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Development of a Web-Based Application for Monitoring and Measuring the Physical Condition of Badminton Athletes

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Abstract

The research aimed to develop a digital solution for monitoring and controlling the physical condition of badminton athletes at Bina Darma University, enabling coaches to track whether athletes' physical conditions have decreased, remained stable, or improved. Previously, physical condition measurements were recorded manually in notebooks, requiring coaches to manually search and compare past records to assess badminton athletes' progress. This manual process was time-consuming and inefficient. To address these challenges, a responsive, web-based application was developed for real-time monitoring and management of athletes' physical data. This application, accessible from both laptops and smartphones with internet connectivity, allows for convenient access from any location. By streamlining data collection and tracking, the application provides a more efficient tool for coaches to evaluate badminton athletes' physical condition over time. The transition from a manual to a digital system improves data security and accessibility, supporting enhanced decision-making in athlete management and training.

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I. INTRODUCTION

The research was conducted to control the physical condition of badminton athletes at Bina Darma University, assessing whether an athlete's physical condition decreased, remained stable, or improved over time. The physical condition of badminton athletes is an important aspect as improving physical condition fosters strength and enthusiasm in competition. Physical condition is a fundamental and essential component in achieving success across various sports, alongside technical, tactical and mental preparation [1], [2]. Badminton is a sport played using a net, racket and shuttlecock, involving techniques that range from relatively slow to very fast movements, often accompanied by feint [3], [4]. The basic components of physical condition based on the muscular concept include endurance, strength, power, speed, flexibility, agility, balance and coordination [2].

In this study, the problem addressed is related to measuring the physical condition of badminton athletes. At Bina Darma University College, this process is still carried out using a notebook, where data on athletes' physical conditions are recorded. The current manual system present challenges for coaches, who must search for and compare past records to assess whether a badminton athlete's physical condition is declining, stable, or improving. This process is time-consuming and less effective. Additionally, physical records are susceptible for lost or damaged due to accidental spills, wear and tear or exposure to rain. For badminton athletes, another issue is the difficulty in accessing results of their physical condition tests and tracking their progress over time.

As a solution, researchers developed a digital system for measuring the physical condition of badminton athletes at Bina Darma University, transitioning from a manual to a digital approach. The system was developed as a responsive web-based application for measuring the physical condition of badminton athletes. The advantage of this application is that it can be accessed using a laptop and smartphone connected to the internet, making it available from anywhere. This application is designed to monitor and record changes in the physical condition of badminton athletes each time they take a physical test, eliminating the need for manual record-keeping. Through this application, coaches can track athletes' progress in various physical aspects, such as strength, speed, flexibility and endurance. This allows coaches to easily assess whether an athlete's physical condition is decreasing, remaining stable, or improving by comparing existing data with new data. The responsive web-based badminton athlete physical control application allows coaches to monitor and manage athlete data more efficiently, and it also provides badminton athletes access to their physical condition test results and comments given from coaches. Such a system is expected to improve athlete performance and support better results in badminton competitions.

The application development method used in this research is the waterfall method [5], as it allows for optimal time allocation by ensuring the completion of each stage before moving to the next. The aim of this research is to develop an application for controlling the physical condition of

badminton athletes, making it easier to collect data on test results and enabling coaches to monitor changes in badminton athletes' physical condition more easily.

II. LITERATURE REVIEW

The previous research used as a reference in this research includes [6], [7], [8]. These studies provide information on the components of physical condition that need to be measured. These components are incorporated into the application as fields for inputting test result data specific to the physical condition of the badminton athlete. Other studies referenced include [9], [10], [11]. These studies describe the instruments or physical condition component that are essential for testing badminton athletes. These components are also used as references for inputting physical condition test data into the application.

The difference between previous research and the current research is that, in the previous research, the assessment and analysis of physical condition components were carried out manually. However, in this ongoing research, the process of inputting data on physical condition test results will be digitalized through the use of an application on a smartphone. The advantage of this system is that data can be easily searched and accessed from anywhere, allowing changes in physical condition test results to be analyzed quickly.

III. RESEARCH METHODOLOGY

A. Method of Collecting Data

Interview Technique [12] [13]: In this technique, the researcher conducted interviews with badminton coaches and athletes at Bina Darma University. The purpose of these interviews was to obtain data relevant to the research. The core focus of the interview was to inquire the process of measuring the physical condition of badminton athletes, the media used to record the results of these tests, the storage location for records of physical test results, and the time required to retrieve data when needed.

Documentation Technique [14]: In this technique, the researcher collected documents used in the research. These documents consist of records resulting from calculations of the physical condition of badminton athletes.

