SoftwareX 22 (2023) 101382

Contents lists available at ScienceDirect

SoftwareX

journal homepage: www.elsevier.com/locate/softx

Original software publication

Digital government: Mobile applications and their impact on access to public information

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ARTICLE INFO

Article history:
Received 9 January 2023
Received in revised form 8 March 2023
Accepted 24 March 2023

Keywords:
Mobile application
Government efficiency
Access to information
Digital government
Digital channel

ABSTRACT

The adoption and use of mobile technologies has transcended exponentially around the world in recent years, therefore, the great challenge for public organizations is to successfully implement technological initiatives that fall within the framework of digital government. In that sense, the objective of this research is to develop a mobile application on the Android platform to improve access to information for users of municipalities in Cañete. The development methodology used was Mobile-D based on exploration, initialization, production, stabilization and testing of the product; it also favored agile and timely development and ensured the quality and usability of the mobile application. The results indicated that after the development of the software and the analysis of the variables, the pretest had an average of 8.75 points while the posttest result was 14.27, with a significant difference of 9.05 points, concluding that the access to information in relation to consultations of procedures, driver's licenses and events carried out by the municipalities was satisfactorily improved. This contributes to provide general access to information as a fundamental support to restore societies with inclusive and resilient knowledge, capable of achieving sustainable development.

Code metadata

Current code version	v1.2
Permanent link to code/repository used for this code version	https://github.com/ElsevierSoftwareX/SOFTX-D-22-00457
Permanent link to reproducible capsule	https://github.com/rdrgcastilla/MuniApp/tree/main
Legal code license	Apache License
Code versioning system used	GitHub
Software code languages, tools and services used	Java, Android SDK
Compilation requirements, operating environments, and dependencies	Android Studio 4.0 or more
If available, link to developer documentation/manual	
Support email for questions	rodrigocastilla.279@gmail.com

1. Motivation and significance

Currently, mobile applications have replaced television as the main form of communication in society, ranking first in terms of versatility and effectiveness when it comes to obtaining reliable information at any time of the day or night and keeping users up to date on any subject that is available [1]. Any type of mobile application is developed and executed within an ecosystem, and for this reason, according to [2], in order to achieve a successful implementation, it is necessary to take into account the operating system, the users, the information to be entered and the future distribution channels. According to [3], Android is a "software stack" or software platform because it is made up of the operating system, where all the functions are developed, the middleware, which enables network connectivity, and the APIs, which make up all the programs that a phone is capable of running. It is also a completely free platform, based on Linux, which allows the development of Java-based applications and the modification of existing applications. The introduction of the Android platform has had a significant impact on the development of mobile applications, leading to widespread acceptance on the global market, where stakeholders are becoming increasingly demanding. [4].

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https://doi.org/10.1016/j.softx.2023.101382

According to [5], the right of access to public information creates a limited right, the exercise of which depends on a performance other than, in this case, the performance of the State. Freedom of expression and the right to information are considered "rights of defence" and the right of access to public information would be a "right of provision". It should also be emphasized that any citizen can exercise his or her right of access to public information by accessing the institutional portal or by making a formal request to the government body. On the other hand, [6] state that governments are improving their infrastructures to adapt to current technologies, improving the quality-of-service delivery and access to information under the category of digital government. Digital government is emerging to strengthen trust based on a state that is increasingly digital and closer, creating new tools that facilitate citizen interaction with the public administration through a series of updated digital channels such as websites, mobile applications, consultation software, among others.

Software development, and more specifically mobile application development, is one of the most in-demand areas today and brings with it several development methodologies. For mobile applications, there are development methods based on requirements: waterfall model, rapid application development or agile development, such as Mobile-D [7]. The main characteristic of mobile application development is its short duration, depending on the customer's requirements, due to the fact that there is already a demanding competition in the sector; for this reason, agile development allows the delivery of products and services in intervals with rapid response to changes and improves the customer experience. Each of these mobile applications needs to be deployed on a specific operating system. Among the most popular mobile operating systems are Android, iOS and the outdated Windows Phone, as well as Firefox OS or BlackBerry OS, which are no longer very popular in the market [8]. Android is one of the most widely used mobile operating systems in the world and is found on the vast majority of technological devices such as tablets, smartphones and televisions. Mobile applications on Android are distributed to mobile devices through the Google Play Store (formerly Android Marketplace), but it also supports the installation of applications through a USB connection, APKs and from an SD card [4].

On the other hand, the Organization of American States (OAS) [9] refers to access to information as a fundamental and essential right of citizens. In addition, it attempts to examine more closely the role that communication plays in the processes of citizen participation and transparency, as well as the relationship between these processes and the reduction of corruption, starting from the premise that greater transparency leads to less corruption [10]. It is necessary to mention that nowadays, in order for information to reach citizens in a timely manner, it must be integrated with technological devices that facilitate this activity, since we are in a society where people tend to be more demanding and seek effectiveness and efficiency in finding information.

In addition, [11] presented the eleventh edition of the "E-Government Survey", a report on the progress of digital government worldwide. In the Americas, the ranking of a total of 13 countries is led by the United States, in first place with 94% OSI (online services index) and the only member of the VH (very high) group; Uruguay, in second place with 84% OSI; and Canada, in third place with 84% OSI. Peru is in 11th place with 75% OSI, but with a very low TII (technological infrastructure index), so it is recommended that our country implement technological digitization plans to belong to the high group of the Electronic Government Index (IGDE).

In Latin America, government institutions are seeking to strengthen their mechanisms for access to information through the development of mobile applications, although in several countries digital government plans are still in the integration and interaction phase. As a result, few municipalities in the continent are working on new means of digital inclusion, which leads to planning problems and a lack of coordination on innovation issues [12]. In Peru, the Presidency of the Council of Ministers (PCM), through the Secretariat of Digital Government (SEGDI), approved the [13], whose main objective is to establish the necessary guidelines to implement the use of digital technologies in all the processes that make up the public sector; also, through its interoperability program, it seeks to manage citizen data, making it accessible at any time and available from any digital medium.

Digital access to information is certainly different from traditional access, and local governments need to keep up. Moreover, the use of ICT in the government sector is becoming indispensable; it is seen as a key to modernization and also generates value for the citizen by providing access to information from different channels through the process of digitization and distribution of information. While it is true that local authorities in the capital are already digitizing their services, several provinces and districts in the country are still in their infancy.

