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Development of a Volleyball Smash Measurement Tool

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ABSTRACT

This study aims to develop a valid and reliable volleyball smash power measurement tool as a means of evaluating athlete performance. The research method employed is Research and Development (R&D) using a modified Borg & Gall model, which includes the following stages: potential and problems, data collection, product design, expert validation, product revision, and limited field testing. The research subjects for the trials were volleyball athletes from the Bolo99 Club. The developed measurement tool consists of pressure sensors, such as load cell sensors, and target areas designed to record smash power in kilograms (kg), as well as directional accuracy based on target zones. The final product is a smash power measurement device equipped with load cell sensors to measure impact pressure. Validation results indicate that the tool meets the feasibility criteria: Media Expert Validation achieved a score of 38 (95%), categorized as "Excellent," with revisions made to the microcontroller layout. Coaching Expert Validation achieved a score of 25 (78%), categorized as "Good," with revisions involving the addition of foam for device safety. Volleyball Expert Validation achieved a score of 26 (72%), categorized as "Fair," with suggestions to replace the microcontroller indicators. Furthermore, the small-group trial obtained a score of 201 (93%) in the "Excellent" category, and the large-group trial obtained a score of 399 (92.36%), also in the "Excellent" category, both requiring no further revisions. These results demonstrate that this measurement tool can be used effectively for training and evaluating smash techniques in volleyball.

Keywords: Development of measurement tools, Smash, Volleyball

INTRODUCTION

The basic technique of the smash is used as an offensive strike to score points (Sulisna, 2024). The smash plays a vital role in scoring and overcoming the opponent's defense, making it a key skill in the game. However, to achieve proficient smashing skills, structured and effective training is required (Haprabu, 2022). The smash is characterized as an explosive movement. To improve it, the power-a combination of strength and speed-of the muscles involved in the smashing motion is essential (Widikdo, 2012). In determining smash power, a supporting tool is needed to facilitate identifying exactly how much force a player possesses. Therefore, advancements in Science and Technology (IPTEK) within the sports field have driven the development of measurement instruments, including innovative tools designed to measure specific skills such as the volleyball smash (Purwandaru et al., 2020).

Developmental research also serves to bridge the gap between existing theory and field practice. Through R&D (Research and Development), researchers can identify issues in educational or industrial practices and develop solutions based on needs analysis (Waruwu, 2024). Research conducted by (Irawan, 2020) demonstrates that developed

smash technique aids can be utilized for training; these tools are expected to help athletes improve their smashing skills effectively. A new product is developed using systematic methods and field trials to ensure it meets specific criteria or standards of quality, efficiency, and effectiveness (Okpatrioka, 2023). Based on preliminary analysis, modern volleyball requires technological innovation to achieve better performance and to support the coach's role in measuring smash power. This is particularly urgent given the current inefficiency of smash evaluations, which are still conducted manually without modified tools to measure force. Therefore, this provides the foundation for the researcher to develop a measurement instrument capable of quantifying power in the volleyball smash.

The researcher developed a measurement tool to determine volleyball smash power, utilizing a steel frame as its main structure to ensure strength and stability. At the bottom of this device, a load cell sensor is installed to detect and measure the pressure received when a smash is performed on the instrument. This load cell is mounted on a plywood sheet, which serves as a padding or impact surface for the smash. The plywood is positioned precisely over the load cell sensor so that the measurement results are more accurate, as the pressure from the smash is transmitted directly to the sensor

METHOD

The research design employed is Research and Development (R&D). Research and Development is a process or a series of steps used to develop a new product or improve existing products (Okpatrioka, 2023). Based on the original ten steps of R&D, the researcher has simplified the process into seven stages to suit the development needs, following the model by (Yasa, 2012).

a) Identification of Potential and Problems: Potential refers to anything that, when utilized, will provide added value (Sugiyono, 2013).
b) Information Collection: Identification results show that tools for measuring volleyball smash power are currently unavailable; most existing tools are designed only for smash practice.
c) Product Design: The product being developed is a volleyball smash power measurement tool. In previous development results, smash training tools functioned to deliver balls on a track that adjusted to the player's smash height.
d) Product Validation: Product validation is the process of assessing whether the product design-in this case, a new working system-will rationally be more effective than the old one (Sugiyono, 2013). The research product will be evaluated by experienced experts to assess the newly designed product and identify its strengths and weaknesses. The experts involved are: Material Expert, Media Expert, Coaching Expert
e) Product Testing (Small-Group Trial): This trial aims to obtain feedback, suggestions, and evaluations of the developed product through a small-group test involving 6 subjects.
f) Product Testing (Large-Group Trial): In this stage, a large-group trial is conducted by having subjects use the developed product and complete a questionnaire. The questionnaire results are then analyzed and validated by experts. This large-group trial involves 12 subjects.

g) Final Product: The final product of this research is the result of the expert evaluation process and direct testing with athletes to ensure the developed tool is feasible and effective.

