Development of an Integrated E-Waybill System with Real-Time SMS Notification for Streamlined Goods Movement and Tracking

[1]Fasola, O., *[2]Onwudebelu, U., [2]Opara, O. E., & [3]Ugwuoke, U.C.
[1]Department of Cybersecurity, Federal University of Technology, Minna
[2]Department of Computer Science/Informatics, Alex Ekwueme Federal University Ndufu Alike, Abakaliki,
Ebonyi State, Nigeria.
[4]Department of Computer Science, School of Information and Communication Technology, Federal University
of Technology Minna, Niger State, Nigeria

***Corresponding author email:** anelectugocy@yahoo.com

Abstract
This paper presents the development of an electronic waybill system enhanced with Short Message Service (SMS) alerts, aimed at resolving the inefficiencies inherent in traditional logistics processes. Existing systems are plagued by delays in waybill generation, lack of real-time shipment tracking, limited communication between shippers and receivers, and a high incidence of manual errors. These issues contribute to frequent miscommunication, shipment delays, and inaccurate records. To address these challenges, a web-based solution integrated with SMS notifications is proposed, streamlining waybill management and enhancing operational efficiency. The system was developed using the Waterfall software development model, which emphasizes a structured, phase-by-phase progression through requirement analysis, system design, implementation, testing, and maintenance. This approach ensures thorough documentation and system reliability. The application was built using PHP for server-side programming due to its web compatibility, while MySQL serves as the database management system for robust and scalable data handling. Integration with an SMS gateway such as kudisms.com enables real-time updates, facilitating effective communication between logistics providers and customers. The user interface was developed using HTML, CSS, and JavaScript, delivering a responsive and user-friendly experience across devices. The resulting system offers a secure, scalable, and efficient alternative to traditional waybill methods—improving accuracy, enhancing communication, and enabling real-time tracking of shipments.

Keywords: SMS Notification, E-WayBill, Streamlined Goods, Tracking

Introduction
A waybill is a transport document that carries critical details about a consignment, including its point of origin, destination, and the various stakeholders involved. In the context of this article, an "actor" refers to either an individual or an organization that assumes one or more roles within the transport process. This study explores an electronic waybill (e-Waybill) service by developing a system that utilizes Short Message Service (SMS) alerts—referred to as the e-WayBill-SMS system. We argue that this approach goes beyond merely substituting paper-based waybills; instead, it leverages the capabilities of electronic systems to harness information entities and system functions for broader applications, such as enhancing knowledge about freight movement (Balbo & Pinson, 2018). Interoperability between services becomes feasible when they can share resources like information entities and functional modules. This makes it essential for the e-Waybill service to integrate with existing Intelligent Transportation Systems (ITS). Such integration can foster synergies between the e-Waybill system and other ITS services when shared information resources are effectively utilized (Cane et al., 2019; Madakam et al., 2019).

Given the many benefits of electronic documentation—such as reduced paperwork, increased time efficiency, and enhanced data accuracy—several initiatives have emerged aiming to replace traditional paper waybills with electronic alternatives (Dubovec, 2016). International bodies like the International Road Transport Union (IRU) and the United Nations Economic Commission for Europe (UNECE) advocate for e-Waybill systems to improve supply chain efficiency through paperless processes (IRU, 2012). The UNECE formalized this support with the

e-CMR agreement in 2008, which supplements the original 1956 CMR agreement that mandated paper-based waybills (UNECE, 1956; UNECE, 2008). In the freight transport sector, the International Air Transport Association (IATA) has already implemented an e-Waybill solution for air cargo, known as the e-Air Waybill (IATA, 2012). This system replaces the traditional paper documents accompanying each shipment with technologies such as Electronic Data Interchange (EDI) and Enterprise Resource Planning (ERP) systems. Another example in road transport is DHL's Express Waybill service, where the Fourth Party Logistics (4PL) provider requires consigners to complete an electronic waybill before shipment (Pedersen et al., 2010; Cane et al., 2019). Integration between e-Waybill systems and ITS services can significantly enhance the performance and benefits of both, promoting a seamless, paperless exchange of freight information. This digital transformation reduces administrative overhead, expedites the flow of data, and enhances the security of consignment information compared to traditional paper-based systems.When waybill data is digitized, it can be integrated with other datasets, such as Global Positioning System (GPS) information, to generate insights into truck and freight movements within the transportation network. As a result, the e-Waybill system becomes a vital tool for collecting consignment and traffic data, converting it into actionable traffic intelligence. This leads to greater volumes of digitally stored information on vehicle and consignment movements and supports the development of advanced analytics to detect patterns within this data. Such insights are particularly valuable to policymakers, including public road authorities, who rely on accurate vehicle tracking to make informed decisions regarding toll systems, usage fees, and infrastructure investments (Dubovec, 2016). Over the years there have been various platforms on e-WayBilling system but need enhancement from the following challenges:

i. There is no means where SMS can be sent to the waybill sender to ascertain that the waybill has been delivered.
ii. Lack of live chat where sender can actually chat with support service to get enquiry about the waybill.
iii. There is no means to know the method used to move the parcel to the destination.
iv. There is no means to quickly verify or check for authentication of parcel records.

This research work will help in a good number of ways to ease the management problems in waybill for transport companies. There are many benefits of an e-waybill system and some are listed below:

a. It is very convenient to use it right from the bedroom, office or anywhere in the world.
b. Transactions are secured.
c. It saves a lot of time to management.
d. The need of the paper form of the multiple copies of waybill is eliminated. Hence, the tons of paper are saved per day.

The electronic waybill system using SMS alert faces several limitations that may affect its functionality and overall efficiency. One key limitation is its dependence on network availability. Internet networks are required for the system to function properly, meaning that users in areas with poor coverage may experience delays or even failure in receiving real-time updates via SMS. Additionally, SMS technology itself presents a limitation, as most of the SMS websites will have to approve sender ID before using the API which sometimes takes time and sometimes the sender ID is been rejected. The electronic waybill (e-waybill) represents a digital transformation of the traditional paper waybill, providing a documented record of key information associated with goods transportation, including consignor and consignee details, item descriptions, destinations, and transit timestamps. By eliminating physical documentation, e-waybills mitigate the risk of manual handling errors, enhance operational transparency, and contribute to streamlined logistics processes (Lu et al., 2018). The adoption of e-waybill systems has been instrumental in improving efficiency, accuracy, and regulatory compliance within the logistics sector. For instance, India's Goods and Services Tax (GST) e-waybill framework enables real-time digital tracking of goods, thereby reducing tax evasion and facilitating consignment status updates (Saxena, 2019). However, the effectiveness of e-waybill systems is contingent upon digital infrastructure, particularly reliable internet connectivity. In regions with limited or inconsistent internet access, such as rural or underserved areas, these systems encounter significant adoption barriers (Nair & Manoharan, 2020). This digital divide underscores the need for alternative models that can operate effectively in low-connectivity environments. To address this limitation, the present study proposes the development of a Short Message Service (SMS)-based e-waybill system, leveraging the widespread accessibility and low cost of SMS technology to facilitate real-time consignment tracking and verification, thereby bridging the digital accessibility gap (Lwoga & Sangeda, 2019; Fernando et al., 2019). The design of an SMS-enabled e-waybill solution necessitates a comprehensive understanding of logistics, mobile communication, and digital systems. This section delineates the conceptual framework underlying the development of such a platform, encompassing the functional architecture of e-waybill systems, the technical capabilities of SMS for digital communication, and the implementation strategies requisite for secure and robust logistics support (Saxena, 2019). Specifically, this discussion focuses on the potential of SMS to serve as a reliable

