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Development Interactive Vending Machine For Supporting The Health Protocol of The New Normal Era at Telkom University

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ABSTRACT

Telkom University through the Covid19 task force team urges all employees to comply with health protocols while in the campus environment. Facilities such as masks, hand sanitizers, temperature scanners, and gate sterilizers have been provided to protect the campus community. The entire campus community is encouraged to isolate if there are symptoms of a Covid-19 virus attack. This Vending Machine was developed to provide health protocol facilities in the campus environment with the support of interactive multimedia technology. The development of this tool uses the Prototyping method which focuses on the main functions. The result of the Vending Machine development is that transactions can be used through the Android mobile application device directly through the desktop application contained on the screen at the Vending Machine. The results of the Vending Machine test state that 100% of the functions run according to the procedure and the device User Interface gets a value of 76.9 from the System Usability Scale test method.

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1. Introduction

The 2019 Novel Coronavirus (nCovid19) pandemic has been going on for almost 3 years and the Indonesian government continues to disseminate and educate the public through the Covid-19 task force in each region to comply with health protocols so that the spread of the coronavirus can be minimized or even stopped. These health protocols include wearing masks, washing hands, and maintaining distance [1]. People who violate the health protocol, they can be fined if it is proven that they deliberately violated it.

All companies, industries, and educational institutions must also follow regulations from the government to comply with the health protocol, and if they violate it, the government can close the company's operations [1][2] . One of the educational institutions that are also implementing this health protocol is Telkom University, where the campus has been conducting online learning since the first time the coronavirus entered Indonesia and made it mandatory for lecturers and staff to wear masks for those who are WFO (Work From Office) [3]. The campus has also provided free hand washing facilities and hand sanitizers in every building, and the entrance post staff checks the body temperature of every employee who enters the campus arena.

The development of this Vending Machine (VM) [4] aims to provide various products, including masks and hand sanitizers, while also incorporating body temperature scanning capabilities. This is done to support the Covid19 Task Force team at Telkom University in adhering to regulations and educating the university community about complying with the health protocols mandated by the Indonesian government. Users can also place orders for items using a mobile application to minimize the use of shared screens with other users.

This Vending Machine has several main features including:

1. 19-inch touchscreen monitor to display information and functions in the system, as well as a means of user interaction with the system [5].
2. Glass showcases, transparent glass showcases displaying goods in the form of masks and hand sanitizers.
3. A temperature detection camera, is used to read the user's body temperature and displays the results on the monitor screen [6].
4. Mobile application support, where users can pre-order wherever they are [7].
5. Cashless Payment, users pay for goods using the QR code scanning method provided through the Vending Machine [8].

2. Research Method

The steps to be used in this Vending Machine development research are shown in detail in Figure 1.

