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QR CODES & THEIR USES IN LIBRARY SERVICES : A STUDY

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ABSTRACT

Like other areas of human life, today, libraries have also started using the computers and other electronic devices in providing various services to users and in other house-keeping activities. Use of computers in libraries is called automation of libraries for providing better and quick services to the users. For this purpose, various govt. agencies, institutions & corporate undertakings in India and abroad have developed various new techniques and technologies for libraries. The present article focuses on QR Codes and their history, adoption, design, storage capacity, symbols and types. The article also explains benefits, limitations and elements of QR codes. Besides this, the article is intended to enlighten the uses of QR codes in library services and other sectors.

INTRODUCTION

As all of us know that today, **ICT (Information & Communication Technology)** is being used in each and every area of human life. Libraries are not exception of it. With the advent of ICT, the libraries, too, have seen a lot of changes over the recent years. One of the most prominent changes in libraries is Library Automation**.** By using ICT, now the automated libraries are able to provide better and quick services to the users. By seeing and understanding advantages of library automation, gradually all traditional libraries are stepping towards automation. About five decades before, barcode technology was applied in the libraries as a part of library automation for more speed, accuracy and reliability in accessioning, circulation and other tasks of libraries.

In recent past, the European countries have used a new technology QR code for their existing library system. The full form of QR code is Quick Response code. The QR code technology is just like the barcode technology. The differences between barcode technology and QR code technology is that barcode technology can handle the information only in horizontal direction and QR code technology can handle the information in both horizontal and vertical direction. QR code technology is widely used as a medium to deliver a message to end users. The QR codes are mainly used by libraries for the purpose of promoting their services. Nowadays the QR code technology is widely used by many libraries for providing quickly access to their resources.

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WHAT ARE QR CODES ?

The QR code is the technology that can deliver to the user the information in a code. A **QR code (Quick Response Code)** is a type of matrix barcode (or two-dimensional barcode) invented in 1994 by the Japanese automotive company Denso Wave. A QR code is a machine-readable optical label that can contain information about the item to which it is attached.

The QR Codes are readable by android or smart mobile phones or similar devices with cameras. These are a kind of 2D barcodes. QR Codes are two dimensional images that, when scanned by smart phone's camera, prompt the smart phone to open a webpage or display an image, video, or text. They are sometimes referred to as 2D codes, 2D barcodes, and mobile codes also known as matrix code. QR Codes have length and width of white and black combination of geometric squares and corners. The basic objective behind the development of QR Code is encoding and decoding with high speed and accessible from any direction or any position so that which can be scanned easily by the users. It is a more reliable technology instead of linear barcodes having high storage capacity maximum up to 7,089 characters. Due to having highest restoring capacity it can easily detect errors which is not possible in barcode. Also it could have the capacity to represent e-information more than 100 times than a barcode. This technology is very likely to be accessible, easy to handle and easy to attract and display information to the users. Unlike a barcode, a damaged or scratched QR Code can sometimes be readable. The hyperlink embedded through QR Code, which deflect the communication from physical to virtual mode and accelerate the information significantly and adequately to the users.

HISTORY

The QR Code system was invented in 1994 by **Masahiro Hara**, an engineer from the Japanese company Denso Wave. The initial design was influenced by the black and white pieces on a Go board. Its purpose was to track vehicles during manufacturing and it was designed to allow high-speed component scanning. The Quick Response Code system became popular outside the automotive industry due to its fast readability and greater storage capacity compared to standard UPC (Universal Product Code) barcodes. Applications of QR Code include product tracking, item identification, document management, and general marketing.

ADOPTION

QR codes are now used in a much broader context, including both commercial tracking applications and convenience-oriented applications aimed at mobile-phone users (termed mobile tagging). QR codes may be used to display text to the user, to open a webpage on the user's device to connect to a wireless network, or to compose an email or text message. There are a great many QR code generators available as

software/apps or as online tools that are either free, or require a paid subscription. The QR code has become one of the most-used types of two-dimensional code.

