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Using Agile Software Development Methods to Develop an Android-Based Student Competency Assessment

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Abstract: Using Agile Software Development Methods to Develop an Android-Based Student Competency Assessment. Objective: This study aimed to develop an android-based competency assessment application system, reveal the functionalities, feasibility, performance, validity and reliability of the apps. **Methods:** This research was designed using a research and development (R&D) with Agile software method applied in the development stages (Beck, 1999). Sixty-seven students and two teachers were selected purposively and expressed willingness to participate in this study. **Findings:** Black box testing revealed that all features have run well from the role of admin, educator, and student. **Conclusion:** An android-based competency assessment application was successfully developed and ready to be used as an accurate and reliable electronic assessment instrument.

Keywords: assessment, students' competency, research and development.

Abstrak: Menggunakan Metode Pengembangan Software Agile untuk Menyusun Asesmen Kompetensi Siswa Berbasis Android. ***Tujuan:*** *Penelitian ini bertujuan untuk mengembangkan sistem aplikasi asesmen kompetensi berbasis android, mengungkap fungsionalitas, kelayakan, kinerja, validitas dan reliabilitas aplikasi.* ***Metode:*** *Penelitian ini dirancang menggunakan penelitian dan pengembangan (R&D) dengan metode perangkat lunak Agile yang diterapkan pada tahap pengembangan (Beck, 1999). Enam puluh tujuh siswa dan dua guru dipilih secara sengaja dan menyatakan kesediaan untuk berpartisipasi dalam penelitian ini.* ***Temuan:*** *Pengujian black box mengungkapkan bahwa semua fitur telah berjalan dengan baik dari peran admin, pendidik, dan siswa.* ***Kesimpulan:*** *Aplikasi asesmen kompetensi berbasis android berhasil dikembangkan dan siap digunakan sebagai instrumen asesmen elektronik yang akurat dan terpercaya.*

Kata kunci: *asesmen, kompetensi siswa, penelitian dan pengembangan.*

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INTRODUCTION

The development of information and communication technology in the Industrial 4.0 era triggered major and fundamental changes in people's lives. The Industrial Age 4.0 is a time when technology has developed to the extent that physical, biological and digital aspects have merged so that it is difficult to distinguish them (Putrawangsa & Hasanah, 2018 ; Schwab, 2016) . In Industry 4.0, technology becomes an inseparable part where the boundaries between physical, biological and digital are increasingly disappearing. The Industrial Age 4.0 began when there was a change or transformation that reached almost all industries in every country, and the spread and depth of this change reached all production, management and government systems (Schwab, 2016) . Industry 4.0 is based on nine technological advances, namely Big Data and Analytics, Horizontal and Vertical System Integration, Autonomous Robots, The Industrial Internet of Things, Simulation, Cybersecurity, Additive Manufacturing, The Cloud, and Augmented Reality (Lee et al., 2018) .

The 4.0 industrial revolution pushed for changes in the social order of society and gave birth to a super-smart society or Society 5.0. Society 5.0 is a group structure, in this case society, whose activities are human-centered and technology-based. Society 5.0 can be said to be an improvement from cyber-physical systems to cyber-physical-human systems where humans (humans) are no longer objects (passive elements), humans take an active role as subjects (active players) and work together with machines (physical systems).) (Budiman, 2019) . The addition of humans in the cyber system makes very significant changes, where previously they were not included in the system.

The entry of the Industry 4.0 and Society 5.0 eras in society will affect people's living habits in various aspects of life, one of which is in the education system (Khairunnisa & Ilmi, 2020) . These changes can be seen in the form of digitalization of the learning process and learning tools. Sources of information as teaching materials are abundantly available with unlimited access. Of course the role of educators has also experienced a shift from previously being a source of information to becoming a facilitator and companion (Wardina et al., 2019) . This means that educators must be able to develop themselves to master technology in learning (Adrian & Agustina, 2019 ; Khairunnisa & Ilmi, 2020) . Nonetheless, the learning process still emphasizes three main stages, namely planning, implementation, and assessment (Regulation of the Minister of Education and Culture No. 22 of 2016). In the implementation process, various digital facilities are available with various advantages, such as learning using ZOOM, Virtual Reality, Video, Youtube, Google Classroom, and so on (Sukmawati, 2020) .

