

Development of Woodball Gate Using Acrylonitrile Butadiene Styrene Plastic Waste as a Conservation Effort in the Sports Environment

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Abstract

This research was motivated by several problems, including the difficulty of installing woodball gates during the dry season, the iron at the bottom of the gate often coming loose when in use, the gate breaking when forced into place using a hard object, the gate easily becoming porous due to being frequently submerged in water during the rainy season, the iron at the bottom of the gate often shifting position due to loose soil, and the gate often being eaten by termites. The objective of this study is to develop a Gate Woodball using Acrylonitrile Butadiene Styrene (ABS) plastic waste material for woodball athlete training. The research design used was research and development (R&D). The sample consisted of 70 senior and junior athletes, as well as three senior and junior coaches in the sport of woodball. The development procedure used the Brog and Gall development model. The research instruments consisted of expert validation (woodball, plastic, construction), athlete response instruments, and coach response instruments. The results of the study indicate that the use of Gate Woodball made from Acrylonitrile Butadiene Styrene (ABS) plastic waste can serve as a new breakthrough and is well-received by the general public, including athletes and coaches. Gate Woodball made from ABS plastic waste is considered effective as one of the methods for processing plastic waste found in our surroundings and can accelerate the waste processing process. The analysis results indicate the advantages and disadvantages between wooden gates and gates made from Acrylonitrile Butadiene Styrene plastic waste. The gate made from Acrylonitrile Butadiene Styrene plastic waste has been proven effective for training senior and junior athletes in the sport of woodball to improve their finishing skills. The gate received a "Very Good" rating from experts and positive feedback from athletes and coaches. It is hoped that the results of this study will contribute to improving the finishing stroke skills of woodball athletes, inspire the general public to develop woodball gates using other materials, and serve as a reference for researchers and students in designing better woodball gates in the future.

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INTRODUCTION

In Indonesia, there are Lots of new sports, And Not yet so. Although many sports have been introduced to Indonesia in the past 15 years, Indonesian athletes have brought honor to the country through their achievements. Some examples of new and lesser-known sports include rugby (Sani et al., 2022). Other sports include *woodball*, *gateball*, *petanque*, *kurash*, *sambo*, *kabaddi*, and many more.

In its development, the sport of *Woodball* is becoming more promising if you pursue it seriously. Proven with performance, which is end-to-end in the carving team of the national team of Indonesia. At the *9th Woodball World Championship 2024* held in Shangyu, China, Indonesia won 3 gold and two silver medals. With these medals, Indonesia emerged as the overall champion (Risna, 2019).

During training sessions, athletes encounter obstacles, one of which is the quality of the existing *gates*. *This situation hinders the training process, even though finishing skills significantly impact woodball performance.* There are many shortcomings with the current *gate*, *resulting in many athletes experiencing deficiencies in their finishing strokes.* *These shortcomings include the iron-on gate being easy to remove, the material from the gate being easily corroded and broken, the gate being less sturdy, and the price not being affordable.* Conditions in the field during training are often complained about, including several obstacles, including the condition of the gate, even though the achievements of Indonesian *woodball athletes* who compete in multi-events such as *the ASEAN Beach Games and World Championships* can present the highest achievement is as first rank men's *single stroke* number and first place in women's *single fairway*. Through this obstacle, a solution will be found so that in the future, the performance of athletes in woodball

Indonesia will be better on the international stage.

Sports have a very strategic role in shaping the quality of human resources (Sipahutar et al., 2023). Through sports, the condition of a nation can be improved. Can be changed to more Good again. Sports can instill discipline, self-confidence, independence, and awareness of the importance of maintaining health (Winarno, 2018). Awareness Community participation in sports can improve health and national development figures (Prasetyo et al., 2018). Public awareness of the importance of sports provides positive benefits to the self and the public (Purwanto & Handayani, 2022). With this awareness, people are starting to look at several sports in Indonesia for health needs and the interest in pursuing the world of athletes or achievements.

Sports in Indonesia are divided into several categories: competitive sports, recreational sports, health sports, educational sports, sports as a source of income, and community sports. Realize the importance of exercising after the COVID-19 pandemic and positively impact increasing public interest in sports, including in Indonesian society. After the end of the COVID-19 epidemic, people are starting to find out and enjoy sports, including sports that are still relatively new. In Indonesia, the only sport is soccer (Dewi et al., 2024).

