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ANALYSIS TOOLS FOR SOFTWARE DEVELOPMENT

Cristy Elizabeth Aguilar Ojeda
Tecnológico Nacional de México / ITS del Occidente del Estado de Hidalgo
Mixquiahuala de Juárez, Hidalgo
https://orcid.org/0000-0002-6814-6378

Lorena Mendoza Guzmán
Tecnológico Nacional de México / ITS del Occidente del Estado de Hidalgo
Mixquiahuala de Juárez, Hidalgo
https://orcid.org/0009-0005-7802-6352

Talhia Heidi Hernández Omaña
Tecnológico Nacional de México / ITS del Occidente del Estado de Hidalgo
Mixquiahuala de Juárez, Hidalgo
https://orcid.org/0000-0002-3048-8102

Abstract: In addition to the educational programs, higher education institutions provide complementary services that facilitate school activities, such as printing services, which are essential for the delivery of work and documentation necessary for the development of skills. Currently, the institute only offers this service in one of its nine buildings, serving an enrollment of 2,579 students, as well as teaching and administrative staff. Given the high demand, it is necessary to optimize resources and time to speed up the printing process. Therefore, there is a need to develop a mobile application managed through the telecommunications network. This application would allow the management of printing charges and would control both the users, through a login, and the files to be printed. The article aims to provide an overview of data collection techniques used in mobile application development. Modern mobile applications collect large amounts of valuable data that help developers to better understand users and improve their experience. Passive data collection techniques, which do not require user intervention, are discussed first. These include event logging, which captures interactions with the application and provides information on usage patterns, session duration and actions taken, as well as error logs and performance metrics that identify technical issues and improve overall performance. In addition, active data collection techniques are discussed, which require direct user participation, such as in-application surveys and questionnaires that collect demographic information, preferences, and feedback on the user experience. Usability testing, where users perform specific tasks in the application and their interactions and comments are recorded, is also mentioned. Contextualized data collection techniques that use sensors and mobile device features to obtain additional data such as geographic location, device movement, light level, and social network connectivity are discussed. These techniques enrich the understanding of user behavior and enable more effective personalization of the app experience. It also highlights ethical and privacy considerations in data collection, stressing the importance of obtaining informed consent and adequately protecting and anonymizing the data collected.
Keywords: Mobile application, Data, Printing, Collection, Software

INTRODUCTION

In today's digital age, mobile applications have transformed the way we interact with technology and the world around us. From social networking to productivity and health apps, these tools have become an integral part of our daily lives. However, behind every successful app is a vast set of data that allows developers to better understand users and improve the user experience. Data collection has become critical in mobile app development, as it provides valuable insights into usage patterns, user preferences, and areas for improvement. In this article, we explore in detail the various data collection techniques used in mobile application development, highlighting both passive and active methodologies.

Initially, passive data collection techniques, which are carried out without active user intervention, include event logging, which captures user interaction with the application and provides information about the flow of usage, actions performed and duration of sessions. In addition, we will discuss error logs and performance metrics, which are critical for identifying technical problems and optimizing the overall performance of the application. Active data collection techniques involve direct user participation, this may include the implementation of in-application surveys and questionnaires, which allow for

the collection of demographic information, preferences and feedback on the user experience. Usability testing, in which users perform specific tasks in the application while their interactions are recorded and feedback is collected, is also considered. In addition to passive and active techniques, contextualized data collection techniques, which leverage sensors and mobile device functionalities to collect additional information may include geographic location, device movement, light level, and social network connectivity, among others. Intelligent use of this data enriches the understanding of user behavior and allows the app experience to be personalized more effectively.

In this context, the applications available in the PlayStore that offer printing services were analyzed in order to identify areas of opportunity and analyze the existing services; on the other hand, a data collection instrument (survey) was designed and applied to determine the relevance of developing a mobile application, specific to the institution, to manage the printing process and control the charging of the service.

Mobile printing is an important technology for improving the productivity and profitability of service operations, enhancing the effectiveness of automation efforts and optimizing human and economic resources. In addition, it provides a rapid return on investment by increasing the responsiveness, customer service and efficiency improvements of the programs you use to deliver service to users. This service increases user confidence and loyalty, helping to optimize time, costs and infrastructure when a teacher or student needs to print a document.

