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E-wallet Delivery Technology Architecture Adoption: A Review

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ABSTRACT

E-wallet is a fintech digital tool that enables cashless, quick, and easy transactions, and allows users to review and analyze payment histories. However, the expansion of digital wallet usage has contributed to a surge in overspending where users fail to utilize the generated expenditure data to improve personal financial management. The objective of this study is to compare operational features of existing delivery technologies to ensure the best suited delivery technology is adapted into the proposed adaptive money management embedded e-wallet design. A review was conducted to find relevant articles published between 2017 to 2021. The main inclusion criteria were English articles that discuss the applications of NFC, QR code, Digital (online)-only, and/or SMS. The search resulted in 159 articles but only 12 met all the inclusion criteria. The review highlights the advantages and disadvantages of using the three technologies in financial applications. This review suggests that QR payment is most popular, secure, fast, and costeffective compared to NFC and SMS. This makes QR technology the best suited delivery technology for the adaptive management embedded e-wallet that incorporats the four blocks of Fintech technologies namely, blockchain, AI, IoT and RPA.. Overall, a QR code enabled e-wallet can expedite and automate the process of analyzing transactions, thus providing a solution for secure transactions and better money management.

Keywords: Digital payment; Digital wallet; NFC; QR; SMS

INTRODUCTION

Fintech is a term that combines the words “financial” and “technology.” Fintech is defined as technology that improves fi nancial goods and services, (Financial Stability Board 2017). A digital wallet, a fintech tool, is essentially a digitalized version of a traditional wallet. The primary function of digital wallet is to securely store money and replace bank cards that are typically used as payment methods. Correspondingly, a digital wallet application is designed to store information on the user’s payment methods when executing various commerce transactions like online, in-app and in-store purchases. The system requires the using user equipment such as phones, tablets, or computers, therefore, replacing physical wallet through a virtual medium (Pachare 2016). The first digital payment application was launched in 1997 by the popular drinks company Coca-Cola, when it was installed on vending machines in Helsinki, Finland. It allowed customers to pay for their beverages via text messages. Digital wallets have since advanced and evolved over the years.

IMPORTANCE OF DIGITAL WALLET

Digital wallets possesses many benefi ts. Firstly, it allows cashless transactions and contactless payments to be made more conveniently and fl exibly. It reduces the need to carry and handle cash in public places. Secondly, through a digital form, consistent payments can be made easily with a tap on a personal smartphone. The payments are simpler and more e ffi cient than traditional cash or card payments as the digital counterpart allow multiple transactions that are not fi nancial institution specifi c or dependent on a single platform. Thirdly, it saves post-processing eff orts such as counting the cash. In another context, a record of previous payments can be easily stored and obtained through digital

wallets, making the billing and budgeting process more organized and error-free. Digital payment receipts like e-receipts are easier to save and more centralized than their cash counterpart that needs to be collected and appropriately managed for future use. Furthermore, expense tracking is made easy with monthly transactions of the bank recorded in a more structured way.

In the grand scheme of things, the implementation of digital wallets can contribute to the global economy as increasing number of consumers worldwide are now becoming an e-commerce system user. From the standpoint of public revenue generation, the e-wallet has a high potential to generate higher tax-based income since e-wallet transactions are well documented and easily traced.

Digital wallet has also initiated a significant transformation in both physical and digital transaction security. In terms of physical security, users are now able to make payment without a need to carry physical cash which can sometimes make them victims of theft and robberies. This also eliminates the theft risks for children and the elderly as well as caretakers can pay for the service the dependent is using remotely. On the other hand, digital wallet is still susceptible to digital transaction security and is not yet the safest mode of transaction (Che Nawi et al. 2022). For example, identity theft is a threat when using cashless payment systems (Kandimalla & Bari 2020) however, numerous techniques and approaches like password authentication and biometric protocols, such as fi ngerprint and face recognition access have been introduced to mitigate issues relating to digital security (Garg & Garg 2015; Thawre et al. 2020; Tsiakis & Sthephanides 2005).

POPULARITY OF DIGITAL WALLETS

The world has progressively adopted digital wallets as merchants worldwide have been constant supporters in adopting this technology as part of their payment methods. This has resulted in an estimated approximate of 2.8 billion users worldwide in 2022 (De Best 2020). China has emerged as the world leader in digital payment adoption, followed by India and Indonesia (Pasquali 2019). A study in 2018 suggested that the adoption of digital wallets is still in its infancy in Malaysia and has been gaining followers at a steady pace (Aji et al. 2020). However, the pandemic surged digital wallets usage in Malaysia with the government rolling out Covid-19 e-wallet stimulus. In the post pandemic era, 61% fi rms in Malaysia have adopted the usage of digital platforms for sales or payment solutions (Bank Negara Malaysia 2022). Touch N' Go Wallet was reported to be the most popular digital wallet in Malaysia during Covid-19 and is still widely used post pandemic (Hassan et al. 2021; Oppotus 2020).

