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Innovation for Development of Integrated Digital-Based Jump Power Meter Test for Measuring Limb Muscle Power in Athletes: Aiken Validity and Inter-rater Reliability

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Abstract: Technological advancements create favorable conditions for the world of sports, demonstrating the strength and management of sports through technology. In the 4.0 era, the sports evaluation process is digital already. The test instrument to measure leg muscle power is still done manually today, so a digitally based conceptual design of the leg muscle power instrument is required. Jump power meter (JPM) based on integrated digital technology is an innovative test instrument for limb muscle power with modern technology and the practicality of inputting data. However, for further development, a design assessment by an expert should be carried out. This study aimed to develop a digital-based integrated JPM conceptual design to measure leg muscle power, then tested for content validity and inter-rater reliability. A qualitative and quantitative research method was used with documents and five experts. The first stage of this study was document analysis and field observations, followed by data collection using the Delphi technique in the second stage. The rating scale used was 1-5. The content validity formula for this research was Aiken. Reliability was tested using Cronbach Alpha, while interclass coefficient correlation was used to test the conceptual design of JPM. The study found that the conceptual design of the test instrument to measure jump power could be used to measure an athlete's leg muscle power. Based on the findings of this study, the Aiken coefficient was in the range of 0.85-1.00, with Cronbach Alpha reliability of 0.587>0.6. Meanwhile, the ICC agreements of one rater and between raters are 0.221 and 0.586, respectively. As a result, it can be concluded that the instrument has a high level of content validity and reliability in all aspects.

Keywords: test innovation, jump power meter, integrated digital technology.

用於測量運動員肢體肌肉力量的基於數字的綜合跳躍功率計測試的開發創新：艾肯效度和評分者間信度

摘要：技术进步为体育世界创造了有利条件，通过技术展示了体育的实力和管理。4.0 时代，体育评价过程已经数字化。测量腿部肌肉力量的测试仪器今天仍然是手动完成的，因此需要基于数字化的腿部肌肉力量仪器概念设计。基于集成数字技术的跳跃功率计（摩根大通）是一种具有现代技术和输入数据实用性的创新型肢体肌力测试仪器。但是，为了进一步开发，应由专家进行设计评估。本研究旨在开发一种基于数字的综合摩根大通概念设计来测量腿部肌肉力量，然后测试内容有效性和评分者间可靠性。对文件和五位专家使用了定性和定量研究方法。本研究的第一阶段是文件分析和实地观察，其次是在第二阶段使用德尔菲技术收集数据。使用的评级量表为 1-5。本研究的内容效度公式为艾肯。使用克朗巴赫阿尔法测试可靠性，而使用类间系数相关性测试 JPM 的概念设计。研究发现，测量跳跃力的测试仪器的概念设计可用于测量运动员的腿部肌肉力量。根据本研究的结果，艾肯系数在 0.85-1.00 范围内，克朗巴赫阿尔法信度为 0.587>0.6。同时，一名评估者和评估者之间的 ICC 协议分别为 0.221 和 0.586。因此，可以得出结论，该工具在各个方面都具有高水平的内容

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效度和信度。

关键词：测试创新，跳跃功率计，集成数字技术。

1. Introduction

The Law of the Republic of Indonesia article 20 paragraph 3 of 2005 concerning the national sports system states that there are various efforts to improve the ability and potential of sports to raise the dignity of the Indonesian nation so that sports-related to achievement are implemented through coaching and development in a planned and sustainable manner supported by sports science and technology [1]. It should be emphasized that science and technology play an important role in optimizing sports performance because knowledge and technology are needed in almost every area of life, especially in the 4.0 era where the sports system already uses digitalized tools. This kind of statement is reinforced by other literature, which reveals that success in achieving peak performance is at least influenced by two factors, including internal and external factors. Examples of external factors, in this case, are parental support, training programs, research results, environment, facilities, infrastructure, and more advanced technology [2].

Knowledge and technology are two inseparable things. Technology comes from Greek, which means "art," so technology creates innovations [3]. In addition, technology also refers to someone's knowledge to do something, then design it to be produced and distributed as goods for services [3]. Technology in sports is very important. One of the reasons is that when a country is not technology literate and does not want to change to something more advanced, then that country's position will be far behind other countries. Today, the innovation of developing a tool is quite legendary, as can be seen in general in computing and gadgets [4]. In this field, innovation and selection of new models never stop. This fact then becomes the basis that in the 4.0 era, innovation from technology can improve and affect a person's performance. The results of the literature review state that technological innovation has become an agenda in some sports organizations because it has an impact on performance [5]. Innovation can be defined as a process of introducing ideas that have emerged from critical thinking so that its presence is expected to be able to create a technology in the form of a better tool with high novelty [5, 6]. This idea is reinforced by other literature that innovation is a way to find technology and knowledge in an area and a country to realize better development [6].

