Empowering Sustainability: A Mobile App for Environmental Pollution Reduction

Jehovanni Velarde-Molina[1], Jeymi Arias-Hancco[1], María Bahamondes-Rosado[1], Carlos Fidel Ponce-Sánchez[2], Meyluz Paico-Campos[3], Victor Romero-Alva[3], Enrique Lee Huamaní[3,*]

[1]   Escuela de Posgrado Newman, Tacna, Perú
[2]   Escuela de Ingeniería Industrial, Universidad Nacional de Ingeniería, Lima, Perú
[3]   Image Processing Research Laboratory, Universidad de Ciencias y Humanidades, Lima, Perú

ARTICLE INFO	ABSTRACT
	The present work has as main objective, to reduce the levels of contamination of the district of the olive trees, for this it was necessary to know the problem and its multiple factors, such as the age of the public interested in the cause and the commitment of each one, through a survey carried out and promoted by google forms that was answered by the public (friends, family and acquaintances) thanks to social networks, through this means it was possible to determine and know the different main causes of contamination in the district of los olivos one of for them it was due to the lack of information in public places or institutions. During the investigation, different ideas were sought as a project team and the conclusion was reached to implement a mobile application with the help of software development programs such as Android Studio and as a firebase database to store our user data in the cloud for On the other hand, background information from other mobile applications that also have our same mission was used as a guide in the application. The objective of our app was to help reduce environmental pollution in different parts of the district, such as in green areas, recreational centres, and to inform the population, with the main mission of promoting recycling in multiple ways, incentivizing prizes or points with the support of brands or sponsors who want to help the environment, thus gradually reducing pollution in the olive district.

1. Introduction

Currently, the pollution index in Peru has been increasing over the years due to various factors such as garbage collection, public and private transportation, aerosol or aerosol, among others.

Environmental pollution in Peru is at an alarming rate. The problems arise after the continuous growth of the population, its concentration in large urban centres, and illegal activities, such as illegal mining, incineration and the lack of regulation on smog in cars is undesirable, these problems continue to increase as a result the continuous increase in population. This is a challenge for the

authorities of each district to implement responsible environmental management since it focuses on other problems such as citizen security, works and activities. "Peru has the lowest air quality in Latin America, according to the World Air Quality Report 2021 study carried out by the private firm IQAir. Thus, while our country is located in 26th place (with 29.6 µg/m³) of 117, we have Chile in position 40 (21.7 µg/m³), Mexico 51 (19.3 µg/m³), Colombia 72 (14.1 µg/m³), Brazil 75 (13.6 µg/m³), among others. For the preparation of the IQAir study, the level of air quality in 6,475 cities and 117 countries around the world was evaluated through the existence of particulate matter or PM2.5." [1].

In other words, Peru is positioned in a bad place on the list of countries with very low air quality, despite the fact that with the issue of the pandemic, many people were left isolated and many companies did not carry out their normal activities. enough so that in the year 2021 [2], our country does not lower air pollution rates, the Automotive Association of Peru indicates that actions must be taken such as the optimization of vehicle traffic, the entry of vehicles with new technologies such as electric cars and must be taken by part of the state since this pollution is the reason behind many respiratory diseases in the cities. Cars, trucks and buses are one of the main sources of air pollution. They emit more than half of the nitrogen oxides in our air, and are one of the largest emitters of gases associated with global warming in the United States. Scientific studies have identified that these pollutants have negative impacts on almost every organ in the body [2]. "The bicycle is an extraordinary vehicle to get around and to have a better quality of life. (MINAM) called for joining efforts at all levels of government to promote the implementation of actions seeking good conditions for citizens. "It is not only about reducing emissions, but also that we all think that what we do has to be aimed at improving the quality of life of people" [3]. This means that, promoting the issue of environmental care, not only seeks to reduce pollution, but also to improve our quality of life, using alternative means of transportation that do not generate emissions, to reduce the level of pollution and encourage more people to join our purpose.

After the aforementioned, we propose a mobile application that provides us with information on reducing pollution in our country, implementing didactic forms such as forums and questionnaires, mini-games that promote recycling, offering recycling points and ecological campaigns. Many companies collaborate to recycle the materials that we do not use; For example, placing different containers to facilitate the segregation of waste such as cardboard, plastic bottles, glass, and others; Recycling promotion campaigns are also carried out both in schools and universities [4].