DIGITAL WALLET ADOPTION DURING COVID-19

The Covid-19 pandemic has aff ected human life worldwide in every aspect. The pandemic has forced many nations to go on complete lockdowns and infl icted colossal health and economic catastrophe. Most businesses were forced to reassess their payment methods to be in line with the recommendations that were proposed by the World Health Organization (WHO). Consumers were urged to avoid cash and physical contact-based payments, since this could be a source of infection. Digital wallets, a payment method gaining popularity in recent times, emerged as an essential solution for all businesses and customers. They enabled customers to purchase items with contactless payment while adapting to the new norm of social distancing. This eventually triggered a sharp rise in digital payments. To flatten the Covid-19 infection curve, the Malaysian government encouraged and urged consumers to use digital payments. The government introduced several initiatives under the "Short-term National Economic Recovery Plan" to contribute toward the country's digital economy aspirations as well as compelling people to convert to the various categories of digital payment applications. The initiatives were ePENJANA e-wallet stimulus, Shop Malaysia Online initiative, and the Micro, Small and Medium Enterprises (MSME) e-Commerce Campaign (Daragmeh et al. 2021).

DIGITAL WALLET EVOLUTION

Digital payments can be dated back to 1997, when Coca-Cola allowed citizens to buy canned drinks through text messages from vending machines. PayPal followed suit in 1999 when they fi rst came up with an e-mail-based payment technology. Although when they noticed the overwhelming response from end-users asking buyers and commercial partners to sign-up with PayPal to facilitate faster payments, they swiftly paved the way for eBay payments on the site. PayPal ruled this niche that credit card companies could not fulfi l. In 2006 Amazon introduced 1-Click setting with a high standard for user experience (UX), broadening merchant and consumers vision of digital wallet capabilities (Heiskanen 2016).

In 2011, Google introduced its mobile payments technology, Google Wallet, to replace credit cards with mobile phones embedded with an NFC technology unique chip. The device can be tapped against readers at shop cash registers to make payments (Ghag & Hegde 2012). Three years later, Apple Pay, a mobile payment and digital wallet service was set in motion

by Apple Inc. It allows users, via Apple Pay Cash, to make payments authorization via fi ngerprint. The combination of digital wallet and NFC created a frictionless and secure means of payment in Apple Pay and it is integrated on iOS starting with version 11.2 (Gießmann 2018). A year later, Samsung introduced its own mobile payment called Samsung Pay (Son et al. 2015). In 2015, Google wallet was relaunched as Android Pay. Google had removed the prepaid rechargeable card feature from its Wallet to enable card registration and use in the new Android Pay (Kang 2018). Malaysia accelerates the digital wallet options through GrabPay, Boost and Touch n Go in the following years with their respective e-wallets using QR, and so did banks in Malaysia. Banks either choose to develop their own digital wallets like Maybank's QRPay or make their cards available to third-party wallets such as Boost that is tied-up with RHB Bank or both. Digital wallets are the driving force of mobile commerce, without which consumers must enter a plethora of information into smartphones for every transaction which proves to be repetitive and tedious.

Table 1 illustrates the evolution of e-wallet delivery technology over the years since it was introduced over 2 decades ago. Digital wallets are growing steadily in developing commerce platforms and are predicted to evolve either as general-purpose NFC enabled Wallet, or as proprietary targeting retailer-based wallets adapting technologies like optical/QR code and BLE beacons (Peterson & Wezel 2016).

TABLE 1. Delivery Technology Timeline

Year	Delivery Technology	Example of Service
1997	Text-message	Coca-Cola vending machines
1999	Online Payments	PayPal
2006	Digital only	Amazon 1-Click
2011	NFC	Google Pay
2014	NFC	Apple Pay
2015	NFC	Samsung Pay, Android Pay
2016	POS, QR, NFC	GrabPay
2017	QR	Touch n Go, Boost
2018	QR	Maybank

TYPES OF DIGITAL WALLET

A digital wallet is described as a virtual storage system that stores digital credentials (Singh et al. 2018) and value to allow users to purchase and/or send funds (European Union Agency for Cybersecurity 2016). A digital wallet is an electronic device that stores and carries fi nancial cards in a virtual medium to allow users to perform online fi nancial transactions (Daragmeh et al. 2021; Kanimozhi & Kamatchi 2017; Karim et al. 2020; Upadhayaya 2012).

Digital wallets can be classifi ed into four types: open, semi-open, closed, and semi-closed. Open wallets, as the name suggests, provide multiple services. For example, it allows a customer to buy products and services, transfer money and to withdraw cash from banks or ATMs. Semi-open wallets are subject to the requirement of the specific organization that they are affi liated with. Customers can load funds into their apps and use them whenever necessary. Closed wallets are the most common, especially among e-commerce businesses. Seller would reserve a certain amount of money for refunds or product cancellations. Finally, semi-closed wallets are highly sought after by merchants because they limit them from providing redemption or withdrawals for the product purchased. This type of wallet allows customers to purchase products and services provided by the merchant by registering for a personal account (Chauhan et al. 2017).

