

UNIVERSIDAD POLITÉCNICA DE MADRID

**ESCUELA TÉCNICA SUPERIOR
DE INGENIEROS DE TELECOMUNICACIÓN**



**GRADO EN INGENIERÍA DE TECNOLOGÍAS Y
SERVICIOS DE TELECOMUNICACIÓN**

TRABAJO FIN DE GRADO

**DESIGN OF A METHODOLOGY FOR THE
SELECTION OF MOBILE PAYMENT
TECHNOLOGIES IN DEVELOPING COUNTRIES**

IGNACIO ELVIRA CRUZ

2023

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Resumen

Las transacciones en efectivo se han reducido a un 25% del total en países como China, Canada o Corea del Sur. Esto significa que, por lo general, la gente ya no usa efectivo y la principal razón para esto es el auge de los pagos digitales. La mayoría de estas transacciones se realizan con tarjetas bancarias y con transferencias, sin embargo, en los últimos años han aparecido nuevos agentes que implementan pagos móviles y están consiguiendo un gran éxito. Debido a la aparición de un gran número de tecnologías diferentes para la realización de pagos móviles, aparece una complejidad añadida para seleccionar la tecnología más adecuada para cada escenario.

Aunque los pagos móviles están muy extendidos en varios países, hay aún muchas oportunidades para aprovecharlos en países en desarrollo debido al rápido crecimiento de estas tecnologías. Hay numerosas razones que explican por qué los pagos móviles son especialmente interesantes en países en desarrollo, como la rápida difusión de teléfonos móviles, la complejidad de bancarización en pequeñas comunidades, los bajos costes que conllevan los pagos móviles y la situación social y económica en estas regiones. Estas cuestiones se analizarán en profundidad y el principal objetivo es desarrollar una metodología para seleccionar la tecnología más apropiada para cada entorno.

En este documento se incluye una revisión de los pagos digitales en la actualidad, centrando el foco en los pagos móviles ya que son los responsables del significativo aumento en el uso de pagos digitales. Con el objetivo de implementar nuevos modelos de negocios en países en desarrollo usando pagos móviles, es necesario seleccionar la tecnología más adecuada debido a que por lo general no hay una aplicación dominante. Consecuentemente, una metodología para seleccionar la óptima es imprescindible por lo que, en este documento se diseñará dicha metodología general que pueda aplicarse a la mayoría de entornos. Finalmente, la metodología creada se aplicará en Panamá y en Perú, dos países en desarrollo de América Latina donde la Fundación Acciona.org está realizando un proyecto para extender el acceso a energía limpia. Para hacer esto, se analizará la situación actual de dichos países y la metodología propuesta se seguirá paso a paso hasta lograr seleccionar un único método de pago que se implementará en esos proyectos específicamente.

Palabras clave: Pagos móviles, revisión de alcance, factores, selección.

Abstract

Cash transactions have been reduced to 25% of the total in countries such as China, Canada and South Korea. People no longer use cash and the main reason for this is the rise of digital payments. Most of these transactions are made through the use of cards and transfers, however, in recent years new players have appeared around the world that implement mobile payments and are achieving great success. However, there are many different technologies and services using m-payments, and it is complex to select the most suitable one for each specific situation.

Although m-payments are quite common in many countries, there are still many opportunities to exploit them in developing countries due to the fast growth of these technologies. There are many reasons why m-payments are particularly interesting in developing countries, such as the great diffusion of mobile phones, the complexity of bancarization in small communities, the increased efficiency, the lower costs involved and the socio-economic conditions. This situation in developing countries will be analyzed in depth and the main objective of this work is to develop a methodology for selecting the most appropriate technology for each environment.

This research will provide an overview of digital payments current situation, focusing on mobile payments, as they are the main agents responsible for the significant increase in the use of digital payments. In order to implement new business models in developing countries using these technologies, it is necessary to select the most appropriate one, as there is usually no clearly dominant mobile payment application today. Consequently, a methodology for selecting the optimal one is needed, therefore, this research will include a design for a general methodology so that it can be followed in any environment. Finally, this methodology will be applied directly to Panama and Peru, two developing countries in Latin America where the Acciona.org Foundation is working on a project to bring clean energy access. To do this, the current situation in these countries will be first analyzed and then the methodology created will be followed step by step in order to select only one of the available payment methods, which will be the one to be implemented in those specific projects.

Keywords: Mobile payments, scoping review, factors, M-payments, selection .

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Chapter 1

Introduction

An average American spends around 60.000\$ each year [1]. Since 2019 most of this money is spent with mobile wallets as they overtook credit cards to become the most widely used payment type globally [2], this means that nearly 7 billion U.S. dollars will be spent thanks to the use of this specific type of mobile payment[3].

It is clear that mobile payments are a reality in current fintech landscape and they are seen as a new innovative technology, however, they first appeared in the 20th century thanks to a soda company. In 1997 Coca Cola created a small number of vending machines where the customer could make an m-payment. With this vending machines, the customer would send a message to the vending machine and the machine would vend their product in return [4].

Since 1997 mobile payments have been evolving to the point that most Banks include them in their own apps and expressions such as "Do it in a Blip" or "I will send you a Bizum" have entered daily language throughout the world.

As mobile payment technologies have been evolving, different players have realised the important opportunities that they bring and the problems that they solve. This is the reason why in developing countries, where the banking situation was an issue yet to solve, m-payments have achieved a great success. In fact, there are many emerging countries where mobile payments played a key role in a period when in Europe this was not popular yet, such as Kenya, that had over 18 million m-payment users in 2012 thanks to M-Pesa [5], which became a case to replicate by many other companies.

10 years later, this trend in developing countries has continued and even accelerated as mobile payments have reached astonishing figures in regions like Asia-Pacific, with 1.8 Billion users in 2020 and 65% of the total transaction value in the world, Africa with an estimation of 800 million users in 2025 and 88% of penetration in Latin America [2].

These high penetrations are some outstanding figures considering that in these regions there is a general low bancarization. For example, in Latin America, where mobile payments penetration is 88% there is a 25% of unbanked population [2]. This means that m-payments are solving a social challenge, helping many people to digitalize their income and ease its access. What is more, this digitalization also helps to reduce a social problem such as the shadow economy because digital payments keep track of every transaction.

For the past few years, digital payments have shown that they play a key role in

the digitalization of the society towards a sustainable future by contributing to some of the SDGs, such as the SDG9, related to digital skills and reducing illectronism (digital illiteracy). Furthermore, physical money has a relevant environmental impact which is reduced thanks to digital payments, contributing to the SDG12.

Finally, mobile money fulfills most physical money advantages such as the instantaneous transactions and the ease of payment which is one of the reasons that explains why cash use is decreasing in favor of m-payments and many companies have increased their intention to include them in their businesses. However, due to the remarkable success of m-payments, in most countries there are many companies that implement them. So a new problem arises when it comes to implementing a mobile payment technology in a business process nowadays: the necessity to select the most appropriate technology.

1.1. Objectives

In this research the main goal is to provide a methodology to follow when it comes to selecting a mobile payment application in a general environment. The main focus will be developing countries as most market opportunities can be found there because this environment is highly developed in a big part of the world. However, in developing countries normally there is not a predominant technology yet, this is why choosing correctly the one that will be easier and faster to implant is key.

So as to fulfill this objective, this research has to fully describe the environment of these mobile payments. This includes the different technologies that are included in the concept m-payment, the process that is followed during each transaction and the situation of this payment method nowadays, specifying both the usage and the main challenges that they find in the studied environment, developing countries.

Taking this into account, this research aims to find the main factors to consider while introducing a new mobile payment system in a business model in order to later create this whole methodology to follow. These factors will be found following a scoping review of previous literature and will be deeply analyzed so that it can be seen clearly when they are determinant in the implantation of a mobile payment.

Finally, this will be shown and clearly explained with two implantation examples with Acciona.org Foundation in two developing countries in Latin America: Panama and Peru. The main goal in this last section is to show the user how the methodology should be followed so that the reasoning can be followed and replicated in future cases. To do so, throughout these practical cases, some alternative scenarios will be discussed so that if there is interest to follow the methodology in different situations, a guideline is provided.

1.2. Structure

The structure followed in this document is:

Chapter 2 State of the art: provides a general overview of digital payments' current situation and the common technologies. This section will then focus on mobile payments, therefore, different kinds of mobile payments will be explained and the process followed in a transaction of an application based mobile payment will be detailed. Finally, this chapter will provide some usage figures around the world.

Chapter 3 Methodology: defines the process followed in a scoping review.

Chapter 4 Development: finds the relevant factors to consider when selecting a mobile payment technology in order to finally arrive to a general methodology.

Chapter 5 Case studies: provides some practical examples in which the methodology is applied.

Chapter 6 Conclusions and future guidelines

Chapter 2

State of the art

“Merchants may be penalized if they do not allow cash payments” [6].

In May 2022, a law came into force in Spain that allows to fine businesses that do not accept cash on their premise. A few years ago, this was unthinkable since there was usually a minimum amount to pay by card or even only cash was accepted. However, digital payments have become so popular that cash transactions are now in decline, so before studying more specific issues, the current environment and the causes of this remarkable change will be analyzed.

The reduction in the use of cash in the world is undeniable, with countries such as Canada, Australia, South Korea, China, Sweden, or Norway, where cash transactions are now below 25% of the total [7]. The main reason for this is the strong penetration of digital payments methods over the last decades.

The analysis can start by quantifying the digital payments market by the number of cashless transactions. According to data from a recent PWC report [8] on the expected evolution of these payments, 1035 trillion digital transactions were made in 2020. This figure is particularly interesting if it is disaggregated by geographic region, as it helps to understand the great inequality that exists in this field. Out of these 1035 trillion transactions, only 53 were carried out in Africa and 73 in Latin America, while 494 trillion and 229 trillion occurred in Asia-Pacific and Europe respectively.

When it comes to the expected future of this field, according to the PWC report, the number of transactions is expected to triple by 2030, as it can be seen in the figure 2.1 [8], which shows cashless transactions increase from 1,035 billion to more than 3 billion. However, those regional inequality figures are not expected to improve in the following years because the highest volume of transactions will be concentrated in Asia-Pacific while the African and Latin American regions will suffer a very slow growth throughout these 10 years.

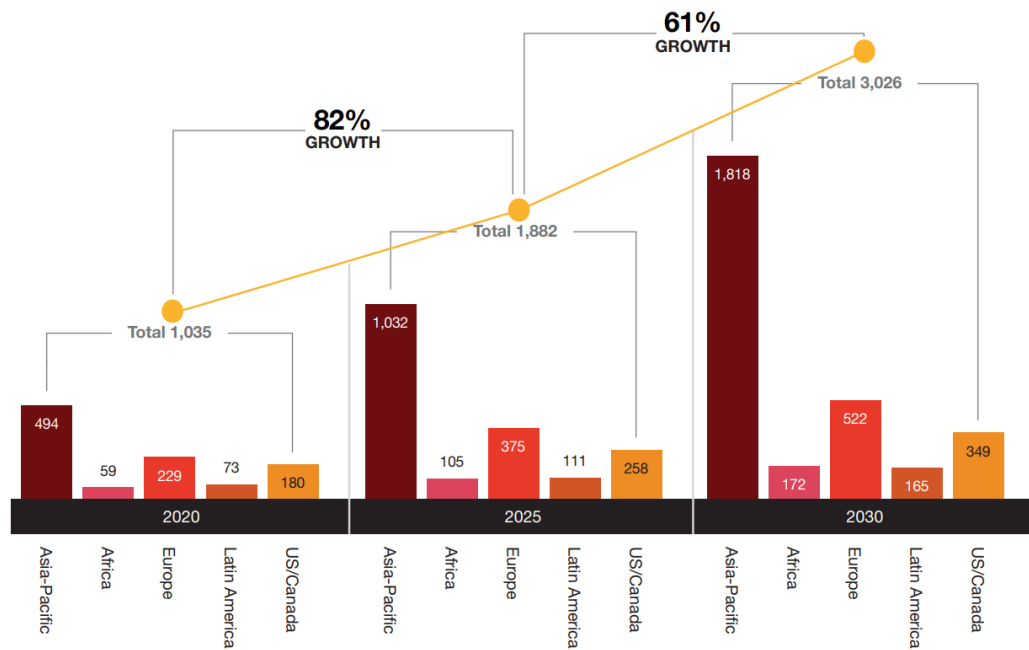


Figure 2.1: Number of cashless transactions in billions

2.1. Digital payments technologies

Digital payment is a wide term that refers to any payment done through digital mode with no exchange of cash involved [9] and it includes many different methods and technologies, however, there are many differences between their characteristics and current use. So as to provide a general point of view, most important methods will be analyzed separately: bank cards, wire transfers, cryptocurrencies and mobile payments.

2.1.1. Bank cards

The appearance of credit cards meant a huge revolution in the fintech sector, and their use has continuously increased up to the current situation, as there are now more than two credit cards per person [10]. This technology has rapidly evolved from a classic approach, where the user inserts this card into a terminal, to a contactless approach in order to increase the transaction speed.

Although in developed countries cards are a common payment method, this is not the case throughout the globe. Adoption is quite different depending on the type of economy of the region and penetration is lower in developing countries [11], as it can be seen in the following figure, which shows how countries such as Spain or Switzerland reach 80% debit card penetration while Guinea or Sierra Leone roughly reach 5% [12][13].

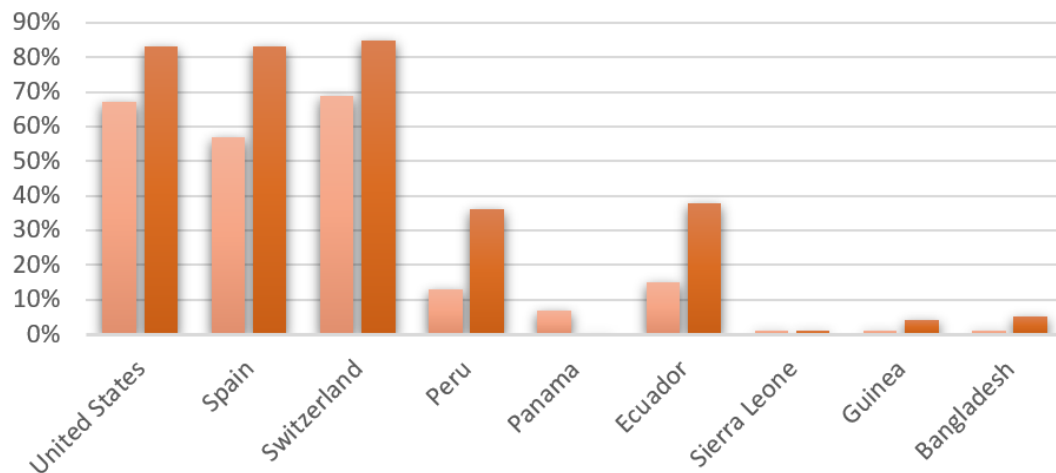


Figure 2.2: Credit and debit card penetration 2021 (Own elaboration)

Their operation principle is based on an entity that allows the communication between origin bank and the destination bank, the card network. Payment process is in this case quite interesting and it will be deeply analyzed in a following section [14].

