



Development of a Digital Based Sit and Reach Test and Measurement Tool

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Abstract

The purpose of this study was to produce an effective and efficient digital-based sit and reach measurement test kit as a test development and measurement of back muscle flexibility. The type of research in this research is a mixed methods research with a Research & Development (R&D) research design from Borg and Gall. This research was conducted with 9 research stages namely, (1) Research and information collecting, (2) Planning, (3) Develop preliminary form of product, (4) Preliminary field testing, (5) Main product revision, (6) Main field testing, (7) Operational product revision, (8) Operational field testing, (9) Final product revision. The population in this study used students from the Faculty of Sports Science and Athletes of Pelatda Sumut. Furthermore, from the Phase I trial, totaling 15 people showed a score of 87.8% with the Eligible criteria, then from the Phase II trial, which totaled 30 Pelatda Sumut athletes, it showed a figure of 90% in the Very Eligible category. From the results of the research/feasibility test carried out by test and measurement experts, IT experts and sports academic experts, it shows a score of 96% in the Very Eligible category, so it can be used. Based on the data obtained, the development of a digital-based sit and reach test and measurement tool was declared feasible to be developed as a test tool and measurement of back muscle flexibility.



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INTRODUCTION

Today the development of science and technology (science and technology) is very rapid. Along with the rapid development of science and technology, there are many innovations from various studies that are growing rapidly as well (Suharta et al., 2021; Supriadi & Mesnan, 2022a ; Kasih et al., 2022). Various human activities in everyday life have also been greatly assisted by advances in science and technology, including in the field of sports which have been assisted in the process of training and matches. In this technological era, science and technology are needed (Sinaga et al., 2022 ; Bangun et al., 2020). Support from science and technology plays a big role in helping athletes to achieve so that starting from talent search, training, tests and measurements, athletes and coaches are also helped (Arifin et al., 2023). The development of science and technology in improving the ability of athletes to carry out tests and measurements is very necessary because it is hoped that when science and technology takes part in the world of sports, especially in terms of tests and measurements, test kits will be more effective and efficient (Hutagalung et al., 2023). At present, technology and knowledge are developing rapidly to support human life in an advanced direction and there is a need for a new breakthrough for the development of digital tools in the field of sports so that we can easily achieve what has been expected so far with the development of more advanced sports equipment. and modern. Facilities and infrastructure are very important for sports development and achievements (Zulyaden et al., 2022; ; Dewi et al., 2023; Nurkadri et al., 2021)

The latest advances in technological innovation in the field of

sports are urgently needed for facilities and infrastructure in the field of sports. Technological innovations in sports are expected to increase effectiveness, efficiency, and accuracy so that they can assist in terms of more valid tests and measurements (Endriani, Sitompul, et al., 2022 ; Hardiyono et al., 2023 ; Harahap et al., 2023). The new technology in this study is test and measurement technology sit and reach digital-based which functions to measure the flexibility of the back muscles using digital-based technology. The importance of this research is carried out because it is to help sports coaches and educators in training young athletes to develop abilities in measuring flexibility. In addition, the overall definition of this research is to change manual test and measurement tools towards the use of technology so that it is expected to be able to increase the level of validity of the test kits. One of the test tools that will be developed by researchers is tests and measurements sit and reach digital based.

(Akhmad, 2016) Physical condition is one of the indispensable requirements in an effort to increase the performance of an athlete (athlete), even as a starting point for an achievement sport, the physical condition of a planned and structured form of physical activity involving movement body repeatedly and aimed at improving physical fitness, (Arni & Indrayana, 2021; Arni & Indrayana, 2021 ; Kresnapati et al., 2020 ; Komaini, 2021) In sports, there are several components of physical condition, namely (1) strength, (2) endurance, (3) muscle endurance, (4) speed, (5) flexibility, (6) agility, (7) balance, (8) coordination, (9) accuracy, (10) flexibility, in the physical condition the author takes one of the components that play an important role, namely

flexibility, in the physical component a person has a high level of flexibility so it tends to minimize injury, especially at the level of flexibility of athletes who not determined by body posture but by the intensity of practice.

