Bulletin of Electrical Engineering and Informatics
Vol. 13, No. 2, April 2024, pp. 1256~1267
ISSN: 2302-9285, DOI: 10.11591/eei.v13i2.6131

Mobile application: awareness of the population on the environmental impact

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Article Info

Article history:

Received Mar 2, 2023
Revised Jul 13, 2023
Accepted Sep 16, 2023

Keywords:

ATLAS.ti 22
Environmental awareness
Environmental education
Environmental impact
Mobile application
Pollution

ABSTRACT

Nowadays, pollution keeps increasing due to social, political, economic, cultural, and environmental factors. Environmental awareness is close to zero because people prioritize personal activities. In that sense, the objective of this investigation is to raise environmental awareness in the population regarding the impact of pollution and support this through a mobile application (APP) that helps reduce pollution. The methodology used was the cascade, and through its phases, it was developed the prototype design of the mobile APP. The results obtained from this hybrid research were through a survey using ATLAS.ti 22; it concluded that environmental awareness begins at home and is taught by the parents, also it should be promoted from elementary school to high school and even in college. Moreover, in a survey, the users stated by 89% that the use of this mobile APP can help reduce the environmental impact. Also, in the validation through expert judgment, all the attributes were accepted with an average of 81%, that of functionality was the lowest, and the highest was that of consistency and integration with 83%. Finally, environmental education should be a priority policy in any country, as this will benefit its population.

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1. INTRODUCTION

Global warming, also known as climate change, is one of the main effects of pollution. Through this process, the temperature of the planet, the atmosphere, oceans, and glaciers keep gradually increasing, reaching alarming numbers on a global scale. Environmental risks have been created by the economy and production expansion [1], including the emission of greenhouse gasses, waste management, and air, water, and soil pollution. In consequence, temporarily as well as permanently, exposure to those high levels of pollution can have a negative impact on health and increase the risk to develop diseases. In that sense, at an international level, and in developing countries in particular, the disease burden and deaths related to pollution are becoming a problem in public health [2]. Peru has alarming levels of pollution. This problem is aggravated by the continuous increase in its population, the centralization in the big cities, and illegal activities such as deforestation, and burning trash. One of the main problems is air pollution caused by land transportation as well as the disposal and burning of trash in urban areas like the lima metropolitan area [3]. Therefore, Peru, through the ministry of education and environment, has focused on establishing educational policies, so that students have a solid foundation in environmental education, transforming teachers into

mentors of people with environmental awareness [4]. The impact of pollution hampers the protection of civil rights, such as the right to a clean environment, and fulfilling those rights requires sophisticated solutions [5]. Thus, promoting a healthy environment and safe and enduring development is the reason why it is important to study the environmental impact. In this study, a mobile application (APP) is created to raise awareness in the population regarding environmental impact and promote recycling techniques. Hence, encourage reducing pollution not only in Peru but on a global scale to protect the environment and guarantee survival and well-being, as well as for other living things. Alfahid *et al.* [6] claimed that pollution is facilitated to a large degree by litter and that children litter more than adults. Therefore, there was a proposal for a gamified APP called DoItRight to promote environmental protection and improve children's behavior of littering. This APP was evaluated using a standardized tool, the system usability scale (SUS). The findings of this evaluation revealed that the APP DoItRight has a SUS score of 93.25 points or a grade, with a percentile rank of 96 out of 100. This shows that the APP DoItRight is functional and solid, and it can accomplish its objective of raising awareness in children regarding the negative effects of littering. Moreover, littering regularly ends up with trash stuck somewhere and this is the main problem of pollution. Fahim *et al.* [7] created a mobile APP with functions such as marking where is the nearest trash pickup point, based on flutter using google maps interfaz de programación de aplicaciones (API) technology, to help people to reduce pollution in their community. Also, it shows the air quality and pollution levels in real-time, with the support of web data scraping from various websites and systems based on internet of things (IoT), to increase people's awareness. Either by making the public aware or facilitating communication between the users and the authority, this APP is effective to reduce pollution. Pollution has an impact on people; thus, a prototype of a mobile APP was proposed to raise awareness on regards of this environmental issue, using the methodology scrum. Furthermore, to gather information regarding different sensors for air pollution, they used technology based on IoT and fire protection [8]; so, that users can visualize pollution in real-time. In that sense, the implementation of this APP helped accomplish its objective as it made people aware of how these contaminants damage the environment.

