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Mobile application to traceability of corn production in the Valle del Mezquital

Aplicación móvil para la trazabilidad de la producción de maíz en el Valle del Mezquital

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Abstract

This work presents the development in Android Studio of three mobile applications and a web service in php that allows the agronomists of Centro de innovación y Desarrollo Tecnológico del Valle del Mezquital (CiDT) to manage the traceability logs of corn production in the field. from the preparation of the soil, sowing, irrigation, applications to the harvest, and that this serves so that the final consumers know the process of the product that they acquire only by scanning the QR code printed on the sack. In this way, the CiDT seeks to give added value to the production of the farmers of the Valle del Mezquital, offering food certainty to its buyers. The scrum methodology was used to organize the user stories, the client server architecture was implemented to establish communication between the database and the mobile devices, after the development an empirical evaluation of usability was applied with the Agronomist in charge to identify his point of view about the ease of use, security, error rate, satisfaction and graphical interface, with 70 points in his perception of usability.

Android, Corn, Traceability

Resumen

Este trabajo presenta el desarrollo en Android Studio de tres aplicaciones móviles y un web service en php que permita a los técnicos agrónomos del Centro de innovación y Desarrollo Tecnológico del Valle del Mezquital (CiDT) gestionar las bitácoras de trazabilidad de la producción de Maíz en campo desde la preparación del suelo, siembra, riegos, aplicaciones hasta la cosecha, y que esta sirva para que los consumidores finales conozcan el proceso del producto que adquieren unicamente escaneando el código QR impreso en el costal. De esta forma el CiDT busca dar valor agregado a la producción de los campesinos del Valle del Mezquital ofreciendo certidumbre alimentaria a sus compradores. La metodología scrum se usó para organizar las historias de usuario, la arquitectura cliente servidor se implementó para establecer la comunicación entre la base de datos y los dispositivos móviles, después del desarrollo se aplicó una evaluación empírica de usuabilidad con la técnico Agrónomo a cargo para identificar su punto de vista acerca de la facilidad de uso, seguridad, taza de errores, satisfacción e interfaz gráfica, con 70 puntos en su percepción de usabilidad.

Android, Maíz, Trazabilidad

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Introduction

Product traceability describes the processes and techniques used to know the location and trajectory of a batch of products along its supply chain, and now with the support of technology, consumer participation is emphasised (Moltoni and Moltoni, 2015), The importance of having it in the agri-food industry is to guarantee the quality and safety of product consumption, in addition to the regulatory requirements imposed by European governments after poisonings or the appearance of diseases such as mad cow disease and Genetically Modified Organisms (GMOs) (Fernandez Andrade, 2012).

Maize production in Mexico has a cultural, social and economic importance, especially white maize destined for human consumption and represents 86.94% of annual production the rest of yellow maize is destined to industry in smaller percentage, but despite its relevance the country still imports to the United States, Argentina, Brazil and Canada to meet its consumption need, the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) has established strategies to maintain production to ensure its supply(SAGARPA, 2017).

In addition, the secretariat and producers in the region have established five demands in plenary meetings to boost maize production, including the Demand for new knowledge, Demand for Training, Demand for the creation of new technology, Demand for public policy and Demand for Technology Transfer (Moctezuma-López et al., 2010).

This paper explains the development of the mobile application that the Centre for Innovation and Technological Development (CiDT) needs to implement with the producers of the Mezquital Valley. As a first point, the background of web or mobile development projects that have been used in similar contexts is analysed, to then describe the problem that the CiDT raises, highlighting the benefits of its construction, followed by the development process and ending with the implementation and evaluation of usability.

Currently, the International Maize and Wheat Improvement Centre (CIMMyT) uses a web-based maize and wheat production traceability system called BEM or Bitácora Electrónica, which is operated by the regional research centres in the country through SEDAGRO, the Secretariat of Agricultural Development, and keeps records of the maize and wheat production process of the producers who are advised by the centres.

