

# **Multi-Feature Usability Testing on Internet of Things-based Smart Gym Machine with All in One Concept Using Nielsen's Heuristics**

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## **Abstract**

Usability testing is needed to know whether a product can fulfill the desires of its customers or not. A product that has good usability will have good prospects because technically the product is feasible to use. This study aims to test the usability of a new innovative product called GYM ATOM "Gym Machine with Artificial Trainer and Automatic Load Modifier". The three newest features of the gym machine are the gym machine is designed with the all in one concept where 1 machine can not only train 1 muscle but can train 7 different muscles, also having an artificial trainer that allows users to practice even though without a companion trainer, and automatic load modifier which is based on internet of things that use the user's voice input and it is converted into mechanical energy to change the load. Until now, GYM ATOM has been produced and has reached the alpha prototype stage. To reach the beta prototype stage until it can be mass produced, the product needs to be evaluated for its usability. So that the aim of this study is to test the usability level of GYM ATOM with multi-feature testing by using Nielsen's Heuristics where usability criteria are measured based on the criteria of learnability, efficiency, memorability, errors, and satisfaction. Based on the results of the usability testing, it can be concluded that the total score of usability is 80.667% which is very good usability. But the product still has to be improved because it has a fairly high error percentage on the automatic load modifier feature. This is because the users must use English as their voice input while respondents are Indonesian who are not fluent in English so it is difficult to use if the user is not good at speaking English. As an evaluation, the product needs to be improved by developing its voice input system so that voice input can not only be used with English but also in languages that are in accordance with the capabilities of its users so that it has better usability.

## **Keywords**

Gym Machine, Multi-Feature, Internet of Things, Nielsen's Heuristics, Usability Testing

## **1. Introduction**

Weight training is a systematic exercise using weights as a tool to increase the strength of muscle function to improve physical conditions, prevent injury or for health purposes (Suharjana, 2007). Weight training is now in great demand by people in the world, it can be seen from the growing number of fitness centers (gym centers) where the increase in the number of center gyms in the world from 2004 to 2014 increased from 82,000 to 180,000 gym centers (Canamero et al., 2018). This is consistent with the benefits of weight training itself because weight training can increase lean body mass, decrease fat mass, and increase resting metabolic rate in adults (Hunter et al., 2004).

Although the number of fitness centers is increasing, it is possible that the public's desire for weight training is not fulfilled. Problems arise when someone wants weight training but the location of a fitness center far from home makes weight training difficult to be done. For some people, sometimes expensive rental fees at the gym center make it unable to exercise weight regularly, while weight training must be done regularly to achieve its goals. According to

Jakicic et al. (2003), it takes training for 30 minutes or more every day to be able to lose weight effectively. The number of gym center users also makes some people embarrassed when they are beginners in weight training or they have to wait a long time when a device (gym machine) that they want to use is being used by someone else.

To overcome these problems, a gym machine is needed that can be used at home so that it can be used freely, cost-effective and easy to reach. However, the problem is that the user must have a lot of gym machines. Because at this time, every gym machine only has one specific function which can only train one muscle section. Even though the size of one gym machine is an obstacle because of its very large size (Coombs, 1997). Apart from that, the gym machine still has a manual load modifier, where one has to remove the iron hook and put it back in with his hand which makes its use impractical. The absence of trainers also makes it difficult to do weight training at home, while the presence of trainers greatly influences the effectiveness of the movement (Wariyanti, 2015).

Rizqi (2019) has conducted a research on the design of a smart gym machine with an all in one concept to overcome this problem called GYM ATOM (Gym Machine with Artificial Trainer and Automatic Load Modifier), the 3 newest features of the gym machine are concept machines designed all in one, has an artificial trainer, and load modifiers are automatic. GYM ATOM is also designed with anthropometric measurements to be ergonomic. Until now, these products have been produced and have reached the alpha prototype stage for support and funding by the Ministry of Research and Technology (Ministry of Research, Technology and Higher Education) in the activities of the Student Creativity Program (PKM). To reach the beta prototype stage until it can be mass produced, it is necessary to know whether the product has met the needs of its users so that it needs to be tested using a usability test. Usability is a term used to explain the ease of the user in using a tool to achieve the goal. Nielsen (2012) defines usability as measured by the criteria of learnability, efficiency, memorability, errors, and satisfaction.