In addition, Kee *et al.* [9] as part of a campaign to teach children the importance of protecting the environment, created a mobile APP about the reduce, reuse, and recycle (3Rs) to raise awareness regarding these 3Rs to reduce solid waste and avoid pollution. For this reason, thirty students from elementary school were part of the test group to try out this mobile APP. The results of this study showed that this APP would be a promising step toward raising awareness amongst the public regarding the environment. While the objective is to increase public interest in the process of climate change and environmental safety through the introduction of mobile APPs in the educational process [10]. They proposed a new technology for mobile learning (m-learning), in order to monitor and manage the environmental indicators through the mobile APP. As result, the students were getting more conscious of the quality of the environment in their local area. Furthermore, as people are constantly generating solid waste or other unnecessary waste, it is important to raise awareness regarding the health benefits of reducing pollution. Also, the design of a mobile APP was created focusing on easy and direct operation for certain activities. In that sense, the android operative system was used to develop the mobile APP, which was designed using balsamiq mockup [11]. An estimate, in real-time, regarding the distance to the closest waste collection service is possible thanks to this mobile APP. This allows the population to become part of the big change, free of pollution.

According to Thibuy *et al.* [12], a big amount of valuable waste is thrown in Saen Suk, Chonburi Province, Thailand; instead of collecting and sorting them properly. Moreover, they found out two of the main reasons why people don't dispose of their waste properly: they don't know how to sort the valuable waste, and they lack the motivation to do so. Therefore, they designed a holistic system for waste management. The system is composed of two parts, the design and establishment of the waste management APP based on the web and a reward system; the second one is the design and establishment of the hardware that uses the IoT and automated learning to sort the waste. People can win points and exchange them for rewards through the mobile APP rewards system. This motivates them to dispose of the waste properly. Sustainable production and consumption broadly used environmental accounting as a reference. Thus, a new environmental accounting infrastructure was created based on mobile devices to promote sustainable consumption and increase environmental awareness in the population [13]. The infrastructure has three components: green purchasing, recycling, and green incentives. The innovative characteristics of this mobile APP were created through a combination of various mobile technologies, such as the new encryption algorithm QR, google maps integration, services based on cutting-edge technology, and multilingual support. Furthermore, to turn recycling into a daily habit, Ablaza-Cruz [14] focused on designing a mobile APP incorporating a hybrid architecture framework. They used a methodology of co-design to define the characteristics of the content, the requirements of the system, and identify the user of the system. The findings of this study can raise public awareness regarding how cutting-edge technology can help fight climate change by raising environmental awareness in people with regard to proper waste management to reduce pollution. Additionally, a green incentives program was established using a mobile APP system

designed to encourage users to make sustainable purchases. The infrastructure of a mobile system has 3 components: database server, communication, and integration; with the four functional models to login and sign up, get eco-credits, use/donate eco-credits, and visualize the history of eco-credits [15]. Using various methodologies for the development of mobile APPs like MySQL servers, programming language PHP, and IP based on the web services RESTful. In order to validate the mobile APP, they did a survey with a questionnaire of eight questions and received thirty-night answers.

The objective of this investigation is to raise awareness among people about pollution through a mobile APP. Therefore, developing responsible environmental behavior and respect in kids, teenagers, and adults. Giving them the necessary tools to make an informed decision and undertake responsible actions to reduce the environmental impact, for the benefit of Peru and the rest of the world through awareness and knowledge about these environmental topics and issues.

In conclusion, several pieces of research have demonstrated the harmful effects that pollution has on health, and how entertainment, games, and activities can contribute and promote through rewards to solve these issues. On the other hand, only a few pieces of research have tried to find possible solutions by raising awareness from the perspective of giving tools to educate on how pollution affects the environment and its consequences. Besides that, giving information is as crucial as the ecosystem is to all living things, as well as offering suggestions or advice on how should recycle waste to avoid pollution. What this study wants is to fill out the gaps.

2. METHOD

This investigation used the waterfall model to establish an innovative proposal. The cascade methodology is based on a sequence, that groups all tasks in phases in order to develop a project [16]. Indeed, analyzes in detail the requirements per phase, which makes it difficult to get back to the previous phase of the project. The use of the cascade methodology is rigorous and controlled throughout the project. This is a specific project, where they reassess as the project progresses [17].

2.1. Phases of the cascade methodology

It considered the four phases of the cascade methodology which is based on contributions from all separated phases. No stage begins until the previous stage has finished, and the completion of each phase is final: there is no return to the previous stage. The only way to repeat a phase is to restart. In this investigation, the cascade methodology is used in order to obtain a good result and accomplish its objective as shown in Figure 1.