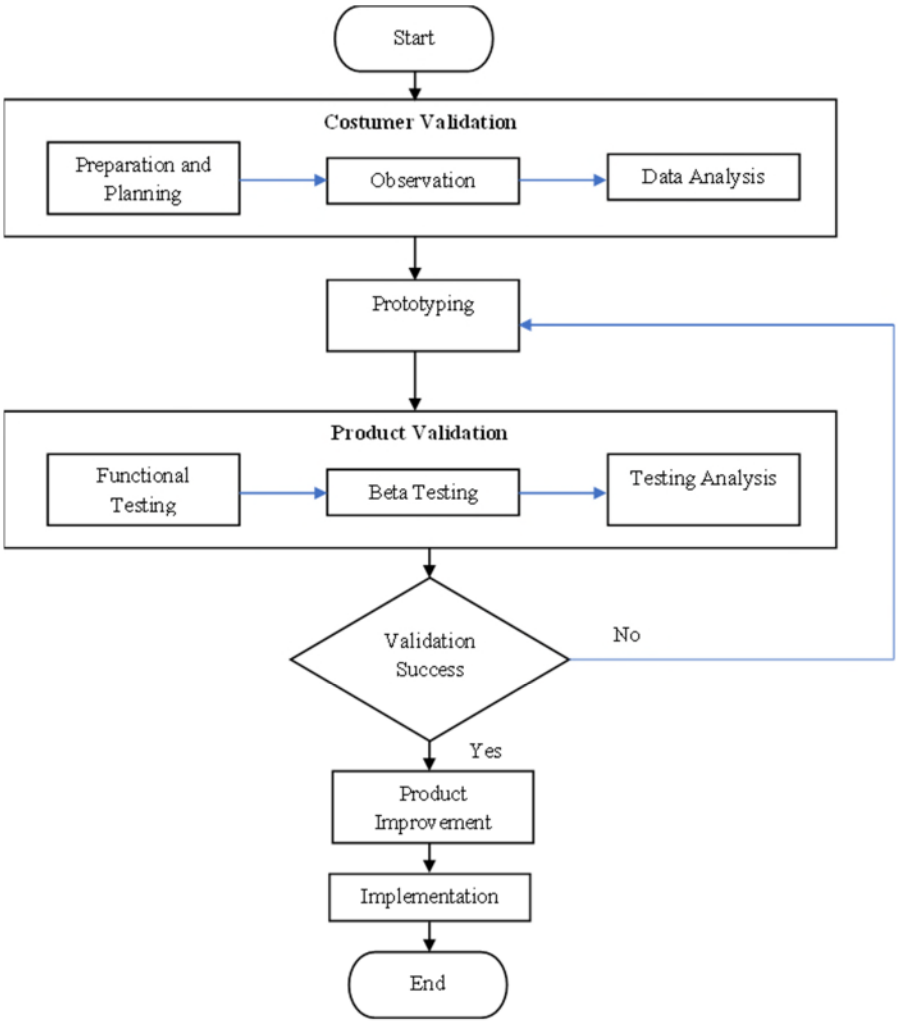


Figure 1 Vending Machine Development Flow

1. Customer Validation. Before starting, product development begins with the Customer Validation stage which aims to get the user's main problems and the specification of the tool requirements expected by the user. At this stage, 3 (three) main stages were carried out, namely preparation/planning, user observation, and analyzing the observed data.
2. Prototyping. After getting the initial development needs, the product development is carried out using a prototype model. The tools built are still limited to prototypes that only focus on the main functions needed by users [9][10]. At this prototyping stage using the model shown in Figure 2.

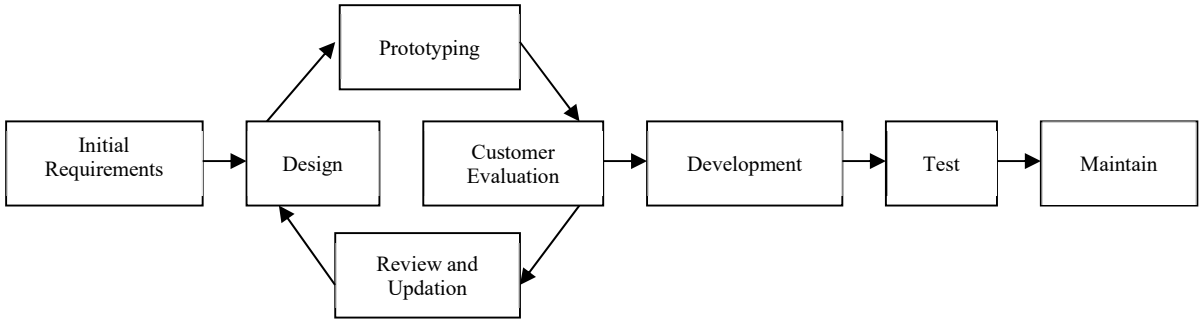


Figure 2 Prototyping Model [11]

3. Product Validation (PV). This stage is carried out after the prototype development process has been completed. The PV stage will carry out a functional testing process and beta testing, this aims to get optimal function and no errors [12]. If there are still errors or do not pass the test, they will be repaired.
4. Product Improvement. This stage is carried out if the prototype tool has passed the test. The process is to add some additional functions and design the packaging so that it is feasible to produce.
5. Implementation. At this stage, implementation tests were carried out directly to end users in several buildings at Telkom University such as the Rector's Building and Faculty Buildings.

3. Result and Implementation

The development of this product resulted in designs and real product.

1. Use Case Diagram (ERD). The access flow for functions or features contained in this Vending Machine can be seen in the Use Case Diagram or Figure 3 [13][14].