The purpose of this article arises from the need to provide the institution the opportunity to improve its processes and streamline its activities with the implementation of technologies that optimize the use of printing system that the institution has to meet the needs, a previous research has been conducted on the type of devices that are suitable for mobile application of printing such as: printers, network, multifunction, copiers, etc., with this study data, a proposal can be presented that meets the needs provided by the quality printing service, with the necessary consumptions, locating the right type of devices in each space in a more rational way and with an effective distribution. It is important to highlight the importance of addressing the ethical and privacy considerations associated with data collection in mobile applications as it is crucial to obtain informed consent from users and to adequately protect the data collected, ensuring confidentiality and anonymization when necessary.

DEVELOPMENT

Currently there are many applications that have been developed to solve problems related to remote access and control of daily activities performed by human beings. *Cloud computing* has become one of the most important trends for sharing and distributing information through remote access and/or in real time using the Internet as an essential means to make these developments work optimally.

There are mobile applications that use telecommunications systems and internet services to provide ease and accessibility to resources that facilitate the development of tasks; as is the case of educational activities that every day must be solved with efficiency and speed in addition to an affordable cost; for example, the printing of files generated in activities such as homework, jobs, etc., involve time and money for the delivery of each of them, which is why it is necessary to make improvements to optimize the process.

In the case of mobile applications aimed at satisfying this type of needs, it has been found that most of them are developed on the

Android platform, which corresponds to the most widely used technology in the market. Among which the following stand out:

- Google Could Print. Application that allows printing from the mobile device accepting documents, contacts, web pages, text messages, emails, attachments, etc. (Google, 2023).
- Easy Print. Allows you to manage printers and print jobs, and print documents and e-mails (Microsoft, 2023).
- Mobile Print. Developed by the Samsung company, it ensures printing of files, web pages, images, calendar events, contacts, text messages, emails, has options to choose paper size, orientation, copies, color, type of file to be printed. (MobileDynamix, 2023).
- PrintJinni. Application that prints any file and allows pre-visualization before printing, not available in Mexico (Thinxtream, 2023).

It is clear that the applications satisfy basic printing needs for users, but do not control the monitoring of files and payment for the service.

GENERAL OBJECTIVE

Describe the data collection techniques used in mobile application development to understand and improve the user experience.

SPECIFIC OBJECTIVES

- Describe, explore and analyze passive, active and contextualized data collection techniques used in mobile application development.
- Explain and understand how passive, active and contextualized data collection techniques work and their usefulness in mobile application development.
- Evaluate the application of passive, active and contextualized data collection techniques in the development of a mobile application, identifying the benefits and limitations of their implementation.
- Design and develop surveys and questionnaires to collect active data from users to improve understanding of their preferences and needs.
- Apply contextualized data collection techniques in a mobile application, using sensors and device features to enrich the user experience and personalize the application.

OBJECT OF STUDY

The object of study of this article is the application of data collection techniques for the development of a mobile application aimed specifically at students and staff of the institution. It describes the various techniques used to collect relevant data about students and staff, their needs and preferences, with the aim of improving the academic experience and student performance and administrative activities through the mobile application.

The importance of the object of study of this article lies in the need to adapt and improve mobile applications to the particularities and specific needs of those who integrate the technological. University students and administrative staff face unique academic challenges and require tools and resources that provide effective support in their learning process. By describing data collection techniques, we seek to obtain valuable information about their preferences, needs and behaviors in order to personalize the application and provide them with a more effective academic experience. By understanding their usage patterns, interests and difficulties, specific features and functionalities can be designed to help them

better manage their time, access relevant resources, improve their productivity and foster their engagement with learning. In addition, the development of a mobile application focused on university students and their staff can facilitate communication and interaction among them and with the institution. It can provide quick access to institutional information, class calendars, important notifications, as well as academic support resources and services such as printing. This not only enhances the student experience, but can also contribute to increased student participation and engagement with the technology.