Therefore, the purpose of this study is to test the GYM ATOM product whether the product meets its needs based on the 5 usability criteria proposed by Nielsen. Where the focus of the testing is carried out on the three main features of the proposed product, namely the all in one gym machine, the artificial trainer, and the automatic load modifier. The results obtained will be an evaluation of product to reach the beta prototype stage until it is ready for mass production.

## **2. Methods**

### **2.1 Data Collection Method**

Based on the considerations of time, cost and energy, 40 respondents were chosen with the inclusion criteria of the respondents who were someone who had used a gym machine and lived in Yogyakarta, both male and female, aged 20-30 years, and working as students. Data collection is done by observation and distribution of questionnaires. Observations were made to assess the criteria of efficiency, memorability, and errors because they can be assessed objectively, while questionnaires to assess learnability and satisfaction criteria because both of these criteria are subjective. The rating scale uses a Likert scale 1-5 where 1 states strongly dislike and 5 states very like.

### **2.2 Instrument Testing**

For data are taken from the questionnaire, before being processed, validity and reliability tests are required first using SPSS 22 software. Tests of validity need to be done so that the data obtained from the questionnaire can reveal the purpose of the research while reliability testing needs to be done to prove that the answers to the questionnaire are consistent (Rizqi, 2019). The testing technique used by researchers to test the validity is using Bivariate Pearson correlation, where the criteria are the questionnaire is said to be valid if  $r_{count} \geq r_{table}$  using a two-sided test with sig. 0.05. The results of the questionnaire are said to be reliable if the value of Cronbach's Alpha shows a value above the minimum limit of 0.60 (Ghozali, 2006).

### **2.3 Usability Assessment**

Usability test results were analyzed using non-parametric descriptive analysis based on frequency percentages. The results are in the form of usability assessment of the 3 main features of the product, which in the end will be averaged and assessed based on usability level to find out the level of ease of the overall product. Usability measurement includes five criteria namely (Rubin & Chisnell, 2008):

- a. Learnability: Measuring how easy the user can learn how to use the product for the first time.
- b. Efficiency: Measuring how quickly users can use the product.
- c. Memorability: Measuring the extent to which a user can remember the steps or processes carried out in achieving his goal.
- d. Error: Measuring how much the user made a mistake, and the extent of the error, and what for the user to resolve the error.
- e. Satisfaction: Measuring how users feel when using products or responses to overall product design.

Assignments were given to respondents in the form of "Operating the GYM ATOM for each movement - Changing the automatic load modifier by talking - Moving the GYM ATOM until the artificial trainer is operating". To reduce bias, the time needed when the GYM ATOM operating is not calculated because it is influenced by internet speed, not by users. Time measurement is done with the help of a stopwatch. The assessment was carried out using the questionnaire and observation with the Likert scale. The way of assessment is shown in Table 1.

Table 1. The Way of Assessment in Usability Testing

Criteria	Descriptive	Scale	Way of Assessment
Learnability	Very easy to learn	5	Questionnaire (User Subjectivity)
	Easy to learn	4	
	Normal	3	
	Not easy to learn	2	
	Not very easy to learn	1	
Efficiency	Can use the tool for max 1 minute	5	Observation (Objective)
	Can use the tool for max 1.25 minutes	4	
	Can use the tool for max 1.5 minutes	3	
	Can use the tool for max 1.75 minutes	2	
	Can use the tool for more than 1.75 minutes	1	
Memorability	Can remember usage after 1 study	5	Observation (Objective)
	Can remember usage after 2 studies	4	
	Can remember usage after 3 studies	3	
	Can remember usage after 4 studies	2	
	Can remember usage after more than 4 studies	1	
Errors	There was no/an error on first use	5	Observation (Objective)
	There was an error on second use	4	
	There was an error on third use	3	
	There was an error on fourth use	2	
	There was an error on more than fourth use	1	
Satisfaction	Very satisfactory	5	Questionnaire (User Subjectivity)
	Satisfactory	4	
	Good enough	3	
	Not satisfactory	2	
	Very unsatisfactory	1	