Plume Air Report "This app provides real-time pollution levels in a specific area and forecasts how the air quality will evolve every hour for the next 24 hours, similar to a weather forecast. In summary, it provides the user with personalized recommendations on the best time of day to carry out their favourite activity (going for a run, walking in the park with children) without overexposing themselves to pollution" [5].

EcoApp is a company founded in 2018, focused on the development of mobile applications, as an opportunity for its own entrepreneurship, founded and created by developers and computer analysts, taking into account the solutions of the different technologies that are currently available, proposing a community good, this company is characterized mainly by the ecological environment of recycling. However, given the aforementioned, a solution to this problem can be found, through different stages, processes, studies, and requirements, promoting and encouraging citizens to be willing to be part of an ecological system [6].

The AndroBici project tries to build a system for the management of bike lanes and bike lanes, and the provision of services through a mobile terminal to its customers. This service includes different components: Check the status of the stations, Plan the route from one station to another according to the bike path, send suggestions and problems to the company in charge of the service, social network where customers can interact [7].

2. Background

The environmental pollution of the air in our country is reaching alarming figures, all this is due to the different forms of contamination that are carried out by the population as indicated in a study carried out by the private firm IQAir, where the different figures of contamination are observed. Taking this into account, the use of the "Plume Air Report" application was launched: This application provides real-time pollution levels in a specific area and forecasts the evolution of air quality every hour for the next 2 hours, similar to a weather forecast. In short, it provides users with personalized recommendations on the best time of day to do their favourite activity (jogging, walk in the park with the children) without having to be exposed to the sun I give too much pollution [5]. Thus, our app can help us eradicate pollution rates without putting our health at risk, in addition to making basic recommendations on outdoor physical activities, it also allows us to schedule alerts for pollution peaks to notify us of high levels of contamination and being able to share this status on different social networks or the use of a forum in the same application, which can be obtained free of charge for Apple iPhone IOs and Android phones.

Cars, trucks and buses are the main sources of air pollution. They release more than half of the nitrogen oxides in our air and are one of the largest emitters of gases associated with global warming. Scientific studies have determined that these pollutants have a negative impact on almost every organ in the body. Taking this into account, measures are currently being taken such as applications in this case Eco App is a company founded in 2018, focused on the development of mobile applications, this company is mainly characterized by the ecological environment of recycling. However, given the aforementioned, a solution to this problem can be found, through different stages, processes, studies, and requirements, promoting and encouraging people who are willing to be part of an ecological system. Therefore, this app aims to offer a complete guide with all the information on how to correctly separate plastic, metal, brick, paper and cardboard containers. It includes a container search engine so that the user can always consult their doubts while classifying.

One of the main causes of pollution is vehicle emissions. In most urban areas, industrial sources and means of transportation also create and contribute to this problem. Emissions move through the air from cities to many regions, affecting the entire planet. The AndroBici project tries to build a system for the management of bike lanes and bike lanes, and the provision of services through a mobile terminal to its customers. This service includes different components: Check the status of the stations, Plan the route from station to another station according to the bike path, send suggestions and problems for handling to the service company Service, Social Network where customers can interact [7].

Develop a mobile application as a strategy to enable the promotion of eco-recycling in different cities of the Metropolitan Area, having our recycling areas located at key points, in addition to being able to visualize the most contaminated areas and be able to take the safest routes for our health. in addition to being able to take into account the importance of conserving natural resources through new habits that they exercise as people when carrying out these actions and promoting new eco-cultures that are sustainable for the environment in our region.

The technologies that will be used for the elaboration of our mobile application on how to help stop environmental pollution are: an (IDE) integrated development environment, which will be Android Estudio thanks to the fact that it has high-level characteristics for the development of applications such as creating designs by dragging elements, it has an Android emulator for testing, it is flexible, also recommended by Google, the Google Maps APIs will also be used to locate the different recycling points in our area, all this will be implemented using the C++ programming language and MySQL will

beused as a data management system that will allow us to store and access data through multiple storage, performance and durability engines.

3. Methodology

The Scrum methodology will be used for the investigation of the study, the benefits of this methodology is the ability to respond to changes, which are not a problem but as something necessary for product improvement and customer satisfaction. The changes are part of the development process of the study, the prototypes of the application will be made through a study, in order to reduce environmental pollution.

