ISBN: 978-628-96613-0-9. ISSN: 2414-6390. Digital Object Identifier: https://dx.doi.org/10.18687/LEIRD2024.1.1.828

Mobile application based on the Android platform to improve inventory management in the Property Control Administration Department

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***Abstract*– Currently in the department of administration of patrimonial control the lack of use of technologies to perform the inventory and verify the registered movable goods is visualized, reason for which can produce the disorder of the information and its subsequent loss. Therefore, the objective of this research is to develop a mobile application to improve the inventory taking process. This is why a graphical interface was developed that allows the verification and registration of movable assets, this interface is based on App Inventor which is a visual block environment, created for the development of mobile applications, which resulted in a 93.75% satisfaction rate, 100% accuracy when requesting information from the Firebase and a latency of 142.3 ms when verifying the information Additionally, the app can work well on devices running Android 7.0 and above with a maximum packet loss of 10.72%, which allows concluding that the mobile application is usable, correctly verifies a movable asset and the application can perform remote monitoring on a constant basis.**

***Keywords*-- App inventor, CSUQ, Graphical interface, Inventory.**

I. INTRODUCTION

One of the most relevant challenges of public management lies in the efficient and regular administration of public assets, therefore it is the obligation of public administrations to carry out asset inventories [1]. The most common way to collect data in state entities for an inventory is through the use of paper forms [2] . In the absence of software for the registration of these assets, the registration is done manually in a notebook and then entered in Excel, allowing the duplication and loss of information of the incoming assets [3]. The Department of Property Control Administration is no stranger to these problems, since the entity does not have a specialized tool to facilitate the inventory, which can lead to inefficient management of the system for the control and control of property assets, as well as the verification of their physical condition [4]. Inadequate inventory and warehouse management, as well as the acquisition of products at the wrong time and in the wrong quantity, always incur increased costs due to the growing volume of products to be stored, and thus the space occupied [5]. In addition, because there are so many items to be inventoried, the manual work is more complex, which can lead to human error and difficulty in tracking [6]. Inventory management of the organization involves decisions that include financing, promotion, sourcing, and procurement management. All of them have high risk and have a direct impact on the financial framework [7]. With the development of a specialized inventory management system, it has been noted in different researches that the levels of reporting delivery generate positive decision making, in which reliable, accessible, compact and structured data is available [8].

Currently, different technological tools have been developed that seek to effectively control inventories in order to allow savings, investing only in what is necessary to reduce costs and storage space [9]. Among these technological tools are APPs, in the development of a mobile application, most of the time, the main components used are almost the same for each application, only varying in the uses and design. Using smartphones combined with a customized mobile application, the inventory takers will be able to instantly record the information obtained from the physical formats [10]. Therefore, in this research the use of apps for mobile devices is applied [11], the application allows the personnel of the control of patrimonial goods to achieve inventory management and information consultation through mobile terminals anywhere in the entity instead of using a fixed PC.

II. METHODS

To achieve the development of this software, three stages were passed. In the first, the design and interaction that the APP would have in conjunction with the database were planned to improve the user experience. In the second stage, the programming and structuring of the APP begins along with the communication with Firebase, which is the database. The third stage is to test the application based on customer satisfaction and service quality parameters.

A. System operation

Mainly the user must enter a correct username and password to be able to enter the system, following this there are two modes of operation as shown in Figure 1.

1) Mode 1.

It will be possible to register a new patrimonial good only if the necessary characteristics requested by the system are provided (patrimonial code, address, denomination, brand, model, series and state of conservation) and additionally an image of the movable and immovable good, if in case the requested data is not fulfilled, the system will show an error

where it will be indicated which are the data that are missing to be completed, Once all the requirements have been entered, the system sends the information to the cloud, in this case we will use Firebase as a virtual server, where the system will send an encryption that will register the data of movable and immovable assets using the api rest that will allow us to verify the database in real time.

2) Mode 2.

The user must use the mobile camera sensor to read the barcode that is on the asset to verify its existence and / or characteristics or otherwise you can also enter your asset code manually and then press "VERIFICAR" then automatically and in real time the system uses the API REST to query information to the cloud and thus to display the required information on the screen.