The question is about how the competencies or skills acquired by students while participating in the learning process, especially for Vocational High School (SMK) students where the education system at SMK places more emphasis on achieving competence so that graduates are ready to enter the world of work (Ghufron, 2018 ; Wardina et al., 2019) . For this reason, it is necessary to implement competency-based learning in a curriculum that is adapted to today's technological developments. To find out the extent to which student competence has been achieved, an assessment process that utilizes technology is needed. Assessment of competency achievement that is carried out properly can provide information on the level of progress of student learning, as well as reveal student weaknesses and strengths. Assessment of the achievement of learning competencies is also a feed back for educators to evaluate the level of success of the learning process carried out so that educators can find out the weaknesses and strengths of the learning carried out so that they

can improve learning so that it becomes better (Regulation of the Minister of Education and Culture No. 23 of 2016). This assessment process is very important in industrial era 4.0 learning by playing the role of controller of the learning process with unlimited teaching resources.

The era of digitalization also encourages the assessment process to be carried out on a digital basis. Applications that can support the digital-based assessment process are also available, such as Google Forms, Quiz modules in Moodle and so on. However, these applications still require manual processing of the assessment data. That is, educators still have to process raw data from student scores. In addition, some educators still do not have good skills in using it because it is still a bit complicated. Access to the assessment program also requires additional programs, such as the Google Chrome search engine or the like, where access can only be made if an access link has been provided. Of course this slightly reduces the practicality and simplicity of a program. To increase the level of effectiveness of digital-based assessments, the use of smartphones can be one of the best alternatives. A smartphone in the form of a pocket computer that is easy to carry will provide practicality in the assessment process. In addition, the development of smartphone use is felt very rapidly among the public, including educators and students. Even their mastery of using the device is also very good. According to survey data conducted by Newzoo in 2020, smartphone device users in Indonesia are 61.7% (170.4 million) and most of them are used to access the internet (Pusparisa, 2021). Based on data from the Association of Internet Service Providers in 2017, the number of urban Indonesians accessing the internet using smartphones/tablets was 59.31%, personal computers/laptops were 0.65%, both (smartphones and laptops) were 38.31%, and others 1.71%. Meanwhile for the rural-urban category, the use of devices via smartphones/tablets was 59.67%, computers/ laptops were 2.88%, both were 32.10%, and others were 5.35%. And in rural areas, smartphones are still the largest media for Indonesian people, namely personal smartphones/ tablets of 48.19%, personal computers/laptops of 2.42%, both of them 38.37%, and others of 11.03%. Based on these data, both in urban and rural areas, smartphones are the main media used by people to use the internet. Smartphones, which are the main media, are not without reason, because mobile application applications have advantages, namely the use of touch screens as interactive controls with users making smartphones more attractive and easy to use, in addition to the probability that smartphone application users feel because they can take their devices anywhere. only (Tolle et al., 2017 ; Saputra et al., 2019)

The use of smartphones in the learning process, especially the assessment process has actually been carried out. However, the activities carried out on smartphone devices are communication. The results of interviews at SMK N 2 Depok, all educators and students have smartphones and most of the smartphone devices they have have an Android-based operating system. In addition, the results show that there are still many educators who have not utilized the smartphones they have for the assessment process. As for educators who have used Android-based applications for the learning and assessment process, the data processing is ineffective because it still has to be processed manually, just like using Google Forms. In addition, these applications have not carried out the system update process for a long time. Meanwhile, the education system continues to develop so it needs readjustment in the assessment application system. In addition, the

Android operating system is constantly being updated, so existing applications must adapt accordingly. Educators also experience difficulties in monitoring and controlling the assessment process, educators tend to be passive after giving assessment tools to students, educators cannot see progress, stop tests or give warnings to students which can usually be done in a conventional assessment process (pen and paper).

