital maturity of the industry includes the IMPULS model (Axmann & Harmoko, 2020) and INDI 4.0 (Ministry of Industry of the Republic of Indonesia, 2018).

Compose instrument dimensions and indicators

The dimensions and indicators of the instrument are the result of a synthesis of the digital maturity dimension theories and the maturity level of vocational schools theories.

Preparation of instrument items

The next step is to arrange the instrument items according to the dimensions and indicators formed. The preparation of these instrument items is also equipped with consideration of how to assess/score.

Empirical trial with validity test and reliability test

Results and Discussion

Digital Maturity Dimensions

In this study, the digital maturity of vocational schools is based on a study of four existing models, namely two models from industry and two models from the educational environment. The model of digital maturity in the educational environment comes from Begičević Ređep's research on the analysis of the digital maturity of pre-university schools in Croatia, and the research of Ifenthaler & Egloffstein on the digital maturity model of educational organizations. Based on the four models reviewed, there are models that assess digital maturity in six dimensions, namely *the* MMEO model and the IMPULS model, while the FDMS model and the INDI 4.0 model group digital maturity in 5 dimensions. The synthesis of the digital maturity dimensions of SMK is shown in table 1.

Table 1   Synthesis of Vocational School Digital Maturity Dimension

Dimension	*MMEO*	*FDMS*	IMPULS	INDI 4.0
1) Management and Organization	Organization Strategy and Leadership	Planning, Management and Leadership	Strategy and Organization	Management and Organization
2) People, Training, & Culture	Employee Culture	Digital competency development ICT Culture	Employee	Society and culture
3) Products and Services	-	-	Smart Products Data-Driven Services	Products and Services
4) Technology, Infrastructure	Equipment and Technology	ICT Infrastructure	Smart Factory	Technology
5) Digital Operations	Digital Learning & Teaching	ICT in Learning & Teaching	Intelligent Operation	Factory Operations

From the results of the synthesis of the SMK digital maturity model, it was concluded that digital maturity involves the assessment of the following dimensions:

 a) Management and organization of the digital transformation process

 b) People, Training, Culture according to the needs of digitalization

 c) Digital-based products and services offered

 d) Technology, Infrastructure used by digitalization

 e) Digital-based Organizational Operations.

a) Management and Organization

In digital maturity, management has the function of planning, organizing, implementing, and controlling digital transformation. Organizations function as a tool that handles the digital transformation process to achieve predetermined goals, as well as in deciding what strategy to choose in digital transformation. Included in this dimension are the budget for digital transformation and the importance of leadership.

b) People and Culture

The dimension of people and culture plays a very important role in the digital transformation process of an organization. The readiness of human resources and the habits, values, and others that are built into organizational culture greatly determine the success of the application of digital technology.

c) Products and Services

The product and service dimension aims to find out and measure the products and services offered to customers, whether they are in accordance with customer needs and adjust to technological developments.

d) Technology

The technology dimension aims to find out and measure the technology used by the organization. Digital technology is an emergent/developing technology such as: mobile phones, big data, cloud computing, IoT, AI so as to improve data processing, communication, connectivity, and computing capabilities.

e). Organizational Operations

The operational dimension of an organization measures the use of digital technology in an organization's operational activities. Organizational operational activities are the operation of functions in the organization, including: marketing and sales, administration, finance, production,

maintenance, logistics and supply chain, and others.

The dimensions and subdimensions/indicators of digital maturity measurement of vocational schools consist of five dimensions as seen in table 2.