The term digital wallet is a general description of various online and mobile proximity payments methods. E-wallet is a subset of a digital wallet (Karim et al. 2020) and varies from a mobile wallet. A mobile wallet is generally used by companies for goods purchases and services exclusively from their organization. An e-wallet, on the other hand, can be developed on any device. An e-wallet can store a balance and be used to purchase goods and services, transfer credit, and is not restricted to being used exclusively by the company. E-wallet can have mobile proximity payments or provide a digital(online)-only service whereby transactions can only be made online only. Mobile proximity payments are made via proximity technology such as NFC, QR and Bluetooth. Figure 1 illustrates the digital wallet breakdown.

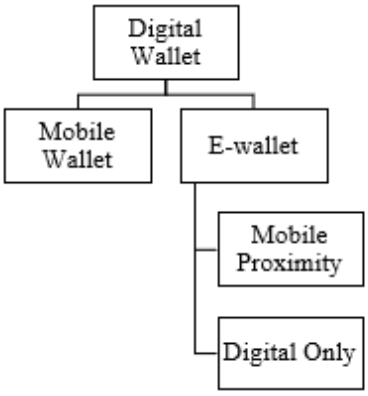

FIGURE 1. Digital Wallet Breakdown

NICHE TECHNOLOGIES

A study suggests that Fintech innovation eras can be classifi ed as card, interbank, online banking and digital innovations with the latter proving to be lucrative for Fintech of late (Kalra 2019). The four main Fintech innovations that have stood out and added value to the development of digital wallets are blockchain, artificial intelligence, internet of things and robotic process automation.

Blockchain is defined as a decentralized and distributed chain of digital signatures and ledgers that are used to record and secure transaction across many entities. A review of the technology specifi c in Fintech application has been provided by (Nelaturu et al. 2022). Since its introduction in 2008 with Bitcoin, blockchain technology has evolved and produces key technologies like cryptocurrency, proof-of-work, directed acyclic graphs, and smart contract which is a key development feature in Fintech (Chen et al. 2019). Despite its advantages, a mapping study in 2019 showed that its implementation in Fintech is still far from ideal in terms of security, legality, scalability, privacy, and to some extent, the latency in service (Azmi & Abdul-Rahman 2018; Fernandez-Vazquez et al. 2019). However, the study has provided the basis for more contribution using this technology such as in the study of (Chang et al. 2019; Devidas et al. 2021).

Machine learning is a subset of data analytics that is a common add-on in a widespread of systems today and it is visible in key technologies like big data and cloud computing. This breakthrough technology has birthed regulations like Know Your Customer (KYC), Anti Money Laundering (AML) and Counter Funding Terrorism (CFT) that are implemented yielding almost accurate predictions which otherwise would have been diffi cult and expensive considering the manpower needed (Kalra 2019). Adding to the value, (Chen et al. 2019) use several machine learning methods (Support Vector Machine, Neural Network, Naïve Bayes, K-Nearest Neighbour, Random Forest, and Gradient Boosting) to identify and classify over 1 million, equivalent to 14 years fi led patents from the U.S. Patent and Trademark offi ce into categories. Based on their study, the most appreciated and the less disruptive technologies are blockchain, robot advising and Internet of Things (IoT)

In 1999, Kevin Ashton introduced the IoT to describe the network of objects/devices in the physical world to the internet. IoT applications aims to reduce human workload and have since multiplied and no longer require RFIDs as a basic requirement for implementation (Chilamkurti et al. 2021). IoT applications can be found almost anywhere such as in homes, transportation, healthcare (Muhamad et al. 2023), agriculture and Industry 4.0. The latter is a term often used interchangeably with IoT, however, is only a subset of IoT applied environment that focuses on manufacturing environment. Likewise, IoT application in Fintech has expanded the opportunity for cashless payments. Today, almost all smartphones are IoT equipped with early movers like Apple. Perfect examples are Apple Pay, Amazon Go, Walmart Scan and Go, and others (Maiti & Ghosh 2021).

The robotics process automation (RPA) is a software solution that has been adopted to automate choreographed routine tasks that are standardized, structured and rule-based (Hofmann et al. 2020; Pramod 2021). Processes that are simple and high-volumed are often candidates for RPA while the complex processes are still left to human experts. These tasks are chosen carefully to gather benefi ts of better process documentation. RPA is often combined with Artifi cial Intelligence to automate backend jobs such as data entry and fi nancial period closings (Kalra 2019) that normally require human labor and is often prone to human error. RPA is a technology that enable businesses to embrace agility and overall performance improvement (Pramod 2021). The RPA is associated to the more popular concept of robot-advising where fi nancial services are based on automated, and algorithm assisted to reduce human supervision (Dyba & Gernego 2019). The most recent works on robo-advising highlighting its potential are (Anshari et al. 2022; Capponi et al. 2022; Isaia & Oggero 2022; Tsai & Chen 2022). Meanwhile, perception and reception study can be traced to (Ku & Wang 2022; Yeh et al. 2023).

E-WALLET STRUCTURAL DESIGN

E-wallet structural design includes the technology required to serve its functional needs. The 4 big blocks of the structure are security, payment gateway, data storage and delivery.