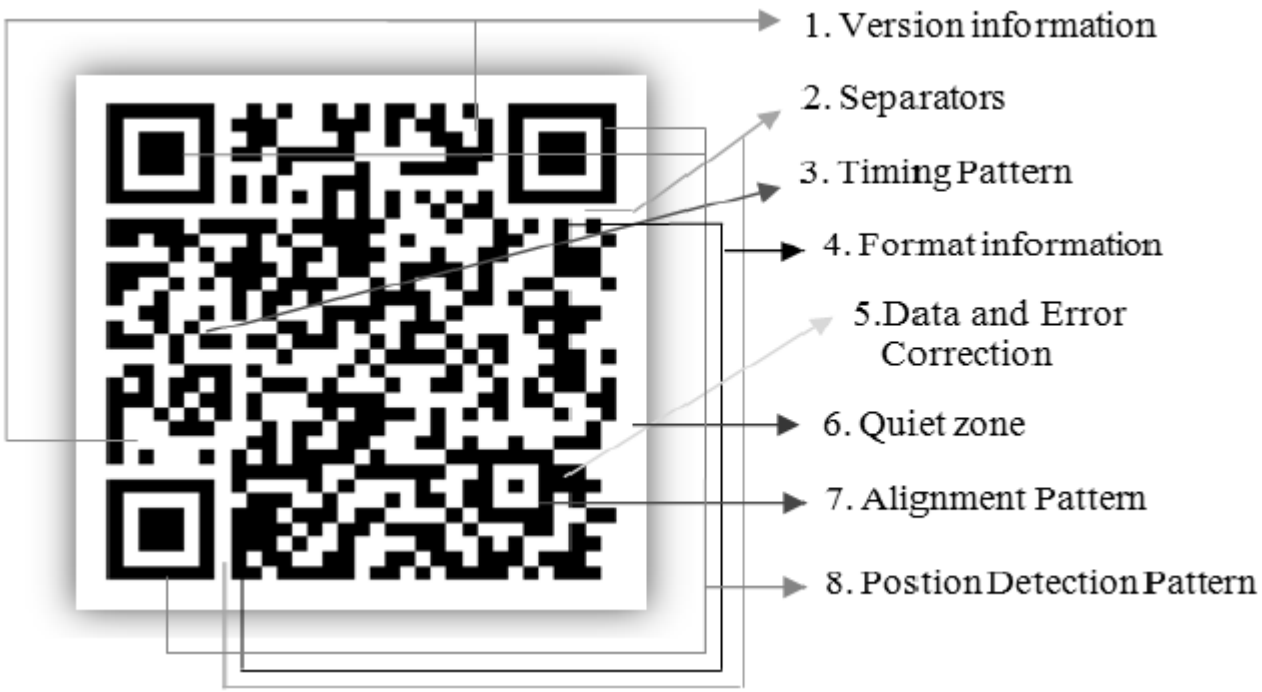
During the month of June 2011, 14 million American mobile users scanned a QR code or a barcode. Some 58% of those users scanned a QR or barcode from their homes, while 39% scanned from retail stores; 53% of the 14 million users were men between the ages of 18 and 34. A September, 2020 survey found that 18.8 percent of consumers in the United States and United Kingdom strongly agreed that they had noticed an increase of QR code use since the beginning of COVID-19 related shelter-in-place orders in March 2020.

ELEMENTS AND STRUCTURE OF A QR CODE

QR Codes may appear to be random but they are in fact slightly different. Although QR Codes can be customized, the shape of the QR Code must always be square. There are 7 different elements in a QR Code.

Positioning marking : This indicates the direction in which the QR Code is printed. Even if your camera is at an angle, you will still be able to scan the QR Code.
A**lignment marking :** If the QR Code is too large, say on a billboard, this helps to orient the image. It is used for modifying the distortion of QR code.
Timing pattern : The timing pattern is made up with black and white modules. This helps the QR Code scanner to determine how large the data matrix is in the QR Code. This pattern is used for determining the central coordinate of each cell in the QR code.
Quiet zone : This is the most crucial part of the QR Code. This helps the QR Code scanner differentiate the QR code from the surroundings. It is a margin space which is used to detect the QR code. It consists of four cells and is used for quiet zone.
Version information : There are over 40 different QR Code versions. These are markers present in a QR Code that specifies the one that is being used. The most common ones are versions 1 to 7.
Format information : The format pattern consists of information about the error tolerance that makes it easier to scan the code.
Data and error correction module : The central part of a QR Code consists of black and white modules where the code stores the data and has blank space surrounding them to allow up to 30% of the code to be damaged. This element has error correction function. It stores data converting into binary digits 0-1. It consists of array of rows and columns.

