

Smart community infrastructures — Guidance on smart transportation by non-cash payment for fare/fees in transportation and its related or additional services

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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Introduction

There is no question on that so many citizens use transportation and its related/additional services, as described in ISO 37154, for work, business, tourism, etc., not only in their living cities but also overseas. In transportation services, in particular to those in cities, citizens' rides are in a short distance and the fare is not expensive. However, so huge a number of citizens use transportation services every hour every day and pay fare/fees whenever taking a ride. Owing to a large number of passengers, fast processing is required for ticketing to avoid congestion in a small ticketing office or requests to customers for patience to wait for their turns at ticket purchases. They have experienced such situations that frustrate and annoy. In some transportation services, transportation operators sell no tickets but ask customers to pay the exact amount of fare/fees, since operators prepare no changes to customers.

In addition, with the development of the internet, citizens have come to call a taxi through online communication (e.g. Uber/Lyft), because they want to enjoy transportation services at their convenience and in an easy way or door to door transit, especially when traveling in areas where little public transportation services have been organized. However, they have experienced requests by drivers for exact amount payment, who are not prepared for changes.

Thus, easy but exact amount payment ways are indispensable in city life and business activities, including whenever using transportation serviced for citizens. Actually, when using transportation and its related or additional services, citizens/passengers have to pay many kinds of fees besides transportation fare. The sums of the amount are extremely large, which are received from customers by transportation operators. To properly collect fare/fees in transportation and its related/additional services in an easy way assists transportation business leading to offering citizens sustainable local transportation services, as the business is promoted and financially stabilized.

This is really troublesome not only for customers but also for operators, because they have to prepare or receive cash, credit cards, pre-paid cards or something in many different ways. Hard currencies, as you know, are not easy to manage, since coins in a pocket and paper bills in a wallet or safe are heavy and voluminous. Some transportation operators can receive exact amounts of fees only without return of changes to passengers. Simple and fast payment procedures have been desired, especially when purchasing tickets at busy ticket office windows and ticket vending machines and taking bus/tram/ferry rides. If easy payment is realized, it is beneficial to citizens to avoid annoying payment procedures and encourages them to more positively take casual rides. Actually, people hesitate to use transportation services, if in a short distance, when they don't have small money. Thus, simplified payment procedures lead to a variety of advantages or local economy stimulation and city life enhancement. Such payment ways also make it easy and safe even for transportation operators to receive, store and manage payment from customers. Currently, payment for transportation fees is mainly by local currencies, including hard currencies. International travelers have to pay for travel cost in a local currency exchanged in advance or with a credit card, the acceptance of which would be limited in any cities. In this situation, in any case, owing to fluctuation in exchange rates, travelers waste money, since they normally exchange a little bit too much an amount to avoid short of exchanged hard currencies to be used on the other side of a national border, when taking cross-border transportation rides to reach other cities therebeyond.

Digitally processed payment (d-payment) is action to pay fees using a digital form of an existing and circulated currency, which works like common coins and paper bills. The adoption of d-payment into transportation business, especially in international transportation services between cities on a border and to/from/within cities having international airports, rail/bus stations and ferry terminals, will work to make it easy to pay for travel cost without complicated procedures. Flying, if a travel distance is over 500 km, is nowadays a common travel manner, when visiting other cities. Thus, a lot of cities are already internationally communicated by people from other countries, who land into an international airport over there. Even if a city has no internationally accessible airports, stations or ports but is famous to and popular among overseas visitors, the city is already international. So typical a city is Kyoto, Japan, that everyone knows, who has interest in visiting Japan. The city is always full of visitors from outside the country. Kyoto, however, has no international airports, rail/bus stations or ferry terminals. The city is still actually communicated by international travelers, while it is

geographically not international. To make their visits and stay in such a city easier without bothering and irritating payment procedures will invite more visitors thereto resulting in promoting business in the city and activating the local economy. Therefore, the simplified procedure of d-payment is a great help to visitors and also to local people, as the former pay costs for their visits and stay in a city while the latter receive payment from visitors and also pay for anything necessary for their city life.