B. Application Development Methods

The application development method used in this research was the waterfall method. Based on the explanation in article [15], using the waterfall method in application development can reduce the likelihood of errors. According to articles [16], [17], the waterfall method is a systematic application development model carried out sequentially or linearly, as shown in Figure 1.

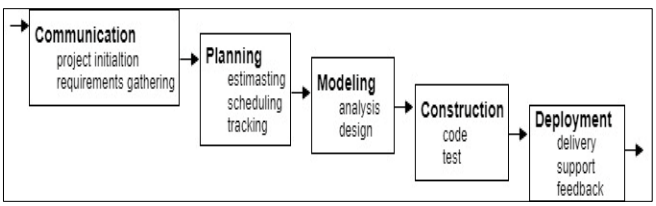

Figure 1. Waterfall method

C. Components of Physical Condition

The components of physical condition used to test the physical condition of badminton athletes was based on article [18]. The physical condition components of badminton athletes used in this research are speed, agility, endurance and explosive power.

Speed: The speed of badminton athletes was measured by running a distance of 30 meters. The components of the instrument for measuring the speed in testing the physical condition of badminton athletes are shown in Table 1.

Table 1
Instrument components for measuring the speed of badminton athletes' physical condition

No	Class Interval 30 Meters	Classification
1	3.58 – 3.91	Very Well
2	3.92 – 4.34	Good
3	4.35 – 4.72	Currently
4	4.73 – 5.11	Not Enough
5	5.12 – 5.50	Very Less

Agility: Agility in badminton athletes was measured using the shuttle run test. The components of the instrument for measuring agility are shown in Table 2.

Table 2
Instrument components for measuring agility in badminton athletes' physical condition

No	Class Interval	Classification
1	< 12.10	Very Well
2	12.11 – 13.53	Good
3	13.54 – 14.96	Currently
4	14.97 – 16.39	Not Enough
5	> 16.40	Very Less

Endurance: Endurance in badminton athletes was measured using the bleep test. The components of the instrument for measuring endurance are shown in Table 3.

Table 3
Instrument components for measuring endurance badminton athletes' physical condition

No	Class Interval	Classification
1	> = 55	Very Well
2	45 - 54	Good
3	36 - 44	Currently
4	26 - 35	Not Enough
5	< = 25	Very Less

Explosive Power: Explosive power in badminton athletes was measured using a Standing Board. The components of the explosive power measurement instrument are shown in Table 4.

Table 4
Instrument components for measuring explosive power in badminton athletes' physical condition

No	Class Interval	Classification
1	> 250	Perfect
2	241 - 250	Very Good
3	231 - 240	Good (Above Average)
4	221 - 230	Medium (Average)
5	211 - 220	Poor (Below Average)
6	< 210	Very Poor (Bad)

IV. RESULTS AND DISCUSSIONS

The results and discussion obtained from each stage of application development using the waterfall method are as follows:

A. Communications

Based on interviews with badminton coaches and athletes, the current system for recording badminton athletes' physical condition test results was done manually by recording them in a notebook. This manual system presented challenges, as it was difficult to track changes in the physical condition of badminton athletes due to the effort needed to compare current test results with previous data. Additional issues included the risk of misplacing, damaging or even losing the physical condition test records. Therefore, the existing system was less effective for monitoring and managing the physical condition of badminton athletes.

From these interview results, the researcher proposed developing a responsive web-based application to facilitate the collection, retrieval, and tracking of physical condition test data for badminton athletes.

B. Planning

The timeline for developing the application to measure the physical condition of badminton athletes spanned approximately eight months, from January 2, 2023 to August 31, 2023. The schedule of each activity is shown in Table 5.

C. Modeling

In the modelling stage, three design components were used: flowcharts, use case diagrams, and interface designs. Each of these designs contributed to the development process, as described below.

Table 5
Timeline of activities for developing an application to measure physical conditions of badminton athletes

No	Activity	Started	Finished
1	Communications	02/01/2023	07/01/2023
2	Planning	10/01/2023	14/01/2023
3	Modelling (Flow Chart, Use Case Diagram, Interface Design)	16/01/2023	28/02/2023
4	Construction (Coding dan Testing)	01/03/2023	31/07/2023
5	Deployment	01/08/2023	31/08/2023

Flowchart [19]: One of the design tools used in this research was a flowchart. This flowchart outlined the process of using the developed application for measuring the physical condition of badminton athletes, as shown in Figure 2 and Figure 3.

