



Public transport payment systems: market survey

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Abstract

In our research work, we study transport card security issues. One of the questions of our study is its relevance in the world and particular in Kazakhstan. Therefore, in this work, we conducted research on the market of transport cards in the world and Kazakhstan. As part of the study, we searched for answers to the following questions: what technologies are used to accept payment by transport cards, in which countries the electronic ticketing system has been introduced, in which cities of Kazakhstan have electronic ticketing systems been implemented, what technologies are used in Kazakhstan. As a result, we showed that the popularity of using NFC payment in the world and in Kazakhstan is growing. We also analyzed the existing electronic ticketing systems in Kazakhstan, made a comparative analysis and got a comparative table.

Keywords: transport payment system, near field communication, NFC, EMV, Bluetooth, RFID.

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In Kazakhstan development of mobile communication systems has become an important feature in the new and emerging technological world. These systems decide a series of problems and help to build smart cities. However, they include cumulative tasks to achieve a high quality of safety and convenience. The main problem that will be discussed in this paper is determining the appropriate type of technology for transport cards. Our goal is to assess the reliability of each of the current modes of payment, in particular, considering opportunities for fraud. We are interested in the determination of relevant approaches among three ways of payment: contact, contactless and mobile payment. We are comparing technologies available to send data to make the payment.

Related works

Development of mobile communication has become an important feature in the new and emerging technological world. Today the number of smartphone user's worldwide reaches 3.5 billion, which means 42.15% of that year's global population. The 2.3 billion of them enable Near-field communication (NFC) technology, it means 30 percent of the world's population have access to NFC [1]. The figure 1 presents statistics of 2016 when there were only 2.5 billion users.

Market analysis

Near-field communication is a set of communication protocols by which two electronic devices communicate without physical contact. NFC is based on radio-frequency identification technology known as RFID. It allows compatible hardware to supply power and communicate with an unpowered and passive electronic tag using radio waves [2]. One of the advantages of NFC from RFID is the presence of both directions in communications, receive and send data. Smart cards, electronic ticket cards, credit cards and mobile payment represents contactless payment systems, which works with a high frequency of 13.56 MHz in the range about 10 centimeters.

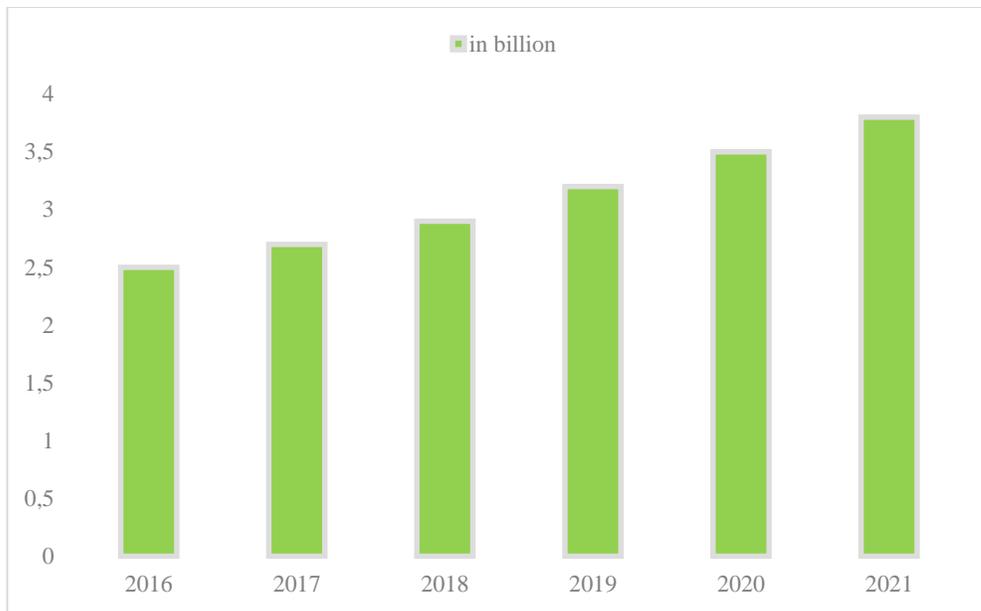


Figure 1. Number of smartphone users in worldwide in 2016-2021 years

Every active NFC device has three operating modes: NFC reader/writer, NFC card emulation and NFC peer-to-peer. The first mode enables NFC-enabled devices to read information stored on NFC tags. This method used in an advertisement, a poster, an electronic ticket cards and an IoT. The second one enables two NFC-enabled devices to communicate with each other to exchange information. The last enables to NFC-enabled devices such as smartphones to act like smart cards, allowing users to perform transactions such as payment or ticketing. This mode of NFC technology often uses by bank, mobile wallets such as Apple Pay, Samsung Pay, PayPal and ATF bank.