Based on this, smartphone devices have not been utilized optimally for the process of assessing student learning outcomes. This potential can be exploited, so it is necessary to develop an application by developing an Android-based assessment device system application that can help the assessment process with a more effective process. Where the application must be integrated with the presentation of the final value automatically. Simple and practical use will make it easier for educators to compile quality questions using the smartphone they have. So that the development of assessments can be done anywhere and anytime. Of course this will provide more practical value than a learning outcome assessment tool so that the educator's work in assessing student learning outcomes becomes more effective and efficient where value processing has been done automatically. Therefore, it is necessary to conduct research with the aim of developing an android-based student assessment device application system that can process and manage student assessments and displays a final summary of the assessment. So that the development of these applications can improve the performance of educators in assessing and managing the value of student learning competencies.

METHODS

Participant

The subjects in this study were 67 students in the information systems, network and application expertise program as well as two educators. Subjects in this study were selected using a purposive sampling technique. Purposive sampling is a sampling technique based on information about the state of the previous population where the researcher assumes that the condition of the sample and population can support research activities (Fraenkel & Wallen, 2008)

.

Research Design and Procedures

This research is research development or Research and Development (R&D) with development procedures using the Agile Software method. The agile method used uses the Extreme Programming (XP) model developed by Kent Beck (Beck, 1999) . In the Extreme Programming (XP) method, the stages of the development procedure are Planning, Design, Coding, and Testing and can be done repeatedly until you get the software as needed (Prabowo, 2020) .

Research Instruments

The instrument used is a non-test instrument in the form of a Likert scale questionnaire. Questionnaires were given to material experts, application experts, educators and students who were used to test the feasibility of the product being developed. The instrument used has been validated by the validator. The results of the analysis using the KMO technique show that the KMO coefficient of the questionnaire is 0.658 > 0.5. Meanwhile, Bartlett's Test of Sphericity (Sig.) showed a significance value of 0.000 and <0.05. Based on the results of this analysis shows that the questionnaire is valid as a whole. All items in the questionnaire have an MSA coefficient > 0.5 so that all items in the questionnaire can be declared valid. The results of the questionnaire reliability test in this study were 0.822. So it can be concluded that the questionnaire instrument can be declared reliable.

Data analysis

Data analysis techniques were analyzed using qualitative statistics. Quantitative data obtained through questionnaires are converted into qualitative data to describe the quality of the product being developed. In order to obtain product feasibility criteria in development research as shown in Table 1.

Table 1. Product eligibility category

Average Score	Category
100 ≥ X ≥ 75	Very worth it
75 > X > 50	Worthy
50 > X ≥ 25	Less Eligible
25 > X ≥ 0	Not feasible

RESULTS AND DISCUSSION

This research develops an Android-based assessment system which is expected to facilitate improving the assessment process carried out by educators through four stages, namely: *planning, designing, coding, and testing* . The results of application development are as follows:

Planning

In this study the planning stage was carried out by defining the requirements of the application being developed, these requirements were divided into two, namely functional requirements and non-functional requirements.

Design

In this study the developed application is divided into two systems, namely server and client. The system on the server will act as a data processing system and the system on the client will act as a system that interacts with users. The two systems interact/communicate using two protocols, namely the HTTP protocol in the API for non-real-time data communication and the Socket protocol for real-time data communication.

Further design is carried out by designing a simple application use case diagram process design using the Unified Modeling Language (UML), data relations in the database using an Entity Relationship Diagram (ERD) which describes data relationships in applications, ERD in the database of applications developed using Crow 's Notation. While the Wireframe User Interface describes a simple display of the application which will later be realized when coding the application. The following is a use case diagram that can be seen in the image below:

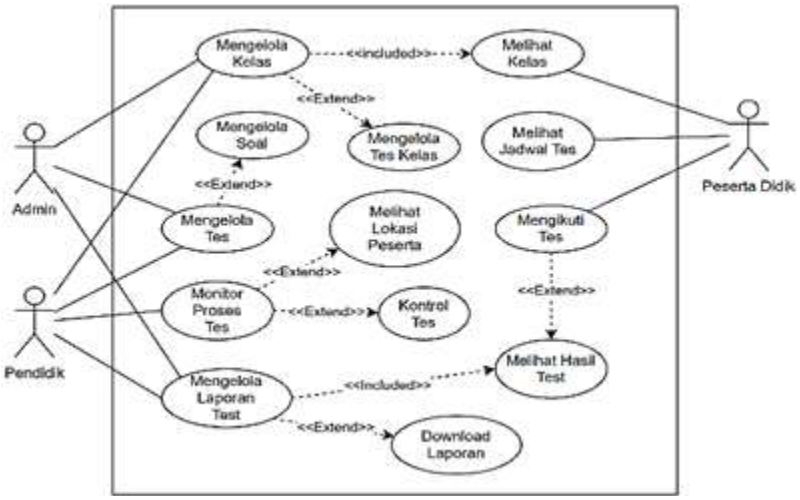

Figure 1. Application use case

Based on Figure 1 above, the application developed has three users namely admin, educators, and students.

Coding (Developing)

The appearance of the application results from coding carried out based on the design made consists of the following:

Figure 2. Login display

In the initial view, namely this login, the user is required to log in in order to access further application features. The username used by the educator uses the educator prefix while students use the student's identification number. After successfully logging in, the user will go to the dashboard menu, this dashboard menu will display the user's profile photo and full name. In addition, four menus are displayed, namely classes to view classes, about us which contains a brief profile of the school, contact us to see the developer's contact list, besides that there is a menu that is specific to the type of user used, in educators there is a Question Bank menu to view the list existing tests and questions, then for students there is a schedule menu to see a list of tests obtained followed by students.

The class list display menu contains lists of classes where the educator is in charge or class owner, or where students are participants in the class. In this menu educators can make class arrangements such as adding, editing, and deleting classes. The add class page menu contains forms for the class title, class description, start time, and class end time. Then there is a participant list menu that displays a list of participants for a particular class. This page will display the full name and profile photo of the student. In the participant list menu, educators can access the function of adding and removing class participants through this page.

The add participant menu contains a list of all students who can be added as class participants. And educators or admins can add participants by pressing the button with the + (Plus) symbol. In addition, there is also a test list menu that displays a list of tests used in the class. In the learner window of each test can be accessed the results of the test and start the test. Meanwhile, on the educator page, additional menus are useful for editing classes, adding or removing tests, and viewing class grade reports. Then the page menu adds a class component which contains a form for the test selected from the test that has the test title, test description, start time, and class finish time.

Test instructions are part of the menu in this application. This view is only shown to students. In this view, students will be shown instructions, the number of questions, and the processing time of the test to be done. In this view there is also a start now button which is useful for starting the test. When starting the test participants may be asked to agree to access the location (GPS) of the smartphone device which is required for the application to record the location of students during the assessment process. On the other hand

there is also a test menu where only students can see the display of this test, and in this view students will be shown questions which may be accompanied by pictures related to the questions and answer choices. Students can answer questions by pressing/tapping one of the answers from the five answer choices provided, and the save button is useful for saving answers and will also automatically change the displayed question to the next question. Students can also skip questions by pressing the skip button, and also change/open certain questions by pressing the question list button and selecting the number of questions they want. After doing the test, students can see the value of the test results through the test results menu.

For educators, a test monitor menu is presented to see a list of participants accompanied by the status of the test progress. This view aims to supervise and can only be accessed by educators. The test monitor menu can be seen in Figure 3 below