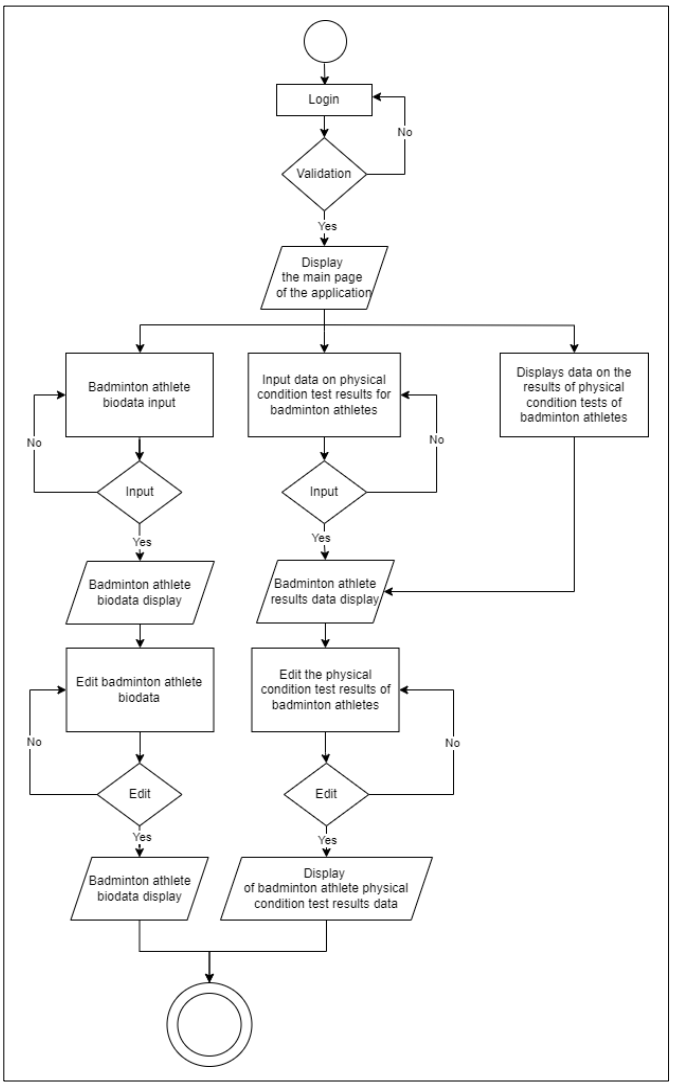

Figure 2. Admin flowchart for using the application to measure the physical condition of badminton athletes

The flowchart in Figure 2 is explained as follows: Before using the application, the admin logs in according to their access rights. After successfully logging in, the admin can input badminton athlete data and input badminton athlete physical condition test result data. The admin can also edit both athlete data and physical condition test result data. Additional features allow the admin to display data on badminton athletes' physical condition test results, including test outcomes, the coach's comments and comparison of current test results with previous one.

