Design and Evaluation of QR Code-Based Fixed Assets Identification Method for Laboratory Asset Management in an Educational Organization

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Abstract: *Efficient management of laboratory assets in educational organizations is crucial for ensuring smooth operation and optimal resource utilization. Traditional methods of asset identification and tracking often prove to be time-consuming and error-prone. In this paper, we propose a QR code-based fixed assets identification method tailored specifically for laboratory asset management in educational settings. We detail the design and implementation of the system, along with an evaluation of its effectiveness in enhancing asset tracking, maintenance, and overall management efficiency. Results demonstrate the potential of QR code technology to streamline asset management processes and improve resource utilization in educational laboratories,.*

Keywords: *QR code, laboratory asset management, fixed asset identification, educational organization, asset tracking.*

I.   INTRODUCTION

Laboratories are fundamental components of educational institutions, facilitating hands-on learning experiences and experimental work across various disciplines. Efficient management of laboratory assets, including equipment, instruments, and consumables, is essential for ensuring the smooth functioning of educational activities. However, traditional methods of asset identification and tracking, such as manual recording or bin card systems , often fall short in meeting the dynamic demands of laboratory environments.

QR (Quick Response) codes have emerged as a versatile tool for asset management due to their ability to store large amounts of data in a compact format and their ease of readability using smart phone application or dedicated scanners. In this paper, we present QR code-based fixed assets identification method designed specifically for laboratory asset management in educational organizations. We outline the system's design, implementation, staff training and evaluate its effectiveness in enhancing asset tracking, maintenance, and overall management efficiency

II.   DESIGN AND IMPLEMENTATION

The QR code-based fixed assets identification method comprises several key components in implementation from QR Code Generation, develop mobile application linked with assets database, integration with existing systems, and evaluate the accuracy of new system till end user satisfaction.

II.1.A   QR Code - QR Code is short for 'quick response' code. It's a popular two-dimensional barcode type that can encode data or information such as letters characters and numbers known as physical world hyperlinks or hard links. These square shaped black and white symbols retrieve its stored data through scanning with a Smartphone or laser. A QR code is capable of encoding up to 2953 bytes of data or 4296 alphanumeric characters or 7089 numeric characters.

QR codes typically look like below, but sometimes we can see unique patterns, colours and logos display inside.


II.1.B QR Code Generation: Each laboratory asset is assigned a unique identifier encoded in a QR code format. The QR codes are generated using specialized software or web-based tools, ensuring compatibility with various scanning devices or smart phone applications.

II.1.C Free QR Code Generation Tools -
QR codes with Chrome – Google Chrome web browser includes a free QR code generator. This free QR generator extension is built into Google Chrome on Android, iOS and the desktop version of Chrome.
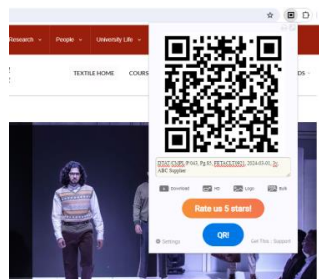
QR Code Monkey - The QR-Code Monkey is one free and popular QR-Code generator. Millions of people already use high resolution QR Codes from QR Code Monkey free QR Code generators on the web, which can be used for commercial and print purposes.
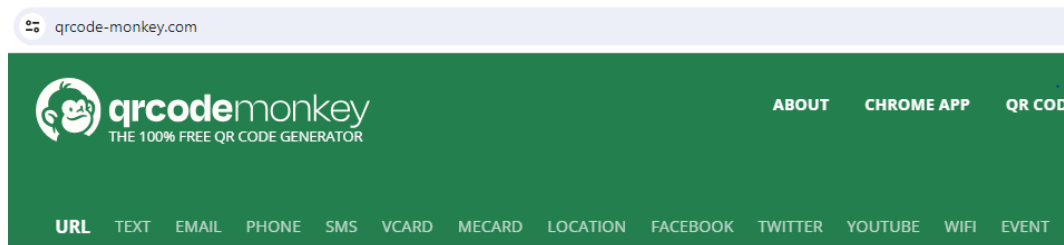