METHODOLOGY

The mixed methodology combines quantitative approaches, which focus on numerical and statistical data collection, with qualitative approaches, which focus on understanding and interpreting the data in context. When describing data collection techniques for mobile application development, it is necessary to consider both objective and subjective aspects of the user experience. The mixed methodology allows objective data to be collected by collecting quantitative metrics, such as operating system, user retention rate, and time spent using the application. At the same time, it allows obtaining qualitative information by conducting interviews and surveys, which provides a deeper understanding of users' perceptions, opinions and needs. Likewise, the mixed methodology allows for data triangulation, which implies the convergence and comparison of results obtained from different sources and methods. By using multiple data collection approaches, a more complete picture can be obtained. This strengthens the validity and reliability of the results, while providing a broad and contextualized view of the problems studied.

PASSIVE DATA COLLECTION TECHNIQUES

Passive data collection techniques are carried out without the active intervention of the user. These techniques are essential for understanding user behavior and optimizing application performance. One of the most commonly used techniques is event logging. This technique consists of capturing the user's interaction with the application, recording actions such as clicks, scrolls and response times. These event logs provide detailed information about usage patterns, session duration and most used functions, allowing developers to make informed decisions about improving the user interface and optimizing the flow of the application.

In addition to event logging, error logs and performance metrics are also used to improve the quality of the application. Error logs help to identify and fix technical problems, while performance metrics help to evaluate the overall performance of the application, such as screen loading speed and resource consumption. This passive data is valuable to developers, as it provides them with objective information about the application's performance and stability, allowing them to make improvements and corrections based on the data collected.

ACTIVE DATA COLLECTION TECHNIQUES

Unlike passive techniques, active data collection techniques require the direct participation of the user. These techniques provide a deeper understanding of the user's preferences, needs and opinions. One commonly used technique is the implementation of surveys and questionnaires within the application. These surveys can collect demographic information, such as age, gender, and location, as well as preferences and feedback about the user experience. The

responses obtained from surveys can help developers tailor the application to the specific needs of users and identify potential areas for improvement.

Another active technique is usability testing. In these tests, selected users perform specific tasks within the application while their interactions are recorded and their feedback is collected. These tests provide valuable information about the usability, intuitive navigation and effectiveness of the application's functions. The results of usability testing allow developers to identify obstacles or problems in the user experience and make necessary adjustments to improve it.

CONTEXTUALIZED DATA COLLECTION TECHNIQUES

In addition to passive and active techniques, contextualized data collection techniques leverage the capabilities of the mobile device to collect additional information. Device sensors, such as GPS, accelerometer and gyroscope, enable the collection of relevant contextual data. For example, geographic location can help personalize the user experience based on location, offering localized information or proximity-based services. Device motion can be used to detect actions such as shaking the phone or turning it, which can trigger specific functions within the app. In addition, ambient light level or social network connectivity can also be considered as useful contextual data to enhance the user experience.

Contextual data collection gives developers a more complete view of the environment in which users interact with the application. This allows them to tailor the application more precisely to the user's needs and preferences, creating a personalized and relevant experience.

PHASES OF DEVELOPMENT

In order to identify and know the needs and/or preferences of the users, a contextualized data collection instrument was designed and applied, which was only provided to users of the Computer Systems Engineering careers; the methodology used to obtain the aforementioned information is detailed below:

1.- Design of the data collection instrument. In this first stage, a survey was generated that included questions to identify the period of the semester in which most printing is done, the average time of service, printing preferences, among other key questions. Figure 1 corresponds to the instrument designed.

2.- Sample calculation. Considering a population of 540 users including students, teachers and administrative personnel, within the Computer Systems Engineering career, and applying equation 1, a sample of 224.71 was obtained, considering a confidence level of 95% and a margin of error of 5%.

$$n = \frac{N \cdot Z^2 \cdot p \cdot (1-p)}{(N-1) \cdot e^2 + Z^2 \cdot p \cdot (1-p)}$$

Equation 1. Formula to calculate sample (Hernández Sampieri & al, 2024)

