NFC vs QR Code: A Comparison in Flight Boarding Transaction

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Abstract: The development of smartphone technology has led to a more convenient and faster digital transactions. One of the transactions that has been affected by the change of business process is the boarding transaction in airports. The conventional boarding process requires a printed boarding pass and an identity card. The use of smartphones enables the data to be stored digitally, supporting paperless transactions. Both boarding pass and identity card can only be used by the right holder. Hence, passengers need to take care of their boarding pass, so that it can only be used once. Types of technology often utilised for transactions are Near Field Communication (NFC) and QR Code. However, these tools may be vulnerable to security gaps. For example, the data might be transferable easily using the screenshot feature in digital smartphones. The advantage of using NFC technology is that the data can be encrypted and sent using peer-to-peer networking, therefore, the data cannot be read without a set of encryption methods. This study concluded that NFC technology had an advantage of security compared to QR Code. Further research may investigate the application of biometric data as a security enhancement in digital transactions.

1 INTRODUCTION

The advancement of digital technology has prompted the development of more efficient transaction methods. One of the transaction methods has been implemented in airports. Airports have a high level of transactions, thus, time efficiency is very essential. One of the methods which can be applied is by using a faster transaction which can reduce the interaction between airport staff and passengers. Some of the common methods which have been utilised include Quick Response Code (QR code) (Lee, 2014) and Near Field Communication (NFC) (Suparta, 2012). More recently, QR code and NFC have been applied in various transactions such as, electronic-ticketing (e-ticketing) (Kolte, 2017), point of sale (Husni, 2012), and fast access in posters (NFC smart posters). These methods have also been implemented in airport transactions, e.g. the boarding process.

Boarding process encompasses the verification process, hence, all the data used in transactions should be secured and the ownership of the data should be guaranteed. The data used in the boarding process include passengers' identity and flight data. One of possible issues is that how to ensure that tickets can only be used by passengers whose names are stated on e-tickets (Ceipidor, 2013). Another issue is that the durability of the data and the media, and the accuracy of the data also need to be ensured.

QR Code and NFC have different characteristics of interactions, thus, these methods also have different security gaps. This research aimed to compare the application of QR Code and NFC in the boarding transaction in airports (Sunday, 2016). The comparison was made in terms of the advantages, the security gaps, and the limitations of their implementation in the boarding.

2 RESEARCH METHOD

In general, NFC and QR Code have certain similarities in their application. Both are utilised to ease data transmission to recipients. One of the significant differences is that while QR Code enables the transmitted data to be seen, but the data cannot be read without decryption; NFC does not allow the data to be read, but the data are stored in