STRUCTURE OF A QR CODE



SPECIMEN OF QR CODE AND BARCODE

QR code

Bar Code

DESIGN OF QR CODE

Unlike the older one-dimensional barcodes that were designed to be mechanically scanned by a narrow beam of light, a QR code is detected by a 2-dimensional digital image sensor and then digitally analyzed by a programmed processor. The processor locates the three distinctive squares at the corners of the QR code image, using a smaller square (or multiple squares) near the fourth corner to normalize the image for size, orientation, and angle of viewing. The small dots throughout the QR code are then converted to binary numbers and validated with an error-correcting algorithm.

STORAGE CAPACITY OF QR CODE

The amount of data that can be stored in the QR code symbol depends on the data type (*mode*, or input character set), version (1, ..., 40, indicating the overall dimensions of the symbol, i.e. 4 × version number + 17 dots on each side), and error correction level. The maximum storage capacities occur for version 40 and error correction level L (low), denoted by 40-L:[11][70]

Maximum character storage capacity (40-L)

Character refers to individual values of the input mode (data type).

Input mode	Max. characters	Bits/char.	Possible characters, default encoding
Numeric only	7,089	3 1⁄3	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Alphanumeric	4,296	5 1⁄2	0–9, A–Z (upper-case only), space, $, %, *, +, -, ., /, :
Binary/byte	2,953	8	ISO/IEC 8859-1
Kanji/kana	1,817	13	Shift JIS X 0208

Here are some sample QR code symbols/variants :

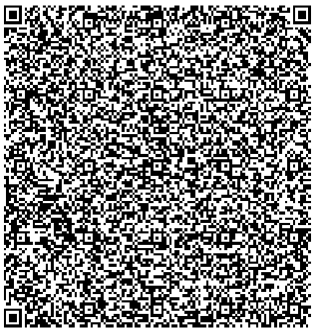
Version 1 (21×21)

Version 2 (25×25)

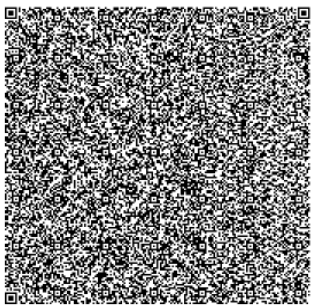
Version 3 (29×29)

Version 4 (33×33) Content : up to 50 characters

Version 10 (57×57) Content : up to 174 characters

- 

Version 25 (117×117) Content : up to 1269 characters

- 

Version 40 (177×177) Content : Version 40 QR Code can contain up to 1852 characters

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TYPES OF QR CODES

- **Model 1 -** Model 1 QR code is an older version of the specification. It is visually similar to the widely seen model 2 codes, but lacks alignment patterns. Differences are in the bottom right corner, and the midsections of the bottom and right edges are additional functional regions.

- **Micro QR code -** Micro QR code is a smaller version of the QR code standard for applications where symbol size is limited. There are four different versions (sizes) of Micro QR codes: the smallest is 11×11 modules; the largest can hold 35 numeric characters.

- **IQR code -** IQR Code is an alternative to existing QR codes developed by Denso Wave. IQR codes can be created in square or rectangular formations. This is intended for situations where a rectangular barcode would otherwise be more appropriate, such as cylindrical objects. IQR codes can fit the same amount of information in 30% less space. There are 61 versions of square IQR codes, and 15 versions of rectangular codes. For squares, the minimum size is 9 × 9 modules; rectangles have a minimum of 19 × 5 modules.

