MKQR Bill Standard and its Application on Mobile Banking and e-Invoicing

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Abstract. Digital transformation is closely related to business development in a systemic way that requires knowledge and skills management and covers multiple processes including online payment. The QR code payment model for mobile banking can be widely used as an alternative to cash payment via mobile phone. An MKQR standard and application for generating MKQR codes is proposed in this paper, and it can be used as an alternative payment system and it can be integrated with the account of the source of the fund without the need to top up the transfer. The proposed system is not only meant for merchant payment but can also be used for person-to-person money transfers. This paper proposes a Macedonian open and independent standard called MKQR, using the QRcode - ISO/IEC18004 standard, for coding and data transmission methods for financial transactions.

Keywords: QR code, Mobile Banking, Mobile Payment, e-Invoicing, QR bill, MKQR standard, MKQR application

1. Introduction

Today, the most important questions are how to optimize existing business operations or functions using information technology, the cloud or digital services, and how to identify, create and manage the needs of the coming digital society. The importance of customer centricity and the identification of upcoming needs are further enhanced by the great agility and fast development of new or adjusted needs [1]. Digitalization offers huge potential to streamline business-to-business (B2B), business-to-customer (B2C), business-to-government (B2G), customer-to-business (C2B), customer-to-government (C2G), processes in terms of the manual amount of work, material, cost and time.

Digitizing an existing business process often proves to be more complicated than expected. One of the components of digitization of the business process is the transition from a paper-based process of handling invoices to electronic invoicing, as preparation for digitalization of all payments. Electronic invoicing (e-invoicing) is the exchange of an electronic invoice document, transmitted and received in a structured data format that enables automatic and electronic processing, as defined in Directive 2014/55/EU.

Due to a lack of standardization, invoices to customers were delivered in different data formats not suitable for digitalization or automation. In March 2016, the European

Committee for Standardization (CEN) approved the first steps towards a unified European standard for e-invoicing [2]. It was a grand step to payment automation and payment process streamlining.

A structured e-invoice contains supplier metadata in a machine-readable format, which can be automatically imported into the customer's billing (AP) system without requiring manual entry [3]. E-invoices contain the data only in a structured form and can be automatically imported into AP systems. With such e-bills, invoices are delivered directly to e-banking platforms, from where they can be paid in just a few clicks with full control over all transactions.

The facilitation of e-payment and e-invoicing requires connecting companies, service providers, government authorities and community researchers. Also, it should be kept in mind that legal frameworks differ worldwide, so this article is focused mostly on e-invoicing in the Republic of North Macedonia considering the e-bill Switzerland example.

Switzerland is a leader in e-invoicing and goes a step further by using a new way of invoicing for simpler payment. Switzerland has replaced traditional payment slips with mandatory QR codes [4]. The QR code included in every e-bill (printed or digital only) contains all the necessary payment information, it can be used physically on paper or digitally.

The future of m-payments is promising, considering the high rate of penetration of mobile devices, especially mobile phones, PDAs and other devices [5]. M-invoicing and QR accounts have gained significant momentum in recent years from a business perspective, as well as from governments around the world, and represent a challenging area in which digitization can be explored.

This paper proposes a Macedonian open and independent standard dubbed MKQR for coding and data transmission methods for financial transactions. This standard defines the data format that describes each aspect of an MKQR entity. Entity data is defined as plain text in MKQR format that follows the URI standard. The text is visually encoded into a standardized MKQR (quick response) code, based on the ISO/IEC18004 standard, which can then be printed on paper, displayed on a screen, etc. A code scanned by a smartphone application creates a text link containing all aspects of an MKQR entity defined by this standard.

The remainder of this paper is organized as follows. First, a review of the literature associated with m-payment and QR bills is discussed. Next, the proposed MKQR Standard is described in detail. Then the application for MKQR code generating is presented. Finally, concluding remarks are given in the last section.

2. Related Work

The four pillars of payment through a mobile application also known as Mobile Payment are defined in [6]: Self-Paying: intended for transfer to the bank account itself through mobile deposit and funds transfer capabilities feature; Paying Other People:

uses Person to Person Payment (P2P) features for individual or group payments; Paying Biller: making a payment to the biller through a mobile application owned by financial institutions or applications owned by the biller; Paying Merchant/Retailer: is for payment transactions on purchases at merchants using NFC sensors, QR code, cloud, or online.

