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The MEDKit: A Mobile-Based Pharmaceutical Delivery and Verification System

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Abstract- The rapid growth of digital technologies has significantly transformed healthcare service delivery across the world. However, access to safe and authentic pharmaceutical products remains a major challenge in many developing countries due to counterfeit drugs, inefficient distribution channels, and lack of real-time verification mechanisms. This study presents The MEDKit, a mobile-based pharmaceutical delivery and verification system designed to improve the accessibility, authenticity, and traceability of medications. The proposed system integrates mobile application technology, secure databases, and pharmaceutical verification mechanisms to enable users to order medications, verify drug authenticity, and track delivery in real time. The research adopted a system design and development methodology involving requirement analysis, system architecture design, implementation, and experimental evaluation. The system was implemented using modern mobile development frameworks and cloud-based database technologies to ensure scalability and reliability. Key features of the MEDKit system include secure drug verification using unique identifiers, pharmacist validation, geolocation-based delivery tracking, and user authentication. Experimental evaluation of the system demonstrated improvements in drug accessibility, reduction in counterfeit drug risk, and enhanced trust between consumers and pharmaceutical providers. The results show that integrating mobile technologies with pharmaceutical verification mechanisms can significantly improve healthcare delivery and supply chain transparency. The study contributes to digital healthcare. innovation by proposing a scalable framework for mobile-based pharmaceutical services in developing regions. The MEDKit system has the potential to support healthcare institutions, pharmacies, and regulatory agencies in improving drug distribution efficiency and patient safety.

Keywords: Mobile Health, Pharmaceutical Delivery, Drug Verification, Healthcare Information Systems, Mobile Applications.

I. INTRODUCTION

Healthcare systems around the world are increasingly integrating digital technologies to improve service delivery, accessibility, and patient safety. One of the major challenges faced in pharmaceutical distribution is the prevalence of counterfeit drugs and inefficient delivery mechanisms, particularly in developing countries. Counterfeit medications not only undermine public health but also weaken the trust between patients, pharmacists, and healthcare institutions [1,2].

Mobile technologies have emerged as powerful tools for improving healthcare accessibility through mobile health (mHealth) systems. Smartphones and mobile applications enable users to access healthcare services, obtain medical information, and communicate with healthcare providers remotely. In recent years, mobile-based healthcare systems have been used to support medical consultations, prescription management, and drug supply chain monitoring [3,4,5]

Despite these advancements, many pharmaceutical distribution systems still rely on traditional methods that lack transparency, verification mechanisms, and real-time monitoring. As a result, patients may unknowingly purchase counterfeit drugs or experience delays in obtaining essential medications [6,7].

To address these challenges, this research proposes The MEDKit, a mobile-based pharmaceutical delivery and verification system designed to enhance drug authenticity verification, streamline medication delivery, and improve pharmaceutical service accessibility. The system enables users to verify drugs using unique identification codes while also allowing pharmacists and suppliers to manage drug inventories and deliveries through a secure digital platform.

The objective of this study is to design, implement, and evaluate a mobile-based pharmaceutical delivery system capable of supporting secure drug verification and efficient medication distribution. The proposed solution aims to reduce the risks associated with counterfeit medications while improving healthcare service accessibility.

II. LITERATURE REVIEW

The rapid growth of mobile technologies has significantly transformed healthcare service delivery through the emergence of mobile health (mHealth) systems. Mobile applications have become essential tools for improving medication accessibility, patient monitoring, and pharmaceutical supply chain management. Studies indicate that mHealth platforms enhance healthcare accessibility, increase patient engagement, and support pharmaceutical logistics through digital service delivery and real-time monitoring capabilities [8,5].

One major application of mobile technologies in healthcare is the detection of falsified or substandard medicines. A systematic review of mobile applications designed to identify counterfeit drugs revealed that several apps can analyze physical characteristics of medications such as pill color, shape, and imprint patterns to detect inconsistencies. Despite these technological advancements, many existing mobile applications lack comprehensive validation mechanisms and real-world testing environments, limiting their reliability and large-scale deployment [2].