As mentioned earlier, sums of fare/fees collected in transportation and its related/additional services are so large, even though the amount to be paid by customers is small every time. The payment systems, therefore, requires high security, including that for a purpose to avoid cheating action by operators' employees dealing with cash and managing fee payment. This document describes the concept of d-payment in transportation and its related/additional services, the safe management and practical application thereof, which will be helpful to citizens and visitors to cities for payment imposed on such services that are used always thereby.

Smart community infrastructures — Guidance on smart transportation by non-cash payment for fare/fees in transportation and its related or additional services

1 Scope

This document describes smart transportation by non-cash or digitally processed payment (d-payment) for fare/fees imposed on transportation and its related/additional services.

This document describes how to organize and implement smart transportation by d-payment in order to avoid inconvenience in payment using local currencies. The purpose of smart transportation is to provide a convenient payment way based on d-payment that will be beneficial not only for citizens and city visitors but also for operators managing fee receipt in transportation and its related/additional services and money transfer or transactions between those business operators and banks or settlement organizations.

2 Normative references

There are no normative references in this document.

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 smart transportation by digitally processed payment

transportation and its related/additional services, in which payment is digitally processed

3.2 digitally processed payment

currency forms operated, managed and controlled in mathematical algorithms like actual currencies having circulation and trading functions, which are cashable or exchangeable for hard currencies, through transaction using digital wallets

3.3 digitally processed payment wallet

digital accounts managed by using public-key cryptography

4 Concept of smart transportation by d-payment

Smart transportation using non-cash payment digitally processed that is designated in this document for transportation and its related/additional services, where a large scale of transactions are normally carried out, should satisfy requirements on convenience, high security, efficiency, low cost and easy settlement or optional traceability. To meet all the requirements, smart transportation by d-payment shall have the following characteristics:

- satisfying non-centralized end-to-end transaction modes;
- adopting public-key cryptography to ensure high efficiency and low cost for transactions and realize the convenience and security of d-payment;
- meeting requirements for online or offline payment transactions;
- including transaction processes that shall not be tampered with or repudiated;
- enabling tractable trading.

NOTE Security technologies mean operation techniques to ensure security in smart transportation by d-payment not by allowing payment forgery, repeatedly traded or repudiated.

Smart transportation should work as transportation services aiming at convenient city life for citizens and leading to United Nations' Sustainable Development Goals, especially Goal 8 "Decent work and economic growth," Goal 9 "Industry, innovation and infrastructure," Goal 10 "Reduced inequalities," Goal 11 "Sustainable cities and communities," Goal 12 "Responsible consumption and production" and Goal 15 "Life on land."

D-payment is applicable at least in transportation services designated in 5.2.6 and 6.3.4 in ISO 37154: 2017, Smart community infrastructures — Best practice guidelines for transportation [1].

NOTE ISO 37154 describes additional services besides transportation, which are:

- weather forecast and information;
- food business (e.g. cafeterias, restaurants, dining cars, minibars on trains);
- shop operation;
- advertisements;
- internet connection;
- business introduced into transportation facilities other than transportation services (e.g. nurseries, polling places);
- coach accommodations (e.g. formation, service equipment);
- storage services;
- service information (e.g. energy station and shop location);
- information signs;
- emergency calls;
- energy stations (e.g. gas, LPG, electric power, hydrogen);
- first-aid stations;

- clinics;
- post offices;
- public phones;
- bank automated teller machines.

5 Reasons to introduce smart transportation by d-payment

5.1 General

Basically, d-payment is welcome in any transportation and its related/additional services. Particularly in the services used by those listed in 5.2, d-payment should be installed for such customers' convenience or reduction in difficulties for them in normal way payment. D-payment avoids cheating action by employees dealing with cash and managing fee payment, since d-payment is perfectly protected from such cheating action.

5.2 D-payment welcome customers

All customers in transportation services welcome d-payment, especially those who are listed below:

- the elderly;
- small children;
- persons with disabilities;
- persons with the elderly, small children or those with disabilities.

