

# Application of SWOT, Principal Component and Cross-case analysis for Implementing and Recommending an ICT Technology in Library - A Case study

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**Abstract:** Many educational organizations and universities are using computer based management information system for increasing efficiency of work in the organizations. Library management plays a vital role in academic organizations. Bar code is one of the computer based technology which helps to increase efficiency and speed of the organization effectively and qualitatively. Though each bar code character is represented by a group of bars and spaces, computer based software can easily understand it. Organizations have to implement new technologies to meet goal of the organization. Implementation of bar code technology in the Library of Dr. BATU, is a tool to minimize the time taken at the circulation counter in charging / discharging the reading material. The new technologies may be a bit difficult to be adopted in the initial stages, but in the long run they improve the image of the organization. The paper is a case study based on the bar coding at Dr. BATU. This paper renders on implementation of Bar code technology and the advantages gained from using bar code technology by looking into each work process in the case library. For better understanding of the bar code based library management system, this case study has been conducted. We used a SWOT analysis for getting actual picture of the situation raised after implementation of the bar code system in the library. We also conducted the survey to understand the values added by this system in the library management system. The conclusion has been drawn based on SWOT analysis, cross case analysis, Implementation report and survey.

**Keywords**—Strategic Planning, SWOT analysis, Cross- case analysis, Bar code technology, Qualitative analysis, library management

## 1. Barcode: Meaning and Working

Bernard Silver had invented the bar code in 1948. [1] He was inspired by Morse code. In morse code, dots and dashes are used to encode letters. [2] Bernard Silver used the long lines. For efficient and effective library management, the computerized information system plays important role. Automatic identification technology called bar code is set of which lines and spaces. Main motto behind attaching a bar code to an object (e.g. books, journal and magazine etc) is identifying and /or describing that physical object. Automatic identification/ data capture technology enables information to be collected directly from device by using barcode scanner and send it to computer for further processing. Set of black and white lines with different variable thickness are used in barcode that one can use to store stock code, serial numbers. When a scanner scans a physical object's bar code, it beeps and then it sends a code to a computer. The computer sends back information about that item [2] [3]. There are various types of bar code (Shown in table 1). Figure 1 shows a barcode symbol. Widely used barcode types are UPC-A, Code 39, Code 93, EAN 8, EAN 13 etc. A QR code abbreviated from Quick Response code is a type of matrix-barcode (or two-dimensional code) (shown in figure 2). [4][5] The scanner passes a narrow light beam onto a bar code. Then the reflected light is measured by a light sensor inside the scanner. Black lines reflect lesser light than white ones. [6][7][8]. Table 2 shows Industry Standards for Barcodes and Labels.[21][22][23][24][25]



Fig. 1 A UPC-A barcode symbol



Fig. 2 QR Code

## 2. The Bar Code Technology for Library - A Case Study

For better understanding of the bar code based library management system. This case study has been conducted. We used a SWOT analysis for getting actual picture of the situation raised after implementation of the bar code system in the library. We also conducted the survey to understand the values added by this system in the library management system.

### A. Library Background

This University was established on 5th May 1989 by the Government of Maharashtra under the Act No. XXII, 1989. The University has a sprawling campus of 468 acres in such a beautiful place which provides just that little isolation from the hubbub of city life necessary to academic life and its pursuit of research and contemplation. Dr. BATU is one and only one of its kinds in the state. The university is located in the college town of Lonere. Established by the government of Maharashtra, it is relatively young, but has been making its mark in the research and technological services through its dedicated faculty and disciplined students. There are 23 courses offered by Dr. BATU catering to the faculties of Engineering in diploma, B. Tech, M. Tech & PhD programmes. [9]

The library of the university has total huge 4000 sqm carpet area. Only 185 sqm are is used as reading space. Total Number of Seats in reading space is 300. Total Number of Users (issue book) per day is 250, Number of Users (Reading space) per day 200. Timing in the Academic Working day is 9.30 a.m to 5.45 p.m. The library hosts 33533 volumes of 18500 book titles, 173 journals in print format and huge number of e- journals and e-resource.