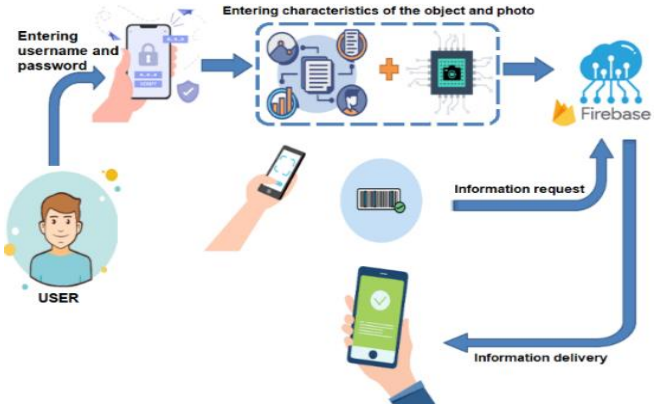

Fig. 1 System operation

B. Software analysis

1) APP Inventor.

AppInventor is a platform developed from Google Labs to create powerful software applications that are familiar with the Android operating system. In a visual way, and from a set of basic tools, the user can link and join a series of blocks to implement the application [12]. It is a programming language based on blocks (like pieces of a construction set), and event-driven. The function of this platform is to give instructions to the operating system of the mobile device about our intentions and the way we want them to be carried out [13]. Its potential for the creation of didactic content applications is remarkable [14]. It has a user interface that includes the layout editor and the block editor; the former, allows dragging and dropping the elements of the application's user interface to position them; and the latter, is the environment in which the user can visually trace the application's logic, using color-coded blocks that are put together like puzzle pieces [15].

1.1. Programming the main screen

In the design environment there is a space called "Screen" where the configuration of the web component and the design of the interface that users can use to perform the inventory, which will help the operator to make decisions and perform tasks [16]. The "Screen" provides access to the different actions that can be performed by the application, either registering a new asset or verifying it, as well as an exit button. If a tool is required, simply click on "Paleta" and choose one of the options and drag it to our "Pantalla virtual". And within each of the elements on the right side of our monitor, we can see the property options to adapt the object to our needs [17].

- Palette: In Figure 2.1. we can see the block where all types of actions can be inserted for the user, such as registers, data entry, sensors, etc.
- Virtual screen: Figure 2.2 shows the reference design of the application screen that the programmed android device will have.
- Components: Figure 2.3. shows all the parts and components of the project, inserted from the Palette block where the various tools are found.
- Properties: Allows you to modify details of each component, and display the modifications in the Virtual Screen window.

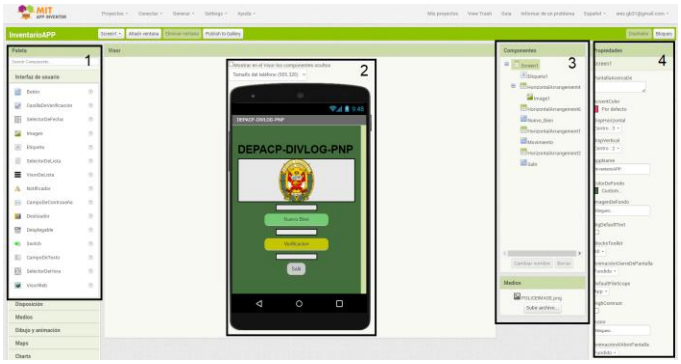

Fig. 2 Main screen

1.2. User data insertion block

When starting the data insertion screen, it will generate string variables such as "usuario" and "password" initially empty. The start_session block refers to a button that will analyze if any content has been entered in the text boxes as shown in figure 3, if the information is not completed a message will be displayed saying "NO DEJAR LOS CAMPOS VACÍOS".