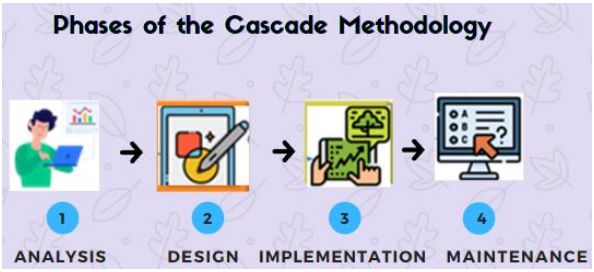


Figure 1. Cascade methodology

- Analysis: the first phase begins by collecting detailed information, in various forms, regarding project requirements [18]. Either through questionnaires, interviews, meetings, and/or brainstorming to come to an agreement. At the end of this phase, all project requirements must be clear, and all the requirements and documents must be shared with the team [19].
- Design: in the second phase, the team will design a system according to the defined requirements. At this stage, there is no coding, but the team defines specifications based on the user requirements. Likewise, the analysis, all strategies, and tasks were defined in the first phase.
- Implementation: in this stage or phase, the coding is performed. All teams and developers analyze the information collected from previous phases so they can create a functional requirement. Usually, all codes are developed and integrated with this phase [20]. Depending on what programming language they are going to use, they will create the components and libraries for the project.

- Maintenance: in the last phase, the final delivery becomes available to the user, and it is tested. When the users come across errors, the team creates an update to be able to fix them. Likewise, in this phase, a final test is carried out in order to be validated. In the same way, the comments of the users regarding the implementation are important to be able to give a good version of the proposed solution [21].

2.2. Development tolls

In the ever-evolving landscape of software development, a diverse set of tools and languages empowers developers to create innovative and engaging digital experiences. Java, recognized as a stalwart in the field, remains unparalleled in developing dynamic websites and mobile applications, boasting cross-platform compatibility and continuous innovation. Python, equally influential, has carved its niche with widespread usage in website development, software engineering, and machine learning, appealing to developers for its power, ease of use, and readability. Complementing these languages are essential tools like CSS, instrumental in shaping the visual appeal of applications, and versatile platforms such as balsamiq and visual studio code, each contributing to a holistic and efficient development ecosystem.

- Java: the java platform is number one in all programming languages. It is used to develop websites and mobile APPs. The java programming language drives an innovative version and improves all services of established APPs. Java can run on any platform, either linux, windows, and/or android. The language is very powerful as it can work across multiple devices [22].
- Python: the python programming language, currently, is commonly used for website and software development, automated learning, and others. All developer teams use python because it is one of the most powerful and easiest to learn programming languages, also it can be used on multiple platforms. Python is a dynamically typed language that is easy to use, read, and interpret [23].
- CSS: it means cascading style sheets, which is a stylesheet language that controls the design of the entire presentation of APPs and websites, these are interactive and didactic. CSS works together with the HTML language, and both together handle the main content of the pages [24]. Its use is relevant in the project.
- Balsamiq: the balsamiq wireframe allows you to create a new project and do a quick design to get a visual idea of how the interface will look like. This will help, later, to create a project as similar as possible to the sketch drawn on a piece of paper. Balsamiq is a tool whose design made it very didactic and easy to use to have a good interface design tool [25].
- Visual studio code: visual studio code is a source-code editor that helps you start coding or programming easily and quickly. It uses different programming languages, without changing the editor. All programming languages such as python, java, C++, javascript, and others are integrated. This visual code program is very useful for all students heading into the programming branch, starting with HTML and CSS [26].

2.3. Methodology development

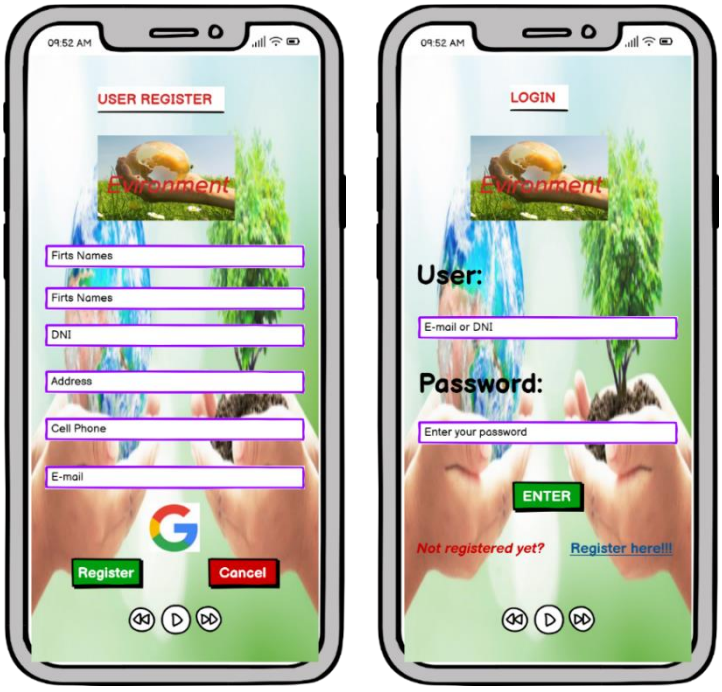
The waterfall methodology, a foundational approach in software development, involves a linear and sequential progression through distinct phases. As the development process unfolds, each stage builds upon the successful completion of the preceding one. While its structured nature offers clarity and organization, it is essential to acknowledge the challenges associated with adapting to evolving requirements, making careful consideration and planning crucial for a successful implementation of the waterfall methodology.