Meza-Leal describes a mobile system in which each producer in the state of Colima Mexico will be able to register all his processes for the traceability of coffee within a database that will have an interface within a mobile device accessing an internet connection. This interface will have two modules, one for registration and consultation of the processes of coffee traceability and the production module in which the type of nutrition that the coffee plant has, the record of pests, diseases, harvest, periods, the number of cuts that are made to the coffee farm of each producer and the record of the sale in kilos are registered. (Meza-Leal et al., 2017).

The León-Duarte study produced a methodology to improve a harness production process through the implementation of an electronic monitoring system using barcode and RFID technology, thereby also seeking faster data capture, reducing errors and cost, reducing paperwork and better measuring productivity, and will be applied in the foam injection process, which is the area where the company has spent about 80% of the budget due to errors and this system seeks to know the products entering and leaving the area, the efficiency per mould and defects per station, among other benefits (León-Duarte et al. , 2020).

The CIDT is a body of the Secretariat of Agricultural Development of the State of Hidalgo and carries out research, validation, training and technology transfer for small producers in the Mezquital Valley region. It is located in the municipality of Mixquiahuala de Juárez Hidalgo and has 4.5 hectares of experimental crops. The results of their research are applied to improve the productivity, profitability and sustainability of the production systems demanded in the region.

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Jaime Bernal Ortega, the head of the research centre, considers it vital to make it known that maize production in the region uses sustainable techniques with a minimum use of chemicals and a good selection of seeds that improve crop yields. And that companies such as Minsa and Bimbo, who buy a percentage of the harvest, continue to maintain their standards as socially responsible companies, making known the details with which the product they purchase was generated.

The electronic traceability project aims to add value to the production of white maize (Zea mays L. Gramineae) and yellow maize from producers in the Mezquital Valley, allowing buyers to know the details of sowing, irrigation, type of substances applied in the fertilisation and pest elimination processes, guaranteeing the origin and production process. The guarantee of origin generates confidence in the buyer by knowing the technical details that were used and that will also be offered later when it has been transformed into derivatives for sale.

The Mezquital Valley contributes 59% of the Gross Domestic Product of the state of Hidalgo, its main activity is agriculture and livestock farming, with a cultivated area of 61,512. 45 hectares, with green alfalfa and corn being the main products it generates and the ones that contribute the most economic value. It is worth mentioning that the region has benefited from irrigation with wastewater from the Valley of Mexico, which has increased the production of the region's arid soil; the importance of corn production is vital if we consider that the state and the region have high levels of marginalisation (García-Salazar, 2019).

Methodology

The main function of the mobile application that was developed is to record in an electronic logbook the traceability of the production system of the producers' maize plots managed by the CiDT. The Scrum methodology was used to organise the requirements in user stories and distribute the development times, after the initial interview, it was summarised in the stories shown in table 1.

ID	Description	Validation
HU01	As: Technician Desire: Manage logbooks for each plot. To: Manage crop traceability.	Add, display and edit logs
HU02	As: Technician Desire: Manage plots To: have plots for each logbook.	Add, display and edit parcels
HU03	As: Technician Wants: Manage producers For: have producer for each plot.	Adds, displays and edits producers
HU04	As: Technician Wants: Generate QR code of completed logs. To: print and add to harvest sack.	Generates a QR code for each completed logbook.
HU05	As: Technician I want: to have secure information for each logbook. To: only me to manage logs, plots and producers under my care.	Verifies that the user and password are registered in the database.
HU06	As: Technician I want to: Scan the QR code To: verify the information that will be shown to the consumer.	Captures a QR code with the scanner and displays the logbook.
HU07	As: Consumer I want: Scan the QR code To: check the traceability of each bag of maize.	Captures a QR code with the scanner and displays the log.
HU08	As: Administrator Wish: Manage technicians To: control the people in charge of each plot.	Adds, displays and edits technicians.

Table 1 User stories
Source: Own elaboration

To solve the needs, an app was developed for each user connected to a single database through a web service in php that handles the requests of three mobile applications developed in Android Studio, as shown in Figure 1.

