

QR CODE BASED PRODUCT VERIFICATION SYSTEM

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Abstract

The increase in counterfeit products has affected consumer trust and caused financial losses across industries. Traditional methods such as holograms and static barcodes can be copied and cannot identify whether a product has already been purchased.

The proposed **QR Code-Based Product Verification and Purchase System** is a secure web application that assigns a unique QR code to each product. The Admin registers products and generates QR codes, while Users scan the codes to verify product authenticity. Each product is initially marked as “**Unused**” and changes to “**Used**” after a successful purchase.

The system identifies products as genuine, already used, or counterfeit using a centralized database. This prevents duplicate purchases and provides fast and reliable product verification, helping reduce counterfeit products in the supply chain.

Key Words — *Product Authentication, QR Code Verification, Counterfeit Detection, Web Application, Real-Time Validation, Secure Purchase, Database Integrity, Supply Chain Security.*

I. INTRODUCTION

Counterfeit products have become a major problem in modern commerce, affecting industries such as electronics, cosmetics, pharmaceuticals, and fashion. They cause financial losses for manufacturers and can also expose consumers to poor quality or unsafe products. As supply chains have become more complex, checking whether a

product is genuine at the time of purchase has become more difficult with traditional authentication methods.

Common anti-counterfeiting methods, including holograms, tamper-evident seals, and embossed markings, provide limited protection because they can be reproduced by counterfeiters. Consumers also have no simple way to confirm whether these physical security features are genuine. Linear barcodes are mainly used for product identification and inventory management, but the same code is often assigned to multiple units of a product. This makes it easier for counterfeit products to use copied codes. Manual verification methods, such as entering a code on a website or sending it through SMS, can provide additional checking but may be inconvenient for users and can still be affected by misleading verification websites.

QR (Quick Response) codes provide a more convenient approach because they can be scanned using a smartphone and connected to a live database. Instead of storing only static product information, each QR code can be associated with a specific product record and its current status. By tracking whether a product has already been purchased, QR-based verification can be used not only to identify a product but also to verify its authenticity. The approach does not require specialised hardware and can be included as part of the purchasing process.

To address these limitations, a QR code-based product verification and purchase system is developed as a web platform that combines unique QR code generation, real-time database verification, and single-use purchase control. Manufacturers or sellers can register products, generate

product images using an AI image generation service, and create a unique QR code for each product. Customers can scan the QR code to check whether the product is genuine, already sold, or counterfeit. A purchase can be completed only when the product passes the verification process. This approach connects product authentication directly with the purchase process and provides an additional layer of protection against counterfeit and repeated use of product codes.

II. LITERATURE SURVEY

Product authentication has developed over time as new technologies have been introduced to overcome the limitations of earlier methods. Different approaches have been used to protect products from counterfeiting, but each method has its own limitations in terms of security, cost, and ease of use.

The early approaches to preventing counterfeiting mainly used physical security features such as holograms, security labels, and special printing techniques. These methods were effective when reproducing detailed physical features was difficult. However, improvements in printing and copying technologies have made such features easier to reproduce. In addition, checking these features may require experience or special equipment, which makes it difficult for ordinary consumers to verify a product at the time of purchase.

Linear barcode systems such as UPC and EAN are widely used for product identification, inventory management, and billing. However, they were not designed to provide product-level security. The same barcode is generally used for all units of a particular product, so it cannot identify an individual item. A counterfeit product can therefore carry a copied barcode without the system being able to distinguish it from the original.

Manual verification methods introduced unique alphanumeric codes that customers could enter on a brand website or send through SMS. This provided better identification because each product could have its own

code. However, entering long codes can be inconvenient and may lead to user errors. Some systems also do not maintain the usage status of a code, allowing the same genuine code to be used multiple times. Fake verification websites can create another problem by showing false confirmation messages to customers.

Centralized serial number databases improved product verification by recording information about individual product codes and their verification history. However, many such systems still depend on manual code entry or SMS-based verification, which can make the process slower and less convenient. Another limitation is that verification is often treated as a separate process from the actual purchase. As a result, confirming that a product is genuine does not necessarily prevent the same product code from being used in another transaction.