medium for transmitting structured logistics data in resource-constrained environments. The efficacy of SMS technology in substituting for internet-dependent communication channels has been demonstrated across various sectors. In low-resource settings, SMS has proven instrumental in enhancing patient compliance with treatment schedules and medical appointments in the healthcare sector (Lester et al., 2010). Similarly, SMS-based information services have empowered farmers in the agricultural sector by providing timely access to market data and agronomic advice, thereby augmenting their decision-making and negotiating power (Aker, 2010; Aker & Mbiti, 2010). The financial sector has also leveraged SMS for mobile banking, offering basic services to users in remote regions lacking digital infrastructure (Asongu & Nwachukwu, 2018). These diverse applications underscore the versatility of SMS as a platform for critical communication and information exchange, affirming its potential to support inclusive logistics systems in digitally underserved areas.

The successful implementation of an SMS-based e-waybill system necessitates the integration of several critical technological components to ensure system functionality, accessibility, scalability, and security. A fundamental component is the SMS gateway, which enables communication between the e-waybill application and users via cellular networks. SMS gateway platforms, such as Twilio and Nexmo, facilitate the embedding of SMS capabilities into software applications, allowing for the automation and monitoring of message exchanges (Singh & Pathan, 2017). These gateways are essential for system scalability, supporting the management of high SMS volumes and ensuring consistent performance under increasing user demand. Additionally, the incorporation of a robust Database Management System (DBMS) is crucial for storing and managing waybill-related data, including waybill identifiers, sender and receiver information, timestamps, and transit locations. Centralized database solutions, such as MySQL and PostgreSQL, offer secure and real-time data access, which is vital for the accuracy and responsiveness of the e-waybill system. Given the sensitive nature of logistics data, the use of secure DBMSs is paramount to maintaining data confidentiality and integrity (Elmasri & Navathe, 2015).

Given the inherent lack of encryption in SMS, implementing additional security mechanisms is crucial to protect data integrity and user privacy. To mitigate the vulnerabilities of SMS communication, the system should employ techniques such as two-factor authentication (2FA), tokenization, and message segmentation. Two-factor authentication enhances user verification processes, ensuring that only authorized individuals can access sensitive waybill data (Zhou et al., 2020). Tokenization, which substitutes sensitive information with unique, non-reversible tokens, further strengthens data protection. These security practices, widely applied in sectors like mobile banking and healthcare, can be effectively adapted to secure logistics information in SMS-based systems. Furthermore, cloud infrastructure is a critical component, offering the scalability and flexibility needed for deploying and maintaining a high-performing e-waybill system. Cloud service providers, such as Amazon Web Services (AWS), Google Cloud Platform (GCP), and Microsoft Azure, supply the necessary computing resources, storage capacity, and network capabilities to support system responsiveness under varying workloads (Rimal et al., 2011). By hosting application backends and databases in the cloud, developers can ensure uninterrupted service delivery, efficient data handling, and robust support for real-time operations. Additionally, cloud environments support essential system features, such as data backup, disaster recovery, and redundancy, thereby contributing to overall system resilience and reliability.

The integration of these technological components enables the development of an SMS-based e-waybill system that addresses the limitations of conventional internet-dependent platforms. By leveraging SMS for communication, employing secure databases, integrating with scalable SMS gateways, adopting robust security protocols, and deploying cloud infrastructure, the proposed solution offers a cost-effective, accessible, and secure approach to logistics tracking in regions with limited internet connectivity. This model aligns with emerging research advocating for SMS-based digital systems and highlights the potential of such systems to enhance logistics efficiency and inclusivity in resource-constrained environments. Existing research on e-waybill systems and SMS-based technologies has significantly advanced our understanding of efficient logistics and real-time goods tracking. For instance, India's Goods and Services Tax (GST) e-waybill system has demonstrated the effectiveness of e-waybill systems in enabling real-time monitoring of shipments, enhancing data management capabilities, and strengthening tax compliance (Saxena, 2019). However, the dependence on reliable internet connectivity poses a challenge in rural or underserved regions with limited digital infrastructure. Consequently, alternative modalities, particularly those leveraging Short Message Service (SMS) technology, have garnered increasing attention in recent scholarly discourse, underscoring the need for innovative solutions that can operate effectively in low-connectivity environments.

Although SMS-based systems are often developed to address communication barriers in low-connectivity environments, their integration into comprehensive logistics tracking, such as in the context of e-waybills, remains

underexplored. Limited research has examined the feasibility of using SMS as the primary medium for end-to-end e-waybill services. Some studies have proposed hybrid models that combine SMS with web-based interfaces to improve system accessibility. For example, Ayo et al. (2011) described a hybrid architecture wherein users in remote areas interact with the e-waybill system via SMS, while administrators in better-connected locations utilize web portals to monitor and manage logistics data. Although these models enhance inclusivity, they remain partially dependent on internet connectivity, underscoring the need for further investigation into fully SMS-based solutions that can operate effectively in low-connectivity environments without reliance on internet access.

The inherent limitations of SMS, such as message length restrictions and the absence of native encryption, pose notable challenges for handling sensitive logistics information. However, recent studies have proposed effective mitigation strategies to address these limitations. For instance, Zhou et al. (2020) suggested the use of tokenization and message segmentation to optimize data transmission and enhance security. Additionally, incorporating two-factor authentication (2FA) mechanisms can further protect against unauthorized access. These security protocols, widely adopted in sectors like mobile banking and digital health records, demonstrate the adaptability of SMS-based systems for secure logistics applications. Despite these promising developments, a clear research gap remains in the development and validation of a fully SMS-based e-waybill system. The current literature predominantly focuses on internet-reliant platforms or hybrid architectures, leaving questions about the practicality, scalability, and security of SMS-only systems unanswered. This study aims to bridge this gap by proposing a robust SMS-based e-waybill framework that emulates the core functionalities of conventional, internet-dependent systems. The objective is to provide a low-cost, scalable, and secure logistics tracking solution tailored to regions with limited or inconsistent internet access. By synthesizing best practices from previous implementations of SMS-based communication systems and adapting them for logistics applications, this research contributes a novel approach aimed at enhancing inclusivity and operational efficiency in under-resourced settings.