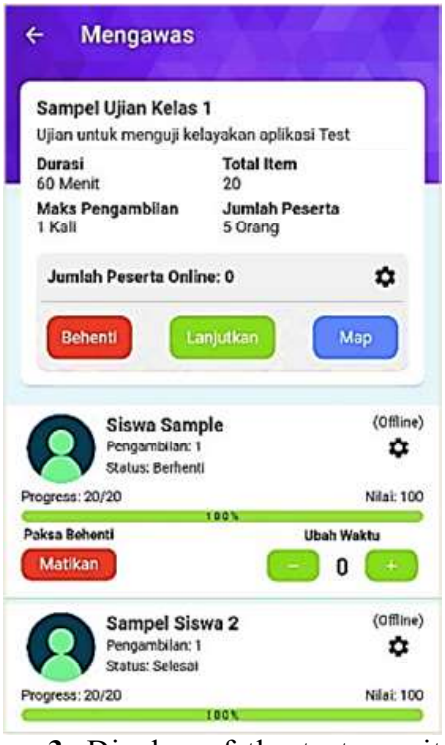

Figure 3. Display of the test monitor ui

The test monitor displays progress in real-time including Online/Offline status and progress status of student test work, educators can also lock/turn off student tests, and set the time (adding/reducing) each student. In addition to the test monitor menu, there is also a student location menu which will collect the participant's location when carrying out the test, and displays location data in the form of a map. The participant's location will be displayed in the form of a location marker in the map, the student's name will be visible when the marker is touched. After students take the test, the class report menu will show a summary of all student scores on each test in the class. Educators or admins can view and share or save reports in excel form by pressing the share button.

There is also a test list or question bank menu that displays the test questions available in the application. In the test list menu, educators can also view descriptions, instructions, and test time allocations. Educators can also add tests to the add test menu. This add test menu page contains a form for the test selected from the test that has a test title, test description, instructions for carrying out, category and test duration. Furthermore, educators can see the questions, the serial number of the test, and the types of question types on the question list menu. Then to create questions, add pictures, add questions, answer choices, and answers can be done by educators on the menu for questions. After the questions have been successfully created, the educators will display the questions in more detail on the questions menu. Educators will be able to see questions, answer choices, and answer keys that are in bold.

Testing

Testing is carried out to test the product in terms of application functionality (Functional testing). The functionality of the application is tested based on the Use Case that is in the Design

stage and is carried out by installing the application system on a smartphone. The researcher divides the test into three parts based on the types of users in the Use Case, namely admins, educators and students.

Black Box testing on the admin role is done by testing 40 functions in the application. The functions tested based on the Use Case are as follows: managing classes, administering tests, monitoring and controlling test progress, viewing participant locations , and managing test reports. Can be seen in Table 2 below:

Table 2 . Admin black box testing results

Results Testing	Amount	Percentage
In accordance Hope	40	100%
No In accordance Hope	0	0%

The test results in Table 2 state that 40 functions or 100% of the functions created in the application for admin users run as expected. So that testing the functionality of the application in the admin role can be concluded accordingly.

While the tests carried out on educators have 40 functions that are almost the same as the admin, however, data access is limited to class or test data owned by educators. The functions tested based on the Use Case are managing classes, administering tests, monitoring and controlling test progress, viewing participant locations, and managing test reports. Overall it can be seen in Table 3 below

Table 3. Educator black box test results

Results Testing	Amount	Percentage
In accordance Hope	40	100%
No In accordance Hope	0	0%

The test results in Table 3 state that 40 functions or 100% of the functions in the application for educator users run as expected. So that testing the functionality of the application with the role of the educator can be concluded accordingly.

Black Box testing for students is carried out by testing the 14 functions available in the application based on the Use Case, viewing classes, viewing test schedules, taking tests, and viewing test results. Overall it can be seen in Table 4 below.

Table 4 . Student black box testing results

Results Testing	Amount	Percentage
In accordance Hope	1 4	100%
No In accordance Hope	0	0%

The test results in Table 3 state that all functions created in the application for educator users run as expected. So that testing the functionality of the application on the role of students can be concluded accordingly.