3.1 Scrum Methodology

The Scrum methodology has a great contribution to projects in different areas, managing the high level of uncertainty that this type of project contains and understanding how adaptation is the fundamental basis for success in a project managed in an agile way. This knowledge acquired during the course will be strengthened in the two practical sessions, where the participants will apply the agile framework in a real case.

3.1.1 Planning

For planning, a session will be held in which the SCRUM team participants will define the output of the sprints. In this meeting, two important questions will be asked, which are: what is going to be delivered? and how is it going to be done? For this, we will have the help of the Scrum Master who will guide us in the process, the Product Owner or owner of the product and the development team will also be present, who will be in charge of carrying out the necessary work to finish the project on time [8].

3.1.2 Development of the sprints

The Sprints are mini projects of no more than a month (with very short execution periods such as between one and four weeks), whose objective is to achieve an increase in the value of the product that we are building [9]. Every sprint has a definition and planning that will help achieve the goals set for our mobile application.

3.2 Prototype Development

The prototype is an evolutionary development model which shows us a preview of how our application will be and to have an idea of time, cost, its evolution and functionality. In our case, it will start with a registration form, an options menu and access to the forum.

3.2.1 Backlog planning

The first table shows us the user stories created that will allow us to do a better job and improve details and features that we want to implement in the mobile application.

Table 1 will show the user stories, also known as requirements, that the application needs to function optimally and that will be implemented during its creation.It will be divided into 4 parts which satisfy the user's needs.

Table 1
User Stories

No.	user stories
1	I, as a user, want a system that shows cycle routes in order to help with traffic congestion.
2	As a user I want a system that shows informationabout an area to detect the level of contamination
3	As a user I want an application that shows recyclingpoints to help care for the planet
4	As a user I want an informative application, to be upto date with the latest pollution news

3.2.2 Used tools

The tools that will be used for the creation of the mobileapplication are the following:

i. *Android studio:* The official integrated development environment (IDE) for Android app development and is based on IntelliJ IDEA [10].
ii. *SQL Server:* Microsoft SQL Server is one of the main relational database management systems on the market thatserves a wide range of software applications for business intelligence and analysis on corporate environments [11].
iii. *Google Map APIs:* It is a type of identification (Application Programming Interface) for the use ofapplications with Google Maps. The first thing we have todo is request it and later we will insert it into our mobile application [12].

Figure 1 shows the tools that will be implemented inthe development of the mobile application which are android studio Chipmunk | 2021.2.1 Patch 1 for Windows 64-bit (929 MiB), SQL Server 2019 and the Google Maps API in such a way that it will allow us to work, communicate and exchange information in our mobile application with each other, managing to extract data and receive orders.

Fig. 1. Used tools

Figure 2 shows the process of the mobile application inaction, the application begins when the user starts the userand password registration process, when he completes the registration and clicks on the next button to continue, whereit will show the options panel of the different functions and

activities to be performed, on the other hand, we also have to save our changes or data to be stored in a SQL server database.
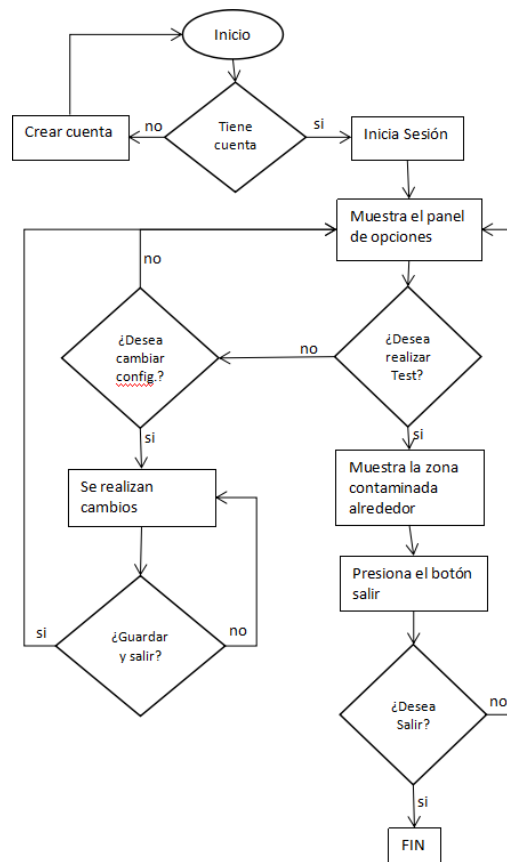