5.3 D-payment welcome business fields

In any service fields, including transportation services, d-payment is welcome, especially in the specific transportation and its related/additional services that are designated by the standards listed below:

- ISO 37157: 2018, Smart community infrastructures — Smart transportation for compact cities [2];
- ISO 37158: 201X, Smart community infrastructures — Smart transportation using battery-powered buses for passenger services [3];
- ISO 37159: 20xx, Smart community infrastructures — Smart transportation for rapid transit in/between large city zones and the surrounding areas [4];
- ISO 37162: 20xx, Smart community infrastructures — Smart transportation for new towns [5];
- ISO 37163: 20xx, Smart community infrastructures — Guidance on smart transportation for allocation of parking lots in cities [6].

5.4 D-payment welcome situations

D-payment is welcome in the situations listed below, which take place in transportation and its related/additional services:

- when travelling in and shipping delivery items and freight from geographically international cities (e.g. Singapore, Hong Kong and Shenzhen, Macao and Zhuhai, San Diego and Tijuana, El Paso and Ciudad Juárez);

- when travelling in and shipping delivery items and freight from cities close to a boarder;
- when travelling in and shipping delivery items and freight from cities holding international rail/bus stations (e.g. London, Paris), ferry terminals (e.g. Shanghai) and airports;
- when shopping in passport-controlled areas in international rail/bus stations, ferry terminals and airports;
- when travelling in and shipping delivery items and freight from cities communicable by overseas travelers (e.g. Kyoto in Japan, Wuxi in China).

6 Features of d-payment

D-payment, which is used in smart transportation, has specific characteristics and advantages as indicated below:

- the equivalent in d-payment exchangeable for reserve currencies, such as US dollars, Euro and Chinese Yuan, that are actually further exchangeable for local currencies;
- decentralization or point-to-point direct transactions of payment;
- d-payment can be applied only by itself and together with other legal local currencies by exchanging the equivalent in d-payment for reserve currencies in advance.

7 Security of smart transportation by d-payment

7.1 General

In transportation and its related or additional services, quick transaction is required, because transportation dispatches should be operated on time. No delay is allowed, except when passengers' and neighbors' safety is secured. Then, security for smart transportation by d-payment shall achieve the requirements below:

- transaction procedures should be immediately completed (e.g. mutual authentication);
- transaction communication shall be protected from risks (e.g. modification, access, blocking, destruction, technological vulnerability);
- transaction organization should be performed at low cost.

Security ensuring is the most important procedure in smart transportation by d-payment in order to successfully organize and operate d-payment in transportation and its related/additional services. Security should perform the following characteristics of d-payment, at least:

- fluidity;
- controllable anonymity;
- non-forgery;
- non-repeatable transactions;
- non-repudiation.

The security technical framework enables and ensures easy but successful implementation of d-payment in transportation and its related/additional services, which consists of security, transaction, identification and certification technologies and so on.

7.2 D-payment wallet security

Transaction through d-payment wallets is secured by public-key cryptography that consists of digital signatures and private and public keys.

NOTE In public-key cryptography, all participants in d-payment can obtain all other persons' public keys, while private keys are hidden by respective participants. When sending money to a money recipient through d-payment, a money sender uses a digital signature encoded with the sender's private key that should be matched with the sender's public key obtainable to everyone including a money recipient, while the money recipient uses a digital signature encoded with the recipient's private key that should be matched with the recipient's public key. Eventually, the money sender and recipient can recognize each other for the right d-payment process.

To make d-payment highly secured, public and private keys should be temporally created by a money sender and a recipient. Furthermore, to confirm matching of private and public keys, a matching field is also temporally created. A sender's private key created by the sender and the sender's public key created by a recipient using a common algorithm are combined in a matching field also temporally created by the recipient. In the same way, a field is temporally created by the sender, where the recipient's private key temporally created by the recipient is combined with the recipient's public key created by the sender in the same algorithm. When both combinations in the two fields are successfully matched, respectively, they recognize each other at higher accuracy. To obtain the higher security, person object data or public and private keys and matching fields should be temporally created and used only one time. The security level by the procedure is the highest. To quickly process the procedure, third-party certification centers are not used but agreements on the procedure to use a common algorithm to temporally create keys and fields are made among the participants in d-payment in advance. Based on the effort, the procedure can be completed in about 200 ms.