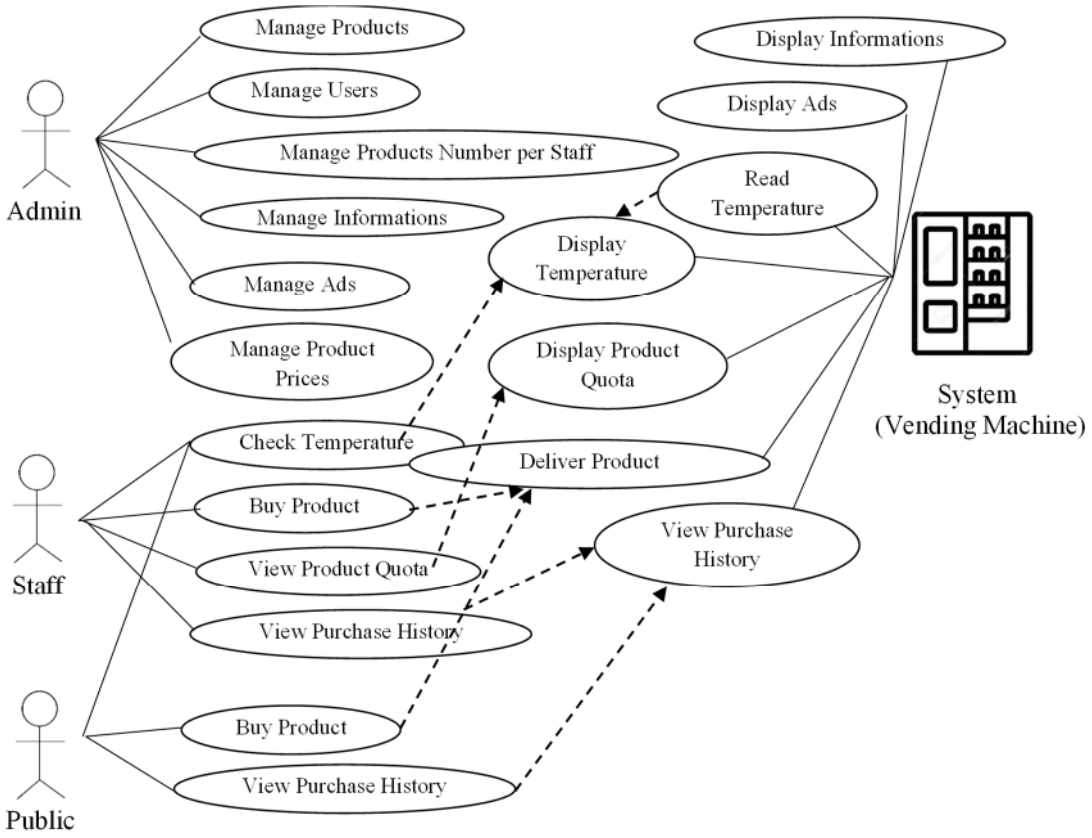


Figure 3 Use Case Diagram

The explanation of each user in the Use Case Diagram design is as follows:

- User Admin. Admin is a user role that has access to managing all data in the database, both goods data, employees, advertisements, information, and others.

- User Staff, Staff are users with employee status at Telkom University who receive special treatment when purchasing products at a vending machine.
- Public Users, General users are VM end users who purchase products. This type of user has several accesses such as registering, editing profiles, and placing product orders.

2. Entity Relationship Diagram (ERD). The development of the Vending Machine tool uses the MySQL database as data storage according to the Use Case Diagram. The ERD design for the database used is shown in Figure 4 [13][14].