Table 1.Types of barcodes [3]

Code	Details
EAN-13	Numeric only barcodes, European Article Numbering international retail product code
EAN-8	Numeric only barcodes, Compressed version of EAN code for use on small products
UPC-A	Numeric only barcodes ,Universal product code seen on almost all retail products in the USA and Canada
UPC-E	Numeric only barcodes ,Compressed version of UPC code for use on small products
Code 11	Numeric only barcodes, Used primarily for labeling telecommunications equipment
Interleaved 2 of 5	Numeric only barcodes, Compact numeric code, widely used in industry, air cargo, other applications
Industrial 2 of 5	Numeric only barcodes, Older code not in common use
Standard 2 of 5	Numeric only barcodes, Older code not in common use

Coda bar	Numeric only barcodes, Older code often used in library systems, sometimes in blood banks
Plessey	Numeric only barcodes, Older code commonly used for retail shelf Marking
MSI	Numeric only barcodes ,Variation of the Plessey code commonly used in USA
PostNet	Numeric only barcodes, Used by U.S. Postal Service for automated mail sorting
Code 39	Alphanumeric barcodes, General purpose code in very wide use world-wide
Code 93	Alphanumeric barcodes, Compact code similar to Code 39
Code 128	Alphanumeric barcodes, Very capable code, excellent density, high reliability; in very wide use world-wide
LOGMARS	Alphanumeric barcodes ,Same as Code 39, this is the U.S. Government specification
PDF417	Two-Dimensional barcodes, Excellent for encoding large amounts of data
Data Matrix	Two Dimensional barcodes, Can hold large amounts of data, especially suited for making very small codes
Maxi code	Two Dimensional barcodes, Fixed length, used by United Parcel Service for automated package sorting
QR Code	Two Dimensional barcodes, Used for material control and order confirmation
Data Code	Two Dimensional barcodes
Code 49	Two Dimensional barcodes
16K	Two Dimensional barcodes

Table 2.Industry Standards for Barcodes and Labels [3]

Sr.No.	Industry Standards for Barcodes and Labels
1	Bookland EAN encodes ISBN numbers, used internationally to mark books
2	ISSN and the SISAC Barcode: International Standard Serial Numbering
3	OPC: Optical Industry Association barcode for marking retail optical products
4	UCC/EAN-128: Widely used data formatting model for Code 128
5	UPC Shipping Container Symbol: ITF-14
6	Co-Operative labels: Located under software

### b. Library Computerization

- The Library uses LIBMAN software package [10], which is an integrated multi-user library management system that supports all in-house operations of the Library.
- Retrospective conversion of bibliographic records has been completed.
- Records of all the Library patrons have also been created in the LIBMAN package. The editing and updating activities are in progress.
- The LIBMAN package has been successfully implemented for the circulation activities, initially for faculty and staff. All faculty and staff members are being migrated to the new computerized circulation system. The package has also been implemented for Acquisition and Cataloguing activities. The data entry work for article indexing is in progress.
- The Library is implementing BAR-CODE based computerized circulation system.
- The Library is a part of the fibre optic-based campus-LAN.

### 3. SWOT Analysis

SWOT Analysis [11] is used to evaluate and analyze the Strengths, Weaknesses, Opportunities, and Threats based on utilization of Barcode technology in Dr.BATU Library. We have also adapted, In addition, SO strategies (use of the advantages – catch the opportunity), ST strategies (use of the advantages – avoid the

threat), WO strategies (improve the disadvantages – seize the opportunity), WT strategies (reduce the disadvantages – avoid the threat) [12][13]

#### A. Strengths

- Small tag size
- Negligible data entry error rate
- Low cost tags
- Low operating cost.
- Speedy check-in and check-out process, No queuing up at check out/check in counters, Save time of the borrower and the staff
- High speed data entry
- Ease of Use
- Supported by many suppliers
- Global standard present
- Reliable
- Reduces staff daily routine work
- Improves efficiency of the management - High costs of collections (inventory, localization etc.)
- Improves the relations between the borrowers and the staff
- Save labour cost
- Improves information availability
- Improves the image of the organization.
- Better for even Small business
- Bar-coding facilities stock verification of books and journals. Easy process for stock verification
- It is mature and proven Technology

