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QR codes in contemporary China:
digital money and people's perception

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Outline of the thesis:

- **Abstract of the thesis**

This thesis discusses the subject of QR codes in the unique frame that contemporary China represents. The country, with its strong control over the society in the digital space and non-, has managed to create a unique situation where QR codes have been taken to the next level, contrarily to the rest of the world. In this thesis we will see how the QR code has been inserted in this frame and has managed to shape the society and in particular the relationship between the society and money.

The outline of the thesis is divided into three chapters, each focusing on a different aspect of this subject. The first chapter explains the subject of QR code technology looking at the history of its invention, starting from one-dimensional barcodes and unfolding the topic all the way to today's technology. The second chapter shows the many applications that QR codes can have in different sectors and for different purposes with a specific look at the Chinese reality, and reflects about the advantages and disadvantages that come with the use of the technology. The third chapter is specific about the Chinese relationship with the QR code. It unfolds the subject starting with its first introduction, its popularization through social media and mobile payment options, the concerns for its safety, the changes to today's Chinese society's relationship with money, ending with some considerations about the future of this technology.

- **Chinese summary**

中文摘要

本论文的题目是 QR 码对当代中国的影响和中国人对电子货币的看法。全文共分为三章，每一章都是关于这个话题的不同方面。第一章是关于 QR 码技术，讨论条形码的发展和历史，从一维条码到最新的二维条码。第二章是关于 QR 码的许多应用，优点和缺点。第三章是关于 QR 码对中国的影响。各章具体内容如下:

第一章的目的是了解到 QR 码技术开发。第一部分的内容是条码的介绍。我解释了一维条码的历史和应用。第二和第三部分是关于二维条码。我解释不同类型的二维码及其特点和应用。

我们在商场购买商品时，经常会看到商品的包装袋上会有一个条形码，这个条形码被称为一维码。一维码自问世以来，已经被广泛应用到商业、工业、金融、医疗卫生与邮电等各个领域。由于一维码的信息容量很小，如商品上的条形码仅能容纳 13 位的阿拉伯数字，所以使用范围受到了一定的限制。正是因为这个原因，人们迫切希望发明一种新的条码，除具有一维码的易于制作、成本低的优点之外，还需要具有信息容量大、可靠性高、保密防伪性强等其他优点。

QR 来自英文 “Quick Response” 的缩写，即快速反应的意思，源自发明者希望 QR 码可让其内容快速被解码。QR 码 1994 年由日本 Denso-Wave 公司发明。这种二维码能够快速读取，与之前的条形码相比，QR 码能存储更丰富的信息。该条码可以把图片、声音、网址、文字、签字、指纹等可以数字化的信息进行编码，用条码表示出来。QR 码可以表示多种语言文字 (比如中国汉字、日本汉字)。QR 码具有纠错功能。这使得二维条码因穿孔、污损等引起局部损坏时，照样可以正确得到识读，损毁面积达 50%仍可恢复信息。

QR 码呈正方形，一般有黑白两色，尺寸大小比例可变。在 4 个角落的其中 3 个，印有较小，像“回”字的正方图案。这 3 个是帮助解码软件定位的图案，使用者不需要对准，无论以任何角度扫描，资料仍可正确被读取。QR 码可以通过光电扫描设备或者图形输入设备对信息进行识别以实现信息的自动处理的过程。QR 码是二维条码的一种，除了 QR 码之外，

也有 PDF417、Data Matrix、Maxi Code、Aztec Code 和 中国的汉信码。除了标准的 QR 码之外，也有别的 QR 码，比如微型 QR 码、iQR Code、SQRC 和 Frame QR。

第二章的目的是介绍 QR 码的具体应用、优点和缺点。QR 码有两种应用：线上应用和离线应用。这种二维条形码的特性特别适用于表单、安全保密、追踪、证照、存货盘点、资料备援等方面。商家可在报纸、杂志、图书、海报、传单、优惠券、广告牌、X 展架、产品包装、个人名片等上加印二维码。QR 码也可以巧妙地嵌入在电视、视频、广告上。

随着智能手机的普及，各种各样的二维码应用也接踵而至，看看有哪些极具创意的二维码应用：二维码请柬、二维码展示海报、二维码签到、二维码墓碑、二维码名片、二维码指示牌、二维码宣传广告、二维码食品身份证。

二维码成为了移动互联网和 O2O 的关键入口。随着电子商务企业越来越多地进行线上线下并行的互动，二维码已经成为电子商务企业落地的重要营销载体。二维码在电商领域的广泛应用，结合 O2O 的概念，带给消费者更便捷和快速的消费体验，成为电商平台连接线上与线下的一个新通路，对于产品信息的延展，横向的价格对比，都有帮助。 “移动超市”将移动电子商务推向一个新台阶，它主要研究开发基于移动终端的移动交易和商家营销应用，借助二维码作为通道，实现消费者随时随地快速浏览真实商品，快速购物。用移动设备上的二维码扫描软件，可直接扫描二维码进入商家的手机网站，点击中意的产品，即可完成下单及支付，实现轻松购物的时尚理念。

二维码支付是一种基于账户体系搭起来的新一代无线支付方案。在该支付方案下，商家可把账号、商品价格等交易信息汇编成一个二维码，并印刷在各种报纸、杂志、广告、图书等载体上发布。二维码支付与传统的银行卡支付相比，具有以下优势：一是携带方便。用户只需要一部手机就可以完成整个支付过程，避免了日常需要携带多张卡片的烦恼；二是操作简单。用户只需要拿出手机，完成相应操作，避免了掏卡、找卡等复杂过程。三是降低商户成本。传统 POS 收单商户需要缴纳 POS 押金，才能实现对于刷卡支付的支持。而二维码支付只需要商户手机装载一个手机 APP 和打印一张二维码，就可以完成整个支付流程，成本相对于刷卡支付大大降低。现有二维码的支付产品模式主要可以分为两类，一类是用户与商户交互模式，另外一类是用户与用户间的交互模式。其中，用户与商户的交互模式又可以分为两类，一类是用户主扫模式，一类是用户被扫模式。

QR 码有很多应用， 比如网络资源下载，产品溯源应用，景点门票等。火车票告别传统文字纸张模式，采用二维码进行售票、检票，提高通行效率，防止伪票。二维码不单只有商业用途，对于个人同样也有实现展示与推广的作用。

QR 码的优点有恨多，比如储存量大、保密性高、追踪性高、抗损性强、备援性大、成本便宜等特性。扫描二维码有时候会刷出一条链接，提示下载软件，而有的软件可能藏有病毒。其中一部分病毒下载安装后会对手机、平板电脑造成影响；还有部分病毒则是犯罪分子伪装成应用的吸费木马，一旦下载就会导致手机自动发送信息并扣取大量话费。对此，资深手机软件专家洪志刚认为，利用二维码骗取手机话费是完全可行的，理论上讲，二维码本身不会携带病毒，但很多病毒软件可以利用二维码下载。

第三章是关于 QR 码对中国和中国人的影响。这一章的第一部分的目的是介绍中国的情况以及有利于在中国引入 QR 码的因素。第二部分阐述了二维码对支付方式，金融和社会的影响。第三部分显示了中国中央银行和中国社会对安全问题的担忧。最后一部分解释了什么是 QR 码的未来。

中国是一个大国，并且是世界上人口最多的国家。中国有很大的多样化，土地、人口、文化、语言等方面有多样化。中国的多样化带来的主要问题之一就是城乡差距。为了管理这个大国，政府对各方面都有严格的控制。

智能手机和平板电脑的普及应用催生了之前并不被看好的二维码应用，大家竞相投入大量资源进行技术研发。

目前支付领域中，移动支付是增速最快的业务方向。随着移动支付业务的发展，市场中出现了很多种新型的支付方式，如 NFC、二维码、虹膜支付、声音支付与指纹支付等等。在上述支付方式中，二维码支付是目前市场中应用范围最广，占据市场份额最高的移动支付方式。

国内移动支付市场已经由一众独立支付公司的圈地大战逐渐演变成群雄之争。在这方面有两个互联网巨头，阿里巴巴集团的支付宝和腾讯的微信支付。

二维码支付是由支付宝正式引入中国市场的。2011 年，支付宝由于淘宝的存在，已经占据了国内线上网络支付市场的绝大部分市场份额，而国内线下支付市场则主要是以银联为标识的银行卡占据的。按照央行规定，线下银行卡消费必须通过银联，这种四方交互模式与非银行支付机构的三方交互模式是完全不同的。支付宝为了拓展线下支付业务，不断的在对线下业务进行思考，并且对各种支付媒介进行尝试。

伴随着二维码业务的发展，支付宝的线下用户与商户的数量逐步增加。其他支付机构在看到支付宝的成功经验后，也逐步跟进，增加了二维码的相关应用。2013 年 8 月 5 日，腾讯正式发布微信 5.0 版本，开启了微信二维码支付模式。

微信是腾讯公司于 2011 年推出的一个为智能终端提供即时通讯服务的免费应用程序。微信支持跨通信运营商、跨操作系统平台通过网络快速发送免费语音短信、视频、图片和文字。通过为合作伙伴提供“连接一切”的能力，微信正在形成一个全新的“智慧型”生活方式。微信二维码是腾讯开发出的配合微信使用的添加好友和实现微信支付功能的一种新方式。其已经渗透进入以下传统行业，如微信打车、微信交电费、微信购物、微信医疗、微信酒店等。微信为医疗、酒店、零售、百货、餐饮、票务、快递、高校、电商、民生等数十个行业提供标准解决方案。微信支付是集成在微信客户端的支付功能，用户可以通过手机完成快速的支付流程。微信二维码支付向用户提供安全、快捷、高效的支付服务，以绑定银行卡的快捷支付为基础。

支付宝钱包在支付方面具有优势，金融属性更强，用户通过该软件进行金融支付和理财，对安全性的认可度较高，更适合银行机构参与其中。微信 App 在用户黏性上更具优势，微信支付目前是众多社交软件中用户黏性最高、活跃度最强的，大部分人都会和朋友、家人、客户保持实时沟通，并保持着较高的使用频率，而未来手机移动支付将承载更多离线支付(020)元素。

2013 年，支付宝的母公司—阿里巴巴电子商务有限公司，宣布将以其为主体筹建小微金融服务集团。跟它脱胎而出的阿里巴巴一样，小微金融(筹)也将服务人群锁定为小微企业和个人消费者，并将通过互联网的技术和思想打造一个开放的金融生态，实现“让信用等于财富”作为自己的目标。小微金融（筹）成为蚂蚁金服的前身。蚂蚁金服旗下拥有支付宝、支付宝钱包、余额宝、招财宝、蚂蚁小贷及网商银行等品牌。

由于支付机构的二维码支付从根本上绕开了银联，快速占领线下市场，使得银联的线下市场遭受了极大的威胁。另外，二维码支付作为一种新型的支付方式，其技术性与安全性也没有建立相应检测标准，所以央行于 2014 年 3 月向支付宝公司下发紧急文件《中国人民银行支付结算司关于暂停支付宝公司线下条码（二维码）支付等业务意见的函》，禁止了支付宝的二维码线下支付活动。

QR 码支付使电子货币受欢迎。用户的手机里大多都有了支付宝和微信支付，还包括银行类的金融 App，这些 App 的用户基数和用户粘性都要高于银联钱包。因此，银联钱包才拉上了银行，降低获客成本，再利用自己互联互通的优势进行推广。电子货币是指以数码记账

的方式代替使用現金交易的货币系統。电子货币有效提高交易的效率与安全，例如消费者无须携带大量现金，商户同时无须人手点算现金。交易过程主要通过金融机构或 P2P 系统来完成，故安全性极大的提高。還擴指網路消費用的虛擬錢包，包括网上银行、第三方支付平台（支付宝、Paypal 等）。这类网上钱包只需要有账号及密码或手机等终端就可以进行交易。

尽管央行 2014 年禁止基于二维码的线下支付方式，但是由于线下支付市场具有的巨大吸引力，支付宝等机构并没有停止对于线下支付市场的探索，继续对二维码支付的技术模式及安全性进行改进，并且不断的在进行业务尝试。在支付机构的不断努力下，随着二维码技术的不断完善，2016 年二维码终于获得了央行的认可。

2017 年 12 月，央行印发《条码支付业务规范（试行）》的通知，要求扫码支付根据交易验证方式强弱确定是否限额以及限额多少。该规范适用于包括支付宝、微信以及银联在内的所有二维码支付，这意味着二维码支付业务问世以来，首份监管规范细则出台。

尽管有些人不看好二维码的应用，但无可否认，只要培养了足够多的用户群，再结合良好的商业模式，二维码将成为桥接现实与虚拟最得力的工具之一。

未来，二维码支付是否还会像现在一样，在支付领域占据优势地位还需要拭目以待，但是支付方式一定会向更加便捷、更加安全的方式进行演化。二维码支付的国际化是未来二维码发展最重要的一个趋势。

Chapter 1

I. Before QR codes: one-dimensional barcodes

The history of QR codes begins with one-dimensional barcodes or simply barcodes, as we usually call them. Barcodes were created in the United States around 1950, and consist of optical representations of data in the form of parallel lines used to describe an object for a machine to read. These parallel lines can be more or less wide and are placed next to each other with different spacing, forming the barcode.

The first barcode was invented by Bernard Silver and Norman Joseph Woodland, two technology graduates who around 1950 started a research to create something that could help their local food chain in better managing the checkout phase. The project of this automatic information reader failed many times before it was released. The first attempt used ultraviolet ink which was not a good option because it was too expensive and faded easily, the second attempt was made by Woodland using the sand on a beach and was inspired by the Morse code. After a series of attempts they were able to create a working system and in 1949, they filed the applications for the patent of both the barcode and the reading system which were later issued in 1952, they were then purchased first by Philco[1] which then sold them to RCA[2].

During the 1960s, big barcodes made with steel plates were placed on either side of railroad rolling stocks. The steel plates had on them coloured stripes painted in different combinations, they were read by a trackside scanner usually located at the entrance of classification yards. The different combination of stripes represented the information about the owner, the equipment and the identification number. This method was not efficient but year after year both barcodes and scanners became more sophisticated. The credit for the innovation of this technology is partially of David J. Collins, who continued the research and created the first error correction feature.

At this point barcodes started being used in the car production system of General Motors during the production and shipping phases for the purpose of identifying cars and components which were constantly moving on conveyors. In 1969, another important company that adopted barcodes, this time in the distribution industry, was the General Trading Company in New Jersey.

