International Journal of Undergraduate Research 3 (1): 140-147, 2022
e-ISSN: 2682-8189

DOI: 10.26666/rmp.ijur.2022.1.21

Design and Development of Workout Intensity: A Web-Based System for Workout Intensity Indicator

Nurul Alyani Fatini Khalid, Mohamad Farhan Mohamad Mohsin*

School of Computing, Universiti Utara Malaysia, Sintok, 06010, Kedah, Malaysia
*Corresponding Author: farhan@uum.edu.my

Abstract: Heart rate reserve (HRR) is the difference between a person's measured or predicted maximum heart rate and resting heart rate. HRR is calculated as an indicator of cardiovascular fitness by subtracting the difference between maximal and resting heart rates. It is used to determine workout heart rate zones and the amount of cushion in heartbeats available for activity because not everyone is physically fit enough to do extensive workout activities. As a result, users who want to participate in workout activities should measure their resting heart rate to determine their maximum heart rate during a workout. It can keep them from becoming overly tired, making them vulnerable to heart attacks even if they are in good health. This project aims to develop a Workout Intensity Indicator System that will assist people in identifying training intensity forces that are appropriate for their bodies. This system was developed using the Rapid Application Development methodology (RAD). This system allows users to calculate their heart rate reserve, determine an appropriate exercise zone, and perform a systematic and safe workout. The Workout Intensity Indicator System was found to be both beneficial and straightforward to use. Furthermore, respondents rated the app's feature that allows customers to create and manage exercises satisfactory.

Keywords: *Indicator, Heart rate reserve, Maximum heart rate, Workout, Exercise*

Received: 15 May 2022; Revised: 30 May 2022; Accepted: 10 June 2022; Published: 30 June 2022.

1. Introduction

Workout goals can include improving fitness, losing weight, training for a competition, or combining these. Knowing the workout's goal is crucial because it will determine the appropriate workout intensity level, such as aerobic or strength training [10]. During the workout, we are working hard, and our heart rate responds to our activity. Therefore, the workout intensity should be moderate to vigorous for maximum benefit. In addition, the more intense or prolonged the activity, the more calories burned for weight loss [9].

As a result, an athlete will not become stronger solely through regular training if he or she does not know the appropriate training intensity for the specific workout. Even though heart rate monitors can reliably detect heart rate during physical exercise, experts are sceptical about the effect of heart rate monitoring on physical performance. Other variables may, in turn, influence the relationship between work rate and heart rate. However, the advancement of technology in the field of sport is currently accelerating,

Corresponding Author: Mohamad Farhan Mohamad Mohsin, Universiti Utara Malaysia, School of Computing, UUM, 06010 Sintok, Kedah, Malaysia, 04-9285125

and there is an application that can measure heart rate performance.

Understanding heart rate data is critical. It needs to investigate whether heart rate is a reliable indicator of health. Monitors may be misused [1]. Before the automatic calculation, the calculation was done manually, and the 220-age formula is a well-known and frequently used formula. The formula's origins can be traced back to a speculative calculation. This formula, along with others, is used to calculate MHR and, from there, an appropriate exercise load. In contrast, this calculation generates an MHR using a tried-and-true formula [2].

The study provides formulas for estimating heart rate based on activity intensity. Maximum heart rate (MHR) forecast reserve heart rate, sport-specific training intensities, and therapeutic levels can be found. Some people are unaware of their heart's rhythm or pace, while others are acutely aware of even minor irregularities. That is not a sign of a problem if no symptoms, such as fatigue, dizziness, fainting, or a lack of capacity to exercise. A rapid heart rate is characterized by a racing heart, shortness of breath, difficulty breathing, or stiffness [3]. Heart rate correlates with oxygen consumption when intensities reach 50 to 90 percent of VO2 max. As a result, exercise intensity is expressed as a percentage of maximum heart rate.

