Annals of Library and Information Studies
Vol. 67, September 2020, pp. 156-163

Use of QR codes for enhancing access to library resources and services: a case study of IIT Gandhinagar library

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Received: 22 January 2020; revised: 05 September 2020; accepted:11 September 2020

The Quick Reference (QR) Code is the trademark for two-dimensional barcode (or matrix barcode). This code system has become a popular technology in the present era because of its fast readability and greater storage capacity compared to standard barcode. The QR code is multidimensional barcode with various color, size, and shapes. The main goal of this code is to direct communities to particular products or resources through links. Quick Response Code is, usually developed, for product promotion like the barcodes. This paper attempts to present a quick overview of the technology and how libraries adopted it early, to promote their resources and services. IIT Gandhinagar library has been one of the early users of this technology for promoting its services amongst its user community. It has adopted and demonstrated the benefits of this technology by applying it to over dozen areas of library services. Because of its ease of use and speed, it has been observed that during last two-three years, acceptance and use of this technology among current generation of students has gone up for retrieving and downloading information. In fact, more number of students have been asking for applying QR in other areas of library services. Authors presents here a successful case study of how QR code technology has been implemented at IIT Gandhinagar Library on an Android based mobile phones and how it has now become a part of routine application for enhancing access to library resources and services.

Keywords: QR code; Academic libraries; Smartphones; Mobile devices; Information services

Introduction

The rapid development in the area of Information and Communication Technologies have changed the face and shape of the Libraries. These technologies have offered huge opportunities to deliver the services differently, than what was being done traditionally. Technologies, such as smart mobile phones, have revolutionized the way how user access and organize the information. This has taken the expectations of library users to the next level. To meet these increasing expectations, Libraries around the world have been quick in picking every possible technology and adopt them suitably for making it easy to access library resources and services. One such recent tool being adapted in the library environment is QR codes. One of the goals of libraries being "Save the Time of Users" (Fourth Law of Library Science) propounded by Dr. S. R. Ranganathan, the mobile devices and applications such as QR codes help achieve this goal in a big way.

The QR codes (Quick Response)-an easy to understand and use technology is slowly bridging the gap between print and digital era. The QR codes widely known by now is a two-dimensional code which was developed by Denso Wave in 1994 for a Toyota subsidiary in Japan. This technology was developed for application in manufacturing, product marketing and promotion by Toyota. Later, it has been widely used by many companies and other service organizations. Now, the application of QR codes is visible in almost every field which deals with end users/consumers. Realizing the benefits of this technology, library and information professionals have been exploring the use of it for promoting its products such as digital documents, audio, video and other types of e-resources. This paper makes an attempt to give an overview and the usefulness of QR codes and also present a case study of its successful application at IIT Gandhinagar Library.

What is QR code?

The QR code is a type of matrix code which can be scanned using a QR code reader/ software downloaded onto a smart phone. The QR code is an optically machine-readable label that is fixed to an item and records and represents information regarding the item.

"QR code (short for Quick Response code) is the two-dimensional barcode invented in 1994 by the Toyota Motors subsidiary Denso Wave to track vehicles and different parts during the manufacturing process. The QR code consists of black modules (square dots) arranged in a square grid on a white background. The information encoded may be made up of data (numeric, alphanumeric, byte / binary, Kanji) or, through supported extensions, virtually any type of data."[1]. "Normal barcodes only hold information in one dimension (horizontally) and are seriously limited in the amount of data they can contain. Denso Wave developed QR codes as a way of holding information in two dimensions (they go horizontally and vertically) and are strictly described as a matrix code rather than barcodes."[2].

In a nutshell, QR code represents information about an item to which it is attached that can be read using a specific software installed on smartphone or any other handheld device. Fig. 1 illustrates best, the QR code and how it represents the information:

How are QR codes generated?