[1] Philco was an American pioneering company in the electronics sector, and is now a brand owned by Electrolux

[2] RCA stands for Radio Corporation of America, a major electronics company located in the United States

It is important to note that even if the production of the actual barcodes was relatively inexpensive, companies that wanted to use them first needed to purchase the scanner devices, which allowed to read them by pointing a beam of light on the code and were considered expensive technology.

However, barcodes gained popularity especially in the industry they were created for, the food industry. During the 70s, after being perfected, they started to gain popularity in many grocery chains around the United States. They were used in order to automate the checkout systems, in fact they solved for the first time the problem of inserting each item price at the cashier, making the process faster and more efficient. Barcodes completely revolutionized this industry and they are still in fact well used nowadays for this purpose.

The National Association of Food Chains (NAFC), soon decided to set some guidelines on barcode development, and this allowed the creation of the Universal Product Code (UPC), which is the code that we are still used to see nowadays on the products in the stores. IBM[3] was able to create this barcode in 1974 by employing the creator of the first barcode, Mr. Woodland.

By the end of the 70s and all through the 80s, barcodes spread almost everywhere around the world. Many countries created their own barcodes that are used for many different purposes, for example the postal services in many countries use different types of barcodes to track mails and packages.

Barcodes are a part of what is called the AIDC (Automatic Identification and Data Capture), which are the many technologies used for identifying objects, collecting data and entering those data into computer systems. Barcodes gained the supremacy over other AIDC technologies at least until the 2000s thanks to their simplicity, universality and price.

The initial promise with the introduction of barcodes in the stores was that of an immediate and consistent decrease in operating costs. The reality was that barcodes only managed to decrease the operating costs by 1-2%, however this allowed stores to lower their prices and increase their market share. What immediately stood out instead were the other benefits achieved with the barcode system, which included having a more efficient product management and useful sales information that allowed grocery shops to know their customers' habits, needs and preferences.

[3] International Business Machines Corporation: also known as "Big Blue", is an American company in the industry of computing and it's one of the world's best and largest companies in the whole technology field

The uses and types of one dimensional barcodes have multiplied during these many years, from code 39 which is used for example by the American military industry to mark all their products, to different variation of the UPC barcode used for example in the healthcare system to identify patients and pharmaceutical products.

1.1 example of Code 39

Barcodes where introduced in China in the 80s with a strong push coming from the government encouraging their use. In 1988 in China was even established the Article Numbering Center of China (ANCC or GS1[4] China), a body competent in managing the many aspects of article numbering and auto-identification.

As barcodes were, and still are, very useful especially in many western countries because of their ability to contain information coded in alphanumeric characters, at some point with their global spread this also became their limit in other countries such as China and Japan that don't use alphanumeric characters. Other limits of the barcodes that affected all their users were the small amount of information that they can contain as well as their readability and legibility. These limits resulted in the need to create a barcode that could code different types of characters and symbols, in a big quantity and that was fast and easy to read. That's how many groups of developers in different parts of the world decided to try, and develop a more sophisticated code.

II. QR codes

As we have seen, countries where alphanumeric characters are not commonly used were the ones more interested in the creation of a new alternative to the barcode, and that's why the history of the QR code starts in Japan. The Denso Wave Incorporated was a company that produced barcode readers, and in the 90s the company only had two developers, but they decided to take this challenge. Masahiro Hara and his co-worker were the development team and they had two main objectives: first was developing a barcode that could contain a bigger amount of information and second was developing an easy and fast way to scan the code. Researches were done, and they discovered that in order to store more information the barcode would have to contain the data in

[4] GS1 is a non-for-profit organization that develops and maintains global standards for business communication

both its horizontal and vertical direction, making it two-dimensional. The second thing that the developers realized was that the code needed some position detecting patterns in order to be recognized by the scanner. The research also evaluated the design that the detection patterns should have by studying the pattern of various symbols and pictures printed on many different supports and their black to white areas. The research showed that the best shape was a square and it would need to have a specific ratio of black to white areas which is 1:1:3:1:1. By doing some tests the team found that by placing a detection pattern on three of the four corners of the barcode it would allow the scanner device not only to find immediately the barcode on a surface that possibly contains a background with other symbols and patterns, but also to scan the barcode from any angle. This project lasted one and a half year and at the end, in 1994, Denso Wave Incorporated released the code, obtained the patent and registered the trademark with the name of QR code, which is the abbreviation of quick response, because of its characteristic of being 10 times faster to read than any other barcode.

1.2. example of QR code

Specification

For better understanding what are QR codes and why they are a small but important part of today's society we need to get to understand some their basic characteristics and aspects of their specification:

1. High capacity

   While one-dimensional barcodes only have one row of lines, QR codes which are two-dimensional barcodes, use a number of rows and columns that can be up to 177, forming a grid of modules in which the data is stored in a number that can be up to 31329. That is why a barcode can only contain a maximum of 85 characters, while QR codes can store much more data.

There are 40 different versions of the QR code from which to choose, from version 1, that can store a little amount of data (up to 41 numeric characters data) and consist of 21 modules, each version increases by 4 rows and columns until the version 40, that can store a great amount of data (up to 7000 numeric characters data) and consist of 177 rows and columns. However, the maximum data capacity of each version of QR code depends on the type of data encoded and the error correction level.

2. Small size

   Being a two-dimensional code, information is stored horizontally and vertically, this means that for the same amount of data the space occupied by a QR code is one-tenth of the space occupied by the linear encoded data of a one-dimensional barcode.

3. Different types of data

   QR codes supports numeric data, alphanumeric data, symbols, control codes, binary data, Kanji, Katakana and Hiragana meaning that the content of these codes can be Chinese characters and various types of digital content as well. The possibility of coding binary data widens to the possibility of storing different type of digital content such as images and sounds. The amount of data that a standard QR code can contain depends on the type of content: numeric characters data can reach 7089 digits, alphanumeric characters[5] can reach an amount of 4296 characters, digital content can reach the size of 2953 bytes, Japanese characters can reach the amount of 1817 characters, and Chinese characters depending on the encoding method can reach a maximum amount that goes from 984 characters using UTF-8 to 1800 characters using BIG 5.

   Being the QR code developed in Japan, a great attention was paid to the capability of encoding all types of Japanese characters. In fact, these types of characters use only 13 bits of volume per character, making the QR code the most efficient among the two-dimensional barcodes, holding 20 % more data than other barcodes.

   Apart from storing the content, the QR code needs to contain the data about its positioning, timing, alignment, format, version and error correction. Apart from the error correction, these other data about the framework of the QR code don't subtract any of the volume of data that the code can store.

4. Error correction

[5] Alphanumeric characters include the mix of digits, letters, uppercase letters, spaces and the symbols %-*+/.:$

The error correction is a feature that allows to restore data in the case of damage of the barcode, and it's implemented by adding a code to the original data. The volume that this added code occupies varies according to the four levels of correction available. The four levels of error correction are called level L, M, Q and H, from L which is the one with less code words and can be chosen for operating in a clean environment and a large amount of data, to level Q and H which are usually chosen by factories which use these codes in a dirty environment where they can be easily damaged. The most frequently used level is level M which has a maximum of 15% of code word restauration.

5. Structured appending

   This characteristic means that one single QR code can be divided and transformed into multiple QR codes (up to 16), and multiple QR codes can be rebuilt into forming a single one.

6. 360° speed reading

   As we saw, the creators of the QR code found that a position detection pattern was necessary to make the code immediately recognizable for the scanning device from any possible background. By inserting three of these position detection patterns the creators made the code not only fast to detect but also omni-directional, so it could be scanned from any direction. Furthermore, at a later stage, an alignment pattern was added making it easier to read the code on surfaces or when the image is distorted.

From a more aesthetic point of view, for its representation in order to be easily read, the barcode should be designed to have some contrast between the modules and the blank spaces, therefore the developers decided to use black and white colours and square shaped modules as they are the most readable. However, QR codes can use a reverse scheme of colours or any other colourful variation that allows the contrast to be enough for the scanner to read.

As for the shape of the modules anything can be used from spots to colour stains. QR codes can be in the form of a digital image on the computer screen, as ink on paper, they can be engraved on a surface or built using almost anything such as neon lights, Lego bricks, flowers etc. becoming also a form of art.

Scanning a QR code

QR code scanners detect the whole barcode with a two-dimensional sensor, as it is an image. This sensor first finds the location and alignment patterns, and then reads the data contained in the modules.

Nowadays the most common tool used for scanning QR code is the smartphone. Any smartphone with a camera and a QR code reading application can scan this code, and they have also the convenience of being able to directly connect to the internet.

Other types of scanners are used in the industrial field, in businesses and many industries. There are mobile scanners that can be held in one hand, and through a cable or radio signals send the information to a computer where the data is shown. Other scanners similar to the last one, have an operating system that allows them to process and show the data directly on the scanner device. Lastly, there are scanners that can be embedded in other devices, they send the information to a computer by cables, and are commonly used in stores, airports, admission gates and many other places.

Types of QR code

Besides the different versions of QR code that we saw in the last section, there are different new types of QR codes as well. In this section we will see the different types of QR code whose patent and trademark are held by Denso Wave, while in the next sections we will encounter some other variations made by third parties.

The different types of QR code created by Denso Wave are the Micro QR code, the iQR code, the SQRC and the frame QR.

1.3. example of micro QR code

Micro QR code

This barcode, as the name suggests, has a small size and small capability of data storage. It comes in four variations from version one with 11 modules that can only contain 5 numeric characters, to version four with 17 modules that can contain a maximum of 35 numeric characters, 21 alphanumeric characters, 15 bytes of binary data or 9 kanji characters.

It is easily recognizable by its small size and the fact that it only contains one position detection pattern in one corner. The error correction feature can be used in micro QR code on level L, M and Q on the version four, and on level L and M on the version two and three, while it can't be applied on version one. Denso Wave made the specification of this type of code publicly available.

iQR code

The iQR code is, as for now, the best type of QR code existent. It can be shaped in a rectangular or squared shape, and it is suitable for storing the widest range of information. It offers 61 versions for the square shaped and 15 versions for the rectangular shaped.

The minimum number of modules for this barcode in its square shape is 9 (storing 6 numeral characters), making it the smallest QR code even compared to the micro QR type, while the maximum number of modules is 422 (storing about 40,000 numeral characters) making it also the largest QR code. In its rectangular shape the number of modules ranges from the version one with 5x19 modules (storing 6 numeral characters), to the version fifteen with 43x131 modules (storing up to 1200 characters). It stores the data with more density occupying 30% less space than the standard QR codes and holding 80% more information. It also introduced a new error correction level, the so-called level S that allows the restoration of the damaged areas up to 50%, and it is available in both the square and rectangular shape. Unfortunately, this code is still new, so the ISO specification is not available and only Denso Wave products can manage this barcode.

SQRC

The SQRC, or safety QR code, is a typology of barcode that allows to store the data using two types of control level in order to insert private information to be read only by some specific type of scanners. Recognizing this type of barcode from a regular QR code is not possible, as the appearance and all the other specification of the SQRC barcode are the same, it is therefore optimal to use for security purposes.

Frame QR

1.4. example of frame QR code

The Frame QR was launched on the 20th anniversary of the invention of the QR code in 2014. It takes in consideration the design aspect of the QR code and the code itself acts as a frame to a canvas area positioned in its centre where any type of image, graphic or photo can be inserted. It is easily recognizable by this canvas area in the centre that can have any shape. This type of QR code is mainly used for promotion purposes and in business cards.

Diffusion

After the Denso Wave Inc. released the QR code, they had yet to introduce it to companies and organizations, and convince them to switch from one-dimensional barcodes to QR codes. The first to adopt QR codes was the automotive industry, and they used it to improve their lean management in the production and delivering phases. In 1997 the QR code was first approved as Automatic Identification Manufacturers International standard. After that, in the following years, QR codes began to be used in other industries – from food, to pharmaceutical and even contact lenses companies – in order to track their products and even to respond to the concerns of the society about safety issues and company transparency.

The first big step was in June 2000 when the QR code was approved as an international standard by the ISO[6], and later in 2011 when it has been approved as a standard for mobile phones by GS1.

Denso Wave still retains the patent rights to the code but the policy of the company since the beginning is that to make its specifications available to the public so that its use can be spread easily and at no cost. As stated by the company, the goal was that of creating a public code for the free use of all the people all over the world.

In Japan the QR code became popular among the society already in 2002 thanks to mobile phones offering the QR code reading feature. One of the occurrences that first lead to the use by the population of the QR code was when in 2003 arose the case of BSE threatening people's health[7], so that the society called for more transparency from the whole food industry, and many

[6] ISO: International Organization for Standardization is the organization that develops and publishes International Standards

[7] BSE: Bovine Spongiform Encephalopathy, also known as mad cow disease

companies responded by putting QR codes on their products, which could contain all the information about the production and logistics of the food.

The introduction of the QR code to China happened in the same period as its popularization in Japan, but as we will see in the third chapter the situation of the country was not favourable and mature for the popularization in China yet. China however took a great interest in this technology and approved a national standard for QR codes which is the GB2312 coding system encoded in 13-bit compaction mode.

III. Two-dimensional barcodes

As we will see in the third chapter, nowadays in China the use of QR codes is so widespread among the population that they are called indistinctly QR 码 (QR mǎ) – QR code or 二维码 (èr wéi mǎ) – two-dimensional code, even if other types of two-dimensional barcodes are still used for many purposes. This is the reason why we must understand better what are two-dimensional barcodes and what they can do.

Two-dimensional barcodes have the characteristic of storing data in modules built in a grid of rows and columns, this means that as we have seen for the QR code, they can hold much more data than one-dimensional barcodes and maintain a small size. Examples of two-dimensional barcodes are the Data Matrix, PDF417, Aztec and Maxicode. Two-dimensional barcodes can be easily recognized and distinguished because of the patterns of their modules of squares, dots and other geometric shapes. A special look will be given to the Chinese two-dimensional barcode, the Han xin code.

We will now analyse some of the main two-dimensional barcodes:

1.5. example of Data Matrix

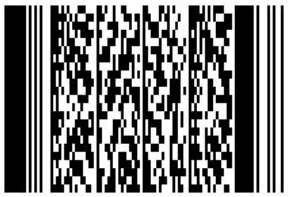
Data Matrix

The Data Matrix barcode can store a maximum of 2335 alphanumeric characters or 1556 bytes of data and has the possibility to encode an error correction code. Its creation is not certain as a patent was issued in 1992 in Germany, but other patents were issued, claimed and complained in the United States in the 2000s.