SECURITY

An essential measure of the usability of a digital wallet is its security robustness. Security can be classifi ed into four diff erent mechanisms, i) application security which ensures that the wallet can be trusted, ii) device security to ensure that the device is not compromised, iii) communication security and iv) dynamic data ensure that transmitted data is confi dential between the wallet and the payment network. There are various security methods to ensure these rules are met and some of the popular methods are password, biometrics, and tokenization. Passwords are a very familiar

type of security method present in ATMs, mobile phones and computers. It is an authentication method that uses pin, patterns, phrases, or words to authorize access to a device or account. A biometric system is a pattern recognition system that uses biometric indicators to compare and match an individual to their account. Fingerprint authentication is one of the popular biometric authentication approaches used in mobile phones today (Manikandan 2022). Tokenization is a process of generating an often disposable, unique group of characters called a token to replace sensitive data. Many systems today use more than one security method. Those systems are termed as two-factor or multi-factor authentication depending upon the number of methods used (Kaur et al. 2018).

PAYMENT GATEWAY

A payment or top-up method is essentially a mechanism or tool used to add credit value into the digital wallet. Digital wallets normally provide a variety of payment methods. One of the common and more efficient methods of digital wallet top-ups is to link the credit card as well as debit card of the user to the digital wallet. The user may be able to add a specific amount of credit value where the application charges the credit card or debit card that has been used during registration. Another method of topping up would be through online banking. This is done by redirecting users to an online bank environment of their preference to perform the transactions with their bank credentials. One of the more popular methods of online banking platforms is the Financial Process Exchange (FPX).

DATA STORAGE ARCHITECTURE

Data storage architecture allows application to send, receive and store information to or from the database or server. An e-wallet can have either have a client-side or a server-side data storage architecture. On the client-side, data is encrypted and stored on their device itself and is easily self-maintained. Meanwhile, server-side architecture saves and maintains information on a server. Lately, server-side digital wallets or thin wallets are preferred over the client-side, especially among companies because of better data security and data managing efficiency (Uddin & Akhi 2014).

In line with good data management, the data storage architecture also includes Representative State Transfer (REST) architecture emphasizing a unified interface between components. This client-server style has low coupling between frontend and backend of the architecture. REST is also resource oriented. It abstracts all things in the system into resources and operates with HTTP, CRUD and URI methods to exchange data in JavaScript Object Notation (JSON) and XML formats (Zhang et al. 2012).

JSON is a data format that is supported by REST. It is a lightweight because it uses unordered collections of key-value pairs to store information as object. JSON attributes only have a key in front of a string and therefore, require lesser characters. Its smaller volume with higher data compression allows for faster data transmission than XML. JSON has become one of the Web application standards and become an ideal language (Zhang et al. 2012) for data exchange because of its efficiency and simple data parsing (Niu et al. 2014).

DELIVERY TECHNOLOGY

Delivery technology is another prominent aspect of the overall e-wallet architecture of an e-wallet. It is an execution method used by the user to exchange credit value data. Digital wallet primarily uses one delivery method, but it is not uncommon to have a combination of delivery alternatives. Digital wallets can adopt Quick Response (QR) codes, Near-Field-Communication (NFC), Short message service (SMS) and digital(online)-only transactions.

QR is a 2-dimension barcode proximity system, readable by compatible QR readers and camera when displayed on print or on-screen. The barcode technology consists of square pattern black modules positioned on a white background to create different information. The larger the modules, the bigger the storage capacity of the code. QR codes stores information in 4 modes that influence the storage, numeric, alpha numeric, binary and Kanji (Demir et al. 2015; Tiwari 2016). The information can be text, video, advertisement, and other digital information. It provides elaborate information compared to information found in a traditional bar code (De Luna et al. 2019).

NFC is a simple setup set of four to ten centimeters short-range wireless technology for communication that offers low-speed connection. NFC devices actively generate a radio frequency field for the receiver to interact and exchange information (Timalsina et al. 2012). Payments must be made physically in a store or at a compatible terminal by user equipment getting close to the terminal which minimizes accidental transactions or worse hacks. This technology garnered attention because it is a simple and easy data exchange application when compared to Bluetooth systems that require device discovery and synchronization (Mahansaria & Roy 2019). NFC technology can adopt many functions and features (De Luna et al. 2019).

S MS is a basic communication protocol for sending and receiving messages between mobile phones. It mainly utilizes Global System for Mobile Communication (GSM) network but can also work in the presence of General Packet Radio Services (GPRS) and Universal Mobile Telecommunications System (UMTS). The systems are most known as the 1G, 2G and 3G (Husni & Hidayat 2018). SMS payment is favored in African countries where cash usage is common but unsafe and banks are unpopular. Internet access is usually scarce in these areas therefore limiting the usage of higher bandwidth methods, thus a higher preference toward SMS in financial transactions (De Luna et al. 2019).

Digital wallets were initially created for online use with few usage options in the physical world. It was first designed with an objective for online web-based transactions. PayPal was the fi rst digital-only wallet that was introduced. Since then, online and in-applications payments have been used in certain marketplaces. Furthermore, online payments with merchants were off ering wallets for payment too. Thus, this method limits the physical contact between the merchant and the customer (Peterson & Wezel 2016).