The changes in blood volume can be used to calculate the heart rate. The heart rate calculation can be supplemented by the calculation of the parameter, which can be used to learn more about how the heart works. People can use the system to monitor their heart health, leading to early detection of abnormalities and rapid diagnosis of illnesses, thus saving time and money. As a result of this issue, there is an urgent need for a mechanism that can calculate the automatic heart rate reserve (HRR) without requiring manual calculation, and the system has kept a database that can be used to track progress. As a result, a web-based system could be a valuable tool for calculating heart rate reserve to determine the training intensity that is appropriate for performing a specific exercise while not delaying recovery

It can assist people in keeping track of their heart rates after exercise, jogging, when they are not feeling well, when worry strikes, or when they are nervous. If any abnormalities in heart rate are discovered, an appointment can be made to have an ECG performed for further illness diagnosis. Furthermore, real-time heart rate detection can also aid in discovering other factors [4]. Therefore, this paper bridges the gap by investing in the design and development of web-based applications' potential for the system to save users' access. Furthermore, this system can help the users know their ability to check their training intensity.

As a result, the Workout Intensity Indicator System, a prototype of a web-based system for exercise calculation and management, was developed and tested. The study contributes to a better understanding of the system requirements for such a web-based system and may serve as a description language for programmers and academics looking to improve an existing system. This paper is structured as follows: The background and related studies are described in the next section. The following section describes the concept and development of the Workout Intensity Indicator System. The usability evaluation of the Workout Intensity Indicator System is explained in the next section. The final section of this paper summarizes the findings and suggests future research.

2. Related Works

From the standpoint of computer science study, this section discusses the background of HRR and associated studies evaluating the impacts of training intensity using calculating resting heart rate. An incremental, graded, and maximal program was developed using a cycle ergometer. The MHR was calculated using a Monark Ergomedic 828e that had been manually calibrated according to factory specifications. The patients were given five minutes to warm up on the bicycle without any weight and at 60 rotations per minute [2]. Later, three-minute phases with 30-watt increments between each stage were started and continued until the maximum requirements were met. The heart rate was logged. It used a wrist heart rate monitor and its chest band sensor.

Factors that raise sympathetic or reduce parasympathetic nervous system activity increase the risk. Those who reduce sympathetically or raise parasympathetic nervous system energy increase the chance of ventricular arrhythmias, whereas those who increase sympathetic or decrease parasympathetic nervous activity increase the risk of cardiac arrhythmia. The activity of the parasympathetic nervous system decreases [5]. It provides a non-invasive, reasonably cheap, and widely available method for monitoring heart health using Photoplethysmography (PPG). It is based on flash-enabled smartphone cameras, which are becoming increasingly common in today's society. The method was used, and the findings of cardiac parameters were compared to those obtained by analyzing ECG reports and pulse oximeter readings from the same people.

After endurance training, heart rate measured at a steady work rate under controlled conditions will decrease and may thus be underestimated. Nevertheless, it is a metric for measuring endurance training. Drifting of the heart happens as the length of exercise increases. Therefore, it is possible that there is less cardiac drift following endurance exercise. Another thing to think about is the fact that the advancements are ongoing. After training, a person will notice a significant improvement in individual running performance; any alterations in the cardiovascular system, as a result, involve the consumption of oxygen, the volume of a stroke, or the heart rate, and hence will be a more accurate indicator of the endurance training condition [1].

After then, a regular assessment of the relationship

between a runner's pulse rate and walking pace is necessary, which can be performed regularly. The test can be incorporated into the warm-up portion of the workout. The runner must wear a heart rate monitor with the ability to record heart rate data and run across a designated, calibrated distance (about 1 km) on wind-protected terrain. After the runner has fully warmed up and established a steady condition, this test should be done. Running pace does not have to be consistent between tests if the time for the known distance is recalculated and recorded.

A method for tracking inhalation in a problematic situation would include measuring carbon dioxide in exhaled breath for signs of breathing and oxygen to detect metabolic acidosis. Carbon dioxide and oxygen concentrations may be calculated using a gas analyzer. Typically, this is a laboratory operation, although there are a few semi-portable devices available that have been reworked to make them suitable for use in flight simulators [6]. Table 1 shows the example of the calculation.