Generating a single QR code involves a very simple process. There are several websites that offers free software to generate QR codes and without spending much of time. Here are few steps used in QR Code generation;

- Find and open QR code generator site: If you are creating a QR code for your website or URL of any contact card (visiting), you can use a free QR code generator. The sites will create a QR code for you but do not provide any advanced tracking or analytics.
- Choose your data format: Most free generators will offer format options. These may include general text, URL of the website, email contacts, phone numbers, text messages, or vCard (contact card), etc. Select the format depending on the purpose.
- Enter data: Now you have to enter your data/information into the fields given by the generator. If you are entering text or a URL, it should be limited to 300 characters as older phones and other devices have difficulty in reading codes larger than 300 characters.
- Design QR code: You may design your code as you like. If you are using a paid service, you often have access to more custom QR codes, including logo embedding and unique styles and shapes, but free code generator tool will have limited options.
- Modify or change the color: Generally, as we all know by default, the QR codes are black and white, but we can select and add colors of our choice. Mostly free code generators allow you to adjust the colors on your QR code.
- Test it and download or share your code: Once you have created QR code, then save/download it to your computer as an image or any other format and then open the file and preview it.

On successfully reading the newly created QR code, it is ready for the final step. Usually, free QR code generators allow you to download the code in PNG format. This image file can be easily added to a

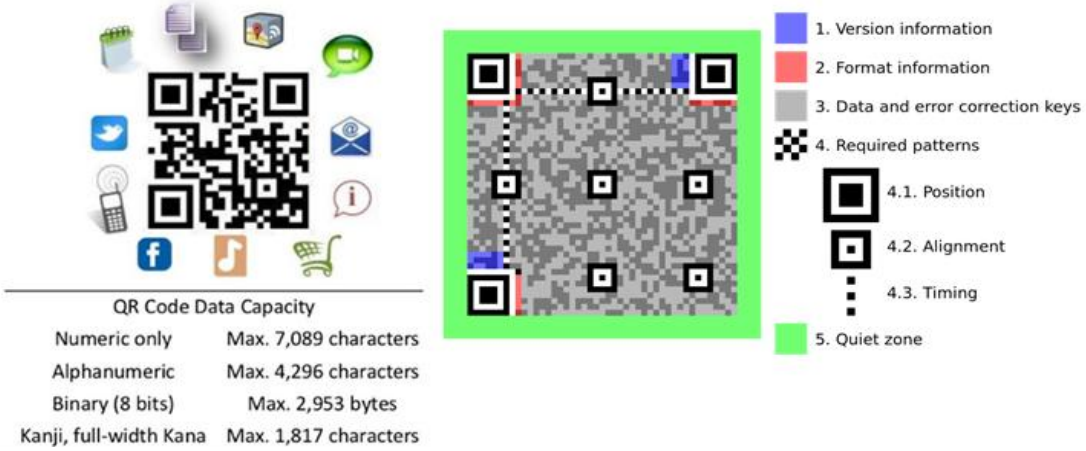

Fig. 1 — QR code Structure (*Source: Wikipedia*)

document, uploaded to a website, or even added to your email signature.

How are QR codes read?

If you have any Android based or any other smartphone or tablet, then you may download or go for an open source QR code reader, install the same, then open it up and read any QR code that you want to read. An example is given in Fig. 2.

Standards and Size

With regard to following standards and specifications for characteristics of the symbols, nature of data, error correction rule, the quality requirement for their production, dimensional characteristics setting etc., the ISO Standard ISO/IEC18004: 2015 defines all of these clearly. For most smartphones, the relationship between scan distance and minimum QR code size is approximately 2.5cm (1 inch). QR code printed on a magazine page will have a nominal effective scan distance of about 250mm (10 inches). All of these are well-set standards and widely followed in technologies associated with QR Technologies[3].

What are the software and hardware tools required?