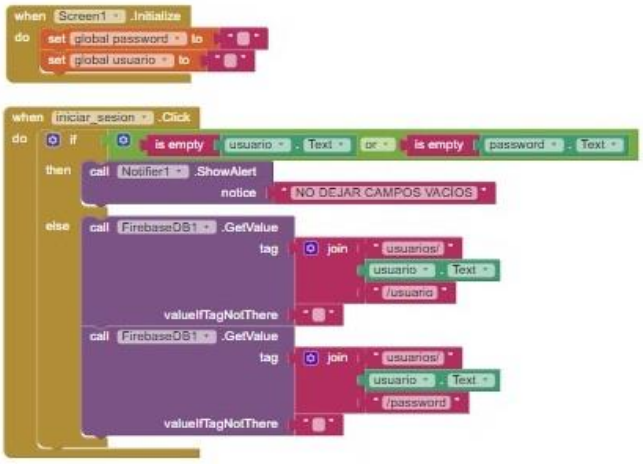

Fig. 3 APP inventor data insertion block

1.3. User verification block

Data such as user and password are entered into the Firebase block and validated by means of text comparison.

Once validated, an image of the user will be requested in order to continue [18]. It continues with the block of the creation of the JSON structure, which will first allow access to the control block of the WEB component after obtaining a text with which establishes a connection to the Firebase database and then the text box will insert the names of the headers of the JSON structure in which the information will be stored [19] as shown in Figure 4. If in case an attempt is made to omit the information related to the identity, password and user photo, the system will simply issue an error message.

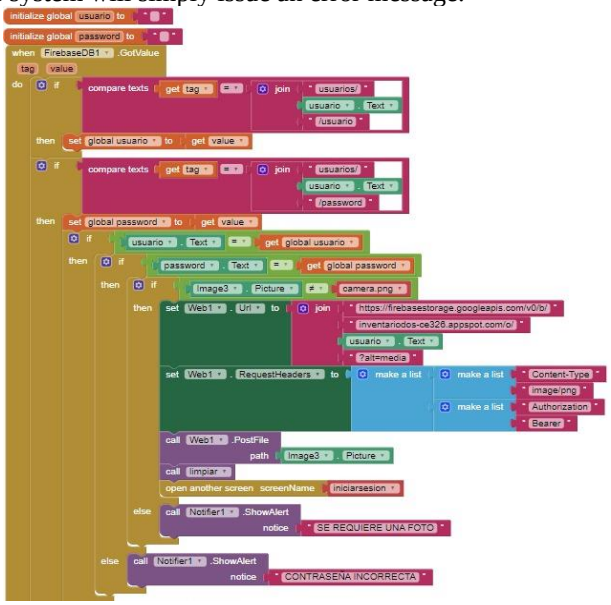

Fig. 4 User data verification block

1.4. Block for the storage of information on movable and immovable assets

In this block the characteristic values of the movable and immovable assets will be entered, such as the patrimonial code, address and denomination, if the data is not complete a message will appear indicating that the information is incomplete, then these values entered from the application can be saved in the Firebase by pressing the "Save" button as shown in Figure 5, from where the information can be extracted remotely from the cell phone or computer.

Fig. 5 Firebase information storage block

1.5. Blocks for the extraction of the information

To extract the information from the Firebase, click on the button "Tomar_código", the camera will be activated to start reading the barcode as shown in figure 6. A. After scanning the barcode, the block "LectorCódigoDeBarras1" stores the result obtained from the scan in the Tex_cod as shown in figure 6. B. Finally, in the figure 6.C you can see the consult button, once you press the button the Firebase link is joined with the scanned code, this URL takes us to the database hosted in the Firebase, directly to the record that has the patrimonial code to be able to visualize the information.

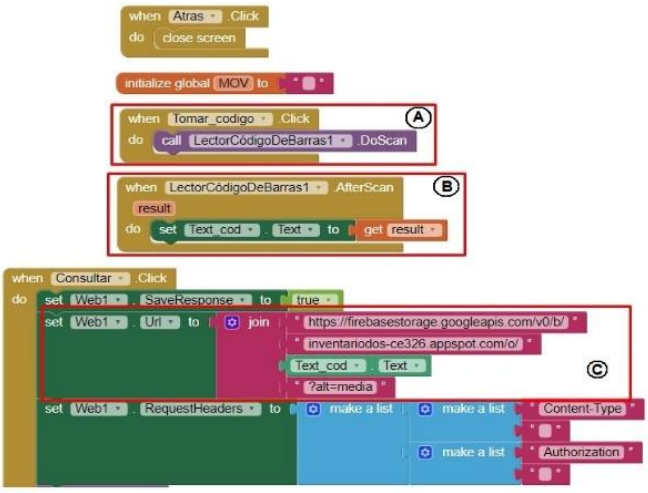

Fig. 6 Characteristic extraction block by bar code scanning A) Switching on the camera to capture the barcode B) Barcode reading block C) Information query block