According to the "Report on Advances in Digital Government and Digital Transformation" published by the (Presidency of the Council of Ministers, 2022), the gob.pe platform has more than 3000 million visits at a general level and more than 8750 citizen-oriented services. On the other hand, considering that, according to the National Register of Municipalities - RENAMU - published by the (National Institute of Statistics and Informatics - INEI, 2020), there are a total of 1874 municipalities, of which, according to [14], only 32% of the provincial municipalities (64 out of 196) show progress in migrating to the gob.pe platform. Similarly, only 11% of the municipalities have prepared and approved their digital government plan. On the other hand, the report also showed that the municipalities in Cañete have not yet prepared or approved their digital government plan, projects or initiatives.

This problem arises due to the lack of budget, trained personnel or human capital for the development of these mobile platforms that allow citizens to access public information such as basic services, procedures, licenses, events, among others. Also, citizens as end users are very critical when it comes to evaluating the usability of these digital systems, therefore mobile systems or applications should be governed by standards or guidelines that help to evaluate their quality through factors and metrics as proposed by [15].

In the province of Cañete, the municipalities are in the process of adapting to digital government and still do not have a mobile application for consultation of procedures, events or driving licenses, detailing relevant information, in this sense, the municipality should act as a catalyst to improve the way of relating to citizens to ensure secure and efficient access to information. For citizens, the process is not only the delivery of documents, it starts from the moment they are informed and ends when their need is solved. Therefore, after the enactment of [13], the Secretariat of Digital Government seeks to implement new digital channels such as mobile applications that favor the relationship with citizens. Consequently, this study seeks to implement a mobile application on the Android platform for access to information in the users of the municipalities that make up the province of Cañete. Finally, the research contributes to the digitization of the consultation of the services of the entity through the use of a mobile application, generating public value for the citizen, since it is essential to present universal access to information as a fundamental pillar to rebuild resilient and inclusive knowledge societies, capable of achieving sustainable development.

While it is true that there are several applications with similar purposes in other regions, it is important to note that the application described in this article has been developed specifically for

Table 1
Comparison between agile and traditional methodology
Source: Adapted from [16].

Criteria	Agile Methodology	Traditional Methodology
Approach	Predictive. This method plans the entire project over a long length of time or by monitoring the project's progress. As it outlines all of the system's functions, each team member's responsibilities, the project's cost, and its timeline, this plan serves as the framework for the system's building. This entire project was predicted based on previous, successful projects, but this plan occasionally makes false assumptions about the future.	Adaptive. His approach is primarily for embracing developmental shifts. The agile methodology permits changes at every step of development because it thinks that changing requirements or anything else is the best way to create a product that will satisfy customers.
Documentation/Balancing Flexibility and Planning	The greatest key for development in this methodology is documentation. It implies that appropriate documentation should contain all of the data needed for coding, as well as customer requirements, system requirements, and other information.	Although planning is the most crucial element, it is not the best strategy to plan the entire undertaking at once. Being prepared for a brief period of time is a good strategy or preparing in a way that will allow you to quickly change your decisions or reverse your decisions depending on the situation because there are many factors that change during development.
Orientation	There is a specific procedure for carrying out every task in the system, but it is unclear who will use it since anyone can do so. The responsibilities of managers, developers, analysts, testers, etc. are described in this process, but it is unclear how to carry out these tasks.	Instead of focusing on any particular process, this methodology views the organization's workforce as the most important component of growth. The workforce consists of talented and highly skilled supervisors, developers, designers, and testers who are dedicated to the company. It claims that if a person possesses these traits, they will be able to rapidly adapt to and implement any development process for any project. Utilizing multiple processes within the company is beneficial.

the region in question, taking into account its particular needs and requirements. In addition, the application complies with local laws and regulations and the structure of the local government. These aspects are important to ensure the effectiveness and relevance of the application in the local context.

It is important to highlight that this tool is innovative in the local context and represents an important solution to improve citizens' access to public information. Specifically, the application allows municipal users to easily access relevant information such as procedures, licenses, events, among others. In addition, its development shows how technology can be used to improve public services and encourage citizen participation. This may be relevant for other municipalities and public authorities that wish to implement digital solutions to improve the management of and access to public information. Therefore, it represents an innovation in the local context and has a significant impact on access to public information, and its development can contribute to the advancement of the implementation of digital solutions in the public sector.

2. Software description

On the other hand, during the software development process, companies need to consider different approaches. For example, an agile model will only be considered over a traditional one if the project involves dynamic requirements, responsible developers and customers who are willing to get involved. In this way, an agile methodology will always provide an adaptive speed, adapting to the needs and requirements of the customer and involving a process of self-adaptation. Under this premise, Table 1 shows a comparison between the agile and traditional methodologies, based on five factors: size, product, dynamics, number of employees and organizational culture.

There are currently a number of methodologies that facilitate large-scale software development by allowing the generation of functional modules thanks to small iterations and their exclusive relationship with the customer, such as RUP, SCRUM, Mobile-D or XP.

According to [17], Mobile-D is based on the development of successive phases, evolving from simpler to more complex systems. In addition, it uses the spiral development model as a basis and incorporates usability evaluation processes, prioritizing user participation in all design lifecycle processes. It is based on development practices derived from eXtreme Programming (XP), enjoys the scalability derived from the Cristal methodology, and takes into account the life cycle according to the Rational Unified Process (RUP) methodology. This methodology was first proposed by Pekka Abrahamson and VTT Electronics in 2006 [17] and comprises five phases, shown in Fig. 1, each of which has a set of associated tasks, stages and practices.

2.1. Software architecture

For the development of the mobile application, the client–server architecture was taken into account. This architectural style is the best known and is composed of two essential components: the client and the server. The server provides a series of data or resources that are consumed by the client. In this case, all the people who have installed the mobile application make massive queries to access their information. As shown in Fig. 2 the mobile application with internet access will connect to the physical servers of the entity through a web service (uses protocols and standards to establish connections between applications) and these will consult the database, returning the values that will be displayed in a view in the app.

As shown in Fig. 3, the logical structure of the database to be developed is determined and in this fundamental way determines how to store, organize, and manipulate the data.

The mobile application connects directly to a municipality's servers via APIs to retrieve information on the status of procedures performed by users or data contained in driving licenses, and to display them in views. Regarding the consultation of municipal events, a web system has been developed to allow area managers to create, edit or delete events, so that these events are automatically displayed in the mobile application, as shown in Fig. 4.

In order to choose the methodology to be used for this research, evaluation criteria were taken into account, including: fulfillment of the objective, integration, testing and adaptations. According to the evaluation and the analysis of each methodology, it was concluded that the Mobile-D methodology is the optimal one for the mobile application development process. The following is a description of each stage of the development process.