The components of physical condition consist of strength, speed, endurance, and flexibility. The four components cannot be separated from one another (Dewi et al., 2022). One component of the physical condition which is the object of research is flexibility. (Hendi Gunawan, 2013) Flexibility or flexibility is the ability to move within the widest range of joint motion. Flexibility is a component that some coaches or athletes sometimes forget. In fact, one of the benefits of flexibility is reducing the risk of injury. Even flexibility can increase one's efficiency in carrying out movements. One of the flexibility that is often measured is the flexibility of the back muscles (back muscles and hamstrings) or the joints involved are the leg joints (hip joint).

Flexibility is the ability to move the joints with a very wide range of motion, according (Ricardo Valentino Lathuru, 2019) flexibility implies, namely the range of motion of one joint or several joints. He further stated that there are two kinds of flexibility, namely (1) static flexibility, and (2) dynamic flexibility. In static flexibility is determined by the size of the range of motion (range of motion) one joint or several joints. The benefits and goals of having broad flexibility, namely, making muscles and joints healthier, reducing stress on muscles and releasing muscle tension during exercise, making postures more balanced, flexibility is divided into 2, namely dynamic and static, dynamic is a person's ability to move straight at high speed, static is the ability of a person to move widely slowly. Broadly speaking,

the factors that affect the level of flexibility of a person include; elasticity of muscles, tendons and ligaments, bone structure, joint shape, body temperature or temperature, age, gender. The back muscle flexibility instrument that is often used is Bench/Meja Sit and Reach Sit and Reach Test. There are also those who measure it with a bow and compass manually.

Observations are made to see the accuracy and usability of the test and measurement tools directly, this is done to assess and analyze how the test and measurement tools work according to the test and measurement tools themselves, observation of the test kits sit and reach seen that the test and measurement tools sit and reach During the physical test of the North Sumatran KONI towards the 2024 PON at the Multipurpose Building on road Willem Iskandar, the equipment used still uses a meter attached to the floor, then the athlete reaches as far as possible by reaching for the hand, the measurement is based on how far the hand reaches on the meter. Tool used to perform tests and measurements of back flexibility sit and reach seems to be still conventional by only using a meter and glued to an insulator that is attached to the floor, this has actually become very ineffective considering that there is no use of appropriate technology to help see the long reach through the flexibility of the back. Tools that are used conventionally are difficult to do the transfer because tester must open and display the insulating tape installed on the floor again, besides that when measuring using a meter, the position of the back is straightened, then the hand reaches out towards the meter that is installed on the floor, the calculation results are measured through a distance of cm, sometimes it is not valid because when tester perform tests and measurements to the fullest not infrequently tester pulling back his hand

so that what is measured is not the height he reached initially but where the last position of the hand extended on the meter, with technological sophistication is expected when tester carry out tests and measurements to the fullest, the results that are read are the highest maximum results from the treatment carried out by tester.

The researcher conducted a preliminary study by looking for the development of similar tools through literacy studies, YouTube and previous studies. From previous research, researchers found the tool "Instrument Innovation Sit and Reach Based on Digital Technology" to measure back flexibility/flexibility developed by (Yeni, 2020a), which is a development tool that aims to measure the back flexibility of athletes. Seen that tool sit and reach This digital technology-based has several weaknesses and shortcomings which form the basis of the research that the researcher will design. Researchers try to describe the advantages of research tools that researchers design are efficient and effective. The effective meaning is the tool that the researcher designed does not change the tests and measurements of sit and reach itself means that the researchers designed by the researchers are connected to the digital sent through an Android-based application and the tool does not use an iron framework in designing the tool. While the intended efficiency is the tool that the researcher designed, portable can be carried anywhere with not too many components used but does not reduce the validity of the test kit.