Sports that refer to the development and improvement of achievement cannot be separated from technology. Technology is the most important aspect to increase competitiveness internationally in the sports industry [6]. In the 4.0 era, the world of sports requires a touch of technology for performance improvement activities to be effective and efficient [6]. Some experts state that the world of sports requires science and bright ideas to continue to develop their knowledge optimally [7]. In line with another opinion, it is stated that science requires advanced technology that puts forward innovation that can have a real impact on people's lives, especially in sports [6].

Indonesia is a developing country where the implementation of science and technology for sports coaching achievement is still low. The low utilization of science and technology is caused by the lack and limitation of sufficient funds and human resources [2]. One of the products is a prototype used to create synergy between academics and experts in technology. Prototype development is expected to educate individuals and organizations to be more independent and catch up in more advanced fields of science and technology [2]. The development referred to here is a tool to support and facilitate coaches and athletes to be more advanced and easier in conducting tests and measurements. A tool to support athletes' success needs to be developed. In particular, the tool that needs to be developed is a test instrument to measure the athlete's ability digitally.

Tests and measurements are an important part of sports because they are useful for seeing the ability and progress of the exercises that the coach has programmed. Another opinion reveals that some of the purposes of conducting tests and measurements are to predict future performance, identify physiological strengths and weaknesses, track and evaluate performance over time and manipulate exercise doses [8].

Apart from the stated objectives, the intended and standard tools are available; it is just that the way it works is still manual based. Examples of such equipment are tools used to measure leg muscle power tests, namely vertical jumps and standing broad jumps, where these instruments can be cheap and economical. On the other hand, developed countries have developed a more sophisticated and accurate tool to meet the needs in sports. The importance of the developed instrument is very helpful in achieving more optimal success. For this reason, a test to measure leg muscle power with a touch of modern technology needs to be considered. Based on this background, the researchers began to innovate by developing a test instrument to

measure leg muscle power based on an integrated digital system to measure leg muscle power. After a conceptual design is prepared, the next step is to test content validity and reliability between raters.

Validity is an important part of compilation design in development research [9-12]. Content validity is used to develop a design at an early stage where items related to the conceptual dimensions will be reviewed further [13, 14]. Content validity plays an important role in supporting construct validity [15]. In addition, reliability is defined as the expert's answer consistency to the questions [15]. Therefore, this study aims to test the content validity and reliability between raters on the conceptual design of the JMP test instrument based on an integrated digital system.

2. Material and Methods

2.1. Sampling and Data Attainment

This research is development research where quantitative and qualitative approaches are combined to obtain complete and valid data [11]. Quantitative and qualitative research methods are often referred to as mixed methods. Mixed methods are when researchers combine qualitative and quantitative research that is carried out simultaneously or one by one, aiming to examine the problem in depth [16]. The participants in this study were documents and five experts. The five experts consisted of two electrical experts and three sports test and measurement experts with doctoral degrees. There are six stages in this research. Stage 1 is the stage to analyze qualitative data, namely analysis of textbook documents, ebooks, and journal articles. Field observations are also carried out to obtain an appropriate conceptual design. In stage 2, a conceptual design has been produced, called an integrated digital-based JMP test instrument. The questionnaire and test scores are prepared with an assessment scale of 1-5 in step 3. In stage 4, the conceptual design is prepared using the Delphi technique is submitted to experts for later evaluation. At this stage, researchers meet one by one expert who will assess the designs that have been prepared until a consensus is reached [17-19]. Quantitatively, the research step carried out in stage 5 is to analyze the results of the assessments of the five experts using the Aiken formula [20]. This step aims to test the validity of the conceptual design content prepared. The last stage or stage 6 is a step in research that is used to test reliability using the Cronbach alpha formula and interclass coefficient correlation [21, 15].

2.2. Data Analysis

Data analysis in this study was carried out using the Aiken formula [20], while reliability measurements were carried out using Cronbach alpha and interclass coefficient correlation (ICC). This data analysis technique is processed with the help of the SPSS 20 application. The following is the Aiken Lawshe formula:

$$V = S / [n (C-1)]$$

where S = r – lo, Lo - lowest score, C - highest value, R - score given by the rater.