Expert Validation

Validation was carried out to 4 experts, namely 3 material experts and 1 application expert. The results of the validation were used to revise and improve the initial product that was developed. Material expert validation is to validate the questions in the application, Material expert 1 is a lecturer at the Faculty of Engineering (FT) Yogyakarta State University who masters the material for the Information Systems, Network and Application (SIJA) expertise program, especially basic programming subjects, while material experts 2 and 3 is an educator of the SIJA expertise program at the State Vocational High School (SMK) 2 Depok. The results of the material validation test can be seen in table 5 below:

The results of the material expert validation into the aspect of product suitability with the aspect of expert assessment giving a score of 100%, expert two of 86% points and expert three of 89%, while in the aspect of conformity processing

Table 5 . Material expert validation results

Aspect	Expert 1	Expert 2	Expert 3	Average	Category
Suitability with aspect evaluation	100%	86%	89%	92%	Very worthy
Suitability processing evaluation	100%	89%	100%	96%	

the assessment of expert one gives a score of 100%, expert two of 89 % points and expert three at 100%. While the average validation score in the suitability aspect of the assessment processing is obtained at 96% which, when converted, is categorized as feasible. From these two results an average aspect of 94% can be obtained so that it can be stated that according to material experts the application system competency assessment device for Android-based students is stated to be very feasible.

Furthermore, application expert validation is carried out by technology experts who have experience and understanding in terms of the process of creating and developing Android applications. Expert validation in this study was carried out by an application expert lecturer at the Faculty of Engineering (FT) Yogyakarta State University. The results of the application expert validation test can be seen in table 6 below.

The results of the tests conducted by material experts and application experts show that

Table 6 . Application expert validation results

Aspect	Score	Average	Category
Usability	83%	85%	Very worthy
Functional Suitability	88%		

the application is in the very feasible category, although the material and application experts provide some input and suggestions, including test instructions that need to be clarified regarding the stages of how to answer questions in the application and provide a differentiator (Sparator). on the appearance of the test between questions and answers to emphasize and not confuse students, this input is then used as a guide for improving the application before testing is carried out.

Product Eligibility

The quality of the products developed is based on the results of tests conducted on respondents, namely 2 educators and 67 students, which are seen based on usability, functional suitability and maintainability.

The results of data analysis from respondents on the usability of the application system for Android-based competency assessment device applications can be seen in Table 7 below.

Table 7 . Usability test results

Respondents	Score	Average Score	Category
Educator	85%	87%	Very worthy
Participant educate	89%		

The test results from two educator respondents obtained an assessment result from the product quality aspect on the usability aspect of 85%. Meanwhile, based on 67 student respondents, a score of 89% was obtained which indicated that it was in the very decent category. From the results of the two types of respondents, the average score obtained was 87% and it can be concluded that the application system for Android-based competency assessment device developed from the usability aspect is considered very feasible.

The results of data analysis from the Functional Suitability test on the application system based on student competency assessment tools can be seen in Table 8 below.

Table 8. Functional suitability test results

Respondents	Score	Average Score	Category
Educator	82%	83%	Very worthy
Participant educate	83%		

Based on the two educator respondents, a score of 82% was obtained. While based on the respondents 67 students obtained a score of 83%. From the results of the two types of respondents the average score obtained was 83% with a very decent category. So that it can be concluded that the application system product for competency assessment device based on Android is considered very feasible in terms of functional suitability.

While the Maintainability Index is obtained by analyzing the source code of the application before compiling it, the Maintainability Index is obtained based on Halstead's Volume, Cyclomatic Complexity, and Number of lines of code. Based on the results of the analysis of the program code using Dart Code Metrics which shows that the Android-based competency assessment tool application system for students obtains a Maintainability Index score of 75%. So that it can be said that the maintainability of the application system for the competence assessment device for Android-based students that was developed has good maintainability. Overall these results can be seen in Figure 4 below.