Table 2. Dimensions and Subdimensions of Digital Maturity Measurement of Vocational Schools

Nr	Dimension	Subdimensions/Indicators
1	Management and Organization	1. Digital transformation strategy 2. Investment 3. Innovation Management, leadership
2	People and Culture	1. Procurement and competency development 2. Cross-section collaboration 3. Organizational culture 4. Openness and readiness for change
3	Technology	1. Network infrastructure 2. ICT equipment in schools and programm tools for teachers 3. Cyber security system
4	School Operations	1. Standard operation procedure 2. Digital platform , e-learning 3. Work with digital equipment in the classroom 4. Digital document center and information sharing 5. Digital care system
5	School Products and Services	1. Graduate notes 2. On-demand education and training services 3. Collaborate with partners

Digital Maturity Level

The MMEO model, FDMS model, and INDI 4.0 model have five levels of digital maturity, while the IMPULS model has six levels of maturity. This study groups the level of digital maturity following INDI4.0. Digital maturity is divided into five *levels*, namely: Level 1 – Not Ready; Level 2 – Initial Readiness (Have a Plan); Level 3 – Intermediate Readiness (Start Digital Transformation); Level 4 Mature Readiness (Has Digital Transformation); and Level 5 – Already Implemented.

The calculation of digital maturity is carried out by:

1. Each dimension is calculated based on the sum of the values of the question in that dimension.

2. The digital maturity level of an organization, company or industry is the average of the result of multiplying the value of each dimension with each predetermined weight, namely:

   - Management and organization: 17.5%

   - People and culture   : 30.0%

-   Technology   : 17.5%
-   School operations   : 17.5%
-   School product and services   : 17.5%

The dimensions of people and culture are given the largest weight, which is 30.0%. The reason is because the success of digital transformation will be greatly influenced by the people and culture in the organization

From the results of the assessment of the organization's digital maturity, the organization's digital maturity level is grouped into 5 (five) as seen in figure 1.
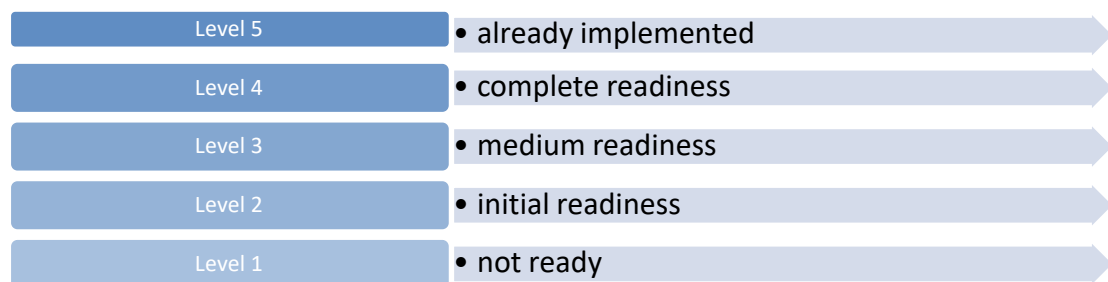

Fig 1: Digital Maturity Level

The next stage is the development of vocational school research instruments. Each question is graded using the Likert Scale (1 – 5). The digital maturity instrument is then processed by experts to validate the content to get input and improvements. The instrument was then tested for validity and reliability, by conducting trials on populations similar to the study subjects. The SMK digital maturity instrument was tested at one of the vocational schools in another place. The results of the validity and reliability test are shown in table 3.

Table 3. Reliability Statistics

Cronbach's Alpha	N of Items
.935	29

The results of the validity and reliability test in table 3 show that the instrument item has a Pearson correlation value greater than 0.361 and a Cronbach (Alpha) value of 0.935. The questions covered in the SMK digital maturity instrument are proven to be valid and reliable.

Profile of Research Subjects

The descriptive statistics of SMK respondents are shown in Table 4, which shows the characteristics of respondents based on age, gender, last education and job title/status.