Table 1. Heart rates during training

Variables	10-km ($n = 6$)	21-km ($n = 6$)	42-km ($n = 5$)
Heart rate during race (beats min^{-1})	163 ± 13	166 ± 10	156 ± 6
Heart rate during training (beats min^{-1})	143 ± 22*	151 ± 13*	137 ± 17*
HR_{diff} (beats min^{-1})	20 ± 7	15 ± 7	19 ± 13

As previously stated, heart rate is an unreliable indicator of exercise intensity. However, if the elements that affect heart rate are under control, the heart rate will continue to rise with a day-to-day variation in pace; the connection is very stable at any submaximal level, a fluctuation of up to 6 beats min-1 speed. It presents a challenge to scientists, coaches, and athletes who want to improve their running performance and have a lot to learn about how to use heart rate data to achieve its most tremendous potential. It is tempting to believe that, in the future, as more information about it becomes available the future heart rate data, heart rate data, heart rate data, heart rate data, heart rate data, heart rate data, heart rate monitors may be approved as ergogenic aids [1]. However, during a simulated flight, experienced pilots' pulse rates nearly always rise less than during an actual flight. This distinction is particularly noticeable with basic simulations, where heart rates may not rise in pilots with a lot of experience [6].

3. Methodology

The research was carried out using Dennis's Rapid Application Development (RAD) approach [7]. RAD stands for rapid application development, which entails prototyping to gather requirements for web-based applications. Although software development technique has evolved through time [8]. Requirement planning, prototyping (user design and construction), testing, and cutover are all still important and frequently utilized by software. Figure 1 depicts the phases' order of occurrence.

Figure 1. The phase of RAD

The requirement of planning the demand for a web-based app for exercise intensity indication is part of the planning process. According to Dennis et al. [7], the requirements of a system are defined and represented using Unified Modelling Language (UML) diagrams such as use case, activity, and class diagrams. The user design and construction are prototyping phases being carried out simultaneously while the web-based system's user interface is being created. Users are involved during the prototyping process, where they provide feedback for improving the web-based apps' user interface and information flow to measure the heart rate reserve. Furthermore, the testing phase to test or check the function that is going to smooth the process. Finally, during the cutover phase, an evaluation of the web-based app's usability is performed. The following sections go into the specifics of how the stages were executed. The prerequisites for planning and prototyping are user design and construction, testing and cutover. The cutover phase is discussed in the Evaluation of Workout Intensity Indicator, while the design and development phases are addressed in the next section.

4. Design and Development of Workout Intensity Indicator System

This section discusses the design and implementation of a web-based system for calculating and listing workouts. The subsection is devoted to constructing a prototype for the Workout Intensity Indicator, a web-based system created to illustrate the specifications obtained.

4.1 The Requirements of the Workout Intensity Indicator System.

The requirements were gathered using two methods: (1) interviewing people who are interested in sports and (2) analyzing papers and applications connected to exercise indicator systems and heart rate reserve that were found on the Internet. The interview was conducted informally on the person who was interested in sports. They were given a few questions, mainly about the characteristics of the web-based application system for the Workout Intensity Indicator System that is easy to use in a web-based system. Their opinion was recorded where they had been involved directly during the construction (development) phase, whenever the prototype's design was shown to them, and user feedback

and suggestions were solicited.

The papers were primarily searched utilizing the Google searching engine for the secondary requirements gathering phase "workout"," heart rate reserve", "indicator", "calculate heart rate reserve", "measure fitness level", and "exercise intensity". Table 2 describes the Workout Intensity Indicator System's requirements, consisting of four mains: login and register to the Workout Indicator System, calculate the heart rate reserve, manage the applications and view the Workout Intensity Indicator System.