Where

n = Sample size to be calculated

N = Population size

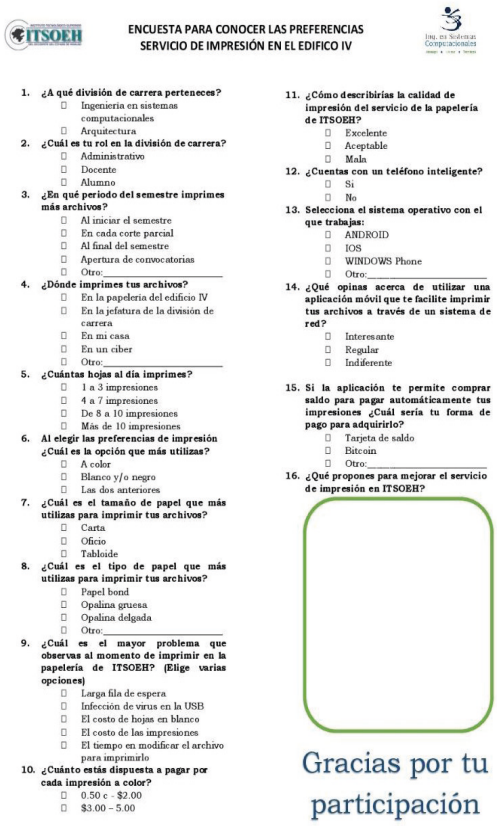
Z = Deviation from the mean value,

e = Maximum margin of error that I admit

p = Proportion expected to be found

3.- Application of the instrument. During this stage, 225 surveys were applied to users through printed forms that were delivered to students, teachers and administrators of the aforementioned careers.

4.- Analysis of results. Office tools were used to analyze the data found in the application of the instrument.



ITSOEH

ENCUESTA PARA CONOCER LAS PREFERENCIAS SERVICIO DE IMPRESIÓN EN EL EDIFICO IV

Ing. en Sistemas Computacionales

1. ¿A qué división de carrera perteneces?
   - ☐ Ingeniería en sistemas computacionales
   - ☐ Arquitectura
2. ¿Cuál es tu rol en la división de carrera?
   - ☐ Administrativo
   - ☐ Docente
   - ☐ Alumno
3. ¿En qué periodo del semestre imprimes más archivos?
   - ☐ Al iniciar el semestre
   - ☐ En cada corte parcial
   - ☐ Al final del semestre
   - ☐ Apertura de convocatorias
   - ☐ Otro:_____
4. ¿Dónde imprimes tus archivos?
   - ☐ En la papelería del edificio IV
   - ☐ En la jefatura de la división de carrera
   - ☐ En mi casa
   - ☐ En un ciber
   - ☐ Otro:_____
5. ¿Cuántas hojas al día imprimes?
   - ☐ 1 a 3 impresiones
   - ☐ 4 a 7 impresiones
   - ☐ De 8 a 10 impresiones
   - ☐ Más de 10 impresiones
6. Al elegir las preferencias de impresión ¿Cuál es la opción que más utilizas?
   - ☐ A color
   - ☐ Blanco y/o negro
   - ☐ Las dos anteriores
7. ¿Cuál es el tamaño de papel que más utilizas para imprimir tus archivos?
   - ☐ Carta
   - ☐ Oficio
   - ☐ Tabloide
8. ¿Cuál es el tipo de papel que más utilizas para imprimir tus archivos?
   - ☐ Papel bond
   - ☐ Opalina gruesa
   - ☐ Opalina delgada
   - ☐ Otro:_____
9. ¿Cuál es el mayor problema que observas al momento de imprimir en la papelería de ITSOEH? (Elige varias opciones)
   - ☐ Larga fila de espera
   - ☐ Infección de virus en la USB
   - ☐ El costo de hojas en blanco
   - ☐ El costo de las impresiones
   - ☐ El tiempo en modificar el archivo para imprimirlo
10. ¿Cuánto estás dispuesta a pagar por cada impresión a color?
    - ☐ 0.50 c - $2.00
    - ☐ $3.00 – 5.00
11. ¿Cómo describirías la calidad de impresión del servicio de la papelería de ITSOEH?
    - ☐ Excelente
    - ☐ Aceptable
    - ☐ Mala
12. ¿Cuentas con un teléfono inteligente?
    - ☐ Si
    - ☐ No
13. Selecciona el sistema operativo con el que trabajas:
    - ☐ ANDROID
    - ☐ IOS
    - ☐ WINDOWS Phone
    - ☐ Otro:_____
14. ¿Qué opinas acerca de utilizar una aplicación móvil que te facilite imprimir tus archivos a través de un sistema de red?
    - ☐ Interesante
    - ☐ Regular
    - ☐ Indiferente
15. Si la aplicación te permite comprar saldo para pagar automáticamente tus impresiones ¿Cuál sería tu forma de pago para adquirirlo?
    - ☐ Tarjeta de saldo
    - ☐ Bitcoin
    - ☐ Otro:_____
16. ¿Qué propones para mejorar el servicio de impresión en ITSOEH?