PURPOSE OF STUDY

Financial knowledge is one of the top issues many people struggle with. As many continue to use digital wallets actively, the ease of the application has contributed to a surge in overspending. Studies show that many are exhausting their savings whilst simultaneously incurring more debts. It is noted that Malaysia alone has 45,746 bankruptcy cases from 2018 to 2022 as reported by the Department of Insolvency Malaysia, highlighting the millennials as the highest age group (Malaysian Department of Insolvency 2022). Financial management guidance is more vital now than ever before. However, digital wallets in the market today do not have a feature that takes advantage of the transaction data in creating an adaptive guided mechanism to improve fi nancial literacy. At present, users do not benefi t from their expenditure data that could potentially drive them towards better fi nancial management. There is a need to design an e-wallet that analyses users' expenditure data to strategically provide adaptive guidance on spending money.

This review seeks to compare the advantages and disadvantages of existing delivery technologies available. More particularly, the review is done to choose and identify the delivery technology that would be most suitable to be implemented in the proposed adaptive money management embedded e-wallet design.

RELATED WORK

A review that analyses, compares, and reviews digital Wallet's delivery technology namely, NFC, QR, Digital(online)-only and SMS has not been conducted yet. Existing reviews have only been conducted focusing on each delivery technology in specifi c environments and applications. These articles providing useful insight into reviewing the benefi ts and disadvantages of the individual delivery technologies are elaborated as follows.

Demena, et al. (2022) reviewed studies that used SMS reminders to promote adherence and retention to antiretroviral therapy (ART) in low- and middle-income countries and other forms of assistance. SMS was chosen due to its low-barrier and low-cost intervention that yields cost-effi cient impacts on health. However, they concluded that mobile phone-assisted mHealth effectiveness in boosting adherence and retention to ART is inconclusive because of high variability.

Similarly, a study focused on the interest to deploy SMS or NFC as a mobile payment system. The study concludes that the choice to use both technologies depends on the level of acceptance and preferences. It was highlighted that NFC is preferred over SMS owing to its usefulness, security, and a cooler system (Liébana-Cabanillas et al. 2017).

Another review focuses on the existing use of N FC in a student a ttendance system. It is revealed that some countries around the world have adopted it because NFC promotes contactless and easy attendance signing (Mohd Nasir et al. 2015). Chee & Tan (2021) reviewed studies that discuss the i ntegration of QR codes in language teaching. According to the review, there is an increment in QR codes integration in education due to its convenience and ease of use. The study suggests that although QR codes benefi t students retrieving information, it does not come without its limitations such as lack of internet connection and lack of smartphones to name a few. However, the advantages outweigh the drawbacks.

METHODOLOGY

RESEARCH QUESTIONS

The research questions addressed throughout the literature search are the following:

1. RQ1. What type of applications use NFC, QR, SMS and digital payments?
2. RQ2. What are the advantages and challenges of using NFC, QR, SMS and digital payment?

3. RQ3. Which type of delivery technology is best suited for an e-wallet

SEARCHED DATABASES

A literature search was performed to investigate the relationship between Digital wallet, NFC, QR, Digital(online)-only and SMS. Relevant articles were identified using digital Wallet* AND qr* AND nfc* AND sms* AND digital payment* keywords.

Articles published between 2017 and 2021 were chosen from the following databases:

1. ScienceDirect provides access to journals, technical reports and scientific articles published by Elsevier,
2. Scopus which furnishes access to academic journal articles.
3. Google Scholar as the repository of published resources across many disciplines and sources.

SEARCH PROCESS AND FILTERING CRITERIA

The main inclusion criteria for the search results were English published scientific articles with abstracts and full texts that discuss or compare QR, NFC, SMS, Digital only in Digital wallets. Review papers, letters, conference papers, articles in the press, editorial notes and short surveys were not included. Only studies that discussed a relationship between digital Wallet, QR, NFC, SMS and digital payment were selected for this review. Table 2 illustrates the inclusion and exclusion criteria applied in the process.

TABLE 2. List of Inclusion and Exclusion Criteria

Acronym	Description of the criterium
Inclusion criteria	Articles published between 2017 and 2021
	Articles that are written in English only
	Studies that discussed a relationship between digital wallet, QR, NFC, SMS and digital payment
	Articles with abstracts and full texts
Exclusion Criteria	Duplicate articles
	Review papers, letters, conference papers, articles in the press, editorial notes, and short surveys

All articles were considered in three phases before being chosen for the review. Figure 2 presents the flowchart corresponding to the selection process to chosen articles.

Any article that did not fit the article type inclusion criteria was filtered out in the first stage. Then, abstracts of the remaining articles were reviewed again in the second phase, and duplicates were removed.

Finally, three independent readers carefully read the remaining articles to exclude any articles that did not fit the selection criteria. Before the data extraction stage, all readers had to unanimously agree on the selected articles criteria to be reviewed. Any conflicts of opinions or disagreement between the reviewers were resolved through mutual discussions. A data search form was used to conduct all data searches independently. The following information was put together from the articles: main author; publication year of the article; and discussed delivery technology discussed. As a results, 12 articles were included and elaborated in this review.