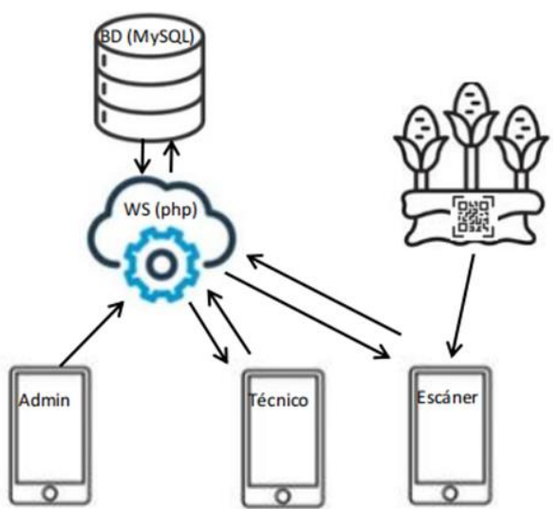

Figure 1 Implementation diagram
Source: Own elaboration

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The administrator app registers the agronomists and the technician app manages the logbooks which keeps records of producers, plots, sowings, applications, irrigations, soil preparation processes, and harvesting, through a database managed in the cloud and at the same time, Another mobile application allows buyers to access the detailed report of the product they purchase by scanning the QR code printed on the bags of the final product, showing all the information that the technicians recorded, thus giving added value to the maize produced in the Mezquital Valley, offering certainty of the type of maize and its entire production process.

The CiDT technicians are the ones who keep track of the plots of each producer in each agricultural cycle, and the QR code reader will be the application for the companies that purchase maize from the producers of the Mezquital Valley and manages the CiDT.

- The agronomists are responsible for managing (registering, deregistering and modifying) producers, plots and sowings.

- The agronomists register the logbooks associating the plot and the producer, recording gradually as irrigation and applications evolve from soil treatment to harvest, which is the moment when the QR code is generated, which the producers can print on the sacks of the final product.

- When registering the data of the plot, the georeference data is also registered, to identify its physical location, which was a specific requirement of the technicians.

Usability is an intangible quality that consists of a series of characteristics that a software product must have to ensure that it will be adopted by users, there are empirical and heuristic methods for evaluation, some evaluation proposals are the ISO 25010 Standard (Mex-Alvarez et al., 2019).

The evaluation of the final product was carried out using the empirical proposal of Mascheroni et all, who apply a series of questions to the end user about ease of use, security, error rate, satisfaction and adequate graphical interface, assign weights and make an estimate of the percentage of usability (Mascheroni,2012).

Results

The relational database in Figure 2 shows that the logbook table is managed by a single technician and this in turn relates to several jobs, sowings, applications, irrigations and harvests for a single plot, and that a farmer can have more than one plot.

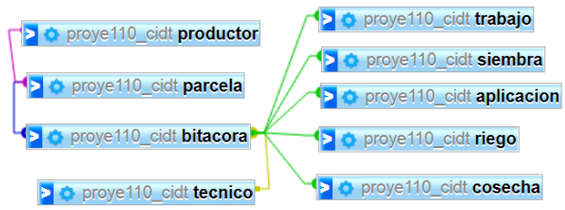

Figure 2 Database diagram
Source: Own elaboration

The development of the application was done in Android Studio for SDK 29 with minimal16 and the use of the google maps API for the location of the plots.

The administrator app shows the list of agronomists with a search box for when the list is larger than one screen, Figure 3 shows a view of the list. For each technician in the list, the name, email and the total number of logs he/she manages are displayed, the figure shows the list view with a floating add button with a plus symbol.