As other two-dimensional codes it's square shaped and it's composed by a pattern of square cells but it's recognisable by a border on its left and bottom sides. The use of this code is usually that of labelling small electronic components or other small items because of the ability of this code to encode up to 50 characters in a space of 2 or 3 mm^2.

PDF 417

The PDF 417 is a stacked barcode invented in the United States in 1991. It can encode 2710 digits, 1800 alphanumeric characters and 1100 bytes of data and error correction. More like a one-dimensional barcode, this code is rectangle shaped and presents both bars and cells. It doesn't need recognition patterns, but because of its linear characteristic, the area it occupies is four times larger than that of other two-dimensional codes. This format of code is used by many postal services, and airline companies use them by placing them on paper boarding passes.



1.6. example of PDF 417

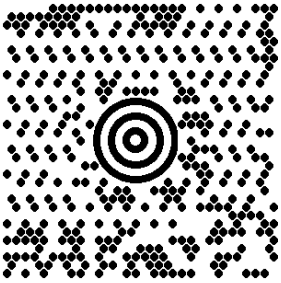
Aztec

1.7. example of Aztec code

The Aztec barcode was invented in the United States in 1995 and published in 1997, it can contain a maximum of 3832 digits, 3067 letters and 1914 bytes of data and an error correction system. This code is square shaped and composed by square patterns. It's easily recognisable by the square shaped detection pattern placed in its centre. This code is used by many European transport companies for electronic boarding passes, some examples of companies that use this type of code are Trenitalia, Deutsche Bahn, Swiss Federal Railways, Nederlandse Spoorwegen, Eurostar…

Maxicode

Maxicode is a barcode created and used by UPS[8], it was created in 1991 and released in 1992. As other two-dimensional codes it is protected by an error correction code, but the data it can contain is restricted to its use in the postal service for tracking and managing the shipment of packages. This means that its content can include alphanumerical characters to indicate postal code, country code, class of service and additional data that can include tracking number, customer reference and other information. This barcode is square shaped and recognizable by the bullseye in its centre which is used for a fast detection of the code, and its pattern consisting of hexagonal dots.



1.8. example of maxicode

Hanxin code 汉信码

The same premises that brought the creators of the QR code to develop a two-dimensional barcode in Japan, drived China to create the Hanxin code. During the nineties barcodes became popular in China and emerged the need to create a code that could be used to store more information and encode the Chinese language. As in many other countries researches were done to try and find a better alternative to the barcode. This code was invented by the ANCC (GS1 China) with some help from some Chinese companies for its research and development.

There are 6 patents for this technology held by GS1 China and registered in 2006, while the Chinese standards for the code were issued in 2007. The code is now used in the industrial chain, in logistics and healthcare fields.

1.9. example of Hanxin code

The hanxin code, in Chinese 汉信码(hàn xìn mǎ), is very similar to the standard QR code in its appearance, it is in fact square shaped and composed by square modules, the main difference is that it presents location patterns on all of its corners. The Hanxin code comes in 84 versions, from version 1 which is composed by 23 modules, to version 84 with 189 modules. The maximum capacity of data that it can store is 7827 numeric characters, 4350 alphanumeric characters, 2174

[8] UPS: United Parcel Service, is an American package delivery company known all over the world

Chinese characters or 1739 Chinese characters if they’re encoded in 2-byte or 1044 Chinese characters in 4-byte, and 3261 binary byte data.

Chapter 2

I. Applications

QR codes are now used all over the world for many purposes from paying the bill to renting public bicycles, from tickets to advertising. In this chapter we will analyse how QR codes are used for different purposes especially in China, and how this will, and already has affected people's lives. Later in the chapter, with the knowledge of the many ways in which we can use QR codes, we will discuss the pros and cons of QR codes.

As we have seen in the previous chapter there are different types and variations of QR codes. They have different characteristics, and depending on the purpose you need the QR code, you can choose the type and variation of code that is most appropriate. A simple example is the micro QR code that can be placed in a space of 1 cm^2 and can contain little information, so that this type of code is most suitable for identifying objects using a short ID number in a situation when the dimensions of the surface is very small or whenever there is little information to be encoded, for example as a secure way to inform of a pin or a password.

Another thing we must take into account is that in different frameworks, different functionalities of the QR code are used.

a. Commercial sector

In the commercial sector the QR code is a very convenient option that can be integrated in the logistics and in a marketing strategy. The characteristics that make the QR code a good option in the commercial sector are: its cost, because QR code is a very cheap tool; its simplicity, because there's no need of hiring an expert in the company to create and manage QR codes; and the versatility, because it can be used for different purposes. Many shops, brands and businesses have incorporated QR codes into their marketing strategy, this is because they allow to convey a great amount of information to and from the organization, reaching a great amount of people, with a very low cost. We will now see how QR codes can help organizations.

Brand awareness and engagement with customers

Organizations can use QR codes to connect with consumers, allowing both sides to gain more information about the other. Consumers are invited to scan a QR code placed on a product which takes them to a social media account of the organization where consumers can obtain information about the organization and its products, they are then invited to follow the account to receive news, discounts and more information and this gives the consumers the possibility to send a feedback about their experience.

An example of this practice is the Starbucks initiative of 2012, when the Refresha drink was introduced to the Chinese market and the organization invited people to scan a QR code from the cups, which took them to the Starbucks social media accounts. On the WeChat account the consumers were asked to follow the account and share how they were feeling sending an emoji to which the organization answered by sending back a happy or sad song. The result of this campaign was a success because the WeChat account of Starbucks gained 270,000 fans and the Weibo account increased its numbers by 15%.

This practice allows the organization to have a direct interaction with the consumers of their products or services gaining a lot of information about themselves, their tastes and ideas, it is therefore a powerful tool for the organizations.

O2O

O2O is a practice that organizations use to drive their consumers from an online experience to an offline experience. In this segment we are going to see how the QR code is used by many organizations for this purpose.

As we have just learned in the previous section, the QR code has proved to be an excellent tool for driving consumers from an offline experience to an online experience, but it can also serve the purpose of doing the opposite job.

The Chinese online retail market is the biggest in the world, as we will see in the third chapter, and it makes sense for the organizations to try and drive the consumers to their offline channels and integrate their online and offline worlds. This is also the reason why Chinese O2O is the most advanced in the world.

Organizations may want to drive their costumers online because an automated system allows the organization to easily gain information that allows it to improve, because online businesses, especially in their starting phase, are cheaper to run and can reach a bigger amount of population, because the online experience helps to reinforce the relationship between the organization and the consumers resulting in loyalty, and the list of reasons goes on. What organizations should instead seek to do is unifying their online and offline worlds and create an integrated experience for their customers. In fact, as they might want to drive customers to their online platforms they might also want to do the contrary and drive their online public to the real world. For example, some types of products, especially expensive and customizable ones such as cars, formalwear, technology or furniture, need for the customer to have a hands-on experience and the assistance of an expert. However, the main reason is that nowadays in any type of business, due to the big presence of the internet in people's lives, and the big success of e-commerce especially in China, driving customers to the offline channel is also very important for the maintenance of the actual physical stores or other facilities and their employees.

The same goes for consumers, they may want to access to the online channels of the organizations to learn about the organization, its products, compare prices, receive and share opinions, complain, ask for support and even purchase things online when it's easier and more convenient. However, they might need to experience the reality in a more physical way, confront face to face the organization, have a visual impact with the brand, and form a concrete idea in their minds.

Many brands and businesses use QR codes to drive both online to offline sales and offline to online sales depending on the context. In China it is very common to find QR codes containing the link to an online shopping website or the social media account of the brand or business placed anywhere online and offline, on websites, on products, in movies, on newspapers, in metro stations, on buildings… In China, social media platforms are the favourite tool used for the O2O strategy, the leader being the most used social media in China, WeChat, that made QR code the tool of its success. By following a brand or any type of business's official account on WeChat they can send consumers personalized and targeted content and engage with the clients. Because of this big power that social medias offer, WeChat decided that some kind of limitations were necessary to protect the consumers, so they decided to create some rules that allow official accounts to do this type of direct advertisement with a limit of four direct messages a month to each follower.

A western company that understood the important of unifying their online and offline worlds is the British company named Cambridge Satchel Company. This company placed QR codes inside their store in London as a strategy directed towards their Chinese customers that are very familiar with this technology but not with the brand. The manager of the social media engagement that operated this strategy, Mr. Zhou, said that the purpose was in fact to transform the mere transactional relationship into an emotional relationship by involving in this case the Chinese consumers using the most appropriate tool to reach them.

We have seen how the main objective of O2O for organizations can be that of driving the sales on one specific channel. In order to do it efficiently they often encourage customers to purchase on one or the other channel by giving special offers and coupons to use on one specific channel.

We can easily see how O2O in China is not only used in B2C but it's essential also in B2B. In Chinese tradeshows and exhibitions, it is very common to see exhibitors have their own QR code on display at their stands linked to their WeChat official account and they sometimes encourage to scan it to receive a small gift.

WeChat is not the only social platform that promotes QR codes, other platforms are for example Alibaba, Weibo and LinkedIn. However, the major players in the Chinese O2O scenery are the giants Alibaba and Tencent which we will discuss in more detail in the third chapter, keeping in mind that Tencent is the company owner of WeChat.

These two companies have the credit to have helped creating the Chinese O2O market which is the most advanced in the world and is still growing. As we will see in the next segment these companies allow consumers to do online payments using the smartphone via the QR code technology while they are in the offline stores.

Online payments and reservations for offline services are also an important part of the O2O market. In particular, voucher-selling and carpool services have caused some interesting battles between companies in China.

The first battle started with the entrance in the Chinese market of the American Groupon in 2011. The American company in collaboration with the giant Tencent, formed a joint venture named Gaopeng[9] in order to enter the Chinese market, but made some big mistakes because of the poor knowledge of the local market. It immediately found many local Chinese competitors, and had a

[9] Gaopeng group buying website 高朋团购网站 (gāopéng tuángòu wǎngzhàn)

difficult time adapting to the Chinese market, wasting a lot of money and failing at the end. The many Chinese competitors grouped together under big companies, allowing them to gain the biggest shares of the market. Tencent and Alibaba are now investors of Meituan-Dianping group[10], which is the leader in the voucher selling industry and in Chinese O2O. Groupon now has only a small presence in China, and is partially owned by Alibaba.

The second battle was the one that the company Uber fought against the two Chinese taxi apps Didi Dache[11] and Kuaidi Dache[12] when entering China in 2014. Uber thought that by offering an alternative to taxi rides could gave the company an advantage in China, but again, the poor knowledge of the country and market caused the overseas company many problems. The first big problem is that the American company service uses Google Maps to track the vehicles, and the Google company is being blocked by the Chinese firewall since 2008. Without the knowledge of the barriers at the entrance of the Chinese market the company had to waste some time to adapt their service to the Chinese equivalent of Google Maps which is called Baidu Maps. The second problem was the payment system. The American company offered a system based on credit and debit cards payment, ignoring the fact that this is not a common payment method in China and its use has declined in favour of the QR code mobile payment. A third problem was that Chinese companies, especially big companies that own a big market share are supported by the whole system of government, banks and other big companies. This is the reason why the competition between Didi Dache and Kuaidi Dache instead of bringing advantages to Uber, resolved in the merger of the two companies into the Didi Kuaidi company which then become the Didi Chuxing[13] company in 2015, which benefits from the investment of Tencent and Alibaba and now owns 95% of the market share and ended acquiring Uber China.

What we can get from these two stories is that the Chinese market is very unique, the O2O segment is very important, and that the two giants Tencent and Alibaba shaped commerce around them so that surviving in the Chinese market without their help is impossible for both Chinese and foreign companies.

The Alibaba Group in 2014 even launched a programme in partnership with PepsiCo and Tsingtao Brewery Co.[14] that made use of their initiatives in O2O to promote QR codes. This way they

[10]Meituan-Dianping group 美团点评集团(měituán diǎnpíng jítuán)
[11] Didi Dache 滴滴打车 (dīdī dǎchē)
[12] Kuaidi Dache 快的打车 (kuàidi dǎchē)
[13] Didi Chuxing 滴滴出行 (dīdī chūxíng)
[14]Tsingtao Brewery Co. 青岛啤酒股份公司(Qīngdǎo píjiǔ gǔfèn gōngsī)

succeeded in spreading the use of QR codes and gained from the success of the O2O activity. The programme consisted in marking almost 2 million cans of drinks with QR codes that allowed users to connect with the brands. From many years now, Alibaba has in fact made a main objective of the company to create a better platform and service for both users and merchants, allowing now for example, to order the groceries from a smartphone and having them delivered home with an App. A big importance from Alibaba, is given to pushing the mobile commerce as well as QR codes. One of the projects they are testing now are physical supermarkets with the characteristic of being completely self-service. Customer can access to these supermarket using an App on the smartphone that allows them to scan the items while shopping, do the payment and only when the last step is concluded to unlock the door and exit. The employees are almost completely replaced by the computer system that monitors the stores and products, and signals when it's time to replace or restock the items. A major importance in this project is given to the whole barcode technology.

Payments

As we have seen in the previous section one of the tools used in online-to-offline practices is the online payment and specifically mobile payment. This topic will be better discussed in the next chapter, specifically regarding the situation in China, but we can now briefly see how mobile payments work and how they are linked to QR codes.

Again, we see how the two giants Alibaba and WeChat shaped yet another sector in China with Alibaba's Alipay and WeChat payments. We will see how these services came to be in the next chapter, but we will now analyze how they work.

First, we should understand how these transaction looks from an exterior point of view. There are three different ways to use QR codes for the transactions, and they mainly depend on who are the two parties between whom the payment occurs.

2.1 QR code payment

When a barcode scanner and a POS are present at the cashier, either the QR code of the buyer can be scanned from a card, digital card or mobile wallet App, or a QR code for the transaction can be generated by the cashier on a screen connected to the POS and scanned by the buyer authorizing the transaction. Companies like Walmart and

Starbucks have designed their apps and cards and enabled this type of transaction. PayPal also introduced mobile payment inserting a QR generator in its App in 2014, but Alipay is the leader in this type of mobile payments.

When the seller doesn't have a barcode scanner, the buyer, using the mobile wallet App, scans a printed QR code placed on display and inserts the amount of the transaction. This is the case of the many street vendors in China, like the one in the picture on the right. However, in order to do this type of payment, the buyer using the mobile wallet must be online, meaning that the smartphone must have an internet connection. To avoid this problem, it is possible for vendors that only sell one product (or a couple of products at different prices) to print different QR codes for each product corresponding to the price so that the buyers can complete the transaction without the need of an internet connection.