a. Analysis: in the first phase, a collection of information is carried out through interviews, in order to solve the problems identified. After this, all the collected data is analyzed. The team proposes ideas to reach an agreement; then, the team can establish the requirements to counteract pollution in the City of Lima. Thus, raising awareness within society to take care of the environment. Table 1 shows five questions asked to thirty-seven people representing six districts of North Lima.
b. Design: in this phase, the design of the mobile APP is made, with the purpose of counteracting pollution. With the analysis and the requirements gathered, the team and developers begin to design the APP, to raise awareness among the users by promoting taking care of the environment, and consequently, having a good quality of life. Figure 2 shows the design of the mobile APP, to register by entering all the required data, and logging in. Figure 2(a) shows the registration window where the user will have to fill in all required fields and there is also an authentication method through google, in order to log in. Figure 2(b) shows the login window where the user, after registering, will have to fill out the fields using the login credentials to be able to enter the environmental APP.

Figure 3 shows the design of the APP for environmental care. In Figure 3(a), you can visualize all the main topics related to the environment to raise awareness within society with regard to environmental care. Figure 3(b) shows the concept of the environment found in the previous figure as well as the main topics. The purpose is to help people take care of the environment and counteract pollution.

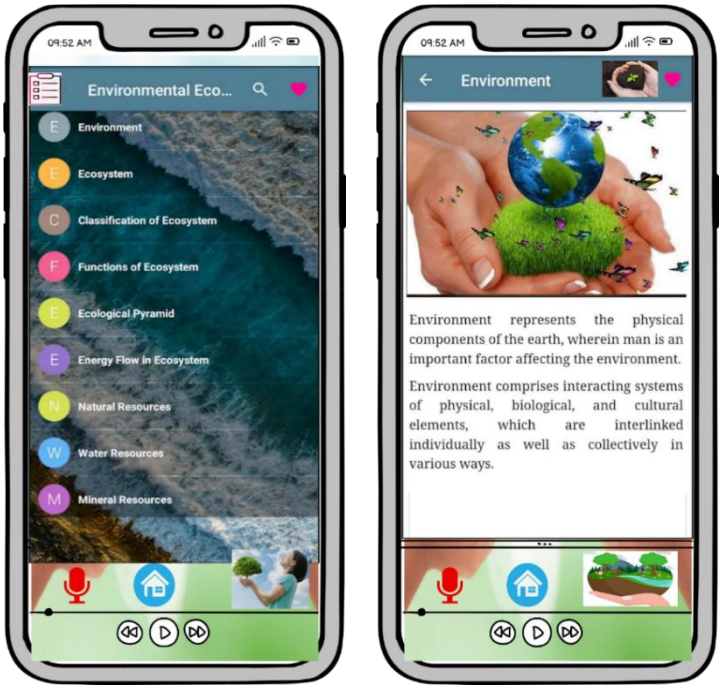
Table 1. Interview

No	Interview questions
1	Which district of Lima do you live in?
2	In the district you live in, do people have awareness of the environment?
3	What is the impact of pollution on society?
4	Is pollution taught in school?
5	Can a mobile APP raise awareness of taking care of the environment?



(a) (b)

Figure 2. Mobile APP: (a) register and (b) login



(a) (b)

Figure 3. Mobile APP: (a) environmental topics and (b) definition of environment

Similarly, Figure 4 shows the content section that the APP has. Figure 4(a) shows all the natural resources regarding environmental care. Figure 4(b) shows the ecological pyramid, which begins with the producers on the bottom, then the primary consumers, as well as secondary consumers and tertiary consumers.

