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Designing an Automated Badminton Shuttlecock Launcher to Enhance the Athletic Performance of Badminton Players

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Abstract

This research aims to develop an automatic shuttlecock throwing/launcher device and reveal the suitability of this device for badminton experts and athletes. This research is research and development (R&D) research. The flow of development research carried out is 1) potential problems, 2) problem analysis, 3) initial product, 4) expert validation and revision, 5) small-scale trials and revisions, 6) large-scale trials and revisions, and 7) final product. Three experts assessed this tool, including media experts, badminton coaches, and sports experts (academics). The research subjects used in the small-scale trial stage were badminton athletes from the PB Pratama Surabaya club with 12 athletes. In comparison, 41 athletes from 4 different clubs were used in the large-scale trial stage. The research results show that this shuttlecock launcher was declared feasible from expert validation after revision, small-scale trials, and large-scale trials. From the three stages of research, a feasibility percentage value of more than 80% was obtained, so it can be concluded that the shuttlecock launcher developed has good feasibility. The conclusion is that this badminton shuttlecock throwing device with a remote control as a controller that coaches can use has been declared feasible and ready for mass production. So, it will impact increasing the efficiency and effectiveness of the coaches' performance in developing the abilities of badminton athletes.

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INTRODUCTION

There are many sports worldwide, and one famous is badminton (Phomsoupha & Laffaye, 2015). This is proven by the estimated number of people playing this sport more than 300 million people in the world (Badminton World Federation, 2020). The sport that uses this racket is known as the fastest racket sport in the world (Ramasamy et al., 2021; Towler et al., 2023) because the speed of the shuttlecock can reach more than 250 km/hour at the elite athlete level (Malwanage et al., 2022). Currently, badminton is known as an explosive and high-intensity sport (Guven et al., 2017; Kuntze et al., 2010).

Badminton is a popular sport in Indonesia because it has won many medals internationally and is even the only sport capable of bringing gold medals at the Olympics (D. W. P. Dewi et al., 2021; Indrayani & Sunarto, 2019; Maksum & Indahwati, 2023; Prastya et al., 2022). However, Indonesia's badminton sporting achievements have been declining in recent periods. This happened because of the inconsistency of Indonesian badminton athletes, which reduced athletes' achievements and performance (Labib Siena Ar Rasyid et al., 2023; Purwanti, 2023). It can be seen from several super series tournaments in the Sudirman Cup 2023, Thailand Open 2023, Indonesia Open 2023, Canada Open 2023, Korea Open 2023, and Japan Open 2023 that they have 0 titles (Thalia, 2023). Even at the 2022 Asian Games, Hangzhou also won 0 titles.

This decline in badminton performance needs to be a concern so that the glory of Indonesian badminton can return to good. One thing that needs to be considered is the coaching process carried out. A good coaching process through training will produce quality athletes capable of achieving achievements (Haugen et al., 2019). To achieve good sports development, it is necessary to be supported by adequate sports infrastructure (C. Dewi et al., 2021). In badminton, several training facilities and infrastructure can make it easier for coaches and make training more efficient, one of which is the shuttlecock thrower (Tay & Xiang, 2021). When badminton athletes are practicing, they need to feed or feed the shuttlecock so they can hit it according to their learning technique. This requires an automatic shuttlecock-throwing machine that can feed the shuttlecock with a certain pattern set by the trainer (Deepandurai et al., 2020). Currently, there are many shuttlecock-throwing machines on the market. However, these products still need to be made abroad, making them difficult for regional badminton clubs to obtain. Therefore, it is necessary to develop a domestic badminton shuttlecock throwing device by providing the latest innovations and remote control as a controller by the coach.

METHODS

Types of Research

This research is development research (R & D). Development research is a product development process that systematically creates and verifies the item being developed (Rifki et al., 2021).