#### B. Weaknesses

- Cost of Scanner, Printer and overhead due to cost tags per volume.
- Unlike RFID (Radio Frequency Identification), it has no theft detection function
- Scanning problems due to physically damaged label
- CCD Scanner problems
- Selecting the distance between the bar code and the CCD Scanner.
- Tallying borrower's signature every time at the circulation counter.
- Compare to successor technology like RFID, capabilities of the barcode are limited. The barcode is a "passive form" - that is, a visual contact between the product and scanner must be created in order for the code to be read. In the process, errors occur relatively often. RFID, on the other hand, is an "active format" that enables labelled products to be automatically identified and located.
- Defective labels always lead to wrong/no reading of data.
- Laminated barcode library identity card are required [26]
- Less capacity

#### C. Opportunities

- Prospect for development
- Extending library opening hours
- Implementation of this system in other departments of University e.g. student section, Account section.
- Starting new small Bookshop in the library.

#### D. Treats

- Loss of employee jobs
- Choose RFID or Barcode?

#### *E. Strengths- Opportunities (SO) strategy*

The strengths of Bar code technology are good reasons of why to implement it in library Management. This technology is easy to understand and implementation. Both the library's management efficiency and also the patron satisfaction can be improved by adopting this new technology. Barcode printer already purchased for the library system can be used for generating bar codes for other departments in the university e.g. student section, account section. This technology can be also be used for Regular identity cards of the students, staff and faculty. Due to bar code, stock verification in the library becomes easy. This method of stock verification can be applied to other academic departments as well as administrative departments in the university.

#### *F. Strengths and Threats (ST Strategy)*

Through barcode technology offers many strengths, RFID is an advanced technology compared to bar code. But Cost of Barcode tags and cost of hardware readers are very much less than RFID technology. Barcode technology is comparatively very inexpensive and application for small business also. It is true that barcode based library system requires less human power. Therefore it is possible to increase Library timing and patrons may use library even on holidays. Patrons may take maximum advantages of library. Librarians spend more time helping customers and less time hefting volumes.

#### *G. Weaknesses and Opportunities (WO Strategy)*

There is scanning problems due to physically damaged label. Defective labels always lead to wrong/no reading of data. There may be hardware problem like CCD Scanner problems. Capacity of barcode may be less. Due to the rapid growth of the industry these issues shouldn't be difficult to solve. New possible Bar code applications are continuously discovered. If required the capacity of the barcode can be increased by using colour barcode etc. There may be overhead cost due to tags and scanner, printer but same printers can be used to generate bar code tags for stocks in other departments also. A small bookshop can be stated in the library to increase revenue.

#### *H. Weaknesses and Threats (WT Strategy)*

It seems that there are two issues with Barcode technology 1. Some limitations, some Imperfections of the Bar code technology.

2. The Strong competition.

These challenges can also be seen as opportunities to further progress and reduce the weaknesses of barcode technology. Because of these issues, in order for a library to gain real benefits from using bar code it needs to consider various factors before investing in it.

## **4. Application**

Following hardware and software are required of Barcode Technology implementation:

- (1) Personal computers
- (2) Barcode Scanner
- (3) Barcode Printer
- (4) Printing Software
- (5) Communication Software;
- (6) Database of Library Holdings;
- (7) Library Software
- (8) Membership Database [14] [15][16]

There is high error rate associated with manually storing and entering data into computer using traditional keyboard based method. According to one study, this error rate is 1 error per 300 characters. Barcode data entry has an error rate of about 1 in 3 million. Barcode is a better data processing and mining tools [17][20].Cost of RFID Tag, RFID readers and implementation of RFID is more than that of Barcodes, so we preferred Barcode technology. The price of a barcode based library management system is very less than RFID based library management system. [11]Bar code system is implemented in 3 phases in the library. Training to library staff about usage of bar code system, process of borrowing and returning of books cataloguing, classification and bar-coding is conducted first. Bar code system is very simple so staff learned and understood the system very easily.

Phase 1: design and issuing bar coded Library card to the students and staff.

Phase 2: Bar coding of all existing books department wise. Each item, used for circulation, has been labelled with a barcode tag. In the process of converting to Barcode, libraries typically get an immediate benefit from the recovery of misplaced books—often hundreds of them—that were thought to be lost. Printing barcode labels and pasting in three places of each book viz. Title page, Secrete page and due date slip were entrusted. This generating of Bar-coding labels and pasting the labels for all 33,553 volumes were completed within five months.