1.6. Flowchart

The process starts with the request of identity, password and the request of the user's image, if the requested information is not completed correctly, it will show an error message, otherwise it will access the next screen, in which one of the 2 modes of operation previously mentioned is established as shown in Figure 7.

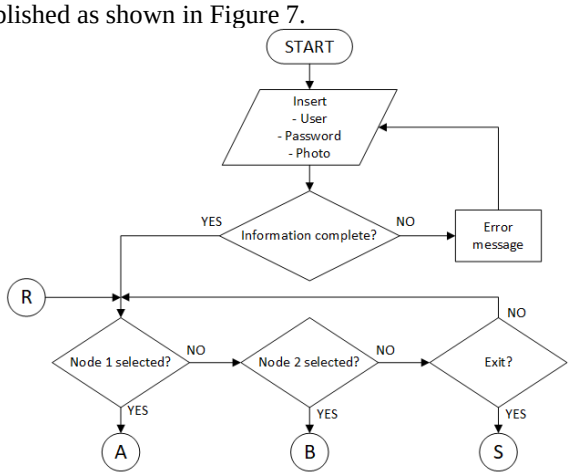

Fig. 7 Area of the block diagram that is responsible for requesting the user's personal data.

In the case of selecting mode 1 it will be possible to register new real estate, to be able to add them it is necessary to enter the information about the Unit, Patrimonial Code,

Denomination, Brand, Model, Color, Series and State of conservation of the real estate. After that, it is required to store the data entered in the Firebase, to achieve this, click on the "Guardar" button where a double selective will be established where the query will be made: Continue Registering Assets, if the answer to this selective is "YES", you must enter the information of a new asset with the characteristics previously mentioned, otherwise if the answer to the compound selective is "NO", you must click on the "Exit" button and you will return to the home screen. The information of each element in the structure are separated by the item ID [20], which will be stored in the Firebase. At the start of the program when mode 2 is selected, the information about the movable and immovable assets stored in the Firebase can be verified through the barcode or by manually typing the asset code of the object, in both cases the "VERIFY" button must be pressed (see Figure 8). The patrimonial codes are individualized so that each patrimonial code is unique according to the national catalog of movable property of the state [21].

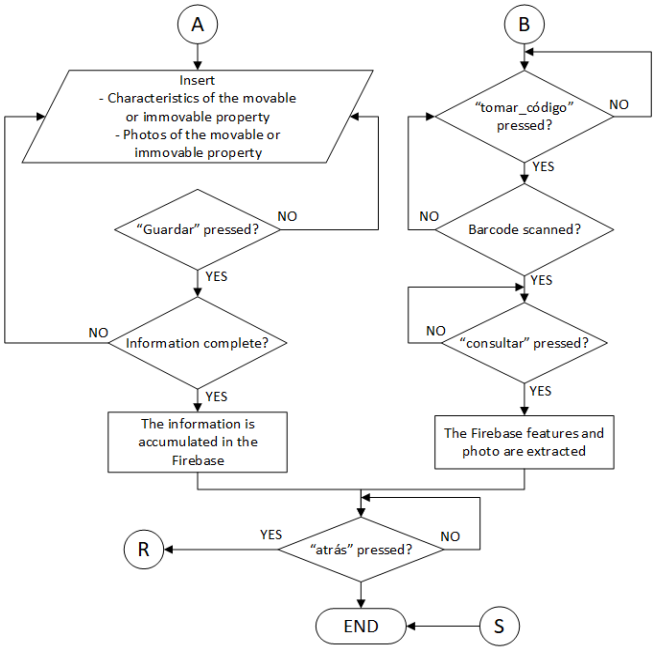

Fig. 8 Area of the block diagram that gives you the choice of the mode of use.