### 3. Results and Discussion

#### 3.1 Product Description

As explained earlier, GYM ATOM is designed with 3 main features that will be tested for usability to the respondents. The first feature is the gym machine designed with the concept of All in One where it does not only train 1 muscle but it can train 7 muscles, namely biceps, triceps, stomach, chest, legs, back and shoulders in 1 machine. The proposed All in One design can be seen in Figure 1.

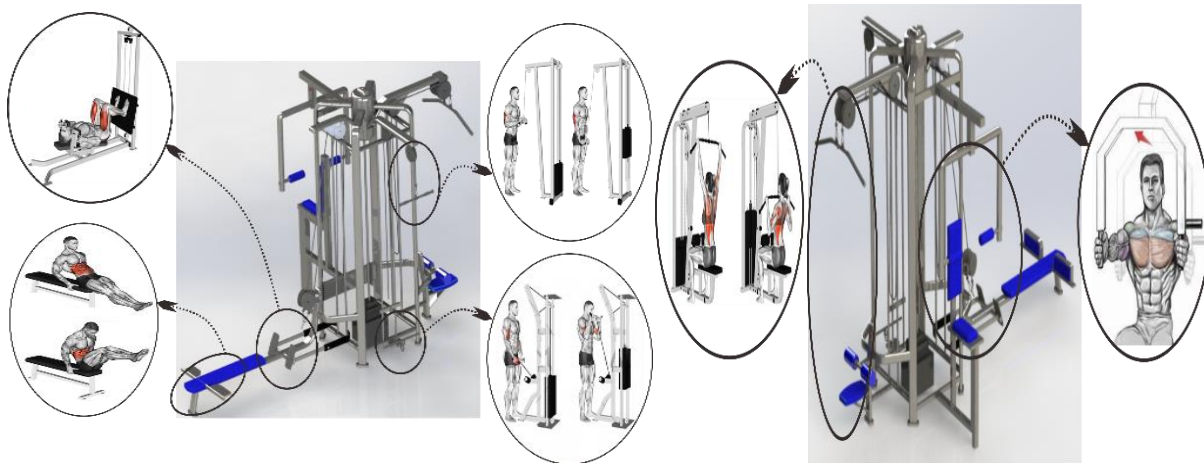


Figure 1. All in One Design

The second and third feature is the gym machine that has an artificial trainer feature and an automatic load modifier feature utilizing existing technologies such as Ultrasonic Sensors, Google Home, Arduino, and Servo motor. The working mechanism that will be tested for the usability of the artificial trainer feature can be seen in Figure 2 and the working mechanism of the automatic load modifier feature can be seen in Figure 3.