Phase 3: Bar coding on already issued books especially to the faculty members and reissuing.

When a new journal or book arrives to the library it required to be tagged with a barcode.

Bar code readers are very simple to connect. A barcode reader (or barcode scanner) is an electronic device for reading printed barcodes. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating optical impulses into electrical ones. Additionally, nearly all barcode readers contain decoder circuitry analysing the barcode's image data provided by the sensor and sending the barcode's content to the scanner's output port [2]. Per unit price of Bar Code Scanner Hand Held with USB Interface type is Rs.5000. Scan rate & decode rate of the bar code scanner is 200 per second. This scanner is compatible with Symbology UPC-A / UPC-E, EAN-8 / EAN-13, JAN-8 / JAN-13, CODE-39, CODE-128, CODABAR, ADD-ON-2, ADD-ON-5, CODE-93. Industrial codec is Interleaved 2 of 5. Price of Bar Code Printer is nearly Rs.20, 000. When a book is issued to or received from a member the circulation counter staff scans the bar coded membership number from member's ID card to check if he is exceeding the issue/any book(s) are overdue/restricted access to certain books etc. Then staff scans the bar code number from the book. The transaction completes and the book gets issued to the member automatically and the transaction gets updated simultaneously in the database. With the bar coding technology, the operational time decreased to nearly 50% for the whole operations.

### 5. Survey Statistics And Cross-Case Analysis

We also conducted a survey focuses on the library service to understand the values added by this system in the library management system. The research question is: Does the application of Barcode technology increase the patron's satisfaction level of availing the services of the library compare to a library system based on traditional approach? . Are they satisfied with the library automation currently used?

The University has a conducted institute of its own, "Institute of Petrochemical Engineering (IOPE)", running Diploma Courses in eight streams of engineering and technology. This institute is also having huge library with nearly 20,000 books. The IOPE Library does not use the barcode technology which is selected to compare with DBATU library. A small quantitative survey questionnaire has been conducted with 200 random respondents, 100 respondents from DBATU library users and 100 from IOPE library users. The survey uses the convenience sampling method to gather the quantitative data. Users filled out a background information sheet and a seven-question survey. Survey questions have to be carefully considered so that the results will provide meaningful data. Questions must be Clear– Unambiguous. it is important to ensure that the respondents know the answer and are able to answer it and are willing to answer accurately.[18][19]The data was then analysed by a cross-case analysis to reveal the facts. Measuring patrons' satisfaction of using the library is the core of this survey, and the measuring result would be the answer to the research question.

Table 3.Respondent data

<b>Respondents</b>		<b>DBATU</b>	<b>IOPE</b>
<b>Library Staff</b>		5	5
<b>Faculty</b>		10	10
<b>Female %</b>		38%	32%
<b>Students</b>	<b>Daily Visitors</b>	44	36
	<b>Weekly Visitors</b>	29	34
	<b>Monthly Visitors</b>	12	15
	<b>Total</b>	85	85

The Survey conducted during 11th January 2012 to 15th January 2012. Table III shows Respondent data. The Result of the survey is shown in Table IV, Figure 3, Figure 4 and Figure 5. Grades (Excellent, Good and Bad) are calculated based on answers given by respondents and their level of satisfaction for library serving quality. The result shows (Figure 3 and 4) the clear differences of the satisfaction level in two libraries, and it is clear (Figure 5) that the daily visitors in DBATU Library have higher satisfaction than in IOPE Library.

### 6. Conclusions

The Barcode Technology being more intelligent library management technology offers considerable advantages in library management compare to traditional keyboard system. Barcode technology not only plays a vital role in systematizing the tasks of the library (especially issue and returns i.e. circulation) but also increases patron’s satisfaction level. Implementation of bar code technology in Dr.BATU Library is tool to minimize the time taken at the circulation counter in charging/discharging the reading material. The time save in the operations can be utilized for developing additional/advanced skills. It is used for its speed, accuracy and reliability. Its use increases the rapidity and accurateness in library circulation processes. Barcode supports the speedy operations, minimizes errors, accurate record retrieval. Barcode technology will improved the image of the library among the users and develop a positive attitude towards the library. The cost of barcode technology is much cheaper than other competitors like RFID technology therefore it is very much useful for small business.