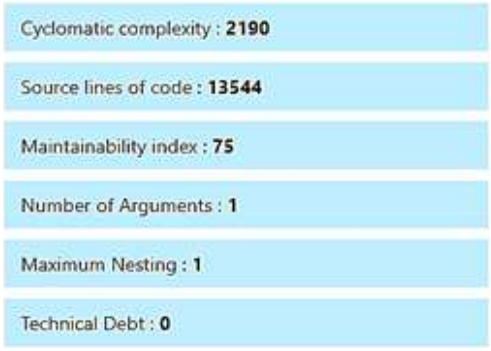

Figure 4. analyst results of dart code metrics

Application feasibility testing is carried out to ensure that the application is feasible to use. The test was carried out in two stages, the first stage was carried out by validating expert judgment and the second stage was testing the respondents. Validation using expert judgment is carried out where software/application experts can provide a coherent assessment of the level of achievement related to various quality factors and attributes (Rosqvist, Koskela, and Harju 2003 ; Towns 2014) . While the validation results for application experts obtained a score of 85% with a very decent category. These results indicate that the assessment device application system application developed is declared valid with a

very feasible category and can be used. Even so, there are some suggestions and inputs given by material and application experts, namely improving the sentence of the test instructions to make it more clarified and displaying alternative answers that need to be labeled to distinguish between questions and alternative answers. The input from the expert is then applied before the trial is carried out.

Quality testing is carried out based on quality testing using the ISO/IEC 25010 quality standard. Measuring the quality of information systems using the ISO/IEC 25010 quality standard can be carried out using several aspects of the quality standard (Mulyawan et al., 2021) . Testing is done by testing three aspects, namely Usability, Functional Suitability, and maintainability. Usability Test, Functional Suitability conducted on 2 educators and 67 students in two test sessions.

Usability describes how good a product is in achieving satisfaction with certain aspects which in the context of application development Usability is seen based on several factors including UI (Adnan, Prasetyo, and Nuriman 2017 ; Slepkov et al. 2021) . The results of research conducted on the Usability aspect obtained an average score of 87%. The test results for the application system for competency assessment device based on Android are stated as very feasible, indicating that the product made is very feasible in terms of user interface and user friendliness, starting from color, fonts, margins, contrast and others, also in terms of ease of navigation or function. certain. In the aspect of functional suitability, an average score of 83% is obtained or if it is categorized as an application system, an Android-based assessment device is considered very suitable for use in the aspect of functional suitability, stating the level of a product or system in meeting needs or functions when used under certain conditions (Set, functional suitability). describes the level of user satisfaction with the expected functions, high/very decent functional suitability states that the Android-based assessment device application system made successfully meets development needs and expectations, functional suitability describes the extent to which a product or system performs functions in accordance with the specified criteria when used under certain conditions (Rodríguez et al., 2016) . Furthermore, the maintainability tested on the source code of the Android-based assessment device application system using Dart Code Metric obtained an independent maintainability score. x by 75% which, if it is categorized in the level of maintainability of the application system, the Android-based assessment device developed has good maintainability. Maintainability refers to the ease with which a product can be repaired, modified, or further developed (Mulyawan et al., 2021) .

■ CONCLUSIONS

Based on the results of research and development of Android-based Student Competency Assessment Tool Application Systems in the Information Systems, Network and Application Expertise Program, it can be concluded that the product resulting from this research is an Android-based competency assessment device application system developed with several stages including Planing. Design, Coding (Development), and Testing, have the functions of managing assessment tools and assessment results as well as monitoring progress, locations during assessment, and controlling the student assessment process in real-time. Testing using black box testing, all functional applications developed have run according to expectations from both the role of admin, educators, and students with a percentage of reaching 100%.

■ REFERENCES

Adnan, F., Prasetyo, B., & Nuriman, N. (2017). Usability testing analysis on the Bana game as educational game design references on junior high school. *Indonesian Journal of*

Science Education , *6* (1), 88–94. Doi:10.15294/jpii.v6i1.9597

Adrian, Y., & Agustina, RL. (2019). *Kompetensi guru di era revolusi industri 4* [teacher competence in the 4th industrial revolution era]. *Lantern: Educational Scientific Journal* , *14* (2), 175-181.

Beck, K. (1999). Embracing change with extreme programming. *Computers, 32(10), 70-77.* , *32* (10), 70–77.

Budiman, A. (2019). *Kolom Pakar: Industri 4.0 vs Society 5.0* [Expert Column: Industry 4.0 vs Society 5.0].. *Faculty of Engineering Ft. Ugm. Air conditioning. id.*

Fraenkel, Jack R., & Wallen, NE. (2008). *How to design and evaluate research in education* (7th.ed). McGraw Hill.