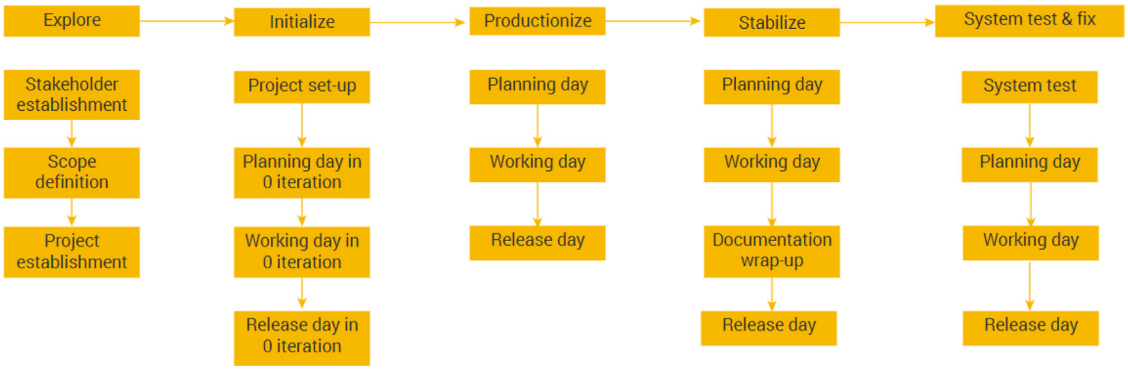

Fig. 1. Phases of the Mobile-D methodology.
Source: Adapted from [17].

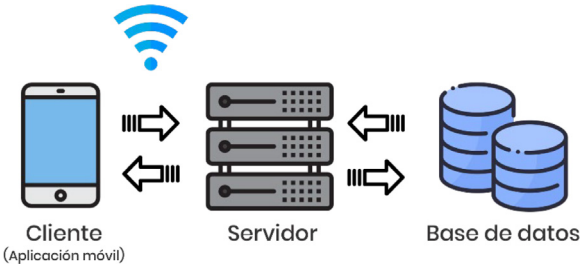

Fig. 2. Client Server Architecture.
Source: Adapted from [18].

1. Exploration The exploration phase in the Mobile-D methodology focuses on identifying the user's needs and the features that the mobile application must have to satisfy them. This phase is crucial for the success of the project, as it allows the development team to gain a clear understanding of the user's expectations and requirements. In this first phase of the methodology, the stakeholders, the project manager, the application users (citizens, employees) and the main sponsor were described, and the scope and establishment of the mobile application development project were defined.

The following activities were carried out in the exploration phase:

- User identification: We identified who the users of the application are and determined what their needs and expectations are.
- Defining of the objectives: The objectives of the application were defined and the characteristics that the application should have in order to meet those objectives were established.
- Competitive Analysis: A competitive analysis was carried out to identify the characteristics of other similar applications and determine how they could be improved.
- Technology selection: The appropriate technology was selected to develop the application.
- Project planning: The resources required for the project were identified and a work plan was defined to carry out the following phases.

2. Initialization The project consists of the development of a mobile application for access to information in municipalities. The mobile application was native for mobile devices with Android operating system and had the following modules: consultation of procedures carried out, consultation of driving licenses and consultation of events held by the municipality. Similarly, according to [19], it is necessary to use a programming language that helps in the structure, customization and operation of a software, in this case Java was chosen for the development of the mobile application and PHP for the web system.

The Initialization phase in the Mobile-D methodology is the starting point of the project. In this phase, the bases, and foundations for the development of the mobile application are established. Other activities of this phase are described below:

- Setting objectives: In this activity, the project objectives were established. Long-term goals were identified and success criteria for the project were established.

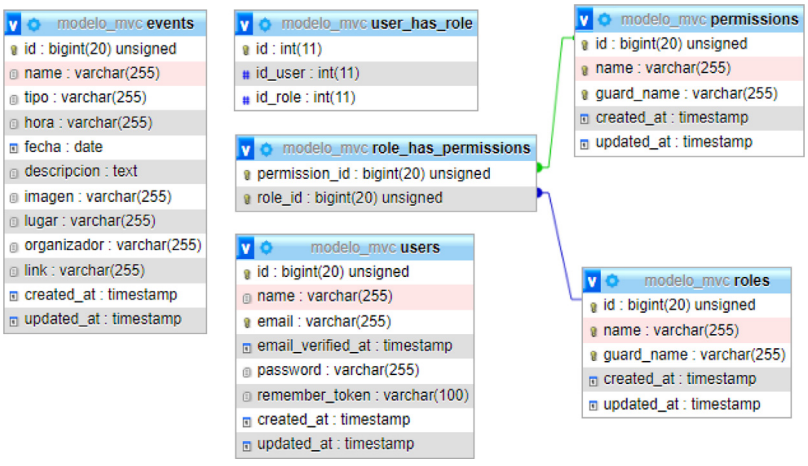

Fig. 3. Physical database model.

```java
public interface LicenciaApi {
    /**Obtain security token**/
    String PUBLICKEY = "APP-MUNI-XYZ";

    /**View license data*/
    @FormUrlEncoded
    @POST ("api.php?PUBLIC-KEY=" + PUBLICKEY)
    Call<Licencia> generateToken(
            @Field("none") String none
    );

    /**View license data*/
    @FormUrlEncoded
    @POST ("api.php?PUBLIC-KEY=" + PUBLICKEY)
    Call<Licencia> buscar(
            @Field("APP_TOKEN") String token,
            @Field("n_dni") String n_dni
    );

    @FormUrlEncoded
    @POST ("api_vehicular.php")
    Call<Licencia> buscar_test(
            @Field("n_dni") String n_dni
    );
}
```

```java
public interface DocumentoApi {

    @GET("api_tramite.php")
    Call<List<Documento>> consultaTramiteDocumento(
            @Query("format") String format,
            @Query("nexp") String nexp
    );
}
```

```java
public interface EventoApi {
    /**List all events*/
    @FormUrlEncoded
    @POST("all")
    Call<List<Evento>> all(
            @Field("PUBLIC-KEY") String publi_key
    );
    /**Get more details of an event*/
    @FormUrlEncoded
    @POST("show")
    Call<Evento> show(
            @Field("PUBLIC-KEY") String publi_key,
            @Field("eventId") String eventId
    );
    /**Search by event name*/
    @FormUrlEncoded
    @POST("find")
    Call<List<Evento>> find(
            @Field("PUBLIC-KEY") String publi_key,
            @Field("filter") String filter
    );
}
```

Fig. 4. Application Programming Interface.