(a) (b)

Figure 4. Mobile APP: (a) list of natural resources and (b) the ecological pyramid

Figure 5 shows tasks and messages that boost users to make proper waste disposal. Figure 5(a) displays a reminder to dispose of the trash correctly. Figure 5(b) shows different types of trash and recycling bins so that people can learn how to sort, recycle, and reuse them.

c. Implementation: this phase shows the coding part of the mobile APP, which will allow us to know the internal part of the APP, like how was developed based on its functionality. This coding was done through the visual studio code program. It used the python language, which allowed the coding of the mobile APP whose purpose is to counteract pollution (see Figure 6). Figure 6(a) shows the coding of the APP. At this point, the variables are established, as well as the name of the mobile APP "environmental APP". All required fields to register users are coded. By providing all the required data and their gmail, they can access this APP. Likewise, Figure 6(b) shows the coding for the initiation of the components of the mobile APP. In this part, the required fields for login are created. In order to enter the required fields to access the APP it is essential to have a username and password. This was done taking into consideration all the requirements needed to achieve the objective and solve the problem found. Figure 7 shows the coding of some reports regarding pollution. Also, in the image variable, you can view and read the coding of images regarding pollution. Also, it shows a combo box that will allow them to visualize the variables of the Lima districts and a button that allows them to log out.
d. Maintenance: in the last phase, a survey is carried out by users. Those who have used the APP have been selected to provide feedback. In this way, they can give their point of view regarding whether the APP is useful or not. Table 2 shows the four questions asked to the ninety-two users, which represents a sample of the population of one hundred and twenty, with a confidence level of 95% and a margin of error of 5%. The questions were answered dichotomously with a YES and NO answer.

(a) (b)

Figure 5. Mobile APP: (a) reminder to dispose of trash and (b) recycling information

```
% Create Figure and components
function CreateComponents(app)
% Create Figure and hide until all components are Create
   app.Figure = figure ('visible','off');
   app.Figure.Position = [100 100 640 480];
   app.Figure.Name = 'ENVIRONMENT APP  ';
% Create image
    app.image = image (app.figure);
    app.image.Position = [271 318 100 100];

 % create UsuarioTextArealabel
    app.UsuarioTextArealabel = label (app.figure);
    app.UsuarioTextArealabel.HorizontalAlignment = 'right';
    app.UsuarioTextArealabel.FontSize = 18;
    app.UsuarioTextArealabel.Position = [172 208 89 23];
    app.UsuarioTextArealabel.Text = 'pasword:';

 % create UsuarioTextArea
    app.UsuarioTextArea = textarea(app.figure);
    app.UsuarioTextArea.Position = [276 206 150 27];

 % create RegisterButton
    app.RegisterButton = button(app.figure, 'push');
    app.RegisterButton.BackgroudColor = [0.651 0.651 0.651];
    app.RegisterButton.FontSize = 18;77;
    app.RegisterButton.FontColor = [1 1 1];
    app.RegisterButton.Position = [271 72 100 30];
    app.RegisterButton.Text ='Register';

% create UsuarioTextArealabel
    app.UsuarioTextArealabel = label (app.figure);
    app.UsuarioTextArealabel.HorizontalAlignment = 'right';
    app.UsuarioTextArealabel.FontSize = 18;
    app.UsuarioTextArealabel.Position = [213 254 48 23];
    app.UsuarioTextArealabel.Text = 'User:';

% create UsuarioTextArea
    app.UsuarioTextArea = textarea(app.figure);
    app.UsuarioTextArea.Position = [276 252 150 27];

% create UsuarioTextArealabel
    app.UsuarioTextArealabel = label (app.figure);
    app.UsuarioTextArealabel.HorizontalAlignment = 'right';
    app.UsuarioTextArealabel.FontSize = 18;
    app.UsuarioTextArealabel.Position = [206 160 55 23];
    app.UsuarioTextArealabel.Text = 'Email:';
```

(a)

```
% Components initialization
  methods (Access = private)
% Create Figure and components
  function CreateComponents(app)
% Create Figure and hide until all components are Create
   app.Figure = figure ('visible','off');
   app.Figure.Position = [100 100 640 480];
   app.Figure.Name = 'ENVIRONMENT APP  ';
% Create image
    app.image = image (app.figure);
    app.image.Position = [271 292 100 100];

% create UserTextArealabel
    app.UserTextArealabel = label (app.figure);
    app.UserTextArealabel.HorizontalAlignment = 'right';
    app.UserTextArealabel.FontSize = 18;
    app.UserTextArealabel.Position = [213 228 48 23];
    app.UserTextArealabel.Text = 'User:';

% Create UserTextArea
    app.UserTextArea = image (app.figure);
    app.UserTextArea.Position = [276 226 150 27];

% create UserTextArealabel_2
    app.UsuarioTextArealabel_2= textarea(app.figure);
    app.UsuarioTextArea.Position = [276 206 150 27];
    app.UsuarioTextArealabel_2 = label (app.figure);
    app.UsuarioTextArealabel_2.HorizontalAlignment = 'right';
    app.UsuarioTextArealabel_2.FontSize = 18;
    app.UsuarioTextArealabel_2.Position = [172 182 89 23];
    app.UsuarioTextArealabel_2.Text = 'Password:';
% Create UsuarioTextArealabel_2
    app.UsuarioTextArealabel_2= image (app.figure);
    app.UsuarioTextArealabel_2.Position = [276 180 150 27];

% create LoginButton
    app.LoginButton = button(app.figure, 'push');
    app.LoginButton.BackgroudColor = [0.651 0.651 0.651];
    app.LoginButton.FontSize = 18;77;
    app.LoginButton.FontColor = [1 1 1];
    app.LoginButton.Position = [271 72 100 30];
    app.LoginButton.Text ='Login';
     end
end
```