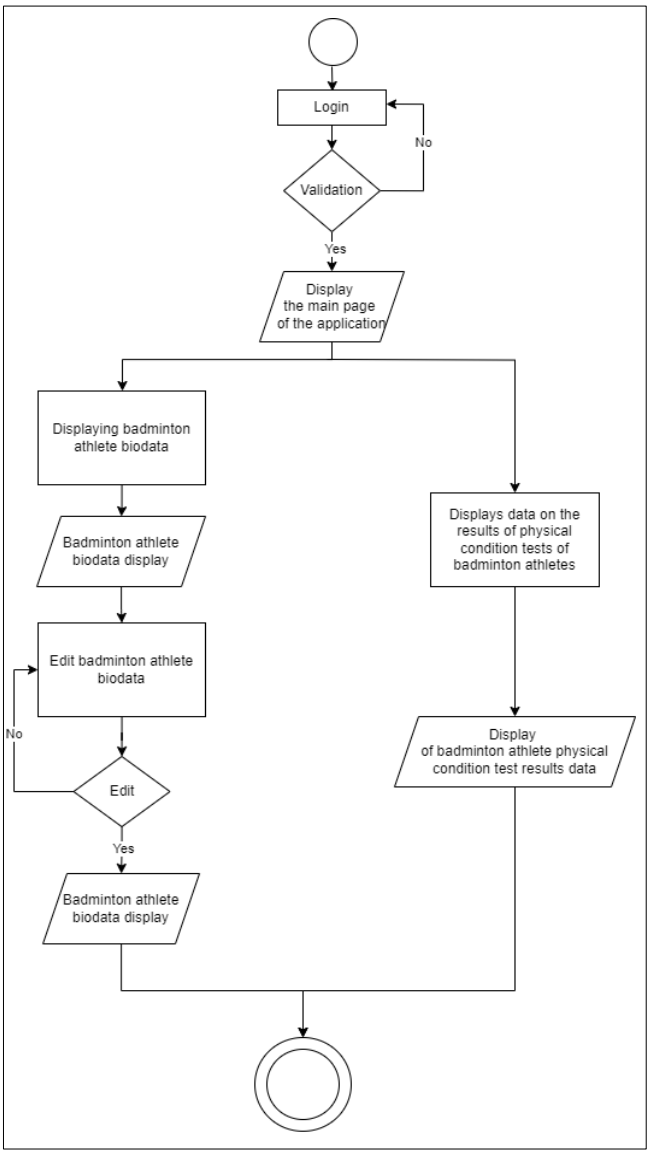

Figure 3. Flowchart of athletes using an application to measure the physical condition of badminton athletes

The explanation of the flowchart in Figure 3 is as follows: Before using the application, athletes must log in according to their access rights. After successfully logging in, athletes can view their profile data and physical condition test results. Athletes are only permitted to make changes to their biodata; they cannot alter the data related to their physical condition test results. In the physical condition data display, athletes can see the results of the physical condition test, the coach's comments on the test results, as well as a comparison of the current results with the previous one.

Use case diagram [20], [21]:This research also employed use case diagrams in application design process. Use case was used to describe the activities that actors can perform in the application. The use case diagram for using the application to measure the physical condition of badminton athletes is shown in Figure 4.

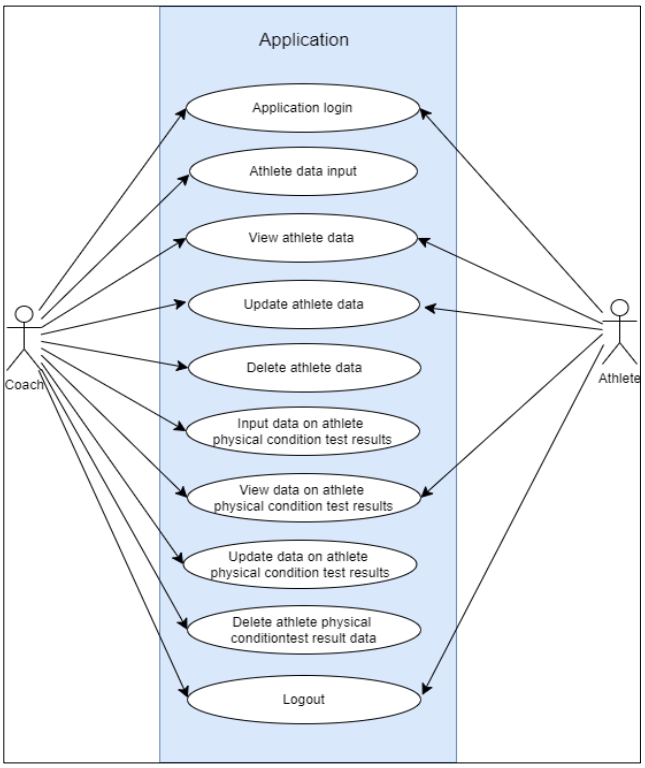

Figure 4. Use case for the application to measure the physical condition of badminton athletes

The explanation of Figure 4 is as follows: For the admin actor, before performing any actions, the admin must log in according to their access rights. After successfully logging in, the admin can manage the athlete data collection page, physical condition data collection, athlete data display, and physical condition data display. In the badminton athlete data collection and physical condition data collection sections, the admin can input data related to athletes and their physical condition test results. In the athlete data display and athlete physical condition sections, the admin can view, update, and delete athlete data and physical condition test results.

Meanwhile, for athlete actors, they must log in according to their access rights before performing any activities. After successfully logging in, athletes can view their profile, update their biodata, and view their physical condition test results.

Interface Design: This interface design was used to structure the visual layout of the application. The interface designs for the application to measure the physical condition of badminton athletes are shown in Figure 5, Figure 6, and Figure 7.

The explanation of Figure 5 is as follows: The login design is part of the application’s security features. The security mechanism includes a username and password that can only be accessed by admins and athletes with the appropriate access rights. This design was implemented through coding, producing a secure login for the application.

The explanation of Figure 6 and Figure 7 is as follows: These designs show the results of measuring the physical condition of badminton athletes. They were used to display the results of tests on athletes' physical conditions within the application.