- **Secure QR code -** Secure Quick Response (SQR) code is a QR code that contains a "private data" segment after the terminator instead of the specified filler bytes "ec 11". This private data segment must be deciphered with an encryption key. This can be used to store private information and to manage company's internal information. SQR codes have been developed by the FORUS Foundation to enable secure transactions, and published under a Creative Commons Licence. The SQR solution guarantees the integrity of the source data as well as the validity of the originating party. The payment instruction string is made up of the electronic instruction data from the scanned QR code appended with a SHA-2 cryptographic hash.

- **Frame QR -** Frame QR is a QR code with a "canvas area" that can be flexibly used. In the center of this code is the canvas area, where graphics, letters, and more can be flexibly arranged, making it possible to lay out the code without losing the design of illustrations, photos etc.

- **HCC2D -** Researchers have proposed a new High Capacity Colored 2-Dimensional (HCC2D) Code, which builds upon a QR code basis for preserving the QR robustness to distortions and uses colors for increasing data density (at this stage it is still in prototyping phase). The HCC2D code specification is described in details in Querini *et al.* (2014),[85] while techniques for color classification of HCC2D code cells are described in detail in Querini and Italiano (2014),[86] which is an extended version of Querini and Italiano (2013).

- **JAB code -** JAB code (Just Another Barcode) is a color 2D matrix symbology made of color squares arranged in either square or rectangle grids. It was developed by Fraunhofer Institute SIT (Secure Information Technology).

The code contains one primary symbol and optionally multiple secondary symbols. The primary symbol contains four finder patterns located at the corners of the symbol. The code uses either 4 or 8 colors. The 4 basic colors (cyan, magenta, yellow, black) are the 4 primary colors of the subtractive CMYK color model which is the most widely used system in industry for color printing on a white base such as paper. The other 4 colors (blue, red, green, white) are secondary colors of the CMYK model and originate as an equal mixture of a pair of basic colors.

ELEMENTS OF QR CODE

There are five basic elements which are used for QR code functionality. These elements are Pattern, Alignment Pattern, Timing Pattern, Quiet Zone and Data Area :

- **Pattern -** The Three big squares which are found in the corners of a QR Code are used for identifying size, position and angle.
- **Alignment Pattern -** It is used for modifying the distortion of QR code.
- **Timing Pattern -** The timing pattern is made up with black and white modules. This pattern is used for determining the central coordinate of each cell in the QR code.
- **Quiet Zone -** It is a margin space which is used to detect the QR code. It consists of four cells and is used for quiet zone.
- **Data Area -** This element has error correction function. It stores data converting into binary digits 0-1. It consists of array of rows and columns.

BENEFITS/ADVANTAGES OF QR CODE

- It is available free. One can generate QR code using free software/mobile apps.
- It can be used by anybody at any time anywhere.
- It is very fast to access the information embedded with the code. It works in a nanosecond as to fulfill Ranganthan's fourth law "Save the time of the reader".
- It is a technology based library services that enhanced mobile learning.
- No need of any technical accessories only require smart phones like Android phones, i-phone with proper internet connection.
- It contains more storage capacity in comparison to barcode and used by any direction angle.
- No need to have any specific skill or expertise.
- It has the capacity of damage resistant as if the symbol is damaged partially it can easily restored data & detect the error correctly.

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LIMITATIONS OF QR CODE

- Lack of awareness about QR code among people and users.
- Need of scanning device and QR code reader app/software. If you want to access the information in the QR code, you should have a device that supports the QR code scanning facility.
- It takes time to scan the code embedded in the QR code, if there is network or server issue.
- It needs an internet connection.

QR CODE WEBSITE/SOFTWARE AND READER

There are a number of software for PCs freely available in the market for creating QR codes and also there are various QR reader apps for smart mobile phones in google play store. The following are some examples of software and QR readers apps :

Software :

- CODETWO
- TEC-IT
- QR-CODE STUDIO

QR Reader Mobile Apps :

- WeChat
- MyCam
- QR & Barcode Scanner
- Scan – QR Code and Barcode Reader
- QR Code Scanner
- Free QR Code Generator
- Barcode Scanner
- RedLaser
- i-nigma
- QR Code Reader