Fig. 2. Application Flow Diagram

Figure 3 shows the architecture of the software where the user, once he enters the application, will provide his data and make the queries he needs, on the other hand, he will also be provided with notifications about social eventsthat contribute to the environment, all of these The data will be sent and stored in the database where it is necessary to be able to link the server with the users through the mobileapplication, then the information obtained from it will be sent and stored in the SQL server database that will be used, in addition all the information will be managed. information in a pdf where you can view a list of help pointsin the olive trees area, this information will be updated andnotified in the registered emails of our users from the mainserver.
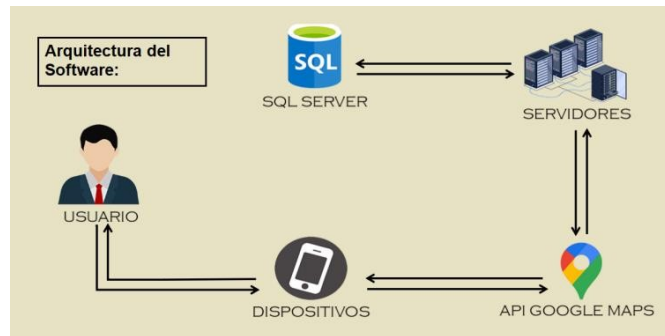
Fig. 3. Software architecture for the mobile application

3.2.3 Research application prototype

The prototypes are a graphic representation in which the functionalities of our mobile application will be shown, starting with a registration interface so that the application can then be entered through the login where a panel will be displayed with the different functions such as air quality or the climate forecast will also be able to observe the agenda with the different types of indicators to be able to recycle.

In Figure 4 We can show the registration form where users will have to complete their respective data such as: names, a valid email and their password in order to register on the platform, shows the login where previously registered users will have to enter their email and password to be able to log in and navigate the application.
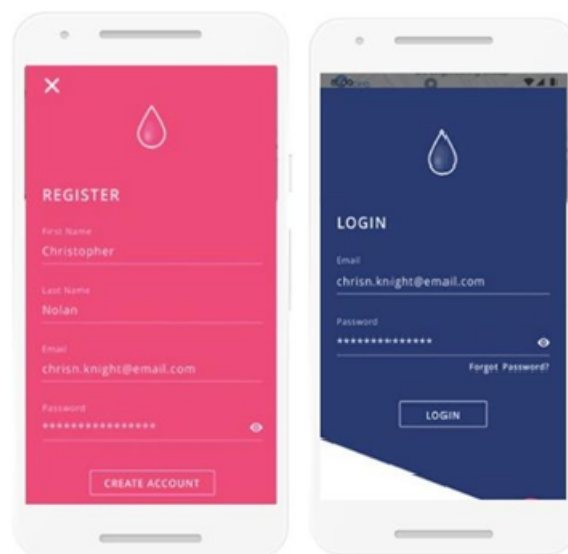

Fig. 4. Registration y login form prototype

In Figure 5, we can see the Panel where the different options for the use of the application can be found, such as: see traffic, search for locations, show air quality or know how the weather is. All of the above mentioned will be done thanks to the Google Maps API which provides us with these services.
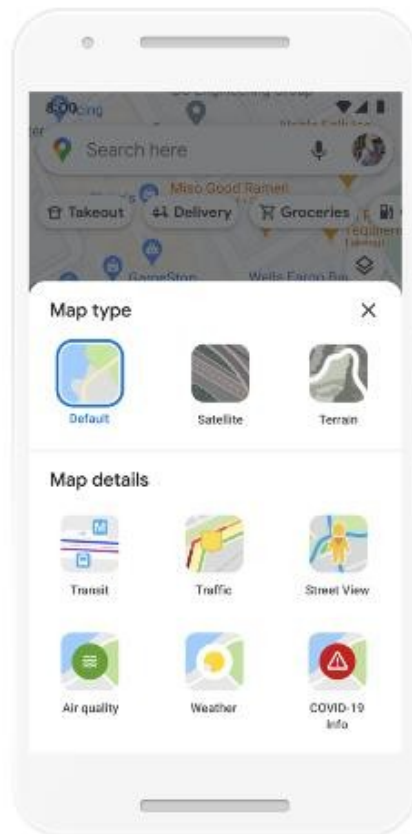
Fig. 5. Navigation panel prototype