Based on the mapping of the four pillars of mobile payment strategy from Sachdev, the goal of QR Code Payment in mobile banking is to build an ecosystem that will facilitate payment/issuing and ultimately reduce the volume of cash withdrawal transactions. It can be used as an alternative method of payment transactions with a merchant and for service person to person. Building an ecosystem is a long-term process.

QR Code Payment is based on QR (quick response) codes, that represent 2D matrix-type symbols with a cell structure arranged in a square. QR codes were approved as an ISO international standard (ISO/IEC18004) in June 2000. Unlike many traditional 2D bar codes that need to be decoded by a specific scanner, QR codes can be decoded by a small program in a cell phone or a personal computer with a built-in camera. According to the security of the online transaction, QR code as well as NFC and biometrics is categorized as an alternative to the multi-factor authentication process. In addition, QR code only needs a camera to scan, so all types of mobile phones have QR Code support. Although initially, QR codes were mainly used in areas such as downloading digital content and product information, today, they are applied in various application streams related to marketing, security, academics, as well as finance [7].

EU has set the goal to make e-invoicing the primary method of invoicing by 2020 [8]. Therefore, the EU launched initiatives to drive the adoption of e-invoicing such as the Pan-European Public Procurement OnLine (PEPPOL) initiative seeking to enable interoperability between dissimilar systems by providing technical specifications being implemented into existing e-procurement applications [9]. Moreover, the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT), a body of the United Nations Economic Commission for Europe (UNECE), drives the harmonization of trade processes internationally [2].

Today, from an EU legal point of view, sending documents in a PDF format via e-mail is a legally compliant way of e-invoicing, as long as the authenticity and integrity of the document can be proven through adequate internal business controls and it is properly supported by accounting documents.

From a technological perspective, there has been a recent convergence of e-invoicing standards, across different solutions and systems. Moreover, there is a trend towards business software solutions implementing e-invoicing as a basic functionality, following established standards [2].

Switzerland is going a step forward and a new way of invoicing use for simpler of payment. This new option is based on the standards of the Single Euro Payments Area (SEPA), which harmonize bank transfers across 34 states in Europe and was established using a unified data format following the ISO 20022 standard [10]. In 2017, the Swiss Financial Center presented the new QR bill, a future-oriented solution that enables the different interest groups to meet the challenges of digitalization and regulation

efficiently. The QR bill was introduced in 2020 as part of efforts to harmonize and digitalize the Swiss payment transactions ecosystem. After a two-year transition period, all financial institutions in Switzerland will discontinue processing red and orange payment slips. The QR bill replaces traditional payment slips [4]. QR code contain all necessary payment information, it can be used physically on paper or digitally.

QR-code, also displays the payment information in text format on the right, making it readable for non-automated processing as well. The invoice-processing software will inevitably have to incorporate relevant functionalities for generating invoices and reading the new payment slip QR bill.

QR bill or digitization of invoicing allows faster payment and fewer errors without typing the account numbers and reference numbers. The QR bill, defined according to ISO 20022 standards, facilitates payments thanks to automated data processing. This is not just SEPA-conforming, in terms of euro payments, but accommodates all domestic and foreign payment transactions [7]. It enables both issuing and paying invoices.

Since 2017, Switzerland used the new QR bill, which can be printed or issued digitally and is a replacement for previous payment slips. The QR bill consists of a payment and confirmation section. All payment information is contained both digitally in the Swiss QR code and - as usual - in plain text. This allows the recipient of the invoice to check the accuracy of the payment data after scanning and before approving the payment and, if necessary, enter the payments manually. The QR bill is divided into two parts (like the existing payment slips): 1) a confirmation part and 2) a payment part. The Swiss QR code contains all the relevant information needed for invoicing and payment. The QR bill is perforated, so the recipient of the invoice can easily separate the payment and bill part of the invoice.

