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ENHANCING CONTAINER LOADING EFFICIENCY WITH A MOBILE BARCODE SCANNING APPLICATION

Muhammad Hafizzuddin Md Teni[1]* and Nurul Nasmurni Azhar[1]

[1]*Mechanical Engineering Department, Politeknik Ungku Omar, Ipoh, Malaysia*
*mhafizzuddin33@gmail.com

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ABSTRACT

Recent advancements in microprocessor technology have significantly enhanced the capabilities of mobile phones, enabling them to perform functions once limited to personal computers. This paper presents the design and implementation of a mobile application developed using the Scan It-Office platform, aimed at improving the container loading process through barcode-based automation. The application integrates barcode scanning functionality using the smartphone's built-in camera, eliminating the need for dedicated scanning hardware. By capturing and decoding barcode information directly from containers, the system enables real-time identification and tracking, reducing manual data entry and minimizing errors. The methodology involved developing the mobile application with barcode decoding features using Scan It-Office, followed by field testing across multiple container loading operations. Time taken for loading using the manual method (by workers) was compared with the mobile barcode scanner system across nine containers. Each test recorded the number of items processed, the time spent and calculated the efficiency gains. Results showed that the mobile system consistently reduced container loading time by 75% to 90%, demonstrating its reliability, speed, and effectiveness as a practical logistics solution.

1. Introduction

The efficient management of goods during loading and transportation is a critical aspect of modern logistics. One technology that has significantly enhanced this process is the use of barcode scanners for container loading. Barcode scanning is a widely adopted method that enables faster, more accurate, and more efficient operations by automating the identification and tracking of individual items. A barcode is a visual representation of data consisting of bars and spaces of varying widths, which may contain numbers, letters, and symbols. Barcodes allow for rapid data input into computers (Sangkharat 2021). In the container loading process, each item is assigned a unique barcode label. As the items are loaded, the barcode scanner reads the label, updates the inventory system in real time, and verifies that the correct item is placed in the correct container. This information should be stored in computers in order to count company sales and purchase amounts separately scanning device its makes the system generates a signal that is processed in the computer (Rahman 2017). To authenticate the

certificate, individuals can scan QR Code using a designated smartphone application (Singhal 2015). This approach reduces human error, improves operational accuracy, and streamlines workflow.

Various barcode formats are used across industries, including Code 128, Code 39, and EAN, each designed to store information efficiently in a compact space. Barcode scanners whether laser-based or camera-based rapidly read these codes and transmit the information to a computer system for processing. This enables fast, consistent, and reliable data entry, reducing manual labour and improving productivity in sectors such as retail, manufacturing, and warehousing. According to Firas (2015), it not only simplifies the billing system, but it also allows us to sending billing information to customers' mobile phones and automatically detecting amounts from their interlinked bank account.

In other journal, barcode scanners have revolutionized the way businesses operate, particularly in industries such as healthcare and hospitality. By using barcode scanners, businesses can increase efficiency and accuracy while reducing costs and errors. That identify of patients about their specimens and laboratory test results that connect to them is efficient in all healthcare hospitality. That focus on reduction of medical errors (Syahrul 2008). Each barcode type has unique technical specifications, such as bar thickness, encoding methods, and data formats. Categories include numeric-only barcodes, alphanumeric barcodes, two-dimensional (2D) barcodes, and industry-standard label formats. In advanced applications, image processing techniques such as thresholding are employed to enhance barcode readability, even in low-light or challenging visual conditions.

The integration of barcode scanning into container loading offers multiple advantages, including increased accuracy, faster processing times, and improved inventory control. Moreover, it supports more effective planning and management of logistics operations, contributing to higher overall efficiency in goods transportation. Holding inventory incurs various expenses such as the cost of using the capital that could have been invested elsewhere, expenses associated with managing the warehouse, insurance and taxes, and the risk of spoilage (Abudullah 2017). As global trade and supply chain demands continue to grow, barcode-based systems present a practical, reliable, and scalable solution for modern logistics challenges.