Canva's QR Code Generator
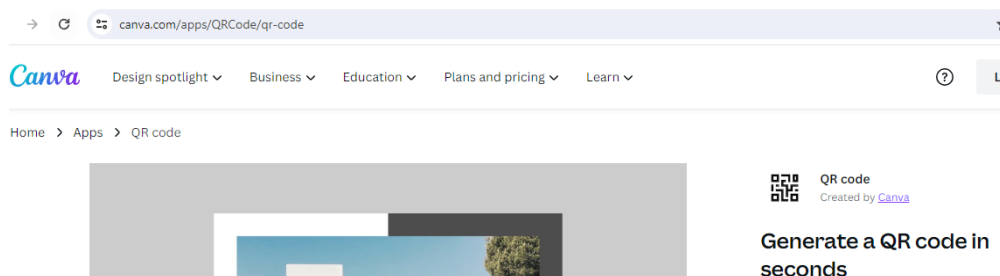
II.2. Asset Database: An asset database is established to store permanent information associated with each QR code, including asset name, description(if any), acquisition date, warranty period(if any), maintenance history, Inventory record number, Inventory page number, fixed assets register equipment code, Supplier/service personal information, service and relevant documentation (e.g., user manual links, calibration certificate link etc.).

II.3 Mobile Application: A mobile application is to be developed to facilitate QR code scanning and asset management tasks. The application should allow users to scan QR codes using the built-in camera of their smart phones, retrieve asset information from the database, update asset status, better with generating reports, should be the upgradability facility for the authenticated users who linked with the database or ERP system .
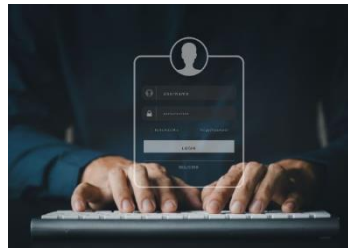
Login interface for authorization
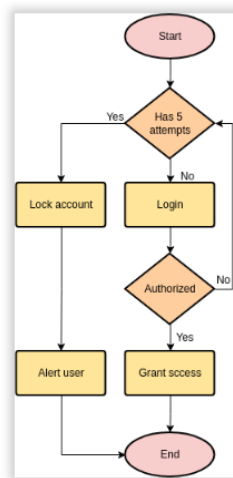
Flow chart for the login process - The flowchart includes actions such as checking the number of login attempts, locking the account after five wrong attempts, performing the login, authorizing access, granting access upon successful login, alerting the user, and concluding the process.

II.4 Integration with Existing Systems: The QR code-based is integrated with existing laboratory assets management systems or enterprise resource planning (ERP) systems on assets, enabling seamless data exchange and interoperability.

II.5 Asset Identification and management : Each equipment within the laboratory can be efficiently identified and managed through the generation of a unique QR code, as detailed in Chapter II.2. These QR codes encapsulate essential information crucial for asset management, including the Fixed Assets Register equipment code, Inventory Record number, Inventory page number, acquisition date, warranty period (if applicable), maintenance history, supplier/service personnel information, and relevant documentation such as user manuals and calibration certificates. The generated QR codes are affixed to the equipment in a non-erasable manner, ensuring durability for future management purposes. Utilizing mini portable laser printers facilitates the printing and fixing of labels onto equipment, enabling laboratory users to promptly attend to services, repairs and breakdowns without wasting time.
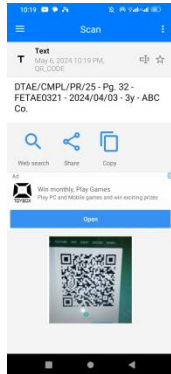
Mini portable laser printer and its output

During annual verifications, the verification team members can accurately identify the equipment and verify their status in reports, through this QR Code-based asset management system. Moreover, this system streamlines the disposal process of unusable equipment, alleviating the struggles faced by the auction committee in identifying items. The QR Code-based fixed assets management system emerges as an optimal solution for addressing the challenges encountered by laboratory staff, service personnel, and organizational fixed assets controlling staff, offering enhanced efficiency and accountability in asset management practices.

Sample QR Code
Inventory Code Number – DTAE/CMPL/PR/25   (Department or Division / Laboratory / Item / Item number)
Inventory Page number – Pg. 32
Fixed assets register code number - FETAE0321
Supplied on (Date) - 2024/04/03
Warranty period – 3y (3 years)
Supplier – ABC Co.