Modern m-payment systems, from the traditional "buyer-seller" exchange, passed to more complex transaction models, including also network providers, finance companies for money transaction management, generally a credit card or debit card issuing company and/or other institutions operating inside the Internet [11]. Taking into account the right end users, the right payment circuit, technology factors and business models can produce a successful m-payment solution. Security requirements must be imposed, in order to ensure trust and avoid fraud, as well as interoperability and privacy requirements. In addition, in this m-payment environment, the speed of execution and ease of use are mandatory requirements, too.

3. MKQR Standard

In terms of PESTEL (political, economic, social, technological, environmental and legal) factors, it becomes obvious that the political, technological and legal infrastructure in the Republic of North Macedonia is ready to support digitalization and that a great effort has been made to facilitate digital changes. Although not all factors are truly optimal, from an economic perspective, the business case for digitizing business processes is strong. Since there will never be an ideal moment in which there is absolute certainty concerning all circumstances, the digitization of business processes

including the digitization of all types of financial obligations, should be understood as a basic task of managers in the Republic of North Macedonia.

The MKQR is an independent and open proposed standard, based on the ISO/IEC18004 standard [12], for coding and data transmission methods for financial transactions. By simply scanning the QR code with his mobile phone in the payment section and approving the payment, without the need for additional entries in e-banking, the recipient of the bill will be able to complete the entire transaction. The standard defines the form of data that describes every aspect of an MKQR entity. The data for an entity is defined as plain text in MKQR format that follows the URI standard. The text is visually encoded into a standardized MKQR, which can then be printed on paper, displayed on a screen, etc. A code scanned by a smartphone application creates a text link containing all aspects of an MKQR entity defined by this standard. Applications that fully implement this standard can perform financial transactions through standardized text links and their corresponding MKQR codes. The standard is versioned semantically. The base version is 1.0.0. The definitions of data, the description of process and the plain text format are given in Table 1.

Table 1. Definitions of data attributes describing a payment process and the plain text format

Term	Description
MKQR	Reference to this standard
MKQR URI	Plain text following the URI standard
Entity	An entity consists of all the data defined by the MKQR standard
Client	An application that implements the MKQR standard
Creditor	The private or legal entity that is the entity's destination
Debtor	The private or legal entity that is the source of the entity

The data for each entity is combined into a single plain text instance in *MKQR URI format* that applications implementing the standard can parse. The MKQR URI format starts with a fixed segment: mkqr://pay?. All required data and all data containing the MKQR URI text must be valid. Validation is done before generating the MKQR code. MKQR does not guarantee the complete validity of the data as it cannot be fully validated before the generation of the MKQR code. Customers can perform additional data validation, according to their own needs.

The MKQR URI starts with the "mkqr://" prefix to be possible to be used as a trigger to activate and start any smartphone app that can handle such URIs. The idea is that the standard does not define the apps, there can be multiple apps that support and recognize MKQR and it will be up to the user to choose which app will be used to handle the MKQR data. In a practical scenario, most probably the first adopters of such support will be the e-banking apps of the banking providers (banks).

The MKQR code can be in color or monochrome. A color QR code has a gradient that starts at the top of the red QR code (#CC0708) and ends at the bottom of the black QR code (#000000). In the center is the MKQR code logo. The MKQR code logo has a 1-square-thick border on all 4 sides. The frame has a yellow color defined on the flag of the Republic of North Macedonia. In the center of the logo are the letters MK, colored with the yellow color defined on the flag of the Republic of North Macedonia,

which has a total width of 11 squares and a total height of 5 squares. The size of the logo is 13 squares in width and height. The background is red as defined on the Macedonian flag. The logo transparency is 20%.

A monochrome code contains only the colors black and white. The dimensions of the logo are the same as the dimensions of the color QR code. The background of the monochrome code is black, and the frame and text are white. Examples of the appearance of the MKQR code are illustrated in Figure 1.

Accounts   Donations   Payment slips (monochromatic)

Figure 1: Examples of the appearance of the MKQR code.

Table 2 contains explanations of all elements that are defined by the MKQR standard. Table 2 shows all entity data of the attributes included in the MKQR string (abbreviations, definitions, values, data types and some remarks), with the following abbreviations in the data type column: M - Mandatory; O – Optional; C – Conditional; S - structured address; K - combined address.