2.2 street vendor offering QR code payment method

A mix of these types of transactions is the peer to peer payment, where people can transfer money directly between their mobile wallets. One person, with the same principle, generates a QR code on his app and the other person scans it authorizing the transaction. WeChat, PayPal, Bitcoin and many banks offer this service.

The Chinese mobile payment market is the biggest in the world, where it is accounted that more than 55% of the internet users in the country have made at least one mobile payment. As 2017, the mobile payment market share sees the two giants Alibaba and Tencent owning the biggest shares of the market, where Alipay is the favourite tool with 54% share and WeChat Pay is second with 37% share.

Alipay is a digital wallet that has the users account linked to their debit or credit cards. It works by having the vendor scanning the buyer's QR code or scanning the vendors QR code. It isn't restricted to China, and many shops around the world are enabling its use. Alipay was created to improve Alibaba's e-commerce service, therefore it acts as a guarantee between vendors and buyers, locking the money of the transaction from the buyer's wallet and unlocking it to the seller once the product or service has been received by the buyer.

WeChat allows users to make a payment by both generating a QR code and getting it scanned at the cashier or by scanning the vendors code. WeChat also offers the opportunity of in-app

purchase, a feature that is strongly connected to the social media nature of the App. The money contained in the WeChat wallet can either be money sent by other users or the money linked to a credit or debit card. The secret of the success of WeChat Pay lies in the ease and convenience of these free transactions, however in 2016 WeChat decided to charge a small fee of 0.1% for withdrawals from this digital wallet to the users' debit cards for amounts over 1,000 Yuan. Another interesting feature that WeChat has launched is the bill payment feature, it is simple to use by inserting a number present on the bill or by scanning the QR code printed on it.

Fighting fakes

Fighting fakes is another important reason that induced various organizations to use QR codes. This is a hot topic especially discussing the Chinese market, China in fact is known for its fake markets and counterfeit products. The importance of fighting fakes not only is important because of the respect of trademark, copyright and patent laws but is fundamental, particularly concerning the food industry, where rip-offs can cause a large variety of health issues to consumers.

Some brands decided to use QR codes as their means to carry all the information that prove the authenticity of their products. When the QR code is scanned, consumers are redirected to an HTML5 platform that contains all the data that the consumer needs, such as the history of the product and the supply chain, the date of manufacture, the date in which the product left the country of origin, when it arrived at the destination and who is the distributor. The practicality of these codes is what made the organizations choose them for this purpose, in fact they can be placed on any type of product, being it inside a can, under a scratchable surface or on a tag so that they can be scanned to check the authenticity of the products.

It's been proven that using this method to distinguish the authentic products helped decreasing the circulation of fake products and also to identify companies that produced these products and sold them online and offline.

In recent times the technology for fighting counterfeit products is moving toward new typologies of QR codes that are considered safer, and they will be discussed in the next chapter.

b. Industrial use

In the industrial field QR codes have also a lot of ways in which they can be used. The error correction feature is what makes them particularly suitable for the sometimes-dirty environment that can be found in many industrial facilities.

QR codes can be used in this field to contain any type of documents for their maintenance, or they can be placed on some types of documentation such as permits and licenses to represent the possess of the authorizations and the compliance to the regulations. These codes can also be used in order to contain different type of instructions on the use of any type of equipment or the procedure for performing different tasks, they have in fact the advantage of being able to represent the instruction in different forms (text, images or videos). The different representation of the information can also be helpful to contain anything necessary for the maintenance of structures and buildings, such as information and maps of the buildings, the plumbing system and electrical system. Lastly, the industrial field can also make use of QR codes in the inventory by storing all the information about the many different components.

c. Credentials

Many times for security reasons various systems, platform and websites require the visitors to access through a login process using a username and a password in order to be able to control the traffic. This process can be replaced using the QR code.

Chinese online platforms and websites already make use of this technology. When accessing to some content on the computer, the websites show a QR code to be scanned using the mobile phone. Users can choose to access by inserting the number of telephone or e-mail, or by scanning the QR code using the platform's App or one of the many popular social media such as WeChat or QQ. The website then asks for the authorization through the mobile phone to access to the content.

The same principle can be applied in order to connect to a public hotspot, by scanning a QR code displayed in the area covered by the hotspot and accessing with a social media account.

WiFi networks often use QR codes to share the credentials to access to the network, consisting basically in QR codes containing a password. This can be used for public places, hotels, restaurants, bars or even for private use.

d. Tourism, travel and hospitality

These codes have applications also in the tourism sector. One application of QR codes that many countries adopted in the tourism scenario, is to convey information on their visas. Using QR codes instead of stamps on passports has proven to be a method that helps reducing the waiting time at the custom clearance and it's safer because they are harder to reproduce. China saw the opportunity to use this technology and at the same time to promote tourism by simplifying the visa procedure for the short-term visitors. This application of the QR code was tested in Shanghai by using a QR code sticker as an alternative to the visa with the duration of 6 days that allowed tourist to visit the city. These QR code visas can also be helpful for the hospitality structures accommodating the tourists in order to speed up the check-in process.

This is not the only way QR codes can help the tourism promotion of a certain area, in fact many villages, cities or regions have put into good use this tool. An example is a village in Hebei province called Xilinshui that created a giant QR code that can be seen from the sky[15]. It was made using trees and it covers a squared area where every measure 227 meters. The giant QR code connects who scans it to the official WeChat account for tourism of the village.

2.3 aerial picture of the QR code in Xilinshui, Hebei

The tourism industry, moreover, has found that the QR code is a very helpful tool to direct tourists to online sources and materials about attractions, restaurants and other activities that can substitute the expensive tourism guides which can be easily outdated. This is an advantage that can be very beneficial to the tourists who visit a country without speaking the local language. This is because QR codes erase the problem of inserting any type of written text or a URL[16], directly

[15]Xilinshui: 西林水村 Xīlínshuǐ cūn is a small village in the Qingyuan county in Baoding, Hebei.

[16] URL is the acronym that stands for Uniform Resource Locator, and is commonly known as a web address that locates and retrieves a specific resource on a computer network

landing on a web page that can be easily translated to any language by any mobile devices, which can include smartphone and tablets.

The language barrier problem can be easily avoided with the use of QR codes, but it's in many cases a personal choice of the territorial tourism institutions and the many structures that work in the tourism industry.

Many museums around the world have adopted QR codes placing them on the object labels to disclose all the extra information about the artist and the works of art on display that are usually not placed on those labels.

One of the most popular uses of QR codes is for tickets. The practice of replacing all kind of tickets, from airplane tickets to museums tickets, with a digital version has been very common since the rise of smartphones and online payments.

2.4 QR code on a Chinese train ticket from 2011

They are particularly convenient in the transportation field, making checks faster, easier and safer. These codes can be printed on physical tickets or exist in a digital form that can be used with a smartphone or tablet. Digital tickets are supposed in the near future to be completely replacing physical printed tickets all over the world because of their sustainability, they in fact avoid wasting paper and help protecting the environment. The Chinese Ministry of Transport in 2009 started promoting the use of technology in this sector.

This resulted in the adoption of QR code e-tickets by many infrastructures since 2009. The first infrastructures to experiment with this innovation were Canton airport, and the railways stations in Hangzhou and Shijiazhuang.

As we have seen in the payment section, in China, the taxi service has seen the investment of Alibaba and Tencent. The influence that these two companies brought to the taxi service is that cash payment for taxis is now almost never seen, instead QR codes are used for payment with the two companies' payment services, Alipay and WeChat Pay.

One of the people's favourite transportation in China, mainly in the 90's, was the bike. Following the economic growth in the country, the society has started to move towards cars instead of bikes, but in the last couple of years bikes are re-emerging thanks to many programs of bike-sharing present in most of the big cities. The companies that offer this service have put QR codes to good use. Unlike the public bicycle system that offers this service from certain fixed docking stations and users need to own a rental card to use it, the new system offered by these bike-sharing programs works with mobile Apps. Users, on the App, can find the nearest available bike by looking at a map which uses the GPS to monitor the location of the bikes. The bikes can be reserved and then unlocked by scanning a QR code placed on the bike itself, which is also used for the payment of the service. At the end, the bike can be left in the areas designated for the bikes, locking it using the QR code and the App once again.

2.5 QR code bike-sharing scanning

e. Other uses

The universality and the flexibility of QR codes have given people the chance to experiment with this technology and find many original uses to this barcode.

We've already mentioned that QR codes are used in the Chinese social media WeChat while talking about payments, but that is not the only way that these codes are used on this social media. Given the nature of the Chinese language and the large number of users of the social media, it is very common to have many cases of homonyms, for users' names and official accounts. The social media for this purpose added the QR code generator feature to allow users to add contacts by scanning each other's user QR codes. They can be generated and scanned directly from the smartphones, they can be sent digitally as a vCard[17], or printed on a business card. Business cards in China are a big part of the social structure and it is a custom to hand out one's business card when introducing to a new person. We can easily see how this custom in recent years has changed, and instead of receiving the classic business card, it is now common to be asked to scan a QR code.

[17] vCard is an electronic business card that can be shared with e-mails, instant messaging or on the web. They can contain the personal information that are usually contained in a business card such as name, address, telephone numbers, e-mail address and other additional content such as images, audio files and links to web pages.

The purpose of identifying objects this way can also be extended to people. Many workplaces have adopted QR codes on the employees' badges to identify them and guarantee the access to the workplace, directly sending the data to the organization computer servers which register the presence. QR codes can be used in hospitals to contain the medical conditions and personal information about the patients, they can be printed or carved onto tags used to identify pets and other animals, or placed on some objects like bracelets and necklaces for kids and elders to wear so that they can be helped to find the way home in the case that they get lost.

2.6 picture of people scanning job-offer QR codes

In public places in China it is possible to find walls covered in QR codes containing the information about job offers, as we can see in the picture on the left. People can scan these QR codes to find the details of the working position and directly apply for the job from the smartphone.

As we have seen QR codes offer a wide range of possibilities concerning their content, opening them to many bizarre purposes. In the last 10 years a trend has begun to spread all over the world in cemeteries of engraving tombstones with QR codes in order to insert all types of information about the deceased. The memories of the departed can be stored this way with a method that is believed to be more permanent. The QR code can hold a lot of information, from a simple biography to a whole website with pictures, videos and the social medias of the deceased. In China, again, thanks to the big popularity of QR codes, this idea has been well received by the population and has been also recommended by the Funeral Association that is constantly in search for modernization. Due to the large population present in China, it is recommended by the state to opt for the cremation of the deceased to help saving space and

2.7 QR codes in cemeteries

protect the environment, and is believed that using QR codes on tombstones can have the same effect reducing the consumes of materials and resources.

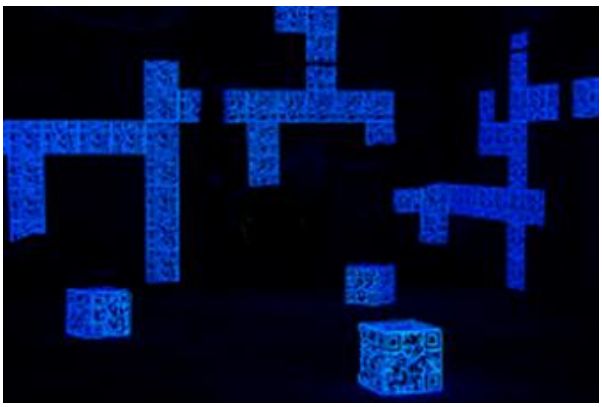
Given the large extent to which they are used in China, many creative ways to use QR codes come directly from the society. It is not very uncommon to see QR codes used by beggars asking for digital donations, by wedding couples receiving virtual money gifts from the attendees and even by churches to collect tithes.

2.8 beggar using the QR code

Art

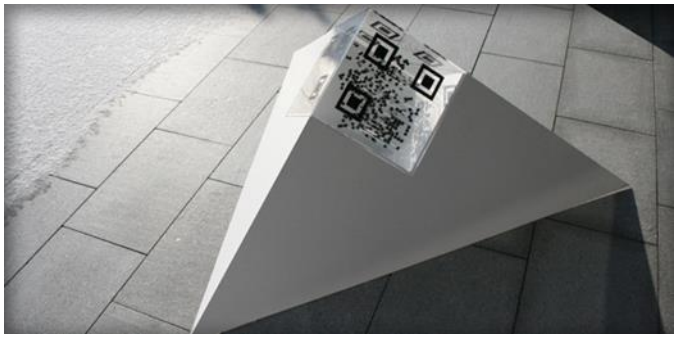
The purpose of QR codes is usually that of being a vehicle for some information, but it can also have an artistic purpose on its own that can be doubled with the actual content. Of course, QR codes can have some very good-looking designs that helps making people want to scan them, but they can also be actual works of art in many different forms. Many creative ways of creating QR codes have been done, from body art to jewellery and even carpets.

In the pictures below, we can see some examples of art works made with QR codes.



2.9 street art by Anonymous

2.10 street art by Sweza



2.11 sculpture by Frank Haase

2.12 Eardley by Trevor Jones

2.13 painting by Lu Yiying

2.14 Frubes by Jimmy Andersson

The picture 2.9 shows one of the projects of an anonymous street artist that uses QR codes for their art and was made in Madrid in 2010.

The urban artist Sweza uses QR codes as archives and gateways to his works. He places QR codes on his street art works and when they are removed he returns and places another QR code that links to the image of the previous street art that was in that place how we can see in the picture 2.10. Not only visual art is conveyed in his QR code art works but also music in his famous works representing a radio. It is possible to find his works also in street advertisement, as he fights the use of street art as marketing tool from companies by replacing an existing one with his art or adding his QR code to the advertisement bringing the viewer to see his version of that specific street art work.

The picture 2.11 shows one of the sculpture that the artist Frank Haase made with QR codes. He transformed the two-dimensional code into a three-dimensional object creating three different QR codes that are scannable as part of the artwork.
The picture 2.12 is a painting made by the artist Trevor Jones, named “Eardley”. As he stated, he painted QR codes because of their dual nature of being a real image in front of one’s eyes and at the same time they are a door into the unknown of the digital world.
The picture 2.13 shows one of the paintings in the art project “Beautiful Traps” by the Lu Yiying, who is an expert in the conjunction of technology and art. She included QR codes on some of her paintings because this can give the possibility to expand the viewer experience with the artwork.
The picture 2.14 is the work of the artist Jimmy Andersson named “Frubes”, that puts together the modern concept of the QR codes and their squared shape, and the traditional idea of art that is represented with a still-life painting.