In Figure 6, you can see the main functionalities which are the air quality around us and also the weatherforecast, which are focused on the district of los olivos.
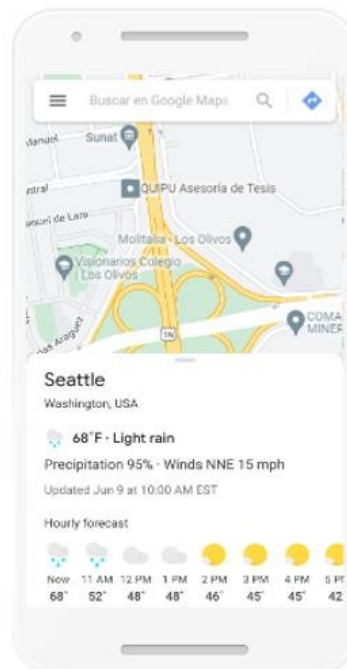

Fig. 6. Prototype of main
functions of the application

In Figure 7, the agenda section can be seen, where recycling events can be added and other users will be informed about different events specifying the place, date,time and description, on the other hand, it can show the recycling points closest to us and to be able to schedulethem as can be seen in Figure 8.
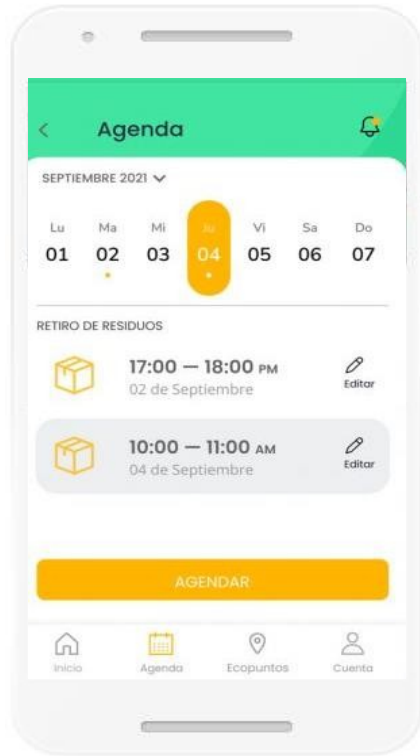

Fig. 7. Virtual agenda prototype

Fig. 8. Prototype of collection points

4. Results and Discussions

Figure 9 shows the Event Log, which helps the user toadd events to his calendar on environmental events.

Fig. 9. Environmental
event log

Figure 10 shows the Map. (Recycling points) around our area to be able to visualize the closest one and be able to make the shortest route in the different recreational areas.

Fig. 10. Recycling points in nearby areas

4.1 Evaluation Questionnaire

The first three questions were asked to learn a little about the people who complete the questionnaire, which also helps to know the average age of the people involved for the purpose.

Table 2
Participants of our survey

	Edad	Sexo
Participants: 40	Mayor: 52	Masculino:21 (55%)
	Promedio: 23.1	Femenino: 15 (40%)
	Menor: 12	Otros: 4 (5%)

Resulting in 40 participants, mostly male and the average age of the participants is 23 years. In Figure 11 as the first question on the subject, which is Have you heard about environmental pollution? With which you want to know if the respondents know something about environmental pollution.
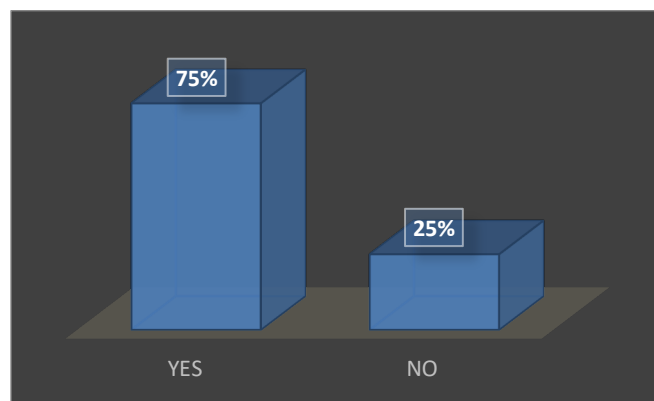