Technology comparison

Although NFC is not only one and the best technology in the field of communications or payment. There are other technologies that provide functionality that makes them suitable for needs that NFC can't address. For success implementation, it is important to choose the right technology for a particular task by comparing these technologies. In this article, we are comparing NFC with wired and wireless technologies.

Comparison EMV, Bluetooth with NFC is a bit unnecessary because EMV and Bluetooth have been more available for many years and in many countries. There are several important technical differences between them, that gives NFC some significant benefits in certain circumstances.

The main difference between the EMV and NFC is that EMV is standard for smart cards, which allows contact payments. EMV cards contain a computer chip that acts as a miniature processor and transmitter. The information in this chip is dynamic. When an EMV card is inserted into the chip reader, the sliding contacts start reading from the chip, so it works at a super short distance. Thus, transactions by EMV chips are time consuming. Despite this, EMV is a more secure payment system.

The main argument for comparing NFC with Bluetooth is that both are wireless technology for communication. The range of transmission data in NFC is shorter than Bluetooth. Bluetooth connections can send data up to 10 meters, while NFC sends data in the range of about 10 centimeters. NFC has several advantages: fast connectivity, fast speed, convenience. The basic advantage in favor of NFC is that it requires much less power consumption than Bluetooth. This makes NFC perfect for passive devices, such as the electronic ticket cards, as they can operate without a major power source.

Over the past five years, the transport payment system industry has grown rapidly. EMV with NFC is the most popular technology that has been implemented in many major cities. In 2015, Bogota became the first city in Latin America, to introduce MasterCard payments on an urban transit system. In 2017, Singapore chose MasterCard to trial open-loop payments on its metro system. Since then more than 100,000 MasterCard users have participated in the pilot version. New York's subway and bus system has used a “tap and go” payment system since 2019.

In addition, *Global Mass Transit Research* analyzed NFC-based mobile ticketing transit in 300 cities: 50 of them from North America, Latin America – 20 cities, Asia Pacific – 75, Europe – 115, Middle East and Africa – 40 cities [4]. The result of research demonstrated on figure 2.