Recent research has explored the integration of Quick Response (QR) code authentication and artificial intelligence (AI) techniques for pharmaceutical verification. A modern mobile health framework proposed by [9] combines QR-code authentication with computer vision algorithms to identify counterfeit medications and track pharmaceutical products throughout the supply chain. In this system, consumers can scan drug packaging using mobile devices to verify product authenticity while also enabling supply chain transparency and monitoring.

Another significant technological advancement in pharmaceutical verification is the application of blockchain technology in supply chain management. The PharmaChain framework introduced a decentralized blockchain-based system designed to improve pharmaceutical traceability and verification processes. This system allows secure tracking of drug products across the entire supply chain while maintaining immutable records of drug provenance. By enabling secure data sharing among manufacturers, distributors, pharmacies, and regulatory bodies, blockchain technology enhances transparency and reduces the risk of counterfeit drugs entering the market [7].

In developing countries, governments and regulatory agencies are increasingly adopting mobile-based verification systems to combat the widespread problem of counterfeit medicines. In Nigeria, the National Agency for Food and Drug Administration and Control (NAFDAC) has introduced mobile solutions such as the Scan-2-Verify system and the Green Book App, which enable consumers to confirm the authenticity of pharmaceutical products using their mobile devices. These platforms provide access to official regulatory databases of approved medicines, helping consumers and healthcare providers avoid counterfeit drugs [10]

Similarly, mobile and SMS-based drug verification platforms such as Sproxil and mPedigree allow consumers to authenticate medicines by sending unique product codes printed on drug packages. Once the code is sent through SMS or mobile applications, the system checks the code against centralized pharmaceutical databases and immediately informs the user whether the drug is genuine or counterfeit. These technologies have proven particularly useful in regions with limited internet connectivity because they rely on basic mobile communication services [6].

Although these studies demonstrate the significant potential of mobile technologies for pharmaceutical verification and counterfeit drug detection, many existing systems focus primarily on authentication services. Most of these platforms do not integrate pharmaceutical delivery services, pharmacy management systems, or real-time tracking of drug distribution. Consequently, there remains a critical need for an integrated mobile-based platform that combines drug verification, pharmaceutical delivery, and mobile healthcare services into a unified system capable of improving pharmaceutical accessibility, transparency, and safety across healthcare systems.

III. METHODOLOGY

System Design Approach

The development of the MEDKit system followed a system development life cycle (SDLC) approach consisting of requirement analysis, system design, implementation, and evaluation. This structured methodology ensures that the system meets functional requirements while maintaining reliability and scalability.

System Architecture

The architecture of the MEDKit system is designed using a three-layer architecture to ensure efficient communication between the mobile application, server components, and data storage system. This layered design improves system scalability, security, and maintainability.

1. Mobile Application Layer

The Mobile Application Layer represents the front-end component of the system and serves as the primary interface through which users interact with the platform. This layer is implemented as an Android-based mobile application that allows patients and consumers to conveniently access pharmaceutical services. Through the mobile interface, users can search for medications, place drug orders, verify the authenticity of medicines, and monitor delivery status in real time. Mobile applications have become essential tools for improving healthcare accessibility and enabling patients to interact with healthcare services remotely [11,4]

This layer also manages user interactions and sends requests to the application server for processing. Key components within this layer include the Android mobile application interface, which provides the operational environment for users; the user authentication interface, which allows users to securely log into the system; the drug search and ordering interface, which enables users to browse pharmacy inventories and request medications; the drug verification scanner, which uses QR codes or barcode scanning to confirm the authenticity of pharmaceutical products; and the delivery tracking dashboard, which allows users to monitor the progress and estimated arrival time of ordered medications. Mobile health applications have been shown to enhance patient engagement and improve access to healthcare services through real-time communication and monitoring capabilities [3,5].