- Identifying requirements: This activity identified the project requirements. The functionalities that the mobile application must have been determined and the technical specifications necessary for its development were defined.
- Definition of the working team: In this activity the working team responsible for the development of the mobile application was defined. The roles and responsibilities of each team member were defined.
- Project planning: In this activity, a work plan was defined, including the schedule of activities, budget, required resources and project deliverables.
- Project document creation: This activity created the project document, which included the detailed project description, objectives, requirements, work plan and other relevant details.

3. Production Each module to be implemented was defined conceptually and the corresponding functional requirements were defined for each module. Also, according to [20], it is necessary to prototype the mobile application in relation to the functional requirements of each module to be developed in order to visually understand the project and its scope, help to explore other options and allow to anticipate future problems. On the other hand, the production phase in the Mobile-D methodology is where the development of the mobile application takes place. This phase is divided into several iterations, each consisting of a complete cycle of planning, design, implementation, testing and release.

The main activities of the Production phase are described below:

- Iteration Planning: This activity planned the iteration to be carried out. The objectives of the iteration were established, the requirements were identified and the functionalities to be developed were defined.
- Design: In this activity the user interface was designed and the navigation flows were defined. It determined how the information would be organized in the application and defined the graphic and design components.
- Implementation: In this activity, the implementation of the mobile application was carried out. The source code of the application was developed, the components were integrated and unit tests were performed.
- Testing: In this activity, quality tests were performed to ensure that the mobile application works correctly and meets the established requirements. Integration tests, performance tests and usability tests were performed.
- Launch: In this activity, the mobile application was launched on the appropriate platform. It was published in the app store, access permissions were set and the security of the application was configured.
- Evaluation: In this activity, the success of the iteration was evaluated and it was determined whether the set objectives were met. Areas for improvement were identified and the necessary changes for the next iteration were determined.

4. Stabilization In the stabilization phase, the integration actions were completed to confirm that the mobile application was working correctly in its entirety, and that continuous improvement was being put into practice. Also in this phase, the methodology requires the documentation and user manuals of the mobile application. The main activities of this phase are described below:

- Bug fix: In this activity, bugs found in the Production phase were corrected. Problems in the operation of the mobile application were identified and solved.
- Certification: In this activity, the certification of the mobile application was performed, which was necessary for its launch in the corresponding app store.
- Documentation: In this activity, the documentation of the mobile application was updated, including the user manual and system requirements.

4.1 APK export, internal testing, and upload to Google Play

The APK was exported from Android Studio to perform initial internal testing of the mobile application. The mobile application was uploaded to Google Play in order to counteract any possible loading errors and thus carry out real-time testing for its subsequent release. It was also installed on the smartphones of 40 citizens, as a sample of the population defined in the research methodology. After the validations, the user manual was created and each test case was verified.

5. Testing According to [21], it is essential to perform tests that evaluate the functionality of the software in order to identify possible bugs, ensure compliance with standards and provide the

customer/end user with a quality product. Furthermore, according to [22], testing on real mobile devices is used to detect possible unexpected closures, visualize the behavior of windows and even confirm functionality when there is no Internet connection.
a. Approval/rejection cases

- Serious Errors: Erroneous data recorded in the databases, server crashes that directly affect the mobile application, main functions do not meet the objectives.
- Medium Errors (common): Insufficient documentation, errors in information display, secondary functions do not meet the objectives, crashes of secondary interfaces (auxiliary programs).
- Slight Errors: Delay in loading interfaces, graphic palette and logo are not displayed correctly, field aesthetics, alignments.

b. Usability Test

This test was exclusively oriented to test the usability of the mobile application. For the usability test, only the employees of the Information Technology Sub-Management were surveyed with 10 questions, which had favorable results.

2.2. Software functionalities

a. **Module 01: StartApp.** In this module the Splash and Onboardings of the mobile application were designed and developed with first instructions of use. The user could skip this part or get oriented in the use of the mobile application.
b. **Module 02: Consultation of procedure files**. The user was able to consult the status of his or her file processed in a municipality by entering the file number in the search engine. The mobile application showed the corresponding details in one view.
c. **Module 03: Consultation of driver's licenses.** The user was able to consult details of his driver's license, data stored by the municipalities, by entering the ID number in the search engine. The mobile application displayed the corresponding details in one view.
d. **Module 04: Consultation of municipal events.** The user was able to view the upcoming events organized by the municipalities. The details of these events were loaded from the web control panel managed by the managers of the corresponding areas.
e. **Module 05: Manageable web system.** It had a web service connected to the mobile application for the administration of events and users (add, edit and delete). Updates were reflected in the mobile application in real time.

2.3. Sample code snippets analysis (optional)

3. Illustrative examples

Subsequently, testing strategies were initiated in five stages:

- First stage: The functionalities of all the modules proposed for the present project are operational.
- Second stage: The functionalities that were integrated in each module (functional and non-functional requirements) are operational.
- Third stage: To achieve the objective of compliance with the requirements, the installation, UI, and interface tests were carried out.
- Fourth stage: Corroboration of anomalies in the solution (bad connection with web service, database).

Fig. 5. Initial application interface.

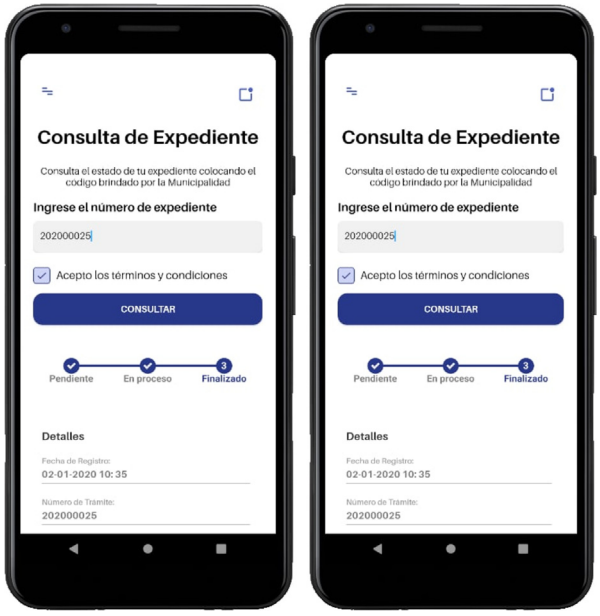

Fig. 6. Documentary procedures status query interface.

- Fifth stage: Behavior of the mobile application in different mobile devices with different screen sizes.

Finally, the follow-up and verification were done, where the tests performed are repeated for each new version that is developed. Approval or rejection cases are redefined to correct the detected errors. Finally, statistical reports are issued to verify progress and updates of the application (see Figs. 5–9).