2.1.2. Wire transfers

It is clear that while analyzing every digital payment it is necessary to include one of the most traditional ones, bank transfers. Even though they are quite useful for big amounts of money, their use is not increasing as fast as it could because of their weaknesses, mainly the delay involved in each transaction and the high commissions that banks normally charge.

Specifically in Spain national transfers usually take a day to be completed and international ones should be ready between 2 and 3 days [15]. When it comes to fees, international transfers are charged with a 0.6% and there is a minimum transfer value of 15/20€, which is a much bigger constraint.

2.1.3. Cryptocurrencies

Cryptocurrencies are digital assets that are designed to be used as forms of exchange like traditional money. Like most traditional currencies, cryptocurrencies do not possess an intrinsic value because their value is set through transactions [16].

Cryptocurrency market has caused an important controversy in the last few years due to its tendency to speculate, a direct consequence of their volatile nature. Nonetheless, it is essential to include this technology in this overview because of the high number of transactions that are completed thanks to cryptocurrency and their unexpected growth.

This method uses the blockchain technology so as to secure transactions and one of its main characteristics is the lack of a central authority, like a national bank, and the exponential growth that it experienced after its arrival (which is represented in the figure 2.3), in fact, the number of different cryptocurrencies increased from 109 in 2014 to 1500 in 2018 [17]. Nowadays there are more than 8.000 [18].

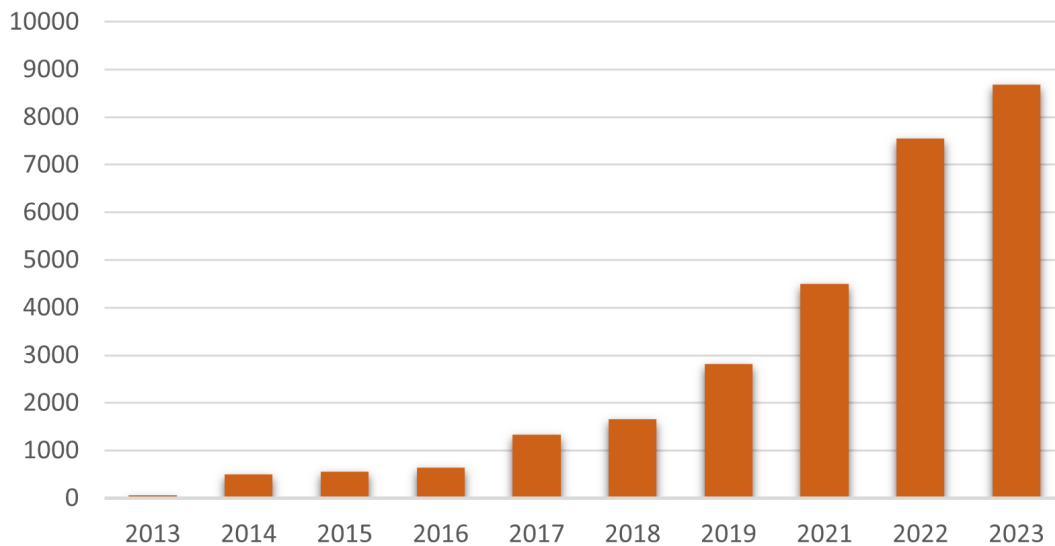


Figure 2.3: Number of cryptocurrencies worldwide (Own elaboration)

This fast growth can be explained by the security that it guarantees and the low cost in those transactions, which is significantly lower than the previous method. However, there are many challenges yet to solve, like its legal framework, the amount of energy that it implies and the speculative ecosystem that surrounds this technology [19].

2.1.4. Mobile payments

Finally, mobile payments will play a key role in this document and is also one of the new technologies that are making digital payments reach these high usage figures [2].

Every transaction initiated on a mobile device such as a cell phone or tablet is considered an m-payment. Mobile payment is still a wide term that groups many different technologies like NFC, QR, SMS or bank applications which will be briefly explained in a following section, but first some general information will be provided.

There are many attributes that explain the benefits of these payments to consumers, such as convenience, cost, security, and the ability to control account balances from any location. However, their most important characteristic is that mobile devices can be used for a variety of payments, including person-to-person transfers, purchases on the Internet or physical purchases in a shop.

Users can make deposits in a mobile payment in a variety of ways, the user can use a credit, debit, or prepaid card, they can do deposits directly from their bank account or they can fund these applications through an intermediary, this option is quite common in developing countries as it allows to change cash into funds in the selected m-payment that can be later used in micro-payments [20].

2.2. Micropayments

Not only innovative technologies have arisen in the past few years but the way they are used has also changed. In the beginning digital payments were mainly used for transfers of large amounts of money, nonetheless, due to the remarkable decrease in the use of cash during the last decade, an alternative was needed to complete small, quick transactions and done on a daily basis, this is how the micropayment idea was born.

A micropayment is a transaction, which occasionally deals with amounts smaller than one dollar (although each company fixes a different threshold to consider a transaction a micropayment), these transactions are normally done online and they enable the appearance of many digital businesses thanks to in-game purchases and digital rights and royalties [21].

Despite the need to expand the use of micropayments, there was still one of the biggest challenges to their worldwide implementation: transaction costs. Most digital payment methods have fees and in many cases, there is a minimum fee, which is a big problem for small transactions, like micropayments.

The efforts of Fintech companies, the emergence of new technologies and the strong demand for these types of transactions have helped to overcome the problem of commissions and the payment methods detailed above have been forced to adapt.

The method that has not adapted to the rise of micropayments is bank transfers, minimal transfer amounts and fees have been maintained as mentioned above. In addition, the delay in receiving the money completely eliminates bank transfers from the dispute for handling this type of payment.

At the moment, cryptocurrencies are not a viable option in this field either, due to the extremely small number of businesses that accept payment with them. Although there are cities that are introducing payment with cryptocurrencies in some businesses [22], at the moment it is more experimental than practical.

Credit cards have reduced their fees from 1.59% to 0.36% in the last twenty years, with an all-time low in 2020 just after the start of the pandemic [23] [24]. This has gradually led to the use of credit cards to pay any type of amount and to the elimination by most merchants of the minimum payment restriction that was quite common a few years ago.

As for mobile payments, it could be said that they are the great beneficiaries of this trend in society towards the demand for small, frequent, and fast payments. Peer-to-peer technologies are perfectly suited to the concept of micropayment, and this explains the success of these services in recent years.

In addition to this, the emergence of disruptive companies in the sector that

have eliminated commissions in this type of operations (such as Revolut) and the technologies that arise thanks to agreements between banks, as is the case of Bizum in Spain, have facilitated its use for clients in a very noticeable way, making the transition to these new technologies quite easier.

2.3. Mobile payments: Insights

Now the focus will shift towards mobile payments as they are clearly the major beneficiaries of the micropayments upswing.

The main purpose of this section is to introduce the reader to the main technologies used nowadays in mobile payments, so SMS, NFC, QR codes and application based payment methods will be addressed.

Finally, some usage figures will be provided and the situation in developing countries will be studied, which is a key section in this document as the final goal is to implant mobile payments in these regions.

However, before going in deep in those topics, current environment must be briefly analyzed. Nowadays, there are many companies working in this field and they can be abruptly classified into two categories: international and local.

Most used apps are normally local because they offer lower commissions and a better service thanks to partnerships between banks in one region. In the following map some of the most important m-payment applications in each region are shown:



Figure 2.4: Local m-payment applications (Own elaboration)

However in the last few years there has been a rise in the number of international mobile payment applications because of the super-apps success (mainly in China) and

many other fintech companies that offer their services in many more countries than the companies shown just before.



Figure 2.5: International m-payment applications (Own elaboration)

Although global solutions might be appealing because of their convenience while traveling, they normally offer a worse service because it is very difficult for them to partner with local banks throughout the world, which leads to closed services inside their platforms or higher commissions for transactions with people that do not use these applications.

2.3.1. Mobile payments methods

There are many different technologies that can be grouped into m-payments, however, they are used in completely different ways and each one of them have specific advantages and disadvantages. This is the reason why all of them will be presented first in order to offer a general overview of all the technologies.

2.3.1.1. SMS

Short Message Service (SMS) is a text message service that enables short messages to be sent from a mobile phone. SMS was first introduced in the GSM (Global System for Mobile Communication) system [25].

SMS is nowadays mainly used in marketing because of its high CTR, 19% much higher than the 1% that Facebook offers [26] and some other useful characteristics for businesses such as the quick read by customers (60% of them check their text message notifications within 1-5 minutes) [27].

This can be one explanation to the usage growth that SMS is experiencing in the past few years as it is shown in the figure 2.6, which also shows how A2P SMS market size is expected to grow to almost 100 billion USD with a steady GAGR of 1,041 [28].

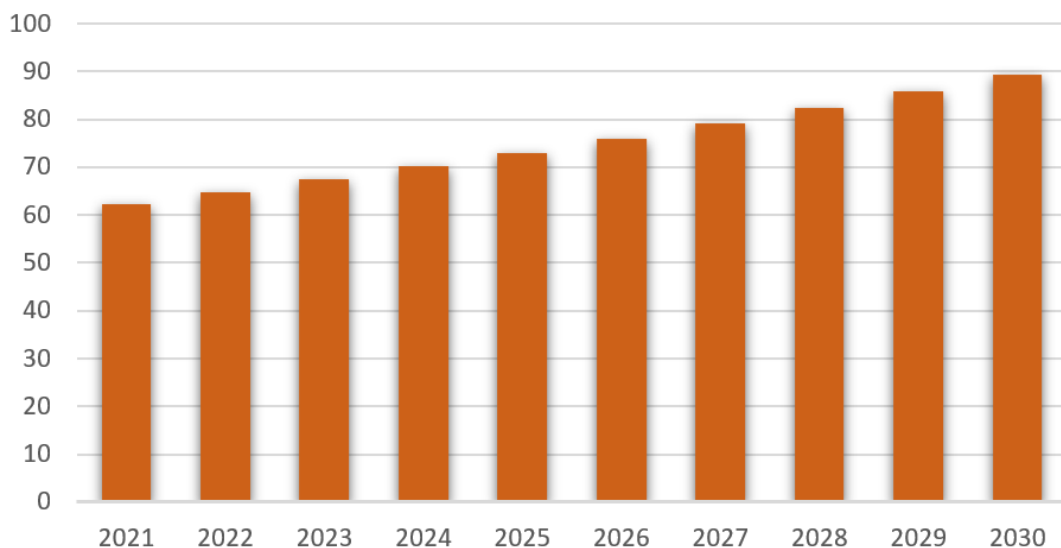


Figure 2.6: A2P SMS Services Market size 2021 - 2030 (USD Billions) (Own elaboration)

SMS payment technology was used in the 2000s mainly in developing countries because of the large unbanked population and there is a necessity to find an alternative to cash. SMS is normally used for payments when there is a low smartphone penetration or bad internet access as these are necessary to use some possible substitutes [29].

SMS has been supported by every digital-based mobile communications system and, at the moment, it was a cheap and efficient substitute to cash. This technology can be seen as the first mobile payment and it set the steps to follow in new technologies from the wireless era [30].

Certain problems have arisen in SMS payments because of cases of unauthorized third-party charges on phone bills [29]. Some other main disadvantages are that they

had normally a short length (140-160 characters) and the high costs that it implies nowadays compared to other services. Fortunately, these fees have been reduced in the past years, anyways, this payment method is being replaced by other technologies and SMS is used almost exclusively in marketing.

2.3.1.2. NFC

NFC is a wireless short-range communication technology based on existing standards of the RFID infrastructure [31].

This technology is widely used nowadays in public transport and in many stores by simply approaching the mobile device to a compatible terminal. The ease of use, the convenience of just approximating NFC devices and its economical attractiveness, as it is based on open standards and users are not obliged to pay for licensing fees, are some of the reasons that explain their 1000% growth in the past 10 years[29][32]. Furthermore, growth expectations are optimistic because this pace will continue as it is shown in the figure 2.7, which shows the NFC market size through time[32].

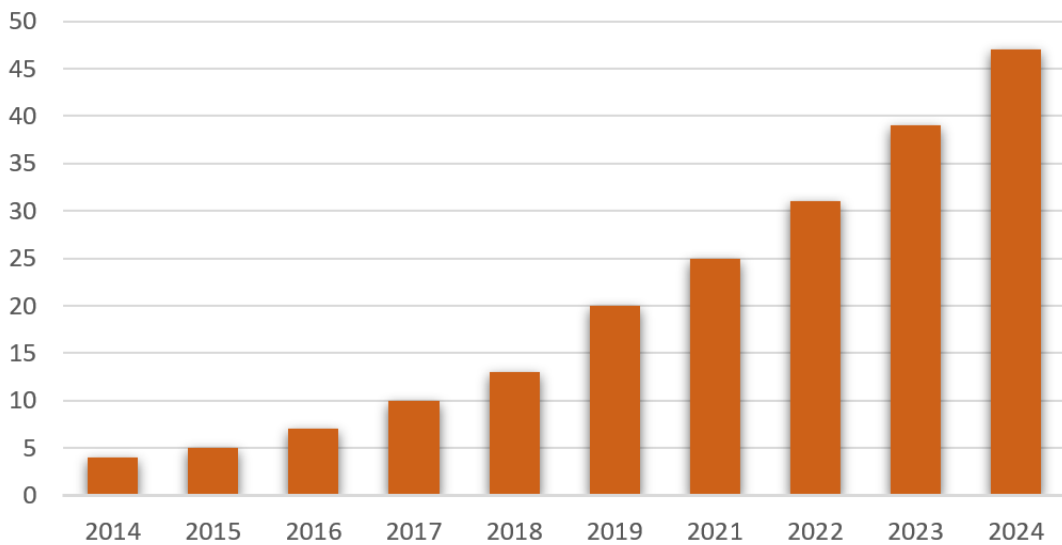


Figure 2.7: Global NFC Market size, 2014 - 2024 (USD Billions) (Own elaboration)

Compared to when this technology began, most mobile phones are compatible with this technology so the inability of using the preferred mobile phone has disappeared. Although the main obstacle for this technology has been surpassed, NFC payments still have some disadvantages like the proximity necessity and the concerns of the majority of users regarding this technology, such as it being used with their lost/stole mobile phone and security in general for safe transactions [33].