Ghufron, M. (2018). *Revolusi industri 4.0: tantangan, peluang, dan solusi bagi dunia pendidikan* [industrial revolution 4.0: challenges, opportunities, and solutions for the world of education]. *National Seminar and Multidisciplinary Panel Discussion on Research Results and Community Service 2018* , *1* (1), 332–337.

Khairunnisa, GF, & Ilmi, YIN. (2020). *Media pembelajaran matematika konkret versus digital: systematic literature review di era revolusi industri 4.0* [concrete versus digital mathematics learning media: systematic literature review in the era of the industrial revolution 4.0]. *Journal of Tadris Mathematics* , *3* (2), 131–140. Doi: 10.21274/jtm.2020.3.2.131-140

Lee, MH, Yun, JHJ, Pyka, A., Won, DK, Kodama, F., Schiuma, G., Park, HS, Jeon, J., Park, KB, Jung, KH, Yan, MR, Lee, SY, & Zhao, X. (2018). How to respond to the fourth industrial revolution, or the second information technology revolution? dynamic new combinations between technology, market, and society through open innovation. *Journal of Open Innovation: Technology, Market, and Complexity* , *4* (3), 21. Doi: 10.3390/joitmc4030021

Mulyawan, MD, Kumara, INS, Bagus, Ida Swamardika, A., & Saputra, KO. (2021). *Kualitas sistem informasi berdasarkan iso / iec 25010* [quality of information systems based on ISO / IEC 25010]. *Scientific Journal of Electrical Technology* , *20* (1), 15–28.

Prabowo, M. (2020). *Metodologi pengembangan sistem informasi* [information system development methodology]. LP2M Press IAIN Salatiga.

Putrawangsa, S., & Hasanah, U. (2018). I *ntegrasi teknologi digital dalam pembelajaran di era industri 4.0* [integration of digital technology in learning in the industrial age 4.0]. *Journal of Tatsqif* , *16* (1), 42–54. Doi:10.20414/jtq.v16i1.203

Rodríguez, M., Oviedo, JR, & Piattini, M. (2016). Evaluation of software product functional suitability: a case study. *Professional Quality Software, 18* (3).

Rosqvist, T., Koskela, M., & Harju, H. (2003). Software quality evaluation based on expert judgment. *Software Quality Journal* , *11* (1), 39–55. Doi:10.1023/A:1023741528816

Saputra, K., Nazaruddin, N., Yunardi, DH, & Andriyani, R. (2019). Implementation of haversine formula on location based mobile application in syiah kuala university. *In 2019 IEEE International Conference on Cybernetics and Computational Intelligence (CyberneticsCom)* , 40–45.

Schwab, K. (2016). The fourth industrial revolution: what it means and how to respond. *World Economic Forum* , 1–7.

Slepkov, AD, Van Bussel, ML, Fitze, KM, & Burr, WS. (2021). A Baseline for Multiple-Choice Testing in the University Classroom. *SAGE Open* , *11* (2). Doi:10.1177/21582440211016838

Sukmawati, S. (2020). *Implementasi pemanfaatan google classroom dalam proses pembelajaran online di era industri 4.0* [implementation of using google classroom in the online learning process in the industrial age 4.0]. *Online Creative Journal* , *8* (1).

Tolle, H., Pinandito, A., Kharisma, AP, & Dewi, RK. (2017). Mobile device application development. Brawijaya Press University.

Towns, MH. (2014). Guide to developing high-quality, reliable, and valid multiple-choice assessments. *Journal of Chemical Education* , *91* (9), 1426–1431. Doi:10.1021/ed500076x

Wardina, UV, Jalinus, N., & Asnur, L. (2019). *Kurikulum pendidikan vokasi pada era revolusi industri 4.0* [vocational education curriculum in the industrial revolution era 4.0]. *Journal of Education* , *20* (1), 82. Doi:10.33830/jp.v20i1.843.2019