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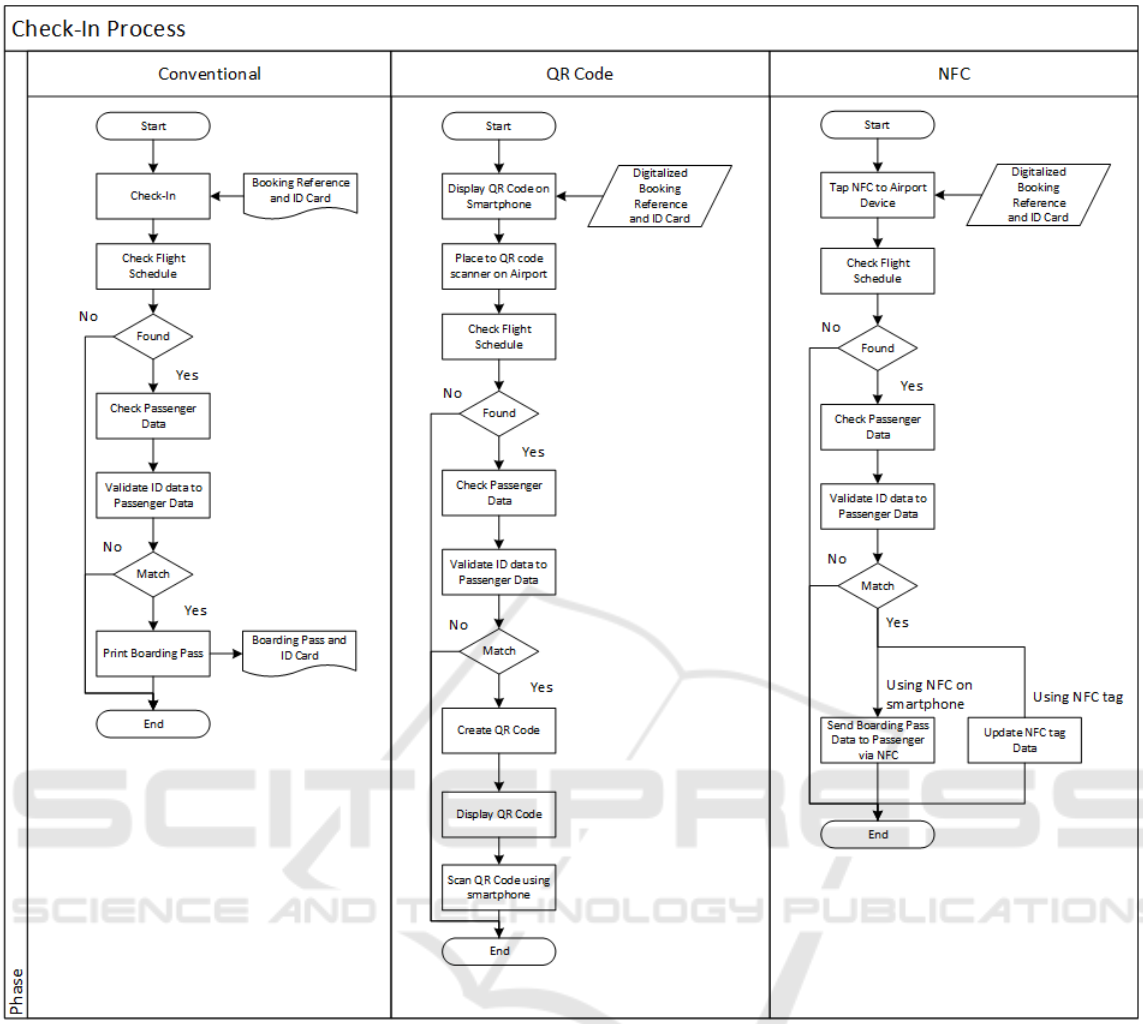

Figure 1. Flowchart proses Check-In.

plain text. The data stored or sent using QR code (Coleman, 2011) and NFC can be in the form of plain text , URL, telephone numbers, map coordinates, etc (Renardi, 2017). this research focused on how the implementation of both technologies could overcome the security gaps in the boarding process in airports. This study also focused on offline transactions.

Some research has investigated the use of QR Code in the educational sector including checking the validity of study reports (Rochman, 2017) and sharing links for learning materials (Durak, 2016). In the sales sector, studies have examined the use of QR Code as a marketing tool (Asare, 2015) and mobile marketing (Cata, 2013). Other research has also touched upon the payment sector (Putra, 2018) such as, point of sales, medical records (Basjaruddin, 2017), toll payment (Kumar, 2017), and baggage claim in airports (Renardi, 2017). The application of QR Code and NFC in airports can also encourage paperless transactions and enhance data management in smartphones (Zupanovic, 2014).

2.1 E-Ticketing

E-tickets are utilised to shorten the transaction process and to ease the data management (Sunday, 2016). E-tickets can store information as in printed tickets. It can also be accessed through the internet and be stored digitally in emails or smartphones. During the check-in, the validity of passengers' identity is checked and their tickers are printed out. However, by using e-tickets, passengers are not required to print out their tickets. They only need to