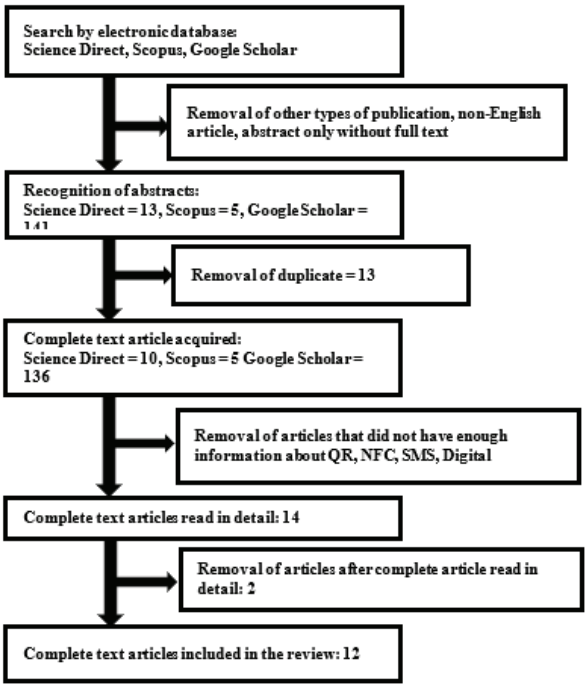

FIGURE 2. Selection process for the reviewed articles.

RESULTS

Table 3 lists the features that were used to compare the different delivery technologies in this literature research.

TABLE 3. E-wallet Design and Operational Features

Features			Description
1	Range	a	Proximity
		b	Remote
2	Security	a	Short-range wireless technology that requires two devices to be paired in close distance to create link for data transfer
		b	Manually activate or approach the receiver for payment
		c	SSL, SET security
3	Application method	a	Scan POS terminal using device
		b	Scan codes either at counter or an individual's unique code from mobile
4	Adaptability	a	High
		b	Low
5	Setup Cost	a	High
		b	Low
6	User Experience	a	Convenient
		b	User-friendly
		c	Trust
		d	Replace credit card/ reduce plastic
7	Devices	a	Runs in application-specific hardware and/or software components.
		b	Runs on all types of user equipment that can link to cellular radio networks.
8	Coverage	a	Only in areas with at least 3G network
		b	Anywhere with cellular radio networks
9	Standardization	a	Open

The selected papers for this research are listed in Table 4. The findings are sorted by year of publication, type of application, type of delivery technology, existing features from Table 3 and country of research.

TABLE 4. Result of Review

Ref.	Year	Application	Delivery Technology	NFC	QR	SMS	Country of Study
(Gerpott & Meinert 2017)	2017	Mobile phones app	NFC, QR, SMS	1(a), 4(b), 7(a)	1(a), 7(a)	1(b), 7(b)	Germany
(Madureira 2017)	2017	Mobile phones app	NFC	3(a), High 6(a), 6(d), 4(b), 9(a)	none	none	Norway
(Solano et al. 2017)	2017	Smart vending machines	NFC, QR, SMS	High 6(a), 6(d), 4(b)	7(a), 6(d)	Low 6(a), Low 6(b)	Spain
(Madureira 2017)	2017	Mobile phones app	NFC	High 6(a), 6(d), 4(b)	none	none	Portugal
(Nesse et al. 2017)	2017	Mobile phones app	NFC, SMS	4(b), Low 6(c)	none	4(b), High 6(c).	Norway
(Liébana-Cabanillas et al. 2018)	2018	Mobile payment	NFC	4(b), 2(a)	none	none	Spain
(De Luna et al. 2019)	2019	Mobile payment	NFC, QR, SMS	High 6(a), 4(b), 2(b), 9(a), 5(a)	4(a)	High 6(a) in 8(b) areas	Spain
(Sikri et al. 2019)	2019	E-wallet	NFC, QR, SMS	2(a)	2(c), High 6(a)	none	none
(Webb et al. 2019)	2019	Mobile payment	NFC	3(a), 4(b), High 6(a), 8(a)	none	none	UK & India

continue ...

.. *cont.*

(Olufemi et al. 2020)	2020	Mobile payment	NFC	High 6(a), High 6(b) 3(a), 2(a), 4(b), 5(a)	none	none	Nigeria
(Acker & Murthy 2020)	2020	Mobile payment	NFC, QR	none	3(b)	none	USA
(Leong et al. 2020)	2020	Mobile payment	NFC, QR	9(a)	1(a)	none	Malaysia

RQ1: What Type of Applications Use NFC, QR, SMS and Digital Payments? & RQ2: What Are the Advantages and Challenges of Using NFC, QR, SMS and Digital Payment?

All the papers chosen to discuss the advantages and disadvantages of the delivery technology used in the specified application. A total of 4 papers discusses the advantages and disadvantages all three technologies (NFC, QR and SMS) in their applications. Similarly, 2 papers discuss the pros and cons of NFC and QR in their applications and 1 paper discusses the advantages of using NFC and SMS. Finally, a total of 5 papers discusses the positives and negatives of using NFC in their application. No papers were found on digital only applications.