Recent approaches have also examined blockchain and IoT technologies for tracking products throughout the supply chain. Blockchain can provide a permanent record of product information, while IoT devices can collect and share data during different stages of product movement. Although these technologies provide useful features for traceability, their implementation can require additional infrastructure, technical knowledge, and investment. These requirements may make them difficult for small and medium-sized manufacturers to adopt.

The existing approaches show that product authentication has improved from basic physical security features to digital verification and supply chain tracking. However, there is still a need for a simple system that combines a unique identity for each product, real-time status checking, and purchase control. The proposed system addresses this need by using QR codes linked to a centralized database, allowing product verification and purchase to be handled within the same web platform.

III. PROBLEM STATEMENT

Consumers often do not have a quick and reliable way to check whether a product is genuine before making a

purchase. Physical security features such as holograms and security labels can be copied, while static barcodes cannot distinguish between individual products. Manual verification methods that require customers to enter codes on a website or send them through SMS can also be inconvenient and may not prevent the repeated use of the same code. Although some systems use centralized databases for product verification, they mainly confirm whether a product is genuine and are not connected to the purchase process. This creates a gap between product verification and the actual sale.

Manufacturers also need a simple and affordable way to register products, create unique product identifiers, and track the status of products in their inventory. Setting up complex infrastructure for this purpose may not be practical for every manufacturer or seller. Therefore, there is a need for a system that provides each product with a unique digital identity, allows customers to verify the product using a smartphone, and ensures that a verified product code cannot be reused for another purchase.

The proposed system addresses these issues by assigning a unique QR code to each registered product and storing its details in a centralized database. When a customer scans the QR code, the system checks the product information, current usage status, and authenticity before allowing the purchase. After a successful transaction, the product status is changed to "Used", preventing the same code from being used again. This approach connects product verification with the purchase process through a lightweight web application without requiring specialized hardware or manual code entry.

IV. EXISTING SYSTEM

Current product verification methods mainly use physical security features, barcodes, manual code verification, and centralized databases. Each method provides some level of protection, but none of them

fully addresses the challenges of modern counterfeit products. Traditional security methods use features such as holograms, tamper-proof seals, embossed markings, and special printing. These methods depend on making the product or packaging difficult to reproduce. However, holograms and other physical features can be copied, while tamper-proof seals mainly show whether the package has been opened and do not confirm whether the product itself is genuine. Special printing methods may also require specific tools or experience for verification, making them less convenient for regular customers.

Linear barcodes such as UPC and EAN are mainly used for inventory management and billing. The same barcode is normally assigned to all units of a particular product, so it cannot identify an individual item. As a result, a copied barcode can be placed on counterfeit products without providing a way to distinguish them from genuine products. These barcodes also cannot indicate whether a particular product has already been sold.

Manual code verification systems use unique codes printed on product packaging. Customers enter the code on a website or send it through an SMS service to check the product. Although this provides individual identification, entering long codes can be inconvenient and may result in errors. In addition, systems that do not record the usage status of a code may allow the same valid code to be used repeatedly.

Centralized serial number databases improve verification by storing product codes and their verification history. However, many such systems still depend on manual code entry and may provide verification through basic websites or SMS services. Customers may also be misled by fake websites that imitate the original verification service. Another major limitation is that product verification is usually separate from the purchase process. Therefore, even after a product is verified, the system may not prevent the same code from being used for another transaction.

V. LIMITATIONS OF EXISTING SYSTEM

The existing product authentication methods have several limitations that reduce their effectiveness in protecting consumers from counterfeit products.

Physical security features such as holograms, tamper-proof seals, and special markings are not always reliable because they can be reproduced by counterfeiters. In addition, checking these features may require specific knowledge or equipment, which is not practical for most consumers.

Linear barcodes contain the same information for all units of a particular product. Since they do not provide a unique identity for each item, copied barcodes cannot be easily detected. They also cannot be used to track whether an individual product has already been sold. Therefore, although linear barcodes are useful for inventory and billing, they provide limited protection against counterfeiting.

Manual code verification systems can provide unique identification for individual products, but they require customers to enter codes manually. Long codes can be difficult to enter correctly and may discourage customers from using the verification service. If the system does not maintain the usage status of each code, the same genuine code can be reused to verify multiple counterfeit products. Fake verification websites can also mislead customers by displaying false authentication results.