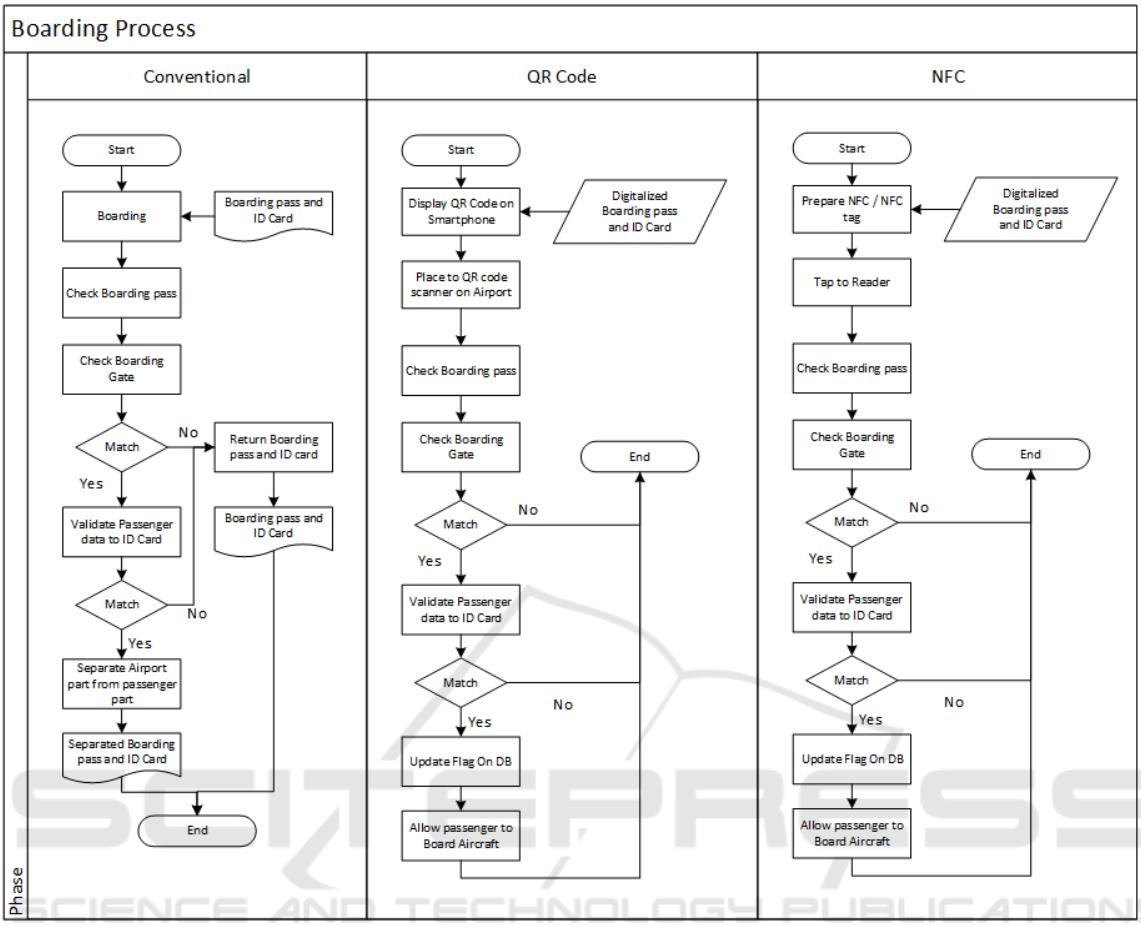

Figure 2. Flowchart proses Boarding.

show their e-tickets to the airport staff, so that the staff can check the originality of the data. The identity data can be stored digitally, thus, these can be used to validate passengers' identity (Coca, 2013).

One of the possible issues is that how to ensure the originality of e-tickets. Automatic validation using systems could be the solution for this problem. QR Code (Maheswar, 2018) and NFC (Zupanofic) are some of the transaction methods to ease the exchange of e-tickets (Qteishat, 2014). Using these technologies facilitates a faster input process to the validation system and alter the interaction pattern (between airport staff and passengers to between systems and passengers) (Renardi, 2017).

The use of QR Code allows passengers to open the data regarding booking reference and identity cards. These data are shown in QR Code (Figure 1). Passengers need to scan QR Code on the scanner. The machine then decrypts and check the validity of the data. The result of check-in can be given to passengers in a form of QR Code and passengers can scan the code to save the data. Meanwhile, the use of NFC enables passengers to send the data using card emulation mode or peer to peer (Figure 1). The result of the check-in process can be given to passengers using the peer to peer mode or writer/reader in the NFC tag.