Table 4. Respondents by Age, Gender, Education, Employee Status

	Number (Person)	Percentage (%)
Age (Years)		
- 21 – 30	3	10,3
- 31 – 40	8	27,6
- 41 – 40	10	34,5
- 51 - 60	8	27,6
Sex		
- Man	16	55,2
- Woman	13	44,8
Education		
1. Junior High School	-	-
2. Senior High Sch	1	3,5
3. Diploma & Bachelor	23	79,3
4. Post Graduate	5	17,2
Employee Status		
- Teacher	28	96,5
- Employee	1	3,5

Table 5 shows the result of the calculation of the digital maturity of SMK that is the subject of the study

Table 5 Digital Maturity Levels of Vocational Schools Research Subjects

Dimension	Average Score	Digital Maturity Level
Management and Organization	4,17	complete readiness, and some aspects have carried out digital transformation
People and Culture	4,24	complete readiness, and some aspects have carried out digital transformation
Products and Services	4,13	complete readiness, and some aspects have carried out digital transformation
Digital Technology	4	complete readiness, and some aspects have carried out digital transformation
Organizational Operations	4,19	complete readiness, and some aspects have carried out digital transformation

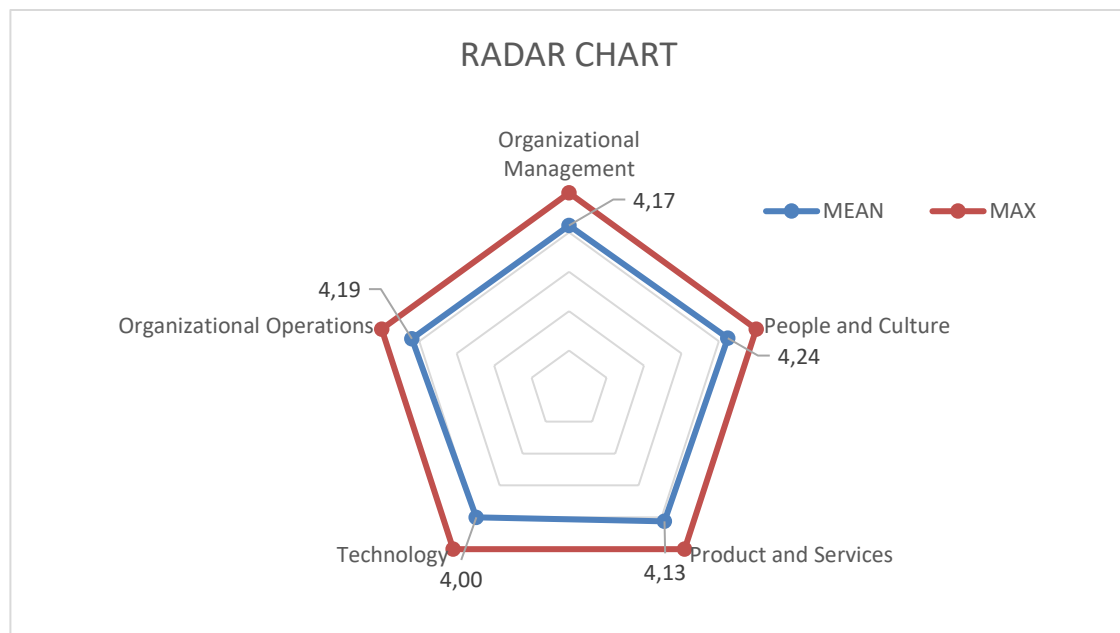The digital maturity radar chart of the vocational school is depicted in figure 2.

Figure 2   Radar Chart of SMK Digital Maturity

The value of the digital maturity of the SMK of the research subject is = (0.175 x 4.17) + (0.3 x 4.24) + (0.175 x 4.13) + (0.175 x 4) + (0.175 x 4.19) = 4.16. The result of the calculation of digital maturity is 4.16. This shows that the organization is at a mature level of readiness for digital transformation. The digital maturity dimension is a discussion to answer research question 1 (RQ1): what dimensions are used to measure the digital maturity of vocational schools? The digital maturity dimension of vocational schools consists of five dimensions, namely: management and organization, people and culture, products and services, technology, and organizational operations. The digital maturity dimension of vocational schools is a synthesis of the existing school digital maturity model (MMEO model and FDMS model) and the industrial digital maturity model (IMPULS and INDI 4.0 model).