4. Impact

The population for this research work was finite and included 350 users of the municipalities in Cañete, a monthly average of users who make inquiries related to procedures, licenses, or events. A questionnaire was developed as an instrument to measure access to information. The questionnaire contains indicators associated with speed, time, among others, and is made up of

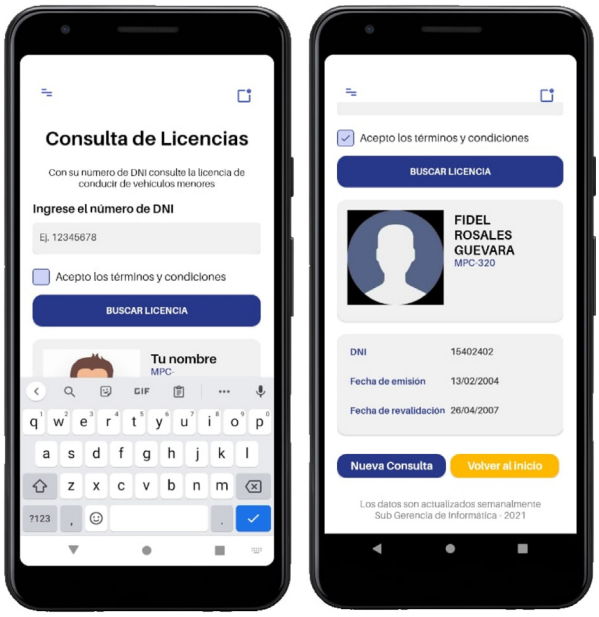

Fig. 7. Driver's license consultation interface.

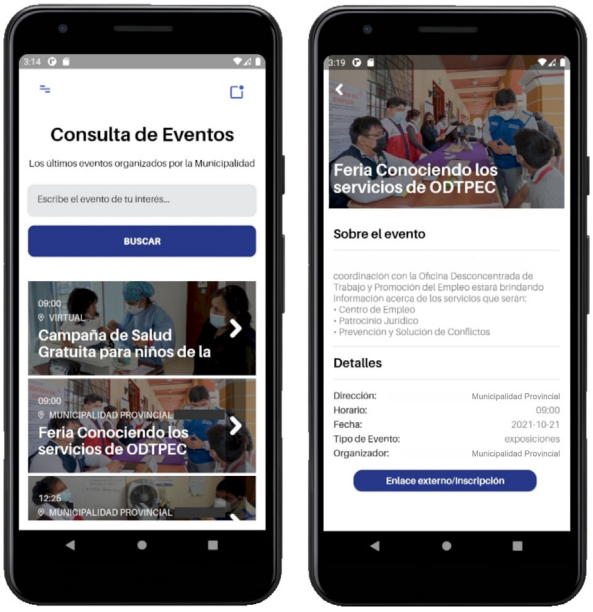

Fig. 8. Municipal events consultation interface.

20 items. For its analysis, data collection and organization, interpretation, discussion, hypothesis testing and systematization of results were carried out.

a. Independent Variable: Access to information (Consultation of Procedures, Municipal Events and Driver's License).

Fig. 10 shows the variable consultation of procedures, municipal events and driver's license, pretest and posttest of a single group, showing the comparison of the means with a significant difference. It is observed that the pretest had a mean of 8.75 points while the posttest shows 14.27 points, showing a difference of 9.05 points. Subsequently, after the application of the Mann Whitney U test that measures the independent variable, pretest and posttest, a significance level of less than 0.05 was obtained (asymptotic sig. (bilateral) $= 0.00 < 0.05$). Consequently, the null hypothesis is rejected, and the alternative hypothesis is accepted, i.e., it is assured that the development of a mobile application on the Android platform significantly influenced the access to information of the users of the municipalities.

b. Dimension 01. Consultation of document processing

Fig. 11 shows the document processing consultation dimension, divided into pretest and posttest of a single group, showing the means compared with a significant difference. Thus, the pretest mean obtained a value of 7.55 points while in the posttest the mean is observed whose value was 13.93 points; demonstrating that there is a difference of 6.38 points; consequently, after the application of the Mann Whitney U test that measures the consultation of documentary procedures, pretest and posttest, the significance level obtained is less than 0.05 (Asymptotic Sig. (bilateral) $= 0.00 < 0.05$). Consequently, the null hypothesis is rejected, and the alternative hypothesis is accepted, i.e. it is assured that the development of a mobile application on the Android platform had a significant influence on the consultation of documentary procedures of the users of the municipalities.

c. Dimension 02. Consultation of municipal events

Fig. 12 shows the dimension consultation of municipal events, pretest, and posttest of a single group, showing the comparison of the means where there is a significant difference. Thus, the pretest mean obtained a value of 9.38 points while in the posttest the mean was 14.40 points; a significant difference of 5.02 points was observed. Consequently, after the application of the Mann Whitney U test that measures the consultation of municipal events, pretest and posttest, the significance level obtained is less than 0.05 (asymptotic sig. (bilateral) $= 0.00 < 0.05$). Consequently, the null hypothesis is rejected, and the alternative hypothesis is accepted, i.e., it is assured that the development of a mobile application on the Android platform significantly influenced the consultation of municipal events carried out by the municipalities.

d. Dimension 03. Driver's license consultation

Fig. 13 examines the driver's license consultation dimension, with pretest and posttest of a single group, showing the comparison of the means with a significant difference. It is evident that the pretest average obtained a value of 9.17 points while in the posttest the average is observed whose value was 14.50 points; noting a significant difference of 5.33 points; therefore, after the application of the Mann Whitney U test that measures the consultation of driver's licenses, pretest and posttest, the significance level obtained is less than 0.05 (asymptotic sig. (bilateral) $= 0.00 < 0.05$). Consequently, the null hypothesis is rejected, and the alternative hypothesis is accepted, i.e., it is assured that the development of a mobile application on the Android platform significantly influenced the driver's license consultation of the users of the municipalities.

The purpose of the research was to develop a mobile application that allowed access to information on the most common queries in municipalities. The mobile application was able to satisfy the need for advanced technology in the governance of information handled by the municipality, thus, these results coincide with [23] and [24]; who concluded that digital technology guarantees a new possibility of communication and access to information by users as a basis for accountability and transparency in the public sector.

In relation to the consultation of the status of documentary procedures carried out by citizens, it was shown that thanks to the development of the mobile application, this daily process was improved and streamlined. This result agrees with [25] and [26] who described that the development of mobile applications is an undoubted contribution to the efficiency in the resolution of consultations of formalities, public guidance and other information services based on open data.