Centralized serial number databases provide better product tracking, but many systems still depend on manual entry, SMS services, or basic web forms. They may also be affected by fraudulent websites that imitate genuine verification services. Another important limitation is that product verification is usually separate from the purchase process. As a result, verifying a product does not always prevent the same code from being used again for another transaction.

Overall, existing solutions address different parts of product authentication but do not provide a simple system

that combines unique product identification, real-time verification, status tracking, and purchase control. These limitations create a need for a more convenient authentication system that can verify products and control their usage through a single web platform.

VI. PROPOSED SYSTEM

The proposed QR Code-Based Product Verification and Purchase System is a secure web application designed to improve product authentication and prevent the repeated use of product codes. The system focuses on four main aspects: assigning a unique identity to each product, verifying products in real time, preventing the reuse of verified codes, and connecting verification with the purchase process.

The system uses a three-tier client-server architecture consisting of the presentation layer, application layer, and data layer. The presentation layer is developed using React.js and provides separate interfaces for administrators and customers. The admin interface is used for product management, while the customer interface allows users to scan QR codes and purchase verified products. The application layer uses Node.js and Express.js to handle QR code generation, product verification, status updates, and communication with the external AI image generation service. MongoDB is used as the data layer to store product details, QR code information, image URLs, and the current status of each product.

In the Admin Module, an authorized administrator registers a product by providing details such as the product name, description, and price. The backend generates a product image using an external AI image generation service and creates a unique identifier for the product. The identifier is generated using the product's database ID along with a secure random value. This identifier is then converted into a QR code using a QR code generation library. The QR code is stored with the product details and the initial status is set to "Unused". The administrator can download the generated QR code and use it on the product packaging.

In the User Module, customers can scan the QR code using a smartphone or computer camera through a browser-based scanner. The scanned code is sent to the backend for verification. The system first checks whether the code exists in the database. If the code is not found, the product is identified as "Fake".

If the code exists, the system checks its current status. A product with a "Used" status is shown as "Already Used", while a product with an "Unused" status is considered "Valid". For a valid product, the system displays the product name, description, price, and image along with the option to proceed with the purchase.

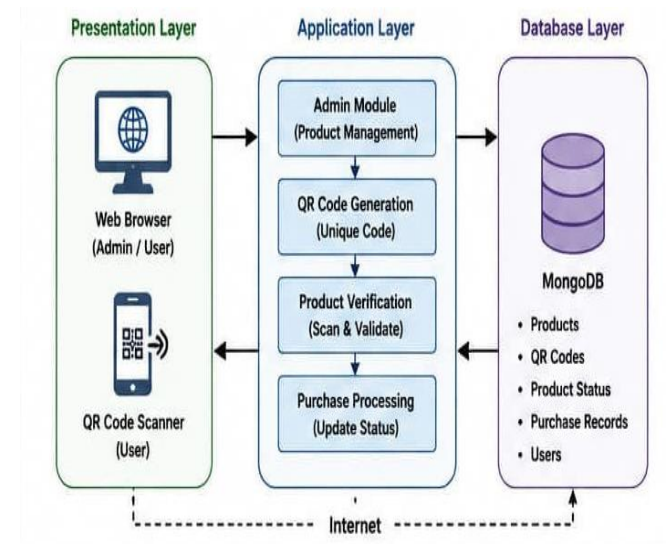
The Purchase Module is available only after successful product verification. When the customer confirms the purchase, the backend checks the product status again before completing the transaction. The status is then changed from "Unused" to "Used" as a single database operation.

This prevents the same QR code from being used for multiple purchases, even when more than one verification request occurs at nearly the same time. As a result, the system connects product verification with purchase control and provides better protection against duplicate use of product codes.

The system also records the **first successful purchase or verification**, helping to identify repeated or suspicious scans of the same product. If a QR code is scanned multiple times after purchase or from unauthorized sources, the system can display an appropriate warning to the user.

An admin module allows authorized manufacturers or administrators to register products, generate unique QR codes, update product information, and monitor verification activities.

VII. SYSTEM ARCHITECTURE



The overall workflow of the proposed system connects product registration, verification, and purchase in a simple sequence.

