NFC Solutions for Purchasing Public Transport Tickets at Babahoyo Terrestrial Terminal

Soluciones NFC para la Compra de Boletos de Transporte Público en la Terminal Terrestre de Babahoyo

José Rosado Anzules[1,*], Wander Lindao Uchubanda[1,†], Angel Villagomez Gurumendi[1,‡],
and Nelly Esparza Cruz[1,⊗]

[1]Universidad Técnica de Babahoyo.
{jrosadoa002;lindaou890;avillagomezg923;nesparza}@utb.edu.ec

Abstract—**Buying tickets at the Babahoyo terrestrial terminal can become a slow process, causing delays and costs for users to queue to be able to mobilize to the different destinations on offer. The objective of the project is to demonstrate the feasibility of using the computer system that implements NFC technology through mobile phones and smart cards that allow to speed up the purchase process, all for frequent travelers who must use this service. The data presented in this article were obtained through an exploratory study of qualitative and quantitative nature. The people who participated in the study were the users of the Babahoyo terrestrial terminal transport, who answered questions to determine their level of acceptance to a computer system using NFC technologies and the results determined that a large majority were available to use telephones and smart card readers. About 90 % of respondents believe that the software will have a positive impact on the ticketing process at the Babahoyo terrestrial terminal. Even in the country, the advantages of NFC have not been seen, however, it is expected that by 2018 will have a high impact by the use of applications that make use of the benefits provided by this technology. NFC technology emerged about 15 years ago, however, in Ecuador has not yet become popular the use of it.**

Keywords—**NFC, Mobile payments, IOT, Tags, RFID.**

Resumen—**La compra de boletos en el terminal terrestre de Babahoyo puede convertirse en un proceso lento, que genera pérdidas de tiempos y molestias a los usuarios que diariamente deben realizar largas filas para poderse movilizar hacia los diferentes destinos que se ofertan. El objetivo del proyecto es demostrar la factibilidad de usar un sistema informático que implemente la tecnología NFC a través de teléfonos móviles y tarjetas inteligentes que permita agilizar el proceso de compra, sobre todo para los viajeros frecuentes que diariamente deben usar este servicio. Los datos presentados en este artículo fueron obtenidos a través de un estudio exploratorio de carácter cualitativo y cuantitativo. Las personas que participaron en el estudio fue una muestra de los usuarios de transporte del terminal terrestre de Babahoyo, los cuales respondieron preguntas para determinar su nivel de aceptación a un sistema informático que use tecnologías NFC y los resultados determinaron que una gran mayoría estaría dispuesto a usar teléfonos y lectores de tarjetas inteligentes. Alrededor de un 90 % de los encuestados cree que la aplicación informática propuesta tendrá un impacto positivo en el proceso de compra de boletos en el terminal terrestre de Babahoyo. Aun en el país las ventajas de NFC no se han visto, sin embargo, se prevé que para el 2018 se tenga un alto impacto mediante el uso de aplicaciones que hagan uso de los beneficios que provee esta tecnología. La tecnología NFC apareció hace aproximadamente unos 15 años, sin embargo, en Ecuador aún no se ha popularizado el uso de la misma.**

Palabras Clave—**NFC, Pagos móviles, IOT, Etiquetas, RFID.**

INTRODUCTION

The increase in the number of mobiles today nowadays gives much to talk about, and it can be observed that the percentage of use of the devices has increased greatly and will continue in the coming years at a global level. They allow the user to have at his finger-tips a technological tool that, in addition to providing communication and internet services, can become a secure and fast payment method. One of the places where crowds are crowded is the terrestrial terminal of the city of Babahoyo, which is why a survey was conducted to determine the problems that exist in ticket purchases by the window. It is necessary to make long queues and wait to go to their destination becoming an important part of daily life to travel through these spaces for those living outside the city. During the holidays this process is further complicated by the large influx of tourists.

Since 2014 Ecuador's government has been promoting the use of electronic money Grijalva Beltrán (2014) as a mechanism for financial inclusion in order to reduce poverty

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*Estudiante de Ingeniería en Sistemas.
†Estudiante de Ingeniería en Sistemas.
‡Estudiante de Ingeniería en Sistemas.
⊗Magister en Informática Empresarial.

and improve the economy, it is expected that users will use this card through the use of prepaid cards or mobile devices payment method. The implementation of this payment mechanism brings many benefits to the users of the same and can be an advantage for the implementation of a system of mobile charges when recharging the NFC cards.