In order to successfully implement QR codes in the Library, it is necessary to have the following basic tools to generate and read:

- Android-based smartphone and tablets or PC (using with camera)
- Printer (Normal Printer)
- Reader/Scanner
- Internet connectivity

QR Code Generators

As mentioned in the earlier section, QR code generation software are available at cost and free. Some of the free software, which are frequently used listed here.

- Free Online *QR Code Generator:* https:// www.the-qrcode-generator.com/

Fig. 2—Exam: https://www.iitgn.ac.in/library.htm

- I-nigma: http://www.i-nigma.com
- Kaywa: http://www.kaywa.com **or** http://qrcode.kaywa.com/
- QR codes are measurable: http://www.qr-code-generator.com
- QR stuff: http://www.qrstuff.com

Few others are available over the internet freely listed here.

- BeeTagg: http:// www.beetagg.com
- *Desktop QR code scanner:* http://dansl.net/*qrreader/*
- Neoreader: http://www.neoreader.com
- Quick Mark: http://www.quickmark.cn/
- Softonic*:* http://free-qr-creator.en.softonic.com/*download#downloading*

Some of these software may remain on the scene for a long time and some new ones may come with more new features. One has to track the new ones and use their experience and select one that is going to be available for a long time to come.

Why use QR codes in Libraries? (General Benefits)

Though, the QR code technology was invented in 1994, the actual application beyond the manufacturing sector has started much later. It took some time for the people in other sectors to realize the benefits. Some of the benefits applicable to all segments are listed here;

- It's easy to add tools to provide a *virtual experience* in the library.
- Offers more content at the point of need.
- Interactivity with the medium i.e., smartphones.
- It is easy to acquire and implement as many generators are available online and simple to use, just in put brief information, generate code and copy and paste it on the item.
- There is hardly any cost involved.
- QR code is well designed, with a higher capacity than other matrix codes and with error correction capabilities.
- Does not need any extra equipment. All that is required is using of already available technologies i.e. computer and printer.
- The inventor Denso-Wave holds no patent rights on the QR codes, so no royalties need to be paid.
- It does not need extra staff as it is not labor intensive.
- Easy to modify and has error correction capability.

Literature survey

Barcodes and QR codes are a type of coding systems that turns any information into a black and white rectangle or square bars or dots. Through scanners or readers, we can scan these and retrieve the data much faster than conventional processes. Quite a few studies have been carried out on use of QR codes in libraries and museums. These studies highlights the piloting of QR codes in an institution, surveying participants, tracking statistics on usage, marketing of information resources and services. On the other hand, RFID, which is now a widely used technology in the libraries, is more than a simple barcode or QR Code. It has a smart chip on which the data is written and linked to a Library Management Software, using which the issue and return of a documents (Book, CDs/DVDs etc.) can be done by self and also used for security purpose to avoid stealing materials.

The following section covers a literature review highlighting the studies that have been done specially focusing on implementation of QR technologies in the libraries.

Libraries, museums, and other cultural Institutions from different parts of the world have been using different technological tools for efficient management of their resources and also to improve their user experiences. The advent of smartphones accelerated this process further as these smart handheld devices can be easily used in different ways to reduce the time and energy required for using these facilities productively and enhancing the experiences. One such tool which works its best is the Quick Response (QR) code technology. The published literature points that there have been numerous studies highlighting benefits of implementing QR code systems in institutions like museums and libraries. For instance, a study by Perez-Sanagustin, M., Parra, D., Verdugo, R., Garcia-Galleguillos, G., & Nussbaum, M. (2016) presents an experiment of using QR code technologies which offer potentially outstanding opportunities to transform the digital information or content in museum-like spaces in engaging the public or visitors. They examined two types of QR codes, namely one-way and two-way QR codes. They found that two-way QR codes are very popular, cheaper, and effective tool for obtaining feedback from the users and for delivering digital content in museum-like spaces[4].