3. Results

3.1. JPM Conceptual Design Based on Integrated Digital System

A conceptual design was found for further development based on a qualitative analysis conducted by reviewing documents, journal articles, textbooks, and ebooks and strengthened by field observations of the urgency and need for an integrated digital-based power test. The conceptual design can be presented as follows:

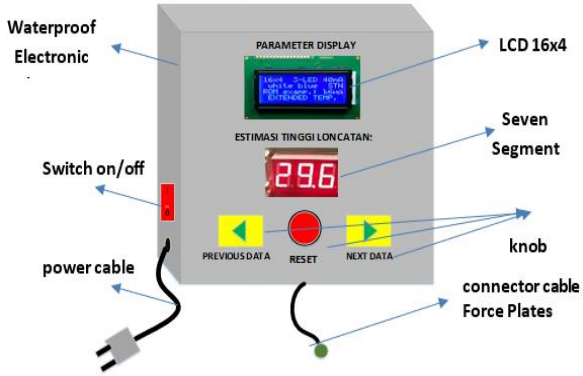

Fig. 1 Conceptual design of integrated digital-based JPM

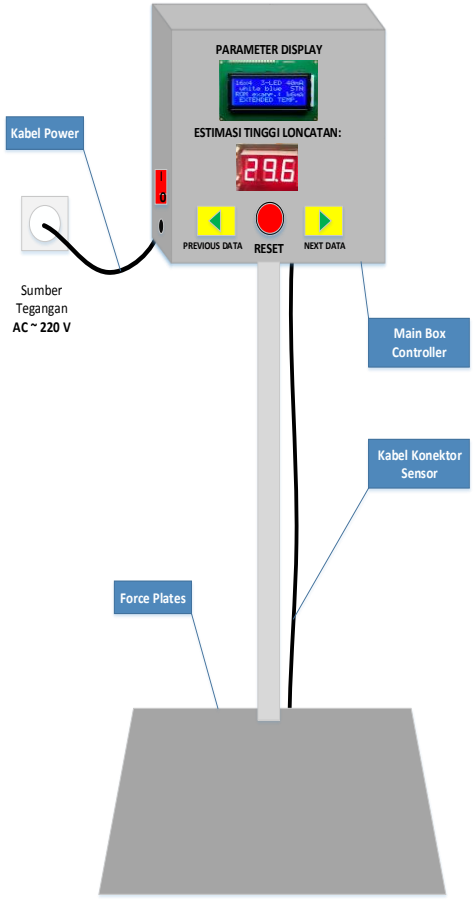

Fig. 2 Conceptual design of integrated digital-based JPM

Table 1 Specifics of JPM research products based on an integrated digital system

Component	Specifications	Utility
Plate	Hollow iron 40x60 mm with a thickness of 2 mm	Plate Frame
	Iron plate border 2 mm	Plate base for weighing and stepping
Load cell	500 kg	Weight meter
Tripod	Carbon- Velbon cx 640	Stanchion box load cell and cable channel to box
Box	Acrylic	A place for electronic component circuits, display measurement results
Electronic Components	1 set of Atmel ATmega 32 microcontroller	System programming components
	1 set sensor unit hx711	Timer component
	18650 battery charging system module	Electric power system
	2004 LCD module	Show data
	Atm microcontroller programmer ATmega	Programming system

3.2. Procedure of Usage and Analysis

Stage 1: The person being tested is asked to climb onto the force plate equipped with a load cell sensor. After he climbed onto the fore plate, the system will measure his weight in a stable condition.

- Shortly after the weight measurement results appear, the system will instruct to jump, marked by a sound on the alarm buzzer.
- The person being tested jumps right away.

Stage 2: The stage focuses on the process of collecting data on the strength of repulsion and the time of repulsion just before the test person takes off from the force plate

Stage 3: At this stage, the person being tested has taken off from the force plate and made a jump until he lands back on the force plate

- The system calculates the estimated height based on the parameters that have been obtained.
- When the person being tested has landed, the force plates will detect a significant change in pressure as a sign that the user has made the landing process.
- When the landing process is detected, the system will display the results of all the parameters obtained on the LCD layer. The measurement parameters are the user's body, the strength of the repulsion pressure, the time of repulsion, and the estimated height obtained from the vertical jump made by the user.