The researcher conducted a needs analysis of 10 athletes who often carried out tests and measurements, the needs analysis here is meant to see the extent to which the test and measurement tools that the researcher will design are used, whether they are needed by user (user). From the needs analysis that the

researchers carried out through questionnaires compiled by the researchers, it can be seen that 100% of athletes have taken tests and measurements sit and reach 100% of athletes are still doing tests and measurements sit and reach in the conventional way, 100% of athletes wanted to say they had never tried digital-based tests and measurements, 100% of athletes and coaches said they needed digital-based tests and measurements of back muscle flexibility and 100% of athletes wanted new test and measurement tools.

The results of the analysis carried out by the researcher gave rise to ideas and ideas for conducting research with the title "Development of Test and Measurement Tools Sit And Reach Digital-Based" which later these test kits can make it easier for athletes in terms of use and maintenance. With this tool, the researchers hope that in the future athletes and/or other sports practitioners will no longer have difficulty knowing how much flexibility the back muscles produce. This tool will also help to maximize the ability of athletes as self-evaluation material. Several studies regarding the development of digital-based test and measurement tools (Arifin et al., 2023; Hutagalung et al., 2023; Mesnan & Supriadi, 2022; Supriadi & Mesnan, 2022b; Supriadi & Nopember Haloho, 2022; Zega et al., 2022).

METHODS

Types of research in research Thesis research mixed methods. This research is a research step by combining two forms of research that have existed before, namely qualitative research and quantitative research. According to (Endriani, Akhmad, et al., 2022) mixed research is a research approach that combines qualitative research with quantitative research. According to

(Sugiyono, 2010) that the research method is a combination (mixed methods) is a research method between quantitative methods and qualitative methods to be used jointly in a research activity, in order to obtain data that is more comprehensive, valid, reliable and objective. In this study, it is not about the sample but the research subject. Subject taking technique in this study is to use a total sampling technique. The reason for taking total sampling is because according to (Sugiyono, 2010) the total population is less than 100, the entire population is used as a research subject. Then the research subjects will be explained in the following table:

Table 1. Criteria and Research Subjects

Research Stage	Number of Subjects	Criteria	Instrument
Early Product Plan	3	3 sports lecturers	Interview
Expert Evaluation	3	1 IT expert 1 Measurement Test expert 1 sports academic	Interview
Small Group Try Out	15	a. PON Pelatda Athletes for the Tarung Degrees Sports Branch	Test and measurement tools shoulder and wrist digital based
Field Try Group	30	a. PON Pelatda Athletes b. North Sumatra National Athlete	Test and measurement tools shoulder and wrist digital based

Research procedure

Research and development in this process uses a quantitative approach and uses a research design Research & Development (R&D) from (Mesnan & Supriadi, 2022) which consists of ten steps, among others.



Figure 1. Model Penelitian Borg and Gall Research and Development

Data analysis techniques aim to organize data in a meaningful way so that it can be understood. In the test tool development research sit and reach digital based. Engineering analysis data is used with techniques analysis quantitative descriptive with percentage. This technique is used in order to obtain quantitative data analysis obtained from distributing questionnaires through the presentation formula as follows:

$$P = \frac{F}{N} \times 100\%$$

Information: P = Percentage
F = Amount earned
N = Number of respondents

RESULT

Flexibility is the ability to move the joints with a very wide range of motion, flexibility implies, namely the range of motion of one joint or several joints. He further stated that there are two kinds of flexibility, namely (1) static flexibility, and (2) dynamic flexibility. In static flexibility is determined by the size of the range of motion (range of motion) one joint or several joints. The benefits and goals of having broad flexibility, namely, making muscles and joints healthier, reducing stress on muscles and releasing muscle tension during exercise, making postures more balanced, flexibility is divided into 2, namely dynamic and static, dynamic is a person's ability to move straight at high speed, static is the ability of a person to move widely slowly. Broadly speaking, the factors that affect the level of flexibility of a person include; elasticity of muscles, tendons and ligaments, bone structure, joint shape, body temperature or temperature, age, gender. The back muscle flexibility instrument that is often used is Bench/Meja Sit and Reach Sit and Reach Test. There are also those who measure it with a bow and compass manually.