Further reinforcing the relevance of digital waybill systems, Bi et al. (2022) conducted a study utilizing electronic waybill data and state records from garbage trucks to identify high-traffic nodes, in construction waste transportation networks. By applying machine learning algorithms, including XGBoost, decision trees, random forests, and gradient-boosted decision trees (GBDT), they significantly improved the accuracy of waybill generation prediction. Their case study, based on Shenzhen's construction waste transportation system, revealed that the XGBoost model achieved a prediction accuracy of 90.5%, outperforming other models. A key recommendation from their findings was the strategic reinforcement of high-traffic nodes to mitigate accident risks. Similarly, Kurganov et al. (2022) explored the integration of electronic waybill systems into digital management frameworks for motor transport enterprises. Employing methodologies such as comparative analysis, statistical data interpretation, and digital modeling, the researchers developed a generalized information flow scheme within a digital enterprise model. Their work demonstrated how the incorporation of electronic waybill systems can enhance operational efficiency and streamline data-driven decision-making in motor transport enterprises. These studies collectively underscore the evolving role of electronic waybill systems in optimizing logistics operations and highlight the need for inclusive technological innovations, such as SMS-based systems, that address infrastructural disparities in the digital supply chain landscape.

The aim of this research work is to develop an e-WayBill system using SMS alert. The objectives are as follows:
  i. To integrate an SMS gateway to a web based system to inform sender that their parcel have been delivered.
  ii. To integrate a live chat to the web based platform where senders can chat with support service to get enquiry about the waybill.
  iii. To create a module where the administrator can input the method used to send the parcel and sender can as well be notified on the method used to send the parcel.
  iv. To build a module for verification of waybill and authentication of records.

Research methodology
Structured system analysis and design methodology was adopted as a choice of methodology for the development of an e-waybill system using SMS alert as it applies a methodological approach to software design and it proposes structural methods which are sets of notations and guidelines for software design. It involves the specification of procedures and methods for collecting and analyzing data necessary to define or solve the problem for which the research is embarked upon.

Data gathering technique

We employed the qualitative approach in data collection such as interview, observation and journals which were used to source for data in the course of the research development.

a) **Interview:** In applying interview as a method of data collection, the researchers went to the Nigeria Post Office in the state, where the researcher had a one on one conversation with one of the officer at the front desk. He asked questions of how they have been managing their records, know the location of parcels, financial statement, and staff information. The researchers further asked the officer on the constraint they are currently facing using the present method.

b) **Observation:** The researchers use all of their senses to examine people in natural settings or naturally occurring situations. The researchers observed that letters and parcels that are either waiting to be sent or received are usually documented by writing the information on a paper log. Also activities within the post office or complex such as sales of stamp, staff information, and other miscellaneous are also written on a paper log for onward safe keeping.

c) **Internet:** The Internet has appears to be a very promising medium for researchers. As a vehicle for data collection, it promises increased sample size, greater sample diversity, easier access and convenience, lower costs and time investment, and many other appealing features. The researcher employed the use of internet papers and problem manuals in further collection of data.

Analysis of the existing system

An electronic waybill (e-Waybill) is a service that provides the functions of a paper waybill, and which is capable of storing, at least, the information present in a paper waybill as well as enabling faster paperless transfer of information during freight transport. Furthermore, e-Waybills contribute towards reducing the administrative overhead typically associated with paper waybills. The authors in recently argued that the potential synergies between an e-Waybill and other services could lead to increased utilization of intelligent transport systems (ITS) services. In turn, this could lead to more sustainable transport, for example, by enabling more efficient use of vehicles and transport infrastructure. There exist several examples of electronic replacements of the paper waybill. The International Air Transport Association (IATA) implemented an e-Waybill for air freight transport, which is referred to as an e-Air. Finally, a multi-modal e-Waybill, which is an important initiative for achieving the vision of using a single transport document during a consignment, was proposed in the e-Freight project.

Advantages of the existing system

The current waybill system has certain strengths that make it functional for managing logistics operations:

a) The existing system often involves manual paper-based processes that are easy to understand and operate. Staff and users require minimal technical skills to generate, record, and verify waybills.

b) Employees and management are familiar with the traditional method, which reduces the need for extensive training. The long-standing process is trusted within the logistics sector.

c) The manual system incurs lower upfront expenses as it does not require significant investment in technology, software, or technical infrastructure.

d) Paper waybills allow for quick, hands-on verification of documents at checkpoints and other physical inspection points.

Disadvantages of the existing system

Despite its familiarity, the existing manual waybill system has notable drawbacks that hinder efficiency and reliability:

a) Manual entry and processing of waybills can result in mistakes such as incorrect data recording, misplacement of documents, or failure to update key information on time.

b) The manual handling and verification of waybills require more time, slowing down the process of delivery and tracking of goods. This delay can result in increased operational costs.

c) Since waybills are handled manually, there is no provision for real-time updates regarding the status of goods in transit. This limits the ability of businesses and customers to track deliveries efficiently.

d) Paper-based systems lead to storage issues as records accumulate over time. Retrieving old records for audits or reports becomes cumbersome.

e) The system is not easily accessible to remote parties, like customers or stakeholders, who need real-time updates on shipments.

High-level model of the proposed system

The proposed electronic waybill system using SMS (e-WayBill-SMS) offers an automated, real-time solution designed to overcome the inefficiencies of the existing manual system (see Figure 1). The high-level model of the system includes the following key components:

a) **Waybill generation module**: This module allows the creation of waybills electronically. Users input shipment details via a web interface, and the system automatically generate a unique waybill number and relevant information.

b) **SMS notification system**: After a waybill is generated, the system sends an SMS notification to both the sender and receiver, containing key details like waybill number, item description, and estimated delivery time.

c) **Tracking module**: This feature enables real-time tracking of shipments. Updates about the current status of the goods will be sent via SMS to all involved parties, ensuring transparent communication throughout the delivery process.

d) **Database and reporting**: The system stores all waybill data electronically, allowing for easy retrieval, reporting, and auditing. The database support quick searches and generate reports for management and regulatory purposes.