Table 2. Entity data

Attribute Name	Abbr.	Definition	Values	Note	Data Type
QRType		Standard type.	MKD	MKD is a fixed value for MKQR.	M
Version	v	Version of the specification according to which the MKQR code is generated.	Fixed length, 4 digits.	1.0.0	M
Coding	c	Type of code page of the data in the text.	1 for UTF-8 encoding but only with a subset of Latin characters. 2 for UTF-8 encoding with all characters including Cyrillic.		M
IBAN	iban	IBAN of the creditor's account.	Complex data is validated with the expression.	Customers can also implement	M

Attribute Name	Abbr.	Definition	Values	Note	Data Type
				additional IBAN validations.	
Alternative IBAN	aiban	Alternative IBAN accounts of the creditor, separated by pipe character "|".	Maximum 77 characters, each individual entry is validated with the expression.	Alternative accounts are arranged according to the creditor's preference.	O
Address Type	cat	Creditor Address Type.	S - structured address in multiple fields. K - combined address in two fields.		M
Creditor Name	cn	Name (and surname) of the creditor.	Maximum 70 characters.		M
Street or address line 1	cadd1	For a structured address S, the creditor's street name or postal code is entered. For combined address K, the first line of the address, street and number or postal code is entered.	S - maximum 16 characters. K - maximum 70 characters.	If cat=K, then this data must exist.	O
Building number or address line 2	cadd2	For a structured address S, the address number of the creditor is entered. For combined address K, the second line of the address is entered: the creditor's city and postal code.	S - maximum 16 characters. K - maximum 70 characters.		O
Postal Code	cz	For a structured address S, the postal code is entered.	S - maximum 7 characters. K - is omitted.	If cat=S (structured address), then this data is required.	C
Town Name	cg	The name of the creditor's city.	S - maximum 35 characters. K - is omitted.	If cat=S (structured address), then this data is required.	C
Country	cc	State of creditor.	Fixed length, 2 characters, according to the ISO 3166-1 standard.		M
Amount	a	Amount	An 8-byte decimal numeric data equivalent to a double as defined in the IEEE-754 standard.	The sum must be a text that can be converted to a double. If the amount cannot be converted into this format the MKQR generation should be stopped.	O

Attribute Name	Abbr.	Definition	Values	Note	Data Type
Currency	cur	Payment currency.	Fixed length, 3 characters, according to the ISO 4217 standard.	The customer determines whether the currency of payment is allowed. Whether the currency is valid is determined by its presence.	M
Ultimate Debtor address type	pat	The debtor's address type.	S - in multiple fields. K - in two fields.		O
Ultimate Debtor Name	pn	Name (and surname) of the debtor.	Maximum 70 characters.		O
Street Name or Address Line 1	padd1	For S, the creditor's street name or postal code is entered. For K, the first line of the address, street and number or postal code is entered.	S - maximum 16 characters. K - maximum 70 characters.		O
Building Number or Address Line 2	padd2	For a structured address S, the address number of the creditor is entered. For combined address K, the second line of the address is entered: the creditor's city and postal code.	S - maximum 16 characters. K - maximum 70 characters.		O
Postal Code	pz	For a structured address S, the postal code is entered.	S - maximum 7 characters. K - is omitted.	If pat=S (structured address), then this data is mandatory.	C
Town Name	pn	The name of the creditor's city.	S - maximum 35 characters. K - is omitted.	If pat=S (structured address), then this data is mandatory.	C
Country	pc	State of creditor.	Fixed length, 2 characters, according to the ISO 3166-1 standard.	Whether a country code is valid is determined by attendance	O
Payment Reference Type	rt	Reference type. The following codes are allowed: QRR – QRR reference. SCOR – Creditor Reference (ISO 11649) NON – no reference.	Maximum of 4 alphanumeric characters. QRR (when using QR-IBAN) or SCOR / NON (when using IBAN).		M
Payment Reference	ref	Reference. A structured reference is either a QRR reference or an ISO 11649 - Creditor reference.	Up to 27 alphanumeric characters; QRR reference: 27 numeric characters, calculation of calculation sum according	Mandatory if QR-IBAN is used.	C