The process starts with the Admin Interface, where an authorized administrator enters the product details. The information is sent to the application layer, which performs two tasks. It generates the above image using the AI image generation service and creates a unique QR code using the product's database ID. The generated above image and QR code are then stored in the MongoDB database along with the product details. The initial product status is set to "Unused".

On the customer side, the QR Code Scanner Interface uses the device camera to scan and decode the printed QR code. The decoded value is sent to the Validation Engine, which checks the product details in the database. The system performs three checks: whether the code exists, whether it has already been used, and whether the product is valid. Based on these checks, the system returns one of three results: "Fake", "Already Used", or "Valid".

If the product is valid, the Purchase Module is enabled and displays the product name, description, price, above image, and a "Buy Now" option. After the customer confirms the purchase, the application layer updates the product status

from "Unused" to "Used" in the database. A purchase confirmation is then sent to the customer interface. If the same QR code is scanned again, the system checks its updated status and returns "Already Used", preventing another purchase using the same code.

VIII. OUTPUT ANALYSIS AND DISCUSSION

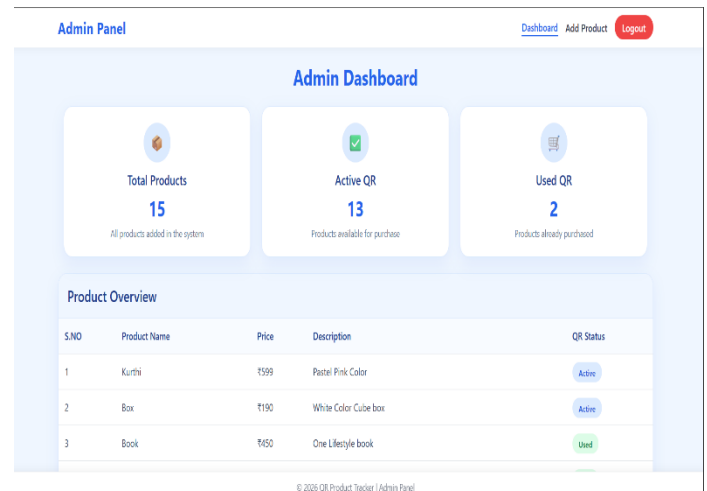
The below figures show the outputs of the proposed system in both offline and online modes. The prototype was tested using its main functions, including product registration, QR code generation, product scanning, verification, and purchase completion.

The Admin Dashboard displayed the registered products along with their below images, QR codes, and current status. Administrators were able to add, edit, and delete product records successfully, with the changes reflected immediately. When a new product was registered, the system automatically generated the below image and QR code without requiring manual steps. The registration process worked consistently during testing.

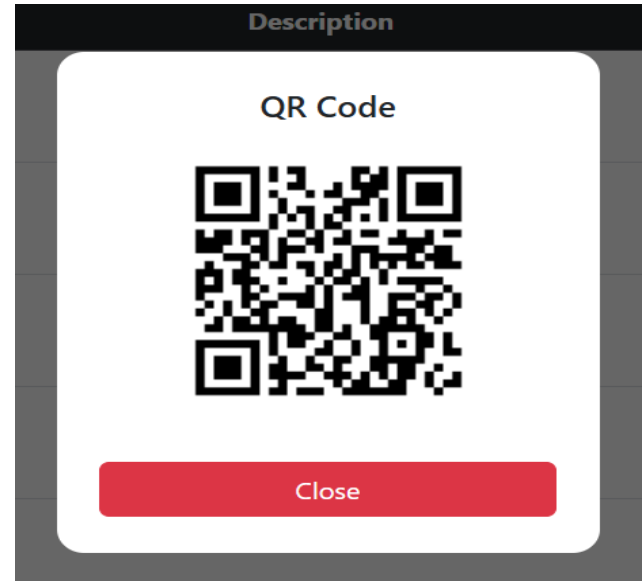
The QR Code Scanner Interface was tested using genuine products, previously used codes, and invalid codes. Genuine and unused QR codes displayed the product details and purchase option correctly. QR codes that had already been used displayed an "Already Used" message and prevented another purchase. Codes that were not available in the database were identified as "Fake". The browser-based scanner also worked consistently on both mobile and desktop devices during testing.