2.3.1.3. QR

QR stands for Quick Response, this technology was designed by a Japanese company in 1994 and it consists of two-dimensional barcodes that represent 2-dimensional information that can be read from a vertical or horizontal direction, and it provides much more information than a traditional barcode [34].

QR codes are commonly used nowadays, in fact, 84% of people have scanned a QR code before and 32% have scanned a QR code in the past week (Chambers, 2020). This technology has become the standard in most shops and restaurants since the COVID-19 pandemic and it has a lot of value in packaging or magazines [29], however, its use for mobile payments is not that spread.

To complete a transaction a QR code can also act as an alternative to cash, consumers just need to scan a QR code with their smartphone. QR code-based mobile payments' advantages and disadvantages are quite similar to the NFC technology as the user needs to have almost direct contact between their smartphone and the code.

In the last years this method has been growing because it eliminates costs related to the point of sale, it saves time and it increases efficiency allowing quick transactions [35]. In fact, the market size will triple by 2030 as the figure 2.8 shows [36].

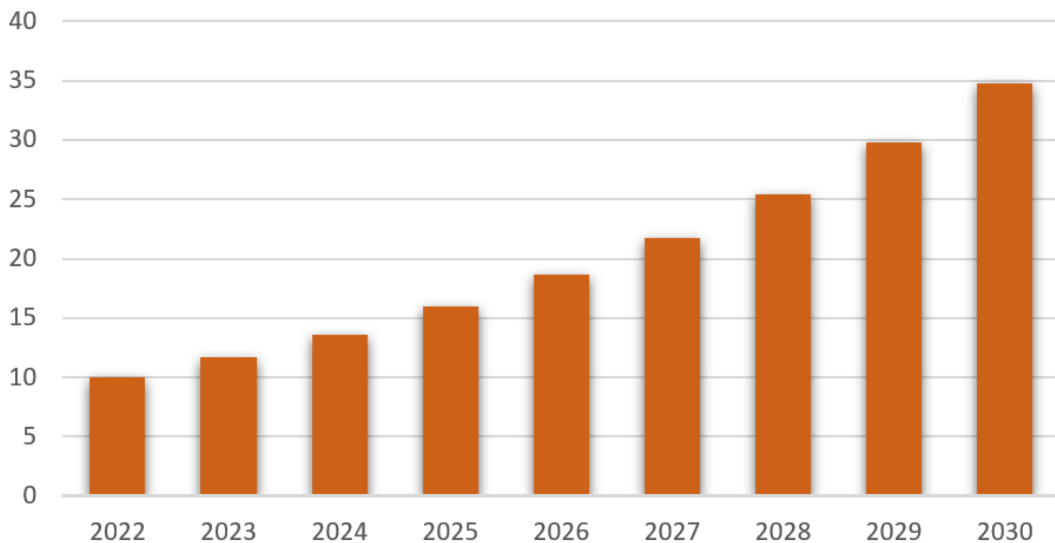


Figure 2.8: Global QR code payment market size, 2022 - 2030 (USD Billions) (Own elaboration)

2.3.1.4. Application-based

In this section most banking apps are included, as the trend is that banking apps include themselves a payment service between peers. The success story of Bizum that

was previously mentioned is included in this kind of payment.

The payment process is quite simple, the application can access the users' contact agenda information, the user decides to whom the payment will be made and the amount. Afterwards, a confirmation method is normally used, with SMS mainly, and the transaction is finally completed in real time. Behind these steps there is a much-complicated process that will be explained in a dedicated section.

For security reasons, there are normally some constraints in these services, for instance, Bizum, the dominant technology in Spain, only allows 30 transactions per month with maximum thresholds per transactions and per day [37].

This method is the one that explains the exponential growth in mobile payments that in a later section will be analyzed. It is natural to wonder how the process involved in this type of transaction works. Understanding this process is necessary in order to be able to explain the speed of the transactions and the low fees involved, so the following section will focus on explaining the mobile payment process.

In the following table a brief summary of these four mobile payments applications can be seen:

	Range	Advantages	Disadvantages
SMS	Long	-High CTR -Quickly read -Works with bad internet connection	-Security issues -Short length messages -High costs
NFC	Short	-Ease of use -Open standards -Convenient in many daily situations	-Security issues -Used with stolen device -Proximity required
QR	Short	-Ease of use -Fast -No need for a point of sale	-Proximity required
Application based	Long	-Speed of transactions -Low fees -Security	-Complexity -Limited number of transactions or amounts

Table 2.1: Mobile payments summary

2.3.2. Mobile payment process: inductive analysis from card payment process

In order to perform an in-depth analysis of the mobile payments' environment, it is key to explain each one of the steps that are followed in the transaction process, from the moment the customer decides to start the transaction until he/she is notified of the charge to his/her account and the merchant receives the corresponding amount.

After researching whether there are already specific analyses or terminology for this

specific case, it was concluded that no academic article has focused on the transaction process of an m-payment, so it was decided to extrapolate terminology from an older process with many studies that around it: digital payments with credit cards.

Before describing each of the steps involved in this payment flow, each of the agents involved will be described [38] [39] [40] [41] [42]:

-Payment gateway: software application that allows merchants to accept credit and debit card payments. It is responsible for encrypting the information and transferring it from the merchant to the processor. Throughout this document, multiple different gateways will be analyzed, among which Bizum, Yappy or Yape can be highlighted.

-Payment processor: service contracted by the acquiring bank that is authorized to process credit or debit card transactions between merchant and customer. They must accept and process card payments and integrate fraud detection measures. Many banks have their own processor, although there are widespread independent companies such as Redsys.

-Issuer: financial institution that offers debit or credit cards to customers on behalf of the card network, that is, the name of the bank that appears on the card is the issuer. It is responsible for making the payment to the acquirer and therefore assumes the risk that the customer may not be able to repay the credit.

-Acquirer: financial institution that processes credit or debit card transactions on behalf of businesses. They allow merchants to accept card payments and handles communication with card networks and issuers to complete the payment.

-Card network: company that provides the electronic networks that allow all agents to communicate and process transactions. They charge fees to both acquirers and issuers and must facilitate transactions and oversee payment processing. Each card network has a specific compliance policy that is regulated and administered by each company, such as Visa, MasterCard or American Express.

Once it is clear what role each agent plays, the analysis will start by describing the process followed in an online card payment.

1	The flow begins when the customer decides to initiate the purchase process.
2	At that point the merchant processes the card information and sends it to the payment gateway.
3	The gateway communicates this information to the payment processor.
4	The payment processor asks the card network for authorization for the payment to go through.
5	The card network is responsible for submitting the request to the issuing bank.
6	The issuing bank is responsible for deciding whether to assume the credit risk and for approving or denying the requested authorization.
7	Once the card scheme has the response, it sends it to the acquirer.
8	The acquirer communicates the response to the merchant.
9	At this point, it is up to the merchant to decide whether to accept the transaction.
10	If so, the acquiring bank makes the deposit in the merchant's account and sends the transaction data to the card network.
11	The acquiring bank receives the payment and charges the issuing bank.
12	The process is completed when the issuer shows the charge to the customer and the transaction is closed.

Table 2.2: Process flow with a card payment

The complete process has been represented in the following figure to facilitate its understanding.

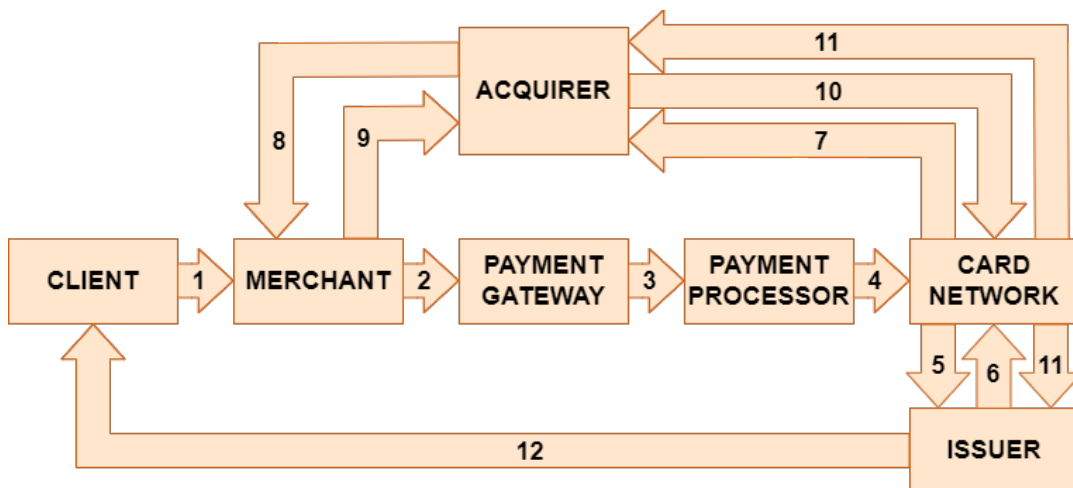


Figure 2.9: Process flow with a card payment (Own elaboration)

After having deeply analyzed this first process, it is necessary to determine the similarities that exist with the mobile payment process. Clearly, the process starts

and ends in the same way, with the customer's initiative to make a payment and the communication of the charge respectively, however, in the intermediate process there will be several important differences.

Because there are multiple scenarios within the world of mobile payments, certain assumptions will be made so as to provide the most common process flow:

-Firstly, the acquiring bank and the issuing bank will be considered to be the same entity. Although there are systems that allow mobile transfers between accounts at different banks, as is the case of Bizum (the most widely used gateway in Spain for this type of payment), this decision was considered to be the most appropriate given that the systems that will be most important throughout this document are Nequi, Yappy and Yape, which require their users to have an account with their services or with the banks on which they depend in order to send or receive money.

-Secondly, the main difference with the case of online card payments must be considered, which is quite clear: the card network is not involved in this process because transfers are made directly between accounts. This does not imply that this step in the money flow is omitted. Instead, a new agent emerges, which will be called the transfer network. This agent is in charge of validating the information of the source and destination accounts and facilitating the communication between issuer and acquirer.

-Finally, in a transfer of this type, the issuer does not need to consider whether to assume the credit risk since only mobile payments can be made with the money already in the account, so the issuer's tasks are reduced, and the process is again simplified.

After having addressed these first three differences, it is possible to get to a new scheme based on the first one that was detailed.

1	The beginning of the process is similar, since the client initiates it
2	The merchant communicates with the gateway
3	Which transmits the information to the processor
4	The processor sends the information to the transfer network
5	The transfer network validates the account information and requests authorization from the issuer
6	The response (almost always positive since it does not need to assess the possibility of granting a credit) is sent to the transfer network
7	The response is forwarded to the acquiring bank
8, 9	Information is exchanged with the merchant, the corresponding deposit is made in its account
10	The acquiring bank sends the final response to the transfer network
11	The transfer network makes the deposit to the acquirer and charges the issuer
12	The issuer can now show the charge to the client

Table 2.3: Process flow in a general application based mobile payment

The process is shown in the following figure, it has also been decided to write an example of each agent with a real entity, therefore, the case of Yappy [43] has been specifically analyzed. Yappy is a payment gateway created by Banco General de Panamá that is going to be of special importance throughout this document.

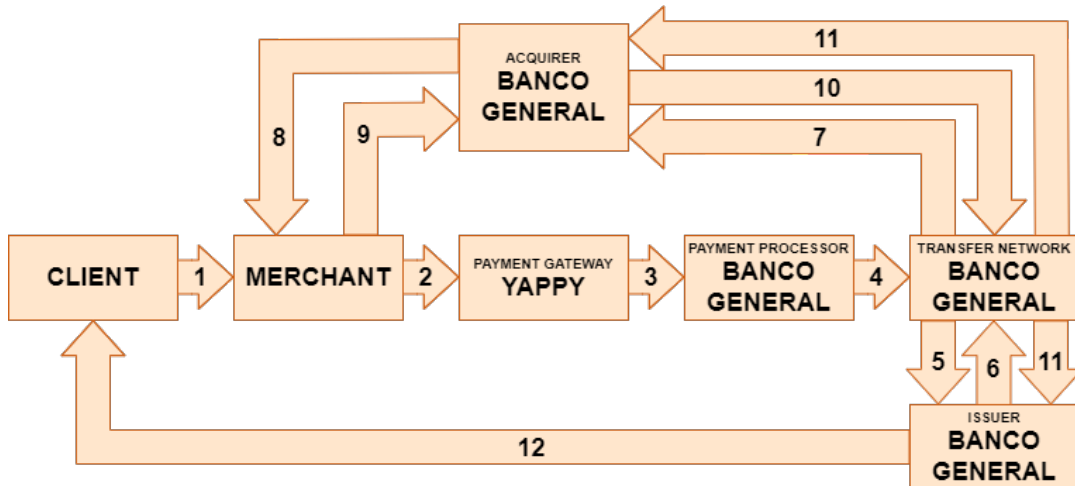


Figure 2.10: Process flow in a general application based mobile payment (Own elaboration)

After analyzing the scheme, it can be seen that it can be simplified since the tasks of several agents are performed by the same entity, in this case, Banco General. Therefore, it was decided to aggregate all the tasks performed by the acquiring bank, the issuing bank, and the transfer network into a single agent. This new agent has been called the transfer network+.

This new player is mainly responsible for the internal communication of all the information involved in the process, as well as the corresponding checks. Consequently, it has to validate the account information and ensure that there are no inconsistencies. The transfer network+ has direct communication with both the merchant and the customer and it makes charges or deposits when necessary. The payment processor has not been included in this new agent because in the general case, those tasks are outsourced by banks to other specialized companies.

With these details in mind, the process can be restructured, simplifying several of the steps that were carried out in the first version.