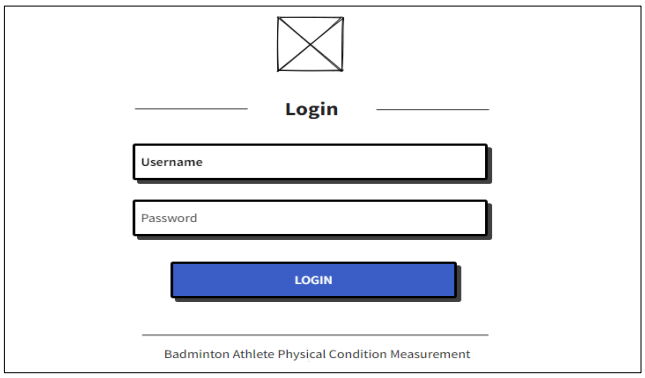

Figure 5. Login design for an application for measuring the physical condition of badminton athletes

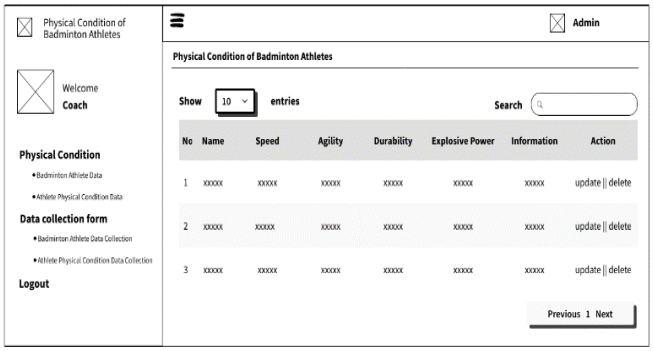

Figure 6. Display of physical condition measurement results for badminton athletes in the admin account

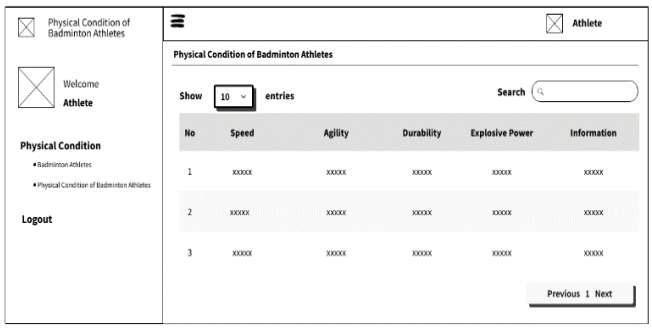

Figure 7. Display of physical condition measurement results for badminton athletes in the athlete's account

In Figure 6, the display shows the admin account. This account includes features for updating and deleting data. The admin account displays all physical condition test results from athletes. Meanwhile, in Figure 7, the display shows the athlete's account, which presents individual data for the athletes who is logged in. On athlete accounts, users can only view data and cannot update and delete it.

D. Construction

The construction stage consists of two stages: coding and testing. The coding stage involves translating the models into a functioning program, while the testing phase was conducted on the completed application using black-box testing. The purpose of this testing was to determine the quality of the application, ensuring it meets the standards for functionality and usability.

Coding: The result of the coding stage was the implementation of an application for measuring the physical condition of badminton athletes. The login page provides access to the application using a username and password, which also serves as security feature. Only admins and athletes with valid username and password can access and perform activities in the application. The application's login page is shown in Figure 8.

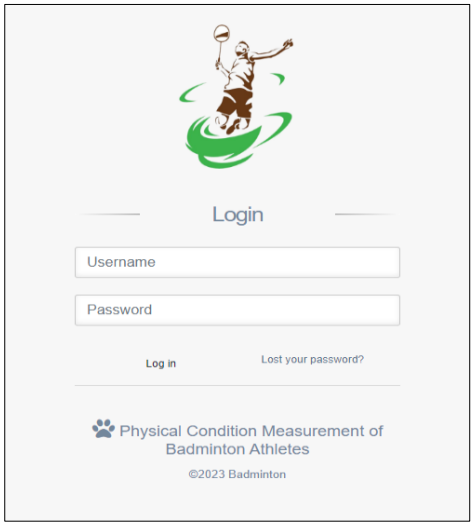

Figure 8. Login

The badminton athlete data page displays the biodata of all badminton athletes at Bina Darma University. This biodata is essential for viewing detailed information on each athlete, including contact details such as cellphone number and email, which are available for communication if needed. On this page, both admin and athletes can edit data and delete badminton athlete data. This page can be accessed by admin and athletes. The data display page for badminton athletes is shown in Figure 9.