The dimensions present in MMEO and FDMS address the dimensions of strategy and organization, people and culture, technology/infrastructure, and teaching and learning operations, and do not address dimensions related to educational products and services. The dimensions of products and services are taken from the IMPULS and INDI 4.0 models. The dimensions of these products and services are not found in the reviewed school digital maturity model (MMOE, and FDMS). The dimension of products and services is added to the digital maturity of vocational schools by researchers based on the idea that vocational schools produce outputs in the form of graduates who are ready to work. Schools are also required to provide services to the community. The

dimensions of educational products and services are important to assess, based on the idea that vocational schools must be close to and in accordance with the needs of the industry. Customers and stakeholders need to be included as one of the dimensions of SMK's digital maturity. According to Alenezi, (2021) school customers include existing students and potential students, alumni, the educational community, the government, and various partner institutions. Therefore, the dimension of products and services is important to measure the digital maturity of vocational schools.

The research (Barry et al., 2022) analyzed 30 digital transformation models from various sectors (health, industry, and education). The results of a systematic literature review of several models of maturity and digital transformation resulted in 9 (nine) main dimensions, namely the dimensions of structural, informational, environmental, security, quality, financial, cultural, innovation, and participatory. The research on the number of dimensions of digital maturity models is a study conducted by (Barry et al., 2022) which stated that the number of dimensions has a variation of four to nine dimensions while research by (Schumacher et al., 2016) has stated that the dimensions of maturity usually amount to 4 – 16 dimensions. According to these studies, the result of the development of the digital maturity dimension of vocational schools is suitable for use.

The digital maturity instrument developed is the answer to question 2 (RQ2): How is the instrument for assessing the digital maturity of vocational schools? The digital maturity dimension is the identification of what scopes/areas play a role in the digital maturity of vocational schools. Each dimension is supported by an instrument that has a function to assess the level of digital maturity of vocational schools. The tool used for research data collection is in the form of a questionnaire, which is equipped with a Likert scale of 1 (strongly disagree) – 5 (strongly agree).

Research question 3 (RQ3):

In the trial of the SMK digital maturity instrument, the amount of data is N = 30. then r table = 0.3610 is obtained. Based on the results of the Pearson correlation value calculation, all SMK digital maturity questions had an r calculation > 0.3610, which means all the qustions are valid. In the reliability test, it was obtained that the Cronbach Alpha value of 0.935 was greater than 0.7, so it can be concluded that the SMK digital maturity instrument is reliable.

The digital maturity value of SMK that is the subject of the study is 4.16, and is at a mature readiness level for digital transformation. The average value of each dimension is also above 4.

The success of digital transformation and digital maturity of this SMK Surakarta is supported by research by (Muktiarni et al., 2021) which stated that vocational teachers are more inclined to platforms that are free, easy to use, and attractive and require little effort and preparation to

operate. They also need flexibility and variety to use digital platforms to adjust lessons to their abilities, and the needs of students. The results of the digital transformation of vocational education in vocational high schools in China explain that the digital economy is driving change in vocational education. Digital transformation is in accordance with the concept of integration between industry and education. Furthermore, considering that vocational school teachers have a strong desire to embrace digital transformation, it is very important to improve their digital literacy.

Improving digital literacy can be done by: first, secondary vocational school institutions carry out coordinated planning and improving digital development mechanisms; second, strengthening the relationship between institutions and companies, the application of the concept of industrial integration and education; third, deepening the concept of digital transformation, strengthening the digital training of teachers (Jing & Xuan, 2024). Vocational schools correlate positively and clearly with graduates and it is beneficial to know the labor market. Therefore, education stakeholders, policymakers, and curriculum developers need to adopt labor market information moderation (Kaula Stephen, 2023). The researcher (Ristic, 2018) proposes a model that can provide a basis for self-evaluation of e-school maturity and planning for improvement, namely: digital culture in schools; security and technical requirements and support; digital skills of teachers, students, and employees in professional services; digital learning environment; inclusion of digital technology into the curriculum, as well as effective implementation of digital technology in school organizations. This model is not only an instrument for evaluation, but also a model for effective management and decision-making.