Table 2. List of Requirements of Workout Intensity Indicator System

Table Head	LIST OF REQUIREMENTS APPLYING AND MANAGING THE WORKOUT SYSTEM	
ID	*Requirement Description*	*Priority*
WIIS1	NEW USER REGISTRATION	
WIIS1_1	The user shall be able to register the web-based application by entering their information, email and password	High
WIIS1_2	If compulsory fields are not complete, an error message, "Please fill out this field" will be displayed on the field.	Medium
WIIS2	LOGIN TO THE SYSTEM	
WIIS2_1	The system shall be able to allow the user to log in to the system	High
WIIS2_2	The system shall be able to display the primary interface if the username and password are invalid	Medium
WIIS2_3	The system shall be able to display the message "Login Failed " will be displayed on the pop-up window	Medium
WIIS3	MANAGE CALCULATION	
WIIS3_1	The system will allow the user to input the resting heart rate to calculate the heart rate reserve	High
WIIS3_2	The system will display the result of the calculation of heart rate reserve	High
WIIS3_3	The system shall able to "reset" or "cancel" when the user clicks that button	Medium
WIIS4	MANAGE EXERCISE	
WIIS4_1	The system shall allow the user to view the history calculation in history.	Medium
WIIS4_2	The user shall be allowed to click button "DELETE" the calculation details in the history	High
WIIS5	MANAGE PROFILE	
WIIS5_1	The user can view the profile that the user has inserted the information when register	High
WIIS5_2	The user shall allow clicking the button "Back" to back in the history page	Medium

Table 2 shows how the requirements have been converted into information systems capabilities. The next stage is to use the appropriate modelling technique and tools to describe and model the web-based requirements for the system. The constraints of this project were visualized and represented using the Unified Modelling Language (UML). This study utilized two behavioral diagrams, namely use case and activity diagrams, and a class diagram that depicts the web-based system's structural components. UMLet software was used to create the diagrams. The use case diagram and exchanges between the actors and the cases are depicted in Figure 2. for a web-based system that can calculate heart rate reserve and manage the workout. Four major use cases are register, login, calculate heart rate reserve, and manage the exercise. The use case of manage exercise allows users to perform sub-functions including "Delete calculation" and "View history calculation".

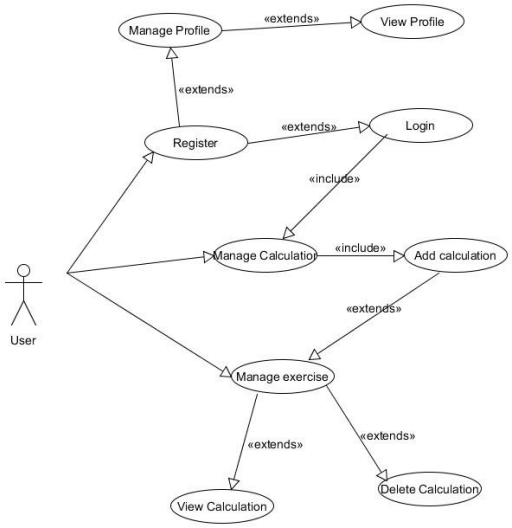

Figure 2. The use case diagram of web-based for creating and managing exercise

The use case diagram is comprehensive to demonstrate the system's dynamic behavior. As a result, an activity diagram of Figure 3 depicts the operations involved in utilizing the web-based system for Workout Intensity Indicator System, which is self-explanatory.

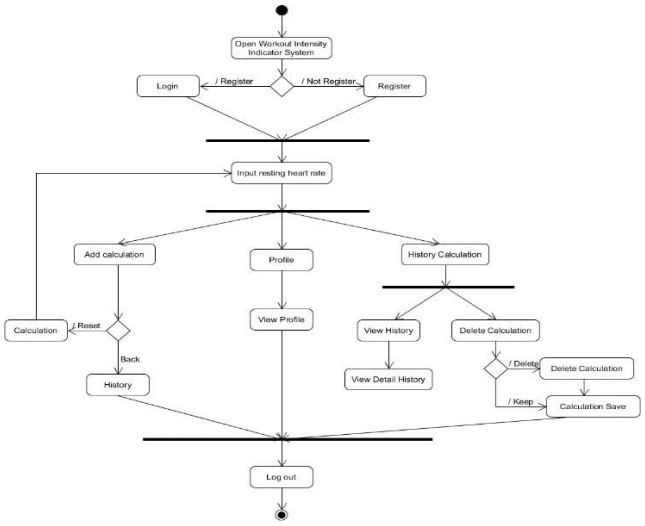

Figure 3. The activity diagram of a web-based system for calculation and managing exercise

As shown in Figure 4, the structural components of a web-based system for producing and maintaining calculations are represented in a class diagram. The system's properties and operations are depicted in the class diagram in Figure. Four primary classifications were found in this study: user, calculation, history, and profile. The graphic depicts the relationships between classes.