e) **Security and authentication**: The proposed system incorporates user authentication protocols to ensure that only authorized personnel can generate or update waybills. This will improve the security of the data and prevent unauthorized access.
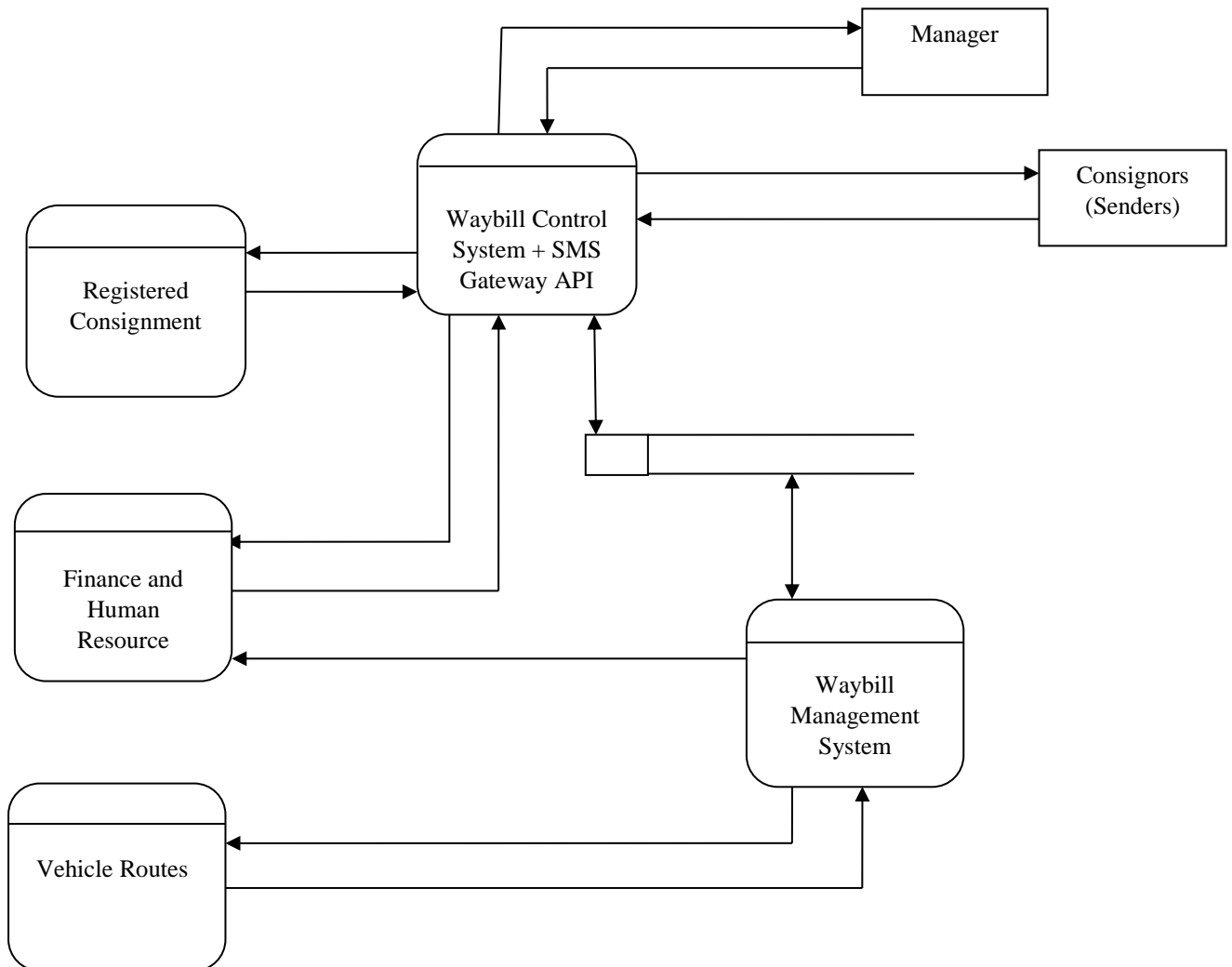

Figure 1: High Level Model of the E-WayBill-SMS System

The integration of SMS notifications makes the system accessible to users who do not have internet access, ensuring wide applicability across different regions as well as causes businesses to experience faster waybill processing, real-time tracking, enhanced security, and improved customer service.

Analysis of the proposed system

The proposed system, e-WayBill-SMS, employs a computerized platform in managing data generated in waybill management and tracking system. In an e-WayBill-SMS system there are two users the user and the admin. The function of the administrator is to register parcel, once a parcel is been registered a tracking number is generated for that parcel, the administrator can view parcel, the administrator registers sub admin, the administrator can view sub admin details, as well as view parcel on transit either by day, month or year and finally activate a registered parcel, while the function of a user is to enter tracking identification number in other to track parcel location. The system automatically collates and computes all information which then saved in a central database. The system automatically searches for that particular record and displays it on the screen. The system as a web based information enable ease of access to information, as user does not necessarily need to be in the office before they can access to the information.

Justification of the proposed system

The e-WayBill-SMS system has been found to complement the current system in a number of ways such as:

i. The proposed system enables user to track parcel on transit.
ii. Errors are eliminated, because the system automatically collates, compute and process all information entered.
iii. Data are always safe and secured, as the data's can always be backed up in any removable media, such flash drive, or an external hard drive.

System design

The principle goal of system design is to establish a design approach that provides the functions described in the system specification and requirements documents. This section concentrates on how the above analysis and specification can be achieved through designing of the interface. The software includes all the design of the interface and forms described in this system.

System architecture

The architecture of the proposed e-WayBill-SMS system is structured to handle the core functionalities of waybill generation, real-time tracking, and SMS notifications. The system architecture consists of the following layers:

(i) User interface layer

(a) **Web interface**: This component provides a web-based platform where users, such as shippers, couriers, and administrators, can log in and perform operations like creating waybills, tracking shipments, and accessing reports. The interface is designed to be user-friendly and accessible on computers.

(b) **SMS interface**: The system also supports SMS-based interactions, where users can receive notifications and request tracking updates via SMS, providing service to users without internet access.

(ii) Application layer

(a) **Waybill management module**: This module is responsible for creating, updating, and managing waybills in the system. It ensures the accurate recording of shipment details and generates unique waybill numbers for each transaction.

(b) **Tracking and notification module**: This module tracks the status of shipments and triggers SMS notifications when updates are available, such as dispatch, transit, and delivery. It integrates with the SMS gateway to send notifications automatically.

(c) **User authentication and authorization**: This component manages login credentials and ensures that only authorized users can access specific features of the system. Different user roles e.g., administrators, couriers, and customers have varying access levels.

(iii) Database Layer

(a) **Waybill database**: A central database stores all waybill information, including shipment details, sender and receiver data, tracking history, and SMS logs. The database supports efficient querying, enabling users to retrieve data for reporting or auditing purposes.

(b) **User and role database**: This database stores user profiles and authentication credentials, managing permissions and access control across the system.

(iv) Communication layer

(a) SMS Gateway: The system connects to an SMS gateway to send real-time notifications to users. This gateway allows the system to communicate effectively with users via SMS, ensuring timely updates even in areas with limited internet access.

(v) Security layer

The combination of encryption and access control layers ensures that the proposed system is robust, scalable, and secure while providing real-time communication and efficient waybill management. The SMS integration broadens the system's reach, making it accessible to a wider range of users.

(a) Encryption: To protect sensitive data, the system employs encryption protocols for all communications, especially for user authentication and waybill generation.

(b) Access control: Role-based access control ensures that only authorized users can access and modify sensitive information, further enhancing the system's security.