Attribute Name	Abbr.	Definition	Values	Note	Data Type
			to module 10 recursive, 27th position of the reference. Creditor reference (ISO 11649): maximum 25 characters, alphanumeric. Ignored if filled for rt=NON.		
Payment Code	pcd	Payment code	3 digits	The description of the codes is available.	M
Payment Type	nac	Method of payment	1 digit		O
PP50 Payment account	us50	Consignee's transaction account	Fixed length, 15 digits.		O
PP50 Account Single User	usek50	Consignee's transaction account	Fixed length, 15 digits.		O
PP30 Payment account	us30	Consignee's transaction account	Fixed length, 15 digits.		O
PP30 Account Single User	usek30	Consignee's transaction account	Fixed length, 15 digits.		O
Additional info, USTRD	i	Additional information	A maximum of 140 alphanumeric characters.	Documentation	O
CheckURL	curl	Address for additional validation of entered data. The response must be HTTPS in JSON format and must contain an "IsValid" attribute that defines whether the validation was successful or not.	Complex data is validated with the expression		O
Alternative Payment Scheme	ap	Name of the alternative payment method.	Maximum of 20 alphanumeric characters.		O
Alternative Payment Values	av	Value of the alternative payment method.	An 8-byte decimal numeric data equivalent to a double as defined in the IEEE-754 standard.		O
Alternative Payment Description	ad	Description of the alternative payment method.	Maximum of 240 alphanumeric characters.		O

Attribute Name	Abbr.	Definition	Values	Note	Data Type
Alternative Payment Currency	ac	Currency of the alternative payment method. It can be omitted.	Fixed length, 3 characters, according to the ISO 4217 standard.	Whether the currency of payment is allowed is determined by the customer. Whether the currency is valid is determined by its presence.	O

An example of MKQR encoded string for e-invoice payment with multiple destination IBAN accounts and metadata:

mkqr://pay?t=1&v=200&c=1&iban=3123452523424&aiban=210068329110129|3000 00003538887|530010101565335|200002545849091|250010000232377|27006832911 0136&cat=1&cn=Топлификација Скопје&cadd1=Лондонска бр. 8&cadd2=&cz=1000&cg=Скопје&cc=Македонија&a=1751,00&cur=MKD&pat=& pn=Петко Петков&paddr1=Партизанска 111&paddr2=&pz=1000&pg=Скопје&pc=Македонија&rt=&ref=17180904216&i= &=&=&ap=&av=&ad=&ac=&pc=&nac=&us=&usek=&ps=&pr=

4. Creation of MKQR strings

The application together with the invoice form is designed to work collaboratively with other systems to which it will be connected. The application is designed to be filled out automatically by the system to which it will be connected. The QR code is generated and the user is redirected to the website where he will pay the bill.

After the invoice is paid, the invoice application provides the data about the user and the amount he paid, together with the same QR code that he scanned in PDF format, with the possibility to download and save it, for further records. In this way, the user can whenever he wants to scan the QR code and find out when, where, how much and what he paid for that amount of money.

The application consists of a web form that has 37 fields to fill. Each place is specific to a certain data. The application detects whether numbers or letters are written in the fields, and whether the language entered is English or Macedonian, Cyrillic or Latin. In the process of code generation, if an important field is empty, it warns the user with a message that the field is mandatory and needs to be filled (Figure 2). When the necessary and mandatory fields are filled in, the QR code appears. The code is intended for charging for services and products in Macedonia, where through it, by scanning it, citizens will be able to pay bills, donations, products and services from home and via smartphone or computer. The QR code is specific to Macedonia with a logo with the initials MK or the Macedonian flag in the middle of the QR code (Figure 1). When the

QR code is scanned, the user is redirected to the specified website to complete the transaction. After that procedure is completed, the Invoice application appears which provides the invoice in PDF format with the data entered in the form.

Figure 2. MKQR Application – QR code generation

For the application development, several technologies and tools were used: JavaScript, NodeJS, HTML2PDF and jsPDF - an open-source library for generating PDF documents using JavaScript.