3.3. Results of Validity Test

Content validity analysis was conducted using the Aiken formula found the results described in this section. The validity test results are shown in Table 2 below.

Table 2 Results of Aiken's analysis on conceptual design of JPM

		Expert						
		A	B	C	D	E	∑s	V
Question 1	Score	5	5	5	5	5	20	1.00
	S	4	4	4	4	4		
Question 2	Score	4	5	4	4	5	17	0.85
	S	3	4	3	3	4		
Question 3	Score	4	5	5	5	5	19	0.95
	S	3	4	4	4	4		
Question 4	Score	5	5	5	4	5	19	0.95
	S	4	4	4	3	4		
Question 5	Score	4	5	4	5	5	18	0.90
	S	3	4	3	4	4		
Question 6	Score	5	5	5	5	5	20	1.00
	S	4	4	4	4	4		
Question 7	Score	5	5	4	5	5	19	0.95
	S	4	4	3	4	4		
Question 8	Score	4	5	5	4	4	17	0.85
	S	3	4	4	3	4		
Question 9	Score	4	5	4	5	5	18	0.90
	S	3	4	3	4	4		
Question 10	Score	4	4	5	5	5	18	0.90
	S	3	3	4	4	4		
Question 11	Score	5	5	5	5	5	20	1.00
	S	4	4	4	4	4		

The results of Aiken's analysis on the first question related to the conceptual design of JPM has a practical and simple design, got a V value of 1.00. The second question, namely the conceptual design of JPM, which has simplicity in its operation, got a V value of 0.85. The third question related to the conceptual design of JPM has simplicity in the procedure for conducting tests, obtained a V value of 0.95. The fourth question regarding the conceptual design of JPM has the simplicity of the amount and information obtained from the data related to the ability of leg muscle power received a V value of 0.90. Furthermore, the value of V obtained in the fifth question related to the conceptual design of JPM having simplicity in how to inform the data was 0.90. In the sixth question, the value of V is related to the acceptability of the trainer to use JPM so that the leg muscle power can be known as 1.00. In the seventh question related to the acceptability of the athlete's side to use JPM as a tool to determine leg muscle power, the V value of 0.95 was obtained. The V value in the eighth question related to JPM measuring and determining bodyweight was 0.85. Similar to the fourth and fifth questions, the ninth question related to the ability of the JPM tool to accurately measure the jump time got a V value of 0.90. Likewise, in the tenth question, which obtained a V value of 0.90, this question was asked about the ability of the JPM tool to measure and know the jump height accurately. In the eleventh question, the V-value got 1.00.

3.4. Reliability Results of Cronbach Alpha

Reliability results of Cronbach Alpha are shown in Table 3 below.

Table 3 Cronbach Alpha reliability results

N	r-table 5%	Cronbach Alpha	Status
5	0.878	0.587	Reliable

Cronbach Alpha analysis obtained a value of 0.587 > 0.6. This result indicates the consistency of answers from 5 experts to the researcher's questions. Thus, it is concluded that the measuring instrument is reliable.

3.5. Reliability Results of Interclass Correlation Coefficient (ICC)

Based on the results of the ICC analysis, it was found that the agreement of one rater was 0.221, and the agreement between raters was 0.586. These results indicate a good agreement following the expert's opinion which stated that the category of agreement value between raters > 0.75 included a fairly good consistency [15].

Table 3 Results of interclass correlation coefficient (ICC)

	Interclass correlation	95% Confidence Interval		F-Test with True Value 0			
		Lower Bound	Upper Bound	Value	Df1	Df2	Sig.
Single Measures	0.221[a]	0.021	0.565	2.667	10	40	0.013
Average Measures	0.586[c]	0.098	0.867	2.667	10	40	0.013

4. Discussion

Advances in information technology encourage favorable conditions in the world of sports. Besides, information technology facilitates practicing and evaluating individually and in teams [22]. Sports achievement in its development requires adequate technology, especially in the 4.0 era, a digitalized world where the data input processor for evaluation of sports is carried out using a touch of modern technology. Reinforced by experts, the use of technology and information in sports shows how far the strength and management of sports exist. For this reason, brilliant ideas are needed to compile a conceptual design that can become a digital-based program or tool in the future. One of the test instruments developed is an integrated digital-based JMP. The function of this JPM is to measure leg muscle power in athletes. One of the reasons for this JPM development is that the measurement of leg muscle power used so far is still manual-based. The instrument can be feasible if it has a degree of validity and reliability > 0.6. Another opinion explains that validity and reliability are two important aspects of evaluating a good measuring instrument [23].