Woodball sports include several important things, not only from the perspective of achievement development (Putri, 2018). *Woodball* is included in the target games that can be taught in physical education (Dewi et al., 2024). From previous research, it explains that *woodball sports* are not only included in the realm of achievement sports, but can be included in physical education learning, students can be formed their characteristics through *woodball sports*, the characters formed include discipline, self-confidence, focus in completing and facing situation in field so

that character This will help participant Educate to *survive* in everyday life. *Woodball* is a relatively new sport in Indonesia, popular among various age groups, from young to old (Goddess, 2016). *Woodball* is a target sport classified as a small ball game (Chang & Lee, 2017). *Woodball* is a sport that is almost the same as golf (Dewi & Sukadiyanto, 2015).

Game *woodball* has several techniques based on using a *mallet (woodball stick)* tool, including *swing*, long-distance hit, half hit or medium, short-range shots, and *gating or finishing shots*. At the same time, the techniques without tools include *setup positions*, *preswing* routines, and hitting movements using the ball (Dewi & Broto, 2019). How to play *woodball* this way: hit the ball from the line, and enter the goal, which is called *a gate*. The player with the fewest hits wins the game.

The sport of *woodball* uses various facilities and infrastructure. Sports facilities are equipment used for sports activities (Risna, 2019). Means: These are used in *woodball sports* as sticks (*mallets*), balls, *gates* (goals), and ropes, which are used as barriers. The field includes flags (to mark the starting and end lines of the field) and pegs. Meanwhile, the infrastructure used in the sport of *woodball* is a field track, which is given a limit with a rope or line. Field: What is used can be a large field, such as a soccer field or a field explicitly made for playing or competing in *woodball*.

In its rapid development, the sport of *woodball* in Indonesia has become... Wrong One branch sport Which promising For in persevere, Lots athletes from Indonesia who have achieved success in the international *woodball championship arena*, such as Ahris Sumariyanto Which Once occupy ranking one world on men's *single stroke* competition category, Ika Yulianingsih who ever ranked three world in number match *single stroke* daughter And Bi Three Daughter ever won the *single fairway* event *Asian Beach Games Woodball*

Championship. Besides that, *woodball* is also suitable for developing the *sports tourism sector* in Indonesia.

There are many challenges with the gates used in woodball, one of which is the quality of the existing gates. This is a serious factor that must be addressed immediately, as finishing shots significantly affect the number of hits in woodball. The following table analyzes the advantages and disadvantages of *woodball gates* made from wood and those made from plastic waste.

METHODS

This study used a *Research and Development (R&D)* method with a mixed *methods approach*, which combines qualitative and quantitative data. The development research aims to produce a specific product and test its effectiveness (Pratama et al., 2025). The product developed in this study is a *woodball gate* made from used plastic waste. The plastic waste is recycled through a melting process and then molded using a molding tool according to the shape and *gate specifications* set by the *International Woodball Federation (IWbF)*.



Figure 1. Stages of borg and gall development (Adi Susanto et al., 2022)

According to Sugiyono (2015: 409), the steps in research and development consist of 10 steps as follows: (1) Potential and problems, (2) Data collection, (3) Product design, (4) Design validation, (5) Design revision, (6) Product trial, (7)

Product revision, (8) Usage trial, (9) Product revision, (10) Mass production.

Trials were conducted in two stages: a small-scale trial involving 21 junior woodball players and three coaches in Semarang, and a large-scale trial involving 49 woodball players and three senior coaches in Central Java. Before the trials, the product was validated by material experts, plastics experts, and construction experts to ensure its content and appearance suitability. The data analysis technique used in this study was percentage calculation. This study included feasibility testing through small- and large-scale trials and effectiveness testing to assess the product's durability.

RESULTS AND DISCUSSION

In this development research, the Brog and Gall development model is used which has 10 stages in its development, therefore this research describes each stage of research from stage 1 to stage 10 to produce a woodball gate with *Acrylonitrile Butadiene Styrene plastic waste material* as a conservation effort in the sports environment and data analysis is carried out to determine the effectiveness of the tool created and to measure the acceptability of the woodball gate with *Acrylonitrile Butadiene Styrene plastic waste material* in the environment of athletes, coaches, and the general public who try and pursue woodball sports.

Acrylonitrile Butadiene Styrene plastic waste is used to train junior, senior, and student woodball athletes. In the development of this woodball gate, in addition to having a different material from the previous gate, which was made of wood, the iron at the bottom was made of 4 parts resembling chicken claws on the building, so that the resulting gate is sturdier and does not shift position. This gate, made from *Acrylonitrile Butadiene Styrene plastic waste*, is more effective for training regarding material durability and specifications.