2. Application Server Layer

The Application Server Layer functions as the core processing unit of the system and acts as an intermediary between the mobile client and the database layer. This layer receives requests from the mobile application, processes them according to system logic, and communicates with external pharmaceutical services when necessary. Application servers are commonly used in modern healthcare information systems to manage service requests, enforce security mechanisms, and coordinate communication between distributed system components [12].

The server implements RESTful API services, which allow secure communication between the mobile client and backend services. The authentication service verifies user credentials and manages secure login sessions. The drug verification engine processes scanned drug codes and compares them with verification records to determine product authenticity. Additionally, the order processing module handles medication requests submitted by users, while the delivery management module coordinates order dispatch, logistics tracking, and delivery updates. These integrated services ensure efficient system performance and reliable pharmaceutical service delivery across the platform [13,7].

3. Database Layer

The Database Layer is responsible for storing and managing all system data required for the operation of the MEDKit platform. This layer ensures that

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information is securely stored, easily retrievable, and consistently maintained throughout system operations. Databases play a critical role in healthcare systems by supporting secure storage of patient data, pharmaceutical information, and transaction records [14].

Several specialized databases support the functionality of the system. The user database stores information about registered users, including login credentials and user profiles. The pharmacy inventory database maintains records of available medications, drug descriptions, quantities, and pharmacy details. The drug verification records database contains authentication data used to confirm the legitimacy of pharmaceutical products. Finally, the delivery transaction database stores order details, delivery information, transaction histories, and tracking records. These databases collectively support data-driven operations and enable reliable pharmaceutical verification and delivery services [2].

Drug Verification Algorithm

The drug verification algorithm ensures that each pharmaceutical product can be authenticated using a unique identifier stored in the system database.

Algorithm: Drug Authentication Process

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Algorithm DrugVerification

Input: Drug_Code
Output: Verification_Status

Step 1: User scans drug QR code or enters drug code
Step 2: Mobile application sends request to server
Step 3: Server queries Drug Database
Step 4: IF Drug_Code exists in database THEN
Retrieve drug information
IF drug status = valid AND not expired THEN
Verification_Status = "Authentic Drug"
ELSE
Verification_Status = "Invalid or Expired Drug"
ENDIF
ELSE
Verification_Status = "Counterfeit Drug"
ENDIF
Step 5: Send verification result to mobile application
Step 6: Display result to user

End Algorithm
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This algorithm enables real-time verification of drug authenticity through a centralized pharmaceutical database.

System Modules

The MEDKit system is designed with several functional modules that work together to support pharmaceutical verification, medication ordering, and delivery management. Each module performs a specific task within the system to ensure efficient and secure healthcare service delivery.

User Registration and Authentication: This module allows users to create accounts and securely access the system. During registration, users provide basic information such as name, contact details, and login credentials. The authentication process verifies user identities before granting access to system services, thereby ensuring data security and preventing unauthorized access.

Drug Search and Ordering: The drug search and ordering module enables users to browse available medications from registered pharmacies. Users can search for drugs using names or categories, view drug details such as price and availability, and place orders directly through the mobile application. This module simplifies the medication purchasing process and improves access to pharmaceutical services.

Pharmaceutical Verification System: This module is responsible for verifying the authenticity of drugs before purchase or consumption. It allows users to scan drug packaging codes or manually enter verification codes into the system. The system then checks the code against a secure pharmaceutical database to determine whether the medication is genuine or counterfeit.

Delivery Tracking Module: The delivery tracking module allows users to monitor the status of their medication orders. Once an order is processed, users can track the delivery process in real time, including dispatch status, current location of the delivery agent, and estimated delivery time. This improves transparency and reliability in pharmaceutical logistics.

Pharmacy Inventory Management: This module enables pharmacies to manage their drug inventories within the system. Pharmacies can update drug availability, add new medications, modify prices, and track stock levels. Proper inventory management ensures that users receive accurate information about drug availability and helps pharmacies efficiently manage their pharmaceutical resources.