1	As in the two previous cases, the customer starts the purchase
2	The merchant uses the payment gateway to accept the transaction
3	The gateway communicates with the processor
4	The processor performs the necessary operations with the information (to detect fraud among other measures) and sends the data to the new transfer network+
5	At this point, the transfer network+ must validate the account information, detect possible errors in the data and return an error message in case of any problems. If the transaction has reached this point successfully, this agent communicates directly with the merchant
6	The merchant accepts the payment
7	The final step is also greatly simplified since it is the transfer+ network itself that makes the payment to the merchant, charges the customer, and notifies the customer accordingly.

Table 2.4: Simplified process flow in an application based mobile payment

This way the analysis arrives at a flow that has been represented in the following figure:

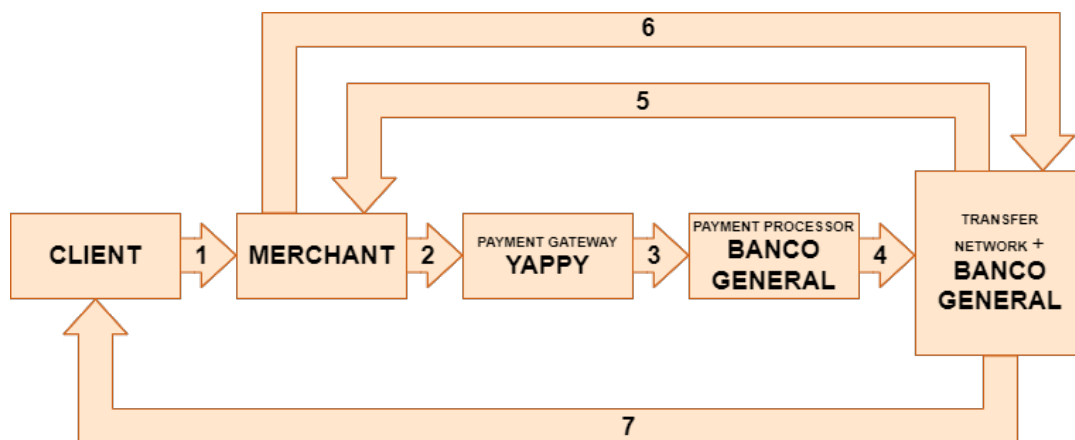


Figure 2.11: Simplified process flow in an application based mobile payment (Own elaboration)

Looking at the diagram, it can be seen how much simplification has been achieved by having the same bank at both ends of the transfer. Interoperability is the current trend with these apps as governments are forcing it and companies are seeing the benefits of having a larger userbase. This means that the most common process will probably be the second scenario so this last simplified process will be only left for monopolies or regions that have not yet become interoperable.

2.3.3. Usage figures

In 2019, mobile wallets overtook credit cards to become the most widely used payment type globally [2].

It is clear that the trend during the last few years is to use mobile wallets and m-payments globally and the expectation is a continuous growth. In fact, in 2020, there were almost three billion mobile wallets in use and the forecast is to have around five billion mobile wallets in 2025. When it comes to unique users, there were 1350 million users in 2022, which implies a 18% global increase compared to 2021. Not only people have mobile wallets but they also use them frequently with an increasing number of activities, actually, mobile money processed one trillion dollars in transactions in 2021, which is twice the world's wealth and this figure is growing a 31% every year [44]. Although this growing trend is quite global, there are certain regions which are experiencing a faster growth, such as Russia, Brazil or Singapore which have a GAGR (compound annual growth rate) of 45% [2].

One of the main reasons that explain this particular interest in mobile payments during the last years is the COVID-19 pandemic, which caused a drop in the use of cash and acted like an accelerator of the digitalization of payments. For example, in India, more than 80 million adults completed their first digital payment after the start of the pandemic, while in China this number increases to 100 million adults [45].

In Spain there was a severe increase in mobile payments with a 3% raise and a higher growth in application-based mobile payments, with 13 points increase in the use of Bizum, the reference tool in Spain [46].

China is an interesting market not only because of the enormous potential userbase, but also because of the differences between their ecosystem and the one predominant in Europe or America nowadays. Mobile payments are completed with super apps, which are a particular model of app that assumes most functions of a smartphone [47]. In terms of market size, Alipay and WeChat Pay are the two biggest players with 52 and 37% of the market [48] and in terms of users, Alipay count on 400 million users and WeChat Pay counts on almost 300 million. Super apps origin is located in Asia, however, developing countries in other regions are a perfect environment for them to grow as M-Pesa and MNT-Halan have shown in Egypt and Kenya respectively.

Digital payments already play a key role in developing countries, for example, in Africa they process more than 600 billion dollars every year (more than half of the transactions are done in this continent). In fact, it is clear that in the future mobile payments will be widely used in most of these regions because of the remarkable growth (shown in figure 2.12): 40% in Sub-Saharan Africa, 49% in Middle East and 39% in Latin America and the Caribbean [44]. These percentages almost double those from Europe and Central Asia, therefore, it is known that m-payments are not only more used, but they will also continue to be more dominant in these regions compared to the rest of the world.

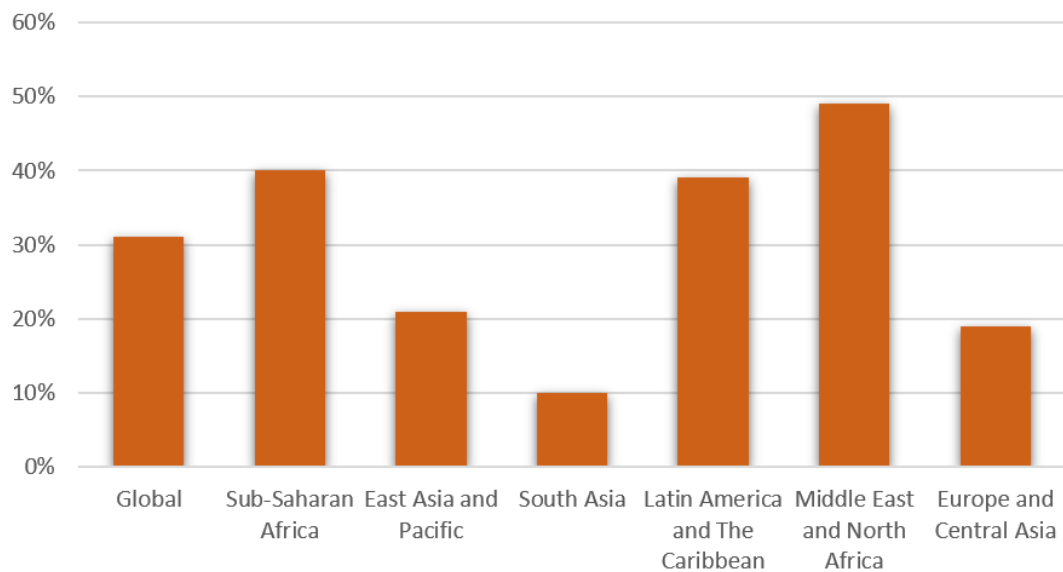


Figure 2.12: Mobile payment transaction growth (Own elaboration)

It has already been shown that the transaction value is huge, however, in order to fully understand how people use these technologies, there is another value to analyze: the mean value per transaction. As it was stated previously, one of the reasons that may explain these digital payments boom is the necessity to complete micropayments online so it would be expected to find a small value per transaction. It has been mentioned that the global transaction value is one trillion dollars, and the transaction volume is around 50 billion transactions, that makes the mean value per transaction 20\$ which is quite smaller than the mean value in a bank transfer [44].

However, are digital payments used in this way throughout the world? The answer is found in the data and there are some differences, which can be seen in the following figure: while in Europe and Central Asia this mean value is also around 20\$, in Latin America the mean value per transaction is 31\$ even though the expected outcome should be also smaller than the global because of the lower GDP per capita. Some possible explanations are mentioned in the next section, nonetheless, the main reason for this is probably the low bank access so transactions that would normally be completed with a bank transfer are also done with mobile payments [44].

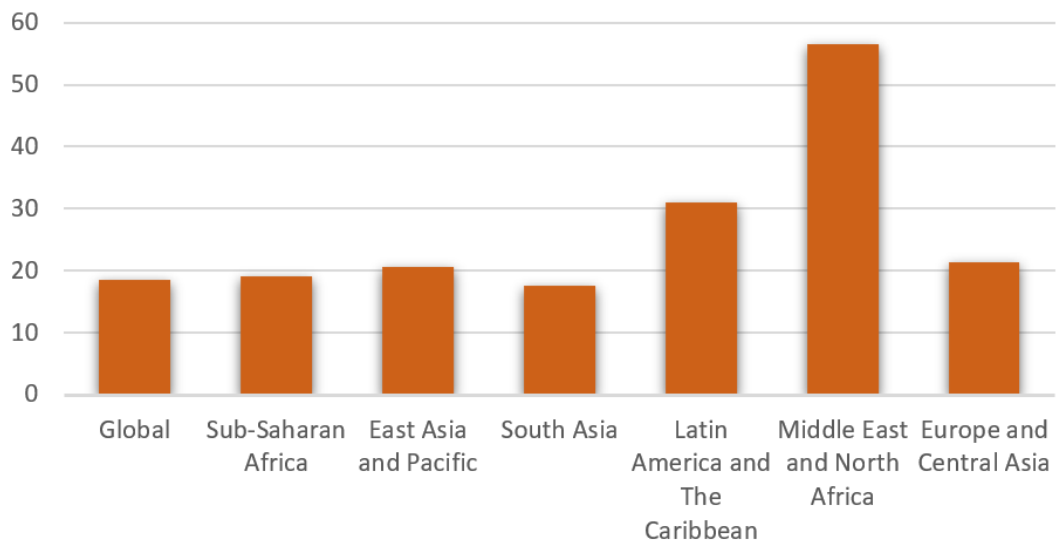


Figure 2.13: Mean transaction value (USD) (Own elaboration)

As later in this paper the research will focus on certain regions in Latin America, a few key indicators from this region will be highlighted. According to Boku in their mobile wallets report, the number of users in 2020 amounts to 227 million and this figure will enlarge to more than 600 million in 2025. However, an indicator which is quite more interesting is the penetration, as it will mainly enable many activities in remote areas. In 2020 this value was not so promising as mobile wallets only covered a third of the possible users, fortunately, in 2025 nine out of ten users will have access to these technologies. This implies one of the biggest strengths that mobile payments have in developing countries, which is the high accessibility.

2.3.4. Challenges and opportunities in developing countries

In light of the figures, it seems clear that mobile payments are on the rise, in particular in developing countries, where a growth of 12% in general digital payments is expected [49] and mobile payments growth will continue current trend (between 40 and 50% as it was explained just before). Therefore, there are many opportunities to exploit in these markets and new ways to do so.

There are many reasons that could give an explanation to the question that arises: why mobile payments are growing this quickly in these specific environments? Firstly, a decisive factor is the lack of alternatives to cash due to the low bancarization (defined as access to and use of financial services generally and banking services [50]) in these territories, which is shown in figure 2.14 [2]. While the percentage of unbanked population in the US is 7% and in Spain is 6% [51], in Africa and Middle East there is a 39% of unbanked population, which involves a core difference regarding how the financial market works in each area and is explained by the financial onboarding

complexity and the difficult accessibility to banking services even though they are extremely necessary to guarantee their savings safety [5].

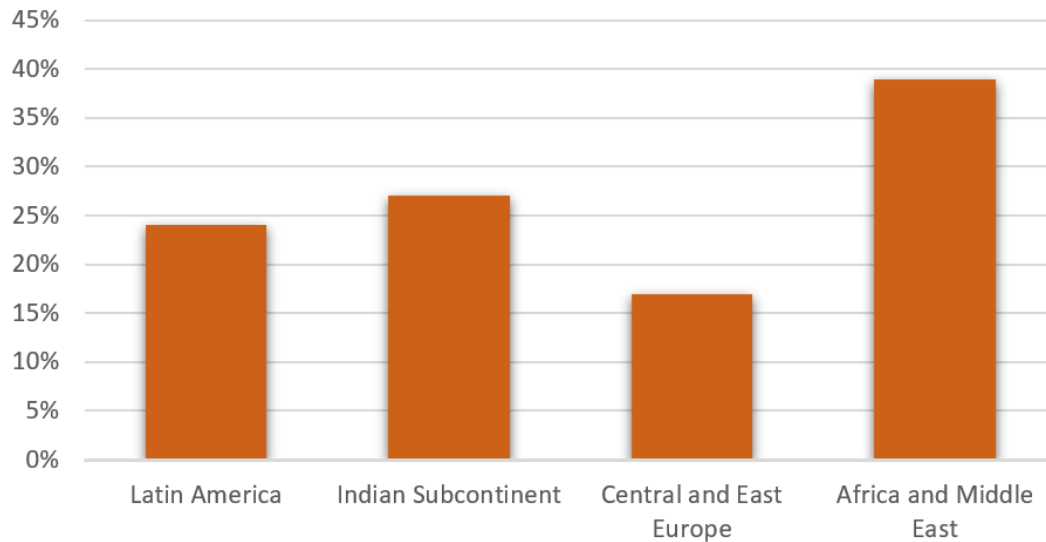


Figure 2.14: Unbanked population in emerging markets (2020) (Own elaboration)

In fact, during 2015, 99% of transactions in Africa were done in cash in contrast to 66% of European ones [52]. Despite this, since the rise of m-payment technologies, cash use has dropped significantly every year to the extent that in that same continent, Africa now counts on 70% of the mobile payments market [53].

It is also necessary to consider the rapid diffusion that mobile phones have had in developing countries. Indeed, more than 80% of the population owns a mobile phone [54] and the users have almost multiplied by 10 in fifteen years as it is represented in figure 2.15 [55]. Taking this into account and knowing that only 20% of the families have a bank account [5], it can be understood why mobile payments seem so appealing in developing countries. The key factor is the high accessibility and their ease of on boarding.