Likewise, the mobile application developed for municipalities showed a significant improvement in the consultation of

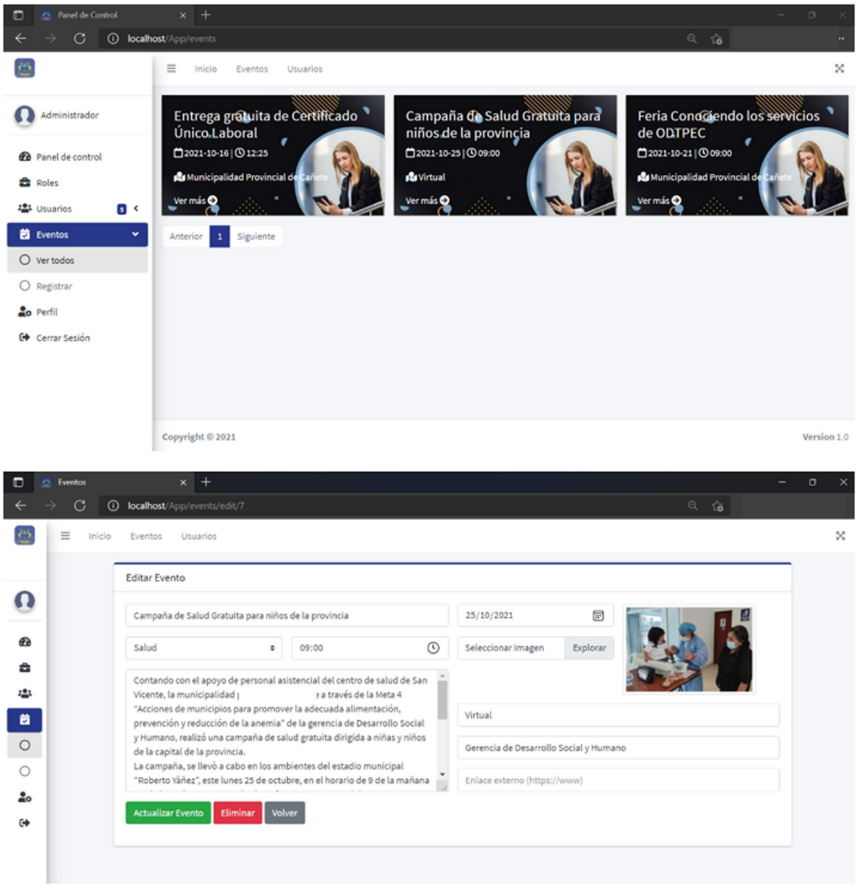

Fig. 9. Municipal events consultation interface.

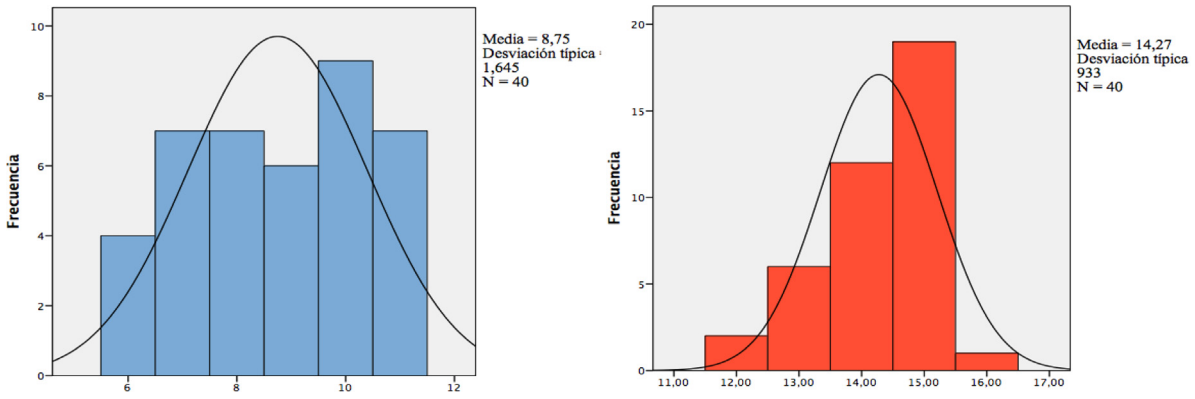

Fig. 10. Consultation of procedures, events, and licenses — Single Group (pretest–posttest).

events carried out by the entity. It also benefited the population by constituting an identity, traditional and cultural offer and, consequently, a new form of direct communication between municipality and citizen. This is consistent with the results obtained by [6] and [27] who state that the mobile application "Soy CIO" developed by the Colombian state facilitated the implementation of the digital government policy and brought citizens closer to public entities. This application has a chat as the main interaction resource, a knowledge bank, and an events section.

Finally, this study was able to demonstrate that the development of a mobile application improved access to users' driver's license information (correlative number, last name, first name, date of birth, address, document number, class and category; restrictions, date of issue and renewal); These results coincide with [28] that proposed a software with an online data set for the consultation of license plates and driver's licenses; it also agrees with [29] who proposed the creation of a mobile application for drivers to facilitate the learning and self-assessment of drivers so that they could gradually improve their performance, in addition this application contained information about the driver, driver's licenses, insurance, geolocation, etc.

5. Conclusions

The mobile application was able to improve access to information for users in relation to their queries in real time, the use of this tool collaborates with the objective of complying effectively, efficiently and with quality attention to citizens, benefiting them

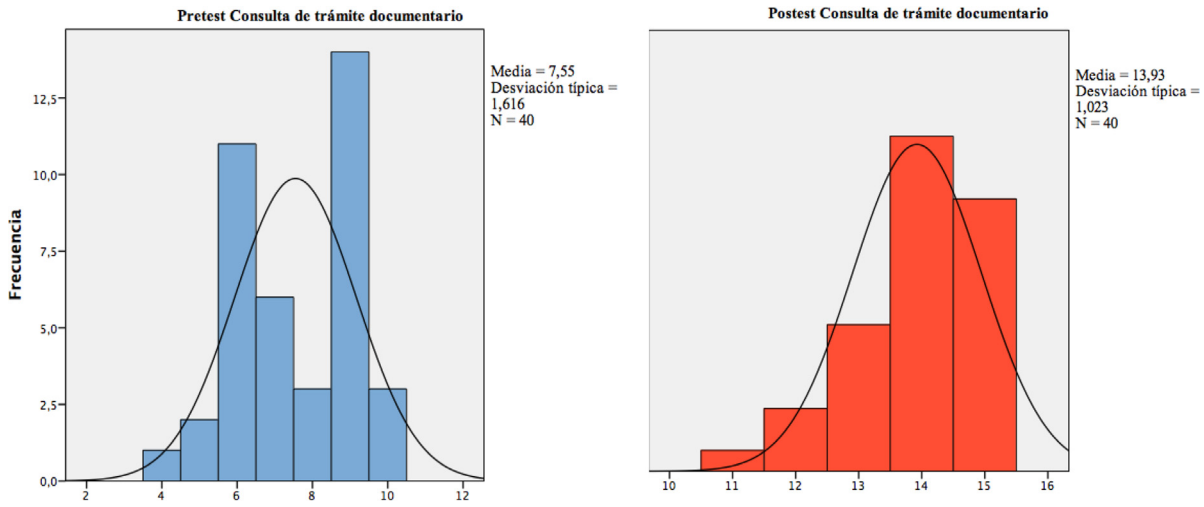

Fig. 11. Documentary Procedure Consultation (pretest–posttest).