Early development

At this stage, researchers make a product as a gate with *Acrylonitrile Butadiene Styrene plastic waste material*, based on the draft made. At the stage of making this gate begins with collecting *Acrylonitrile Butadiene Styrene plastic waste material* found in used motorbike bodies, after that through the stage of changing the used motorbike body into small powder by grinding it using a grinder, after it becomes powder, it is then inserted into an iron pipe that is used as a mold, after that it is burned using a torch connected to a small gas, after burning it is pressed using a simple jack, after that the finished material is turned using a lathe so that its shape resembles a gate with existing standards.

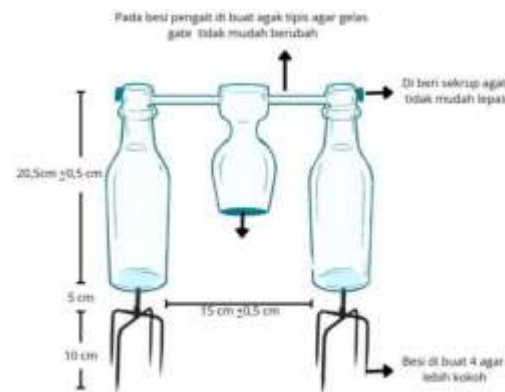


Figure 2. Initial product developed

Expert Validation

Product validation is done by presenting several experienced experts or specialists to assess the newly designed product (Sugiyono, 2015). This product feasibility assessment is carried out by three experts: a woodball expert, a plastics expert, and a construction expert, and is assessed based on responses from woodball athletes and coaches.

Woodball expert

Table 1. Results of woodball expert assessment

Indicator	N	Subject Matter Expert			Mean	Information
		Expert 1	Expert 2	Expert 3		
material quality	4	4.0	3.8	3.8	3.8	Very good
specification	6	3.8	3.8	3.7	3.8	Very good

The analysis of expert scores indicates that the woodball gate made from *Acrylonitrile Butadiene Styrene plastic waste* is classified as "very good." Based on the expert assessment, the woodball gate made from *Acrylonitrile Butadiene Styrene plastic waste* is suitable for woodball training for senior, junior, and student athletes.

Plastic expert

The plastics experts in this case are experts from Semarang State University. These experts provided assessments and input on the gate product made from *acrylonitrile butadiene styrene plastic waste*. *The results of this assessment will later be used as input for improvements and refinements to the gate using acrylonitrile butadiene styrene plastic waste.*

Table of plastic expert assessment results

Indicator	N	Subject Matter Expert			Mean	Information
		Expert 1	Expert 2	Expert 3		
material suitability	4	3.7	3.7	3.7	3.7	Very good
material quality	6	3.8	3.7	3.8	3.8	Very good

Construction expert

Table 1. Results of construction expert assessment

Indicator	N	Subject Matter Expert			Mean	Information
		Expert 1	Expert 2	Expert 3		
material suitability	12	3.8	3.5	4.0	3.8	Very good
material quality	18	3.8	3.5	3.8	3.7	Very good

The analysis of expert scores indicates that woodball gates made from *Acrylonitrile Butadiene Styrene plastic waste* are classified as "very good." Based on the experts' assessment, plastic made from *Acrylonitrile Butadiene Styrene plastic waste* is suitable for woodball training for senior, junior, and student athletes.

Small-Scale Trial

In June, a study on acrylonitrile butadiene styrene plastic waste was conducted at SMP Negeri 13 Semarang with 21 athletes. The trial was conducted by explaining to students the gates developed and how to fill out a Google form on their smartphones. All students were enthusiastic and tried the gates made from plastic waste, after which they filled out the provided Google form.

Table 3. Results of Small-Scale Trial Data Analysis

Small-scale trial of 21 students	
Item	Mean
1	3.2
2	3.0
3	3.1
4	3.3
5	3.4
6	3.5
7	3.5
8	3.4
9	3.8
10	3.4
Total	707
Percentage	84%

The results of this small-scale trial showed an average score of 84% positive responses at this stage. In this small-scale trial, there was a problem with the *Acrylonitrile Butadiene Styrene gate*: the center cup broke in the middle. Repairs will be made before the large-scale trial is conducted.

This small-scale test showed positive feedback and interest in the gate made from plastic waste. They stated that the gate was effective and innovative, and could be a way to process existing plastic waste. Several students actively asked questions about the development of the woodball gate using plastic waste, from the manufacturing process to the materials used. A summary of the students' comments and input is as follows:

Student 1: "Very cool, produce more, sis."

Student 2: "Innovative, hopefully in the future there will be woodball gates with lots of colors so that students will be more interested."