Table 4.Satisfaction for library serving quality

Respondents	Library	Excellent	Good	Bad	No Comments
Library Staff	IOPE	3	2	0	0
	DBATU	4	1	0	0
Faculty	IOPE	6	2	2	0
	DBATU	7	3	0	0
Daily Visitors (students)	IOPE	5	15	14	2
	DBATU	39	5	0	0
Weekly Visitors (students)	IOPE	11	13	10	0
	DBATU	9	10	10	0
Monthly Visitors (students)	IOPE	6	7	1	1
	DBATU	5	5	2	0

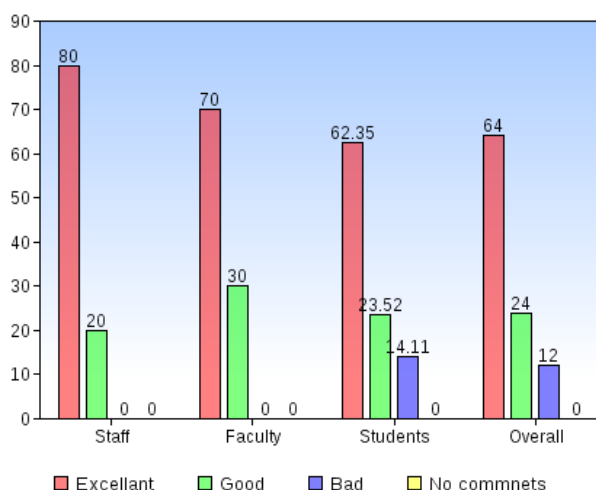


Fig. 3 Result of the Survey: Satisfaction for library serving quality case of Bar code based DBATU Library (In percentage)

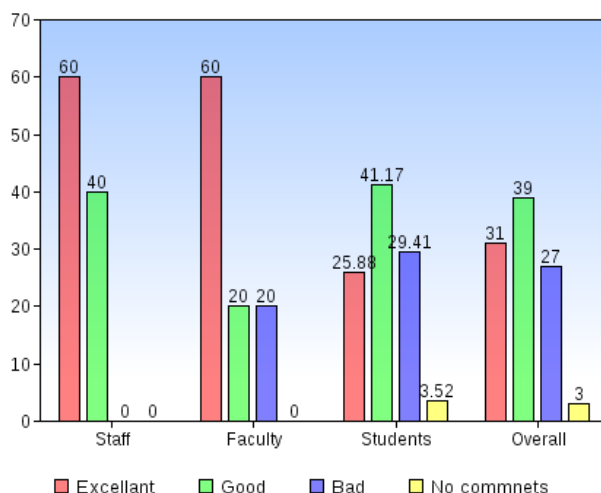


Fig. 4 Result of the Survey: Satisfaction for library serving quality case of Non Bar code based IOPE Library (In percentage)

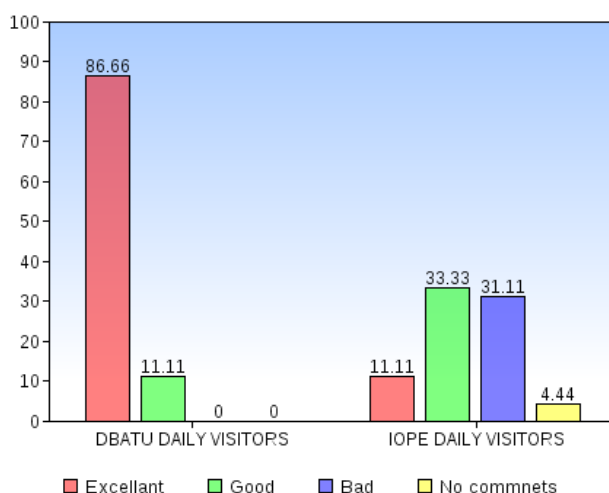


Fig. 5 Result of the Survey: Daily student visitors’ Satisfaction for library serving quality (DBATU vs. IOPE) (In percentage)

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