NOTE In transportation services, especially in services by bus, subway, ferry and shared bicycle, the procedure must be completed in 350 ms in China, to avoid congestion and service delay caused by slow payment procedures.

8 Operation of smart transportation by d-payment

Smart transportation by d-payment can be performed based on transaction online and/or offline technologies, so as to ensure easy and fast payment in transportation and its related/additional services.

NOTE Mobile payment using d-payment is useful, especially where smart phones are commonly used. In smart transportation, d-payment users can complete transactions through mobile communication networks and payment platforms or other mobile terminal connections. Users can also complete transactions with other mobile terminals in the related fields, such as transactions from a d-payment wallet to a d-payment wallet and a physical card or a mobile phone with a d-payment wallet. D-payment in smart transportation is applied through mobile carriers adopted as many as possible, which operate smart phones, wearable devices and physical cards (e.g. d-payment wallets).

9 Management of smart transportation by d-payment

9.1 General

The management of smart transportation by d-payment should be organized by establishing transaction security-trusted infrastructures, registration centers, payment and transaction communication modules, terminal application modules, etc.

9.2 Secure trusted infrastructures for d-payment systems

The security and credibility infrastructure of d-payment systems to be used in smart transportation consists of trusted service management modules and big data analysis centers, etc.

9.2.1 Credible service management modules

Credible service management modules provide multiple application management to secure safe d-payment transactions, which includes support to related business access to, application and management of and authentication and authorization functions for d-payment.

9.2.2 Big data analysis centers

Big data analysis centers ensures the security of d-payment transactions to prevent fraudulent transactions, black money laundering, terrorist financing and other illegal action and approach, by customer transaction analysis using big data and cloud computing technologies. Big data analysis centers provide references for the payment flux and cycle of d-payment in smart transportation.

9.2.3 Registration centers

Registration centers should record information listed below. Registration centers also complete the registration of transaction processes of d-payment in smart transportation:

- corresponding relationships between d-payment and its user identity information;
- transaction flows in d-payment.

9.2.4 Transaction communication modules

Transaction communication modules should support online and offline transaction communication and so on. Users perform online d-payment through internet offering intelligent terminal services and also can complete offline d-payment based on offline trading communication (e.g. NFC, bluetooth) that is provided with intelligent terminal offline services.

9.2.5 Terminal application modules

Terminal application modules should include mobile terminals equipped with client and security modules. Mobile terminals are held by d-payment users or consumers and merchants.

10 Quality maintenance of smart transportation by d-payment

10.1 General

In order to ensure smart transportation by d-payment, observe the following parameters regularly and make corresponding evaluation to improve the quality of the smart transportation services and assist with planning and implementation of d-payment in other geographical areas or business fields in the future.

10.2 Parameters to be observed

To ensure the performance of smart transportation by d-payment, compare the following parameters:

- number of time that d-payment is chosen as a payment way when customers order articles or services in transportation and its related/additional services;
- time duration spent by customers for d-payment;
- security verification number taken in d-payment;
- security verification time duration taken in d-payment;
- number of agencies and business activities using d-payment (e.g. per month);

- measures provided by agencies and in business activities using d-payment in order to protect users' privacy from disclosure;
- d-payment introduction or application ratio in target cities/regions where smart transportation is installed;
- economic indicators in target cities/regions where smart transportation is installed;
- number of operational failures in d-payment;
- citizen facilitation indicators specified in ISO 37120: 2018, Sustainable cities and communities — Indicators for city services and quality of life [7], and ISO 37122: 20XX, Sustainable development in communities — Indicators for Smart Cities [8].

By considering the results obtained through observation of the parameters, the actual utilization of d-payment for fare/fees and cost imposed on transportation and its related/additional services can be grasped in a target area. This information will help in further planning and improving the application and management of smart transportation in such services.

Bibliography

- [1] ISO 37154: 2017, *Smart community infrastructures — Best practice guidelines for transportation*
- [2] ISO 37157: 2018, *Smart community infrastructures — Smart transportation for compact cities*
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- [6] ISO 37163: 20xx, *Smart community infrastructures — Guidance on smart transportation for allocation of parking lots in cities*
- [7] ISO 37120: 2018, *Sustainable cities and communities -- Indicators for city services and quality of life*
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