With the emergence of new technologies Porto Solano et al. (2017) such as NFC (Near Field Communication), they are becoming strategic allies to solve problems related to mobile payments, analysts believe that NFC technology will be at 685 million smart phones. The most developed countries such as Spain, Germany, Japan, among others already use this new technology and are successful worldwide.

Although there is no exact translation into Spanish of this technology can be considered to be a communication between nearby fields. The devices involved in the communication process must be within a few centimeters. Depending on which device can start the communication we would talk about active NFC, the two devices would create their own electromagnetic field, in this case, both devices should have their own power supply, a battery or battery would be enough, or we could be talking about NFC passive, case in which we will focus to comment the experiences in several libraries.

In the passive NFC operating mode, only one of the two intervening parties can start the communication and it will be the one that can generate a low-frequency radio wave, operating at 13.56 MHz. When another device, which will be a simple card, sticker, poster (called all tags) containing a small antenna in the form of a spiral is close enough an inductive magnetic coupling is generated, by means of which a transfer of energy and da-ta can be performed between the devices, basic operation consists of forming a sufficient electric field to activate a chip that is in the tag that allows communication with the mobile device. The card has no external or internal power system, only the energy generated by the approximation of the inductive coupling that works only for very short distances. Precisely this is one of the factors that differentiate them with other technologies more extended and well-known like they are Bluetooth or Wi-Fi, where these work to maximum distances, approximate, of 10 meters and 100 meters respectively.

NFC technology has a maximum data rate Imbachi et al. (2015) of 424 Kbps, compared to 720 Kbps of Bluetooth and Wifi (up to a maximum of 1Gbit/s in 802.11ac). NFC is not the most suitable to move large amounts of information but is more secure than other technologies. Although NFC has not been designed to transfer information at high speeds, the pairing time between Bluetooth devices is five or six seconds, while NFC does this in 200ms which means it is much faster to make the link.

This work demonstrates the feasibility of implementing a ubiquitous NFC-based solution for the transportation sector, by applying a survey to the users of the terrestrial terminal of the city of Babahoyo.

NFC Advantages

The advantages of NFC technology Muñoz-Quintero et al. (2016) can be summarized as follows:

- It is safer to transfer data because of its short range, it is difficult to be intercepted by third parties.
- Communication between devices is quick and easy, it is enough to bring the devices closer without major configurations.
- It is possible to apply NFC technology in a wide variety of areas thanks to its three modes of operation: Read / Write, Point-to-Point and NFC Card Emulation.
- Its use for novice users is easy since it is not necessary that they have knowledge of NFC to use it.
- Has high compatibility with RFID infrastructure and smart cards.
- With the implementation of NFC technology in mobile phones, the benefits of mobile devices.
- NFC technology is considered as an Internet tool of things, being one of the most used options in the solutions that access the internet through mobile devices.

NFC Practical Applications

- Since its inception, NFC technology has been well received and numerous applications have been developed for mobile devices Muñoz-Quintero et al. (2016), among which we can mention:
- Mobile applications for payment systems, which link directly to banks to make payments using savings, current, credit and debit cards.
- Mobile payments and purchase of tickets in stores equipped with NFC sales systems, buy movie tickets, concerts, among others.
- Electronic keys, for opening and closing doors of hotels, offices, classrooms
- Identification, NFC technology for its ability to store information allows us to record personal information, business, pets, among others.
- Quick configuration of devices, it is possible to establish profiles for the phones, household temperature settings in home automation applications, among others.

Standards and Protocols

NFC technology is standardized and obeys protocols formulated by some organizations such as the NFC Forum, ISO / IEC, ECMA International. The most important protocols and standards of NFC technology Muñoz-Quintero et al. (2016) are:

- ISO / IEC 14443: Describes the parameters required to perform the communication between a proximity card and a proximity coupling device, in addition to determining the byte format.
- ISO 18092 (NFCIP-1) or ECMA 340: Defines NFC communication modes, modulation schemes, transfer rates, initialization schemes, and control mechanisms.
- ISO / IEC 21481 (NFCIP-2) or ECMA 352: Determines mechanisms for selecting the appropriate NFC communication mode.
- ISO / IEC 15963: Describes the use of the Radio Frequency Labels Identifier and the systems available for the identification of such tags.