USES OF QR CODES IN LIBRARY SERVICES

The libraries are using the QR Code as a medium to communicate the users about their documents/information that they want. In 21st century, the libraries are fully automated and they know the users' demands very well. They always try to provide world class services to their users beyond physical boundaries. There are many libraries in India and abroad that have implemented QR code. The names of some notable libraries are given below:

- San Diego State University Library
- Central Library, IISER, Bhopal
- Bath University Library, U.K.
- Half Hollow Hills Community Library, New York (USA)
- Derby Academy Library, Massachusetts (USA)
- Tezpur University Central Library, Assam (India)
- Contra Costa County Library, California (USA)
- Tompkins County Public Library, New York (USA)
- Syracuse University Library Learning Commons, Syracuse, New York (USA)
- Lafayette College Library, Easton, Pennsylvania (USA)
- Harold B. Lee Library, Utah (USA)
- Topeka & Shawnee County Public Library, Kansas (USA)

There are several ways to use the QR codes in library services. It is one such technology which fulfill the user requirements of providing access to e-resources through mobile phones and other portable devices. Now a days, many libraries are applying this technology and some have already applied. Under this section we are highlighting some features of QR Code which are beneficial for library services :

➢ **Library websites** : Now a days it is very difficult to remember different URL's for different purposes. So, it is very convenient to scan QR Code generated by library that will automatically direct the user to the Library website, resources and references .

➢**Contact to library** : Applying this QR Code technology, the users can easily go through the direct contact of any particular library where they will get email, phone no, address and website of that library.

➢ **OPAC** : By linking QR Code of OPAC, users can easily get the information regarding the particular book/item/resource including author, title, publisher, call number, location etc.

➢ **E-books** : In addition to physically books, any user can access e-books also on his mobile phone using QR Code. The e-books which are subscribed by respective library will be displayed in his device, and the user can read the desired book online or download it.

➢ **E-Thesis: /E-dissertations** : QR Code has the ability to access additional link for thesis and dissertations according to their user needs.

➢ **Online Journal/magazine** : If any user is willing to access any journal/ magazine and doesn't has much time to visit library and read physically, then he can scan the related QR code sent by library& undoubtedly he will get the pdf within a second.

➢ **Full text databases** : It can be possible by using QR Code, just to scan it and accordingly what you need, you receive it without any hindrance.

➢ **Article file** : If someone want to access any particular article, then request to the librarian to send only one QR Code, you will receive full text article in your mobile.

➢ **Bibliographic databases** : According to the availability of resources, if any user asks for databases, then they can just scan QR Code and undoubtedly get direct link to databases. It will easily come to your mobile.

➢ **Old question papers & study material** : The list of old question papers and study material will be displayed on user mobile phone after scanning related QR Code.

➢ **Video library** : If any institution has collection of videos, created by itself and YouTube playlist videos or a video library embedded with QR Code technology, then any individual can access it and save it for later use also.

➢**Particular content** : If any user need particular paragraph, theme, pictures, table from any library exhibitions, encyclopedias or other resources, there is no need to open the particular website, by scanning with QR Code, the user can easily acquire, read & download it and store for future purposes.

➢ **Library exhibition**: Users can receive update information regarding library exhibitions, their features, planning and designs; users can find quickly by scanning QR Code.

➢ **Study room reservation**: By scanning the QR Code pasted on the doors of study room areas the user can reserve his seat and get it later very easily.

➢ **New arrival collection** : Many times the library has huge collections in the form of new arrival materials. So to promote library materials, new arrival collection QR Code helps prominently to users.

➢ **i- help**: By scanning i-help QR Code, any user can get any online/offline help regarding his needs & purposes.

USES OF QR CODES IN OTHER SECTORS

QR codes have become common in consumer advertising. These include commercial tracking, entertainment and transport ticketing, product and loyalty marketing and in-store product labeling. They can also be used in storing personal information for use by organizations.. Typically, a smartphone is used as a QR code scanner, displaying the code and converting it to some useful form (such as a standard URL for a website, thereby obviating the need for a user to type it into a web browser). QR code has become a focus of advertising strategy, since it provides a way to access a brand's website more quickly than by manually entering a URL. QR codes storing addresses and URLs may appear in magazines, on signs, on buses, on business cards, or on almost any object about which users might want information. Users with a camera phone equipped with the correct reader application can scan the image of the QR code to display text, contact information, connect to a wireless network, or open a web page in the phone's browser.