Model of Research and Development

The following is a description of the development model carried out:

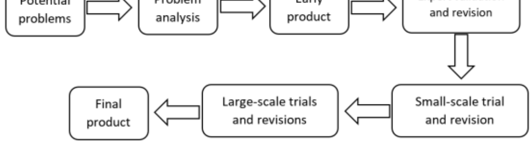

Fig 1. Research development flow (Mustofa et al., 2022)

Research Stages and Procedures

The stages in this research consist of (1) the pre-development stage, (2) the product development stage, and (3) the product validation stage. In the Pre-development stage, a preliminary study was carried out by surveying by asking coaches questions about the performance of badminton athletes, documenting studies regarding the difficulties coaches face in providing training to badminton athletes, as well as tools that can support them during the training process. At the development stage, steps were taken to plan and develop a prototype shuttlecock launcher.

The product validation stage is carried out to determine the suitability and practicality of the product for use in trials and to obtain input on the design of the product to be made. Product validation in this research uses content validation that considers input from experts in the field. The experts include media experts, experienced coaches, and sports experts (academics). The results of the validator assessment are assessed by applying the feasible percentage calculation as stated by Sugiyono (2017), which is expressed as follows:

$$\text{Score Percentage} = \frac{\text{Calculate score}}{\text{Criteria score}} \times 100$$

After calculating the percentage above, it continued testing the badminton shuttlecock launcher on a small and large scale with lift calculations (quantitative) to determine its feasibility value. The feasibility value is based on the Arikunto assessment guidelines 2013 (Mustofa et al., 2022).

Table 1. Feasibility assessment guidelines

No	Score (%)	Categorization
1	<40	Not feasible
2	40 – 55	Less feasible
3	56 – 75	Decent enough
4	76 – 100	Worthy

Research Subjects

The research subjects used the PB Pratama Surabaya club for small-scale trials during the trial process. In contrast, large-scale trials used SDK Badminton training, PB Bayu Kencana, PB Nikko Stell, and Jaya Raya Samudra BA.

RESULT

The results section explains it according to the development flow carried out.

Potential Problems

From the results of observations of 5 badminton clubs, it was found that, on mean coaches fed shuttlecocks manually to their athletes for more than 2 hours, meaning they stood for more than 2 hours. Additionally, trainers cannot provide correct technical direction if they are too focused on feeding the shuttlecock. Therefore, this is a potential problem for coaches. Hence, other strategies must be implemented so that coaches focus more on the corrections and direction given to athletes.

Problem Analysis

From the information obtained on the field, badminton coaches still use manual methods to feed or feed shuttlecocks to their athletes. This is considered less effective because the coach does not focus on correcting and directing the athlete's technique. Additionally, feeding or feeding shuttlecocks manually for hours makes the trainer tired and is not good for elderly trainers. For this reason, it is necessary to develop a tool similar to a shuttlecock throwing machine to assist coaches in feeding or feeding shuttlecocks to athletes so that coaches can also focus more on correcting movements and directing athletes.

Early product

This shuttlecock-throwing/ launcher device uses two throwing motors, a shuttlecock-throwing speed control, and the throwing direction. This tool also has wheels on four legs and a height adjuster. There is also a shuttlecock queue line in a tube to insert the shuttlecock continuously. This tool is also equipped with a vertical and horizontal angle control system for the shuttlecock to regulate the direction of the shuttlecock throw. To control the direction and distance of the throw, this tool is equipped with a wireless-based remote control that the trainer can control. The following is the design that has been designed.