C. *Analysis tools*

1) *CSUQ Survey*

The CSUQ evaluates software from a software engineering perspective, providing an opportunity for the respondent to express satisfaction with the usability of the system. The questionnaire helps to understand the user's points of satisfaction and concerns regarding the use of a particular computer system. The questionnaire respondent should think about the tasks he/she performs with the system while answering the questions asked. The scale of possible answers ranges from 1 (strongly agree) to 7 (strongly disagree) [22]. Among the reasons why CSUQ was chosen as the evaluation instrument was that the Computer Usability Scale (SUS) is not validated in Spanish, being the most widely used in usability studies in mobile health. Another reason for its use is the strength of the CSUQ for measuring usability in field studies [23].

To make use of the SUS value scale, equation 1 was applied to obtain the correspondence of CSUQ to SUS [24], for each of the respondents.

$$CSUQ = 100 - \left(\left(\sum_{n=1}^{16} P_n / 16 \right) - 1 \right) (100/6) \quad (1)$$

III. RESULTS

A. *Development of the survey*

For the validation of the Mobile Application based on Android platform proposed in the Department of Property Control Administration, the degree of satisfaction of usability will be taken as an indicator. A survey based on Computer System Usability Questionnaire (CSUQ) was conducted in the comparative study of usability questionnaires.

1) CSUQ takes four factors into account

- System quality: questions 1 through 6.
- Quality of information: questions 7 through 12.
- Interface quality: questions 13 through 15.
- Overall satisfaction: in question 16.

2) CSUQ consists of 16 questions

- In general, am I satisfied (a) with how easy it is to use this mobile application?
- Was it easy to use this mobile application?
- Am I able to complete my inventory work quickly using this mobile application?
- Do I feel comfortable using this mobile application?
- Was it easy to learn how to use the mobile application?
- Do I think I became productive quickly using this mobile application?
- Does the mobile application give error messages that clearly tell me how to solve problems?
- Every time an error is made using the mobile application, do I solve it easily and quickly?
- Is the information (Verification: "Address, Description, Make, Model, Series, State of conservation) provided by this mobile application clear?
- Is it easy to find the information I need in the mobile application?
- Was the information provided by the mobile application effective in assisting me in taking inventory?
- Is the organization of the information on the mobile application screens clear?
- Was the interface of the mobile application pleasant?
- Did I like using the mobile application?
- Did the mobile application have all the tools I expected it to have?
- In general, was I satisfied with the mobile application?

In order to evaluate the survey, a 7-point Likert scale was used, with 7 totally disagreeing and 1 totally agreeing, as shown in Table 1.

TABLE I
RESPONSE OPTIONS AND THEIR LEVEL ON LIKERT SCALE

CSUQ response level	Value
Totally agree	1
Strongly agree	2
Somewhat agree	3
Neither agree nor disagree	4
Somewhat Disagree	5
Strongly Disagree	6
Totally Disagree	7

The values of the System Usability Scale (SUS) questionnaire scale shown in Figure 9 have been taken into account for the results given in the survey.

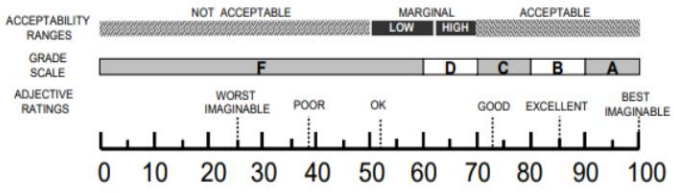

Fig. 9 Scale of values.