II. Advantages and disadvantages of the QR code

In this chapter as in the previous one we have come to know the characteristics and uses of the QR code. We can now discuss the advantages and disadvantages of this technology to understand how and why they can be a successful tool or a failure. As we may already have figured out, the cultural and societal perspective from where we look at the subject of the QR code completely changes the result of our balance.

The universality of the QR code is probably one of its greatest strengths, as its creators intended it to be. These codes are the same all over the world, as it is the way of encoding the data and the devices used to scan them. In particular, we need to mention that the great diffusion of smartphones, tablets and personal computers had had a big influence on the utility of the QR code. We can say that without this technology in the hand of a big part of the world population the use of the QR codes would have been confined to an industrial use in factories for production and storage activities.
However, one of the biggest reasons why QR codes are a failure in western countries is that the majority of the mobile phones brands don’t offer an in-built QR reader on the device, nor do the most popular apps used in western countries such as Facebook, WhatsApp, Twitter and so on. This

is where we see the big difference with the situation in China, where most of the popular apps following the example of WeChat included a QR code reading feature. The only exception among the western apps can be considered Snapchat, which was bought in 2014 by Scan.Me which was an app designed for scanning QR codes. Snapchat's users profile accounts are now characterized by the so called "snapcodes", which are in fact a variation of QR codes. The app is so designed to read these codes and can be used to read traditional QR codes as well, but its functions are restricted to adding snapchat contacts and reading only the written content of QR codes. However, the app hasn't made one of its objective the promotion of the QR code technology and almost anyone of the users knows that this app can be used to scan QR codes.

One of the greatest advantages of QR code is that they can act as direct links to web pages allowing people to avoid having to type the URLs. This characteristic is particularly appreciated in countries like China where the society is not very acquainted with the Latin alphabet that is used for writing URLs, and the English language that rules the internet. This way scanning a QR code can solve the problem of mistyping that string of characters and risking to land in a wrong web page. Moreover, Chinese websites URLs have the characteristic of being usually a mix of numbers, transliterations and abbreviations, which are difficult to remember and can be easily mistyped. This explains not only the success of QR codes in China, but also their popularity in other non-Latin script countries such as South Korea, Japan and India.

QR codes in their digital form on a screen can serve as a portal to their content by clicking on them, instead of scanning them. They are in fact images, and digital images can be turned into hyperlinks to other content. This means that when a smartphone user finds a QR code in an email, on a webpage or on a social media, and this image is on the screen of the device that they use to scan QR codes, so that it's not possible to scan it with the device itself, it is still possible that the QR code content has been linked by the creator on the image and it is accessible by clicking on it. Keeping in mind that technology is an integrated part of today's society, when anyone creating a QR code wants it to be read, should make the most of the tool and link the content in both of these two ways.

As we have seen anyone can easily create a QR code for any type of use simply using an App on a smartphone or on many specialized websites, but particular attention must be paid in the case of one wanting to link their own webpage. It is important to remember that those codes most of the times are scanned or opened using a smartphone, therefore the creator of the QR code should

firstly design a landing page that can be easily used from a smartphone and any other device. While it's easy to create a QR code and place it somewhere, it's not very easy to create a mobile optimized landing page.

Another important thing to keep in mind when we want a QR code to be scanned is that it must be easily seen. This means that one must think about the size, location and design, and make sure that these characteristics are consistent with each other. For example, in the case of using a QR code to advertise some products, good places to attract many scans are in the subway, on the back of lorries or in airports, and the size should be rather big for the people to see and be able to scan.

The aspect of QR codes on which people are more sceptical about is the risk of encountering a code that has been encoded with some compromised content that can infect the system of the device used for scanning or opening the QR code. Internet thieves and hackers have found their ways through the QR technology creating malicious QR codes that if scanned can compromise the user's privacy and get the access to the content of the computer or smartphone, to the camera, to internet, gps, storage, passwords and to other Apps that contain personal data such as a digital wallet App. These actions can be easily done by IT experts creating additional codes that can be simply attached to the normal code, these additional codes are able to work in the background and in the worst scenario can end with the users having their identity stolen.

However, must be said that QR codes are only one of the many tools that can be used for these actions, and the risk of using QR codes is the same that we can face every day for example by downloading an app, opening an e-mail, entering a web page or sharing digital content with other users. The main reason why society seems to have a feeling of mistrust with QR codes and computer science is that there is a lack of regulation about it. Despite some countries having adopted some regulations about this subject, because of its global dimension and its virtual nature, the reality of a universal law protecting the users and punishing mischievous behaviors is not happening yet.

Chapter 3

This last chapter is about the role of the QR code in today's China. This technology impacted the lives of millions of people in this country, and had a big part in the transformation of the perception of money by the Chinese population and impacted the whole country's economy.

I. Introduction of the QR code in China

In this section we will see how the QR code has been inserted in the Chinese framework. The first thing we will take look at is the Chinese context, then we will see which were the factors that first helped creating the base for the success of the QR code in the country, and at last we will talk about the main factors that drove its popularization and promoted its success.

a. General framework of the country

As in this chapter we will talk about how the QR code was integrated in the country, how and why it gained success and how it managed to change some aspects of the society, it is first important to understand what is China and who is China. We will now try to create a general framework of China that contains and analyses the main points that are important to understand the relationship of this country with QR codes.

China, as we know, is a big country with over 1,4 billion people, making it the second largest country in the world and the world's most populated country. With such big numbers it's easy to understand that within the country there is a lot of diversity.

From a geographical point of view, China, is composed by 22 normal provinces (23 including Taiwan), five autonomous regions where most of the population that is part of the ethnic minorities live, four direct-controlled municipalities and two special administrative regions. Within the borders, the country has a great variety of landscapes that include deserts, mountains, the ocean and tropical islands, and most of the population, due to the characteristics of the territory, lives on the coastal area and on the eastern side of the country.

From a socio-cultural point of view, among the population there are 56 recognized ethnic groups of which the Han is the largest and forms 91% of the population. The 55 minorities live mainly in the western and norther regions and in particular in the autonomous regions, they have different cultures and languages, which are protected by the constitution. The cultural diversity is not only present among the minorities but also within the Han population, being it for the history of the big territory that covers the country or other factors such as religion, customs, education, wealth, language and other factors. Language, in particular, is an important component of the Chinese diversity, in fact, 70% of the population speaks the official language, Mandarin, and its many different dialects, but there are almost 300 other separate languages spoken in China. To solve this big problem of understanding one another, standard Mandarin is taught all over the country in order to allow everyone to understand each other at least through writing. Written Chinese is the common ground for the Chinese population to understand each other, even if in some areas traditional writing is still used instead of the newer simplified (Hong Kong, Macau, Taiwan).

Geographical and socio-cultural factors have also had an impact on the economy. In fact, there is a big gap in the economic development between rural and urban areas. The urban areas, especially the ones in the south-eastern areas of the country, have been developing since the 80s and have been driving the country's economy since then, but today the gap between urban and rural areas is becoming a problem by slowing down the general development of the country. In the recent years the objective for the economic development of the country is including the objective of reducing the gap between these two different areas. The urban areas have been encouraged to slow down the pace of their development in order to allow some time for the rural areas to catch up. The rural areas seem to have been forgotten in the past few decades, there is in fact a slow development that only in the recent years is being pushed by the government in order to narrow the big gap. Most of the people live on the eastern side of the country near the rivers and the sea, these areas have a big presence of factories which is commonly known to cause big problems of air and water pollution.

China is a developing country and one of the fastest-growing emerging economy, and this has also been possible thanks to the dedication of the government and its close relationship with companies.

Since the foundation of the People's Republic of China the Chinese government has in charge as the ruling party the Chinese Communist Party and acts according its ideology, which has shaped

itself during the years since its foundation to become a form socialism with Chinese characteristics. From the ideology of the country to other many aspects, we will see in this chapter how China has a pattern of adapting any type of thing to the Chinese characteristics by making them effective for their objective and successful in the country.

One of the main objectives for the Chinese government is to solve the many problems caused by all this diversity, as in the case of the language, trying to find a common ground for everyone to understand each other. To do so, the government through its branches tries to have the control over as many aspects as it can, together they provide 5-years plans to be implemented on a local, regional or national level, even if the decisions that they make can sometimes be considered controversial. In fact, handling the many problems caused by the diversity has been a challenge in China and sometimes the result ended consisting in bans, arrests and censorship. This is the case for topics and activities regarding religion, territory, politics, environment and others.

One platform that has been subjected to a strict control from the government is the internet. As for any aspect, China has decided to apply a strict control over the internet inside the country. In particular, internet censorship is justified by the Articles 5 and 8 of the "Computer Information Network and Internet Security, Protection and Management Regulations" issued by the Ministry of Public Security in 1997, that don't allow using the internet to distribute information that can cause instability to the country or public disorder. Four years after internet arrived in China, in 1998 was created what is called the Great Firewall. The Great Firewall is the mix of legislation and technology that censors the internet in China. The objective is to block many different types of content that are considered inappropriate by the government creating almost a bubble surrounding China. This of course means that many foreign platforms are being blocked, from search engines to news websites, facilitating the creation and growth of Chinese internet platforms and online companies.

One last important thing to mention is that there are big differences between the People's Republic of China and the Republic of China, or as they are also called, Mainland China and Taiwan. For the purpose of the thesis, now on when referring to China we will be intending only Mainland China.

b. Factors that promoted the success of QR codes in China

As we have seen in the previous chapters, the reason why QR codes have gained a big popularity is mainly due to their connection to the popularization and diffusion of mobile communication devices such as smartphones and tablets, and secondarily to the diffusion of the internet. It is therefore very important to have a basic knowledge of the situation in China regarding these topics to understand how and why QR codes have become an important tile in today's picture of China.

Today's Chinese population is close to 1.4 billion, making it the most populated country in the world and among many other things, the country with the most smartphones and internet users in the world. According to the Newzoo's Global Mobile Market Report of April 2017, the penetration rate of smartphones in China is 51.7%, meaning that there are in China approximately 717,310,000 smartphone users. In a statistic made by statista.com we apprehend how by the end of 2017 in China have been registered more than 1.4 billion mobile phone subscriptions, more than the actual population of the country, a gigantic number that comprehend both people that own a mobile phone different from a smartphone and people owning more than one. These numbers are relevant considering that the number of smartphone users estimated in the entire world is a little higher than 2 billion, meaning that one third of the smartphone users in the world are Chinese.

According to chinainternetwatch.com, there are today approximately 751 million internet users in China, meaning that the internet penetration rate is 54.3%. 96.3% of the Chinese internet users, which means 724 million people, are mobile internet users. The internet penetration rate is constantly increasing in China but from this statistic we can still see that the difference between the urban and rural areas is high, in fact 73.3% of the internet users are residents in the urban areas and only 26.7% in the rural areas, meaning that the internet penetration rate in the rural areas is only 34%, while in the urban areas is almost 70%. The top three regions in China with the highest internet penetration rates are Beijing, Shanghai and the Guangdong province, where the rates exceed 70%. According to this statistic the usage of the internet in these two different areas is different, for example in both areas is strongly used for instant messaging, but only in the urban areas it is used extensively for transactions, payments and other services like food delivery and car-hailing. In any case, keeping a precise track of these numbers is almost impossible because

they are constantly increasing, and this is due to the fast modernization happening in China and telecommunication companies offering good and affordable solutions in the mass market.

This information is very important because it explains also the usage of QR codes across the country, in fact the popularity of QR codes in the urban areas is greater than in the rural areas, but it's spreading along the spread of smartphones and internet access.

As we saw in the second chapter, there are many applications for QR codes, but in order for it to be used by the great majority of the population in China the first essential point was the spread of smartphones. In particular, what took a big part in the success of QR codes has been the possibility for people to make purchases from their smartphones and mobile e-wallets. We will now see the importance of two companies in this regard.

c. The central role of Alibaba and Tencent

Along with the popularization of smartphones in Japan and South Korea, the QR code gained a big success in those countries. Following this example, in 2010 many QR code start-ups emerged in China, believing, as many other tech companies, that smartphones would have had the same big success in China as they were having in Japan and South Korea.

The popularization of the QR code among the Chinese society, and its subsequent success, have without any doubt to do with the two companies Alibaba and Tencent. In fact, even if many big Chinese tech companies decided to promote the QR code, no one managed to get the attention of the population as these two companies did. They leveraged on the popularity of their platforms and created a new market in China with the mobile payment function, and started a competition war that is still going on.

QR codes are an integrated part in the success of these two companies that completely shaped two important industries in China, the e-commerce industry and the social media industry. Moreover, these two companies are not only important in the Chinese framework, but they also have a big impact on a global level because they are both public listed internet companies with big market value, that as the beginning of 2018, was 490 billion dollars for Alibaba and 530 billion dollars for Tencent.

We can now unroll the story of how these two companies brought popularity to the QR code, and at the same time QR codes were one of the factors that contributed to the success of these two companies.

Alibaba

Alibaba was founded in 1999 by Jack Ma. Its full name is Alibaba Group Holding Limited, in Chinese 阿里巴巴集团控股有限公司 (Ālǐbābā jítuán kònggǔ yǒuxiàn gōngsī), and it is a conglomerate of portals and platforms of e-commerce and other services. The first platform to be created was the B2C e-commerce platform Taobao, in 2003.

Along the Taobao platform was created the payment system called Alipay, that one year later, in 2004, was separated from the Taobao platform as a third party in order to solve the problem of mistrust between sellers and buyers. As we have seen in the second chapter, the Alipay system holds the money of the transaction until the product is confirmed to be received in good condition by the buyer. All the other platforms that were created from that moment used the Alipay system for the payments.

In 2008 was created a C2C e-commerce platform called Taobao Mall. In 2009 was created the Alibaba Cloud Computing and in 2010 was created a search engine specific for shopping, called eTao. In 2011 Taobao was organized into three different companies (Taobao Marketplace, Taobao Mall and eTao). 2011 was an important year because the Alibaba Group discussed the importance of smartphones and began to support QR codes. In fact, in 2011 the Alibaba Cloud Computing created a smartphone that run an operating system that they developed themselves, and the Alipay system began to support offline payments from smartphones using QR codes.