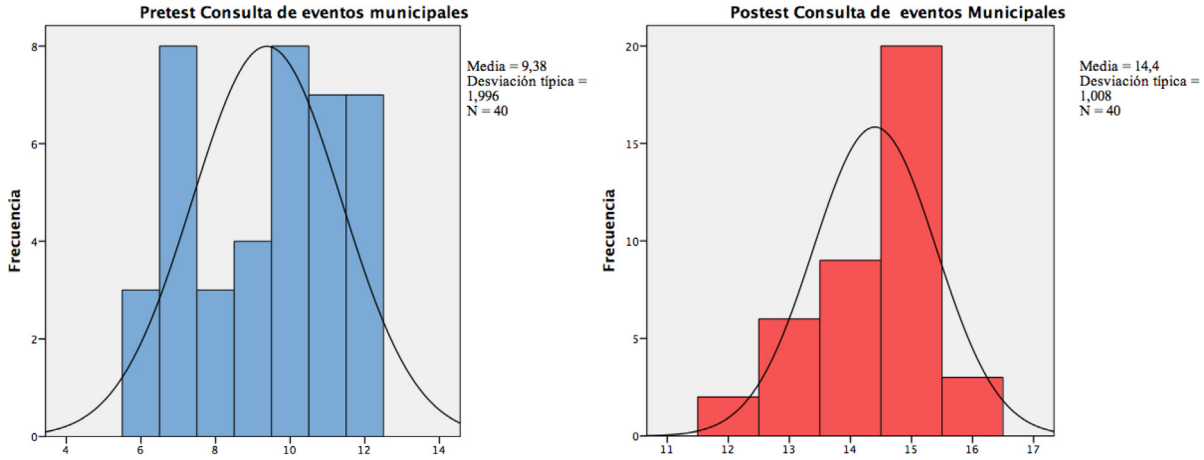

Fig. 12. Consultation of Municipal Events (pretest–posttest).

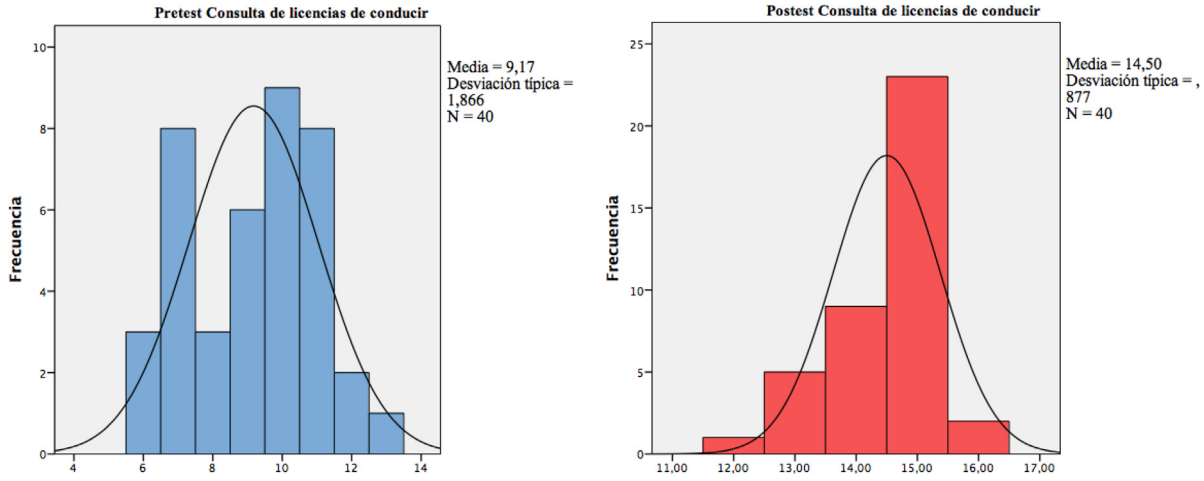

Fig. 13. Driver's License Consultation (pretest–posttest).

with the elimination of administrative procedures, bureaucracy, or service schedules. Any document processing consultation in digital form is justifiable in the reduction of the time it takes a user to perform this operation. Through the mobile application developed for the municipalities, the citizen has access to the status of his procedure (rejected, eliminated, closed, waiting, archived, finalized, with observations). To comply with this process, the entity interacts with all its organizational units to ensure the uniformity and consistency of the information that will be provided to citizens through the mobile application.

Likewise, the proposal to access information on events or campaigns for citizen participation through a mobile application stands out. In addition, the management and execution of events is a factor in the consolidation of the municipality as a brand. By considering it as a brand, it is necessary to reinforce it in relation to its contribution as a public organization to different social classes or interest groups, thus, it deserves constant dissemination under different media that the municipality can use. On the other hand, the driver's license "is an official document issued by the competent authority that certifies the holder's aptitude and authorizes him/her to drive a vehicle". By means of a mobile application, a greater availability and portability of the data of the driver's licenses administered by the municipalities was made possible.

The research contributes to the digitalization of the consultation of the services of the entity through the use of a mobile application, generating public value for the citizen; also, the modernization of procedures in the public sector opens a path between the citizen and the State through multichannel and personalized digital services that listen to the citizen, i.e., putting the focus on the user experience. Therefore, it is recommended the deployment of the application in other mobile operating systems and the inclusion of business intelligence tools or Big Data so that this contribution is reflected in decision-making in favor of the end user.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Rodrigo Castilla reports financial support was provided by Universidad Nacional de Cañete.

Data availability

Data will be made available on request.

Acknowledgment

The project has been funded by the Universidad Nacional de Cañete with the grant of Contract No. 008-2021-UNDC-PSI, through the "II Grant Competition for the Financing of Thesis Projects by Students or Graduates", organized by the Vice-Presidency of Research.