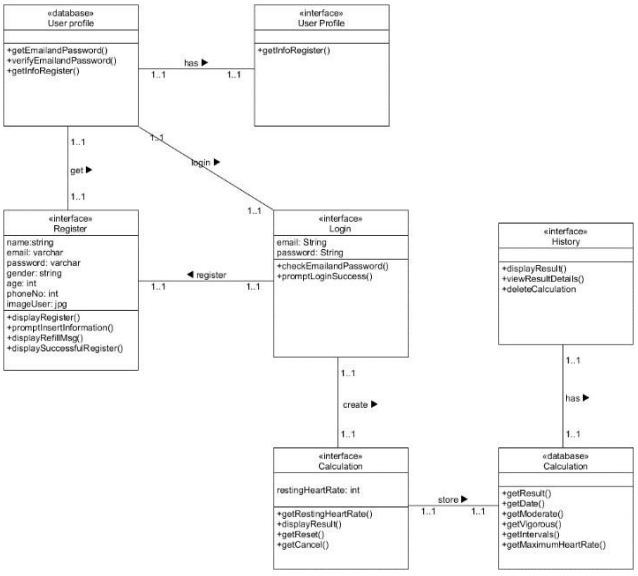

Figure 4. The class diagram of a web-based system for calculation and managing exercise

5. The Workout Intensity Indicator Prototype

A prototype web-based system for calculating heart rate reserve was developed. It summarizes the requirements outlined in the previous section. System prototyping is a common technique for demonstrating system requirements so that users can provide additional feedback and suggestions based on their interactions with the prototype. The primary integrated development environment (IDE) tools used were Visual Studio Code. Furthermore, the cPanel development platform was used to streamline critical functions such as user authentication and database data storage. Figures 5, 6, 7, 8, and 9 depict the Workout Intensity Indicator System interfaces.