Through issue analysis in Company ABC, it was identified that workers often spent more than thirty minutes counting goods, with one or two workers sometimes required to verify the accuracy of customer orders. This inefficiency extends the time needed to manage customer orders during the container loading process, which involves multiple stages such as receiving, putting away, order picking, and shipping. The extended handling time contributes to stock inaccuracy, where items may be lost, misplaced, or miscounted during loading. Such inaccuracies can lead to financial losses, particularly in terms of safety stock that has already been produced but is either unaccounted for or incorrectly recorded. The objectives of this project is to:

1. To study the delivery processes of finish goods in warehouse.
2. To develop a record system of finish goods delivery by using “Scan IT-Office” application.

3. To calculate the efficiency of the implementation "Scan It Office" system to protect all the goods in the warehouse department.

2. Methodology

In this research, the primary data sources are informants with relevant expertise and knowledge regarding finished goods in the warehouse. The objective of the research is to examine the implementation of a smartphone-based barcode scanner for managing finished goods, with the aim of improving warehouse efficiency. Accordingly, the required information is obtained from warehouse personnel, particularly those with direct experience in operating and managing the warehouse management system (WMS) show in Figure 1.

Figure 1. Example barcode finish good

2.1 Theoretical framework

The process flow for the proposed system is illustrated in Figure 2. The system begins with the input stage, where each item is assigned a unique barcode number. This barcode serves as the primary identifier for the goods. In the process stage, the barcode of each part number is scanned using a smartphone equipped with a barcode scanning application. This allows for efficient and accurate identification of goods without manual entry. The captured data is then processed in real time to match the scanned items with inventory records. Finally, in the output stage, the system automatically counts the total quantity of goods based on the scanned barcodes. This automated counting process reduces human error, improves stock accuracy, and enhances overall warehouse efficiency.

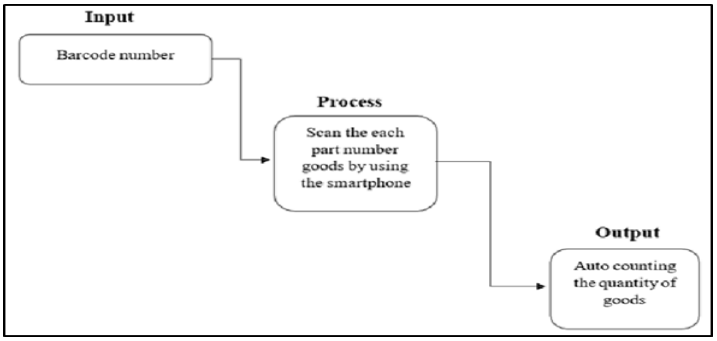

Figure 2. Theoretical framework

2.2 Implementation of Barcode

Before implementing a mobile barcode scanner for container loading to achieve the first objective, it was necessary to study the delivery process of finished goods in the warehouse. The initial step involved defining the job scope and understanding the roles of each warehouse staff member in the delivery process. This was followed by mapping the entire delivery workflow—from preparing finished goods in the staging area to loading them into the container. By documenting the complete process, potential issues could be identified. The person in charge then collected and analysed key performance metrics, such as loading times, to establish a baseline for comparison after the barcode scanner implementation. Subsequently, discussions and briefings were conducted with warehouse staff to explain the technology and its intended benefits. Once the objectives were clearly defined, specific requirements for the barcode scanners such as barcode compatibility and data capture capabilities were determined.

To achieve the second objective, the Scan It-Office application was installed on mobile devices designated for the container loading process. The person in charge ensured that the devices were compatible with the application and equipped with necessary hardware, such as built-in cameras for scanning barcodes. An Excel sheet was prepared containing part names, part numbers, and container numbers, with all entries aligned to the correct details. Before scanning, finished goods were organised according to customer orders. During the delivery process, the application was used to scan the barcode labels on each item, and the captured data was automatically generated into the system sheet.