The admin page for physical condition measurement displays data on athletes' physical condition test results. This page also allows for comparing an athlete's current test results with previous data to assess whether their physical condition has improved, declined or remained stable. Coaches can add notes or comments related to the physical condition test results, which badminton athletes can later view. These comments were intended to motivate athletes to improve their physical abilities. Both admin and athletes can access this page; however, only the admin can edit or delete data, while athletes can only view it. The results display page for physical condition measurements is shown in Figure 10.

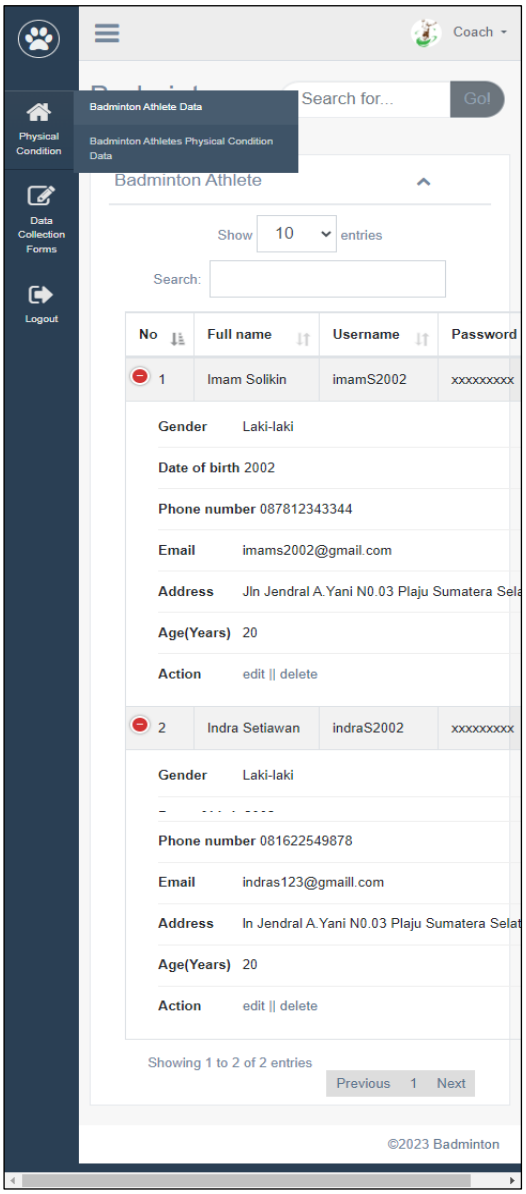

Figure 9. Badminton athlete data display

On the admin page, there is a badminton athlete data collection feature used to input new data regarding badminton athletes. This page is accessible only to admins. The display of the athlete data collection page is shown in Figure 11.

On the admin page, the badminton condition data collection feature is used to input physical condition test results for badminton athletes. This page is also restricted to admin access only. Figure 12 shows the display of the athlete physical condition data collection page.