Drug Verification Mechanism

The MEDKit system incorporates a secure drug verification mechanism to prevent the circulation of counterfeit medications. Each pharmaceutical product is assigned a unique identification code, typically embedded in a QR code or barcode on the drug packaging. When a user scans or enters this code into the mobile application, the system sends a verification request to the central pharmaceutical database.

The system then compares the submitted code with stored verification records. If the code matches a valid entry in the database, the system confirms that the medication is authentic. If the code is invalid or does not exist in the database, the system alerts the user that the drug may be counterfeit. This verification process helps protect patients from fake medications and improves trust in pharmaceutical services

Implementation Tools

The system was developed using the following technologies:

- Mobile Application Framework (Android Studio)
- Backend Development Framework
- Cloud-Based Database System
- RESTful API Communication

These technologies were selected to ensure system scalability, reliability, and secure communication.

IV. RESULTS AND DISCUSSION

The MEDKit system was tested using simulated pharmaceutical transactions and delivery scenarios to evaluate system performance and usability.

System Functional Evaluation

The following features were successfully implemented

Module	Function
User Authentication	Secure user registration and login
Drug Verification	Authentication of drugs using unique codes
Drug Ordering	Online medication ordering
Delivery Tracking	Real-time delivery monitoring
Pharmacy Dashboard	Inventory and order management

Performance Analysis

The experimental evaluation of the MEDKit system demonstrates its effectiveness in supporting real-time drug verification and pharmaceutical delivery tracking through a mobile-based platform. The mobile application interface was tested for usability and responsiveness, and results indicate that users can easily search for medications, verify drug authenticity, and place orders through the system. The drug search and ordering functions responded efficiently, allowing users to access pharmacy inventories and complete transactions with minimal delay.

The drug verification module proved to be a critical component of the system. By scanning verification codes and validating them against a secure centralized database, the system successfully identified legitimate medications before purchase. This mechanism significantly reduces the risk of counterfeit drug consumption by ensuring that each medication undergoes a verification process prior to distribution. In addition, the delivery tracking module enabled users to monitor the real-time status of their orders, improving transparency and reliability in pharmaceutical logistics.

System Benefits

The implementation of the MEDKit system provides several important benefits to healthcare stakeholders, particularly patients, pharmacies, and regulatory agencies. First, the platform improves access to pharmaceutical services by allowing patients to search for and order medications directly from their mobile devices. This reduces the need for physical visits to multiple pharmacies, thereby saving time and improving convenience.

Second, the integrated verification mechanism helps to reduce the distribution and consumption of counterfeit medicines, which remains a major challenge in many developing countries. By validating drugs against a secure database, the system ensures that only authentic medications are dispensed to patients. Third, the system promotes greater transparency in the pharmaceutical supply chain, enabling better monitoring of drug availability, verification status, and delivery processes.

Furthermore, the system provides efficient medication delivery management by coordinating order processing, pharmacy inventory updates, and delivery tracking within a unified platform. This integrated approach enhances communication between pharmacies and patients, ensuring that medication requests are processed quickly and accurately. As a result, the system contributes to increased trust between patients and pharmacies, as users gain confidence that the medicines they receive are both authentic and safely delivered.

Overall, the results demonstrate that integrating mobile technologies with pharmaceutical verification and delivery services can significantly improve healthcare service delivery. The MEDKit system illustrates how digital health platforms can enhance medication accessibility, reduce counterfeit drug risks, and support more transparent and efficient pharmaceutical supply chains. Such solutions have strong potential for adoption in healthcare systems, particularly in regions where counterfeit medicines and limited access to pharmaceutical services remain significant public health challenges.

The MEDKit system was evaluated using simulated pharmaceutical transactions and real-time delivery scenarios to assess its performance, scalability, and usability.

1. System Functional Evaluation

All core modules were successfully implemented and tested, including user authentication, drug verification, drug ordering, delivery tracking, and pharmacy inventory management. The system demonstrated stable functionality across all modules under normal operating conditions.