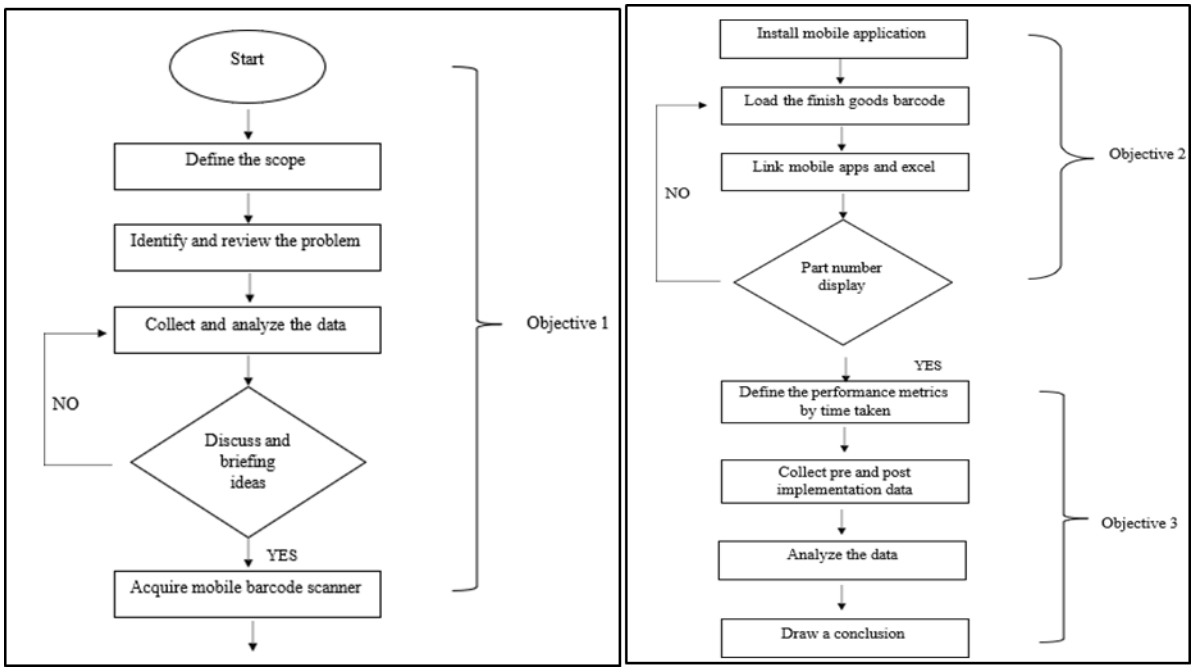

Figure 3. Flow chart of implementation system barcode

For the third objective, system performance was evaluated by measuring efficiency gains, particularly in terms of time savings. Time reductions were recorded for activities such as inventory checks and stock replenishment. The data collected before and after implementation

was compared to determine changes in operational metrics. This analysis assessed improvements in inventory accuracy, reduction of goods handling errors, and overall time efficiency. Patterns and trends indicating the system's effectiveness were identified, enabling a conclusion to be drawn regarding the impact of the Scan It-Office system on warehouse operations.

2.3 Workflow of the Scan It-Office Application

Figure 4 illustrates the workflow for implementing the Scan It-Office application in the container loading process. The procedure begins with installing the application on a compatible mobile device, followed by launching the application to prepare it for use. An Excel sheet is then created containing essential details such as part names, part numbers, and container numbers. In parallel, the Scan It-Office application is configured to link the scanned data directly to the Excel sheet. During the operational phase, finished goods are scanned using the mobile device's camera to capture the barcode information. The application processes this data in real time and automatically generates the results, which are displayed for verification. This workflow ensures accurate identification, automated data entry, and efficient tracking of goods during the container loading process, thereby improving operational efficiency and reducing manual errors.

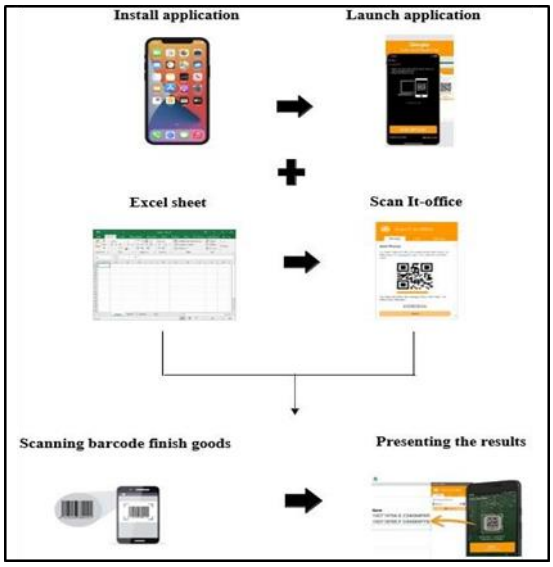

Figure 4. Workflow for implementing the Scan It-Office application

2.4 Developing the Data Entry Spreadsheet in Excel

The process begins by opening Microsoft Excel and creating a new spreadsheet or accessing an existing file. Before data entry, it is essential to ensure that the information to be input is in a format compatible with Excel. The next step involves identifying and preparing the specific cells where the data will be entered, including setting up any required formulas to support automated calculations. If necessary, the spreadsheet is formatted to enhance clarity and usability, which may involve adjusting cell formatting, adding column or row headers, or

applying relevant functions and formulas. Once all data has been entered and appropriately formatted, the Excel file is saved to ensure data preservation and accessibility for subsequent use.