Student 3: "Overall, it is good, please improve your strengths, sis."

Student 4: "The iron is different from before; this one is easy to install."

Student 5: "Good, it does not look like it will rot easily."

Based on the results of this small-scale trial, the gate made from plastic waste received an average score of 84% for quality and specifications, based on student feedback. The gate was deemed durable, corrosion-resistant, easy to install, and a breakthrough. It is suitable for junior athlete training at SMP Negeri 13 Semarang.

In the improvement stage of this small-scale result, the product was made by considering input from several experts and students of SMP N 12 Semarang City, based on the results of large-scale tests. From the results of the small-scale test, it was found that the outer layer of the middle gate cup was cracked so that in this repair, the outer layer was coated with a layer of resin and hardener, which was mixed and coated on the gate part, both on the 2 gate legs and the gate cup in the middle.

Large Scale Trial

Acrylonitrile Butadiene Styrene plastic waste was conducted at the Diponegoro

Military Command shooting range in Semarang City, Central Java on July 20, 2025, with 49 athletes, consisting of 5 junior athletes and 46 senior athletes consisting of woodball athletes from Semarang City, woodball athletes from Bantul Regency, woodball athletes from Muhamadiyah University of Semarang and woodball athletes from Grobogan Regency. The trial was conducted by explaining to the athletes about the gates being developed and how to fill out a Google form via their smartphones.

Table 4. Results of Large-Scale Trial Data Analysis

Small-scale trial of 49 woodball athletes	
Item	Mean
1	3.7
2	3.4
3	3.7
4	3.6
5	3.7
6	3.8
7	3.7
8	3.6
9	3.8
10	3.5
Total	3.6
Percentage	92%

Based on the results of this large-scale trial, the gate made from plastic waste achieved an average score of 92% for quality and specifications, based on responses from senior and junior athletes. The gate was deemed durable, corrosion-resistant, easy to install, and a breakthrough. It is suitable for use in training for both junior and senior athletes.

This large-scale test yielded positive feedback and interest from athletes in the gates made from plastic waste. They stated that the gates were innovative and could be a breakthrough in plastic waste processing. Several athletes inquired about developing

these woodball gates using plastic waste, from manufacturing to materials. A summary of the students' comments and input is as follows:

- Student 1 "very worthy to use"
 Student 2 "It is perfect to be developed as an alternative exercise and to reduce plastic waste."
 Student 3 "Make more ABS gates."
 Student 4 "The gate is good, make more for athletes."
 Student 5 "Good, the iron is powerful and does not come off easily."

In the improvement stage of this large-scale result, the product was made by considering the input from several experts, including junior athletes and senior athletes who tried the ABS gate at the Diponegoro Military Command shooting range in Semarang City, based on the results of large-scale tests. The results of large-scale tests found that the density level had to be increased again to make it stronger when used in this improvement. The density level would be increased during the gate manufacturing process so that the gate product would be better quality than the final product.



Figure 3. Final product result Effectiveness Test

Product durability testing was conducted to determine the strength of gate materials made from ABS and wood when exposed to water (immersion) and intense sunlight. This testing evaluated the product's suitability and durability in extreme environmental conditions, particularly for long-term outdoor use.

Table 5. Product resistance test to water

No	Specimen	Before soaking	After soaking	After it dries
1	ABS	191 grams	194 grams	193 grams
	Wood	192 grams	197 grams	196 grams
2	ABS	193 grams	194 grams	194 grams
	Wood	194 grams	198 grams	196 grams
3	ABS	193 grams	194 grams	194 grams
	Wood	194 grams	200 grams	196 grams

The absorption test results show that wood absorbs more water, while ABS does not absorb much water, so ABS tends to have a constant weight.

Table 5. Weather resistance test of the product

Trial Day	Specimen	Before drying	After drying
1	ABS	208 grams	208 grams
	Wood	164 grams	164 grams
2	ABS	206 grams	205 grams
	Wood	163 grams	163 grams
3	ABS	205 grams	205 grams
	Wood	162 grams	162 grams

By conducting a test of sun exposure of the gate for 9 hours for 3 days with different specimens, namely wood specimens and ABS specimens, it can be concluded that at hot temperatures the wood specimens and ABS specimens do not experience significant weight changes, this shows that both materials are safe to use for woodball gates in terms of weight. From the results of simple laboratory tests, it can be concluded that the gate with *Acrylonitrile Butadine Styrene plastic waste material* is effective for training junior athletes, students, and senior athletes.