(b)

Figure 6. Mobile APP: (a) code to register and (b) login code

```
% Create Figure and components
   function CreateComponents(app)
% Create Figure and hide until all components are Create
    app.Figure = figure ('visible','off');
    app.Figure.Position = [100 100 640 480];
    app.Figure.Name = 'ENVIRONMENT APP  ';
% Create image
    app.image = image (app.figure);
    app.image.Position = [239 242 164 141];

% create ReportLabel
    app.ReportLabel = label(app.figure);
    app.ReportLabel.FontSize = 18;
    app.ReportLabel.Position = [282 409 59 23];
    app.ReportLabel.Text = 'Report';

% create LimaCheckBox
    app.LimaCheckBox = checkbox(app.figure);
    app.LimaCheckBox.Text = 'Lima';
    app.LimaCheckBox.Position = [249 159 65 22];

% create CareEnvironmentLabel
    app.CareEnvironmentLabel = label(app.figure);
    app.CareEnvironmentLabel.FontSize =14;
    app.CareEnvironmentLabel.Position = [2499 197 60 22];
    app.CareEnvironmentLabel.Text = 'CareEnvironment';

app.figure.visible = 'on';
    end
end
```

Figure 7. Coding reports

Table 2. Questions regarding the mobile APP

No	Survey questions
1	Do you find this environmental APP useful?
2	Would you recommend this mobile APP?
3	Do you think this mobile APP will help reduce pollution?
4	Should there be constant training for the use of this mobile APP?

3 RESULTS AND DISCUSSION

3.1. Regarding the interview

In the interview carried out, 4 dimensions were considered (see Figure 8 and Table 1). These dimensions are awareness, environmental impact, environmental education, and mobile APP. The answers are provided by people who represent each district, such as independencia, San Martin de Porres, Olivos, Comas, Carabayllo, and Puente Piedra, and were analyzed by said dimension. In addition, the ATLAS.ti 22 software was used for the analysis of this part of the investigation using a qualitative method. Figure 9 shows the interview was conducted in a systematic way. Regarding the dimension of environmental awareness, practices such as recycling start at home, then are complemented by the school, and end with the college.
In the district you live in, do people have awareness of the environment?

(...) *People do not teach their children about respect of not throwing garbage anywhere, they do not talk to their children about pollution and how severe the consequences are if they do not take care of the environment* (....).

The population must teach, starting at home, not to litter and become aware that if the rules are respected, pollution decreases. Along the same lines, this study agrees with Alfahid *et al.* [6], who emphasizes that the environmental awareness issue is not only about children but also adults. Likewise, Kee *et al.* [9] states that campaigns must be carried out constantly in the community. But also, these campaigns are a strategy that must be carried out wherever you are. For this, the authorities must prioritize activities to raise environmental awareness and share this through all types of media.
What is the impact of pollution on society?

(…) *The environmental impact has increased in all countries; this will depend on the laws that are made in each country. These laws must be supported and disseminated through television, and newspapers, among others. The dissemination must be massive in schools, and companies* (…).

Regarding the environmental impact dimension, in the interview, in its entirety, they answered that it is very high in all parts of the world. In addition, the environmental impact keeps increasing every time people do not respect the standards established in different cities. In this sense, Thibuy *et al.* [12] states that the population is not prepared to properly dispose of solid waste. There should be training programs and carry out periodic campaigns. Likewise, Ramos-Romero *et al.* [8] relied on the use of technology to reduce pollution. These technologies are generally used by young people since adults do not master their use in depth.
Is pollution taught in school?

(…) *The schools rather have more academic courses than culture, civic, and environmental courses (...). The ministry of education and environment must define how environmental culture should be promoted with clear guidelines* (…).