Main menu design

The main menu is the main page of the system that displayed when the user passes through the user interface (Figure 2). The main menu consists of links and buttons that enable users to navigate from one module to another within the application. Figure 2 shows the main menu design that shows other links to the system, where admin can navigate from one menu to another.
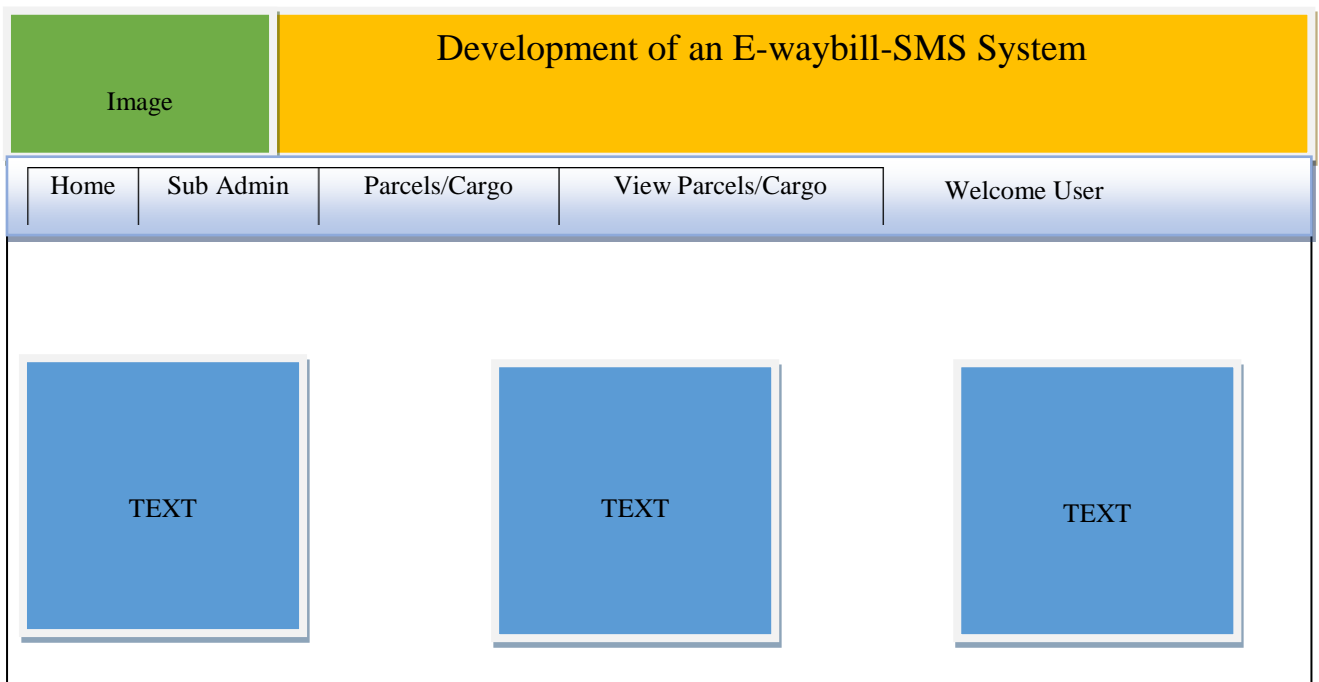

Figure 2: Main Menu Design

Sub Menu design

The e-WayBill-SMS system is structured to ensure that users can navigate through different system functions efficiently. The sub-menus provide a clear categorization of tasks and actions for various user roles such as administrators, shippers, couriers, and customers. The following sub-menu design outlines the key features:

a) **Waybill management**:
   i.   Create New Waybill
   ii. View/Update Waybill
   iii. Search Waybill by ID
   iv. Track Shipment

b) **User management** (Admin only):
   i.   Add New User
   ii. Register parcel
   iii. View parcel

c) **Notifications**:
   i.   View Sent SMS Notifications
   ii. Resend Notification

    iii. Set Notification Preferences

d) **Reports**:
    i. Generate Waybill Reports
    ii. View Delivery Performance

e) **Account settings**:
    i. Profile Settings
    ii. Change Password
    iii. Logout

This sub-menu design simplifies navigation for users based on their specific needs, ensuring easy access to waybill creation, tracking, and report generation.

Program module design

The program modules are the core functional units of the system, each designed to handle a specific operation within the e-WayBill-SMS system. The major program modules include:

a) **Waybill generation module**: This module allows users to enter shipment details such as sender and receiver information, item description, and delivery address. Once the data is entered, a unique waybill ID is generated and stored in the system.

b) **Tracking module**: This module continuously updates the status of shipments in the system. As packages move through different stages (dispatch, in transit, delivered), the module updates the status and triggers an SMS notification to all involved parties.

c) **SMS notification module**: Integrated with the SMS gateway, this module ensures real-time communication via SMS. It automatically sends alerts during important shipment stages such as dispatch, transit, and delivery. It also allows users to resend or configure notification preferences.

d) **User management module**: This module controls user authentication and role assignment. It allows administrators to create new users, define their roles (e.g., admin, courier, shipper), and manage access rights across the system.

e) **Security module**: Ensures secure login through user authentication, and role-based access control is implemented to prevent unauthorized users from accessing sensitive areas of the system.

Database development tool

The e-WayBill-SMS system used MySQL as its database development tool. MySQL is selected due to its flexibility, scalability, and support for relational databases. It offers the following advantages:

i. MySQL is free and open-source, making it a cost-effective solution for small to medium-sized enterprises.

ii. MySQL can handle large volumes of data, making it suitable for a system that processes numerous waybills and SMS notifications.

iii. It offers fast read and write capabilities, ensuring that the system can efficiently process waybill transactions and send notifications.

iv. MySQL supports various platforms (Windows, Linux), allowing easy deployment and management.

v. Built-in features for encryption and access control enhance the security of the database.

Database design and structure

The database design for the e-WayBill-SMS system follows a relational model, where tables are interconnected to manage and store information efficiently. Figure 3 is the database design and also the key tables and their structures are outlined in Figure 3:

Browse	Structure	SQL	Search	Insert	Export	Import	Operation

PHPMYADMIN

Allied1_barry_new (10)

Contacts
feedback
login_details
login_user
online_info
parcel_info
parcel_loc
quotes
recipient
user_table

Contact_id	Fname	Email	Phn_nmb	Date_acct	Phn_n...
1	Dennis Ugo	dennis@gmail.com	08098938095	22/09/2024	0805...
2	Emeka Ani	Emi@yahoo.com	07099886654	22/09/2024	0805...
3	Ufoma festus	Ufo@yahoo.com	09122334455	22/09/2024	

Figure 3: Database Design
Table 1: Login Details Table Specification

Field name	Data type	Field size	Description
Login_id	Int	11	Login identification number in the database
User_id	Varchar	11	User identification number in the database
Time_login	Varchar	5	Time of login of users
Date_login	Varchar	10	The date users login to the system
Action	Varchar	10	The status of login

Table 1 is one of the tables in the database that stores information about all login details in the database.

Table 2: Parcel Information Table Specification

Field name	Data type	Field size	Description
Sender_name	Int	5	The sender name in the database
Address	Varchar	10	The address of the user
Email	Varchar	10	The email address of the user
Phone_number	Varchar	10	The phone number of users
Full_name_of recipient	Varchar	10	The fullname of recipient

Table 2 is one of the tables in the database that stores information concerning all registered parcel.