By conducting a digital maturity analysis, vocational schools can find out the real condition, know the dimensions or subdimensions that need to be improved towards a better level of maturity. One of the tools to carry out the improvement process is to apply 5W2H (Vásquez et al., 2024). With the 5W2H method, questions related to efforts to improve digital maturity include: what, where, who, why, when, how, how much. This tool also has benefits for evaluating and planning steps to deal with obstacles faced by vocational schools, such as budget limitations, resistance to change, or limitations in digital literacy among staff.

Conclusion

Digital transformation in Vocational High Schools (SMK) is a necessity, therefore the existence of an instrument to assess digital maturity is very important to find out the initial conditions and make a better digital transformation plan. Relevant dimensions for assessing digital maturity in

vocational schools consist of management and organization, people and culture, products and services, technology, and company operations. The assessment of digital maturity level consists of five levels, including: not ready, initial readiness, intermediate readiness, mature readiness, and already implemented. The digital maturity instrument developed is valid and reliable and can be used to assess digital maturity. The digital maturity of vocational schools is at a mature readiness level.

The results of the study findings provide several implications both theoretical and practical implications. Theoretical implications: The findings of the SMK digital maturity study provide an overview that the readiness of organizations in carrying out digital transformation can be seen, measured and monitored from their digital maturity level. The measurement results can show the level of digital maturity ranging from not ready to have carried out digital transformation. The dimensions measured include the dimensions of organizational management, people and culture, products and services, technology, and organizational operations. In the vocational school environment as a system, it is also important to assess the dimensions of its products and services. Practical implications: The results of the SMK digital maturity study provide practical implications to school leaders, and practitioners that they can utilize or conduct digital maturity assessments to assess existing real conditions, evaluate the shortcomings or advantages of each dimension and its indicators. The next step is to make a plan to increase digital maturity based on its dimensions or indicators.

The conclusion of the SMK digital maturity study opens up an understanding of digital transformation, digital maturity that takes place in the research subject. Based on the conclusions of the study results, the researcher gave several suggestions:

1. Vocational schools that have reached mature digital maturity can utilize the digital maturity model to maintain and improve their digital maturity.

2. The digital maturity model developed can be used to assess vocational schools and senior high schools, both public and private so that they can find out the condition of their digital maturity and then plan improvements.

3. This study is still limited in terms of the level of generalization and the level of depth. Therefore, it opens up opportunities for future research for digital maturity with a wider scope of data. It also has a broader and deeper scope of the dimensions or subdimensions of the digital maturity model by involving SMK stakeholders such as students, alumni and industry partners.

Email   : joves@mpv.uad.ac.id
Website : http://journal2.uad.ac.id/index.php/joves

References

Alenezi, M. (2021). Deep dive into digital transformation in higher education institutions. Education Sciences, 11(12). https://doi.org/10.3390/educsci11120770

Astuti, M., Arifin, Z., Nurtanto, M., Mutohhari, F., & Warju, W. (2022). The maturity levels of the digital technology competence in vocational education. International Journal of Evaluation and Research in Education, 11(2), 596–603. https://doi.org/10.11591/ijere.v11i2.22258

Awdziej, M., Jaciow, M., Lipowski, M., Tkaczyk, J., & Wolny, R. (2023). Students Digital Maturity and Its Implications for Sustainable Behavior. Sustainability (Switzerland), 15(9). https://doi.org/10.3390/su15097269