Research Instruments

Research instrument is a tool used to obtain, process, and interpret information gathered from respondents using a standardized measurement pattern (Agustina, 2019).

1. Observation

Observation is a data collection technique conducted through direct monitoring, accompanied by systematic recording of the conditions or behaviors of the target object (Gautama, 2016).

2. Non-Test (Questionnaire)

A questionnaire is an indirect data collection technique where the researcher does not engage in a direct Q&A session with the respondents. The instrument, also referred to as a questionnaire, consists of a series of questions or statements that must be answered or addressed by the respondents (Rohman & Sarah, 2021).

The questionnaire for the volleyball expert was adapted and modified from Nugroho (2016), consisting of 7 items. The media expert questionnaire contains 10 items covering two aspects: the physical aspect and the design aspect. For the coaching expert, there are 8 items. For both the small-group and large-group trials, the questionnaire consists of 10 items adapted and modified from (Kurniawan, 2024)

Data Analysis

In this development study, the data analysis technique used is descriptive analysis with percentages. This descriptive percentage analysis is utilized to process data obtained from experts as well as trial results. The results of the data analysis serve as the basis for refining the development of the tool. The data are categorized, analyzed, and then summarized. The following formula is used to process the data:

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

Description:
P = Percentage total
F = Obtained score
N = Maximum possible score of the question items
100 = Constant

Table 1. Feasibility Percentage Categories according to (Arikuto, 2016)

Skor dalam presentase	Feasibility
<40%	Not feasible / Invalid
40%-55%	Less feasible / Poor
56%-75%	Sufficiently feasible / Fair
76%-100%	Feasible / Good

RESULT AND DISCUSSION

Analysis Phase

The analysis phase serves as the initial step in developing a product or instrument. In this study, the analytical methods employed were observation and interviews. Observations were conducted at the Bolo 99 Volleyball Club, while interviews were held with the coach of the Bolo 99 Club.

Product Design Phase

The volleyball smash power measurement tool, which was developed from a training model into a measurement instrument, is illustrated in the following design diagrams:

Figure 1. Volleyball Smash Power Measurement Tool

Expert Validation Phase

The development of this volleyball smash measurement tool was validated by three experts: a media expert, a coaching expert, and a volleyball expert. The following table presents the evaluation results from these three validators:

Table 2. Validation Results

No.	Validasi	Score		%	Criteria
		F	Max		
1.	Media expert	38	40	95	Good
2.	Coaching expert	25	32	78,125	Good
3.	Volleyball expert	26	36	72,22	Fair

Media Expert Validation

The validation of the volleyball smash measurement tool was conducted by a media expert on June 30, 2025, at the Microteaching Court at PGRI Banyuwangi of university. The validation was performed by Mr. Adi Mulyadi, S.T., M.T., using a questionnaire consisting of 10 evaluation aspects. Based on Table 4.1, the media expert validation score was 38, with a percentage result of 95%, which is categorized as "Excellent" or "Highly Feasible."

However, there were specific notes and revisions regarding the device, specifically to apply paint to the product and adjust the layout of the controller placement. Revisions were subsequently carried out on the steel frame of the product and the controller unit.

Figure 2. Product revisions based on media expert feedback

Coaching Expert Validation

The validation of the volleyball smash measurement tool was conducted by a coaching expert on July 1, 2025, at the Microteaching Court at PGRI Banyuwangi of university. The validation was performed by Mr. Agung Setiabudi, M.Pd., using a questionnaire consisting of 8 evaluation aspects. Based on Table 4.1, the coaching expert validation score was 25, with a percentage result of 78.125%, which is categorized as "Good" or "Feasible." However, there was a minor revision requiring the addition of foam padding to the steel frame.

Figure 3. Revision results based on coaching expert feedback

Volleyball Expert Validation

The validation of the volleyball smash measurement tool was conducted by a volleyball expert on July 2, 2025, at the Microteaching Court at PGRI Banyuwangi of university. The validation was performed by Mr. Danang Ari Santoso, M.Pd., using a questionnaire consisting of 10 evaluation aspects. Based on Table 4.1, the volleyball expert validation score was 26, with a percentage result of 72.22%, which is categorized as "Sufficiently Feasible" or "Fair." However, there was a minor revision regarding the microcontroller indicator, specifically changing the term "power" to "strenght" (force/power).