A survey was conducted among the members of the Inventory Taking Process of the Property Control Administration Department and the following results were obtained:

TABLE II
SCORES OF THE QUESTIONS

Answers (Options)	Answers							
	1	2	3	4	5	6	7	8
Totally Disagree	0	0	0	0	0	0	1	0
Strongly Disagree	0	0	0	0	0	0	1	0
Somewhat Disagree	0	0	0	0	0	0	2	0
Neither agree nor disagree	1	1	2	1	0	1	3	5
Somewhat agree	0	0	1	1	0	1	3	2
Strongly agree	4	3	2	4	1	3	1	1
Totally agree	10	11	10	9	14	10	4	7
Total	15	15	15	15	15	15	15	15
Answers (Options)	Answers							
	9	10	11	12	13	14	15	16
Totally Disagree	0	0	0	0	0	0	0	0
Strongly Disagree	0	0	0	0	0	0	0	0
Somewhat Disagree	0	0	0	0	0	0	0	0
Neither agree nor disagree	0	1	1	1	0	1	1	1
Somewhat agree	1	1	0	0	1	0	0	0
Strongly agree	1	1	1	2	4	2	3	2
Totally agree	13	12	13	12	10	12	11	12
Total	15	15	15	15	15	15	15	15

Applying Equation 1 to each respondent's questions, an individual score was obtained as shown in Table 3. Subsequently, the score was calculated giving 93.75% which according to the SUS value scale in Figure 13 means "Best imaginable", this being the usability rating of the application for the improvement of the inventory process.

TABLE III
INDIVIDUAL PERCENTAGE OF EACH QUESTION OF CSUQ

Question	Score
P1	1
P2	1
P3	2
P4	2
P5	1
P6	2
P7	3
P8	1
P9	1
P10	1
P11	1
P12	1
P13	1
P14	1
P15	1
P16	1
CSUQ	93.75

B. Inventory verification

Verification tests of movable and immovable assets will be carried out to calculate the percentage of accuracy of the application, considering the following scenarios:

1. The person has correctly entered the patrimonial code.
2. The person incorrectly entered the asset code.

Each scenario was tested 20 times and the results achieved are presented in Table 1.

TABLE IV
APPLICATION ACCURACY

Scenario	Number of tests	Correct Detection	Incorrect Detection	Accuracy (%)
1.	20	20	0	100
2.	20	20	0	100

Once the asset code is entered, the application will give us an answer with information about the movable asset, if the asset code is correct, we will be able to see the answer of the mobile application as in section A. of Figure 14 and an error message if the asset code is incorrect, as shown in section B of Figure 10.

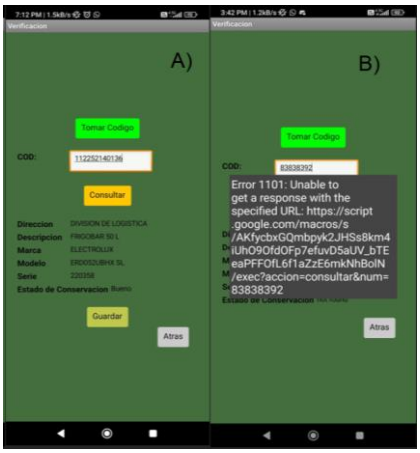

Fig. 10. Mobile application response a) Correct. b) Error.

You can see in figure 11 the information on the movable or immovable property in Firebase where its characteristics appear and which can be accessed from a mobile application or from a computer.

Fig. 11. File opened from Firebase.

Measurements were taken, relating the number of inventoried movable assets between the people who used the application and those who did not use it with respect to the time it took to carry out the inventory. The amount of goods inventoried by the people who used the application and those who did not use it was evaluated for 15 hours, and it was found that the first ones managed to inventory an average of 509 goods and that in the case of those who did not use the application, they inventoried an average of 235 goods as shown in Figure 12.

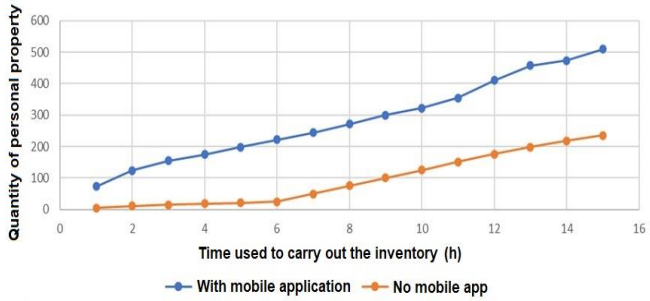

Fig. 12. Quantity of heritage assets vs. time spent during the inventory.