- LLCP: A protocol that provides a link between two active devices enabled with NFC technology to perform the Point-to-Point operation mode.
- NDEF: Provides a standard format for data exchange between NFC devices.
- RTD: Specifies the format and conditions that data must meet to construct record types based on the NDEF format. It includes specifications for text registration, URI (Uniform Resource Identifier), data for smart posters, signatures and generic controls (Porto Solano et al., 2017).

RELATED WORK

The development of payment applications with NFC at the Latin American level is still starting unlike Europe, where solutions have been successfully implemented for some years. The following are the most relevant:

In October 2013, Gemalto (the world leader in digital security) implemented a comput-er-based solution in Hong Kong that allowed subscribers to make payments with NFC devices in retail stores, public transport, among others.

In December 2013, the financial institution la Caixa PYMES (2013) successfully launched its mobile payment services with NFC, the largest launch of such applications in Europe. In the same way, the Transport Consortium of the Community of Madrid Blázquez Susana (2014) at the end of 2013 implemented the payment with NFC in its transport credit cards, at the same time BBVA realized a collaboration agreement with Radioteléfono taxi to pay with NFC cards.

In 2014 the London metro accepted payments with NFC, being this city one of the first to implement in the public transport the form of payment without contact EMV and NFC.

In Latin America, three pilot projects were carried out at the end of 2013. In Rio de Janeiro, São Paulo, several mobile phone operators, together with technology providers, included Gemalto, which implemented this type of system in Asia. They implemented a pilot program that allows the use of NFC ticket systems for public transportation. A pi-lot project of the BAC Credomatic group using NFC technology was launched in Costa Rica.

We also found the implementation of systems with NFC technology in other areas, which are detailed below:

In Muñoz-Quintero et al. (2016) a new use of the NFC is addressed, it is proposed to integrate it into the video games to increase the purchase of the same according to the preferences of the users and the usability of the game. NFC technology has been implemented in video games to bring the mobile device or cards to unlock game content, challenge another player in multiplayer mode, or use the tag as a checkpoint.

In Porto Solano et al. (2017) it addresses the problem that exists in hospitals because of the lack of legibility of the medical prescription proposing a computer solution that through the use of NFC for the identification of patients assign the prescriptions and check them. Additionally with the implementation of NFC tags patients can receive faster care in health centers.

In Imbachi et al. (2015) a proposal for a mobile payment system using NFC technology under the Android operating system in Colombia is presented, the NFC offers advantages such as confidentiality, low costs, simplicity, speed. The majority of the population has an NFC mobile device has become a tool for making mobile payments. The solution is proposed for the agricultural sector, since the implementation of this system will reduce the complex and costly security, administrative payments, fraud, since operating as a mobile wallet gives them greater security by not carrying cash in their pockets.

RESEARCH METHOD

The types of research that were used in the present investigation were the bibliographical and field. We visited the terrestrial terminal of Babahoyo which daily receives approximately 2700 users as reported by the companies that offer the service, once applied the formula of the sample gives us as a result 348.

The formula used to obtain the sample was as follows:

$$n = N/((E)^2(N-1)+1) \qquad (1)$$

The questionnaire was developed to collect data from this inquiry using closed questions that allow simple and rapid tabulation. It should also be mentioned that the reliability and validity indicators were established by the authors of this research.

RESULTS AND DISCUSSIONS

Frente al potencial uso del software multimedia en primera etapa:

1. Do you have a mobile device with NFC technology to pay for tickets at the Babahoyo Terrestrial Terminal?

Table 1. Tabulation Question 1.

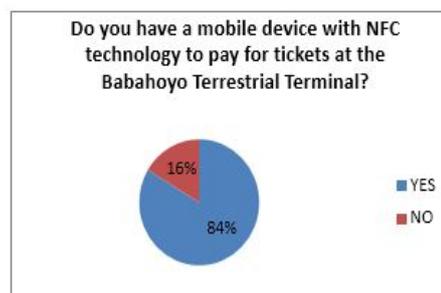| Variable	Frecuency	Percentage
Yes	291	84 %
No	57	16 %
Total	348	100 %

Source: Prepared by the authors.

Figure 1. Results Question 1.
Source: Prepared by the authors.

The vast majority have NFC technology has 84 % of the SI and 16 % of the NO because they do not have a mobile device with this technology.