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Digital-Based Sit And Reach Test Tool Information Collection

The researcher conducted a preliminary study by looking for the development of similar tools through literacy studies, YouTube and previous studies. From previous research, researchers found the tool "Instrument Innovation Sit and Reach Based on Digital Technology" to measure back flexibility/flexibility developed by (Hilda Oktri Yeni, 2020b), which is a development tool that aims to measure the back flexibility of athletes, for more details I will do an analysis of this tool.

Digital-Based Sit And Reach Test Kit Product Development

Test and measurement tool design sit and reach digital-based that researchers have developed can be seen in the image below along with details of the parts of the tools used to design Test and Measurement Tool development products Sit And Reach Digital Based. The design of the test and measurement tools that the researcher will design is as follows:



Figure 2. Development of Test and Measurement Tools Sit And Reach Digital Based

Procedures for Implementation of Test and Measurement Tools Sit And Reach Digital Based:

Objective : To measure back flexibility

Equipment : Test and measurement tools sit and reach based digital

Provisions For Use Of Tools

1. Turn on the device by pressing the ON switch which is behind the box.
2. For early users do Bluetooth pairing by opening the Bluetooth settings on Android, then selecting the Bluetooth name ONE to do the initial pairing (this process is only done the first time using the device).
3. Open the application, then click the bluetooth logo at the bottom left.
4. Select the device name ONE and wait a while, if the connection succeeds will be seen the text connect is green and the tool is ready to use.

5. Inrule the use of tools, athletes must position the body according to the provisions of the coach.
6. Then click START MEN / START WOMEN (adjusting to the gender of the athlete doing the trials).
7. The system will start calculating the bending distance when the box is pushed forward.
8. The system will stop counting if the box has stopped.
9. To reset the system back to the initial box must be pulled backwards to the zero position until the box hits the buffer limit at the start point.

Product Development Design Revision Digital Based Sit And Reach Test Tool

After the researcher made the design test and measurement tools sit and reach the digital base, the researcher submitted the design to test and measurement experts, IT experts and sports lecturers. The goal is to get input or revisions related to the design test and measurement tools sit and reach digital based which will be developed in order to improve the results of research conducted. The design that the researcher gave to the expert did not get revised, so the researcher could proceed to the next stage, namely making the product because according to the expert, a trial had to be carried out first to see the extent of the weaknesses. Advantage as well as effectiveness and efficiency from the use of tools that researchers have designed. However, when the researchers did, the resource persons and supervisors provide advice and input regarding the test and measurement tools that will be developed by the researcher. The input and suggestions for test and measurement tools sit and reach digital bases developed by researchers can be seen in the following table.

Table 2. Input and Suggestions from Resource Persons and Advisors

No	Suggestions / Feedback
1	The tools developed should meet the criteria of effective and efficient both the way of implementation and the cost of making the tool
2	Weaknesses of the tool can be explained conceptually
3	Comparisons between tools that are done conventionally must be able to be described into the tools that are designed
4	Peculiarity tool must be displayed

Phase I Product Trial

Phase I trials were carried out on 15 Pelatda PON athletes for the Tarung Degrees sport. This aims to provide input and an assessment of the results of trials conducted on samples to see the level of usefulness of the tool and the effectiveness of the test and measurement tools sit and reach digital-based, so that it meets the theoretically and empirically feasible criteria.