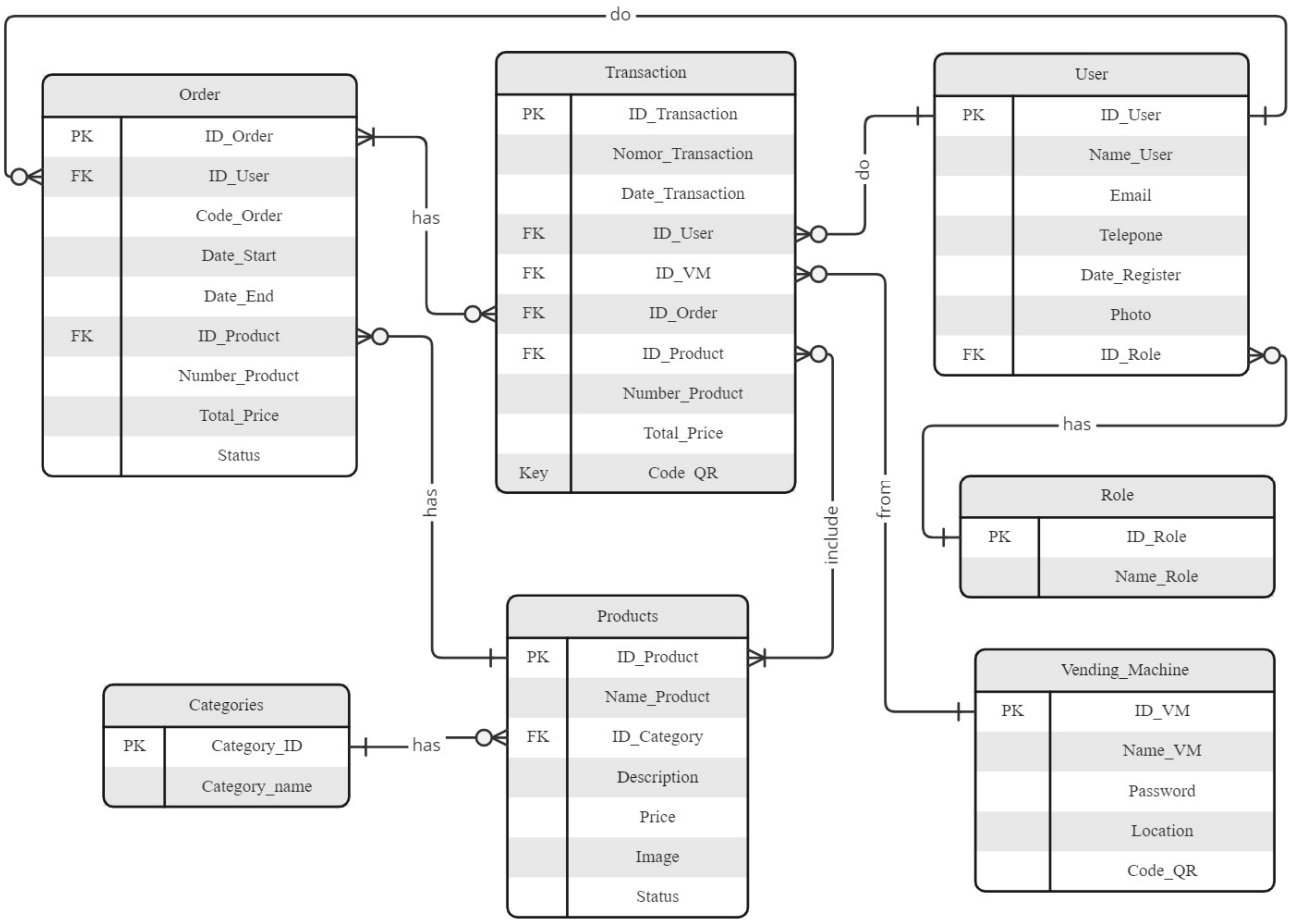


Figure 4 Entity Relationship Diagram

3. User Interface Design for Desktop Application. After getting the function design and table structure, the next step is to make a User Interface Design (UID) for desktop applications [15][16]. The design created will be displayed through the screen on the touch screen monitor device on the Vending Machine to interact with the user. Figure 5 shows some of the user interface designs for desktop applications. Some of the views created are the standby page, login form page for admin, purchase confirmation page (Checkout), payment scan page using QR (Quick Response) Code, and goods delivery page.
4. User Interface Design for Mobile Application, Developing this Vending Machines is also supported by mobile applications from the user. Figure 5 - 7 shows some user interface designs for mobile applications [16][17].