- **Health Sector -** QR Code in health sector has easy to facilitate on vaccination drive for real time updates of vaccination inventory, generate test results and vaccination status to deal with COVID,19 pandemic. QR Code has the ability to verify the brand of packed vaccine, which includes the manufacturing & expiry dates, batch no and temperature requirement. QR codes are also present on COVID-19 vaccination certificates where they can be scanned to verify the information of vaccinee on the certificates.

- **Education Sector -** QR Codes are being used in education sector also by logging in to website URL's. Now a days, due to COVID pandemic, most of the educational institutions have started using online platforms for taking classes. And for this time, teachers and students have to log in to the website by typing URL manually and which takes 10-15 minutes of time to speed up the entire class. So with the help of QR Code without wasting of time just generate it and can directly link to the application. QR codes also have the ability to create a book review in the form of video. Now a days people are using QR Code while taking admissions and giving feedback also.

- **Public Transport -** In the related app, after registration profile, we have to attach our bank details to this app and add money to the wallet. Whenever we go by bus, we have to select from and to location and then we can scan the QR code from the conductor of the bus with a particular ID. Money will directly transfer from our wallet to transport corporation on basis of conductor ID. Then we will get an SMS alert for ticket payment proof.

- **Online Payment system -** QR codes can be used to store bank account or credit card information, or they can be specifically designed to work with particular payment provider applications. There are several

applications of QR code payments across the world. Today, UPI (Unified Payment Interface) online/digital payments apps such as – Google pay, Amazon Pay, Phone pay, Paytm, Bhim etc. by using QR code are very popular and convenient method of payment in various retail outlets, stores and shops.

- **Counterfeit detection -** QR codes have been used by brands and governments to let consumers, retailers and distributors verify the authenticity of the products and to help in detecting counterfeit products, as part of a brand protection program.

- **Virtual Stores** - QR codes have been used to establish "virtual store", which is a gallery of products. QR code is presented to the customer through message. The customer scans the QR codes, and the products are delivered to his home. This experiment was first started in South Korea, and Argentina, but is currently expanding globally. Walmart, Procter & Gamble and Woolworths have already adopted this Virtual Store concept.

- **To login in websites** - QR codes can be used to log into websites. A QR code is shown on the login page on computer screen, and when a registered user scans it with a verified smart phone, he will automatically be logged in. Google tested such a login method in January 2012.

- **For ordering in restaurants** - The restaurants can present a QR code near the front door or at the table allowing guests to view an online menu, or even redirect them to an online ordering website or app, allowing them to order without having to use a cashier or waiter. After the COVID-19 pandemic, QR codes began to be used as a "touch less" system to display menus. Restaurants replaced paper or laminated plastic menus with QR code on the table, which opens an online version of the menu. This prevented the need of disposing of single-use paper menu, and cleaning and sanitizing procedures for permanent menu after each use.

- **Joining a Wi-Fi network -** A QR code is also used to automatically join a Wi-Fi network.

- **Electronic authentication -** QR codes are also used to generate time-based one-time passwords (TOTP) for electronic authentication.

- **Video games -** Popular video games, such as *Fez*, *The Talos Principle*, and *Watch Dogs*, have incorporated QR codes as story and game play elements.

- QR codes have been used and printed on train tickets in China since 2010.

- QR codes have also been incorporated into currency in many countries, originally linked to a special website linked to the historical event and design of currency.

- Multimedia QR codes are also used to direct users to specific multimedia contents (such as video, audio, images, documents, etc.).

CONCLUSION

Thus, from the above study, we learned that in this present era, the uses of new technology of QR Code are increasing day by day. Gradually it has covered various fields like education, health service, marketing, business, e-payment, travelling etc. and libraries are also one of them. The use of QR codes in library demands the changes in ways of information handling services. The user would have easy access to most current and necessary information from the library by using QR code. So to make the effective use of QR code among the user community, libraries must organize user awareness and orientation programs. So that, in the coming time, users can get more amazing experiences by using this wonderful tool.

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