In 2013 was created Yu'ebao 余额宝 (Yú'é bǎo)[18], an internet money market fund, which is basically a financial service that integrates with Alipay. It became the favourite fund for the population because even though the return rate is not higher than that of the banks, there aren't any entry barriers so that anyone could invest even just 1 RMB. Moreover, what made it appealing to the population is its simplicity and ease of access through any smartphone using the Alipay App, and the possibility to use this service for both online consumption and withdrawals. In 2014 both Yu'ebao and Alipay were reorganized into a bigger group called Ant Financial Services Group 蚂蚁

[18]Yu'ebao's is the short name that stands for Tianhong Yu'ebao Money Market Fund 天弘余额宝货币市场基金 tiān hóng yú'ébǎo huòbì shìchǎng jījīn

金服 (mǎyǐ jīn fú), which is still part of the Alibaba Group. It is accounted that there are 520 million of Alipay users, of which approximately 300 million are also Yu'ebao users; almost 80% of the payments of Alipay are done using the mobile App; and 99% of Yu'ebao investors are individuals. Other services offered by the Ant Financial platform include different types of insurance services, credit rating, a personal credit line and banking directed toward small-medium businesses.

It was accounted that in the same year that Yu'ebao was launched, Alipay handled 900 billion RMB in mobile payment transactions from more than 100 million users. The next year, 2014, Alibaba allowed consumers to make purchases from newspaper ads, so that readers by scanning QR codes printed on the newspapers ads were directed on Alibaba's shopping platforms. The results of this strategy were impressive, because QR codes from Alibaba's newspaper advertisement were immediately scanned 200,000 times per minute. Following these results, Alibaba announced a program called Mashang Tao, which was directed to its merchant partners, and would allow them to create and manage QR codes.

In 2015, Alipay's mobile app had the biggest share in China's mobile payment market with 270 million monthly active users.

The Alibaba Group is now the world's largest online retailer, that operates all over the world. Its profits are higher than the ones from the American retailers Walmart, Amazon and eBay combined, with more than 500 million of monthly mobile users that uses the portals of the Alibaba Group.

One of the main points in the success of Alibaba is the constant innovation with the adoption of new technologies, as we have seen in the case of smartphones, QR codes and mobile payments. In recent years other types of technologies have been under the eyes of Alibaba, and these include internet cars, and the facial recognition feature that has already been integrated in the mobile payment feature of Alipay.

Tencent

Tencent was founded in 1998 as Tencent Incorporated. Its current complete name is Tencent Holdings Limited, 腾讯控股有限公司 (téngxùn kònggǔ yǒuxiàn gōngsī), and it's a multinational holding conglomerate that works in the business of internet services and technology. Hundreds of companies are controlled by Tencent in many industries, from e-commerce to space technology

and from financial services to food delivery, making it the biggest investment corporation in the world.

The first product to be released by Tencent was the instant messenger QQ in 1999, later in 2005 they released the mobile version of QQ called QQ mobile. In 2004 Tencent started to invest in the gaming industry, and is now producing its own games. It then invested in search engines, some e-commerce websites, and as we saw in the previous chapter the food delivery website Dianping and the taxi-hailing App Didi Dache. In 2015, Tencent created its own online bank named WeBank, made some deals with companies in the entertainment industry, and invested in the robotic and mobile sector. In 2016 the interest of Tencent was directed toward the electric car industry, in fact they participated in the creation of a company that aims at producing this type of cars within 2020, and bought 5% stakes in Tesla. In 2017, one of Tencent most profitable field after many years was still the gaming industry in which Tencent is investing a lot of efforts, in fact, the company launched a gaming platform called WeGame, made some agreements to build two eSports cities in Wuhu and Chengdu, and invested in other gaming companies. Other activities of 2017 were done in the aviation industry, entertainment, artificial intelligence and tourism.

Many of the Tencent platforms and products are considered to be the Chinese imitations of foreign globally known platforms and products, in fact the company has been critiqued by many for copying other companies' ideas. Tencent's founder Pony Ma himself has expressed his opinion about copying, stating that is not a reprehensible thing from his point of view, and affirming that many products of the company have at least been inspired by other companies'. However, must be said that Tencent is one of the companies that has the highest number of patents in the world, in 2018 there were more than 7400 patents held by the Tencent group.

These Chinese variations of products and services are the absolute winners in the Chinese market because they are adapted to fit it to the best and therefore they work better than the originals in the country. The reason why this strategy works really well is that the Tencent Group is very fast in importing these products as they come out, and adapting them to the Chinese market before the foreign companies can enter it or gain a significant market share. Another reason is that the Chinese society is forward-looking, likes innovation and welcomes new ideas, but at the same time has some specificities to which these ideas must be adapted, and it's exactly what Tencent does. Part of this strategy of creating Chinese platforms controlled by Chinese companies is shared with

the Chinese government. In fact, the relationship between government and companies in China is very close, and what happens is that they support each other. For example, in Tencent 23% of the employees in technical positions, which is more than 7000 people, are members of the Chinese Communist Party which rules the country.

WeChat

The most interesting and famous platform that Tencent created is the social network and messaging App WeChat, which was released in 2011 with the Chinese name Weixin 微信 (wēixìn). This platform, more than other platforms owned by Tencent, during the years has been integrated with other platforms and technologies, creating a unique software able to do what would otherwise take many different Apps. Calling this platform a social network or instant messaging App does not describe it adequately, it does in fact allow the users to text, and send voice messages, take pictures and videos and share them, broadcast messages, video stream, play video games and share the location, but there are many other features as well. It is in fact possible to book transportation or a doctor appointment, see a map showing the crowd density, do advertisement, read the news feed, call mobile phones and landlines, and do payments.

Almost one year after the release of WeChat, in 2012, seeing the example of Alibaba, Tencent decided that QR code technology was the key for their expansion into mobile. The result was that in September of the same year they released an update for the App WeChat where they incorporated QR codes, a QR code reading feature and the possibility of generating personal QR codes. At the same time, they were also developing a digital wallet service within the App that used the QR code payment function, named WeChat payment. As we have seen in the second chapter this service allows to do payments and transfer money among the different accounts on the social network using QR codes. WeChat Pay does not offer all the financial services that Alipay offers, however there is a service similar to Yu'ebao's that offers money market investment accounts.

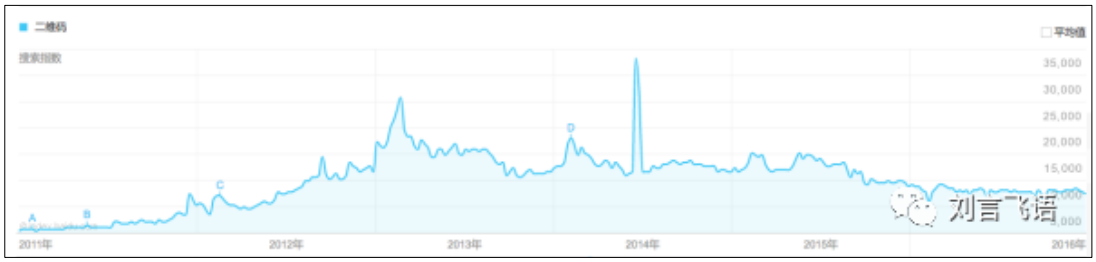
At this point started the competition between Alipay and WeChat Pay on QR code payments. On one side Alipay offered an integrated financial service and the possibility of purchasing items on many digital platforms of e-commerce as well as offline purchases. On the other side WeChat Pay was integrated in the most popular social media, which was already an important part of the life of

many, and offered the possibility of transferring money directly to people on the platform, purchasing different types of services and paying offline. The popularity of those platforms brought popularity to the payment systems and to QR codes, that became quickly a tool used in the daily life of a big part of the Chinese population.

In 2015, WeChat had 700 million active monthly users, and 200 million of these accounts had bundled their bank cards on the WeChat payment service.

After WeChat and Alibaba other Chinese platforms such as Baidu and Sina followed the example and began making use of QR codes on their Apps and platforms.

The chart below shows us the searches that happened in China during the five years between 2011 and 2016, of the term 二维码 (èr wéi mǎ). This term, which literally means two-dimensional code, is the word commonly used to refer to QR codes. This is because the big diffusion of the QR code overshadowed the existence of other types of two-dimensional codes, and the word two dimensional code is now directly associated with QR codes in the minds of the population. This chart helps us understand the extent to which Tencent and Alibaba have a part in the popularization of QR codes in the Chinese landscape.



3.1 chart about the searches in China from 2011 to 2016 of the term "二维码"

As we can see, the searches started growing in mid-2011 when Alibaba started using QR codes on their platforms. It increased growing through 2012, and had a peak when the new WeChat update that included the QR code scanning feature was released, in the third quarter of 2012. From that point the searches slowly decreased until 2014, where there is the highest peak. The peak that we see in the chart corresponding to 2014 is due to the launch of the WeChat payment feature. After that peak is easy to suppose that the big part of the population knew what are these two-dimensional codes, and therefore we see that from that point on the searches decreased.

Other forces

The two Chinese internet giants are only one of the two forces that pushed QR codes in China. The second force, are the thousands of merchants that started taking advantage of this technology in order to advertise their activity, connect to the consumers and use the payment services of these giants for their transactions.

The engagement of the merchants and businesses with this technology was partly driven by Alibaba, for the merchants who were doing business online using their platforms, but for the most part especially the small businesses saw the opportunity to use QR codes because of their advantages. Using this technology, in fact created the opportunity to cut a lot of expenses, and improve the management of the businesses at the same time.

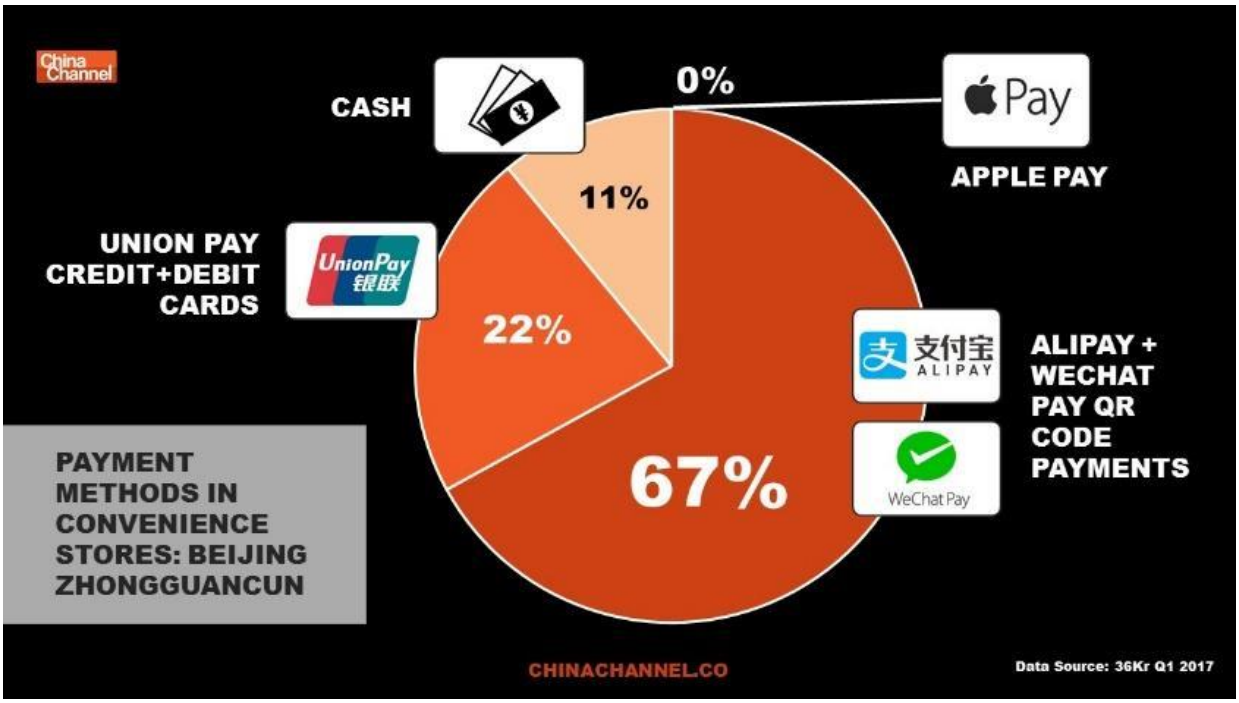
II. Changes in the society

Now that we have seen how QR codes have been inserted into the Chinese frame thanks to mobile payment, we can see how this managed to impact the society and its relationship with money and finance. We will also see some examples of phenomena that we can observe in China caused by the popularization of QR code payments.

a. Relationship with money

In this section, we will talk about how QR codes and mobile payment, which uses QR codes as a tool, managed to impact the life of the population, resulting in a changing of habits in a rather short period of time. In order to understand how, and the extent to which people changed their habits regarding money we will analyze some data.

We will now see and analyze some charts presenting some interesting data about the scanning of QR codes in China and in particular for payment purposes.



3.2 chart about payment methods in Beijing convenience stores

In the chart above we can see the data from chinachannel.com that shows us how payments were done in Beijing convenience stores in the first quarter of 2017. The first thing to note is that the payment methods available were cash, Union Pay credit or debit cards, WeChat Pay and Alipay payment QR code payments, and Apple Pay. What we see is that Apple Pay payments amount for 0 % of the total of payments, cash payments for 11%, cards payments 22%, and QR code payments 67%. This chart is important because it helps us understand the reality of the situation of the daily life of the Chinese population.