This research is a mixed qualitative and quantitative research. Measuring content validity requires a mixed-method because the data developed uses quantitative and qualitative methods that are informative where the process is repeated until consensus occurs [24]. The qualitative stages are: (1) analyzing documents in the form of ebooks, textbooks, journal articles, and field observations to obtain a suitable conceptual design (2) finding a test innovation called an integrated digital-based JMP, (3) compiling questionnaires and indicators.-indicators according to content and needs, (4) assessing research questionnaires containing test indicators (JPM) to five experts using the Delphi technique until consensus is reached. The fifth step in this research is included in the quantitative stage, namely (5) analyzing the data obtained from the assessment of the five experts with the Aiken formula, (6) testing the reliability using the Cronbach alpha formula and the interclass coefficient correlation (ICC).

The results of Aiken's analysis on the first question related to the conceptual design of JPM has a practical and simple design, got V = 1.00. The second question, namely the conceptual design of JPM, which has simplicity in its operation, got V = 0.85. The third question related to the conceptual design of JPM has a simplicity in the procedure for conducting tests, obtained V = 0.95. The fourth question regarding the conceptual design of JPM has the simplicity of the amount and information obtained from the data related to the ability of leg muscle power received V = 0.90. Furthermore, the V value obtained in the fifth question related to the conceptual design of JPM having simplicity in how to inform the data was 0.90. In the sixth question, the value of V is related to the acceptability of the trainer to use JPM so that the leg muscle power can be known as 1.00. In the seventh question related to the acceptability of the athlete's side to use JPM as a tool to determine leg muscle power, V = 0.95 was obtained. The V-value in the eighth question related to JPM measuring and determining bodyweight accurately got V = 0.85. Similar to the fourth and fifth questions, the ninth question related to the ability of the JPM tool to accurately measure the jump time got V = 0.90. Likewise, in the tenth question, which obtained V = 0.90, this question was asked about the ability of the JPM tool to measure and know the jump height accurately. In the eleventh question, the V-value related to JPM's ability to measure and determine the ability of leg muscle power accurately obtained V = 1.00. Summarizing the results obtained, the conceptual design of the JPM instrument has good content validity confirmed by that expert. The coefficient value (Aiken's V) between 0.41 and 0.60 can be said to have a moderate agreement where V = 0.081-1.00 can be said to be high [25].

The reliability analysis results using the Cronbach alpha formula found ebook = 0.587 > 0.6. This finding indicates the consistency of the answers from the five experts to the questions asked. Thus, it can be concluded that the items in this study are reliable. Reinforced by previous research, an alpha value of less than 0.6 indicates that the item is unreliable, whereas

the alpha value is greater than 0, indicating a reliable instrument [25]. The inter-rater reliability and inter-rater consistency results using the interclass coefficient correlation (ICC) formula found that the agreement reliability on one rater and between raters was 0.221 and 0.586, respectively. In other words, a good agreement has been reached. Experts suggest that the category of agreement value between raters > 0.75 indicates a fairly good consistency [15]. Based on the qualitative and quantitative analysis results, it can be concluded that the conceptual design of the JMP test instrument to measure athlete's leg muscle power has a good level of content validity and reliability between raters.

5. Conclusion

This study has developed a conceptual design for the JMP test instrument to measure leg muscle power in athletes based on qualitative and quantitative analysis. The resulting design was found to have high content validity and inter-rater reliability. Thus, the conceptual design can be continued at the next stage. The test instrument to measure leg muscle power uses manual measurement tools and tests like the standing broad jump and vertical jump. Furthermore, the manual-based test only measures the height of the jump and ignores the athlete's weight, force, or repulsion. In this case, the test is only conducted while the athlete is swinging his or her arms, and it is not measured when he or she is not. These limitations, of course, require a solution by developing a new test, namely an integrated digital-based JPM. In the future, the development of the JMP instrument will result in innovation with a high level of novelty in terms of modern technology. The data entry process was also discovered to be more efficient and accurate. It is hoped that this design will result in a perfect tool that can be used to measure and evaluate leg muscle power tests. However, it should be noted that the tester must provide a clear standard operating procedure for the athlete to follow, as the device will be unable to detect the athlete's jump data if the jump is not performed according to the procedure.

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