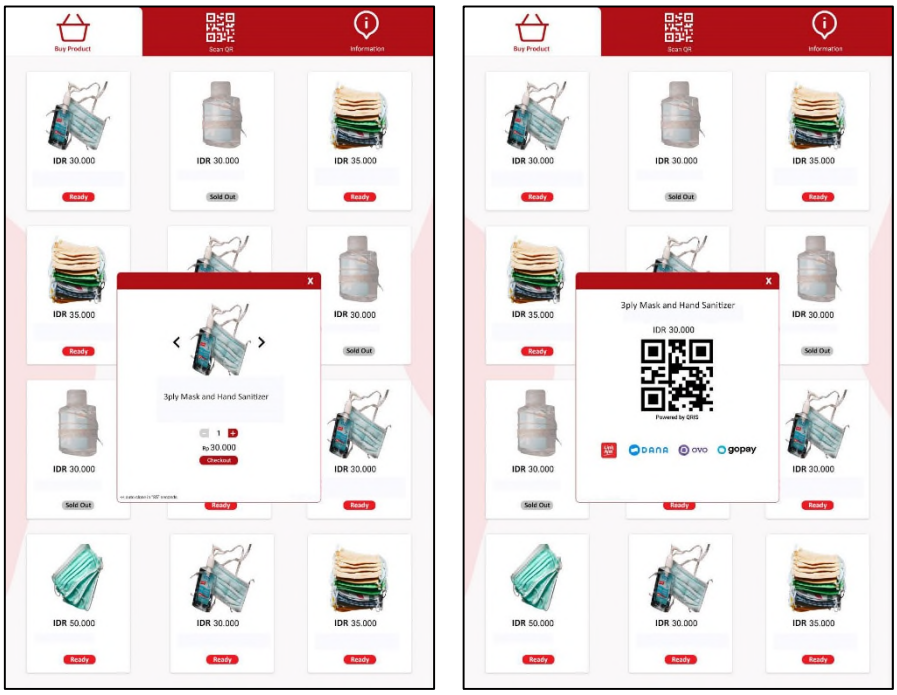


Figure 5 Desktop Application UID

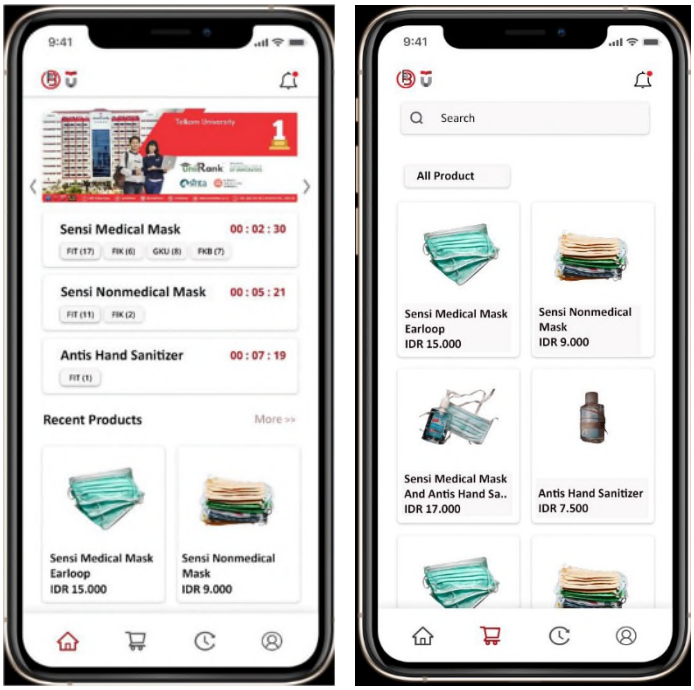


Figure 6 Product Pages UID

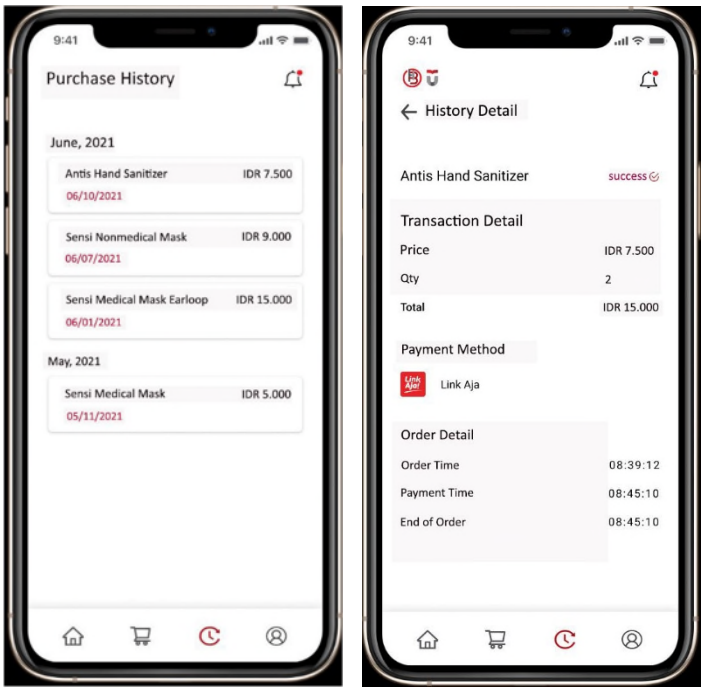
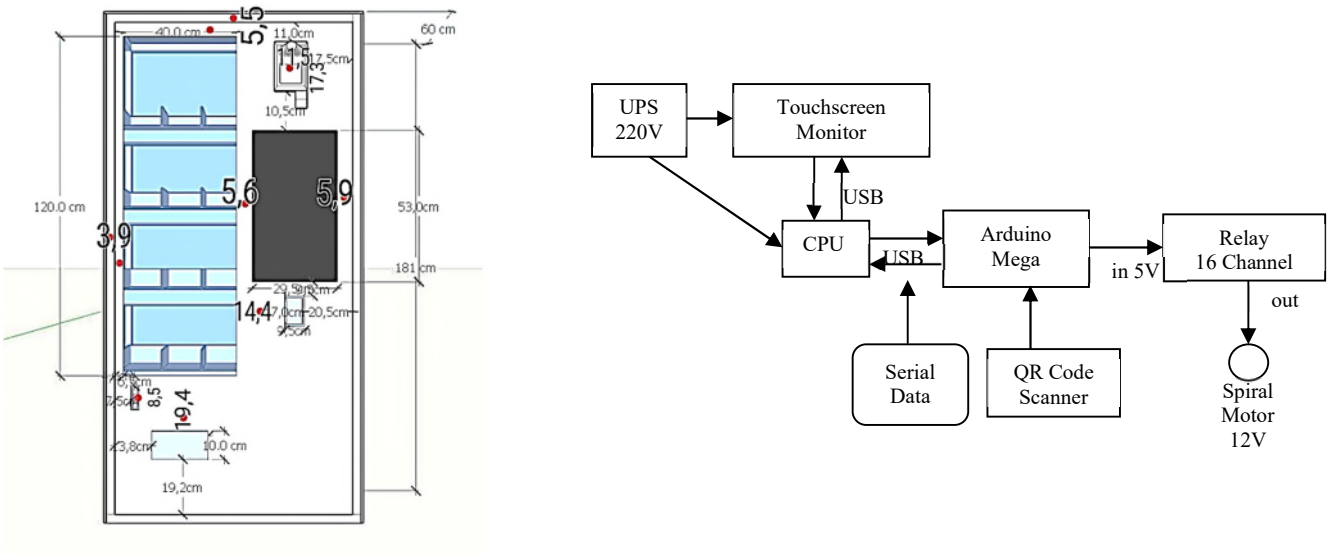


Figure 7 Transaction Report Pages UID

5. The product page offers users the ability to access information about the products available on a specific Vending Machine, examine the details of a selected product, and proceed with placing an order. Additionally, the page includes a timer functionality for managing bookings, ensuring timely retrieval of reserved products. Furthermore, the mobile application provides users with a transaction report feature, enabling them to access comprehensive records of their transaction history, including detailed information for each individual transaction.
6. Vending Machine. The development of the Vending Machine hardware begins with the creation of a three-dimensional (3D) model design to obtain detailed dimensions, sizes, and specifications of the components within. Additionally, a mechanical design is generated to establish interconnections between hardware devices and determine the data flow and power requirements during its intended operation. Figure 8 presents the outcomes of the 3D and mechanical design for the Vending Machine device.