From a series of development stages that have been carried out using the Brog and Gall method that has gone through the

information search stage through the results of the analysis of the needs of coaches and athletes, it can be concluded that athletes and coaches need the development of woodball gates with materials other than wood because of the many obstacles that occur when using wooden gates. Athletes and coaches stated that using wooden gates is still not optimal. Although wooden gates are easily found as basic materials for making them, athletes and coaches hope for innovation in the future so that the gates used will be more effective. With the creation of woodball gates from plastic waste, it is hoped to improve athletes' achievements in the future. Several factors influence the success of finishing shots made using gates, one of which is influenced by effective and accurate hitting speed (FA Irawan et al., 2021). In addition, using adequate infrastructure will affect the results of athlete achievements if it is included in external factors (Yuliawan et al., 2022). According to R. Irawan (2017), utilizing facilities and infrastructure effectively will help improve health. Similarly, when we can innovate effectively in the sport of woodball, these facilities and infrastructure will help us become healthy individuals through exercise.

Most athletes feel the need for innovation and breakthroughs in woodball gates. During small-scale trials, 84% of athletes stated that gate quality improvements were critical for their future performance. Meanwhile, during large-scale trials, 92% of athletes expressed their opinion, through their presentation of athlete needs, that the current gates require improvements and breakthroughs. The development of woodball gates using *acrylonitrile butadiene styrene plastic waste* is expected to help support athlete performance in the future.

(Sastaman, 2023), Tool modification can improve performance, including for athletes still in school. In this case, athletes who train for POPDA, PON Remaja, and

junior athletes can utilize gates made from plastic waste to practice independently, so that their finishing stroke skills will be more accurate. Through this modification of the tool, their achievements will increase in the future. After going through small and large-scale trials, several improvements were made, considering input from woodball experts, plastic experts, and construction experts, as well as input from athletes and coaches. At this stage, improvements were made to the gate quality. At the beginning of gate manufacturing, several obstacles occurred, including when *Acrylonitrile Butadiene Styrene* waste was burned in a container at 200-250 degrees Celsius. The recycled content of *Acrylonitrile Butadiene Styrene material* can increase the container transition temperature. The recycled content of *Acrylonitrile Butadiene Styrene material* can increase the container transition temperature (Budiyanoro et al., 2019).

After being melted, the *acrylonitrile butadiene styrene liquid* is initially mixed with resin liquid to speed up the hardening process on the mold, but it takes a long time to dry. Next, a new technique is used, namely making *Acrylonitrile Butadiene Styrene* into powder by using a grinder as a tool to make *Acrylonitrile Butadiene Styrene* into powder so that when burned, it has the proper density and does not have much foam in the mold.

Acrylonitrile Butadiene Styrene is one of the most interesting specimens because it has high impact strength, heat resistance, and low thermal conductivity, so it is suitable for very hot temperatures (Octori, 2025). In making gates with used waste materials, *Acrylonitrile Butadiene Styrene*, after being made into powder from the grinding process, the powder is then put into an iron mold, and then the mold is raised into a simple jack for the pressing process. Before being pressed, the powder of used waste material *Acrylonitrile Butadiene Styrene* is heated using a simple torch with a rotating technique so

that the inside is burned evenly, the torch is done from the bottom surface with a temperature of 200-250 degrees Celsius for the right melting point. The next stage is to remove the printing results and turn them using a lathe.

Acrylonitrile butadiene waste has heat-stable properties, is resistant to chemical mixtures, can improve impact resistance properties, and is easy to process. (Wicaksono et al., 2019) . The properties of *acrylonitrile butadiene styrene* are the basis for selecting *acrylonitrile butadiene* as the raw material for gate manufacturing. To achieve good performance at the world level, assistive devices can help improve athlete performance (Sumariyanto & Rahayu, 2018). In woodball, gate quality greatly influences athlete performance regarding external factors. Finishing shots using good quality gates will make it easier for athletes to put the ball in as a finish mark on the fairway.

By selecting the appropriate material, the *Acrylonitrile Butadiene Styrene* gate will be appropriate. It will positively impact the future progress of Indonesian woodball athletes' achievements.

CONCLUSION

Acrylonitrile Butadiene Styrene Plastic Waste has proven effective for woodball training senior and junior athletes to improve their finishing stroke skills. The gate received experts' "Very Good" ratings and positive responses from athletes and coaches. It is hoped that the results of this study can provide a real contribution in improving the results of woodball athletes' finishing stroke skills, become an inspiration for the general public to develop woodball gates with other materials, and become a reference for researchers and students in designing the development of better woodball gates in the future.

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