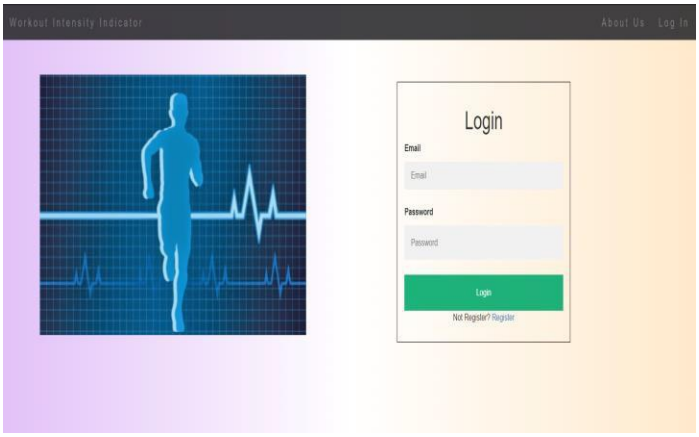

Figure 5. The interface for main menu

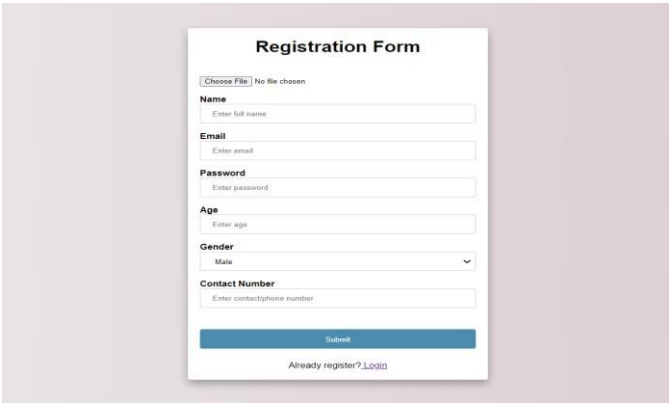

Figure.6. The interface for registration

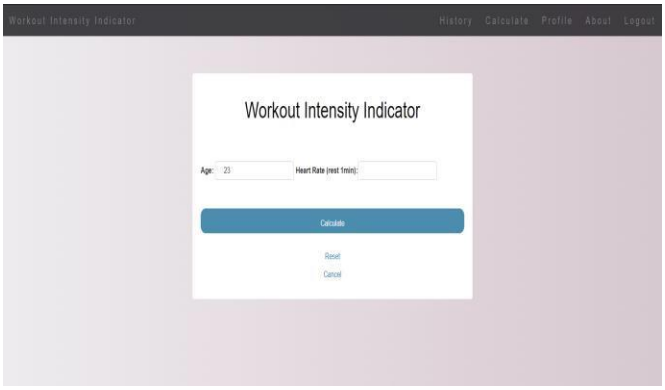

Figure.7. The interface for calculation

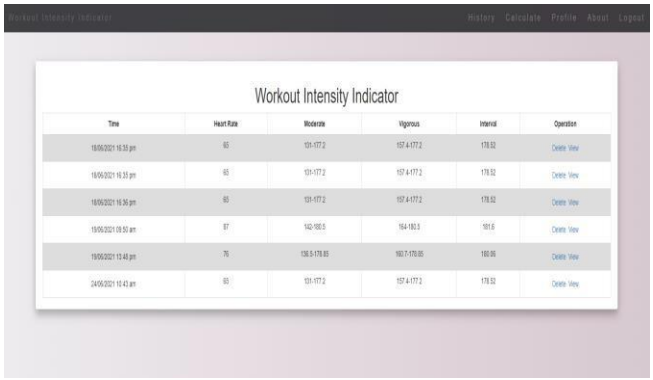

Figure.8. The interface for view result

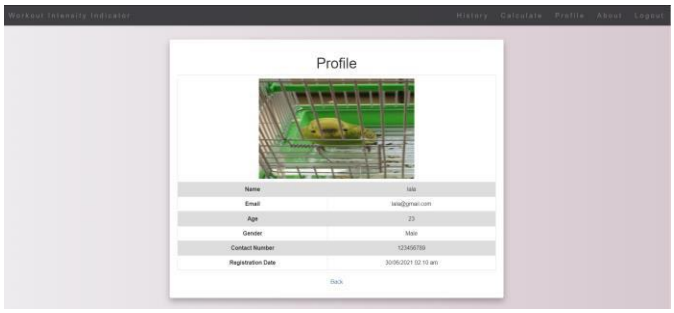

Figure 9. The interface for profile

6. The Evaluation Of Workout Intensity Indicator System

6.1. The Evaluation Setting

A usability evaluation was conducted on 30 respondents, consisting of Universiti Utara Malaysia students interested in the sport. Respondents were contacted at random using WhatsApp and a Google Form. Participants in the study are on a purely voluntary basis. The Workout Intensity Indicator system and a post-task questionnaire were utilized in the evaluation. The post-task questionnaire is divided into two sections with 20 items. Section A asked about the respondents' demographic information, while Section B asked about the respondents' opinion of the Workout Intensity Indicator System web-based application. On a five-point Likert scale, one indicates strong agreement, and five indicates strong agreement. For the assessment, the participants used the following step-by-step process; (1) read the consent form and sign it; (2) do a pilot test with the respondent; (3) interact with Workout Intensity Indicator System (4) complete the post-task questionnaire, as indicated in the task scenario.

6.2. The Respondents' Demographic Information

An examination of the demographic data provided by respondents reveals that 53.3% of them are female and the remaining is male, that only 46.7% of respondents were UUM students that answered the post-questionnaire. Meanwhile, the age of students between 16-20 years old is 16.7% less than the age between 21-25 years old that get 63.3% and the age 26-30 years old that only 20%. Furthermore, often UUM students use the Internet 86.6% that use the Internet daily is more than occasionally than only 10%. On the other hand, only 3.3% of the 30 respondents often use the Internet weekly. The least number of only often exercise in a week is 4-6 times that only 6.7% that less than 3 of less time in a week that get 60% more than not sure of the often exercise in a week that only 33.3%.