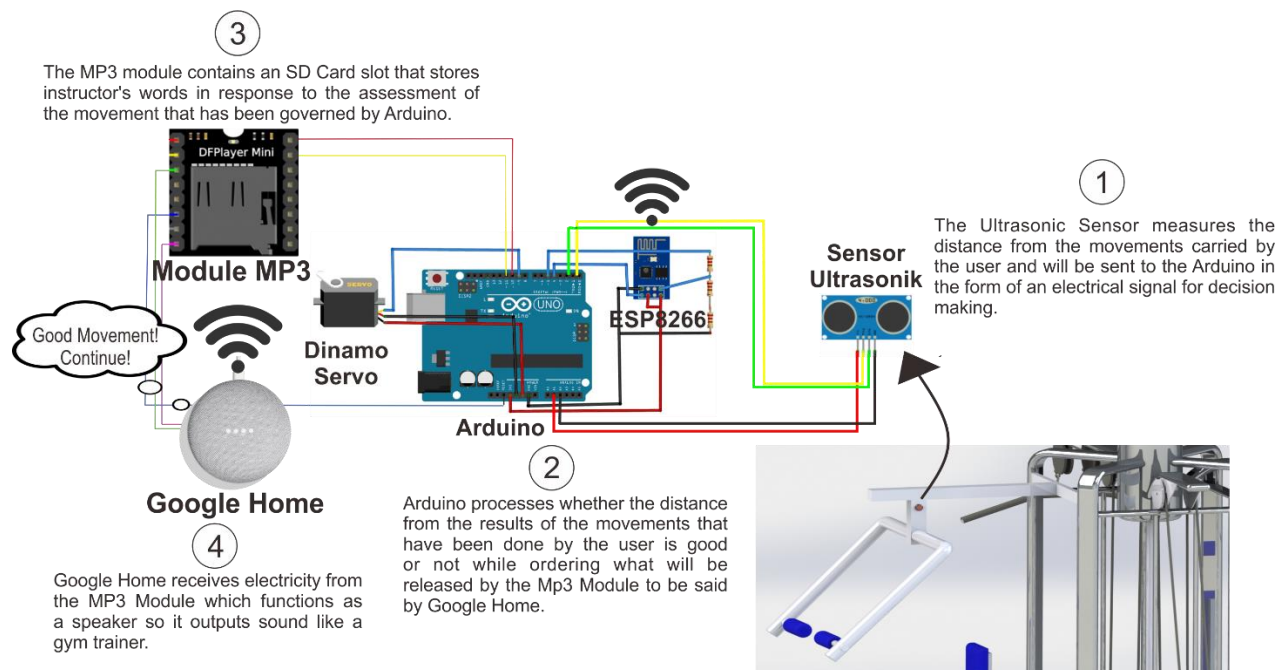


Figure 2. Mechanism of Artificial Trainer

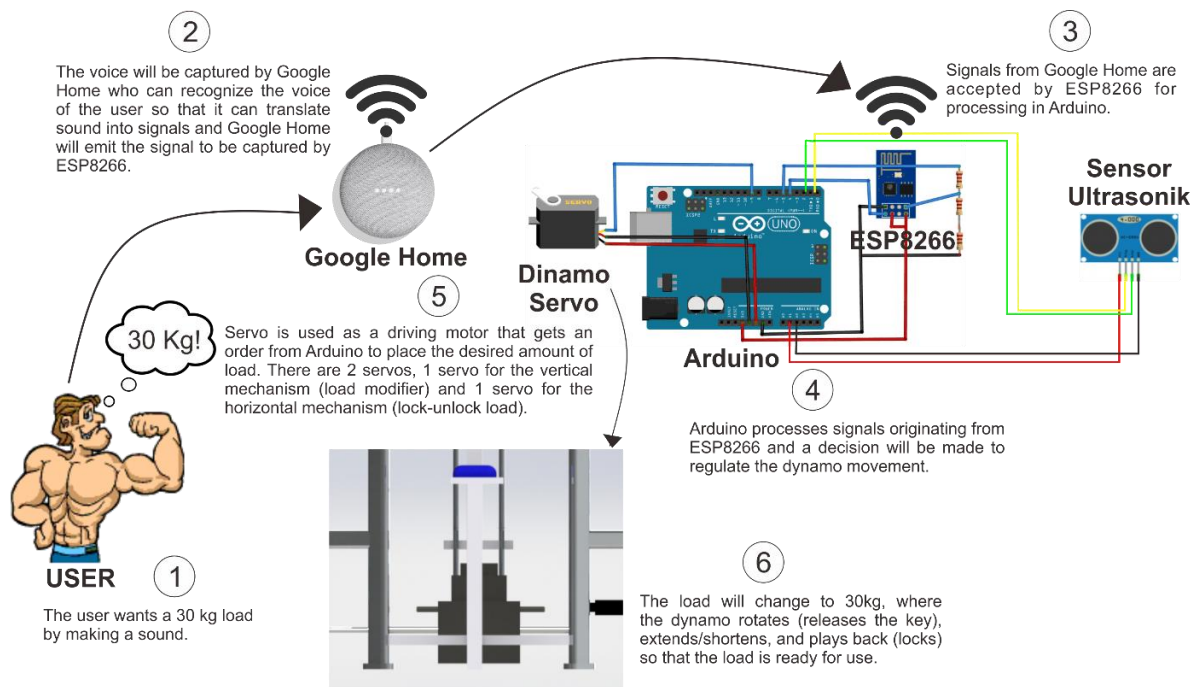


Figure 3. Mechanism of Automatic Load Modifier

### 3.2 Usability Test Result

Usability testing was carried out on 40 respondents which can be seen in Figure 4. The initial step of the testing was done by first explaining how to use the GYM ATOM. Then an experiment was conducted where respondents tried the three main features to be tested on the GYM ATOM for observation. After that, questionnaires were distributed to measure satisfaction and learnability.



Figure 4. Usability Testing Experiment

Before carrying out the analysis, the validity and reliability tests were conducted first on the results of the questionnaire. Based on the results of calculations using SPSS 22, the results obtained that all