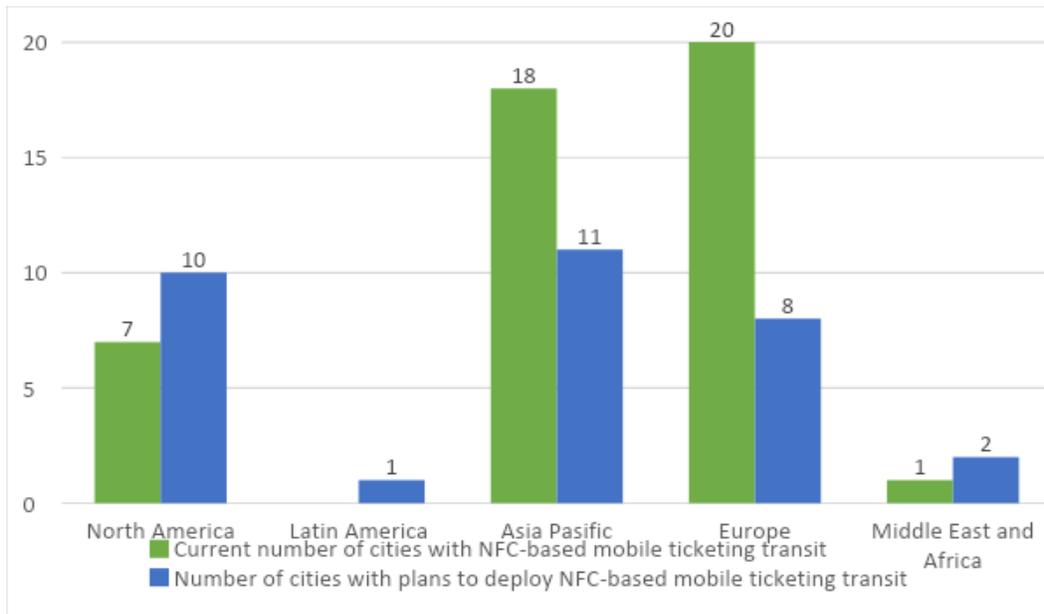


Figure 2. NFC-based mobile ticketing transit in worldwide for 2019

It shows that 46 cities have deployed NFC-based mobile ticketing and 32 cities have unveiled concrete plans to deploy it in the future. Europe is leading the way with 20 cities with NFC-based mobile ticketing transit, followed by an Asia-Pacific region with 18 cities. The North American market has enormous growth potential. Currently 7 cities use mobile ticketing systems based on NFC. In the Middle East and Africa have common 40 cities, of which only three cities with NFC-based transit tickets, and two of them are under development. In Latin America only one city has a mobile ticketing system.

Methods

In this study, our goal was to determine what technologies are used in the world and Kazakhstan. During the study, we searched for available information on the Internet and conducted comparative research.

The standard form of comparative analysis is usually equated with research methods and uses method “Content analysis”, which focused on counting and measuring [5].

Results

In figure 3 we can see, that 7 various transport systems were introduced in 10 cities of Kazakhstan. Transport systems in Kazakhstan are very different and at different levels of complexity and coverage.



Figure 3. Transport cards in Kazakhstan for 2020

Table 1 shows the results of a market study of transport cards in Kazakhstan. Transport card system was introduced in 10 cities within 15 regions. Seven different transport cards have been established in the area of Kazakhstan: Avtobys, A, City Transport Systems (CTS), BPC Aqtobe, BPCbillet, Onay and Tolem.

Table 1

Market survey in Kazakhstan

№	Payment system	City	Apk	NFC RFID	EMV	Bluetooth	Software	Billing
1	BPC Aqtobe	Aktobe	-	+	+	-	BPC	Kazpost
2	Avtobys	Atyrau, Aksu, Semey	+	+	-	+	Avtobys	Allpay
3	Onay	Almaty	+	+	-	-	Onay	Woopay
4	Tolem	Kokshetau	-	+	-	-	KazInterSoft	-
5	CTS	Astana	+	+	+	-	Transcend	Astana LRT
6	A	Ural	-	+	-	-	-	-
7	BPCbillet	Pavlodar, Aktau	+	+	+	-	BPCbillet	bank

All transport payment systems in Kazakhstan work on the base of NFC, but there exist systems which support EMV with NFC technology. They are BPC Aqtobe, CTS and BPCbillet. BPC Aqtobe is a unified social card of a citizen of Kazakhstan, which has bonuses and cashback for payments with a card. Transport system in Astana known as Astana LRT was recently renamed as City transportation systems (CTS). CTS is one of the best transport payment systems in Kazakhstan that differs from others. The system has the opportunity to pay with a transport card, bank card from Eurasian bank and transport ticket with 10 times payment. BPCbillet is a portal, which emulates any bank card as a transport card.

Only two transport cards, BPC Aqtobe and Onay, are capable for other payments such as a post, movie and event ticket. Avtobys is the only system that is implemented in 3 cities and has a new contactless method of payment by Bluetooth. Avtobys, Onay and CTS have a mobile application and supports QR payment.

CTS differs from other cards in different types of routes and tariffs. The fare varies depending on luggage and each type of transport, such as city, express and suburban transport. In addition, the tariff may vary depending on the payment method: cash or transport card. In addition, there are four types of zones in the city that determine how much you are in the city center. The tariff varies depending on the range between the zones. These are the properties of transport payments that are characteristic of large city systems.

Conclusion

In this work, we conducted research on the market of transport cards in the world and Kazakhstan. As part of the study, we have found that NFC technology or other technologies based on NFC are used throughout the world and is growing. We also analyzed the existing electronic ticketing systems in Kazakhstan, made a comparative analysis and, as a result, got a comparative table. In comparative table we can see, that 7 various transport systems were introduced in 10 cities of Kazakhstan. Transport systems in Kazakhstan are very different and at different levels of complexity and coverage. The similarity for all of them based on NFC technology. Also they include other various approaches. We answered to the questions posed at the abstract.

Moreover, for these technologies, the standard of smart card Mifare classic 1K is considered the most common contactless smart card standard in the world. Therefore, this will be a scientific justification and we will continue to work with them.

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