The data obtained is then used as a basis for efforts to make revisions at a later stage. Results obtained in the field after conducting trials Phase I is work test and measurement tools sit and reach digital based which can work quite well and the results of the achievements made are read perfectly by the distance calculation sensor (cm) that is connected to the IOP system on Android which is listed properly. From the results of trials conducted by researchers on 15 Pelatda PON athletes in the Tarung Degrees sport, it can be seen that they have been classified in the form of a questionnaire, by grouping them into 2 aspects, namely, clarity of material, material aspects so that a total of 20 questions, the results of athlete answers grouped into 5 categories namely SS (Strongly Agree), S (Agree), SD (Moderate), TS (Disagree), STS (Strongly Disagree) with an assessment of 5,4,3,2,1. The results of the phase 1 trial on these

students were outlined through the formula for the percentage of the number of answers/maximum score x 100% with the following results. Of the 15 small group trial samples with a total score of 1,756 divided by a maximum score of 2,000 x 100%, it resulted in a presentation of 87.8% with the following criteria: **Worth it.** Can be seen on.

During the Phase I trial, researchers found findings in the field of test and measurement tools sit and reach digital based that the researchers poured into Table 3.

Table 3. Research Findings

No	Research Findings
1	Tester at the time of implementation sit and reach still not familiar with the tool being developed
2	Tester at the time of carrying out the test sit and reach often pushes the tool with the feet, even though according to the test norm, only the back does the flexibility tester
3	Tester at the time of carrying out the test sit and reach often do not straighten the arm so it is not maximal in taking measurements
4	Tester still often stomp hand (pushing hand) while doing the test sit and reach even though the measurement is not by hand but through the flexibility of the back
5	The tool is still often pushed by the leg which is straightened by tester so that the tool can move

Phase II Product Trial

Phase II trials were carried out on 30 North Sumatra PrePon athletes including athletes who often carry out tests and measurements sit and reach, this aims to provide input and assessment of the results of trials conducted on samples to see the level of usefulness of the tool and the effectiveness of the test kit sit and reach digital-based, so that it meets the theoretically and empirically feasible criteria. The data obtained is then used as a basis for efforts to improve the final product of the test kit and reach a digital

base. Results obtained in the field after conducting trials Phase II is work sit and reach digital based whether it is feasible to use and meet the criteria referred to in sit and reach digital based. From the results of the trials carried out, it can be seen and classified in the form of a questionnaire, by grouping them into 2 aspects, namely, clarity of material, material aspects so that a total of 20 questions, the results of athlete answers are grouped into 5 categories, namely SS (Strongly Agree), S (Agree), SD (Moderate), TS (Disagree), STS (Strongly Disagree) with an assessment of 5,4,3,2,1. The results of the second stage of the trial on these athletes were poured through the formula for the percentage of the number of answers/maximum score x 100% with the following results. Of the 30 samples of the Phase II trial with a total score of 2,743 divided by a maximum score of 3,000 x 100%, it resulted in a presentation of 90% with the criteria Very Worth it.

DISCUSSION

Test tool and measurement of back flexibility sit and reach digital based what the researchers observed at the time of the Pelatda KONI North Sumatra athlete's physical test which was carried out at the GSG (Gor Versatile) Jl Williém Iskandar, it was seen that the test to measure the flexibility of the shoulder muscles was still using a manual method, meaning that the test equipment was still using the manual method. , meaning that the test and measurement tools are still using conventional methods. At present, technology and knowledge are developing rapidly to support human life in an advanced direction and there is a need for a new breakthrough for the development of digital tools in the field of sports so that we can easily achieve what has been expected so far with the development of more advanced sports equipment. and

modern. Facilities and infrastructure are very important for the development and achievements of sports. (Hilda Oktri Yeni, 2020b; Rachmat Agusli, 2021)

The latest advances in technological innovation in the field of sports are urgently needed for facilities and infrastructure in the field of sports. Technological innovations in the field of sports are expected to increase effectiveness, efficiency and accuracy so that they can assist in terms of more valid tests and measurements. The new technology in this study is test and measurement technology sit and reach sensor-based which functions to measure the flexibility of the back muscles using sensor-based technology. The importance of this research is to help sports coaches and educators in training young athletes to develop jumping skills, because jumping is a fundamental technique in almost all sports. In addition, the overall definition of this research is to change manual test and measurement tools towards the use of technology so that it is expected to be able to increase the level of validity of the test kits. One of the test tools that will be developed by researchers is tests and measurements sit and reach sensor based.