Axmann, B., & Harmoko, H. (2020). Industry 4 . 0 Readiness Assessment : Comparison of Tools and Introduction of New Tool for SME Industry 4 . 0 Readiness Assessment : Comparison of Tools and Introduction of New Tool for SME. June 2021. https://doi.org/10.31803/tg-20200523195016

Balaban, I., Redjep, N. B., & Čalopa, M. K. (2018). The analysis of digital maturity of schools in Croatia. International Journal of Emerging Technologies in Learning, 13(6), 4–15. https://doi.org/10.3991/ijet.v13i06.7844

Barry, A. S., Assoul, S., & Souissi, N. (2022). Benchmarking of digital maturity models according to the dimension component. 2022 2nd International Conference on Innovative Research in Applied Science, Engineering and Technology, IRASET 2022, March. https://doi.org/10.1109/IRASET52964.2022.9737781

Begicevic Redjep, N., Balaban, I., & Zugec, B. (2021). Assessing digital maturity of schools: framework and instrument. Technology, Pedagogy and Education, 30(5), 643–658. https://doi.org/10.1080/1475939X.2021.1944291

Borda, M., Grishchenko, N., & Kowalczyk-Rólczyńska, P. (2022). Impact of Digital Inequality on the COVID-19 Pandemic: Evidence from European Union Countries. Sustainability (Switzerland), 14(5). https://doi.org/10.3390/su14052850

Cardoso, E., & Su, X. (2022). Designing a Business Intelligence and Analytics Maturity Model for Higher Education: A Design Science Approach. Applied Sciences (Switzerland), 12(9). https://doi.org/10.3390/app12094625

Castelo-Branco, I., Oliveira, T., Simões-Coelho, P., Portugal, J., & Filipe, I. (2022). Measuring the fourth industrial revolution through the Industry 4.0 lens: The relevance of resources, capabilities and the value chain. Computers in Industry, 138, 103639.

https://doi.org/10.1016/j.compind.2022.103639

Fernández, A., Gómez, B., Binjaku, K., & Meçe, E. K. (2023). Digital transformation initiatives in higher education institutions: A multivocal literature review. In Education and Information Technologies (Vol. 28, Issue 10). Springer US. https://doi.org/10.1007/s10639-022-11544-0

Hai, T. N., Van, Q. N., & Tuyet, M. N. T. (2021). Digital transformation: Opportunities and challenges for leaders in the emerging countries in response to covid-19 pandemic. Emerging Science Journal, 5(Special Issue), 21–36. https://doi.org/10.28991/esj-2021-SPER-03

Ifenthaler, D., & Egloffstein, M. (2020). Development and Implementation of a Maturity Model of Digital Transformation. TechTrends, 64(2), 302–309. https://doi.org/10.1007/s11528-019-00457-4

Iglesias-Pradas, S., Hernández-García, Á., Chaparro-Peláez, J., & Prieto, J. L. (2021). Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. Computers in Human Behavior, 119(October 2020). https://doi.org/10.1016/j.chb.2021.106713

Jing, Z., & Xuan, J. (2024). Secondary Vocational School Dilemmas and Strategies for Digital Transformation of Teaching and Learning in Professional Courses. Advances in Vocational and Technical Education, 6(3), 206–218. https://doi.org/10.23977/avte.2024.060330

Kaula Stephen. (2023). Technical and Vocational Education and Training for Producing Graduates with Necessary Skills on Demand of Labour Market: The Moderating Role of Labour Market Information. Journal of General Education and Humanities, 2(1), 35–44. https://doi.org/10.58421/gehu.v2i1.55

Kementrian Perindustrian RI. (2018). Indonesia Industry 4.0 Readiness Index. Kementrian Perindustrian RI, 1–23.

Kovalchuk, V. I., Maslich, S. V., & Movchan, L. H. (2023). Digitalization of vocational education under crisis conditions. Educational Technology Quarterly, 2023(1), 1–17. https://doi.org/10.55056/etq.49

Marliyah, L., Sugiyo, Masrukhi, & Rusdarti. (2018). Model of entrepreneurship education in vocational school on agribusiness study programme. Journal of Entrepreneurship Education, 21(4).