After the model and mechanical designs are created, the next step is to construct the device in the form of a prototype. The prototype device is built using iron material, serving as both the frame and walls of the device. The mechanical hardware components are then assembled according to the predetermined positions in the model design. Figure 9 illustrates the outcome of the prototype device construction, showcasing the final form consistent with the 3D model and the hardware components such as the monitor, spiral, and QR Code scanner, as depicted in Figure 8's design



(a) (b)

Figure 8 Design for Vending Machine (a) 3D Model, (b) Mechanical

Figure 9 Manufacture Results of Vending Machine

The next step is the software installation process that has been made based on the design of the Use Case Diagram, Entity Relationship Diagram, and User Interface Design. And do the packaging so that the appearance of the device matches the theme that is carried. Figure 10 shows the finishing process and the end result of the Vending Machine device.

Figure 10 Finishing Process and Final Result of Vending Machine

The final results of the Vending Machine development show that the device has installed a monitor screen, QR scanner, body temperature detector, and a window glass that has a light accent using an LED strip.

4. Testing

1. Functional Testing. Functional testing is carried out to test all features as a whole, the method used is Black Box Testing [17]. Black Box is a test conducted to observe the input and output results of the software without knowing the code structure of the software. This test is carried out at the end of making the software to find out whether the software can function properly [18]. Table 1 shows some of the results of functional testing using instruments in Black Box Testing.

Table 1 Result of Black Box Testing for Five Functionals

No	Function	Testing Procedure	Input Data	Expected Output	Testing Result		
					Accepted	Accepted w/ Note	Rejected
1	Login for Desktop App	- The user enters the registered username and password on the login form - The user selects the login button	Username : admin Password : 1001234502	Display a dashboard page	✓		
2	Temperature scanning	- The user approaches the VM and is in front of the body temperature detector	Position of user	The body temperature sensor beeps	✓		
3	Product Purchase via VM	- User selects items - The user selects the Checkout button - The user scans the QR Code - User picks up item	- Choose item - Scan a QR Code	- Selected items fall in the pick-up box - The stock of selected items is reduced	✓		
4	Product Purchase via Mobile App	- User selects items - The user selects the Order button - The user comes to the VM, selects the QR Code icon - User inputs Order code - User scan QR Code for payment - User picks up item	- Choose an item - Order code - Scan QR Code	- The status of the ordered item has changed - Selected items fall in the pick-up box - The stock of selected items is reduced	✓		

No	Function	Testing Procedure	Input Data	Expected Output	Testing Result		
					Accepted	Accepted w/ Note	Rejected
5	Delivery Box	- The user puts his hand into the box - User picks up item - The user removes hands and items from the box	- User's hand - Item	- Users can remove items using their hands comfortably		✓ (the box door is small, the user's hand sometimes gets stuck)	

The total functionality tested was 76 functions in terms of hardware, software, network and accessories on the Vending Machine. From a total of 76 functions owned, it was found that 69 were accepted, 7 were accepted with notes, and 0 were rejected. The test results using the Black Box instrument show that 100% of the functions are running, and 90.78% of the functions are running well without any test records. This is in accordance with the purpose of the Prototype model used in device development.

2. User Interface Testing. User interface testing is carried out using the SUS (System Usability Scale) [19][20] method. SUS is a measurement tool in the form of a questionnaire that can be used to measure the level of usability of a system, has 10 questions and 5 answer choices. Answer choices use a Likert scale consisting of Strongly Disagree (SDA) to Strongly Agree (SA) [21]. Each answer has a score as in Table 2.

Table 2 Score of Likert Scale Options

Option	Score
Strongly Disagree (SDA)	1
Disagree (DA)	2
Neutral (N)	3
Agree (A)	4
Strongly Agree (SA)	5

This test was carried out on 25 respondents in the Telkom University environment who filled in validly, namely lecturers, staff and students. Table 3 is a recapitulation of the total number in each question and the answer choices.