6.3. The Usability of Workout Intensity Indicator System

The respondents' replies in Section B of the post-task questionnaire were analyzed. The respondents' perceptions of the Workout Intensity Indicator System's utility and simplicity of use are measured in this section. It also measured the respondents' satisfaction with Workout Intensity Indicator System. Tables 3, 4 and 5 The frequency and average of the replies were provided. For the three dimensions of usability, respondents scored four or five on the post-task measures. None of the respondents assigned a score of one or two. The most neutrally rated.

The evaluation revealed that the Workout Intensity Indicator System is beneficial and simple. Furthermore, the respondents rated the app's function that allows customers to create and manage exercises as satisfactory. The majority of respondents believe that the registration, login, view, delete, and profile operations were simple and beneficial, according to an analysis of their comments on the individual features given by the Workout Intensity Indicator System.

They also believed that the Workout Intensity Indicator System might assist them in calculating heart rate reserve and regulating exercise in a more efficient manner, and that it would meet their needs in this regard. In terms of user interface, respondents said that the Workout Intensity Indicator System was simple to use and that they could quickly recall how to use the web-based system without any written instructions. Furthermore, respondents were pleased with the mobile app's design and wanted to promote it to others.

Table 3. Responses to the Usefulness of Workout Intensity Indicator Systems

The post-task questionnaire items						
Usefulness of Workout Intensity Indicator System	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Average**
Workout Intensity Indicator System increases my productivity.	0 (0.00)	0 (0.00)	13 (43.3)	9 (30.0)	8 (26.7)	3.58
Workout Intensity Indicator System saves me time when I use it.	0 (0.00)	0 (0.00)	9 (30.0)	13 (43.3)	8 (26.7)	4.00
Workout Intensity Indicator System does everything I would expect it to do.	0 (0.00)	0 (0.00)	10 (33.3)	13 (40.0)	8 (26.7)	3.93
Workout Intensity Indicator System enhance effectiveness in the calculation	0 (0.00)	0 (0.00)	1 (3.33)	22 (73.33)	7 (23.33)	4.20
Workout Intensity Indicator System gives me greater control over my work	0 (0.00)	0 (0.00)	2 (6.67)	23 (76.67)	5 (16.67)	4.10
Workout Intensity Indicator System enables to accomplish tasks more quickly	0 (0.00)	0 (0.00)	3 (10.00)	11 (36.67)	16 (53.33)	4.43
Workout Intensity Indicator System is useful in overall.	0 (0.00)	0 (0.00)	10 (33.3)	13 (43.3)	7 (23.3)	3.90

Table 4. Responses to the Ease of Use of the Workout Intensity Indicator System

The post-task questionnaire items						
Ease of Use of Workout Intensity Indicator System	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Average**
Workout Intensity Indicator System is easy to use.	0 (0.00)	0 (0.00)	11 (36.7)	12 (40.0)	7 (23.33)	3.87
Workout Intensity Indicator System is user friendly	0 (0.00)	0 (0.00)	15 (50.0)	7 (23.3)	8 (26.67)	3.77
Workout Intensity Indicator System is easy to learn how to use it.	0 (0.00)	0 (0.00)	5 (16.7)	17 (56.7)	8 (26.7)	4.10
I don't notice any inconsistencies as I use Workout Intensity Indicator System	0 (0.00)	0 (0.00)	9 (30.0)	14 (46.7)	7 (23.3)	3.93
The Workout Intensity Indicator System is flexible.	0 (0.00)	0 (0.00)	1 (3.33)	20 (66.67)	9 (30.00)	4.27
I can use Workout Intensity Indicator System successfully every time	0 (0.00)	0 (0.00)	9 (30.0)	11 (36.7)	10 (33.3)	4.03

Table 5. Respondents' Perceptions of Workout Intensity Indicator in terms of satisfaction