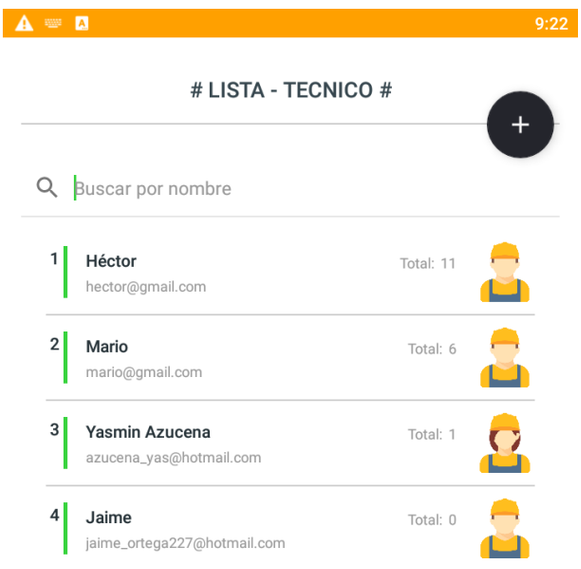

Figure 3 Technician list view
Source: Own elaboration

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When an item is selected from the list of technicians, the general data of the technician and the list of logs that he/she manages will be shown, if it is completed, it will be shown with a QR icon, the floating button with a pencil allows editing the technician's data, such as changing the password, gender or name, A list of logs is shown in Figure 4.

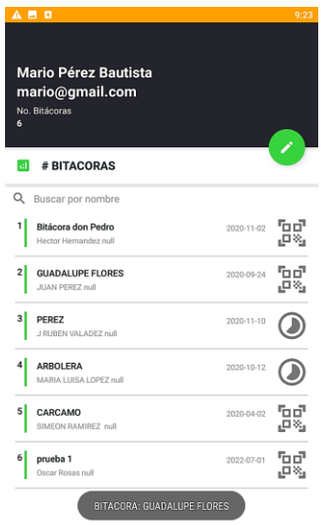

Figure 4 Log list view by technician
Source: Own elaboration

Users of the agronomist application must authenticate themselves to enter the main menu where they can register new producers, plots and logs, as well as scan QR codes, Figure 5 shows the login and Figure 6 the main menu.

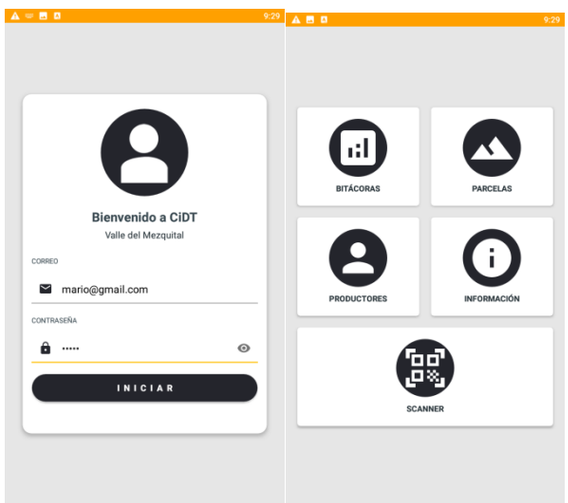

Figure 5-6 Login view and main menu of the technical app
Source: Own elaboration

Figure 7 shows that when the logbook option is selected, it will list those in charge with the option to add new ones, when choosing one of them you can see the general data with the options to edit, add data on planting, work, applications, irrigation and harvest, the status can be completed or in process, while it is in process you can not consult its QR code.

As an example, Figure 8 shows the view for editing applications, but each option in the logbook menu has a view depending on the information required.

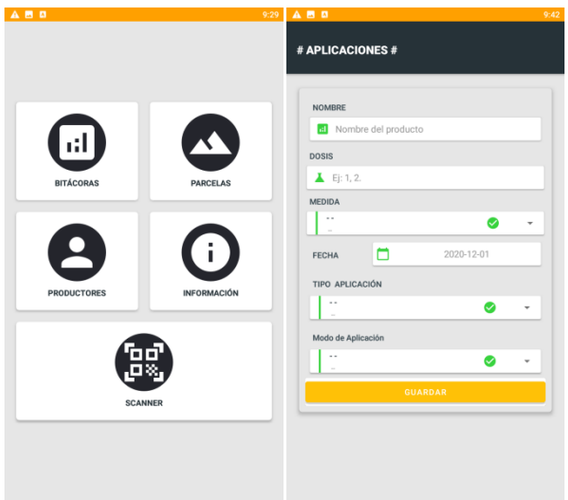

Figure 7-8 Logbook menu and application editing view
Source: Own elaboration

The scanner app turns on the camera looking for a QR code, if it finds a match it displays the log data associated with the code. Figure 9 shows an example of a QR code from a completed log, and Figure 10 shows the information displayed by the scanner app after reading the QR code.