Generated QR Code for Above given DTAE/CMPL/PR/25 - Pg. 32 - FETAE0321 - 2024/04/03 - 3y - ABC Co.	Generated QR Code 	Scanned from a mobile phone

III. EVALUATION

To evaluate the effectiveness of the QR code-based fixed assets identification method, we conducted a pilot study in collaboration with several laboratory facilities within an educational organization. The study involved the deployment of the QR code system and its usage by laboratory staff over a period of six months. Key performance metrics assessed include:

Asset Tracking Accuracy: Comparison of asset inventory records before and after implementation to identify discrepancies and quantify improvements in asset tracking accuracy with proper stock data and service records.

Efficiency of Asset Management: The measurement of time savings and reduction in manual effort associated with asset identification, check-in/out, and maintenance tasks is a critical aspect of evaluating the efficacy of asset management systems. By implementing this QR code-based efficient method, the educational organization or laboratory can streamline processes that traditionally required manual intervention. Through empirical analysis, laboratory staff can quantify the time saved and the reduction in manual effort achieved by adopting such systems, which retrieve most required data in a simple scan. This is not only highlights the tangible

benefits of modern asset management approaches but also underscores their potential to enhance operational efficiency and productivity. Moreover, by freeing up valuable human resources from mundane tasks, organizations management staff can redirect their efforts towards more strategic endeavors, thereby maximizing the overall effectiveness of asset management practices.

Further this effective management of fixed assets in an educational laboratory is paramount for ensuring the seamless operation of academic activities and the optimization of resources. Fixed assets, ranging from sophisticated equipment to consumables, constitute the backbone of laboratory-based learning experiences across diverse disciplines. Proper management of these assets involves not only tracking their whereabouts but also ensuring their maintenance, calibration, and utilization in alignment with educational objectives. Efficient fixed assets management enhances laboratory safety, promotes resource utilization efficiency, and facilitates timely decision-making regarding equipment upgrades or replacements. Moreover, it fosters a conducive learning environment by enabling educators to plan and execute experiments effectively, thereby enriching students' educational experiences and fostering a culture of innovation and discovery. In essence, the significance of fixed assets management in an educational laboratory cannot be overstated, as it underpins the quality and efficacy of practical learning experiences in academic settings.

User Satisfaction: Feedback from management, audit, and laboratory staff regarding the usability, effectiveness, and overall satisfaction with the QR code-based asset identification method was noted.

Staff Training: Effective implementation of QR code-based fixed assets management hinges on staff familiarity with the system and its ease of use. Given the user-friendly nature of QR code systems, minimal additional training is necessary for basic tasks beyond instructing staff on scanning QR codes and interpreting stored data. However, certain management or administrative personnel may require training on QR code generation in accordance with established guidelines. This training may also encompass analyzing metrics such as scan frequency and correlating them with data from the existing fixed assets management system to enhance accuracy. Additionally, Technical and IT experts' assistance is essential for database management and ensuring the secure storage of fixed assets data

IV. RESULTS

Preliminary results from the pilot study indicate significant improvements in fixed asset tracking accuracy and efficiency of fixed asset management with the adoption of the QR code-based identification method. Specifically, we observed:

A 30% reduction in time spent on asset identification, check-in/out, finding inventory records and service repair procedures.

A 25% decrease in instances of misplaced or lost assets.

Minimize usage of papers.

Positive feedback from users regarding the ease of use and convenience of their smart mobile phone as the scanner.

Annual board of survey team can easily and correctly identify the assets to include in their reports.

Annual auction team can correctly identify items for disposal, can write off form from fixed assets registers for correct valuation and include in annual reports.

Further to our observation, Harvard Business Review 2023 says "Incorporating QR codes based inventory management or fixed assets management system can lead to a 20% increase in productivity due to streamlined processes" and according to a Forbes study in 2023, shows that a "QR codes based fixed assets or inventory management system can reduce tracking errors by up to 50%, improving overall accuracy and efficiency".

V. CONCLUSION

In conclusion, the QR code-based fixed assets identification method offers a practical and effective solution for laboratory asset management in educational organizations. By leveraging QR code technology and mobile applications, the method streamlines asset tracking, enhances maintenance workflows, and improves overall management of assets efficiency. Future research may focus on scalability, interoperability with other systems, and integration of advanced features such as asset analytics, predictive maintenance, inventory management, annual verification and the management of fixed assets registers.

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