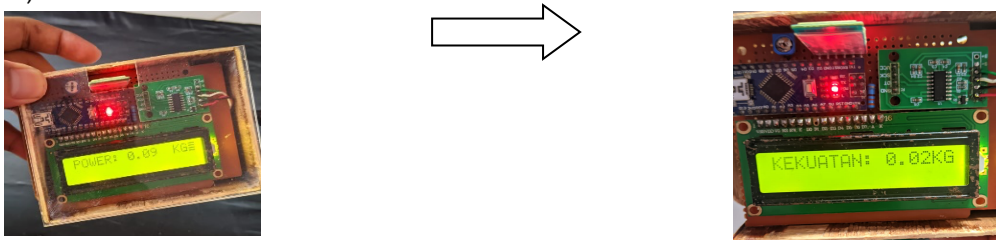

Figure 4. Changes to the indicator

Small-Group Trial

The development of this volleyball smash measurement tool involved a small-group trial with 6 volleyball athletes on July 13, 2025, at the Bolo99 Volleyball Club. The results of the trial are shown in the following table:

Table 3. Small-Group Trial Validation Results

No.	Name	Score		%	Criteria
		F	Max		
1.	Responden 1	29	36	80,5556	Good
2.	Responden 2	34	36	94,4444	Good
3.	Responden 3	35	36	97,2222	Good
4.	Responden 4	35	36	97,2222	Good

5.	Responden 5	33	36	91,6667	Good
6.	Responden 6	35	36	97,2222	Good
Total		201	216	93,0556	Good

Based on Table 4.2 above, the results of the small-group trial show that Respondent 1 obtained a score of 29 (80.55%) categorized as 'Good/Feasible'; Respondent 2 obtained a score of 34 (94.44%); Respondent 3 obtained a score of 35 (97.22%) categorized as 'Good/Feasible'; Respondent 4 obtained a score of 35 (97.22%) categorized as 'Good/Feasible'; Respondent 5 obtained a score of 33 (91.66%) categorized as 'Good/Feasible'; and Respondent 6 obtained a score of 35 (97.22%) categorized as 'Good/Feasible'. Overall, the small-group trial achieved a total score of 201 out of a maximum score of 216*, with a final percentage of 93.05%, which is categorized as 'Highly Feasible.' There were no revision notes for the product during this small-group trial, allowing the research to proceed to the large-group trial. These data are presented in the graphical form shown in the figure below.

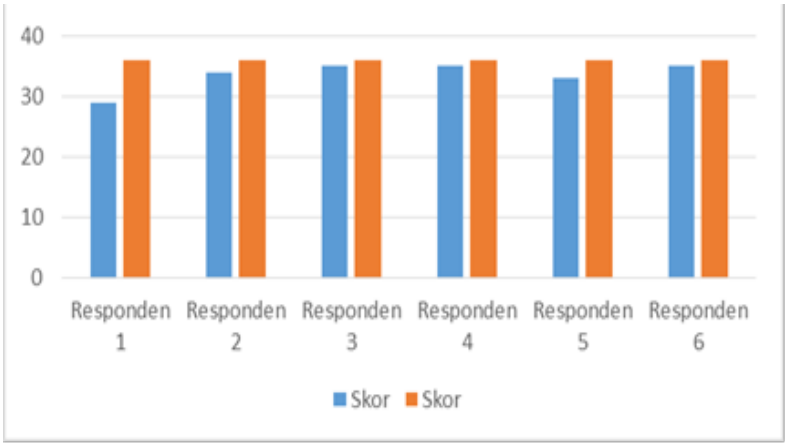

Figure 5. Small-Group Trial Results Chart

The following is an image of the volleyball smash measurement tool, which remained unmodified following the small-group trial, as shown in the figure below:

Figure 6. Volleyball smash measurement tool from the small-group trial

Large-Group Trial

The development of the volleyball smash measurement tool proceeded to a large-group trial involving 12 volleyball athletes from the Bolo99 Club. This trial was conducted on July 16, 2025, at the Cungking regional court. The results of this trial are presented in the following table:

Table 4. Large-Group Trial Results

No.	Nama	Total Score	Max	%	Criteria
1.	Responden 1	29	36	80,5556	Good
2.	Responden 2	35	36	97,2222	Good
3.	Responden 3	35	36	97,2222	Good
4.	Responden 4	35	36	97,2222	Good
5.	Responden 5	33	36	91,6667	Good
6.	Responden 6	35	36	97,2222	Good
7.	Responden 7	34	36	94,4444	Good
8.	Responden 8	27	36	75	Fair
9.	Responden 9	34	36	94,4444	Good
10.	Responden 10	34	36	94,4444	Good
11.	Responden 11	34	36	94,4444	Good
12.	Responden 12	34	36	94,4444	Good
Total		399	432	92,3611	Good

Based on Table 4.3 above, the results of the large-group trial are as follows: Respondent 1 obtained a score of 29 (80.55%); Respondent 2 obtained a score of 34 (94.44%) categorized as 'Good/Feasible'; Respondent 3 obtained 35 (97.22%) categorized as 'Good/Feasible'; Respondent 4 obtained 35 (97.22%) categorized as 'Good/Feasible'; Respondent 5 obtained 33 (91.66%) categorized as 'Good/Feasible'; Respondent 6 obtained 35 (97.22%) categorized as 'Good/Feasible'; Respondent 7 obtained 34 (94.44%); Respondent 8 obtained 27 (75%) categorized as 'Sufficiently Good/Fair'; Respondents 9 through 12 each obtained a score of 34 (94.44%) categorized as 'Good/Feasible.'