Gracias por tu participación

RESULTS AND DISCUSSION

Of the 225 surveys applied, 89% corresponded to students, 10% to teaching staff and the remaining 1% to administrative staff. As shown in the results presented in Table 1, among the data that stood out the most, it was found that the periods where the printing service is used the most correspond to each partial break and at the end of the semester, with 110 and 60 occurrences by students, while for the staff it was 13 and 9, respectively. The results showed that the most frequented places for the printing process correspond to building IV, which includes the stationery store and the career division, with 131 responses.

It was pointed out that the main problems involved in the printing service are excessive waiting time, the cost of service, and finally, damage to electronic files through viruses. Respondents argued that the means to improve service would be to increase the number of computer access and reduce the cost of printing.

Ask	Response options	No. Occurrences	
		Students	Staff
Printing period	At the beginning of the semester	25	4
	In each partial cut	110	13
	End of semester	60	9
	Opening of calls for proposals	0	0
	Other: all semester	13	2
Place of printing	Stationery building IV	131	12
	Career Division	2	14
	Cyber	33	9
Printing problems	Weather	165	8
	Virus infection	100	7
	Cost	147	6
Service improvements	Increase computers	14	2
	Reduce cost	20	2

Table 1. Number of occurrences per question with multiple-choice answers

Continuing with the analysis of requirements identification, it was found that the quality of the current printing service is considered "bad", with 62% for students and 92% for staff, so one of the questions about the possible solution would be to have an application that automates and improves the process, in addition to controlling its cost, so 79% of students and 100% of staff showed interest in the proposal. Finally, it was discovered that 76% of the student enrollment has a smartphone with Android operating system, which gives a guideline to use it as a platform for the development of the project.

Ask	Response options	Percentage	
		Students	Staff
Quality of service	Excellent	16%	8%
	Acceptable	22%	0
	Malo	62%	92%
App review	Interesting	79%	100%
	Regular	16%	0
	Indifferent	5%	0
Operating system	Android	76%	60%
	Ios	13%	32%
	Another	11%	8%

Table 2. Response rates by specific questions

CONCLUSIONS

During this stage of data collection and information analysis, it was detected that the respondents are not satisfied with the printing service provided by the Institute and that among the alternative solutions proposed, the increase in the number of devices to use the service and a gradual decrease in the cost stand out, since the intense printing periods are carried out during the evaluation of each midterm for both students and staff; In addition, it was identified that the problem lies in the waiting time and damage to storage devices that are exposed to malicious files (viruses) because the equipment providing the service is not protected.

In addition, it was agreed that the means to solve the problems that affect the quality of the printing service is through the development and implementation of a technological tool to manage the files and the cost of the same; and that said tool should guarantee that during the identified periods the printing process is expedited.

Finally, the application that will be developed to solve the problem raised will be through the Android platform in order to provide users with a user-friendly interface and easy access.

REFERENCES

Google. (2023). *Google.es.* Obtenido de www.google.es/landing/cloudprint/

Hernández Sampieri, R., & al, e. (2023). *Metodología de la Investigación.* 4ta edición.

Microsoft. (2017). *Technet.Microsoft.* Obtenido de www.technet.microsoft.com/es-es/library/ff5191999(v=ws.10).aspx

MobileDynamix. (20 de abril de 2023). *GooglePlay.* Obtenido de www.play.google.com/store/apps/details?id=com.dynamixsoftware.printershare

PrintJinni. (s.f.). Obtenido de http://www.printjinni.com/

Thinxtream, T. (21 de Noviembre de 2022). *PrintJinni.* Obtenido de www.printjinni.com