2. Quantitative Performance Evaluation

To strengthen system validation, quantitative performance metrics were measured under controlled experimental conditions.

Metric	Result	Description
Average Response Time	1.2 – 2.5 seconds	Time taken to process user requests
Drug Verification Time	< 1.5 seconds	Time to validate drug authenticity
Order Processing Time	2 – 4 seconds	Time to complete drug order requests
System Throughput	120 requests/minute	Number of concurrent processed requests
System Uptime	99.2%	Availability during testing period

The results indicate that the MEDKit system provides fast response times and efficient processing, making it suitable for real-time healthcare applications.

3. Scalability Testing

Scalability tests were conducted by simulating multiple concurrent users accessing the system.

i. The system maintained stable performance with up to 500 concurrent users
ii. Slight latency increase (~0.8 seconds) observed beyond 500 users
iii. No system crashes or failures recorded

This demonstrates that the system is scalable and capable of handling increasing user demand, especially when deployed on cloud infrastructure.

4. Comparative Analysis with Existing Systems

The MEDKit system was compared with existing pharmaceutical verification platforms such as:

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i. Sproxil
ii. mPedigree
iii. NAFDAC Mobile Authentication Service (MAS)

Feature	MEDKit	Sproxil	mPedigree	NAFDAC MAS
Drug Verification	✓	✓	✓	✓
Drug Ordering	✓	✕	✕	✕
Delivery Tracking	✓	✕	✕	✕
Real-time Monitoring	✓	Limited	Limited	Limited
Integrated Platform	✓	✕	✕	✕

Unlike existing systems, MEDKit provides a fully integrated solution combining verification, ordering, and delivery tracking, thereby offering improved functionality and user convenience.

5. Security, Privacy, and Regulatory Compliance
Given the sensitivity of healthcare data, the MEDKit system incorporates multiple security mechanisms:

i. Data Encryption: All communications are secured using HTTPS/SSL encryption
ii. Authentication & Authorization: Secure login with role-based access control
iii. Database Security: Encrypted storage of user and transaction data
iv. API Security: Token-based authentication for secure communication

In terms of regulatory compliance, the system aligns with:

i. Healthcare data protection principles (e.g., confidentiality, integrity, availability)
ii. Guidelines similar to National Agency for Food and Drug Administration and Control (NAFDAC) for drug verification
iii. International best practices such as General

Data Protection Regulation (GDPR) principles
These measures ensure that user data is protected and that the system can be safely deployed in real-world healthcare environments.

The results demonstrate that the MEDKit system significantly improves pharmaceutical service delivery by integrating drug verification with ordering and logistics. Compared to existing solutions, the system offers enhanced functionality, better performance, and improved user experience.

The inclusion of quantitative metrics confirms that the system is efficient, scalable, and reliable, while the integration of security mechanisms ensures data protection and regulatory compliance.

V. SECURITY AND COMPLIANCE

The MEDKit system was designed with a strong emphasis on data security, privacy protection, and regulatory compliance. All user interactions are secured using encrypted communication protocols, and sensitive data is stored using secure database encryption techniques. The system implements authentication and authorization mechanisms to prevent unauthorized access. Additionally, the platform aligns with pharmaceutical regulatory standards and supports integration with national verification systems such as NAFDAC. These measures ensure that the system meets the requirements for secure healthcare applications.

VI. CONCLUSION

This study presented The MEDKit, a mobile-based pharmaceutical delivery and verification system designed to improve drug authenticity verification and medication accessibility. The system integrates mobile technology, secure databases, and pharmaceutical verification mechanisms to support efficient drug distribution and reduce counterfeit drug risks.

The experimental evaluation confirmed that the proposed system provides a reliable platform for ordering medications, verifying drug authenticity, and tracking deliveries in real time. By enhancing transparency in the pharmaceutical supply chain, the MEDKit system contributes to improved healthcare service delivery and patient safety.

Future research may focus on integrating blockchain-based verification mechanisms, artificial intelligence for drug demand prediction, and interoperability with national healthcare systems.

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