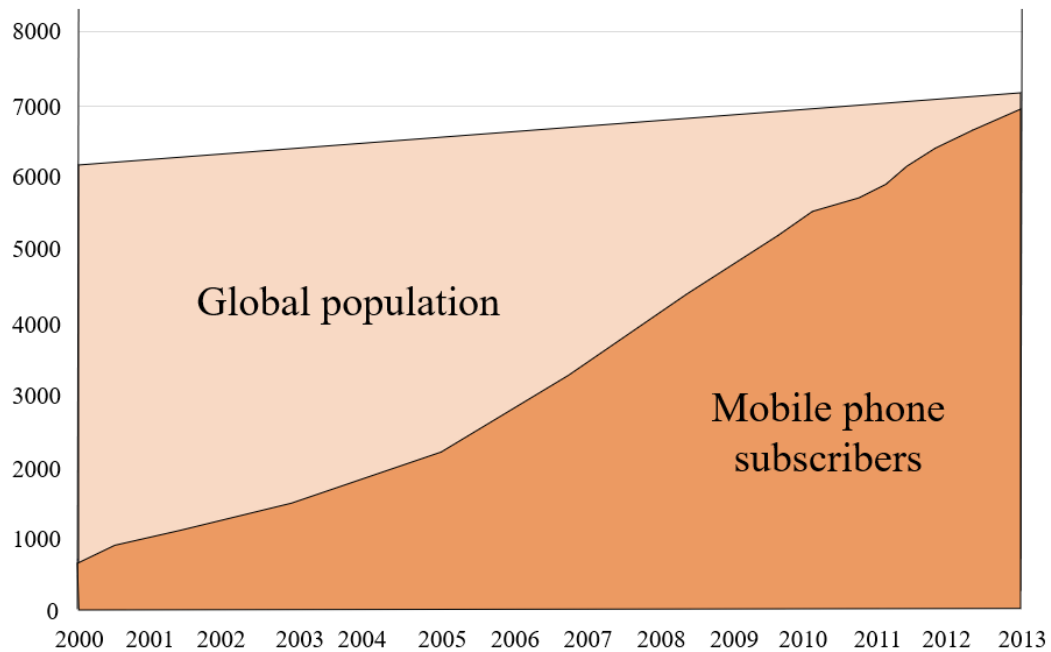


Figure 2.15: Global mobile phone penetration (2000-2013) (Own elaboration)

Due to the possibility to solve this bancarization problem, mobile payments are key to build an equal sustainable future. Thanks to its importance in developing countries, m-payments are contributing to some SDG, like SDG 10, reducing this financial inequality. In addition to this, the growing trend to use PAYG systems with mobile payments in order to enable access to basic services like energy and water, is allowing merchants throughout the world to collaborate with SDGs 6 and 7, which are related to the universal right to water, sanitation and energy.

Low commissions are undoubtedly another reason to consider when comparing mobile payments to traditional payment methods. For example, if the three main applications in Latin America (which are important contenders to become super apps), are taken into account: (Mercado Pago, Rappi and Nubank) [2], they do not charge any fee to users for completing transactions. This makes quite appealing this payment method, mainly when it comes to micro payments [56][57][58].

In most of these countries there is not a unique service because the common situation is to have a different payment application per financial institution or a high competition between financial institutions and independent entities to end up with the whole market. Users do not want to use many applications to complete payments so this market has a high probability to become a “winner takes all” model in which only one technology will be the dominant one at the end. As an example, in the two largest markets in Latin America, Brazil and Mexico, there are four widely used applications and more than 30% of the share is controlled by small applications [2]. In the following figures, the market share per application is shown in four representative regions: Brazil, Mexico, Nigeria and Philippines [2].

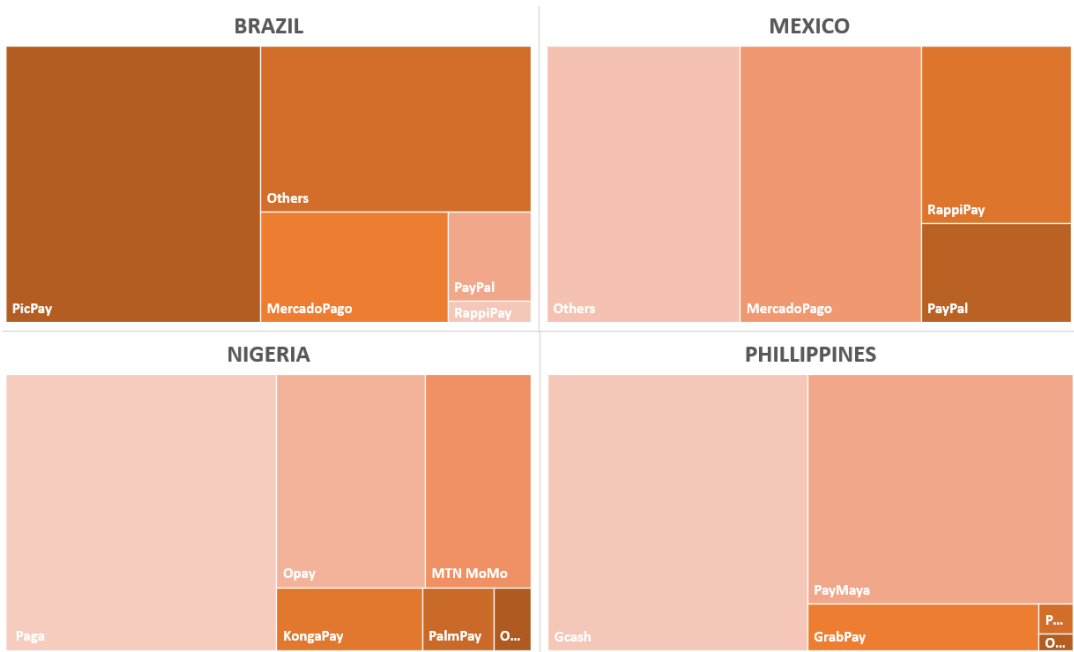


Figure 2.16: Mobile wallet market share examples

This is a great disadvantage because in the vast majority of situations, institutions have not reached an agreement so that the different applications become compatible, as has happened in Spain with Bizum and its great success. Consequently, clients are very split into different independent groups, and it is not easy to select which one is the optimal technology to choose.

Considering this, it is essential to analyze all possible options and to choose the most appropriate one. With this in mind, the scope is to solve this problem by identifying key factors that might help to do this selection. Afterwards, a general methodology will be discussed so as to select the best mobile payment technology in a generic environment.

Chapter 3

Methodology

In chapter 4 of this document the most relevant factors regarding m-payments will be identified and classified, to do so, O'Malley's framework for a scoping review [59] will be followed, therefore, the goal of this section is to fully describe and explain this methodology.

3.1. Scoping review

According to Grant and Booth (2009) [60] a scoping review is a "preliminary assessment of potential size and scope of available research literature. Aims to identify nature and extent of research evidence (usually including ongoing research)."

3.1.1. When to use a scoping study

O'Malley suggests four main reasons to use a scoping review:

- Examining the extension and nature of a research activity: this is quite useful for finding out the range of studies that are available.
- Determining the value of conducting a systematic review: a scoping review can be done before a systematic review to check whether it is feasible or relevant.
- Summarising research findings.
- Identifying research gaps in the existing literature: scoping reviews are commonly used for emerging topics and finding gaps in the knowledge base can be an important goal.

According to Munn [61] scoping studies are a perfect tool to identify the available evidence regarding a certain topic and he extends O'Malley suggestions with four more purposes for conducting a scoping review:

- Identifying the types of available evidence in a given field: this can be especially useful for topics with a large body of evidence and it is necessary to determine their validity or just classify these studies.

- Clarifying key concepts in the literature: there can be variations in the definitions and scoping reviews are ideal to point them out.
- Examining how research is conducted on a certain topic or field in order to investigate the design of certain studies.
- Identifying key characteristics or factors related to a concept.

3.1.2. Methodological framework

O'Malley organizes her framework for a scoping review in five stages: (1) initial research question, (2) identification of relevant studies, (3) study selection, (4) data charting and summary and (5) result report. So these sections will be briefly explained so that the reader can understand the process that will be later followed.

3.1.2.1. Initial research question

The starting point is to state the research question, it guides the scope and it is the main objective of the review. It is essential to correctly determine how broad the question will be as it will have a direct impact in the number of studies addressed. Too many studies will reduce the probability of missing an important research but it may increase immensely the effort necessary to conduct the review because of the huge number of sources.

3.1.2.2. Identification of relevant studies

The next step is to determine the eligibility criteria that will be used to decide which references will be included in the review. Each one of the criteria should be clearly explained. These limits will probably exclude relevant papers, but they are necessary due to practical reasons.

These search criteria will be later used in different databases or reference lists. Researchers must consider which databases to use and which related terms it is pertinent to search for.

3.1.2.3. Study selection

After the initial search, many irrelevant studies will arise, therefore, it is necessary to establish some additional criteria that will help the researcher to exclude those sources that are beside the point.

During this part of the review, it can be quite useful to follow a PRISMA 2020 flow diagram [62], which was introduced in the reviewed version of the Preferred Reporting Items for Systematic reviews and Meta-Analyses statement and is designed to help researchers report what was done and how, the template provided in Page's report is shown in the next figure:

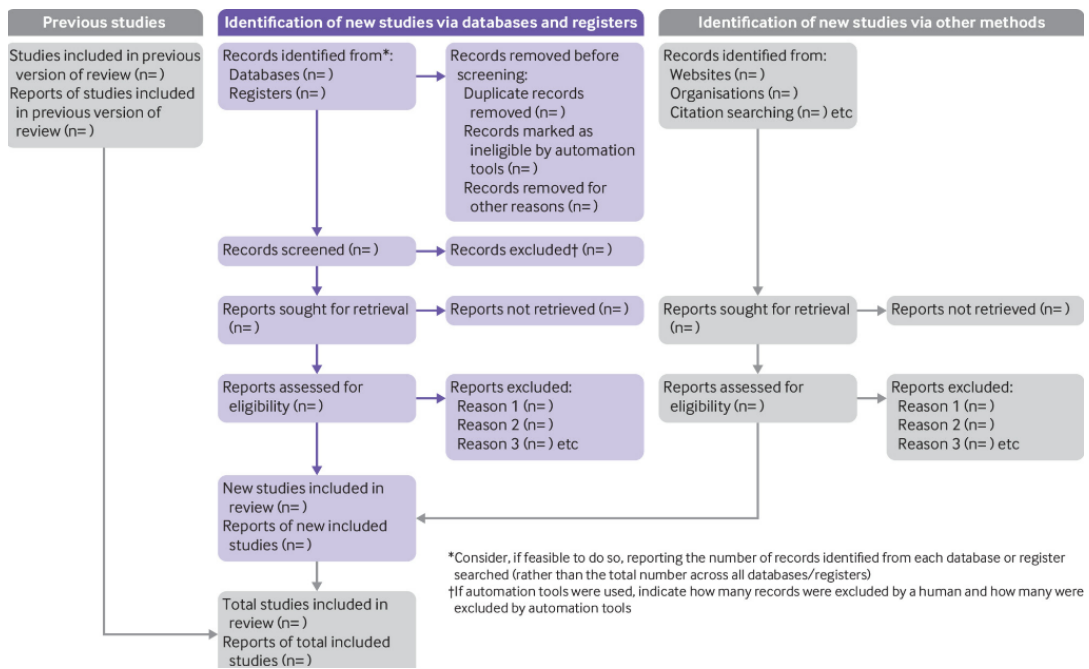


Figure 3.1: PRISMA 2020 flow diagram template

This way, the process of identification and screening of studies can be clearly represented and the reader can follow easily the steps followed by the researcher. In this flow diagram, records are removed in four different steps: before screening the records, after screening (reviewing and abstracts of the identified sources), records not retrieved and finally some criteria is establish to determine which studies will be included in the review out of those assessed for eligibility whose full texts will be read.

3.1.2.4. Data charting

In scoping reviews data charting is the data extraction, the process in which a summary of the results is included and the initial research question is normally answered[63].

The charting table should normally include the main characteristics of the included studies, such as the author(s), the year of publication or the study location and a record of the key information relevant to the answered question. Its main objective is to help the reader to access the results of the review with just a glance so that they can quickly come back while analyzing the final discussion.

3.1.2.5. Summary and result report

Finally, the results are presented and the decision process is shown and explained. In this section, comparisons between the different sources analyzed should be done in order to find contradictory evidence or changes in the approach depending on the source characteristics like the publication year.

Before concluding, the implications of the research and some future guidelines based on the gaps found are usually included in order to rectify the problems identified and prioritize that work.

Chapter 4

Development

Application based mobile payments are achieving a great success and many business opportunities arise thanks to its use. Nevertheless, as this is a new market there are normally many players in each region that offer similar technologies. Therefore, having a methodology to follow in order to select the most appropriate payment method becomes a necessity.

Consequently, this chapter's main goal is to provide a general methodology to follow so as to select the most suitable technology for each specific scenario. So, in the first place, main factors to consider will be identified. Then, the most important ones will be discussed and finally used to create the application based m-payments selection methodology.

4.1. Factors to consider

The main objective of this section is to identify and classify main factors that affect the selection of a mobile payment technology. First we will detail the scoping review that was conducted and then explain the conclusions of this process.

In order to fulfill the research objectives, it was decided to choose a scoping review approach to identify the relevant factors as we seek to identify key characteristics or factors related to a concept [61]. As it was explained in the previous section, this scoping review will follow O'Malley[59] framework: (1) identification of the research question, (2) identification of relevant studies, (3) selection of studies, (4) data charting, and (5) discussion of results.

4.1.1. Initial research questions

The main objective of this chapter is to explain how to select the appropriate mobile payment technology in a general environment. Consequently, the study proposes the following research questions:

- RQ1: Which variables should be considered for selection of a mobile payment technology?

4.1.2. Identification of relevant studies

In order to find relevant studies, we performed a search in Clarivate's Web of Science with the following exact query: (TS= ("mobile payment") OR TS= ("mobile banking") OR TS= ("M-Payment") OR TS= ("M-Banking")) AND TS= (Factor*) AND (TS= (Technology)) NOT (TS= (adopt*)) NOT (TS= (acceptan*)) NOT (TS= (satisfac*))

The first search option that we considered was to look for the keywords "mobile payment", "mobile banking", "M-payment" and "M-Banking" so as to specify the focus of our research. In addition to this, we filtered all the publications that do not mention factors affecting these technologies. At this point, many articles would analyze users' point of view, therefore, it was decided to eliminate the publications that study factors related to the adoption, acceptance, or satisfaction with the technology.