2. Would you be willing to buy a card or device with NFC technology?

Table 2. Tabulation Question 2

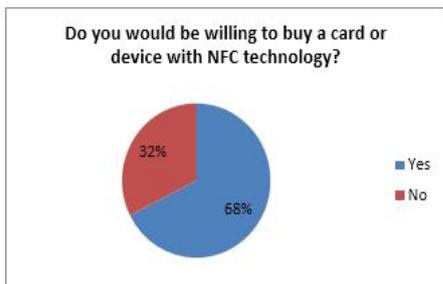| Variable	Frecuency	Percentage
Yes	235	68 %
No	113	32 %
Total	348	100 %

Source: Prepared by the authors.

Figure 2. Results Question 2
Source: Prepared by the authors.

Of the total respondents, 68 % consider it important to invest in NFC technology, and 32 % would not invest in NFC technology.

3. How is the attention at the Babahoyo Terrestrial Terminal?

Table 3. Tabulation Question 3

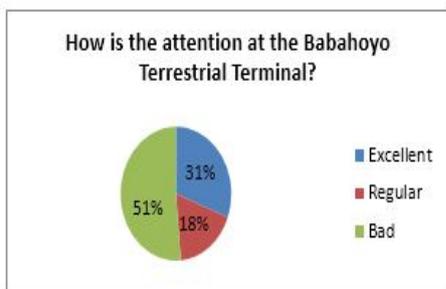| Variable	Frecuency	Percentage
Excellent	107	31 %
Regular	62	18 %
Bad	179	51 %
Total	348	100 %

Source: Prepared by the authors.

Figure 3. Results Question 3.
Source: Prepared by the authors.

According to the data collected, the vast majority of travelers consider that 31 % of them consider that the care is good, that in 18 % they change their care regularly and finally they consider that 51 % the attention is bad because they take a long time to be taken care.

4. Do you think using the NFC cards would improve the purchase of tickets at the Babahoyo Terrestrial Terminal?

Table 4. Tabulation Question 4

Variable	Frequency	Percentage
Yes	263	76 %
No	85	24 %
Total	348	100 %

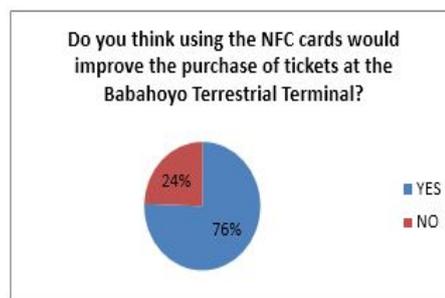**Source:** Prepared by the authors.

Figure 4. Results Question 4.
Source: Prepared by the authors.

A large majority of travelers, 76 % consider that the use of NFC technology would im-prove the purchase of tickets at the Babahoyo terrestrial terminal and 24 % of travelers believe that it would not improve.

5. Do you consider that using a mobile device as payment method decreases the large queues for the purchase of tickets?

Table 5. Tabulation Question 5

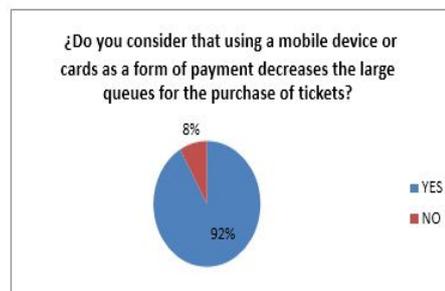| Variable	Frecuency	Percentage
Yes	319	92 %
No	29	8 %
Total	348	100 %

Source: Prepared by the authors.

Figure 5. Results Question 5.
Source: Prepared by the authors.

Of the total respondents, 92 % consider it important to use this NFC technology that would decrease waiting times when buying tickets, while 8 % do not consider the same.

6. What resource would you use to buy tickets at the Babahoyo Terrestrial Terminal?

Table 6. Tabulation Question 6

Variable	Frecuency	Percentage
Mobil Device	208	60 %
Cash	136	39 %
Credit Card	4	1 %

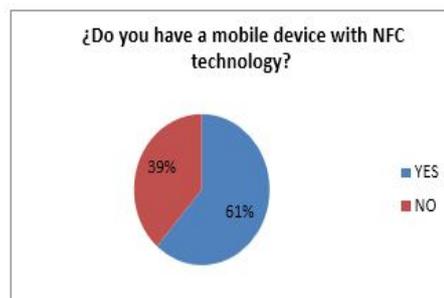**Source:** Prepared by the authors.
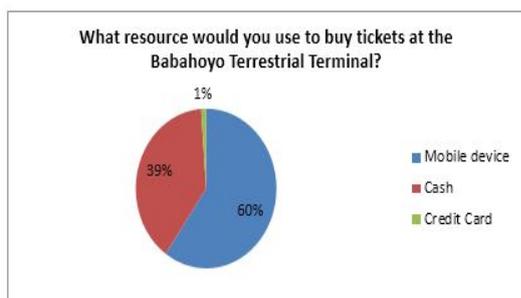
Figure 6. Results Question 6.
Source: Prepared by the authors.