2.5 Process input data into Excel spreadsheet

The procedure begins by launching Microsoft Excel and ensuring that the data to be entered is in a format compatible with the software. The Scan-IT to Office add-in is then installed within Excel to enable barcode data integration. On a mobile device, the Scan-IT to Office application is downloaded from the Google Play Store or Apple App Store and installed. The application is launched, and the barcode displayed on the computer screen is scanned using the smartphone to establish a connection between the device and Excel. Once connected, the system verifies whether the part number is displayed on the Excel sheet as in Figure 5. If the part number does not appear, the connection is re-checked, and the barcode is scanned again to ensure proper linkage. Upon successful connection, the scanned barcode is displayed on both the computer and mobile device, and the system automatically records and counts the goods in real time.

Figure 5. Excel sheet of Scan It-Office

2.6 Distance and Device Requirements for Effective Barcode Scanning

To minimise the risk of incorrect scans, the system employed a phase-based method to determine the distance between the scanner and the goods. Time-of-flight technology was used to focus on the barcode and detect the reflected signal upon its return to the sensor. QR codes were found to provide optimal results when scanned from short distances. However, certain devices, such as smartphones, required the barcode to be at least 6.25 cm² for accurate detection. This size requirement was an important consideration in selecting the appropriate scanning technology. For close-range scanning, an optimal distance of 3 to 12 inches was recommended to achieve reliable performance as in Figure 6. Ultimately, the choice of barcode type and scanner specifications played a critical role in obtaining the best results. In cases where smooth, consistent scanning was required, smartphone-based scanners were identified as a suitable and effective option.

Figure 6. Barcode images captured

3. Results and Discussion

The mobile barcode scanner system began with clear benefits, including improved efficiency and faster morning inventory counts. Users only needed to scan a barcode, and the system automatically updated the data and counted the items in real time. Once the final planning was completed, the new system was delivered and installed according to the prepared layout. Following installation, the system was updated as part of the last phase of the project plan. This implementation addressed the ongoing operational challenges faced by the logistics department and provided a more accurate, efficient, and streamlined process for managing goods.

The Table 1 presents a comparative analysis of the time taken by manual workers and scanners to process various quantities of items across multiple containers, labeled J467 to J477. For each container, both the number of items and the time required by workers and scanners are recorded, along with the absolute and percentage differences in time. The data clearly shows that scanners consistently outperform manual workers in terms of processing speed. For instance, while a worker takes 40 minutes to process 212 items in container J467, a scanner completes the same task in only 30 minutes. Similarly, for containers with larger volumes, such as J471 and J472 (both over 270 items), the scanner still reduces processing time by 10 minutes. The percentage differences, calculated by comparing the time saved relative to the scanner time, range from 75% to as high as 90%, indicating significant efficiency gains.

Table 1. Time taken by manual workers and scanners

No Container	Item (pcs)	Time taken (min)		Differences (min)	% Differences
		Worker	Scanner		
J467	212	40.00	30.00	10.00	75.00%
J468	224	50.00	45.00	5.00	90.00%
J471	288	65.00	55.00	10.00	84.62%
J472	276	65.00	55.00	10.00	84.62%
J473	376	80.00	60.00	20.00	75.00%
J474	284	60.00	50.00	10.00	83.33%
J475	42	13.00	10.00	3.00	76.92%
J476	44	20.00	15.00	5.00	75.00%
J477	53	25.00	20.00	5.00	80.00%

These consistent reductions in processing time highlight the advantages of using scanners, especially in high-volume environments. Overall, the data supports the conclusion that scanner-

based systems can significantly enhance operational efficiency, reduce manual labor time, and improve productivity in item handling processes.