4.1.3. Study selection

This query provides 99 records, so it is necessary to select the most relevant studies. There are many other types of payments with smartphones apart from mobile payment applications, so it was decided to filter out the studies that explained other technologies such as NFC, RFID or SMS (criteria 1). Moreover, articles written from the point of view of the user or those that discuss modifications or innovations for current systems were excluded too because it is intended to analyze technologies already in use (criteria 2 and 3). Finally, we also established some additional inclusion criteria to select exclusively articles written in English or Spanish (criteria 4) after 2003 (criteria 5, articles before this point were considered obsolete) and to eliminate articles that do not focus on M-payments (criteria 6) or could not be found (criteria 7).

The selection of articles follows the PRISMA statement [62]. Figure 1 shows the PRISMA flow diagram.

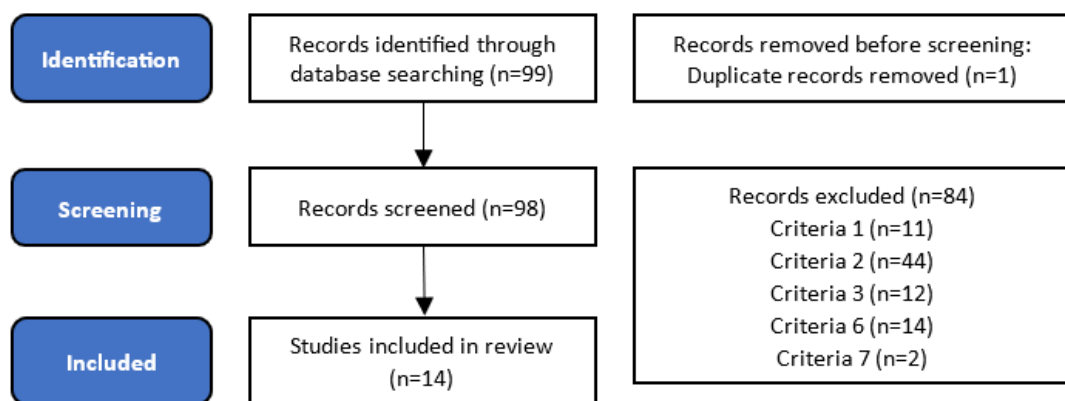


Figure 4.1: PRISMA flow diagram for article selection

4.1.4. Data charting

After reviewing the selected articles, when it comes to choosing a mobile payment technology, fourteen factors to consider could be found.

These variables can be classified into four different categories using the STOF (Service, Technology, Organization, and Finance) model as was done in previous literature [64][65]. Consequently, every variable related to the user has been grouped into the service section, those related to technical aspects into technology, factors that characterize the institution that manages the application into organization and finally the financial elements are independently grouped. For example, the ease of integration is purely technical, so it has been included in the technology group.

In the following table these fourteen factors are explained and classified:

	Factor	Classification	Definition
1	Type of technology used	Technology	There are different mobile payments technologies such as SMS, RFIF or NFC, depending on which one will be used, the implantation has to follow a different methodology. In this research, only application-based technologies will be analyzed.
2	Ease of integration	Technology	Evaluation of how complex it would be to implement the technology in the application or web of organization that will implant it in its business model.
3	Payment infrastructure access	Technology	This refers to how the service access to the payment infrastructure, there are three possibilities: direct access, indirect access (relying on third parties) or open access (Unobstructed access to the bitcoin network).
4	Scalability	Technology	Capacity of the application to grow in number of users.
5	Security	Technology	Protection against cyberattacks and unauthorized use. It includes the three principles of computer security: confidentiality, integrity, and availability.
6	Payment period	Technology	Timing of the payment, it can be real time ("cash" like payment schedule), pre-paid (pay in advance) or post-paid (receive the content before paying).
7	Market	Service	This refers to the main market in which the technology is used at the moment or where it is intended to be used.

Table 4.1: Factors classification and definition

	Factor	Classification	Definition
8	Geographic area	Service	Region where the technology can operate.
9	Ease of use	Service	How intuitive the application is and the number of steps necessary to complete a transaction.
10	Commissions	Financial	Required payments to complete the transaction. In this section every constraint to do transaction is included, such as minimum/maximum transfer amounts or maximum money that can be received by the same account.
11	Trust and financial strength	Financial	Confidence in the capability of the organization to cope with payments without any financial issue.
12	Independent institution	Organization	This factor takes into account whether the application is managed by an established financial institution, like a bank, or by an independent institution which are normally start-ups and may be important competitors to traditional players on the field.
13	Cross-operator functionality	Organization	Compatibility of the application with third parties.
14	User base	Organization	Number of active users.

Table 4.2: Factors classification and definition

Finally, a summary of the fourteen articles, identified by author, year and variables considered are shown in the following data charting (Table 1) [66][67][68][69][70][71][5][72][73][74][75][76][77][78].

Author(s)	Factors													
	Technology						Service			Financial		Organization		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Antovski & Gusev (2003)		x		x	x				x	x			x	
Ondrus & Pigneur (2006)	x				x				x	x		x	x	x
Dahlberg et al. (2008)	x				x	x			x	x	x		x	x
Guo (2008)		x			x	x			x	x				
Min (2009)	x				x				x				x	x
Lee (2011)	x	x			x	x			x	x	x			
Kshetri & Acharya (2012)					x		x	x		x				
Jain (2014)							x	x						
Gannamaneni et al. (2015)	x				x				x					
Raina (2015)	x				x				x					
Imran et al. (2016)	x						x	x	x					x
Kazan et al. (2017)			x										x	
Rukanova et al. (2019)	x						x	x						
Braido et al. (2021)	x			x				x						

Figure 4.2: Summary of the studies included in the scoping review

Factors: 1-Type of technology used; 2- Ease of integration; 3- Payment infrastructure access; 4- Scalability; 5- Security; 6- Payment period; 7- Market; 8- Geographic area; 9- Ease of use; 10-Commissions; 11-Trust and financial strength; 12-Independent institution; 13- Cross-operator functionality; 14-User base

4.1.5. Discussion

The next objective of this research is to identify the main factors that should be taken into account nowadays, to do so, a deep analysis of the previous review will be done. As an overview, technological factors have been losing importance over time because it is not a challenge anymore, in contrast, service factors are key nowadays as applications are becoming user centered [79]. Despite user base and cross operator functionalities, the rest of financial and organization factors are generally not mentioned since they are normally taken for granted.

Regarding the technology group, it can be seen that the type of technology is widely discussed, however, in the last few years, the winners seem to be the application based mobile payment technologies [80], so this will not be considered in the future methodology. Moreover, the payment period, the kind of access to payment infrastructures and the ease of integration are also not considered because these applications are mostly based on real-time transactions, the kind of access will not have an important impact and they are thought to be easily implemented. Despite it is key to make the user feel comfortable and convince them to trust the technology, in our analysis, it can be seen that security has been losing importance through the years as nowadays it is almost taken for granted thanks to the complex protocols and the legislation that concern this matter so this will not be one of the main factors that will appear in the posterior methodology [74]. At last, the technology certainly has to be scalable even though it may not be popular yet [66].

In the second group, which is called service, all three factors will be considered. As two thirds of the articles mention, the ease of use of the selected technology is key for the service to succeed [66]. It needs to be user friendly so that most clients can use the service easily even though they may not be familiar with many other online services. Furthermore, the geographical area is a common factor too, mainly in the newer articles, this is due to the trend that many mobile payment applications are mostly used in certain specific countries as they normally rely on partnerships between regional banks. In the third place, even though there is not a consensus, it was decided to consider in which market; social segments to which it is addressed; each one of the solutions is mainly used so that it is possible to select the target users [75].

In order to be sure that the implantation of the technology is profitable, a factor that must be considered are the commissions that each transaction involve [66]. While it is true that in the last few years publications gave it less importance because fares have been dropping globally, it is still necessary to consider minimum commissions per transaction especially if the intended use of the technology are micropayments. Regarding the second financial factor, trust and financial strength of the provider has always to be considered but it should not be problematic [71].

Finally, when it comes to the organization, it is necessary to mention an important difference between different applications: those created and managed by an already established financial institution and those created by independent institutions. Although the second group normally offers lower fares (factor 12) and a better service, established financial institutions already count on a bigger user base and faster growth expectancy (factor 10) [67]. However, this factor per se does not provide very important information so it will not be included in the final selection. In contrast, another key factor for success is to select a technology that already counts on a large user base because M-payments are services that may gain a strong benefit from network effects, therefore, the probability to increase users in the service will be greater if the user base in the technology also grows. In consideration of this, selecting a technology with a cross operator functionality is very interesting as the total user base will be the aggregated user bases of the different partners. In fact, this is one of the reasons why Bizum has become so popular in Spain as there are more than 30 partner banks [80].

To sum up, in the final methodology, 8 factors will be taken into account: scalability, market, geographic area, ease of use, commissions, trust and financial strength, cross-operator functionality and user base. In a general case, the first step is to find all possible technologies that operate in the desired area by financially trustworthy institutions, then, they should be ordered by user base (considering total user base in case the platform is cross operator and taking into account their market in case several solutions have similar user base). If in this step several solutions with a low user base are found, it is essential to check their scalability capabilities. In the third place, every option with commissions that cannot be affordable should be discarded. Finally, it is necessary to ensure that the technology is easy to use, otherwise, the final implementation has to make sure of this last point. Nonetheless, some of these factors can be irrelevant in some specific scenarios. In fact, scalability may not be considered in case the target users is a small niche, the ease of use will not be necessary for a

public which is familiar with some other technologies. Moreover, user base and cross operator functionality can be disregarded in case the service offered is expected to be so appealing that users would be willing to sign up for a new payment service.

4.2. Selection methodology

At this point, the most relevant factors have been identified, therefore, the next step is to build up a methodology that can be followed in a general case scenario. Furthermore, some specific situations will be explained in order to provide a wide point of view that should help to carry out this selection in most scenarios.

First of all, it is necessary to characterize possible users as there are some factors that depend indirectly on this information such as the user base and the target market of the technology. Some essential elements that have to be analyzed are the financial situation of the region where the service will be deployed, familiarity with new technologies and the level of connectivity or mobile penetration in those territories.

Once an overview of the environment is clear, the methodology should be followed by finding all possible technologies that operate in the desired area. This is indeed, a big constraint as nowadays most mobile payments applications can only work in limited regions because they strongly depend on agreements between banks, which are strongly linked to the places where they operate. Although it should normally not be necessary, it is recommended to check whether the companies behind each one of these technologies is a financially trustworthy institution so as to avoid any problems related to this matter.

Once the list with the possibles solutions is ready, it should be ordered by user base because this will usually be the key factor that will likely determine the success of the adoption of the service provided. The reason behind this is that creating a new account in a payment method is a huge bottleneck as most people are reluctant to have many active accounts at once. Furthermore, the difficulty to create these accounts have to be added, depending on the provider, it can be fast and only last a few days but in some specific cases it is necessary to open a formal bank account and to do so, the user needs to provide much documentation and go through an administrative ordeal.

To estimate the total user base, it is also required to take into account whether the platform has cross-operator functionalities, if that is the case, the total number of users will be the sum of users in each one of the partners. In case there are many options with similar user base, the specific market in which they operate can be considered in order to effectively order the list by priority.

However, user base and cross operator functionality can be disregarded in case the service offered is expected to be so appealing that users would be willing to sign up for a new payment service. This is normally not the case as there will usually be alternatives to the service that is trying to be implanted.

It is possible that in this step there are several solutions with low user base. Before considering those technologies as viable options, scalability has to be analyzed because if the scope of the solution is big, there has to be a security that it will be able to cope

with the expected final user base. Nonetheless, if the target users are a small niche, scalability does not need to be taken into account. For mobile payment technologies that already have a large user base it is not necessary to check scalability because it already works for the desired number of users.

The next step is to study the commissions that the authority charges for the use of this payment method and decide whether they are affordable. In case these commissions could not be assumed, the technology has to be discarded. There are many key fees that have to be considered, depending on the objective of the project some of them will be more important than others. Undoubtedly, the first one that has to be inspected is the commissions percentage in each transaction, nowadays there are many technologies that charge a 0% per transaction but this is not always the case, normally this percentage only holds for transactions between accounts of the same entity. Another common practice in many payment methods are minimum fees per transactions, this is key to determine whether the technology is suitable for micro payments or not. Therefore, if the goal is to use the solution for small payments, minimum fees and minimum amounts per transactions must definitely be taken into account. Finally, there are many technologies with maximum amounts per transaction, so depending on the purpose and expected transferred quantities it may be needed to discard some options.

Finally, it is necessary to ensure that the technology is easy to use, otherwise, the final implementation has to make sure of this last point. The ease of use is not always a constraint because it will not be necessary for a public which is familiar with some other technologies or with similar business models.

The following figure shows a summary of this whole process:

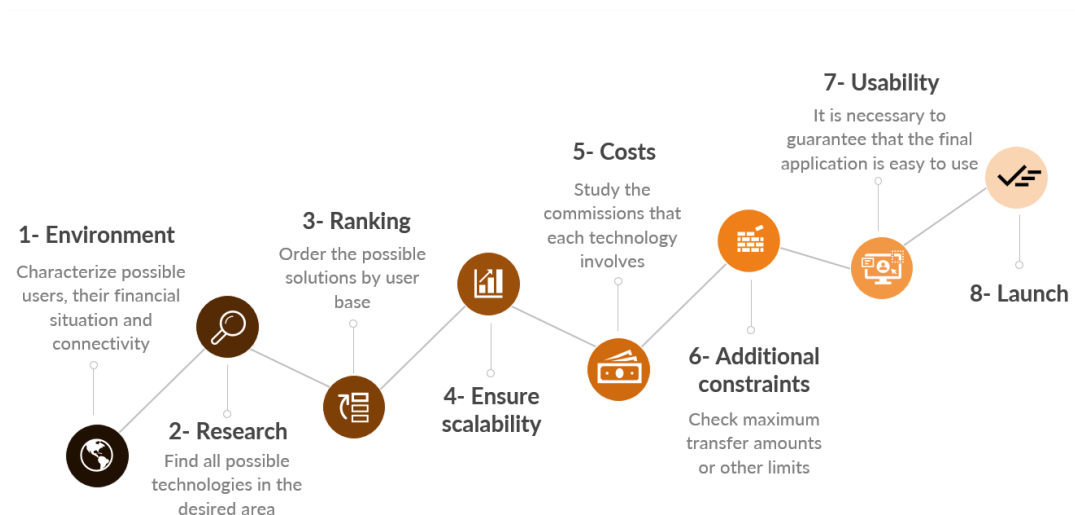


Figure 4.3: Selection methodology (Own elaboration)

Chapter 5

Case studies

In this following section a few implantation examples will be included, this way, the methodology that was just created can be seen into action in real life examples. These scenarios are the ones developed for the Acciona.org Foundation by the Information Technologies for Business Management department in Madrid Polytechnic University.