The vast majority of respondents consider using a mobile device to buy tickets with 60 %, while 39 % would use money and finally 1 % believed to use credit cards.

7. Do you believe that there is a loss of time in the purchase of a ticket at the Babahoyo Terrestrial Terminal?

Table 7. Tabulation Question 7

Variable	Frecuency	Percentage
Yes	319	92 %
No	29	8 %
Total	348	100 %

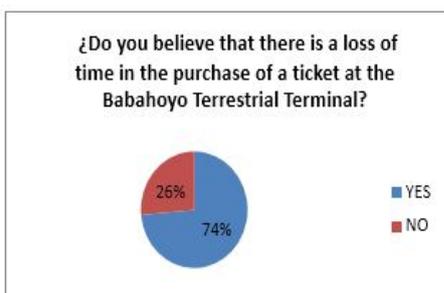**Source:** Prepared by the authors.

Figure 7. Results Question 7.
Source: Prepared by the authors.

8. ¿ Do you have a mobile device with NFC technology?

Table 8. Tabulation Question 8

Variable	Frecuency	Percentage
Yes	214	61 %
No	134	39 %
Total	348	100 %

Source: Prepared by the authors.

Figure 8. Results Question 8.
Source: Prepared by the authors.

According to the data collected, the vast majority of travelers with 84 % of them consid-er that they own 61 % of a mobile device and 39 % say they do not own a mobile device with NFC technology.

9. Would you agree to implement NFC technologies in the Babahoyo Terminal Terminal?

Table 9. Tabulation Question 9

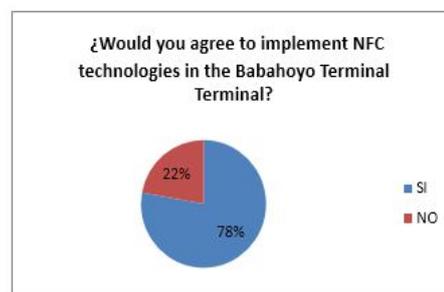| Variable	Frecuency	Percentage
Yes	271	78 %
No	77	22 %
Total	348	100 %

Source: Prepared by the authors.

Figure 9. Results Question 9.
Source: Prepared by the authors.

Of the total respondents, 78 % agree to implement NFC technology, 22 % consider not to agree since they do not use technology.

10. Do you think that implementing a computer system for the purchase of tickets with NFC technology would be of great benefit to travelers as many as provincial and inter-provincial?

Table 10. Tabulation Question 10

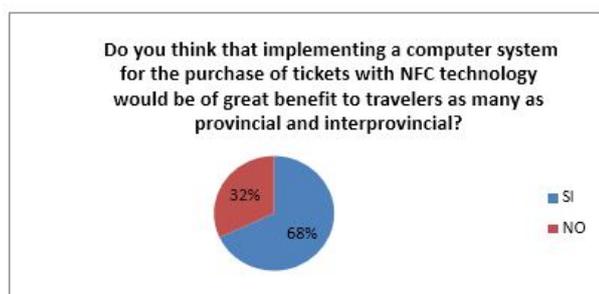| Variable	Frecuency	Percentage
Yes	237	68 %
No	111	32 %
Total	348	100 %

Source: Prepared by the authors.

Figure 10. Results Question 10.
Source: Prepared by the authors.

CONCLUSIONS

The implementation of a mobile payment system favors economic development, increases the profitability of businesses, reduces environmental pollution and reduces insecurity by not carrying cash.

The users of the Babahoyo land terminal are dissatisfied with the current manual ticketing system and expressed their willingness to use a computer system that implements the use of NFC technology to reduce ticket purchase and sale times.

The studies suggest that by 2019 eight out of ten smartphones will have NFC technology, which will mean that payments will be made with the mobile.

FUTURE WORK

In view of the positive results in the survey carried out to the users where the acceptance of implementing and using a computer application to speed up the purchase and sale of tickets at the Babahoyo terrestrial terminal is considered, it is planned to develop an architecture for NFC based systems in web services for devices with Android operating system.

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