The boarding pass obtained during check-in is used as a required document to enter the restricted area of an airport and to board the airplane (Figure 2). In the conventional boarding process, the boarding pass is printed out and given to the airport staff, and the staff will check the accuracy of the schedule and the departure gate. If it is correct, the boarding pass will be torn into two parts; one part is given to passengers and the other one is kept by the staff. Boarding is usually done as fast as possible although the validation process is still executed. The use of QR Code and NFC may facilitate a faster boarding process and a paperless transaction (Evizal, 2013).

2.2 Quick Response Code

QR Code is a type of matrix barcode in a two-dimensional shape formed by an encrypted text (Figure 3) (Asare, 2015). QR Code requires a camera as a scanner to read, while the code can be generated from smartphones and shown in the screen. The making and reading process of QR Code involved digital image processing, and it can be stored in form of texts or pictures. QR Code can be used in two media, that is, printed media such as, newspapers, posters, printed tickets, and magazines and digital media which can use websites and be shown ion computers or smartphones (Coleman, 2011). QR Code does not require specialised media to show the data (the QR Code) because the important thing is that how the code can be seen and read.

Figure 3: Example of QR Code.

QR Code is read by the party that requires that particular information. For example, if a user wants to make a payment using mobile phones, he/she is required to scan QR Code owned by a point of sales. Also, if a user wants to know some information about certain products in a magazine, he/she needs to scan QR Code. In airport context, it is the airport staff who needs information, thus, they need to scan the code.

2.2.1 Benefits of Using QR Code

The application of QR Code in the boarding process offers some advantages. For instance, smartphones have camera features and adequate screen quality, thus, QR Code can be implemented more easily and it is also cost-effective compared to NFC (Wu, 2013). Moreover, the use of QR Code does not require any specialised media, so it can be used with any media. QR Code is also not limited by distance. In other words, as long as the code can be seen clearly, it can be read. In addition, some users can also access and use the same QR Code, but a user can only access the code in a particular point of time.

Another merit of using QR Code is that standard printers and paper can be utilised to print out the code (Sunday, 2016). However, if it is digitally used, it does not have to be printed out. Also, the input process does not require a keyboard. Moreover, QR Code can store big data such as, NFC and RFID, and it has error correction and high detection capacities. Thus, if it is broken, it can still be read. Encryption and digital signature can also be applied in QR Code. Last but not least, QR Code can be used for authentication processes such as, website login, Wi-Fi network login, and messenger login (WhatsApp and Line messenger).

2.2.2 QR Code Vulnerabilities

The digital application of QR Code (especially in smartphones) has some vulnerabilities particularly in its use in the boarding process. Some of the vulnerabilities are caused by the use of the device (Coleman, 2011).

1. Data Duplication
   QR Code is possible to be duplicated and shared by other parties, especially if the code is stored in the gallery. Regarding the QR Code which is generated once the data is made, smartphones' operation systems can take a screenshot of the code, so it is saved as an image file. Texts or pictures taken using screenshot do not affect the object of QR Code. This vulnerability can be overcome by limiting access to screenshot in the application, thus, users cannot save the image of QR Code. Nevertheless, this method seems to be ineffective due to a third-party application. Also, other cameras can also be used to take a picture of the code. It is important to note that QR Code is transferable through emails, chat, and pictures (using camera), thus, QR Code might be safe to be used for important data.

2. Data Integrity
   QR Code cannot be read without using decryption, hence, it is difficult to identify the content of the code manually. It is also difficult to differentiate the code. This security gap may be used to lead users to access certain sites which can steal classified data. In its implementation in the boarding, QR Code is utilised in the boarding gate (final check), thus, the consistency of QR Code with the data

Table 1: TNF Structures.