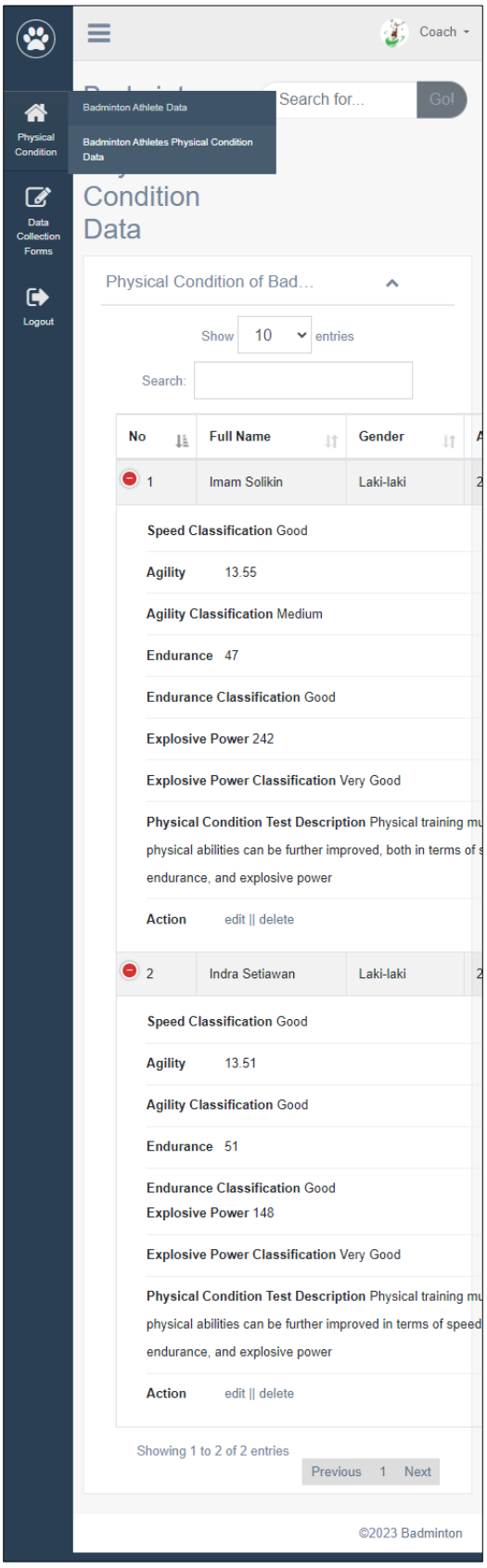

Figure 10. Display of the results of measuring the physical condition of badminton athletes

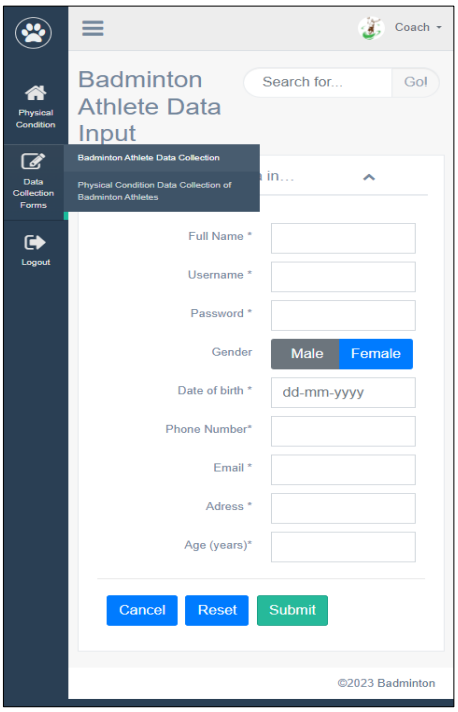

Figure 11. Display of data collection for badminton athletes in the admin account

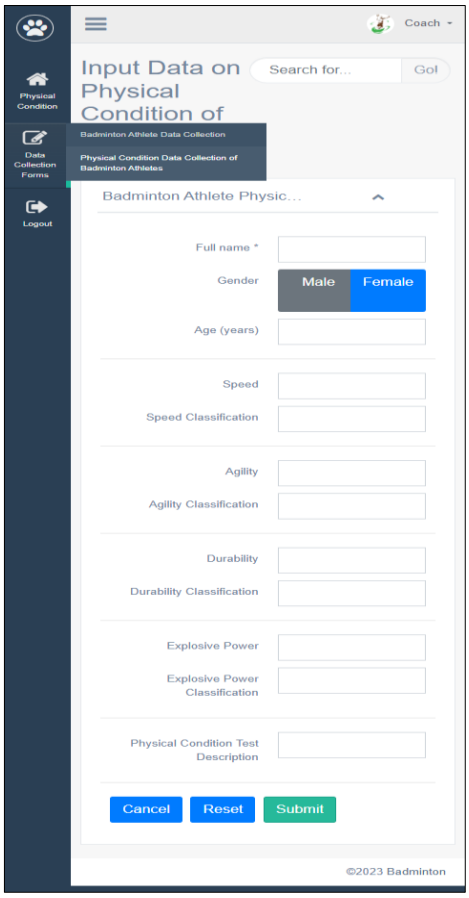

Figure 12. Display of data collection on the physical condition of badminton athletes in the admin account.

Figure 13 presents a coding function designed to classify sprint speed into several categories based on input values.

```php
<?php
// Function to calculate Agility classification
    function classification_agility($shuttle_run) {
        if ($shuttle_run < 12.10) {
            return "Very Well";
        } elseif ($shuttle_run >= 12.11 && $shuttle_run<= 13.53) {
            return "Good";
        } elseif ($shuttle_run >= 13.54 && $shuttle_run <= 14.96) {
            return "Currantly";
        } elseif ($shuttle_run >= 14.97 && $shuttle_run <= 16.89) {
            return "Not Enough";
        } else {
            return "Very Less";
        }
    }
?>
```