5.1. Acciona.org Foundation

Spanish company Acciona has a corporate foundation under the claim of The Energy & Water Foundation which is called Acciona.org. As they explain in their website, their mission is to cooperate for development through promoting the access to energy, water, and infrastructures.

Their objective is to help people and communities with no prospect of having covered those basic needs or people who find it difficult to pay for these services. This goal contributes to the achievement of the Sustainable Development Goals (SDG). In fact, they impact its three dimensions (economic, social, and environmental) but it can be seen directly in the following SDGs: SDG6 on water & sanitation, SDG7 on sustainable & affordable energy, and SDG9 on resilient infrastructures and promotion of innovation because they make an effort to bring access to energy, water, and sanitation to very-low-income people by applying technological and managerial innovation criteria.

To fulfill these goals, it is intended to provide third generation solar home systems (3GSHS), which are very efficient, have a plug and play architecture and can be easily transported due to their compacity and low weight. In order to validate the technology, an integrated Pay-as-you-go (PAYG) system has been adopted so the service is provided in return of a small affordable fee.

Acciona.org Foundation has been functioning for 14 years, and right now they have 15 ongoing projects with more than twenty thousand households benefited up to now. All these projects are carried out in seven countries among which Panama, Peru, Mexico, Chile, and Philippines can be found. [81]

5.2. Panama implantation

The first country in which this research will go into so as to provide the first implantation example is Panama. Acciona.org has worked in Panama through Microenergia Panama since 2013, a non-profit association established in 2018. Their objective there is to bring access to modern energy to low-income people living in Panamanian rural communities, as in those areas it is not expected to have service with conventional means anytime soon.

Nowadays Acciona is operating in one region: Ngäbe-Buglé, which is an indigenous region in the west of Panama where almost 3 thousand households and fifteen thousand beneficiaries receive around six million of available lightning per year, which is equivalent to 1200 tons of CO₂ avoided. [82]

5.2.1. Current situation

The implantation analysis will start with the steps that the methodology has detailed, so it is important to characterize the users in the first place, both financially and socially. In Panama the financial inclusion is quite low as only 45% of adults have their own bank account, that is three points behind the average in Latin America. Most of this people only use the bank account to receive their salary, in fact, only 14% keep their savings in that account and 13% use it to make payments.

It is essential to take into account the big difference between the general statistics and those that are specific for rural areas, which is our implementation environment. When it comes to the number of people with an account, it decreases a 14% compared to urban areas, which is a big difference, as in high income countries this datum barely decreases and in Latin America it decreases only a 7%. This means that there is an important gap between rural and urban areas in Panama [83].

This gap can be clearly seen when the analysis is done per provinces. Panama has 10 provinces and 4 comarcas but three of the provinces and the Indigenous regions have a low financial inclusion indicator. In order to financially characterize these comarcas, an interesting datum is the amount of loans to small or micro companies, in Panama five billion dollars were loaned in this matter and only three hundred thousand come from these areas, that is a 0.004% of those loans [84]. As it has been stated, Acciona.org Foundation's activity is developed in Ngäbe-Buglé. This territory, which was created in 1997, is relatively autonomous to the state of Panama and is managed by the indigenous (the ngäbe and the buglés) with a highly collective political and social organization. This area is located in the west of the Republic of Panama, a region that rises on a mountainous area, with a difficult access due to the abundant rivers and valleys and has a tropical rainy climate. [85]

Ngäbe-Buglé is financially quite poor as they have a multidimensional poverty index (which shows the nature and intensity of poverty at the individual level in three basic areas: education, health, and standard of living) of 93,4%. For our characterization it is necessary to know how familiar the population is with new

technologies and their education level. In this specific case, 70% of the population older than 10 years knows how to read and write and the average number of years of studies passed is four.

If the access to basic services is analyzed, the figures were disappointing as in 2014 only 0.3% of the population in Ngäbe-Buglé had access to water and electricity. Fortunately, this situation has slightly improved since the arrival of Acciona.org, in fact, it reached 13.5% of the population in 2017, which still leaves a lot of work to do but results are certainly arriving [86].

The activity is focused on two districts, Müna and Nole Duima. On the one hand, Müna has an 88% of population in poverty, 66% in extreme poverty and a big Gini coefficient, 0.45, which also implies that there is a big inequality. Finally, another important statistic if this region is that the average salary is 64\$. On the other hand, Nole Duima has an 88% of poverty too, 67% in extreme poverty, a Gini Coefficient of 0.44 and a mean salary of 62\$ [86].

Finally, connectivity and mobile penetration are definitely two facts to consider. In 2010, Panama's Ministry of Economy and Finance found that access to landline telephones in comarcas was almost non-existent. In fact, only 0.9% of households in the Ngäbe and Bugle indigenous groups' comarcas had this access. This situation changed with the arrival of mobile phones and wide-ranging broadband coverage across the country because 26.9% of households in Ngäbe Bugle's comarcas had at least one mobile phone, which enabled the access to mobile banking to rise dramatically [87].

Once the users are fully characterized and understood, the methodology to select a technology can start.

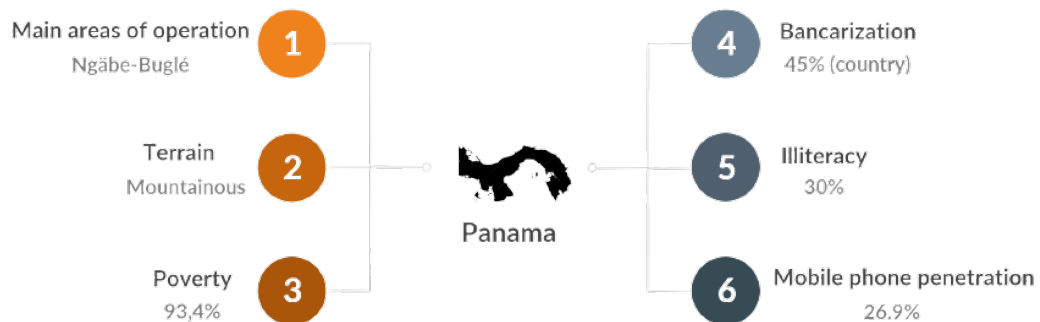


Figure 5.1: Summary of Panama's environment(Own elaboration)

5.2.2. Methodology

After analyzing the key factors of the Panamanian society that we need to take into account, the following task is to apply the methodology that resulted from the previous chapter.

5.2.2.1. Available technologies

As it was explained in the methodology, the next step is to find and analyze the main options that can be found in the region of interest that provide m-payment based applications. In this first case, there are three technologies available: Zinli, Nequi and Yappy.

Zinli is a virtual wallet that allows the user to have a virtual or a physical card, it operates with US dollars, and it allows instant mobile payments to any of your contacts. One of the main Zinli's differentiating factors is the possibility to recharge the virtual wallet with cash, this can be done thanks to a partnership with Punto Pago, a company that deploys physical kiosk in the country where the user can insert the desired amount and send it to their Zinli wallet [88]. Having the possibility to change cash into mobile money is an interesting feature, especially, in this environment because of the low bancarization of the region, as it has already been shown. It depends on the Banco Mercantil Panamá, as it was created by an affiliate branch of this bank [89]. Zinli has reached one million of users, but a big part of its operations is located in Venezuela so their number of users in Panama is quite smaller.

Nequi is a digital bank that was founded in Colombia, and it has achieved great success in that region (14.5 million users), then it expanded to Panama and its intention is to continue growing. Among the main functionalities it includes virtual cards, physical recharge thanks to Punto Pago, as Zinli does too, and instant payments to other Nequi accounts or bank accounts [90]. Nequi is a startup created by Bancolombia [91], one of the main banks in Colombia with more than 25 million clients [92], therefore, this application has a strong financial institution to support it. In 2017 Banitsmo (Panamanian part of the Bancolombia group) introduced Nequi in Panama [93], making out of it one of the first m-payments that arrived to this country, which was a great opportunity and it reached 100.000 users in 2019 [94], however in 2021 it only grew to 150.000 users, falling behind its great competitor, Yappy [95].

Yappy is a mobile payment technology that also allows instant digital payments between peers, the information needed is the phone number and the user can also search for the companies that are registered and complete their payments through this application. Contrary to the previous two payment methods, Yappy is clearly designed to be used by small and medium companies, not only between users [96]. Yappy was created by Banco General, which is the biggest private bank in Panama with 71 branches in the country [97], so the financial strength of the institution behind the technology is not an issue. Yappy has a dedicated section for the integration inside your web, there you can find specific documentation, libraries and plug-ins that should make the integration pretty straight forward, which is an advantage when it comes to choosing this application. Yappy has experienced an incredible fast growth as it only had 100.000 users in 2019 [94] during this year there was an important dispute against Nequi, but only three years later it reached the million of users [98] and became the most used m-payment in Panama.

5.2.2.2. User base ranking

Now these three technologies should be ordered by user base, considering the information that was just mentioned, the ordered list is the following one: Yappy, Nequi and Zinli. Yappy clearly the most used and established technology in Panama, so for the moment there is no doubt regarding which one to use so it is not necessary to analyze the specific market where they operate. Anyways, the three service are oriented towards the general public so it would not be a key factor.

In addition to this, as the three of the solutions have a large user base, it is not necessary to analyze its scalability capabilities. Because of this, the next step to follow is the one heavily related to the economic viability, that is commissions and costs of each one of the options that are being considered.

5.2.2.3. Commissions

First of all, Zinli has no limit in the number of transfers, and it charges a 0% fee per transfer to other Zinli accounts. There is an additional constraint as each wallet has a limit of 1500\$, this should not be a huge problem for users, however, if companies intend to use it for their business, they will likely surpass this limit, this setback will make us disregard Zinli as a viable option for the moment. Nequi has no commissions for transfers to other Nequi accounts or Banistmo's bank accounts. What is more, creating the account is free, however, there are some extra fees for improving the service, such as requesting a virtual card or doing transfers to other bank accounts apart from Banitsmo, which costs 5\$ per year.

Finally, Yappy would normally charge for each payment you receive in your business through any Yappy Commercial payment method, a commission of 1% + ITBMS of the transaction amount will be charged. This is not an important problem; however, they also charge a minimum commission of 0.02\$, which can make quite difficult to make a business based in micropayments available [99]. Fortunately, there are some exception to this and as Acciona.org is an NGO, the commissions charged are null, so in our specific case, no fees would be paid to use Yappy.

5.2.2.4. Conclusions

In the following table we have shown the key characteristics of each one of the payment applications that were analyzed in the previous sections:

	Institution	Users	Cash inflow	Commissions	Constraints
Yappy	Banco General	1 million	No	0%	1% of commissions if the company is not an NGO
Nequi	Banitsmo (Grupo Bancolombia)	150.000	Yes	0%	5\$ for transfers to other bank accounts
Zinli	Banco Mercantil Panamá	1 million (both Panama and Venezuela)	Yes	0%	Limit of 1500\$ per wallet

Table 5.1: Summary of each mobile payment technology in Panama

At this point, our main option is Yappy because it has the most users and it has not been discarded because of high commissions or scalability problems, now the next step is to consider the ease of use of this technology.

As it was shown while analyzing the society in Ngäbe-Buglé, the level of education is usually not very high, therefore, the use of the technology can be a setback. It was decided to establish some specific roles “entrepreneurs” who would be people in charge of managing the application. Before implanting the system, it is necessary to teach them how to use the whole application. These “entrepreneurs” are located in strategic locations (transit towns or those with an important market), so that users from the surroundings can go and complete the necessary transactions.

5.3. Peru implantation

Acciona established Acciona.org Peru in 2009 with the objective of provide access to low-income people to modern energy, safe water, and other basic services as otherwise they would not have access to them.

Acciona.org Foundation has at the moment four operation areas in Peru: Cajamarca, Loreto, Cusco, and Ica where they provide service to almost 350 indigenous or rural communities with more than 38 thousand beneficiaries. They currently receive around 18 million hours of available light, which avoids almost three thousand tons of CO₂ per year.[100]

5.3.1. Current situation

As done previously, it is necessary to start by checking main characteristics of the society in Peru.

This analysis will start with the Human Development Index, which is an indicator developed by the United Nations Development Program that measures the level of development of each country based on variables such as life expectancy, education and per capita income. In the case of Peru, it is now 0.75 as it has greatly increased since the nineties (0.6 in that decade) [101].

In this research the focus will be on the main two regions where the activity is developed: Cajamarca and Loreto, as together they have 93% of the beneficiaries.

Cajamarca is one of the regions with the greatest natural resources, but, in contrast, it has the highest poverty rates in Peru. Poverty reaches a 50.8% level and extreme poverty is in the range of 16.6% to 23.9%. It has practically not moved in recent years, thus demonstrating that Cajamarca is not only the poorest region in the country but also has permanent poverty. One of the reasons to explain this is that this region has the highest rate of rural population, 66% [102].

Loreto is Peru's most remote region, and it has 369,000 square kilometers, most of them of Amazon jungle. Loreto is also one of Peru's regions with lower population density, with a population of approximately one million people (10% indigenous) and it is also one of the poorest regions of Peru with a poverty index above the average of the country, which is between 33 and 37% [103].

Cajamarca and Loreto are the third and the fourth regions in Peru with the least GVA per capita, with ten thousand soles approximately and the two regions that grow the least in this matter [104].

What is more, inequality is a problem too in those regions as they are the ones with the highest Gini index of the country, with 0.51 in Loreto and 0.48 in Cajamarca [105]. When it comes to the bancarization level, the two regions of interest, Cajamarca and Loreto have 8% and 17% respectively, compared to the 50% level in Lima [106]. These low percentages may be a booster for the use of mobile payments in those regions.

As it was done before, education is a key factor to determine the difficulty that users will have while using the technology. Contrary to the previous case, in Loreto a

big gap in education cannot be found, in fact, attendance rates in primary education are quite similar to the national standards (90%). Nevertheless, Loreto has gaps in underachievement, delay, and in the expenditure per student, which is lower than the national average [104]. In this context, it's not surprising that, on average, the population of Loreto has fewer years of education than the national average. The education in Cajamarca has been in the last years one of the worst considered in Peru, with an illiteracy rate of almost 20% [107].