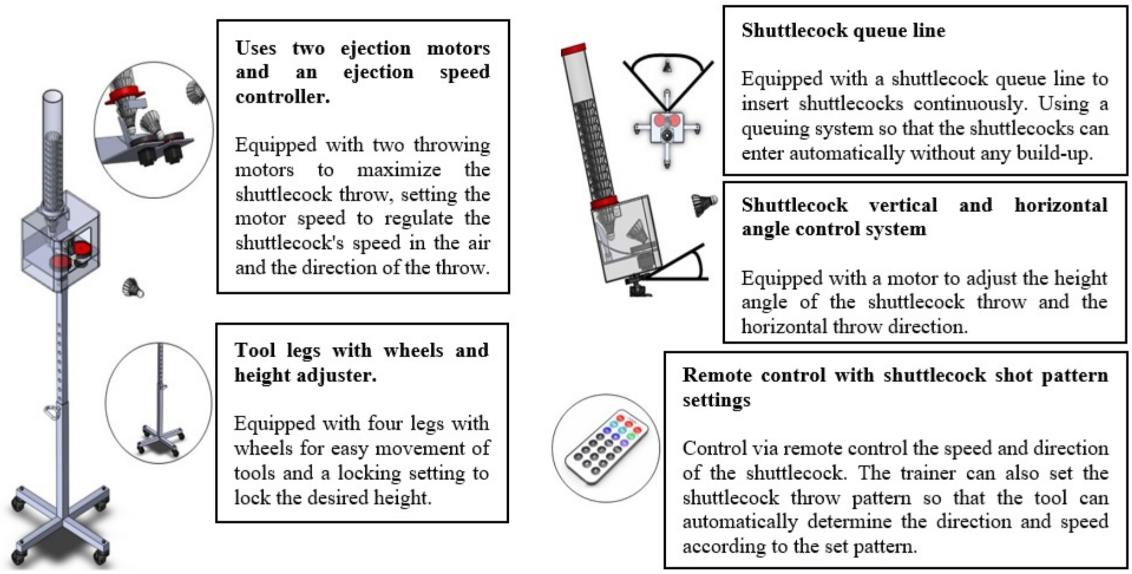

Fig 2. Automatic Shuttlecock Throwing Device Design

Expert validation and revision

Media experts carried out the validation stage for developing the shuttlecock-throwing device, experienced coaches, and sports experts. This validation aims to ensure that the product is considered suitable for use by obtaining validation from experts. This is achieved by offering input or making adjustments (revisions) to the initial product results you want to produce. The table below presents the results of expert validation regarding automatic shuttlecock launchers.

Table 2. Results of expert assessments

No	Expert validation	Calculated score	Criteria score	Percentage	Category
1	Media expert	34	52	65,38%	Decent enough
2	Badminton coach	26	32	81,25%	Worthy
3	Sports expert (academic)	22	32	68,75%	Decent enough

From the initial validation results, it was found that media experts gave a decent score with a percentage of 65.38% and notes to revise the speed controller, remote control, and tool size. Meanwhile, sports experts or sports academics were given a fairly decent score with a percentage of 68.75%, with a note that the tool was designed to be more practical. After the revision, validation was repeated, and the following values were obtained.

Table 3. Results of expert assessments

No	Expert validation	Calculated score	Criteria score	Percentage	Category
1	Media expert	48	52	92,31%	Worthy
2	Badminton coach	28	32	87,5%	Worthy
3	Sport expert (academic)	27	32	84,38%	Worthy

Table 3 shows all validators obtained the validation results after revision and adequate results. These results can be continued to the small-scale trial stage.

Small-scale trials and revisions

The results of a small-scale trial at the PB Pratama Surabaya club with 12 athletes as respondents were obtained.

Table 4. Small-scale trials

No	Respondent	Calculated score	Criteria score	Percentage	Category
1	AF	27	28	96,43	Worthy
2	DAR	26	28	92,86	Worthy
3	AD	26	28	92,86	Worthy
4	MZA	23	28	82,14	Worthy
5	AJ	24	28	85,71	Worthy
6	LS	23	28	82,14	Worthy
7	IG	23	28	82,14	Worthy
8	DS	25	28	89,29	Worthy
9	MY	27	28	96,43	Worthy
10	SS	24	28	85,71	Worthy
11	MP	26	28	92,86	Worthy
12	MA	26	28	92,86	Worthy

Table 4 shows a small-scale trial with the results of all respondents stating that the shuttlecock launcher was suitable for use. These results will be continued to the large-scale trial stage without revision.

Large-scale trials and revisions

Large-scale trials were carried out on four badminton clubs with 41 athletes as respondents. The following are the results obtained from large-scale trials.