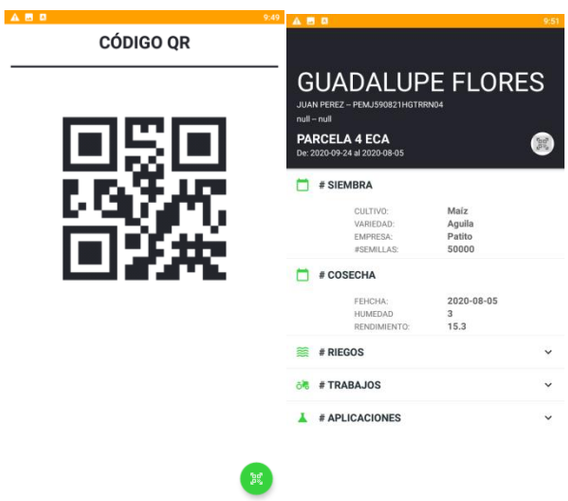

Figure 9-10 QR code view and query in the scanner app
Source: Own elaboration

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In this way, whoever has the scanner application and wants to know the traceability of the product associated with the QR code only has to point the scanner and the app will show a view with the details of the producer, plot, sowing, harvest, irrigation, work and applications, offering certainty of the process that took the maize acquired from the preparation of the soil to the harvest.

Finally, the usability evaluation was carried out by applying the series of questions to the CiDT technical manager, applying the weights per sub-attribute according to the answers she assigned, and the results were summarised in table 2.

Attribute	Question	P	V
Ease of use	Did you find the application easy to use?	30	65
	Did you require assistance to perform the requested tasks?	-7.5	
	Do you consider the application easy to use for anyone with the ability to operate a computer or system?	40	
	Do you consider that no prior knowledge is required to be able to perform the requested tasks?	20	
	Does the application have messages or instructions that are not clear in order to carry out a task?	-15	
	Do you consider that the application has a number of unnecessary steps to carry out each task?	-2.5	
Security	Do you consider the application reliable?	50	80
	Do you consider the application secure, in terms of privacy?	30	
Error rate	Did you make one/many mistake(s) while performing the task(s), due to not clearly reading a message or prompt from the application?	22.5	25
	Did you make one/many mistake(s) while performing the task(s) because a message(s) or prompt(s) on the application was unclear?	22.5	
Satisfaction	If you had the opportunity, would you use the app more often?	50	100
	Were you comfortable with using the app?	50	
Graphical in terface adeq uate	Did you find the app stylish or attractive (appropriate colour scheme, legible font sizes, etc.)?	80	80

Table 2 Usability evaluation
Source: Own elaboration

Conclusions

Table 2 classifies the attributes that had been proposed to evaluate, the question values in points (column P) each sub-attribute and the sum of the attribute is represented in column V, in this way, it is concluded that 65 points are assigned to the ease of use considering that in the evaluation if you had to give assistance because the level of expertise shown by the agricultural technician is medium, she interacts regularly with other applications but because it was the first time with the traceability app if she asked questions.

She assigned 80 points to security because the administrator app does not have a login, it was clarified that in future works the management of technicians and logs can be done more comfortably from a web version, 25 points to the error rate because of connectivity failures on the day of delivery and evaluation the map did not load and due to signal latency she pressed three times to create a job to a plot because it took time for the server to respond. The satisfaction was given 100 points because he considers that it is more practical to register the data of the plots from the mobile phone because he did it from a sheet and had to concentrate manually each logbook in the office, finally for the graphical interface he assigned 80 points, giving on average the accumulated of the sub attributes in 70 points of usability.

The end user's perception is acceptable but future work is expected to add deletion and reporting functionalities from a web version to improve the comfort when managing plots, producers and logs, The main objective was achieved because the technician version will allow the agronomist to register the events that happen to the product in the field and the final consumer will be able to know these details with the scanner version by pointing to the sacks with the printed QR code. With the two main applications, the traceability of maize production in the Mezquital Valley controlled by the CiDT can now be managed and made known.

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