The last point to analyze is connectivity and mobile penetration. Unfortunately, the quality of telecommunications in Loreto is one of the worst in Peru. There are some deficiencies in coverage and speed when it comes to both the mobile signal and internet services. Particularly in rural areas. Even though in these areas the connectivity is much lower than the mean of the country, the situation is good enough to implant our service, as in Loreto 57% of the population owns a mobile phone and 32% uses internet through a smartphone [104].

The connectivity in those regions is good enough as Loreto has a 94% of its districts with mobile phone coverage and Cajamarca has a complete coverage [108].

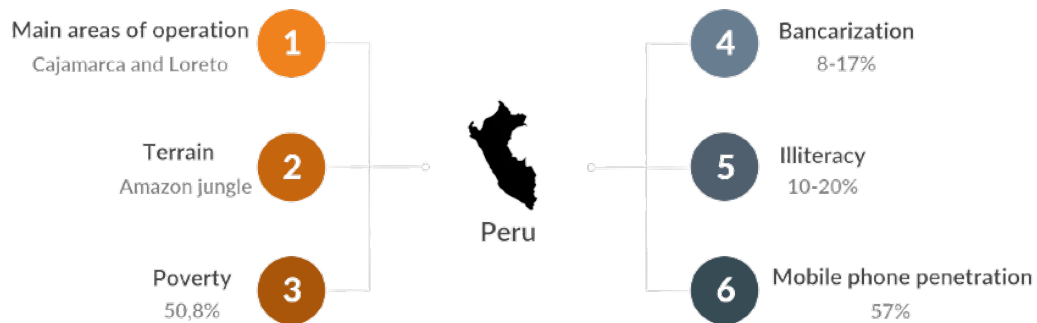


Figure 5.2: Summary of Peru's environment(Own elaboration)

5.3.2. Methodology

As now the general environment has been overviewed, we can directly study the application based mobile payment technologies in Peru.

5.3.2.1. Available technologies

As it was done in the first implantation example, first it is needed to find and analyze the main m-payment applications that operate in our region of interest, Peru. In contrast to Panama, here there are more technologies available, among which Yape, Plin, Tunki and Lukita can be found.

Yape is a mobile payment application that allows instant transfers to any of your contacts in Peru. What is more, it is used by many small businesses because of the

success of its QR payments. Although Yape was created by BCP, it can be used by clients of many other banks such as, Banco de la Nación, Mibanco, Caja Cusco, Caja Huancayo, Caja Ica, Caja Piura, Caja Sullana, Caja Trujillo and Caja Tacna, this increases notably the potential userbase. Furthermore, it is also possible to create a Yape account without a bank account, which also makes this application quite accessible especially in our areas of operation which have a poorer bancarization than the rest of the country but in this case, there are many constraints applied to the account. Another key point is that users are allowed to make cash deposits in Yape through any BCP office. As it says in their web, Yape already has more than 10 million users making it one of the biggest m-payment technology in the region. [109]

Plin is the second most used m-payment method in Peru, with more than 10 million users, it allows transfers between clients of Interbank, Scotiabank, BBVA, BanBif, Caja Arequipa and Caja Sullana. Same as Yape, their transfers are instantaneous, you only need the phone number to select the receiver and it also allows QR payments [110] [111]. Although Plin is a common technology between these banks, each one of them have their own applications and virtual wallets, for example, Tunki (created by Interbank) or Lukita (created by BBVA), depending on the application used, cash deposit will be allowed or not.

Bim is another mobile wallet created by Pagos Digitales Peruanos S.A., an association between multiple Peruvian banks. It has some interesting characteristics that differentiate this option of the rest of competitors. Bim main objective is to help people with low bancarization and access to technologies, to do so, first of all, users do not need a bank account to start using Bim, secondly, there are more than 15.000 businesses such as supermarkets, pharmacies or bookstores where the user can go and make payments using Bim, this is especially interesting to people with no knowledge on how to use the technology or poor access to smartphones or other devices as they cannot use the app on their own [112]. Bim reached 1 million users in 2021 and it continues growing, mainly in the target of population that do not own their own bank account [113].

Agora is a digital wallet that has reached 1.5 million users [114], it allows instant transfers and is linked to a Visa card. It is possible to create an account without a bank account and to charge and withdraw money in their shops and online. The financial institution behind this service is Intercorp, a strong financial group in Peru. [115] [113].

Finally, a new digital wallet is being developed by 11 Cajas Municipales y Crédito (CMAC), it will be available in summer 2023. As it is not public at the moment and there are many unknowns regarding its operation it will not be included in this analysis, but it should be taken into account in the future [116].

5.3.2.2. User base ranking

Until now, there has been an intense competition between Plin and Yape, nevertheless, there has been a drastic change in the environment in 2023 as the BCR (Banco Central de Reserva del Perú) has decided to make interoperability between digital wallets

mandatory. This is a huge revolution because for the moment the most important companies have said that they will not put extra fees on this kind of transactions so the userbase of a web that includes any of these m-payment applications is the sum of every user of all competitors [117].

Considering this mandatory cross-operator functionality, user base is not key to determine which technology to select, however, if the service is known by the user previously, the on boarding will be easier. So, the ordered list will be: Yape, Plin, Agora and Bim. The last two are clearly oriented to low bancarization segments of the society while Yape and Plin focus on offering a service to the whole society, which is the focus of our application too, but the difference in users is right now just too big to select Bim or Agora. Once the interoperation is implanted, the niche of users might increase its importance.

These four applications are big enough not to worry about their future scalability, however, commissions are the next big point to take into account and check whether they are viable in our business model or not.

5.3.2.3. Commissions

Yape charges no commissions for any transaction, however, there are some limits in its usage. As it was explained before, there are many ways to open a Yape account, which results in different privileges: Yape ID account (without a bank account), Yape account linked to a BCP account and a Yape account linked with an account from any other available financial institution. With all of these types of Yape you can send a maximum of 132.55\$ per day, which is not a very low limit so in most cases this should not be an issue. When it comes to the maximum amount you can receive, it depends on the account. Yape ID accounts and BCP ones can receive up to 5301,98\$ per day which depending on the business model and size can be a big constraint, in our case, this amount will not be reached. Accounts linked with other financial entities can only receive 1325,49\$ per day.

Plin has no extra fees per transaction either, however, there are some restrictions when it comes to maximum transfers. Each operation cannot surpass a limit of 132,55\$ and in the same day a unique user is not allowed to send more than 397,65\$, which is a higher limit than Yape. However, there is a minimum transfer amount of 0,27\$.

Opening a new Bim account is free, as it is also free to make deposits or send money to other users. However, the main issue related to Bim's commissions is that they charge an extra fee if the user wants to withdraw money, this fee normally goes from 0.5% to 1%. However, this commissions may change depending on the financial institution that the client is using to access Bim and they offer personalized commissions to companies that are interested in accepting payments with it, but this will vary on the specific project [118].

Agora has no commissions for opening an account or for transactions between users. There are some extra fees for a virtual card, for some kinds of recharge and for withdraws in ATMs.

5.3.2.4. Conclusions

In the following table a summary of each one of the payment methods that were analyzed can be seen:

	Institution	Users	Cash inflow	Commissions	Constraints
Yape	BCP	12 million	Yes	0%	Receive a maximum of 5301,98\$ per day
Plin	Scotiabank, Interbank and BBVA	10 million	Depends on the partner bank	0%	Minimum transfer 0,27\$
Bim	Pagos Digitales Peruanos S.A.	1 million	Yes	0%	Extra fees for withdrawing money
Agora	Intercorp	1.5 million	Yes	0%	Commission for withdrawing in an ATM

Table 5.2: Summary of each mobile payment technology in Peru

At this point, Yape can be considered as our first option as soon as the transactions do not overpass the limit of 5301,98\$ per day, which should not normally be the case because there is not a fixed day to receive all the payments. As the interoperability is not implanted yet at the moment at which this research is being conducted, the big userbase that Yape counts on is still an important factor to consider.

In our areas of operation in Peru the level of education is better than in Ngäbe-Buglé so this should not be an important setback. In fact, the way of operation will be similar with some “entrepreneurs” distributed in the territory who will be in charge of managing the web and completing payments this explains why the differentiating factor of Bim and Agora, the partner businesses, is not necessary and the decision to select Yape is even clearer.

Once the interoperability is implanted, probably Plin would be the better option so as to avoid the maximum transfer limit that Yape imposes. Bim and Agora would eliminate their major problem, which is their low userbase and they would become an option that should be considered if the business model implies that many unbanked customers complete payments throughout the country.

Chapter 6

Conclusions and future guidelines

6.1. Conclusions

In this document the current situation of the digital payments landscape has been overviewed and taken into account in the design of a methodology to select an application based mobile payment. Then this methodology has been applied to two real scenarios in Panama and Peru. After this process a few conclusions can be obtained:

- Digital payments market is growing and is expected to continue with this trend in the future.
- There is an increasing demand on micropayments and mobile payments are the ones more suitable for fulfilling this necessity because of their nature for completing small, frequent and fast payments.
- Mobile payments can be classified into global and local solutions. Even though global solutions may be more convenient, local solutions offer lower fares and a better service overall.
- There are four main types of mobile payments: SMS, QR, NFC and application based. Each one of them has their own advantages and disadvantages so they solve different problems.
- At the moment many application based mobile payments only allow transfers between users of the same platform which simplifies the process of a transaction, however, there is a trend towards interoperability because of specific legislation to do so in many countries.
- Mobile payments can be quite useful in developing countries as they can help to solve the bancarization problem and the low infrastructure in rural areas by taking advantage of the high mobile phone penetration worldwide.
- There are many factors that affect the selection of a mobile payment technology and they can be classified using the STOF (Service, Technology, Organization, and Finance) model.

- Technological factors have been losing importance lately as they are not a challenge anymore, in contrast, user related factors are key nowadays, therefore, usability and user base will definitely have to be considered.
- In order to select an application based mobile payment application, first, it is important to characterize possible users, then all possible options should be considered and ranked. Finally, economical viability has to be guaranteed and the tool needs to be easy and fast to use.
- There are three main application based mobile payments in Panama: Yappy, Nequi and Zinli. Yappy is the most viable option to select in this region mainly because of their large userbase and their 0% commissions.
- Yape has been the selected mobile payment in Peru because it is the most used tool in the region, it has no commissions and their additional constraints are lower than their main competitors, Plin, Bim and Agora.
- With this research we have participated in the 17th International Conference on Industrial Engineering and Industrial Management which will be held in Barcelona the 6th and 7th of July. That paper was titled "Application based mobile payments technology selection: A scoping review" and focused on the factors relevant to the selection of the most appropriate mobile payment application.

6.2. Future guidelines

As it has been explained in the methodology, one of the main variables that affect the selection of a payment technology is the usability, therefore, in order to make sure that our implementation is successful one of the key goals is to make the application and the payment process quite easy to use.

With this objective in mind, we have already started to work on monitoring the user behaviour. To do this we are integrating event tracking in our web application, which will give us information regarding everything that the user does in the web. During this integration we have used Jitsu as a data ingestion engine and Amplitude as a digital analytics tool.

This process will allow us to optimize user's behaviour and characterize our clients, which will result in a data driven approach towards the future development of the application.

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Appendix A

Ethical, economic, social and environmental aspects

In this section the environmental, economic, social and ethical aspects and consequences of this research will be detailed.

A.1. Environmental aspects

This research focuses on mobile payments and provides a methodology to spread its use, which is an example of sustainable IT. Encouraging the use of M-payments contributes to the digitization of payments, which reduces the production of physical money and its impact on the environment. Cash involves many expenses, not only in the production, but also in its hoarding, transportation and destruction, which are highly polluting processes too. In fact, when the Euro banknotes were introduced, the ECB carried out an analysis to determine the environmental impact of the banknotes, it concluded that the three billion banknotes produced in 2003 had an environmental impact equivalent to each European citizen travelling one kilometer by car[119].

Most of this carbon footprint can be eliminated thanks to spreading the use of digital payments, which is one of the goals of this study and is aligned with the SDG12, related to responsible production and consumption.

In addition to this, the implantation examples that were detailed in the research applies mobile payments to a PAYG model of solar panels, so that the use of clean, green energy is encouraged.

A.2. Economic and social aspects

Introducing mobile payments in developing countries is a remarkable innovation effort (SDG9) that aims to increase users' digital skills and therefore reduce the illectronism (digital illiteracy). Becoming familiar with mobile payments will make it easier to understand and use more digital technologies.

Furthermore, mobile payments is an important tool to help people in low bancarization areas access financial products. This consequence is directly related

to the SDG10, which aims to reduce inequalities between countries.

Finally, both implantation examples that were explained in chapter 5 were developed alongside Acciona.org with the intention to ease the access to energy in remote areas of developing countries (SDG7), which will not only improve their life's quality but also accelerate the economic activities in the region.

A.3. Ethical aspects

There are some ethical aspects related to the use of mobile payments, one of the most relevant is the handling of sensitive data. During a transaction much information is exchanged and it is necessary that confidentiality is ensured. What is more, the payment system needs to be reliable so that users can be able to trust the technology.

These both ethical necessities were analyzed in the selection methodology as security was one of the factors that were taken into account. Furthermore, financial reliability of the institution behind the m-payment technology was also taken into account so that any kind of liquidity problem can be avoided and make sure that this will not be a problem for users.

Appendix B

Financial budget

- Personnel costs:

	Cost per hour (€)	Hours	Total (€)
Tutor of the project	30	20	600
Engineering student	18	324	5832
TOTAL			6432

Table B.1: Personnel cost.

- Cost of materials:

	Life time (years)	Uds.	Cost (€)	Amortization (€/month)	Use (months)	Total (€)
Laptop	5	1	1100	18.33	8	146.67
TOTAL						146.67

Table B.2: Cost of materials.

Finally, the estimation of indirect costs will be the 10% of the direct costs and the estimated industrial profit is 5%.

	Costs
Personnel costs	6432€
Cost of materials	147€
Direct costs	6579€
Indirect costs	658€
Direct + indirect costs	7237€
Industrial profit	362€
Subtotal	7599€
IVA	1596€
Total	9195€

Table B.3: Total costs.