Similar studies have been conducted in India and other parts of world which highlights the use of QR code technology in libraries and tremendous benefits this technology offers to their users. Panda, S. P. & Mahapatra, R.K. (2013) in their study stated that QR codes show a new horizon for several applications in business and as also in education. They argue that the libraries should also make use this technology to help improve the relationship among the users. To support this argument, authors state that many Libraries are extensively using QR codes for locating different resources like e-journals, e-magazines, library websites, identifying location of the books, web OPACs, newly released book reviews, audio tracks, etc.[5]. Similarly, Walsh, A. (2010) explained the potential of using QR codes in multiple ways in libraries. He goes on to state that this being a simple and open technology, users are able to install QR readers in their smartphones and other devices and read the codes generated by libraries. Through the mobile, users could access the library resources at the point of their need through the QR codes, which links to the appropriate locations of printed materials in the Library[6].

To step back and look at when QR Code technology was introduced in libraries, we come across an important UK based study by Elmore, L., & Stephens, D., (2012). These authors suggested that the professionals in the UK were already aware of using QR code technology and have extensively used it for promoting their library resources and services. They were early and much ahead of others to explore and successfully implement QR code technology in their academic library environment, thereby bridging the gap between their library and tech-savvy users[7]. Similarly, Mohamed, S. (2014) reported about the project to facilitate access to information by library patrons using QR codes in the Brand van Zyl Law Library, University of Cape Town (UCT). This author states that this technology facilitated the ease of accessing academic library services. He recommends accelerating the use of QR code in the academic environment as the usage of smart mobile phones has increased recently[8].

Some of the authors who conducted their studies in the Indian context believe that more attention needs to be paid for the benefits that QR Technology offers in providing easy access to library resources and services. For instance, Shettar, Iranna M. (2016) explained in his case study that the movement of using QR codes in Libraries is still in its primary stage. His paper focused on how the QR Code works and what are its important features. He shares the

experience of implementing QR code technology at the National Institute of Technology, Karnataka for accessing Library resources and thus creating awareness about the library services[9]. At the same time, another study identifies the need for using this technology and propose the processes involved in implementing QR code technology in libraries. To give you an example, Kumar, G.K., Chikkamanju & Nayak S, M. (2014) in their study explained in detail the process of creating QR code, accessibility, and its application in the Indian library system and highlights new ideas to enhance access to library resources and services. They also emphasize the fact that QR code has the potential to revolutionize the way libraries can disseminate information, connect to the users, and market their services[10]. On the same lines, Manso & Machado (2016) examined the literature and explained the role of QR code technology in formulating programs to improve information literacy. Through a case study of 13 academic libraries, they proposed a set of actions to implement the QR code technology in libraries[11].

The above studies have shown that libraries have been using the QR Codes for more than a decade now. This being simple to use technology, with the proliferation of smartphones and availability of free software for generating and reading QR Codes, the attention of both libraries and their users has caught up more than any other technologies. Considering these and many other successful case studies, highlighting the use of QR Codes in academic libraries, the library at IIT Gandhinagar attempted to use this technology as early as 2016. Now, over a period of almost three years, literally in every possible aspect of library services, the library has introduced QR Codes making access to the content much easier than before.

Areas of application in Libraries

The selected review of recent literature presented in the previous section gives us an idea that the application of QR codes in libraries for various purposes is gaining momentum and wider acceptance. The literature also presents specific areas/tasks/ purposes for which QR code is used in our libraries. Some of the areas where QR codes are often used are listed here:

- *Exhibitions of resources or materials*: Most of the libraries used QR codes on the list of reading materials for reaching the end users through the exhibition of resources. It's a part of strategy for promoting collection and library services.
- *Library stacks, near journals to point to online holdings*: Through using QR codes, users can get access to holding information without any waste of time while retrieving through a mobile device.
- *Library audio/visual collection tours*: Many libraries are using the QR code for promoting their audio/visual collection.
- *Catalogues and bibliographic records*: QR code can be used for catalog records or bibliographic information of the book(s), and other reading materials.
- *Contact information*: To disseminate the details of contact information about faculties/staff and directory pages.
- *Audio/visual collections*: Linking to the online videos/DVDs in the form of summary or trailers which helps the user about the particular resources.
- *Website links*: Many a time user community needs the details about author's interviews, link to their sites. To provide a quick link and retrieve information libraries offer QR codes.
- *Tutorials and e-resources*: QR codes for tutorials of print and electronic resources which will help users to understand as to how to use these resources.
- *Other links*: Link to useful URLs, Email, SMS, phone numbers, text, images and PDF files, etc.

Implementation in India

The list given in the above section is by no means comprehensive, but gives sufficient indications and hope that this technology can be safely considered for implementation in our libraries. In order to find out to what extent this technology has been implemented in Indian libraries, authors made an attempt to review the published literature on this topic and also visited (during 2018) websites of most of the major libraries in the country. Based on this effort, authors were able to locate the eight libraries and identify the activities where QR codes have been applied (Table 1).

This quick survey of websites of these libraries mentioned above, clearly indicate that libraries in India are not far behind as compared to their counterparts elsewhere in the world in adopting QR Technology for promoting easy access and use of library resources and services.

Implementation of QR codes in IIT Gandhinagar Library

Considering the benefits and experience of other libraries in using QR codes and also looking to own

Table 1 — Intuitions and libraries using QR code

Sr. No.	Name of the Institutions or Libraries	Activity for which QR codes are used
1	DITM, Pune	Audio/Visual collection, bibliography
2	Baburaoji Gholap College, Pune	Library URL, contact details, product information, etc.
3	CSIBER Kolhapur Library, Kolhapur	Library OPAC, Location finding, Audio/Visual collection
4	IIT Jodhpur	New Arrival list, Audio/Visual collection, book indent form, contact details, etc.
5	IIT Kharagpur	Events information, different URLs, departmental information
6	Karnataka State Open University Library, Mysore	Staff contact information, Pathfinder, Section location, emails
7	Karve Institute of Social Service, Pune	Periodicals, Rare books collection, CD/DVDs list, Notification, Exam results
8	National Law University, Lucknow	Library website URL, Library Guide
9	NITK-Suratkal	Application of QR Codes in Library resource and service awareness activities

and immediate requirements, the library at IIT Gandhinagar decided to experiment with this technology. All three authors and other colleagues were part of this implementation process. To begin with, we have implemented QR Codes for the following resources and services:

- *Library website*: We have used the link to the library website and created QR codes for enriching and increasing the library visibility and the resources and services to end user.
- *Library web OPAC link*: Using QR code given for our library OPAC, user can get access quickly the holdings of the library and find out the status of required readings.
- *Library brochures*: More than a dozen library brochures created for different memberships and services have now QR codes. Within each brochure QR codes have been provided to link resources, catalogues, contact details etc.
- *E-resources list*: QR Code to link the user to the physical and virtual collections subscribed by the library anytime and anywhere has been implemented.
- *Audio-visual (CD/DVDs) material list*: Codes have been generated and affixed on PDF list of Audi Visual materials uploaded on our website.
- *New arrival list*: Weekly new arrival lists (print and digital) have also QR Codes attached. With this, once download the entire directory on their smartphones.
- *Bibliographies*: To retrieve the information using a variety of methods, we created the QR code to download the list of books in pdf format.
- *Book of the week (URL and PDF):* Our weekly display of *Book of the Week* and its complete list has QR Code.