The post-task questionnaire items						
Satisfaction of Workout Intensity Indicator System	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Average**
I am satisfied with Workout Intensity Indicator System.	0 (0.00)	0 (0.00)	8 (26.7)	17 (56.7)	5 (16.67)	3.90
I would recommend Workout Intensity Indicator System to my friend.	0 (0.00)	0 (0.00)	10 (33.3)	12 (40.0)	8 (26.67)	3.93
Workout Intensity Indicator System works the way I want it to work.	0 (0.00)	0 (0.00)	11 (36.7)	12 (40.0)	7 (23.3)	3.87
I feel I need to have Workout Intensity Indicator System.	0 (0.00)	0 (0.00)	12 (40.0)	14 (46.7)	4 (13.3)	3.73
The Workout Intensity Indicator System is wonderful and pleasant to use.	0 (0.00)	0 (0.00)	10 (33.3)	14 (46.7)	6 (20.0)	3.87

7. Conclusion

This study described the concept and implementation of a web-based system for calculating HRR and managing exercises. The Workout Intensity Indicator System assists people in identifying training intensity forces that are appropriate for their body by calculating their resting heart rate and efficiently managing the workout. This system can help users who want to participate in sports find the most efficient way to ensure they do not experience relay recovery when they get the wrong training intensity. It can also be used to assist users in identifying specific exercises that are appropriate for their level of training intensity. We intend to expand the functionality of this system in the future by further improving the design and functionality of smartwatches. We also plan to use the smartwatch to connect to the heartbeat application, allowing us to track the heartbeat rate without manually checking it. Other studies could be conducted to improve the process of controlling BMI (Body Mass Index), which calculates the number of calories burned during exercise. The Workout Intensity Indicator System will continuously monitor and alert users if they have reached the maximum resting heart rate when workout. Aside from that, the system's design and layout need to be improved because the site appears empty, and the functionality is limited and uninteresting to users.

8. References

[1] M. I. Lambert, Z. H. Mbambo, and A. S. C. Gibson, "Heart rate during training and competition for longdistance running," J. Sports Sci., vol. 16, no. sup1, pp. 85–90, 1998.

[2] L. E. Cruz-Martínez, J. T. Rojas-Valencia, J. F. Correa-Mesa, and C. Correa-Morales, "Maximum Heart Rate during exercise: Reliability of the 220-age and Tanaka formulas in healthy young people at a moderate elevation," Rev. Fac. Med. Univ. Nac. Colomb., vol. 62, no. 4, pp. 579–585, 2014.

[3] "Heart Rate Reserve," News-medical.net, 24-Nov-2009. [Online]. Available: https://www.news-medical.net/health/Heart-Rate-Reserve.aspx. [Accessed: 30-Jun-2021].

[4] S. Paliwal, C. V. Lakshmi, and C. Patvardhan, "Real time heart rate detection and heart rate variability calculation," in 2016 IEEE Region 10 Humanitarian Technology Conference (R10-HTC), 2016, pp. 1–4.

[5] P. K. Stein, M. S. Bosner, R. E. Kleiger, and B. M. Conger, "Heart rate variability: a measure of cardiac autonomic tone," Am. Heart J., vol. 127, no. 5, pp. 1376–1381, 1994.

[6] A. H. Roscoe, " Assessing pilot workload. Why measure heart rate, HRV and respiration?," Biol. Psychol., vol. 34, no. 2–3, pp. 259–287, 1992.

[7] A. Dennis, B. H. Wixom, and R. M. Roth, Systems analysis

and design. John Wiley & Sons, 2018.

[8] B. A. Jnr, M. A. Majid, and A. Romli, "An Empirical Study On Predictors Of Green Sustainable Software Practices In Malaysian Electronic Industries," Journal of ICT, vol. 18, pp. 347-391, 2018.]

[9] Mayo Clinic. Exercise intensity: How to measure it? [Online]. Available: https://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/exercise-intensity/art-20046887 [Accessed: 24 July 2022]

[10] Aparecida, M.C, Carlos, M.P., Fernades, M.G, Silva, E., Medeiros Takahashi, A.E., Carlo, L.M.V. Heart rate variability: are you using it properly? Standardization checklist of procedures. Brazilian Journal of Physical Therapy, 24 (2), 91-102. 2020