Fig. 11. Result Graph

The result of this question gave 75% positive votes and 25% negative votes, letting us know that most people are aware of environmental pollution. Figure 12 presents the second question, has anyone ever encouraged you to recycle? It seeks to know if they have been encouraged to recycle either in schools, homes, jobs or the community.
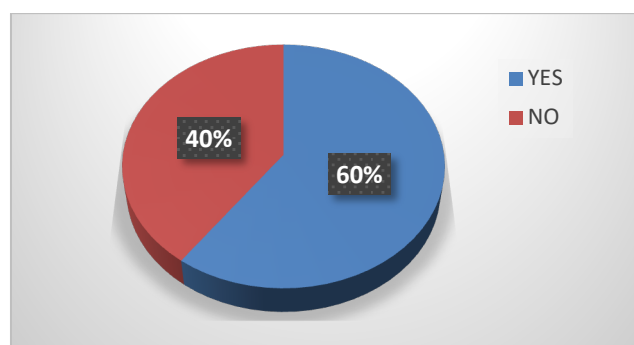

Fig. 12. Incentive percentage to recycle

The result thrown by this question was that 60% of respondents if they have had an incentive to recycle, be it the area where they are, being a very favourable percentageof pollution, since only 40% have not had this incentive.

Figure 13 presents the following question: Howcontaminated do you think the district of Los Olivos is? You want to know the level of contamination in the districtof the respondents.
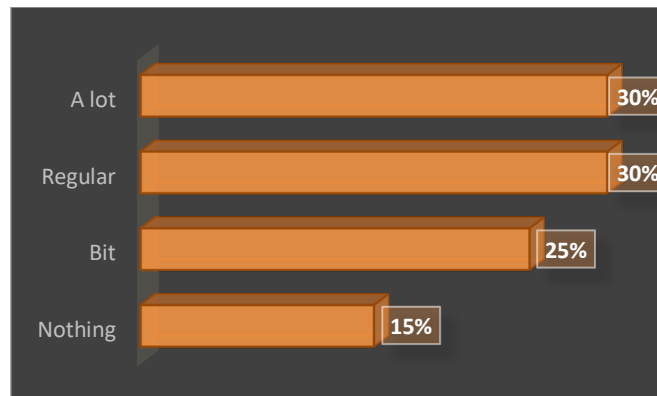

Fig. 13. Olive trees pollution rating

According to those surveyed, the district of Los Olivos is contaminated from 30% to 60% and only 40% believe thatthere are sites that still maintain an area free of contamination.

In Figure 14, the purpose is to know, how important is itto take care of the environment? It is knowing how important the environment is, for those surveyed and thosearound them.
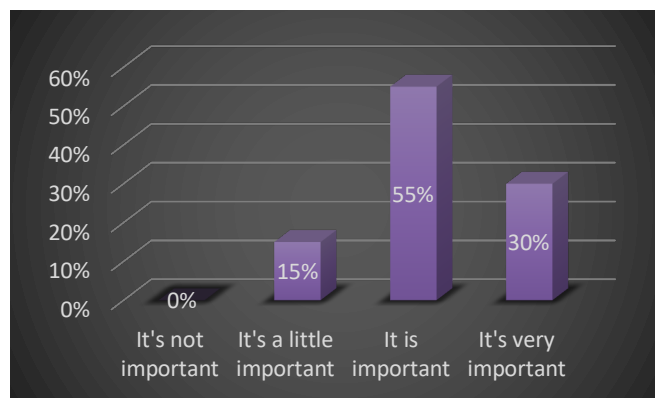

Fig. 14. Importance of caring for the environment

Of those surveyed, 55% say that caring for the environment is important, 30% that it is very important and 15% say thatit is not so important.

After asking the questions to the general public in the Los Olivos district, in order to know who the potential audienceis for this investigation. The main objective of which is to collect data, from different people, to have an overview ofthe problem to be solved, in this way to implement solutions that help the district and can be expanded to morecommunities throughout the country.

5. Discussions

While this project was developed, different observations were made by the team, which will be explained in detail below, it is known that, due to the greatenvironmental contamination generated by the industries and the population itself. As a consequence, I cause damageto our ozone layer producing different natural disasters around the world, that is why our mobile application will help our users to give our planet a better quality of life.

As a first point, our project has a good base, but it is not yetcompared with the related models, we still need to implement many features that we had planned.

Secondly, our approach is still not as ambitious as we hope, since we will only focus on the different recycling points since this would generate cleaner and better distributed green areas.

Thirdly, the facilities that we show in our proposal for the registration of events that we had planned, is a section that was successfully implemented, which shows us that our application can carry out different activities from our homes, facilitating our users since It has the same functionsas a web page.