Record Type				
urn:nfc:wkt:T (text)	T	0x54		
urn:nfc:wkt:U (uri)	U	0x55		
urn:nfc:wkt:Sp (smart poster)	Sp	0x53	0x70	
urn:nfc:wkt:Sig (signature)	Sig	0x53	0x69	0x67

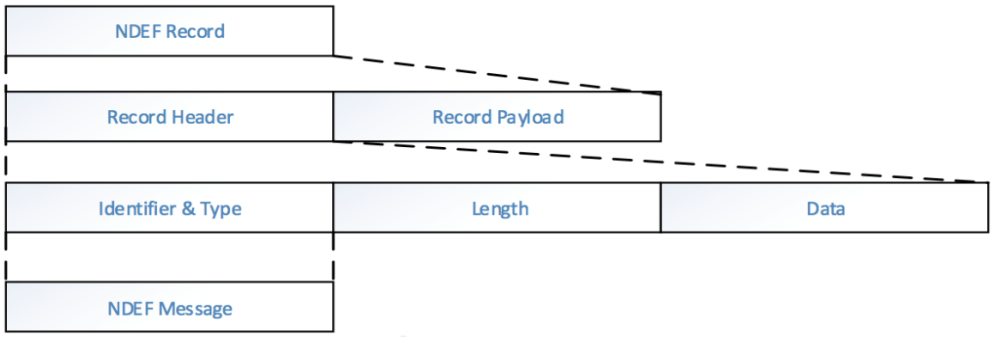

Figure 4: NDEF Breakdown Structures.

should be ensured. Incorrect data may cause administrative problems.

3. User Validation
   One of the security methods used to ensure users' access is by using user validation in a form of password or biometric data. However, since the reader of the QR Code is the airport staff, validation is done before the code is generated. Yet, this method may cause data duplication. Therefore, one of the possible solutions is that using user validation in a particular device in airports when the QR Code is being read. Manual input may slow down the boarding process, thus, validation using biometric data such as, fingerprint is suggested.

2.3 Near Field Communication

NFC technology requires a particular chip in smartphones to read data (Curran, 2012). There are two kinds of NFC: (1) NFC installed in smartphones, (2) NFC tag (in a form of cards, key chains, or stickers). An NFC tag does not require batteries because the power used to active the chip is taken from the reader/writer device in the reading process. Furthermore, NFC itself has three types of operations, that is, peer to peer (P2P), card emulation, and writer/reader (Noh, 2013). Regarding P2P, the sender and the receiver should have an NFC chip which is connected to smartphones or an NFC device. The use of this mode in Android devices can be applied using Android Beam. The process of data exchange can be done by bring both devices back to back. Then, the sender is required to tap on the device's screen. Reader/writer mode is used in the NFC tag (passive). When writer/reader access the NFC tag, the signal will supply power to activate the NFC tag. Card emulation mode may affect the NFC device in the sense that it makes the NFC device work as if it is a smart card (Noh, 2013). This data card emulation is stored in the secure element.

When data is being written and sent, the data are encoded according to certain types of data. This type of data is called Record Type Definition (RTD) (Renardi, 2017). The function of RTD is to explain the type of record used such as text, URL, URI, and vCard. Type Name Format (TNF) (Table 1) is used to explain the characteristic of RTD. The data are then processed into NFC Data Exchange Format (NDEF) (Figure 4).

2.3.1 Benefit of Using NFC

The implementation of NFC in the boarding process offers some benefits. One of them is that the distance of NFC reading which is relatively close can enhance the security as data theft can be minimised (easier to control) (Coca, 2013). Moreover, the reading process inside smartphones can only be accomplished using user (sender)

Table 2: QR Code and NFC Vulnerabilities

Aspect	QR Code	NFC
Data Modification	Yes	Yes
Data durability	Readable with 50% damage	Almost no Damage
Privacy	Low (Anyone can read QR code)	High (saved in secure element)
Unauthorized reading	Yes	Only tag or Card Emulation Mode
Security	Low (Dapat diduplikasi)	High