questionnaires are said to be valid because  $r \text{ count} \geq r \text{ table}$ . And the value of Cronbach's Alpha shows a value of 0.723 which is above the minimum limit of 0.60 so the results of the questionnaire are said to be valid and reliable so that they can be analyzed further. Each scale of the overall respondents, with the recapitulation results based on the 3 tested features can be seen as shown in Tables 2, 3 and 4.

**Table 2. Usability Testing Recapitulation Results for the All in One Feature**

Variable	Nilai (%)				
	Very Bad	Bad	Moderate	Good	Very Good
Learnability	0	5	17.5	45	32.5
Efficiency	0	0	15	15	70
Memorability	0	17.5	22.5	35	25
Errors	0	7.5	17.5	20	55
Satisfaction	0	7.5	17.5	30	45

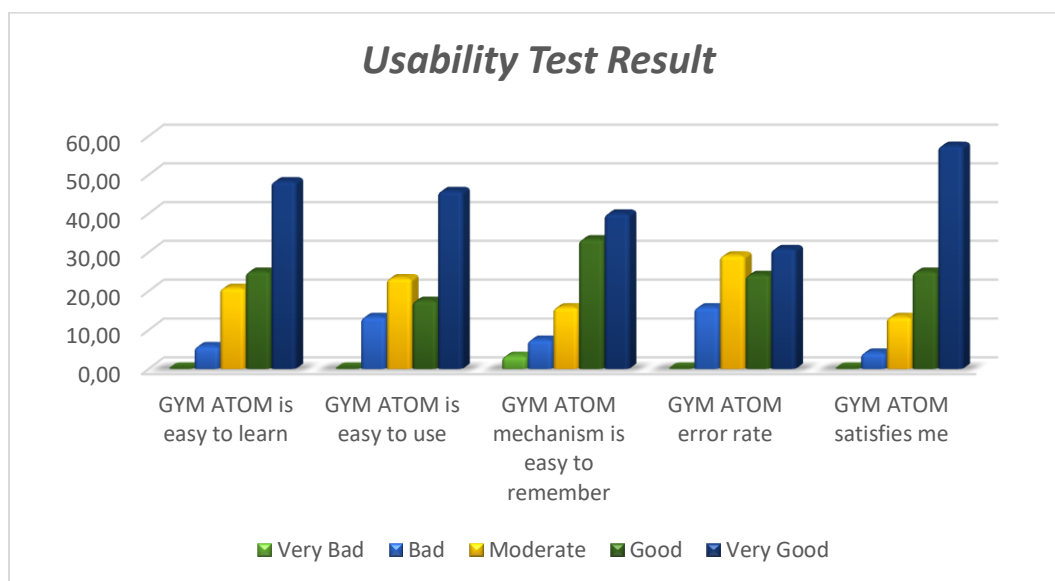
**Table 3. Usability Testing Recapitulation Results for Artificial Trainer Feature**