References

[1] Acosta J, León A, Sanafria W. Mobile applications and their impact on society. Univ Soc J 2022;14(2):237–43.
[2] Mazuera-Rozo A, et al. Taxonomy of security weaknesses in Java and Kotlin Android apps. J Syst Softw 2022;187:111233. http://dx.doi.org/10.1016/J.JSS.2022.111233.
[3] Malave K, Beauperthuy J. Android, Google's operating system for mobile devices. Negot J 2022;19(7):79–96. http://dx.doi.org/10.5281/zenodo.4950518.
[4] Pérez N, Bustos M, Berón M, Rangel P. Android things. In: XXI Workshop of Researchers in Computer Science. 2019, p. 971–4, http://sedici.unlp.edu.ar/handle/10915/77176.
[5] Valim R. The fundamental right of access to public information in Brazilian law. Rev Invest Const 2019;3(1):169–81. http://dx.doi.org/10.5380/RINC.V3I1.45114.
[6] Toro-García A, Gutiérrez-Vargas C, Correa-Ortiz L. Digital government strategy for building more transparent and proactive states. Tril Sci Technol Soc 2020;12(22):71–102. http://dx.doi.org/10.22430/21457778.1235.
[7] Molina J, Honores J, Pedreira-Souto N, Pardo H. Comparison of mobile application development methodologies. 3C Technol. Innov Gloss Appl SMEs 2021;10(2):73–93. http://dx.doi.org/10.17993/3ctecno/2021.v10n2e38.73-93.
[8] Cassinda F. Characterization of cellular mobile operating systems: Android, Symbian, iPhone and Windows Phone. Proj Des Manag 2019;1(2):75–88. http://dx.doi.org/10.29314/PDM.V1I2.200.
[9] Organization of american states - OAS, model inter-american law 2.0 on access to public information. Inter-American Juridical Committee; 2020.
[10] Medranda N, Torres A, Romero I, Patricio A. Communication, citizenship and transparency: Access to public information as a tool for citizen participation in administrative management. Rev Ibér Sistemas e Tecnol Inform. 2020;26:362–75, https://pure.ups.edu.ec/es/publications/comunicaci%C3%B3n-ciudadan%C3%ADa-y-transparencia-acceso-a-la-informaci%C3%B3n-p.
[11] United Nations. E-government survey 2020. Digital government in the decade of action for sustainable development. New York; 2020.
[12] Wilson C, Mergel I. Overcoming barriers to digital government: mapping the strategies of digital champions. Gov Inf Q 2022;39(2):101681. http://dx.doi.org/10.1016/J.GIQ.2022.101681.
[13] Presidencia de Consejo de Ministros, Decreto Legislativo N° 1412 - Ley de Gobierno Digital. Perú; 2018, p. 4–8, Poder Ejecutivo.
[14] Presidencia de consejo de ministros. In: Reporte de avances en gobierno y transformación digital. Secretaría de Gobierno Digital; 2022, https://indicadores.digital.gob.pe/. (Accessed 03 May 2022).
[15] ISO/IEC 25000. Systems and software quality requirements and evaluation (SQuaRE). 2014, https://iso25000.com/index.php/normas-iso-25000. (Accessed 27 August 2020).
[16] Sindhu S. View of comparison of traditional & agile software development methodology: a short survey. Int J Softw Eng Comput Syst 2019;5(2):1–14, https://journal.ump.edu.my/ijsecs/article/view/2583/627.
[17] Sangama A. Agile methodologies Scrum, XP, SLeSS, Scrumban, HME, Mobile-D and MASAN used in the mobile device industry: A contrast in favor of the mobile development industry. Universidad Peruana Unión; 2020, https://alicia.concytec.gob.pe/vufind/Record/UEPU_1908b08cf7b5c6c4ba67374f39154d64.
[18] Ovallos J, Rico D, Medina Y. A practical guide to analyzing vulnerabilities in a GNU/Linux client–server environment using a pentesting methodology Yurley Medina-Cárdenas. Revista Ibérica Sistemas E Tecnol de Inform 2020;29:335–50, https://bonga.unisimon.edu.co/handle/20.500.12442/6943.
[19] Chamilco M, Pacheco A, Peñaranda C, Felix E, Ruiz M. Materials and methods on digital enrollment system for educational institutions. Mater Today: Proc 2021. http://dx.doi.org/10.1016/J.MATPR.2021.04.213.
[20] Ore J, Pacheco A, Roque E, Reyes A, Pacheco L. Augmented reality for the treatment of arachnophobia: exposure therapy. World J Eng 2020;18(4):566–72. http://dx.doi.org/10.1108/WJE-09-2020-0410/FULL/XML.
[21] De la Cruz C, Pacheco A, Robles I, Duran A, Flores E. Smart transportation system for public universities. Int J Inf Technol 2021;13(4):1643–7. http://dx.doi.org/10.1007/S41870-021-00708-9, 2021 13:4.
[22] Castilla R, Pacheco A, Robles I, Reyes A, Inquilla R. Digital channel for interaction with citizens in public sector entities. World J Eng 2020;18(4):547–52. http://dx.doi.org/10.1108/WJE-08-2020-0377/FULL/XML.
[23] Brown DCG, Toze S. Information governance in digitized public administration. 2017, http://dx.doi.org/10.1111/capa.12227.
[24] Serra L, Carvalho L, Ferreira L, Vaz J, Freire A. Accessibility evaluation of E-government mobile applications in Brazil. Procedia Comput Sci 2015;67:348–57. http://dx.doi.org/10.1016/J.PROCS.2015.09.279.
[25] Gértrudix M, Álvarez S, Fernández M. Open Data en aplicaciones móviles: nuevos modelos para la información de servicio. Fonseca J Commun 2016;12(12):117–31. http://dx.doi.org/10.14201/FJC201612117131.
[26] Sharma S, Al-Badi A, Rana N, Al-Azizi L. Mobile applications in government services (mG-App) from user's perspectives: A predictive modelling approach. Gov Inf Q 2018;35(4):557–68. http://dx.doi.org/10.1016/J.GIQ.2018.07.002.
[27] Filippi JL, Lafuente G, Bertone R. Aplicación móvil como instrumento de difusión. Multiciencias 2016;16(3):336–44.
[28] Alghyaline S. Real-time Jordanian license plate recognition using deep learning. J King Saud Univ - Comput Inf Sci 2020. http://dx.doi.org/10.1016/J.JKSUCI.2020.09.018.
[29] Soriguera F, Miralles E. Driver feedback mobile app. Transp Res Procedia 2016;18:264–71. http://dx.doi.org/10.1016/J.TRPRO.2016.12.036.