Overall, the large-group trial achieved a total score of 399 out of a maximum score of 432, resulting in a final percentage of 92.36%, which is categorized as 'Highly Feasible' or 'Excellent.' There were no revision notes recorded during the large-group trial. These data are presented in the graphical form illustrated in Figure 8.

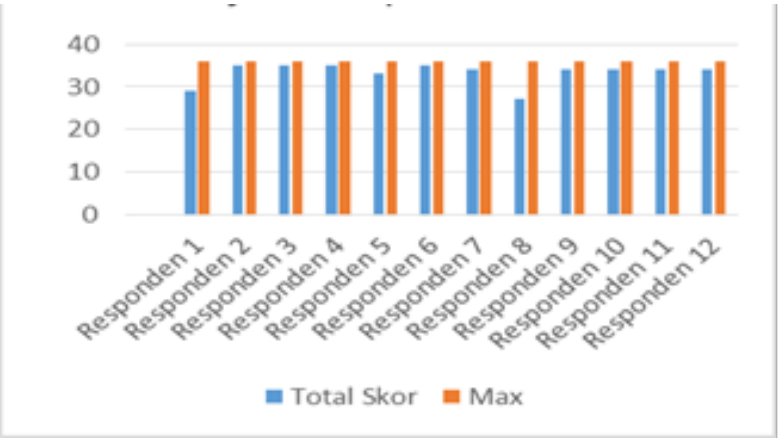

Figure 7. Large-Group Trial Results Chart

Discussion

The results of the field trials and data analysis were utilized for final refinements to ensure the developed product is ready for optimal application within the Bolo99 Club training program, supporting the measurable and efficient improvement of the athletes' smash techniques. The development of this tool involved a series of systematic stages to produce a device that effectively assists training and enhances athletic performance. This volleyball smash training aid was developed using hollow steel for the frame and load cell sensors to measure smash power. The measurement tool was validated by three experts: a media expert, a coaching expert, and a volleyball expert.

Validation results from the small-group trial indicated that nearly all respondents provided scores close to the maximum value, with evaluation percentages ranging from 80.55% to 97.22%. This suggests that the measurement tool was rated as excellent and feasible by the small-group participants. The total score from the six respondents was 201 out of a maximum of 216, resulting in a percentage of 93.05%. This percentage falls into the "Highly Feasible" category, indicating that the tool possesses high quality and validity based on this initial testing.

Furthermore, validation results from the large-group trial showed that the majority of respondents provided positive evaluations, with scores and percentages nearing the maximum. One respondent (No. 8) provided a slightly lower score with a percentage of 75%, categorized as "Sufficiently Feasible" or "Fair"; however, it still indicates that the tool is accepted and considered adequate. The total score from all respondents was 399 out of a maximum of 432, yielding a percentage of 92.36%. This falls into the "Feasible" or "Good" category, signifying that the volleyball smash measurement tool was very well received by a larger, more representative group compared to the previous small-group trial.

The selection of steel as the primary material ensures the tool is durable and sturdy, while key features include sensor paddings, protective support frames, and force sensors for power measurement.

CONCLUSION

This research resulted in a volleyball smash power measurement tool utilizing load cell sensors. The data obtained from the development process are as follows: Media Expert Validation achieved a score of 38 (95%), falling into the "Excellent/Highly Feasible" category, with revisions made to the microcontroller layout. Coaching Expert Validation achieved a score of 25 (78%), falling into the "Good/Feasible" category, with revisions

including the addition of foam padding to ensure device safety. Volleyball Expert Validation achieved a score of 26 (72%), falling into the "Fair/Sufficiently Feasible" category, with a revision to replace the indicators on the microcontroller. The Small-Group Trial achieved a score of 201 (93%), falling into the "Excellent/Highly Feasible" category with no further revisions. The Large-Group Trial achieved a score of 399 (92.36%), falling into the "Excellent/Highly Feasible" category with no further revisions. In conclusion, the development of this smash power measurement tool overall achieved "Appropriate" and "Highly Appropriate" validation levels. Following the revisions suggested by the expert validators, the tool is deemed feasible and ready for use.

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