The components of physical condition consist of strength, speed, endurance, and flexibility. The four components cannot be separated from one another. One component of the physical condition which is the object of research is flexibility. According to (Imran Akhmad, 2017) "Flexibility or flexibility is the ability to move within the widest range of joint motion". Flexibility is a component that some coaches or athletes sometimes forget. In fact, one of the benefits of flexibility is reducing the risk of injury. Even flexibility can increase one's efficiency in carrying out movements. One of the flexibility that is often measured is the flexibility of the back muscles (back

muscles and hamstrings) or the joints involved are the leg joints (hip joint).

Flexibility is the ability to move the joints with a very wide range of motion, according to (Antoni, 2021) Flexibility means the range of motion of one joint or several joints. He further stated that there are two kinds of flexibility, namely (1) static flexibility, and (2) dynamic flexibility. In static flexibility is determined by the size of the range of motion (range of motion) one joint or several joints. The benefits and goals of having broad flexibility, namely, making muscles and joints healthier, reducing stress on muscles and releasing muscle tension during exercise, making postures more balanced, flexibility is divided into 2, namely dynamic and static, dynamic is a person's ability to move straight at high speed, static is the ability of a person to move widely slowly. Broadly speaking, the factors that affect the level of a person's flexibility include; the elasticity of muscles, tendons and ligaments, bone structure, joint shape, body temperature or temperature, age , gender. The back muscle flexibility instrument that is often used is Bench/Meja Sit and Reach Sit and Reach Test. There are also those who measure it with a bow and compass manually.

Researchers try to describe the advantages of research tools that researchers design are efficient and effective. The effective meaning is the tool that the researcher designed does not change the tests and measurements of sit and reach. That means that researchers designed by researchers are connected to sensors sent via an Android-based application and the tool does not use an iron framework in designing the tool. While the intended efficiency is the tool that the researcher designed, portable can be carried anywhere with not too many components used but does not reduce the validity of the test kit.

Then the researcher conducted a needs analysis on 10 athletes who often carried out tests and measurements, the needs analysis here is meant to see how far the test and measurement tools that the researcher will design are used, whether they are needed by them. user (user). From the needs analysis that the researchers carried out through questionnaires compiled by the researchers, it can be seen that 100% of athletes have taken tests and measurements sit and reach 100% of athletes are still doing tests and measurements sit and reach conventionally, 100% of athletes wanted to say they had never tried sensor-based tests and measurements, 100% of athletes and coaches said they needed sensor-based tests and measurements of back muscle flexibility and 100% of athletes wanted new test and measurement tools.

The results of the analysis carried out by the researcher gave rise to ideas and ideas for conducting research with the title "Development of Test and Measurement Tools Sit And Reach Digital-Based" which later these test kits can make it easier for athletes in terms of use and maintenance. With this tool, the researchers hope that in the future athletes and/or other sports practitioners will no longer have difficulty knowing how much flexibility the back muscles produce. This tool will also help to maximize the ability of athletes as self-evaluation material.

CONCLUSION

From the results of the research that has been done, the researchers concluded that the test and measurement tools sit and reach This digital-based is feasible to be used in conducting tests and measurements sit and reach digital based. With the development of test and measurement tools sit and reach digital-based that researchers have developed, p stakeholder sports fields can more easily view tests and

measurements sit and reach digital-based athletes and can also be used as evaluation material, especially in improving the ability of athletes' back flexibility. This development research produces a product test and measurement tools sit and reach digital based, which is expected to work effectively and efficiently so that it can be an attraction for athletes and coaches in activities to find flexibility for athletes as well as for future researchers. This test tool is expected to provide convenience in the implementation of measuring the flexibility of the athlete's back muscles as well as accuracy in seeing the results of the athlete's ability to flex. In carrying out tests and measurements the data will go directly to the IOP device in the Android system.

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