Table 3: Parcel Location Table Specification

Field name	Data type	Field size	Description
Location_id	Int	5	The location identification number in the database
Cargo_id	Varchar	10	The cargo identification number in the database
Dat_Reg	Varchar	10	Date of registration
regUser	Varchar	10	Registration of users

Table 3 is one of the tables in the database that stores information concerning all parcel location in the database.

Input / output format

The e-WayBill-SMS system relies on structured input and output formats to ensure accuracy and consistency in processing waybills, tracking shipments, and sending notifications. Below are the inputs and output formats for key operations:
  a) **Inputs for waybill creation**
      i. Sender Name (Text, max 50 characters)
      ii. Sender Contact (Phone number, 10–15 digits)
      iii. Receiver Name (Text, max 50 characters)
      iv. Receiver Contact (Phone number, 10–15 digits)
      v. Item Description (Text, max 200 characters)
      vi. Pickup Address (Text, max 100 characters)
      vii. Delivery Address (Text, max 100 characters)
  b) **Output of the waybill creation**
      i. Generated Waybill ID (Numeric, unique)
      ii. Confirmation Message: "Waybill Created Successfully"
  c) **Shipment tracking**

i. **Input**:
  i. Waybill ID (Numeric, unique)
ii. **Output**:
  i. Current Shipment Status (In Transit, Delivered)
  ii. SMS Notification (Waybill Status, Current Location, Estimated Delivery Time)

d) **User registration**
  i. **Input**:
    i. Username (Text, max 20 characters)
    ii. Password (Alphanumeric, hashed)
    iii. User Role (Admin, Shipper, Courier)
    iv. Contact Information (Phone number, email)
  ii. **Output**:
    i. Confirmation Message: "User Registered Successfully"

e) **SMS notification**
  i. **Input**:
    i. Waybill ID (Numeric, unique)
    ii. Message Content (Text, max 160 characters)
    iii. Recipient Phone Number (Phone number, 10–15 digits)
  ii. **Output**:
    i. SMS Status: Sent/Failed
    ii. SMS Message: "Your package (Waybill ID) is (In Transit/Delivered)."

Algorithm

The e-WayBill-SMS system employs algorithms to automate various processes, such as generating waybills, updating shipment status, and sending SMS notifications. Below is an outline of the core algorithms used in the system:

A. Algorithm for waybill generation

Input: Sender Info, Receiver Info, Item Description, Pickup Address, Delivery Address
Output: Waybill ID, SMS Notification
Step 1: Validate input data (ensure all required fields are filled)
Step 2: Generate a unique Waybill ID
Step 3: Store waybill details in the database
Step 4: Send SMS notification to sender and receiver with Waybill ID
Step 5: Return confirmation message: "Waybill Created Successfully"

B. Algorithm for shipment tracking

Input: Waybill ID
Output: Shipment Status, Current Location, SMS Notification
Step 1: Receive Waybill ID input from user
Step 2: Query the database for the current status of the shipment
Step 3: If found, return the current status and location
Step 4: Send SMS notification to the user with the updated status
Step 5: If not found, return error message: "Waybill not found"

C. Algorithm for SMS notification

Input: Waybill ID, Status Update
Output: SMS Notification to relevant parties
Step 1: Retrieve recipient phone numbers from the database (sender and receiver)
Step 2: Format the SMS message with Waybill ID and status
Step 3: Send SMS via SMS Gateway
Step 4: Update notification status in the database (Sent/Failed)
Step 5: Log the notification in the SMS Notifications Table

Data dictionary

The Data Dictionary provides an organized description of the data elements used in the e-WayBill-SMS system. It defines each field, its data type, and its purpose within the system (Table 4).

Table 4: Data Dictionary

Field Name	Description	Data Type	Size	Remarks

Waybill_ID	Unique identifier for each waybill	Numeric	10	Auto-generated by system
Sender_Name	Name of the person sending the shipment	Text	50	Required
Sender_Contact	Phone number of the sender	Phone number	10-15	Required, validated
Receiver_Name	Name of the person receiving the shipment	Text	50	Required
Receiver_Contact	Phone number of the receiver	Phone number	10-15	Required, validated
Item_Description	Description of the item being shipped	Text	200	Optional
Pickup_Address	Address where the shipment is picked up	Text	100	Required
Delivery_Address	Address where the shipment is delivered	Text	100	Required
Current_Status	Current status of the shipment	Text	20	Values: In Transit, Delivered
Timestamp	Date and time of status update	DateTime	-	Auto-generated by system
Username	User's login name	Text	20	Required
Password	Hashed password for authentication	Alphanumeric	64	Required, encrypted
Role	User role (Admin, Shipper, Courier)	Text	10	Defines access level in the system
Notification_ID	Unique identifier for each notification	Numeric	10	Auto-generated by system
Message_Content	Content of the SMS notification	Text	160	Message sent to recipient
SMS_Status	Status of the SMS notification (Sent/Failed)	Text	10	Indicates whether SMS was delivered
Tracking_ID	Unique identifier for each tracking update	Numeric	10	Auto-generated by system
Current_Location	Current location of the shipment	Text	50	Required for tracking updates

System implementation

After successful design of the system, the system was implemented and debugged for any syntax error. It followed the trend of testing, documentation and running in a xampp server environment. Any error identified was quickly corrected and the right syntax used. The successful deployment of the e-WayBill-SMS system requires specific hardware components to ensure optimal performance. These hardware requirements include: (i) A minimum of 30GB hard disk drive. (ii) At least a Pentium III 800 MGHz MMX Intel Processor (iii) Minimum of 256MB Random Access Memory. (iv) A CD-ROM Drive. (v)A super Video Graphic Adapter (SVGA) Monitor. (vi) A stabilizer and an uninterruptible Power Supply Unit (UPS). (vii) A keyboard and a mouse. The e-WayBill-SMS system is built on a combination of different software services. The software requirements include:

    a) **Operating system**: The system can run on:
        i. Server: Linux (e.g., Ubuntu) or Windows Server
        ii. Client: Windows, macOS, or Linux

    b) **Database management system (DBMS)**: MySQL was used as the primary DBMS for storing waybill data, user information, and SMS logs. It is chosen for its robustness, flexibility, and scalability.

   c) **Web Server**: Apache was used to host the web interface of the system, handling HTTP requests from users.

   d) **Programming languages**: The system's backend is developed using PHP, while the frontend employs HTML, CSS, and JavaScript.

   e) **SMS gateway API**: An SMS gateway service or API (such as Twilio) will be integrated to handle the sending and receiving of SMS notifications in real time.

   f) **Development environment**: A text editor or Integrated Development Environment (IDE) such as Visual Studio Code or Sublime Text will be used to write and manage the system's code.