The Purchase Module was tested to ensure that a QR code could not be used for more than one purchase. After a purchase was completed, scanning the same QR code again returned an "Already Used" message. The database update also prevented the same product from being purchased again when multiple requests were made within a short period. This confirms that the product status is properly maintained during the verification and purchase process.

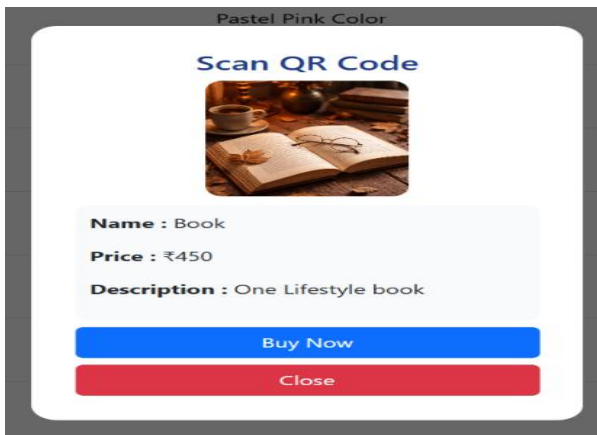
Compared with manual code entry and SMS-based verification, the proposed system makes the process easier by allowing customers to scan the QR code directly using a camera. It also connects product verification with the purchase process, so a product that has already been used cannot be purchased again using the same QR code.



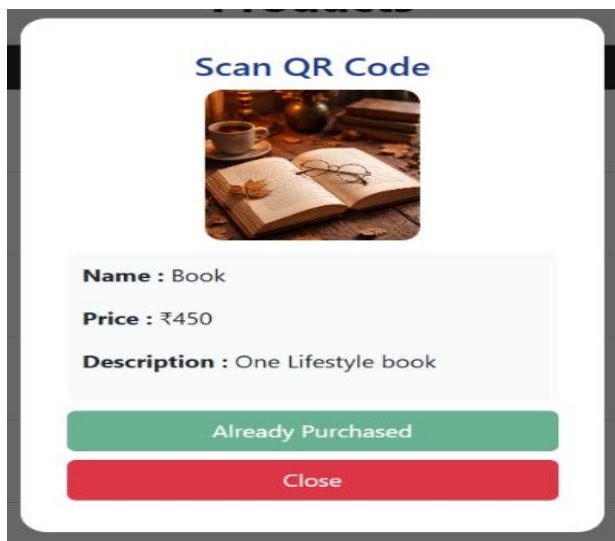
Admin Dashboard



Product Page with QR Code Generation



QR Code Scanner Interface



Purchase Confirmation Page

IX. CONCLUSION AND FUTURE SCOPE

The developed QR code-based product verification and purchase system provides a practical way to address the problem of counterfeit products. It combines a unique digital identity for each product, real-time database verification, and single-use purchase control within one web application. The system uses a three-tier MERN architecture, allowing administrators to register products, generate the above image and QR code, and manage product details. Customers can scan the QR code using a camera to check the product status before making a purchase.

During testing, the three product states, "Valid", "Already Used", and "Fake", helped the system identify genuine,

previously purchased, and counterfeit products correctly. The status update after a successful purchase also prevented the same QR code from being reused. By connecting product verification with the purchase process, the system provides better control than methods that only verify product codes.

The current system has some limitations. It requires an internet connection to access the database and perform real-time verification. The above image generated through the AI service may also require administrator review in some cases. In addition, the current product identifier provides a good level of security for the prototype, but further security improvements would be required before using the system on a large commercial scale.

Several improvements can be considered for future development. A mobile application using React Native or Flutter could make QR code scanning more convenient and support limited offline functionality. Blockchain technology could also be explored to maintain a secure record of product history and transactions. Other possible improvements include online payment integration, AI-based detection of suspicious verification patterns, role-based access for multiple administrators, and an analytics dashboard for monitoring sales, verification attempts, and counterfeit products.

Overall, the developed system provides a simple and cost-effective approach to product authentication. By combining QR code verification with purchase control, it can help consumers identify genuine products and reduce the repeated use of product codes. With further improvements and testing, the system could be extended for wider use in different industries.

X. REFERENCES

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