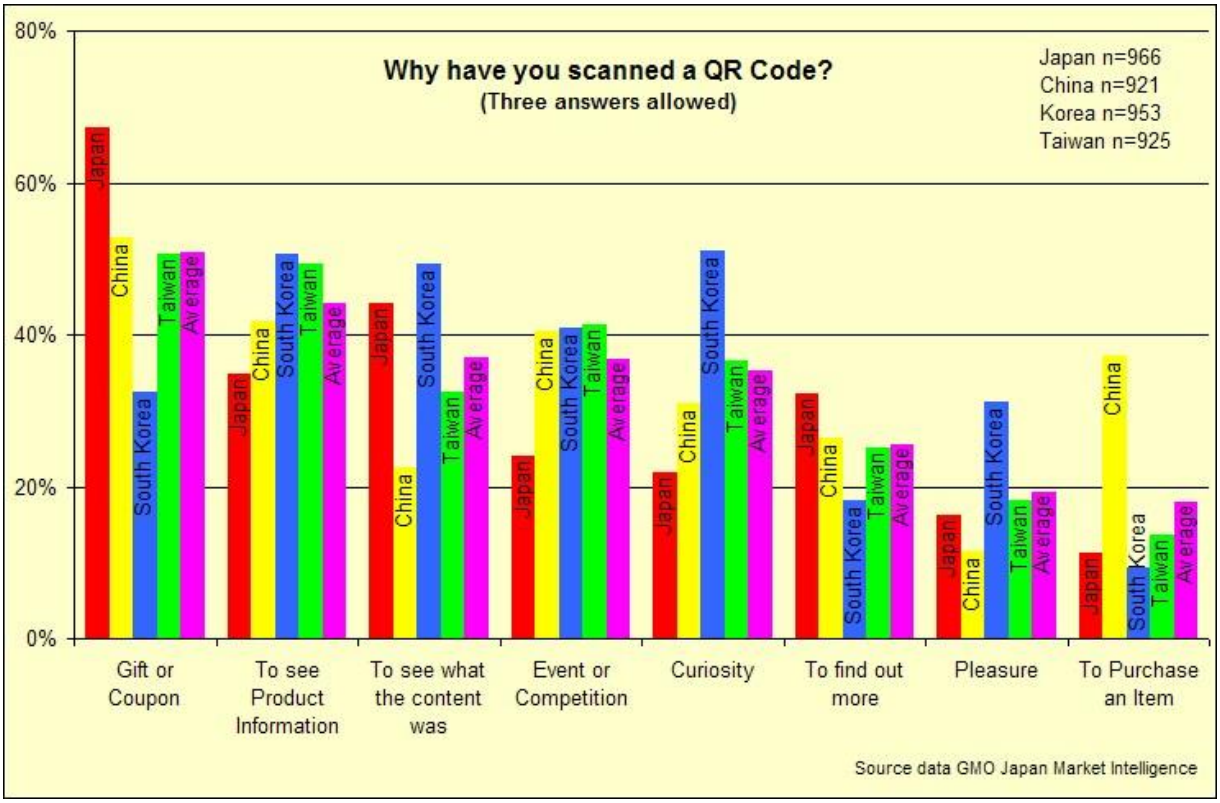
Foreign payment methods such as Apple Pay, even when they are available, they are completely discarded by the Chinese population, in favor of other payment methods.

Cash payments with physical money have been surpassed by both card payments and QR code payments. Cash payments amounting only to 11% is a significant data, which means that every 10-people going to the convenience store shopping, only one uses cash.

The most outstanding data that we can see in the chart is that 67% of the payments are done through QR code payments, meaning that the majority of people going to the convenience store use their smartphones to pay.

This chart give us another hint on the huge presence of the two companies Tencent and Alibaba by separating in a cluster their data on QR code payments, and including the eventual payments done through banking Apps in the UnionPay card payment method. Then again, we can see how in

order to understand QR codes in China it is important to understand their background through Alibaba and Tencent.



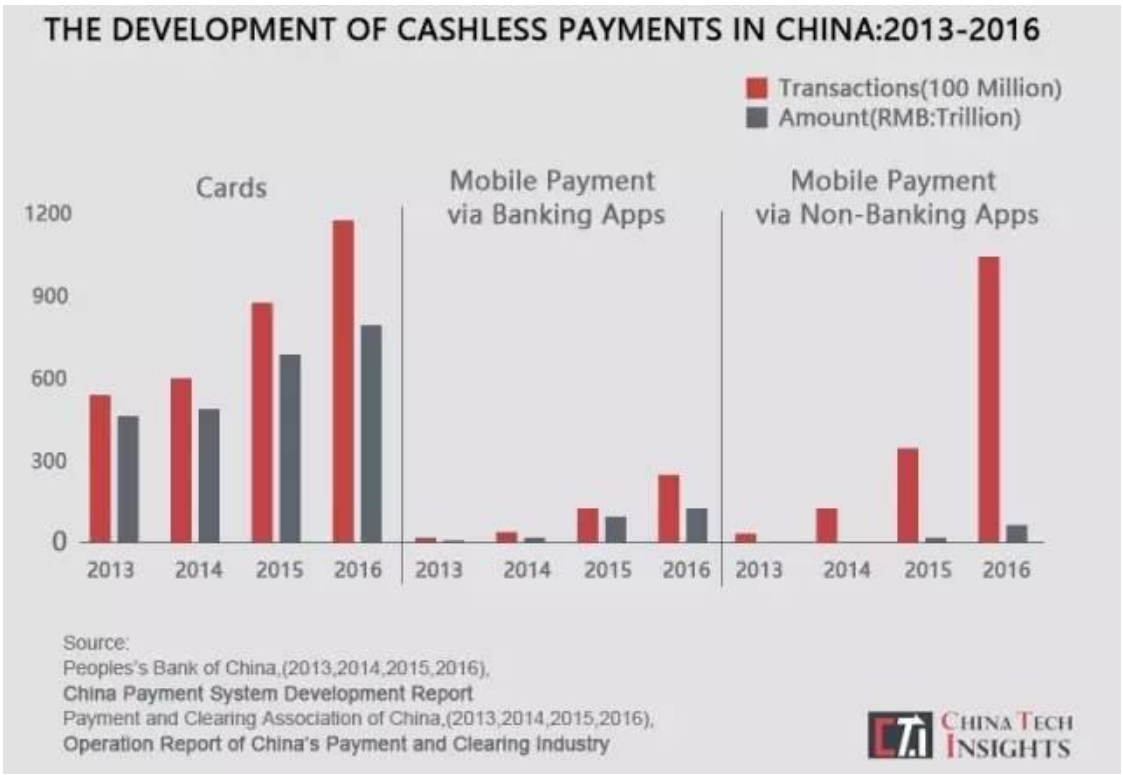
3.3 chart about QR code scanning habits in East Asia

The chart above presents the data from GMO Japan Market Intelligence, and compares the QR code scanning habits in Japan, China, South Korea and Taiwan. People in these countries were asked the first one to three reasons why they scanned QR codes out of eight options that include: to obtain gifts or coupons, to see product information, to see what the content of the code was, to participate to events or competitions, out of curiosity, to find out more about something, for pleasure or to purchase an item. We can see the results of the answers in a decreasing order from the average of the answers in the different countries.

We will use this chart to explain the different perception that people have of QR codes in different countries and in particular we will focus on China and Taiwan. One of the first things to note is, in fact, that this statistic made the controversial decision to separate China and Taiwan, but ultimately the results justify this choice.

The interesting data that this chart shows, is that in China QR codes are scanned more than in the other countries to purchase items. This information confirms that the reason why QR codes are popular among the Chinese population is due to companies such as Alibaba with their e-commerce platforms that use Alipay payment, and Tencent's WeChat Pay payment option.

On the contrary, Taiwan has a much lower percentage QR code payments. This result is, then again, justified by the popularity, or in this case the non-popularity of Alipay and WeChat. Taiwan, because of its history has developed in a different shape than mainland China, and has welcomed foreign companies, products and ideas adapting to them, instead of adapting them to Taiwan's specificities. In fact, in Taiwan, besides Alibaba, other e-commerce platforms such as Amazon are commonly used by the population, and many different social media such as Facebook, Twitter, Instagram and Line are used instead of WeChat. In terms of payments, in Taiwan people prefer using cash and credit/debit cards. Alipay is only being used by those who regularly use the Alibaba's e-commerce platforms, and WeChat Pay does not allow to bound Taiwanese or foreign bank accounts or to pay using a different currency than RMB. We can now understand how different is the perception of Taiwanese and Chinese people over QR codes, and why it was necessary to separate them in this statistic and in this chapter.



3.4 chart about the development of cashless payments in China from 2013 to 2016

The chart 3.4 shows us the development of the usage of cashless payment methods in China from 2013 to 2016. The payment methods that this statistic from People's Bank of China take into account are payment with credit and debit cards, mobile payment via banking Apps and mobile payment via non-banking Apps which means Alipay and WeChat Pay. Compared to the first chart, here we can see the clear general situation of smartphone payments divided into banking Apps payments and non-banking Apps payments.

The chart presents the data about both the number of transactions done with the different methods of cashless payment, and the amount of money expressed in RMB spent with each type of payment method in each year. What stands out in this chart is that all three methods of payment are growing in the number of transactions and amount spent through the years. The increase in the banking mobile Apps usage is smaller in comparison to card payments and non-banking Apps, and the number of transactions done with this method is considerably lower especially in the last couple of years.

Card payments seems to be the favorite payment method with big amounts of money spent every year. Mobile payment via non-banking Apps is the method with the biggest increase through the years. The amount of transactions done with this method in 2016 almost reached that of the card payments, having started in 2013 with very low numbers.

This is the proof of how mobile payments methods such as Alipay and WeChat Pay has risen through these years. From this chart we can also see the big difference in the amount of money spent with cards and the amount of money spent with mobile payment Apps. In particular, watching the data from 2016, and making a comparison between the two payment methods number of transactions and amount of money spent, we can realize how people have started to choose the non-banking mobile Apps payment method to pay smaller amounts, and prefer cards for bigger amounts. This is also confirmed by the first chart about payments in the convenience stores, were little amount of money goes spent, which showed how 67% of the customers paid using the QR code payment of Alipay and WeChat Pay.

b. Changes in the financial sector

According to the consulting firm iResearch, in 2016, the size of China's mobile payments market was already the biggest in the world, hitting 5.5 trillion US dollars, which is 50 times the size of the US's market. QR codes, being strictly connected to the mobile payments market, have managed to impact directly the Chinese economy and indirectly the financial sector.

The factor that made the difference for mobile payments, opposing to bank cards is that they can easily be used by individuals and small vendors, without the need of buying a POS card reader, but simply using a smartphone or printing a QR code.

More than 90% of China's mobile payments are managed by Ant Financial with the platform Alipay, and Tencent through the WeChat platform. These companies receive money from the service they offer as a small percentage on the transactions, and by allowing other companies to use their platforms for mobile payments. In 2017, these two companies even surpassed in number of daily transactions the worldwide known Visa and MasterCard.

Regulators in 2016 targeted online loans, which is a service that is growing very well in China and is offered by both Tencent and Ant Financial. This is because this big growth has begun to be seen as a potential problem by the traditional financial institutions. Many small platforms that provided this type of service had to shut down, while the few bigger platforms such as Ant Financial and Tencent had to apply the measures decided by the regulators such as fixing the interest rates to 24%.

Ant financial in the last couple of years has had more than 12 million users getting short-term small loans, these numbers scared the traditional financial institutions which have experienced a decline in their small loans and have accused these online platforms of predatory lending and practices that involve non-creditworthy borrowers. The reality is that the Ant financial company, thanks to the network of platforms of Alibaba has managed to create a system that allows them to analyse rapidly the behavioural data of their user requiring a loan and creating a credit limit based on the risk metrics in each case, lowering the risk of frauds and being able to approve the loans in the shortest time period.

The secret of the success of these financial services is the fact that Ant financial is using the advantages that they have by being a part of a multiplatform company with hundreds of millions of users.

The government has started to understand that these platforms are a reality and started seeing them as private banks that have a big pool of money and clients. This led the government to

decide that a bigger degree of control over them is necessary. For this reason, the People's Bank of China recently decided to gradually raise the reserve funds of these platforms, in order to better control the use of the e-wallets. The final objective is that to abolish the possibility for these companies to gain huge amount of money from interests that they make by doing investments with their consumers' money. The fact that the companies can invest, and gain interest is ultimately what makes possible for them to be competitive against banks, so this decision is a way to reach a possible balance of financial services.

c. Social phenomena

The popularization of QR codes and mobile payment methods changed the perception that people have about money and the relationship between the two. Along with these changes, China has seen the birth of some phenomena in the society, which are a clear representation of the impact that the technology have had on the society, culture and traditions.

Red envelopes

The red envelope 红包 (hóngbāo), refers to the Chinese custom of gifting money contained in a red envelope during any type of special occasion, including the festivities. This tradition is very ancient, and it is a welcomed gift for everyone, it is in fact believed that the red of the envelopes brings luck to the receiver, while the money brings prosperity.

According to the Chinese beliefs, the amount of money that should be gifted can vary from occasion to occasion, for example at funerals and weddings it is appropriate to gift odd numbers, while in other occasions it is tradition to gift even numbers. The number four and other numbers composed by it, should be avoided always because of the pronunciation of the word four 四 (sì) that sounds like the word death 死 (sǐ). The most common number to use to compose the amount of money to gift in the red envelopes are eight and nine, eight is considered a lucky number for prosperity, and nine 九 (jiǔ) sounds the same as 久 (jiǔ) which means long lasting.

The occasion that generates most of the red envelope exchanges is the Spring Festival, which is the Chinese New Year. The reason why p2p transfer using WeChat payment has become so popular is due to Chinese New Year's red envelopes. In fact, in 2014 WeChat introduced the

possibility to its users to exchange virtual red envelopes using the WeChat payment feature on its platform. To introduce and announce this feature WeChat offered many red envelope prizes to invite the users to join and win. The annunciation was diffused on all medias, including the national television, and the result was that a total of 1.2 billion red envelopes were exchanged with a frequency of 810 million per minute. The next year, in 2015, Alipay decided to offer this service as well, competing against WeChat. Alibaba and WeChat both offered free prizes to invite people to use this feature, and the response from their users was great, 240 million red envelopes were exchanged via Alipay and 1 billion were exchanged via WeChat.

The two companies at this point were at the peak of their competition over mobile payment, and red envelopes were easily exchangeable from the Alibaba platforms to the WeChat platform. This caused the two companies to change their features so that it would be more difficult for the users to do these trans-platform exchanges, and easier to remain on one single platform. Other problems arose other than the competition, in particular the presence of imposters trying to exploit the digital red envelopes do frauds and corruption related activities.

WeChat, in order to protect its users designed a system that would not allow exchanges of big amounts of money, by setting the maximum amount of the red envelopes to 200 RMB. Ultimately, this resulted in a multiplication in the number of transactions performed on the platform, which let the number of red envelopes exchanged grow exponentially, in fact, on the Chinese New Year's Day in 2017 this number was 46 billion.

We can see how this ancient Chinese tradition in a few years was transformed by the mobile payment. Not only people moved from gifting physical money to gifting virtual money, but the pressure given by these companies to use their payment platform shifted the perception of the population on the values behind the gift-giving. It is in fact true that gifting money is not a recent habit, but it has now become an expected gift on any occasion, almost losing all of its meaning. Moreover, in Chinese traditional festivities which contain a important cultural values, such the Spring Festival which is the occurrence in which the families reunite together to celebrate, these traditional values associated with the festivities have started to lose importance to the red envelope exchanging. This can be seen in the example of the Spring Festival which is the biggest holiday in China, when the activities close to allow the people to reunite with their families, but the focus on money and the virtual red envelopes is changing the society. This holiday generates a lot of migrations across the country because of the family reunions, but now we can see how the

familiar values are changing by seeing how the numbers of the people moving during this period are decreasing. Many in fact choose this time of the year to travel abroad or avoid the crowded roads and transportations, giving less importance to the holidays and traditions.