Table 3 Recapitulation of SUS Questionaire

No	Question	SDA	DA	N	A	SA
1	I think I will use this system again	0	0	5	13	7
2	I find this system complicated to use	8	8	5	4	0
3	I find this system easy to use	0	0	2	8	15
4	I need help from other people or technicians in using this system	10	12	3	0	0
5	I feel the features of this system work as they should	0	2	9	8	6
6	I feel there is a lot of inconsistency (incompatible with this system)	5	14	4	2	0
7	I have a feeling that others will understand how to use the system quickly	0	0	3	18	4
8	I find this system confusing	5	18	2	0	0
9	I feel there are no obstacles in using this system	0	0	8	11	6
10	I need to get used to it first before using this system	11	13	1	0	0

After collecting data from respondents, then the data is calculated. In how to use the System Usability Scale (SUS) there are several rules in calculating the SUS score [21]. The following are the rules for calculating scores on the questionnaire:

1. For each odd numbered question, the score for each question obtained from the user's score will be reduced by 1. So the formula used for odd questions is:

$$\sum \text{odd} = n \times (x - 1) \quad \text{.....(1)}$$

The description of equation 1 is:
∑odd = Total score of each odd answer
n = Number of respondens
x = Answer score

2. For each even numbered question, the final score is obtained from the value of 5 minus the question score obtained from the user. So the formula used for even questions is:

$$\sum \text{even} = n \times (5 - x) \quad \text{.....(2)}$$

The description of equation 2 is:
∑even = Total score of each even answer
n = Number of respondens
x = Answer score

3. The SUS score is obtained from the sum of the scores for each question which is then multiplied by 2.5.

From the SUS calculation rules, the next step is to find the total SUS score which can be seen in Table 4.

Table 4 Calculation of SUS Total Score

Question	SDA	DA	N	A	SA	Total	Value (Total × 2,5)
1	0	0	10	39	28	77	192,5
2	32	24	10	4	0	70	175
3	0	0	4	24	60	88	220
4	40	36	6	0	0	82	205
5	0	2	18	24	24	68	170
6	20	42	8	2	0	72	180
7	0	0	6	54	16	76	190
8	20	54	4	0	0	78	195
9	0	0	16	33	24	73	182,5
10	44	39	2	0	0	85	212,5
Total SUS Score (∑x)							**1922,5**

After getting the total SUS score, then calculating the average test score to get a conclusion with the formula:

$$\bar{x} = \frac{\sum x}{n} \quad \text{.....(3)}$$

The description of equation 3 is:
$\bar{x}$ = Average of SUS score
∑x = Total of SUS score

n = Number of respondens

With equation 3 it is known that:

$\sum x = 1922,5$
$n = 25$

So it can be calculated that:

$$\bar{x} = \frac{1922,5}{25} = 76,9$$

The SUS method has several categories including NPS (Net Promoter Score), Acceptability Scale, Adjective Ratings, and Grade to conclude the final results as shown in Figure 11 [22] .

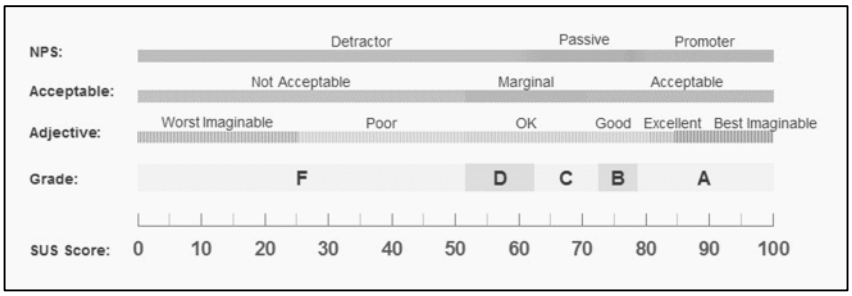


Figure 11 Measurement Category of SUS Method

Figure 11 shows that the results of testing the Vending Machine User Interface using the SUS Method with a final score of 76.9 get a PASSIVE class in the NPS category, the ACCEPTABLE range for the Acceptability Category, GOOD Adjective Rating, and a Grade of B.

5. Conclusions

The development of Vending Machine devices has produced hardware and software that has functions to support health protocols in the new normal era after the Covid19 pandemic with test results obtained in terms of functionality and user interface. Some of the conclusions obtained during the development are:

1. By using this Vending Machine device, users are facilitated with 2 application platforms, namely desktop and mobile, in making transactions.
2. All functionalities that have been developed have completed, even 90.76% of the functions run very well without any notes on the test.
3. User interface testing resulted in a final score of 76.9 in the SUS score, which means that the hardware and software interfaces received Passive, Acceptable, Good Rating, and Grade B classes in each category.

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