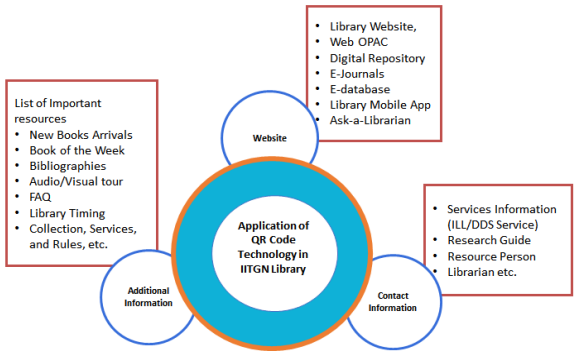

Fig. 3 — Structure for applications of QR codes in IITGN Library

- *List of full-text print journals*: A list (10-12 pages printed and pdf) containing bibliographic details of print journals subscribed in the library also has QR Code.
- *Digital repository link*: We have created the QR code for the URL repository.
- *Subject resource guides*: All our ten resource guides have QR codes linking their URLs.

A list of QR Codes generated and used are given in the ***Annexure I*** to serve as an example. In addition to these, there are several other areas are being explored where QR code can be attached to provide easy access to libraries resources and services. The areas of applications in IIT Gandhinagar Library is show in Fig. 3.

As you may see from the above list, we have successfully implemented QR Codes in the above-mentioned areas using "Free Online *QR Code Generator site*- http://www.qr-code-generator.com/" which allows to create free QR code easily for URLs, texts, and pdf files, etc. Being most popular site for QR code generators, we decided to use it I-nigma- www.i-nigma.com, Kaywa- www.kaywa.com, and QR Codes generator- www.qr-code-generator.com.

Observations, experiences and lessons learnt

Here are few observations, experiences and lessons learnt through implementing of this technology;

- We did not spend any extra money to implement this technology but added it to our workflow.
- It also did not need much technical expertise, nor did take much time to learn as to how to both generating the code and reading technology works.
- The process of application of this technology helped us understand and identify the core areas of work where users expect the ease of access to library resources.
- This process also helped to identify where repetitive work was done and resources are wasted by printing, downloading, and sharing certain documents with users.
- As most users, especially students, use Android based smart phones, we could meet the needs of large number of users.
- Most users found it is much easier to use.
- By making this technology as part of our workflow, we have been able to reach out too many users and enhance the usage of the library.
- The authors also have observed that most visitors who come to the campus for participating in the workshops, conferences, courses etc. find such codes useful as they are able to search many of our resources lists and instantly access resources.
- Certainly, the use of such a small but essential technology saves a lot of time for both users and library staff.
- Experience gained through using such technology boosts the confidence of staff and also explores other newer tools which mainly developed for other areas, but could easily adapt to the library wok environment.

With these experiences, library has already identified some new and more areas to apply QR Codes and are in the process of implementation.

Conclusion

As stated in the first section of this paper, computer and communications technologies have offered abundant opportunities for the library. There are technologies that are developed exclusively, offering solutions to the library domain and equal number of technologies that are developed to automate different processes in other domains. It is only the proactive involvement of library staff in exploring new technologies, both within and outside our domain, which will help improve overall services and visibility of libraries. QR Code is one such technology adopted for offering solutions to different sectors and does not need any extra infrastructure or has any financial implication, most libraries have to grab it and use it appropriately. The main contributing factor in successfully using this technology is most users these days have Android-based smartphones. Considering the benefits that technology offers, many libraries in India being technology savvy have taken full advantage of QR Technology and are offering services to save the time of the user and enhance usage. IIT Gandhinagar Library being a pro-active place for experimenting with new technologies has initiated the process and successfully implemented QR code for over a dozen of our resources and services. Having observed the benefits from the user point of view, we will be exploring all possible areas of our library and will be working for the application of this technology.

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Annexure I

QR Codes generated and used at IIT Gandhinagar Library


Book of the Week


Children Collections


Full-Text E-Journal list


Hindi Collection


IIT Gandhinagar Library Site


List of CD/DVDs


Subject Resource Guide


Pathfinders (Bibliographies)


Online Catalogue


New Additions of Books


A-Z Print Journal List


Digital Repository