Online tipping

At the moment, the QR code and QR code payments are expanding in both their offline and online forms, an example it's the very popular phenomenon to pay a tip for many types of digital content. Tipping is not a common norm in China, as in the past was enacted by people from the upper class for rewarding people with a lower status, for example to entertainers and artists performing in numbers of street performance.

Tipping artists and content creators has now become a very popular trend, changing the old perception of tips receivers as socially disadvantaged. This online tipping practice is called 打赏 dǎ shǎng (or only 赏 shǎng).

Many Chinese internet platforms have started to include a feature that allows the users to give tips to the creators of the content that they are accessing to, using the QR code mobile payment feature. These platforms in many cases even have charts, ranking the virtual tip givers, creating for them a social status boost in the virtual world.

These online tipping practices can be traced to the gaming world, but also literature published online attracts a large number of tips.

Alipay and WeChat are the most popular tools used for tipping, and the platform that has seen this phenomenon grow particularly is the micro-blogging platform Sina Weibo. Sina Weibo in 2014 added the tipping feature, and in one-year time, blog authors gained a total of more than 50 million yuan in tips. WeChat not only is used for the payment of the tips, but the platform also allows to tip on the platform for an amount up to 256 RMB for each tip, an operation that only takes 2 clicks. Alibaba allowed users to tip on its platforms using the Alipay payment system in 2015, additionally simplifying the process by eliminating the need of inserting a password for transaction with amounts lower than one RMB.

These platforms give the users and visitors the opportunity to pay tips for a large variety of content. As we have seen the practice started from the gaming community, but authors of articles, writers, musicians and various types of artists have gained a big success thanks to the online

tipping. Many have been able to make a living, and to even start a completely donation-based career with this method.

One example to explain the extent of this phenomenon is the pop singer Hua Chenyu 华晨宇 (Huà Chényǔ), that after releasing a new song in 2014, in 5 hours managed to receive 105,000 RMB in tips, which is double the amount that he received from the song sales. Chinese online music companies said that 70 percent of their total revenue came from these virtual gifts.

A few start-ups focusing on digital tipping have emerged, like YouShang which was launched in 2015 and allows users to collect tips on various online and offline occasions via QR code.

This phenomenon has also expanded in the offline world, so that tips through mobile payment apps are very common, and among others, street performers, taxi drivers and waiters are now encouraged to ask for tips through QR codes digital tip jars.

III. China's central bank and safety issues

On the topic of mobile payments and transactions through QR code technology, China's Central Bank started having concerns as this payment method grew in popularity. The payment process, mainly in the verification and certification phases was seen as possibly dangerous and risky for the consumers, and not having a satisfactory regulation on the technology itself raised the concerns of the Central Bank, which found itself in the position of not being able to protect the consumers and decided to ban the QR code payment system in 2014. This ban didn't hit all of the QR code mobile payments, but only the offline payment and online purchases that involved third-party payment companies. The ban was in any case effective enough to raise the concerns of the population over this technology and raise the competition between the two main QR code mobile payment platforms Alipay and WeChat Pay. As these two mobile payment services have in the background the support of well-established and trusted companies, the Chinese consumers continued to use the QR code mobile payment feature. The ban ultimately had the effect of increasing QR code payments, giving more visibility to these two companies and eliminating any small competitor that wasn't enjoying the trust and attention from the institutions.

The ban from the Chinese Central Bank finally ended in 2016, after the release of the safety standards for barcode payments by the Payments and Clearing Association of China. UnionPay

bank cards, which are the only Chinese bank cards, can now be used through the different Chinese banks e-wallet apps for QR code mobile payments. The banks offering this service have to deal with the rigid normative about the encryption of the personal data of the consumers approved by the Central Bank of China for the use of this technology.

An interesting change of mind from the Central Bank of China happened about offline payments, which were formally subjected to the ban and have now been encouraged, with the knowledge that they can make the difference for all the many small businesses that work with small funds, which numbers have been multiplying since the raise of e-commerce.

As we have seen the users of QR code mobile payments seems to trust the technology mainly on the basis of the familiarity and trust that they have in the platforms offering it. But these platforms as other institutions must be able to prevent the dangers, guarantee security to the users and deal with the eventual problems.

Recently, in December 2017, the Bank of China introduced some security measures to be applied on QR code payment purchases, these measures are transaction limits on the purchases that must be implemented also in the Alipay and WeChat Pay systems. The interest on this subject by the institutions has been well accepted by these platforms, which immediately decided to abide by the rules. This happened after the 19th Party Congress where it was decided to lower financial risks and have a stricter hand on frauds and illegitimate behaviours, after the occurrence of many different cases in the country.

Elements that can cause risks in the use of QR codes for payments are the falsification of the codes or their alteration. Another element that can compromise the safety of the QR codes are the devices used for scanning the codes, which in most of the cases are smartphones and tablets, that can be easily altered and hacked. The presence of personal data and information in the codes means that in order to guarantee the security of these information for the users, there is the need of using the best, safest and most advanced technology.

Another type of concerns, this time coming from the population, is relative to the privacy of the data collected by the mobile payment platforms. The claim is that these platforms and secondarily other organizations and institutions use the data about mobile payments to do different activities without the consent of the users. It is possible for these platforms to know every detail on the purchasing habits of the general public and each individual, resulting in the possibility to send direct advertisement based on the tastes and habits of the users. As we have seen in the previous

section an example of this type of use is Ant Financial that has been taking advantage of the data collected by the Alibaba company to study the creditworthiness and risk of the users who are asking for a small loan, and creating a personal plan.

Related to this concern, is the fact that some other type of data can be collected from the simple scanning of QR codes, one of which is the location of the scanning, meaning that is possible to know where people are when scanning the codes. The geotagging feature is inserted in many QR codes, for example the ones placed on the rental bikes that we saw in the previous chapter.

At last, an issue related to QR code technology, digital money and mobile payments, that was recently brought to the attention of both the Chinese government and the China's Central Bank is the subject of cryptocurrencies, in particular Bitcoin.

Bitcoin

Another digital payment technology very popular these days is related to Bitcoin. Bitcoin is a digital currency that is not controlled by banks or any other type of institution. Payment in bitcoin are accepted by many activities all around the world. These payments are the peer-to-peer type of transaction that we saw in the second chapter and can be done also using QR codes to transfer the information of the transaction between the two parties.

3.5 example of QR code in Bitcoin payment

One of the reasons why Bitcoin has spread around the world is that it allows to avoid government checks and controls over the transfers of currency, it is therefore used to a great extent in the business and finance sectors as well as in the private sector.

China has been in the last two years the largest Bitcoin market, which is not unexpected considering the large number of the population, the familiarity with digital payments, and the fact that most of the bitcoin mining centres are placed in China.

Mining centres are where new bitcoins are created by a process that involves a big number of computers solving problems. This practice requires a lot of energy and is considered a threat for the environment. Due to the favourable policies and low costs offered in China, mining centres have been growing in number in China until it has become a problem. The Chinese government in

2017 decided limit this phenomenon by putting some restriction on the energy usage, but the environment is not the main issue that the country is worried about.

The Chinese population seems to be very welcoming of this digital currency and this is not surprising considering that the Chinese society seems to have a dislike towards physical money in the recent years. The step between the already existing Chinese e-wallet mobile payments and this new digital currency mobile payment is very small and easy to make for the population, but the possible risks are higher and nor the government nor the banks can protect the citizens because they don't have the control of this currency and payment system.

What happened in the last two years was that the wealthy residents and the business elites used Bitcoins to circumvent government controls and take money outside of the country by storing this digital currency in offline wallets that could be simply saved on USB sticks. The strong control that the Chinese government has over its currency is well known, the amount of money that can be took inside and outside of the country is in fact restricted and strictly controlled. After the China Central Bank warned the risk that Bitcoin could bring to the country and ordered all the banks and financial institutions not to handle this type of transactions, the government decided to ban large trading exchanges of Bitcoin from October 2017. Moreover, many cases of frauds and money laundering happened, and the authorities decided that the next step in regard to Bitcoin is going to be the block of all the platforms trading it.

a. Visualead

Recently Alibaba made a strategic agreement with an Israeli start-up named Visualead, which is specialized in QR code technology. This way Alibaba will use this technology on its shopping websites, apps and other platforms, while Visualead with this new capital coming from the giant Alibaba can develop further its offline-to-online technology.

3.6 example of Visualead QR code

Visualead gives Alibaba the chance to have unique QR code technology where QR codes can be created as proper forms of design, with a much more visual impact than normal black and white codes, to the point that Visualead claims that these QR codes are four times more likely to

be scanned than standard QR codes. But the design of these QR codes is not the only reason of the interest of Alibaba in Visualead's technology, in fact, Visualead's codes can help Alibaba fight the sale of counterfeit products on their platforms.

In fact, Alibaba for years have been claimed to be helping the distribution of counterfeit goods because the platform is just a digital place where buyers and sellers get in touch with each other, but Alibaba itself doesn't stock or ship any goods, so that it doesn't have any degree of control over the goods.

Over the years Alibaba has been attacked by many fronts, one side is the Chinese government accusing Alibaba of turning a blind eye to illegal activity, another side are luxury firms that sued Alibaba for conspiring to produce and sell fake products with their trademark without having their permission, and lastly there are the consumers who consciously or not- receive these products.

Alibaba is now using these codes as service codes to let sign-off the delivery to buyers as well as allowing them to verify the authenticity of the products. All of this goes under the Blue Star program of Alibaba which consists of having each product to carry a unique QR code that links to a database with detailed product information run by Alibaba itself, this way buyers can scan the QR code to verify the authenticity of the goods and get refunds in the case that the products turn out to be fake.

The first categories to which was applied this program were cosmetics, cleaning products, wine and agricultural products. Using this system is not only useful to consumers but it also helps Alibaba to identify where are counterfeit goods coming from, helping the authorities to track down and arrest infringers. According to Alibaba, this Blue Star program benefits the whole ecosystem from shoppers, to brands, to retailers.

IV. Conclusion

In this thesis we have seen how, from the invention of the barcodes, we came to see the big success of the QR code in China, and which are the consequences .

The invention of barcodes in the 1950's was revolutionary for the whole world and influenced many industries, from postal services to the pharmaceutical sector, from the automotive sector to the whole commercial sector with the UPC barcode that identifies the products. The limits of one-dimensional barcodes led to the creation of two-dimensional barcodes, which since their invention

have partially replaced one-dimensional barcodes thanks to the characteristics of having more storage space, having the possibility of containing different types of content, occupying less space and having the possibility of inserting an error correction feature. Among the two-dimensional barcodes the QR code is the most diffused in the world and particularly in China.

With the invention of the QR code, for the first time barcodes had the ability to contain characters different from alphanumeric characters, and this is why this type of code meant a lot for countries such as China and Japan whose written languages use different types of characters. What led to the popularization of QR codes, is the fact that smartphones with a camera could be easily used as scanning devices by simply installing an app. The popularization of smartphones in China in the early 2010's, along the popularization of mobile apps from different platforms of the companies Alibaba and Tencent disseminated the use of QR codes to a big portion of the Chinese population.

These companies adopted QR codes putting them at the centre of the utility of their mobile platforms, and creating a new market in China, the mobile payment market. The fact that these platforms offered every type of service and the answer to any problem for the users, made these platform extremely successful, and the QR code as well.

In only a few years since the introduction and popularization of QR codes, China has experienced a big impact in its economy, society, and even finance.

The introduction of QR codes on the Alibaba online shopping platforms had a great impact in the country's economy, creating the new mobile shopping market and causing the subsequent foundation and rise of companies that work in this sector. The same happened with the introduction of the WeChat payment feature on the Tencent's mobile platform, which created a whole new set of services and the rise of companies and individuals offering them. Moreover, both Alipay and WeChat Pay payment systems had a great influence on offline physical stores and vendors, by lowering their costs and allowing the arrival of newcomers.

Another consequence of the rise and popularity of QR codes payments is that the country is now moving toward a cashless society with a fast pace. A case that can show clearly this change is when recently some thieves stole the money from three different shops before getting caught by the police in Hangzhou and all they found was a total of 1600 RMB, a very little amount of money due to the fact that people don't use physical money anymore. This example demonstrate how Chinese citizens not only trust the whole concept of digital money and believe in the

trustworthiness of the system, but moreover how not having the physical money gives them a sense of security.

This means that the society has been profoundly impacted by this technology. The fact that QR codes can potentially solve any problem from making a gift to paying a taxi, from renting a bike to reading information, led a vast part of the Chinese population to be smartphone and QR code addicted. In particular, the ease of mobile payments changed the perception that the population has about money and traditional values, by promoting a consumerist behaviour, which was not part of the common Chinese mentality. The familiarity of the Chinese population with mobile payments also means that their perception and view of digital currencies is instilled with trust, which is confirmed by their general welcome to other types of digital money such as cryptocurrencies, which are now been banned.

As a consequence of the rise of mobile payments not only cash has seen a decline in its use, but bank cards as well. This means that banks have seen a decline in the money received from fees and commissions because of these third party e-wallets. Not only that, but mobile payment platforms such as Alipay and WeChat Pay have also incorporated in their wallets different types of financial services that are having a good response from the platforms' users, and this is to all effects distancing the control of China's Central Bank and the Government over the Chinese population's money.

Two problems that China is going to face in the next years is finding a way to unify or diversify the QR code payment system by finding an equilibrium between banks and company owned mobile payment services, and narrow the gap between the majority of the population which is using QR code mobile payments and the still great number of people which don't, in turn caused by the development gap between urban and rural areas.

Another problem linked to the previous one, is related to the relationship of China with the rest of the world. The Chinese system of mobile payments is strictly connected to the country and its banks, so that it's not accessible for many foreigners. This also means that these mobile payments are not commonly accepted outside of China.

In order to have a global system of mobile payments there must be a collaboration between the countries and between companies. This could be the case of Amazon which in the global market is the biggest competitor of Alibaba. The two companies besides being competitors are influencing

each other, and a future alliance between the two could really influence the perception that the people around the world have about QR codes, and about mobile shopping and payments.

As for now we can see how the Chinese example has started to influence other countries. Many countries in Asia and South-Eastern Asia have started adopting QR codes and QR code payment. The biggest example is India, which is, as China, a developing country with a big population. Following the example of China and with some help from its companies and institutions, India has started developing its own QR code mobile payment system, which is spreading, and is supposed to reach the majority of the population in a few years.

The reality of the change that QR codes have brought to China and could possibly bring to the whole world, the society and the perception of money is truly impressive.

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