The educational curriculum includes the environmental aspect; but they do not put it into practice, it remains only in theory. The ministry of the environment must coordinate with the ministry of education regarding how to teach environmental culture, which people should have been taught since childhood. In this sense, Thibuy *et al.* [12] says that one way to promote that environmental culture is by teaching and motivating regarding what should and should not be done to contribute to the improvement of the environment.
Can a mobile APP raise awareness of taking care of the environment?

The mobile APP dimension is a complement that allows optimizing the processes, activities, and tasks that must be carried out to reduce the environmental impact. That is why training is important, mostly for the elderly. The mobile APP must be user-friendly so that users do not have much difficulty while using it.

(…) *We older adults struggle to master the use of mobile phones. There should be a workshop or training to make it easier to use the mobile device* (...). (...) *They must spread the different ways to reduce pollution (…)*

The use of mobile APPs is mainly dominated by children and young people more than adults. For this reason, they must get training with a didact method for a better understanding of its use. The design must be validated by experts to ensure that its use would be significant. The authors [6] created a mobile APP to reduce pollution, but it was done differently from this study as it was done through games. However, the mobile APP through games is limited to children as there were no strategies applied for adults. Also, the authors [12] applied the rewards strategy where people can accumulate points in the mobile APP. This strategy is conditional on rewards but has not raised awareness on its own.

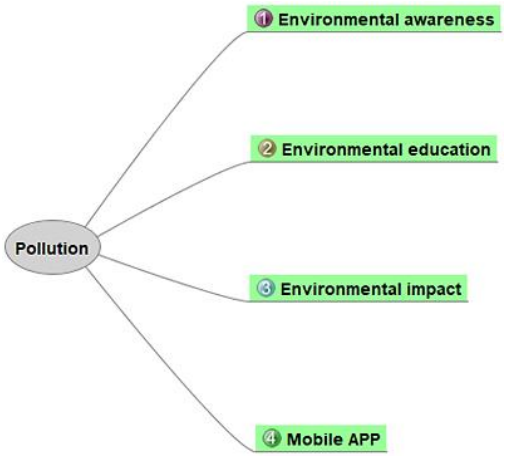


Figure 8. Pollution and its dimensions

3.2. Regarding the survey

In the survey carried out, the highest percentage, 89% believe that using the APP would help reduce environmental pollution. In addition, 55%, which is the lowest percentage of the four questions, answered that they would recommend the use of the mobile APP. In general, it is observed that all users are satisfied with the prototype of the mobile APP (see Figure 10).