Program development

The development of an e-WayBill-SMS system is guided by the need for efficient waybill management and reliable SMS communication. The development process involves coding the system's functionalities, database design, user interface creation, and integration with the SMS gateway. The program development follows a modular approach, where each module (waybill management, tracking, notification) is developed and tested independently before integration. The primary programming language used in developing the system's backend is PHP, while HTML, CSS, and JavaScript are used for the frontend. For SMS integration, the system leverages PHP with an API for the SMS gateway (such as Twilio or a similar service). PHP was chosen for the backend development due to its wide use in web application development, ease of integration with MySQL databases, and strong support for building dynamic web pages. PHP's extensive library support and framework availability make it highly suitable for developing the core logic of the system, including handling form submissions, database queries, and user authentication. Additionally, PHP's ability to interface seamlessly with SMS gateway APIs ensures efficient handling of SMS notifications, a key requirement of the system. The language is also well-supported by hosting providers, making it a cost-effective solution for deployment. For the frontend, HTML, CSS, and JavaScript are used to create a responsive, user-friendly interface. HTML provides the structure for the web pages, CSS ensures a clean and professional design, and JavaScript adds interactivity, such as real-time validation of user inputs and dynamic page updates.

Main menu implementation

The main menu pops up upon successful login, and it provides an interface that enables users to navigate from one module to another and also to perform basic system functionalities. Upon implementation the main menu interface was found to be as shown in Figure 4 and home page of the e-WayBill-SMS system is shown in Figures 5a and 5b. Figure 6 shows the e-WayBill-SMS system page, Figure 7 shows the track parcel page while Figure 8 shows the Sign-in page of the courier tracking panel. Figures 9 and 10 are the courier dashboard and Admin dashboard respectively. Finally, Figures 11 and 12 shows the location information and recipient details page.

Figure 4: Main Menu Implementation
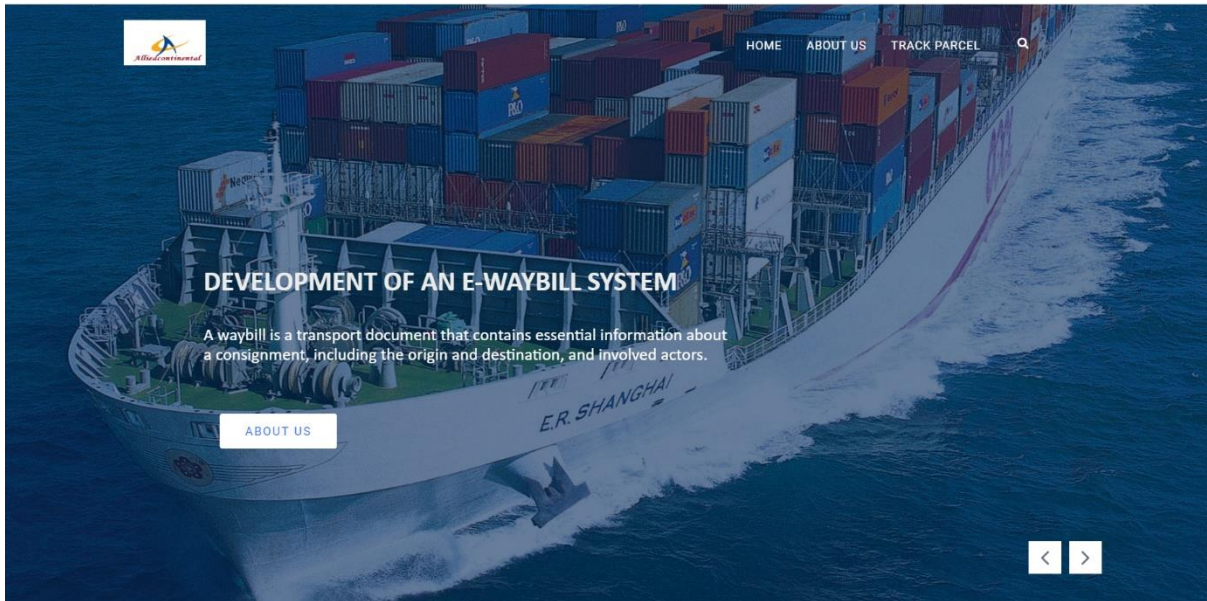
Figure 5a: Home Page of the E-WayBill-SMS System
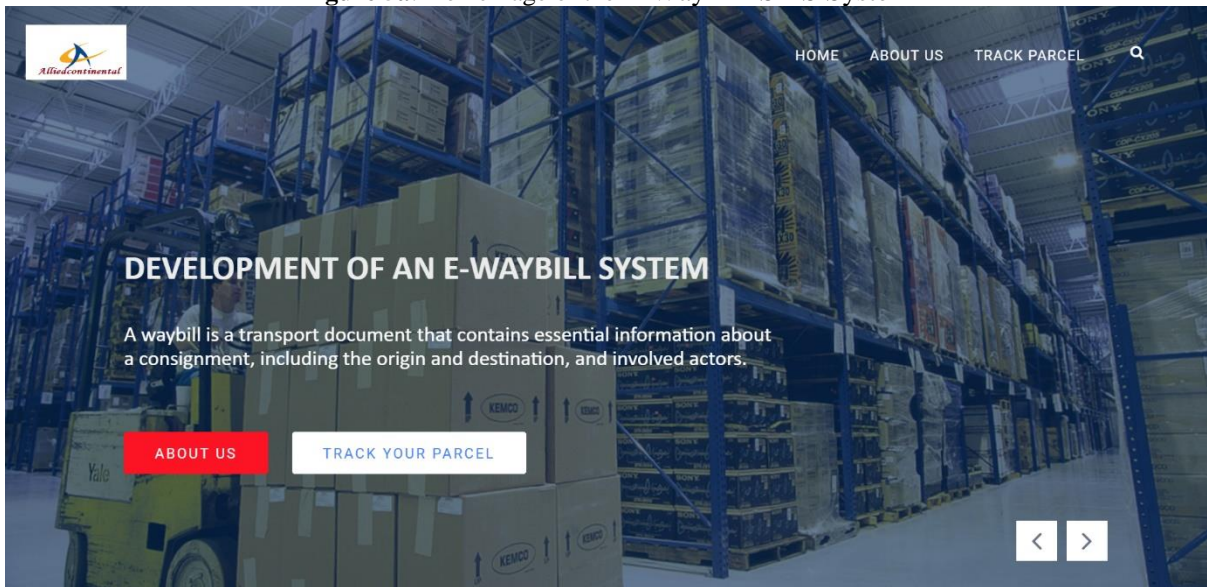
Figure 5b: Home Page of the E-WayBill-SMS System