Table 5. Large-scale trials

No	Badminton club	Respondent total	Mean score calculated	Criteria score	Percentage	Category
1	BK	15	25	28	89,29	Worthy
2	NS	9	24	28	85,71	Worthy
3	FB	8	24	28	85,71	Worthy
4	JRS	9	27	28	96,43	Worthy

Table 5 shows large-scale trials with decent mean results for the four clubs. These results indicate that the badminton shuttlecock launcher is suitable for use without revision and is ready for mass production.

Final Product

The final product from the development of a shuttlecock throwing device with a capacity of 180 shuttlecocks with a frequency of 0.9 – 5.5 seconds per shuttlecock, a horizontal angle of 30 degrees, a power source AC 100-240V, DC 24V with a power of 70 W. The tool has two throwing motors, three-wheeled legs, and a height adjuster.

Control is carried out remotely with six shuttlecock throw positions. The position of 1 set of exercises can be adjusted according to your needs, and the pattern can be saved. Here are the final product results.

Fig 3. The final product of the Shuttlecock Throwing Tool

DISCUSSION

The research results stated that this shuttlecock launcher had been declared feasible through expert validation, small-scale trials, and large-scale trials. The revision was to improve the speed controller into three types, namely front, middle, and rear speed. From the initial validation results, it was found that media experts gave a decent score with a percentage of 65.38% and noted revising the speed controller, remote control, and tool size. Meanwhile, sports experts or sports academics were given a fairly decent score with a percentage of 68.75%, with a note that the tool was designed to be more practical. After the revision, validation was carried out again and media experts obtained a feasibility value of 92.31% and 84.38% by sports experts or sports academics. Speed controller is an important aspect in the development of a shuttlecock launcher. Because ball speed has an important role in determining each shot's difficulty level (Kamijima et al., 2010; Ponnusamy, Yong, and Ahmad, 2015). If the athlete's ability is still at a lower level, then the speed of throwing the shuttlecock used is still low or slow. However, if the athlete's ability is at a high level, the speed of throwing the shuttlecock used will be faster.

Apart from that, the advantage of this tool is that it has a remote control. With the remote control, it will be easier for trainers to adjust training patterns according to the needs and goals to be achieved without experiencing fatigue in training their athletes. So far, badminton coaches still feed shuttlecocks to their athletes manually, namely by throwing or hitting the shuttlecock using a racket to practice various hitting techniques such as lobs, drop shots, smashes, drives, netting, etc (Priyanto, 2017). Feeding the shuttlecock by the coach is very important in improving the ability of badminton athletes. Harun et al. (2020) stated that badminton coaches require high accuracy, consistency, and efficiency in feeding the shuttlecock, thus requiring more training duration than necessary. The badminton coach's ability to feed at a stable and constant speed and angle or direction will be difficult if done for a long period (Kurniawan & Sukardi, 2023). This is normal due to limited conditions or human performance in providing and maintaining concentration and stamina in providing bait or feeding to athletes (Kusnaedi et al., 2018).

The results of both small-scale trials and large-scale trials show that badminton athletes feel that the throwing equipment in this study is suitable for use. In a large-scale test conducted on four clubs with a total of 41 badminton athletes, an eligibility level of 89.29% was obtained from the BK Club, 85.71% from the NS club and the FB club, and finally 96.43% from the 96.43% club. Having a launcher with a remote control will make training easier for trainers. Coaches will be able to focus more on improving and evaluating techniques and movements carried out during training and giving appreciation or praise to athletes who carry out training correctly (Balaji & Suriya, 2018). So, this shuttlecock throwing device using a remote will have a big impact on the implementation of advances in sports technology in badminton coaching because it can increase the efficiency and effectiveness of badminton coaches' performance on the field.

CONCLUSION

This badminton shuttlecock throwing device with a remote control that coaches can use has been declared feasible. Experts, small-scale trials, and large-scale trials have validated the feasibility of this tool. So, this tool can be said to be ready for mass production and will have an impact on increasing the efficiency and effectiveness of the performance of coaches in developing the abilities of badminton athletes.

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