Mergel, I., Edelmann, N., & Haug, N. (2019). Defining digital transformation: Results from expert interviews. Government Information Quarterly, 36(4), 101385.

https://doi.org/10.1016/j.giq.2019.06.002

Muktiarni, M., Ana, A., Dwiyanti, V., Sari, A. R., & Mupita, J. (2021). Digital platform trends in vocational education during the covid-19 pandemic. Journal of Technical Education and Training, 13(3), 180–189. https://doi.org/10.30880/jtet.2021.13.03.018

Nadkarni, S., & Prügl, R. (2021). Digital transformation: a review, synthesis and opportunities for future research. In Management Review Quarterly (Vol. 71, Issue 2). Springer International Publishing. https://doi.org/10.1007/s11301-020-00185-7

Nurjanah, S. A. (2019). Analisis Kompetensi Abad-21 Dalam Bidang Komunikasi Pendidikan. Gunahumas, 2(2), 387–402. https://doi.org/10.17509/ghm.v2i2.23027

Priyono, A., Moin, A., & Putri, V. N. A. O. (2020). Identifying digital transformation paths in the business model of smes during the covid-19 pandemic. Journal of Open Innovation: Technology, Market, and Complexity, 6(4), 1–22. https://doi.org/10.3390/joitmc6040104

Rauseo, M., Harder, A., Glassey-Previdoli, D., Cattaneo, A., Schumann, S., & Imboden, S. (2023). Correction: Same, but Different? Digital Transformation in Swiss Vocational Schools from the Perspectives of School Management and Teachers (Technology, Knowledge and Learning, (2022), 10.1007/s10758-022-09631-9). Technology, Knowledge and Learning, 28(1), 429. https://doi.org/10.1007/s10758-022-09638-2

Ristic, M. (2018). E-Maturity in Schools / Digitalna zrelost škola. Croatian Journal of Education - Hrvatski Časopis Za Odgoj i Obrazovanje, 19(3), 317–334. https://doi.org/10.15516/cje.v19i0.3100

Rujira, T., Nilsook, P., & Wannapiroon, P. (2020). Synthesis of vocational education college transformation process toward high-performance digital organization. International Journal of Information and Education Technology, 10(11), 832–837. https://doi.org/10.18178/ijiet.2020.10.11.1466

Schumacher, A., Erol, S., & Sihn, W. (2016). A Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises. Procedia CIRP, 52, 161–166. https://doi.org/10.1016/j.procir.2016.07.040

Thordsen, T., & Bick, M. (2023). A decade of digital maturity models: much ado about nothing? Information Systems and E-Business Management, 21(4), 947–976. https://doi.org/10.1007/s10257-023-00656-w

Vásquez, J., Castillo, D., Rodriguez-Jaraba, C., Soto, M., & Puertas, E. (2024). Assessment of the Level

of Digital Maturity Through a Process Analysis. Proceedings of the LACCEI International Multi-Conference for Engineering, Education and Technology. https://doi.org/10.18687/LACCEI2024.1.1.1807

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. Journal of Business Research, 122(September 2019), 889–901. https://doi.org/10.1016/j.jbusres.2019.09.022

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. Journal of Strategic Information Systems, 28(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003

Vuță, D. R., Nichifor, E., Chiţu, I. B., & Brătucu, G. (2022). Digital Transformation—Top Priority in Difficult Times: The Case Study of Romanian Micro-Enterprises and SMEs. Sustainability (Switzerland), 14(17). https://doi.org/10.3390/su141710741

Wendler, R. (2012). The maturity of maturity model research: A systematic mapping study. Information and Software Technology, 54(12), 1317–1339. https://doi.org/10.1016/j.infsof.2012.07.007