Figure 13. Coding for sprint speed

Figure 14 presents a coding function that classifies shuttle run values (representing the athlete's speed or agility) into several categories based on the values provided as arguments. The shuttle run is a common agility test frequently used to assess an athlete's fitness.

```php
<?php
// Function to calculate Agility classification
    function classification_agility($shuttle_run) {
        if ($shuttle_run < 12.10) {
            return "Very Well";
        } elseif ($shuttle_run >= 12.11 && $shuttle_run<= 13.53) {
            return "Good";
        } elseif ($shuttle_run >= 13.54 && $shuttle_run <= 14.96) {
            return "Currantly";
        } elseif ($shuttle_run >= 14.97 && $shuttle_run <= 16.89) {
            return "Not Enough";
        } else {
            return "Very Less";
        }
    }
?>
```

Figure 14. Coding for agility

Figure 15 presents a coding function designed to classify physical endurance (stamina) based on the results of the bleep test.

```php
<?php
// Function to calculate Durability classification
    function classification_durability ($bleep_test) {
        if ($bleep_test >= 55) {
            return "Very Well";
        } elseif ($sbleep_test >= 45 && $bleep_test <= 54) {
            return "Good";
        } elseif ($bleep_test >= 36 && $bleep_test <= 44) {
            return "Currantly";
        } elseif ($bleep_test >= 26 && $bleep_test <= 35) {
            return "Not Enough";
        } else {
            return "Very Less";
        }
    }
?>
```

Figure 15. Coding for endurance

Figure 16 presents a coding function used to classify explosive power based on standing broad jump values (distance of standing long jump).

```php
<?php
// Function to calculate Explosive Power classification
    function classification_explosive_power ($standing_board) {
        if ($bleep_test > 250) {
            return "Perfect";
        } elseif ($standing_board >= 241 && $standing_board <= 250) {
            return "Very Good";
        } elseif ($standing_board >= 231 && $sstanding_board <= 240) {
            return "Good (Above Average)";
        } elseif ($standing_board >= 221 && $standing_board <= 230) {
            return "Medium (Average)";
        } elseif ($standing_board >= 211 && $standing_board <= 220) {
            return "Poor (Bolow Average)";
        } else {
            return "Very Poor (Bad)";
        }
    }
?>
```

Figure 16. Coding for explosive power

E. Construction

Testing was carried out using the black box method. Application testing was conducted based on the completed application with tested items listed in Table 5.

Table 5
Tested Application Items

No	Tested items	Function
1	Login	Login process
2	Athlete data collection	Inputting athlete data
3	Data collection on athlete's physical condition	Inputting data on athlete's physical condition
4	Athlete data	Display athlete data, edit and delete
5	Data on the athlete's physical condition	Display athlete data, edit and delete

Testing was conducted on predetermined items. The test results using the black box method are shown in Table 6.

Table 6
Application Testing

No	Tested items	Scenario	Results
1	Login	The admin or athlete will enter the application if they successfully enter their username and password when logging in. Login will fail if you enter the wrong username and password	In accordance
2	Athlete data collection	Inputting athlete data is carried out by the admin. Data that has been successfully entered will appear on the athlete data display page. If the data input does not match the characters or data type, then the data will fail to be input.	In accordance
3	Data collection on athlete's physical condition	Inputting data on athletes' physical conditions is carried out by the admin. Data that has been successfully entered will appear on the athlete's physical condition data display page. If the data input does not match the characters or data type, the data will fail to be input.	In accordance
4	Athlete data	Athlete data can be seen if it has been successfully input by the admin. Athlete data can be seen by admin and athletes. Admins can see all athlete data, while athletes can only see their own personal data. Admins and athletes can also edit data and delete data.	In accordance
5	Data on the athlete's physical condition	Data on the athlete's physical condition can be seen after it has been successfully input by the admin. This data can be seen by admins and athletes. Admins have access to view all athlete physical condition data, while athletes can only view personal physical condition data. Admins also have the ability to edit data and delete data, while athletes can only view the data.	In accordance

After testing, the results showed that the application functions as intended, with no errors detected during the testing process. The conclusion from this test is that the application for measuring the physical condition of badminton athletes functions correctly.

V. CONCLUSION

The conclusion of this research is the successful development of an application to measure the physical condition of badminton athletes. This application allows for quick data collection and measurement of athletes' physical conditions. Physical condition test results are stored securely, eliminating concerns about data damage or loss. The application was developed using the waterfall method, with each stage completed sequentially.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest influencing this research. All processes of application development, data collection, analysis, and interpretation of results were carried out independently and objectively.

AUTHOR CONTRIBUTIONS

Author Imam Solikin: Responsible for the conceptualization of the research, development of the web-based application system, user interface design, and initial testing of the application. The author is also involved in writing and editing the research article. Author Martinus: Responsible for designing the research methodology, collecting data from athletes, testing the application in the field, and analyzing and interpreting data. The author also plays a role in writing the research report and references.

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