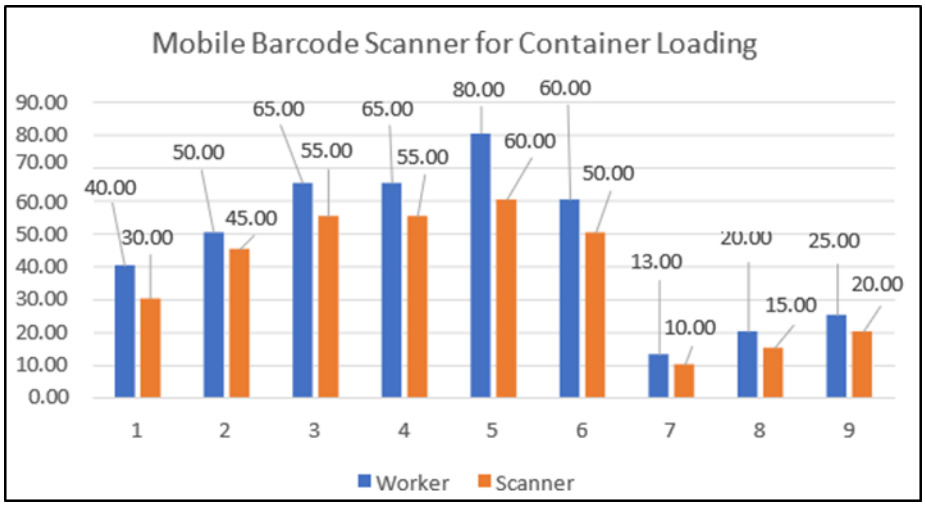

Figure 7. Comparison between the time taken by manual workers and mobile barcode scanners

Parameter	Before	After
Time	More time is needed for user to update stock information into the sheet	Stock information can be updated in real-time condition
Miss stock data	There are many possibilities for missed stock data on paperwork writing	Data will be passed through scanner, there is no possibility for missed data input
Labour cost	More personnel are needed to support shipment activity	It can reduce personnel to support shipment activity by improving some business processes and data entry activity
Data checking	Data checking that related to product part number and part name is needed to be checked manually by user	System automatically counts when user scans the barcode
Corporate image	Some claims relates to missed product shipment can affect corporate image. Corporate is highly committed to on time delivery and to meet order specification with high quality products.	By using barcodes system, claims related is missed product shipment could be avoided.

Figure 8. Summaries improvement before and after implementation

The bar chart in Figure 7 illustrates a visual comparison between the time taken by manual workers and mobile barcode scanners to load items across nine different container instances. Each pair of bars represents the time (in minutes) required by a worker (blue) and a scanner (orange) for a specific container. It is evident from the chart that in all cases, the scanners consistently complete the loading tasks faster than the manual workers.

For example, in container J473, the worker takes the maximum recorded time of 80 minutes, while the scanner completes the same task in just 60 minutes. Similar patterns are observed

across all other containers, such as container 1 (worker: 40 min, scanner: 30 min) and container 3 (worker: 65 min, scanner: 55 min), showing a clear time advantage with the use of scanners. This consistent reduction in time across varying workloads suggests that mobile barcode scanners significantly enhance efficiency in container loading operations. The visual data reinforces the conclusion that adopting scanner technology can reduce labour-intensive processes, speed up loading times, and contribute to more streamlined and cost-effective logistics and warehouse operations. The summaries can be concluded in Figure 8.

4. Conclusion

In conclusion, utilizing a mobile barcode scanner with Scan It-Office for container loading can significantly enhance efficiency, accuracy and data management in the process. This ensures that the mobile barcode scanner is compatible with this system to enable seamless data transfer. This system has a fast and accurate scanning capabilities, capable of reading various types of barcodes commonly used in container loading operations. This makes easy for users to scan the barcodes with wireless connectivity options such as Bluetooth that providing flexibility and mobility during scanning without cables. This kind of project such an ergonomic and durable design, capable of withstanding the demands of the container loading environment. That also a user-friendly scanner with a clear display and intuitive operations to minimize training requirements and ensure efficient scanning. By considering these factors and making informed decisions when selecting a mobile barcode scanner for container loading with Scan It-Office. It can improve productivity, reduce errors and streamline the container loading operations. The combination of a robust scanning solution and efficient data management software enables accurate tracking, inventory control and reporting, leading to optimized logistics and improved customer satisfaction.

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