Taking into account the great acceptance that the mobile application would receive from the population, it isconsidered that it must continue to innovate, in this way different suggestions can be added by our users, such as increasing the information that explains how we can support other districts resorting to brands or sponsors who want to join the good cause. Once this objective has been achieved, the final objective is considered to be sharing this information with all the districts or municipalities of those,so that in this way it is possible to reduce contamination and reduce the most contaminated areas of Lima.

6. Conclusions

In this research, a mobile application has been conceived that allows users to interact and visualize the less polluted areas of their environment. The fundamental premise in the creation of this application has been its uniqueness compared to others, since a variety of useful tools for the user have been incorporated, such as the identification of areas with better air quality, the location of nearby recycling points and the generation of optimal routes to move. These features have led to the conclusion that the application can provide users with more complete information about their environment and, in addition, allow them to share this data through an integrated forum. The services of the application are divided into distinct modules, each fulfilling a specific function according to the user's choice at that time. The feedback of the users in Los Olivos has been fundamental to meet the initial objectives, which include the optimization of routes, the inclusion of images of nearby recycling areas and the acquisition of valuable knowledge in the management of technologies pertinent to mobile projects, overcoming the typical restrictions of this type of devices.

References
[1] Perú21 Redaction, "Peru was the country in the region with the worst air quality in 2021," (2022). https://peru21.pe/ciencia/peru-fue-el-pais-de-la-region-con-peor-calidad-de-aire-en-el-ano-2021-medio-ambiente-contaminacion- peru-News/
[2] U. of C. Scientists, "Cars, Trucks, Buses, Air Pollution," *JIMMY O'DEA/UCS,* (2017). https://es.ucsusa.org/resources/carros- camiones-buses-contaminacion
[3] Ministry of the Environment, "MINAM promotes the use of the bicycle as a means of transportation and to improve the quality of life - Government of Peru," *Unique digital platform of the Peruvian State 2018* (2022). https://www.gob.pe/institucion/minam/noticias/18468-minam-fomenta-uso-de-la-bicicleta-como-medio-de-transporte-y-para- mejorar-la-calidad-de- lifetime
[4] N. Delgado Ruiz and F. Aguilar, "School of Environmental Sciences Eco-Efficiency Project Recycling of Pet Bottles," (2012). http://www.ambientum.com/revista/200 1_24/2001_24_SUELOS/MPCTPLST1.htm
[5] Laura Martín, "The 10 best 'apps' to take care of the environment - Haz Magazine," (2018) https://hazrevista.org/rsc/2018/01/las- 10-mejores-apps-para-cuidar-el-medio-ambiente/

[6]   M. Hormazábal and N. Salgado, "Universidad De Las Américas Faculty of Engineering and Business Career of Engineering Execution in Computing 'EcoApp' Recycling," (2019). https://repositorio.udla.cl/xmlui/handle/udla/247

[7]   Muñoz Romero, Carlos. "AndroBici." (2010).

[8]   youRigas Gallego, M. "Scrum methodology." (2012). http://openaccess.uoc.edu/webapps/o2/bitstream/10609/17885/1/mtrigasTFC0612me moria.pdf

[9]   Srivastava, Apoorva, Sukriti Bhardwaj, and Shipra Saraswat. "SCRUM model for agile methodology." In *2017 International Conference on Computing, Communication and Automation (ICCCA)*, pp. 864-869. IEEE, 2017. https://doi.org/10.1109/CCAA.2017.8229928

[10]   Studio, Android. "Android studio: The official IDE for android." *Retrieved June* 24 (2017): 2019.

[11]   Perez, M. "Microsoft SQL Server 2008 R2. *Database engine and administration. RC Books.* (2011). https://books.google.es/books?hl=es&lr=&id=ExK0AQRjPk4C&oi=fnd&pg=PR13&dq=sql+server&ots=va1TpRQIfH &sig=vhkWnUXULsMy RA0Qq6R4SFDj99o#v=onepage&q=sql%20serve r&f=false

[12]   Boulos, Maged N. Kamel. "Web GIS in practice III: creating a simple interactive map of England's strategic Health Authorities using Google Maps API, Google Earth KML, and MSN Virtual Earth Map Control." *International journal of health geographics* 4, no. 1 (2005): 1-8. https://doi.org/10.1186/1476-072X-4-22