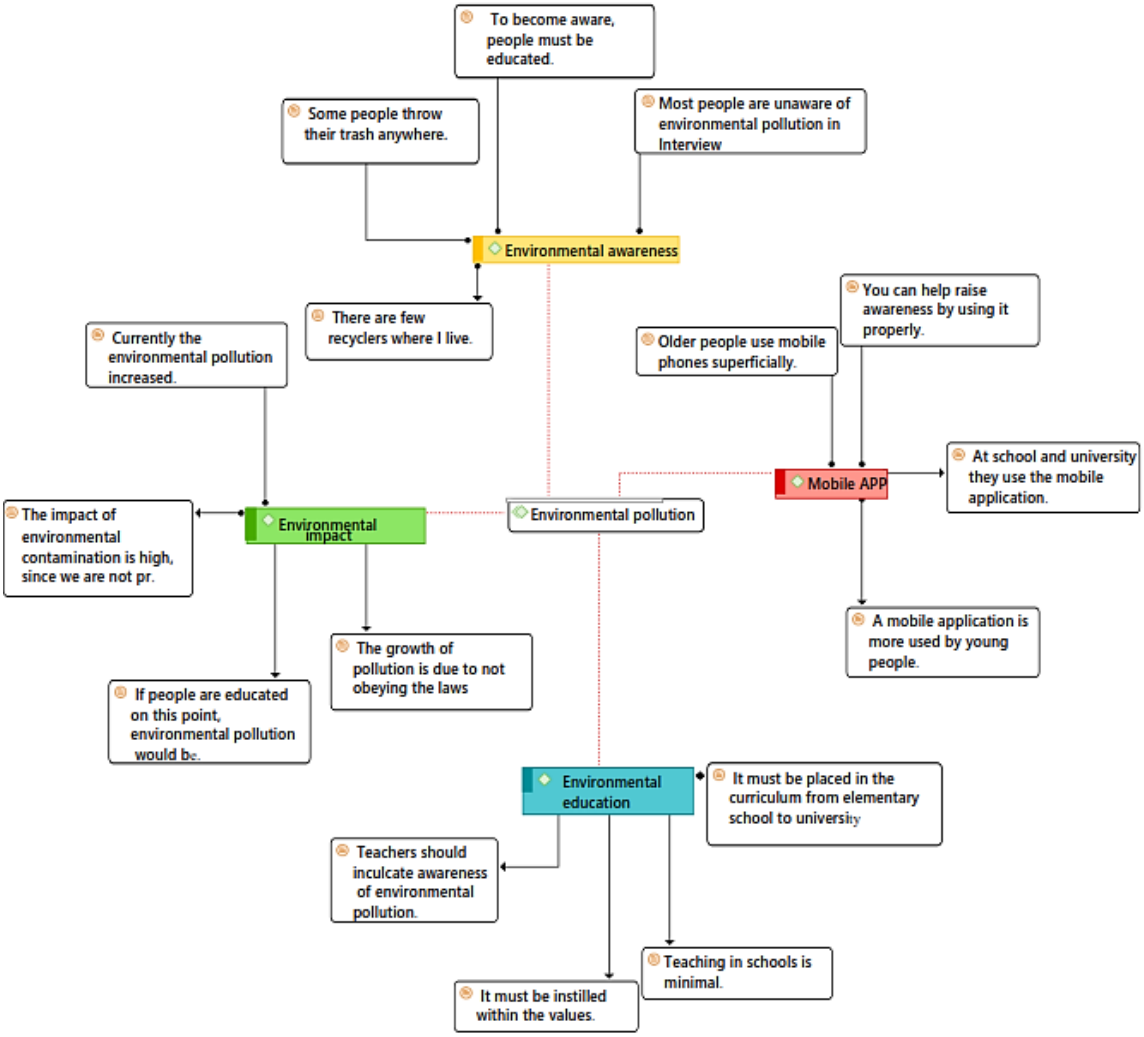


Figure 9. Interview regarding pollution

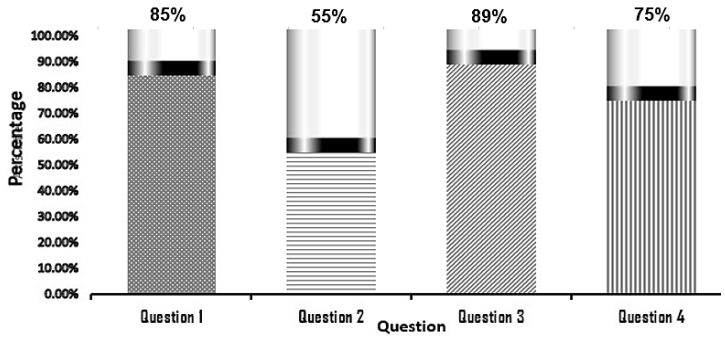


Figure 10. Results of the survey regarding pollution

3.3. Validation through expert judgment

Validation by experts (E) was carried out with a semantic differential scale from 1 to 10. For this, a scale was used where 1 represented very low and 10 represented very high; placing an equivalence that 1 represents 10%. In Table 3 were placed the percentage values for each expert and for attributes, obtaining the highest average of the experts of 92.5% and the lowest of 72.5%. Regarding the average of attributes, the highest value was 83% for its consistency and integration, and the lowest was 81% for its functionality.

Table 3. Validation by expert judgment

Attributes	E1 (%)	E2 (%)	E3 (%)	E4 (%)	E5 (%)	E6 (%)	E7 (%)	E8 (%)	E9 (%)	E10 (%)	Total (%)
Functionality	80	90	70	80	90	80	70	80	80	90	81
Usability	70	90	70	80	80	70	90	100	80	90	82
Consistency	90	80	80	70	80	90	80	90	80	90	83
Integration	80	70	70	80	90	80	80	90	90	100	83
Total	80	82.5	72.5	77.5	85	80	80	90	82.5	92.5	

4 CONCLUSION

As a result of the qualitative method, through the interview, people asked the authorities to make adequate strategies in the educational and environmental fields. In addition, raising environmental awareness must start at home. For this, parents must have an environmental culture so that they can share it with their children. Then, the teachers and professors must promote the practice of environmental values in school and college, such as the proper disposal of solid waste, among others; also, the authorities of the ministries of education and environment should promote this. In addition, the mobile APP must be used as a complement, which helps reduce the environmental impact. In the quantitative part of this study, it stands out that, in order to use the mobile APP, the users must get training; likewise, users are satisfied with the design of the mobile APP. Said mobile APP was validated by an expert judgment, having the approval in all its criteria. A limitation that was found in the study is that it could not be developed for all the districts of Lima due to economic reasons such as human resources cost. It is suggested for a future study the use of emerging technologies such as augmented reality, and the IoT, among others.

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