NFC is a proximity payment system (Liébana-Cabanillas et al. 2018) that is widely used (De Luna et al. 2019) globally. It can be implemented in a wide range of applications as seen in the table above. Studies suggest that NFC is easy, convenient to use without the hassle of pairing devices, (De Luna et al. 2019; Madureira 2017; Olufemi et al. 2020; Solano et al. 2017) and timesaving owing to quick data transfer (Madureira 2017; Olufemi et al. 2020). NFC serves as a great alternative to physical cards as it first, reduces the cost of manufacturing plastic and usage of plastic (Madureira 2017; Webb et al. 2019) and second, eliminates the need of card renewals. The short-range communication nature in NFC is also a benefit highlighted in some studies as it allows for secure data transfer (Acker & Murthy 2020; De Luna et al. 2019; Liébana-Cabanillas et al. 2018; Madureira 2017; Sikri et al. 2019). The lack of NFC standardization has mixed acceptance as it is welcoming to some (De Luna et al. 2019; Leong et al. 2020) but most users see it as an inconvenience (Madureira 2017; Solano et al. 2017), because different vendors may apply different techniques and that may create complexity and confusion to end-users. NFC has a low penetration rate despite posing great benefits because the advantages of NFC are limited to those who have an NFC chip embedded end-user device (Liébana-Cabanillas et al. 2018), NFC capable SIM (Madureira 2017) are only efficient in places with at least 3G connection (Webb et al. 2019). Furthermore, the usage of NFC is also determined by the availability of NFC-enabled point-of-sales (POS) terminals (Gerpott & Meinert 2017) and study suggest that vendors are not ready to replace their original POS terminal (Nesse et al. 2017) because of NFC's high setup cost (Acker & Murthy 2020). This resulted in the low adoption rate of NFC technology among vendors.

Quick Response (QR) is also a proximity payment system that is new but has grown in usage over the years. Based on the study, QR mobile payments have had a very welcoming level of intention to be used despite being the newest compared to NFC and SMS (Madureira 2017). QR codes are convenient as large amounts of information can be stored and this information can be read with a quick scan. The fast attribute is a benefit to users as they only require users to scan unique QR code to make transactions (Sikri et al. 2019; Webb et al. 2019). QR codes may need a native application on the phone to read the code (Solano et al. 2017). However, may application now have built-in QR reader along with a QR display. Many applications use a combination of NFC and QR code but most importantly QR codes can be used as a standalone delivery method. For example, Starbucks Café company in Malaysia adopts QR code as their payment method (Leong et al. 2020), along with TouchNGo and Grab as well.

SMS is a remote payment system and the oldest of the three. A common advantage is that it works on any mobile phone that can be accessed if there is GSM network presence (Gerpott & Meinert 2017). This method is useful in an unbacked population where the later generation mobile network and smartphone penetration is low (De Luna et al. 2019). Although, SMS payments is quite secure (De Luna et al. 2019), it can, however, be unfriendly and complex to the users as it requires many steps to make a payment (Solano et al. 2017). Over the years, free messaging services with smartphones have far outreached the ability of SMS to reach customers around the world efficiently and this has directly decreased the usage of SMS (Nesse et al. 2017).

RQ3: Which Type of Delivery Technology Is Best Suited for an E-Wallet?

From the studies reviewed, it is evident that NFC and QR codes are delivery technologies that are more preferred

than SMS. It is also understood that a digital wallet can have multiple delivery technologies. A common favorite architecture especially in the last decade is a standalone NFC, QR or a combination of both. This also coincides with the technology timeline discussed above and the review results from the study. The study focuses on mobile-based digital e-wallet and thus eliminates the digital(online)-only delivery method.

Based on the statistics of the Malaysian e-wallet market, e-wallets utilizing QR codes are more widely adopted among Malaysian citizens compared to those using NFC technology. Many successful and widely used e-wallets currently used in Malaysia use QR as their delivery technology. Although, this is not the case for users in other countries. However, designing an e-wallet that is beneficial highly depends on the target audience's requirements.

The limitations of NFC in terms of high setup cost and low adaptability seem to outweigh its advantages of being convenient and quick delivery technology. Therefore, QR code is the best delivery technology option for e-wallets designed in Malaysia. It is highly adaptable because of its low manufacturing cost and familiarity among Malaysians.

DISCUSSION

Fintech is rapidly becoming the central part of the world's financial sector. The convergence of blockchain, AI, IoT and RPA in Fintech are the key enablers of a digital revolution in the drive towards a digital economy. These four pillars are embedded in the design of the adaptive e-wallet system consisting of the physical layer, adaptive layer, and the backend layer.

This paper highlights the delivery technology that is part of the IoT block which forms the physical layer in the e-wallet. The physical layer is the closest layer to the end system user that the users see and interact with. This user-facing layer is also a data link layer as it can read and send data to the data layer for further data processing. In this system the physical layer consists of the smartphone and QR code. Smartphones have incorporated image acquisition modules and enhanced data processing capacities in recent years (Ramalho et al. 2020), thus, allowing QR codes to be scanned and extract data. QR code is described as an IoT gateway (Ramalho et al. 2020). It is probably the least expensive tool that has the potential to power IoT in finance. Valuable information can be stored in QR codes that can be read by the smartphone and fed to the data processing layer. IoT is an ideology that is a great help to making contactless payments simply because it ensures physical distancing which is the need of the hour in today's health climate.