Table 3: QR Code and NFC Limitations

Aspect	QR Code	NFC
Read range	As long as it can be seen clearly	<10cm
Media	Display digital and printed media	NFC tag or NFC device
Identification Speed	Slow (camera focus and CPU process)	Fast (Tap and Go)
Data type coverage	Can handle common data	Can handle common data
Availability of devices	Common	Often
Best For	Online transaction	Offline transaction
Internet Usage	Mostly	Sometimes

authorisation, except using card emulation mode or an NFC tag. Additionally, an NFC tag can be rewritable and less complex as it does not use batteries. NFC is utilised for offline transactions because data are stored in the NFC tag or secure element (Wu, 2013). By using NFC-enabled smartphones, users can decide when the stored data can be read or sent and when the data that will be stored can be received or read. The data sent using NFC cannot be identified by third parties, except there is the Man in The Middle attack. NFC can be read without using certain applications as long as the NFC mode is activated. Operation systems will then select registered applications using NFC in their operation. P2P mode can be securely used to send important or sensitive data. However, to ensure the security, encryption can be applied (Renardi, 2017).

2.3.2 NFC Vulnerabilities

NFC vulnerabilities can be found in the use of NFC-enabled smartphones and NFC tag. In NFC-enabled smartphones, the security gap often happens because users do not follow prescribed procedures. Meanwhile, regarding the NFC tag, the security gap usually happens because there is no user validation method (Ceipidor, 2013).

1. Unauthorized Reading (NFC Tag)
   In smartphones which have an NFC sensor, users can determine when the data will be read, sent, received, written because the sensor is active. The NFC tag does not have any validation features, so it can be read anytime and by anyone (passive). As a result, it is possible that data can be read by third parties. A possible solution to this is by applying encryption to the stored data.

2. Rewriteable (NFC Tag)
   Since there is no user validation mechanism in the NFC tag, rewriting can be done by anyone. A possible problem is that the data can be read and changed by third parties, thus, the data stored are not consistent. Therefore, the NFC tag can be made read-only or a certain key/password can be made, so that changes can only be done by authorised users.

3. User Interaction
   Sometimes, some people are not familiar with the use of NFC, so system failures or data loss in the NFC device or NFC tag may happen. Moreover, P2P mode requires additional interactions, that is, touching the smartphone's

screen to send the data (Android Beam), hence, more time is needed to do this transaction.

3 QR CODE VS NFC

QR Code and NFC are two technologies that are applied in mobiles and used to facilitate contactless transactions. Both are widely applied such as in sales transactions, information exchange, document validation, and check-in transactions in airplanes and trains. The implementation of these technologies in the boarding may triggers vulnerabilities and limitations that can be compared in order to determine which technology has lower risks and wider coverage.

In the boarding, transactions are done from users to airport systems. QR Code has a dangerous security gap, that is, data duplication and data breaches in the QR Code (Table 2).

As demonstrated in Table 1, although QR Code has more vulnerabilities, it is easier to be applied compared to NFC. In terms of security, the implementation of QR Code can be secured by preventing users from taking a screenshot. However, users can still duplicate data by taking pictures of QR Code using other devices.

The application of QR Code and NFC has some limitations. Nevertheless, the limitations can also be considered as the advantages in terms of security and suitability for types of transactions. Regarding the distance range for access, QR Code has more advantages as it can be accessed from a distant place as long as the image of the code can be captured by the camera. With regard to NFC, as NFC requires a close distance between both devices to do transactions, it is more secured as attacks can possible by prevented (easier to control). Meanwhile, NFC the tag is a passive device, so anyone may read the data.it is also as dangerous as QR Code.

4 CONCLUSIONS

This research has shown that in terms of security, NFC could be more secured. The application of QR Code could be dangerous because all information can be extracted from an image of QR Code. Thus, this technology might not be appropriate for data exchange which might contain important or sensitive data that are not encrypted. QR Code could be more suitable to be used in online transactions because the data received from the extraction is in a form of links. Nevertheless, QR Code could also be utilised in offline transactions because it can send big data like NFC. It could be argued that the boarding process using QR Code and NFC goes through similar stages. Further research may investigate the implementation of biometric authentication in the use of QR Code and NFC.

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