Variable	Nilai (%)				
	Very Bad	Bad	Moderate	Good	Very Good
Learnability	0	12.5	32.5	12.5	42.5
Efficiency	0	17.5	35	20	27.5
Memorability	0	0	0	17.5	82.5
Errors	0	10	27.5	35	27.5
Satisfaction	0	0	5	27.5	67.5
Total					

**Table 4. Usability Testing Recapitulation Results for Automatic Load Modifier Features**

Variable	Nilai (%)				
	Very Bad	Bad	Moderate	Good	Very Good
Learnability	0	0	12.5	17.5	70
Efficiency	0	22.5	20	17.5	40
Memorability	10	5	25	47.5	12.5
Errors	0	30	42.5	17.5	10
Satisfaction	0	5	17.5	17.5	60

The results of the recapitulation above are then averaged in order to find out the usability of the GYM ATOM as a whole so that the results are obtained like Figure 5.



**Figure 5. The Results of Usability Testing of GYM ATOM**

Based on the results of the usability testing, it can be concluded that the GYM ATOM has the highest very good performance for each criterion, which means it has a very good usability level. However, if analyzed further, the error rate criteria (errors) of GYM ATOM are the criteria with the lowest very good performance. It is caused by the automatic load modifier feature of GYM ATOM that can only be used in the English language while the respondents are Indonesian whose proficiency is not good in English. As an evaluation of future improvements, this feature will be improved so that it can be used in Bahasa Indonesia so that the usability of the GYM ATOM is going better.

To calculate the GYM ATOM's overall usability score, the Actual Usability Score (AS) and the Expected Maximum Score (ES) are needed first. Comparison between AS and ES will get an overall usability score with the usability score classification in Table 5 (Kasmawi, 2013).

Table 5. Usability Score Classification

Score (x)	$0 \leq x \leq 0.2$	$0.2 < x \leq 0.4$	$0.4 < x \leq 0.6$	$0.6 < x \leq 0.8$	$0.8 < x \leq 1.0$
Usability Level	Very Bad	Bad	Moderate	Good	Very Good

ES is calculated through  $40 \times 25 = 1000$ , where 40 is the number of respondents and 25 is the result of the calculation of the number of assessment criteria multiplied by the measurement scale range. While AS is obtained by multiplying the weights of each criterion (Very Bad = 1, Bad = 2, Moderate = 3, Good = 4, Very Good = 5) with the average frequency of all features tested as shown in Table 6.

Table 6. Calculation of Actual Score

	Very Bad	Bad	Moderate	Good	Very Good	Total Score
Learnability	0	2.333	8.333	10	19.333	166.333
Efficiency	0	5.333	9.333	7	18.333	158.333
Memorability	1.333	3.000	6.333	13.333	16.000	159.667
Errors	0	6.333	11.667	9.667	12.333	148.000
Satisfaction	0	1.667	5.333	10	23.000	174.333
					<b>Actual Score</b>	<b>806.667</b>

Based on Table 7, the actual score of the GYM ATOM usability assessment is 806.667, so that the total usability score of GYM ATOM is  $(806.667/1000) \times 100\% = 80.667\%$  or 0.80667. Where 0.80667 is included in the **Very Good Usability Level**. However, it does not mean there is no need for improvement because as we know that there is no the best system but there is always better system. The most important thing to be improved from the GYM ATOM is the automatic load modifier feature so that the error rate will be reduced and the usability level will be better.

## 4. Conclusions

Based on the discussion above, it can be concluded that the results of usability testing for GYM ATOM product using Nielsen's Heuristics method which is tested for 3 innovative features namely all in one concept, artificial trainer, and automatic load modifier has the total score of usability is 80.667% which is very good usability level. However, as an evaluation in the future, it needs to be improved for the automatic load modifier feature because it produces a fairly high error rate. This is because these features can only be used using English while the respondents are Indonesian who are not fluent in English. So it is necessary to repair the automatic load modifier system so that it can be used according to the user's language. After repairs, GYM ATOM is ready to be produced at the beta prototype stage and mass produced.

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## Biography

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