At the time of the inventory, the 509 movable assets to be stored in the Firebase were registered. The latency time that occurs from the time the movable asset is registered until the Firebase information of each asset can be visualized was plotted, obtaining an average latency of 142.3 ms as shown in Figure 13.

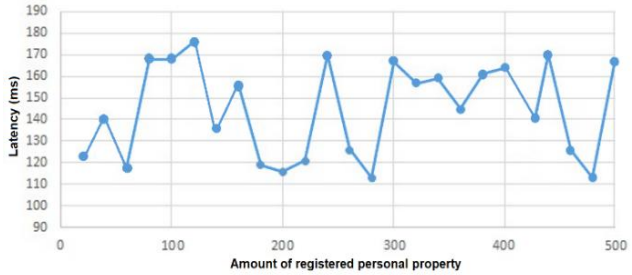

Fig. 13. Latency of the registration of patrimonial assets.

C. Application installation test

Verification of the correct operation of the application is achieved through quality tests after installation and execution of the application on the smartphone, since the quality varies depending on the brand and the different versions of Android. In this case, during the use of the application, the network quality was measured with the Wireshark software. Table 4 shows that the application operates successfully with smartphones whose Android versions are higher than 7.0.

TABLE IV
APPLICATION ACCURACY

No	Name user	Merk Smartphone	Android Version	Functional
1	Catherine Arteaga	Samsung Galaxy A15	Android 14	Success
2	Renzo Gonzales	Samsung Galaxy A52	Android 11	Success

3	Eduardo Chavez	Samsung Galaxy 04A	Android 12	Success
4	Jose Vidal	LG G6	Android 7.0	Success
5	Carlos Huaman	Samsung Galaxy J6	Android 8.0	Success
6	Andres Carballido	Samsung Galaxy Note5	Android 5.1 Lollipop	Failed
7	María Gallegos	Samsung Galaxy J1	Android 6.0	Failed

D. Packet Loss Testing

Figure 14 shows a graph of the results of the packet loss tests performed. Between 09:30 and 10:29 hours, the highest performance occurs where the packet loss fell to 7.14%. While between 1:30 p.m. and 2:29 p.m. the lowest performance occurs with a packet loss of 12.52%.

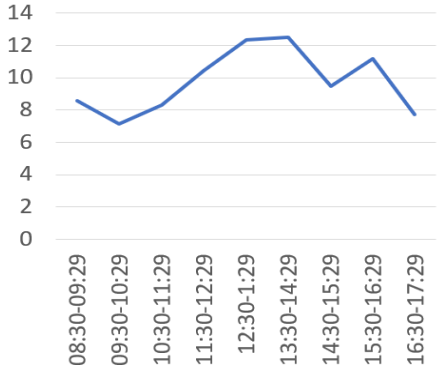

Fig. 14. Packet Loss Test Results Chart

IV. CONCLUSIONS

App Inventor has facilitated programming in a very convenient way. With its wide range of blocks and the ease of connecting them, it has simplified the understanding of the communication between them, allowing the development of the desired application in a simple way.

The implementation of the mobile application improves inventory taking in the Property Control Administration Department due to its easy usability with a satisfaction rate of 93.75%, which according to the SUS value scale means "Best Imaginable".

The software can be monitored remotely as the information can be accessed from the cell phone and computer. In addition, the data is collected in real time, as the latency is very low, averaging 142.3 ms.

The application is very accurate at the moment of validating with the patrimonial code if the objects are registered in the Firebase with a 100% accuracy and displaying the information correctly every time it is requested.

V. RECOMMENDATIONS

It is recommended to use a connection with a database system that allows a better response time when verifying the information needed for an existing asset.

The implementation of QR code or barcode labeling is recommended for a quick reading of heritage codes, since although the verifications of the assets were completed, they must be written manually in the application.

ACKNOWLEDGMENT

Our gratitude goes to the University of Callao for demanding so much from him/her, but at the same time, for allowing him/her to conduct this research. He/she expresses appreciation to every leader for their work and their management, without which the foundations and conditions for acquiring knowledge would not exist.

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