In the next layer, data is classified as input and output data. Input data is the data extracted from QR codes that stores information on products purchased, merchant, type of transaction and the user. This data accumulates as more transactions via QR codes are made in the e-wallet and can be termed big data as the data collection increases in size. Output data is raw collected data that has been analyzed and distributed fit for the next phase in the system. Manual collection and redistribution of data growing is tedious and repetitive; therefore, RPA is adopted to document these data. RPA is a software system that automate technologies to mirror back-office tasks of human workforce (Pramod 2021). In this system RPA is used to extract and insert data connecting the layers above and below, the physical layer and data layer respectively via APIs to integrate and perform repetitive tasks.

AI algorithms and Machine Learning (ML) techniques have been successfully implemented in real-world contexts like Fintech among other industries in recent years. ML is used to "train" machines on how to deal with data more efficiently, emulating the learning notion of rational beings and can be applied with AI algorithms, reflecting rational qualities such as connectionist, genetics, statistics, and probability, based on examples. It is feasible to analyze and extract information using AI algorithms and a machine learning technique to categorize, associate, optimize, group, predict and detect trends. RPA has steadily added implementations of algorithms or AI techniques applied in various situations to its automation capabilities, given the breadth of AI's applicability (Ribeiro et al. 2021). In the context of this system, ML algorithms are applied to form a predictive budgeting model based on the transactions made by the users. This is feasible as it is crucial as user spending habits can vary from person to person and therefore training a large set of data to form accurate predictions are important.

The confluence of blockchain, IoT, AI and RPA in the finance industry has seen a pivotal period of change in recent times. Blockchain is the backbone technology that drives the Fintech revolution. The decentralized nature of blockchain implies that applications running on top of it can achieve high availability and security. Blockchain has a big impact on the business process by establishing trust among untrusted services, which consequently wipes out the need for central authorities (Viriyasitavat et al. 2019). As such, it is the final piece in this system development as it is the connectivity layer between the layers that allows for transparent and secure transactions.

The summary of delivery technology embeds the four fintech pillars in designing an adaptive money management application by ensuring safety and security for children and the elderly. The introduction of digital payment in the 90's gradually changed the expenditure pattern among

users which provided uncontrolled expenditure. Today, e-wallet are prominently used among the millennials and the benefits they reap are plenty. As any other technology, digital payment has its advantages in terms of financial education and safety and can be enjoyed by age groups beyond the millennials, namely the young and elderly. Nevertheless, encouraging the usage of e-wallets can highly benefit users of both age groups in terms of safety and financial literacy (Sundarasen et al. 2016).

The elderly are oftentimes the target of fraud schemes. These schemes are about luring the target to win an item from a well-known brand by paying an upfront cost. Usually, the scammers would request the elderly to provide their credit or debits cards for them to make those transactions. With the usage of e-wallets, only money reloaded into the e-wallet can be spent as opposed to maxing out the credit limit in cards. Similarly, the e-wallet helps children with spending money that parents have reloaded into their accounts with accountability and control. This way parents are aware of how much money is spent while simultaneously teaching their children to manage their money efficiently. The merger of an adaptive money manager and a QR code-enabled e-wallet can form a financially literate society in this digital world regardless of age. An additional benefit of the current predictive analogy will be able to assist the user to have a personalized fintech-assisted expenditure robot with every transaction made with the scanning of QR codes and every transaction monitored and accounted for.

CONCLUSION

An e-wallet is a tool that allows users to make cashless, quick, and easy transactions while reviewing their transaction history in one platform. The frequency of usage of an e-wallet also highly depends on the convenience and simplicity of payment method or delivery technology it incorporates. The objective of this review was to outline the advantages and the disadvantages of different delivery technologies. A review was conducted to identify relevant articles that were analyzed to facilitate the realization of the study objective. The study focusses on the advantages and disadvantages of using NFC, QR codes and SMS in financial applications with a focus on choosing the delivery technology that would best suit the adaptive financial management embedded e-wallet that can be deployed soon.

NFC and QR were more favored than SMS simply because of their convenience and quick payments. It is also not uncommon for e-wallet to have more than one delivery technology. In fact, NFC and QR were the preferred duo for e-wallets with multiple delivery technologies. However, the disadvantages of NFC being high setup cost and low penetration outweighed its advantages. Many successful and widely used e-wallets available in Malaysia used QR code as their delivery technology. The significance of high penetration and adaptability rate of QR codes among Malaysians coupled with is low costing setup influenced the decision of choosing QR code as delivery technology best suited for the adaptive management embedded e-wallet that incorporated the four blocks of Fintech technologies namely, blockchain, AI, IoT and RPA. AI and RPA provide automation algorithms while the IoT with QR unleashes digital data from the physical world and the emergence of distributed ledger or blockchain solutions can potentially reshape the nature of modern business governance. Overall, a QR code enabled e-wallet can expedite and automate the process of analyzing transactions, thus providing a solution to secure transactions and better money management.

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DECLARATION OF COMPETING INTEREST

None

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