5. Concluding Remarks

The MKQR standard and prototype of the MKQR application will modernize payment transactions. MKQR invoices will offer many advantages to both recipients and issuers of invoices. They are convenient because scanning the QR code is so simple. The new account will be both fast and efficient. A few clicks are all it takes to release payment, replacing the tedious task of typing in invoices and reference numbers and significantly reducing a common source of error.

At the same time, the proposed MKQR standard and prototype of the MKQR Application bridges the digital and paper-based worlds and goes a step further. It will advance the digitization processes of businesses in the North Republic of Macedonia. The proposed MKQR standard and MKQR Application will offer many advantages for invoice recipients and invoice issuers such as all payment information transferred electronically; all payment information built into a QR code in digital form; one QR code for all types of payment and reference; more straightforward invoice processing; simplified payment reconciliation, less manual work, fewer errors etc.

The new m-payment infrastructure will ensure a seamless digital payment experience.

References

[1] D. Schwaferts and S. Baldi, "Digital Transformation Management and Digital Business Development," in *Business Information Systems and Technology 4.0: New Trends in the Age of Digital Change*, Basel, Switzerland, Springer, 2018, pp. 81-102.

[2] C. Tanner and S.-L. Richter, "Digitalizing B2B Business Processes—The Learnings from E-Invoicing," in *Business Information Systems and Technology 4.0: New Trends in the Age of Digital Change*, Basel, Switzerland, Springer, 2018, pp. 103-116.

[3] European Commission, "What is eInvoicing," 06 2024. [Online]. Available: https://ec.europa.eu/digital-building-blocks/sites/display/DIGITAL/What+is+eInvoicing.

[4] SIX Interbank Clearing Ltd 2017, "The End of Swiss Payment Slips: How to Keep Your Standing Orders Activated and Working," 06 2024. [Online]. Available: https://www.six-group.com/en/blog/qr-bill-standing-orders.html.

[5] L. Antovski and M. Gusev, "M-Payments," in *2nd Int. Conf. lnformafion Technology lnferfaces /TI 2003*, Cavtat, Croatia, 2003.

[6] S. Sachdev, "(2014). The Four Pillars of Mobile Payments - Immediate Opportunities.," 2014.

[7] S. Tiwari, "An Introduction To QR Code Technology," in *2016 International Conference on Information Technology, (ICIT),* Bhubaneswar, India, 2018.

[8] European Commission 2013, "E-invoicing in public procurement: another step towards end-to-end e-procurement and e-government in Europe," 06 2024. [Online]. Available: http://europa.eu/rapid/press-release_IP-13–608_en. html.

[9] Pan-European Public Procurement OnLine (2017), "What is PEPPOL? " 06 2024. [Online]. Available: http://peppol.eu/what-is- peppol.

[10] The National Adherence Support Organisation (NASO) of Switzerland 2017, "Single Euro Payments Area (SEPA)," 06 2024. [Online]. Available: https://www.sepa.ch/en/home/sepa.html.

[11] A. Vizzarri and F. Vatalaro, "m-Payment systems: Technologies and business models," in *2014 Euro Med Telco Conference (EMTC)*, Naples, Italy, 2014.

[12] "ISO/IEC 18004," 07 2024. [Online]. Available: https://www.swisseduc.ch/informatik/theoretische_informatik/qr_codes/docs/q.

[13] "Six," 07 2024. [Online]. Available: https://www.six-group.com/en/products-services/banking-services/payment-standardization.html.

[14] T. J. Soon, "QR Code," *Synthesis journal,* pp. 59-78, 2008.

[15] T. S. Parikh and E. D. Lazowska, "Designing an architecture for delivering mobile information services to the rural developing world.," in *Designing an architecture for delivering mobile information services to the rural developing world.*, 2006.

[16] Seino et al., "Development of the traceability system which secures the safety of fishery products using the QR Code and a digital signature," in *Marine Technology Society/IEEE TECHNO-OCEAN*, 2004.

[17] Ruslan, G. M. Karmawan, Suharjito, Y. Fernandoand and A. Gui, "QR Code Payment in Indonesia and Its Application on Mobile Banking," in *KnE Social Sciences / FGIC 2nd Conference on Governance and Integrity*, 2019.

[18] M. V. Stiphout and M. Mual, "Payment Methods Report 2017.," in *The Paypers BV.*, 2017.