Figure 6: About the Project Page of the E-WayBill-SMS System

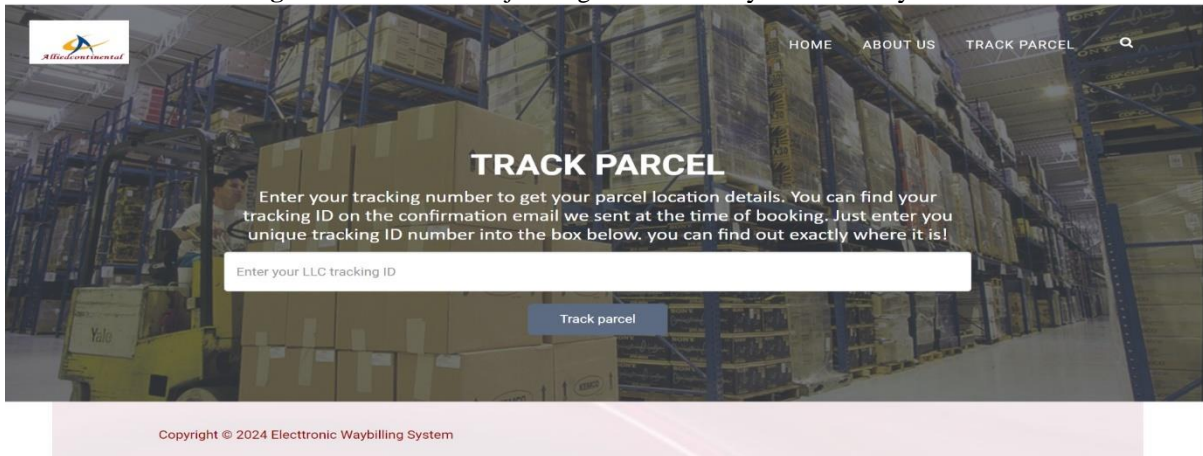**Figure 7**: Track Parcel Page of the E-WayBill-SMS System

Figure 8: Sign-In Page of the Courier Tracking Panel
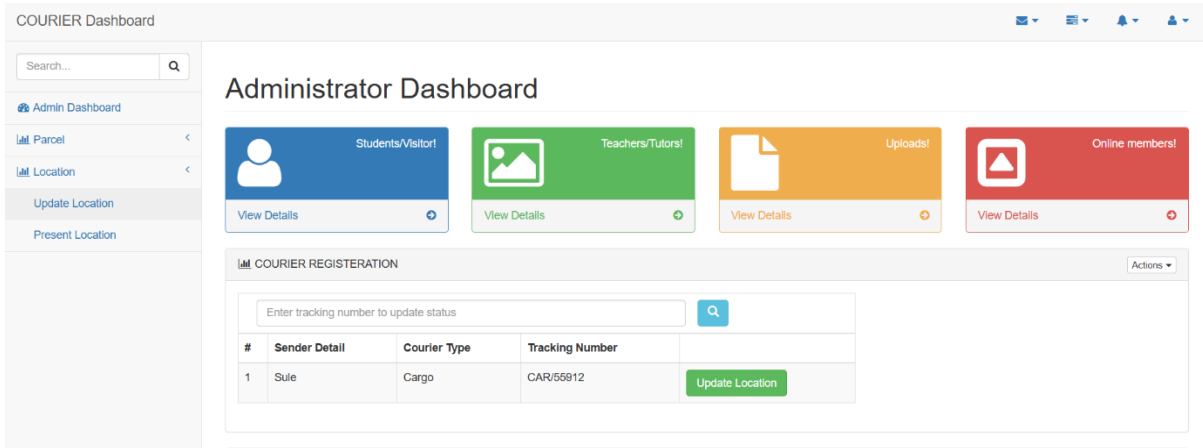
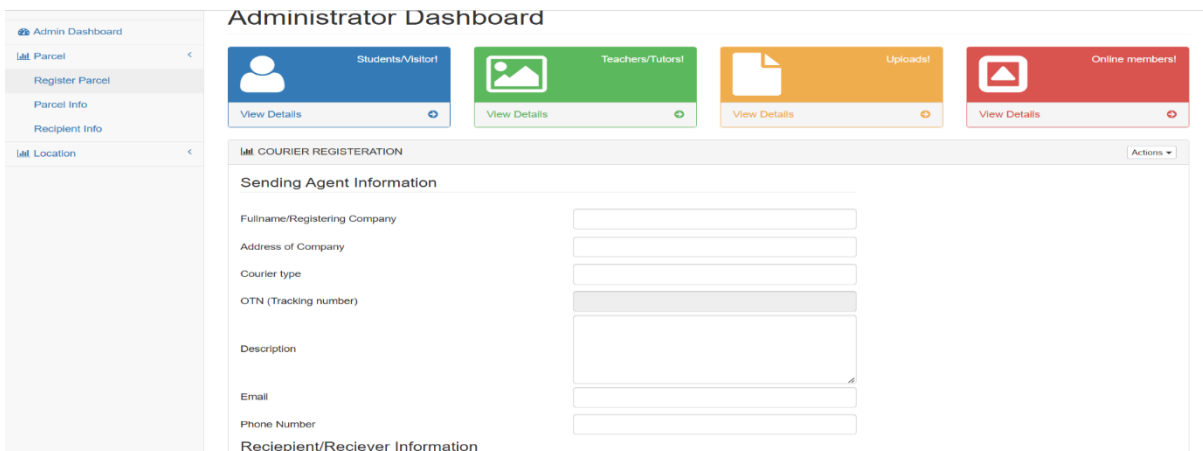**Figure 9**: Courier Dashboard for Courier Registration Page

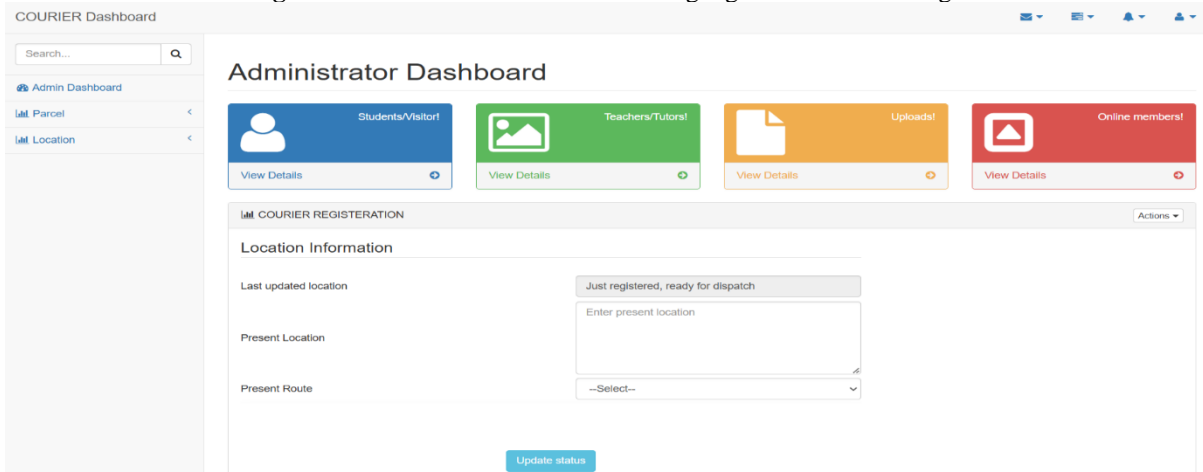**Figure 10**: Admin Dashboard for Sending Agent Information Page

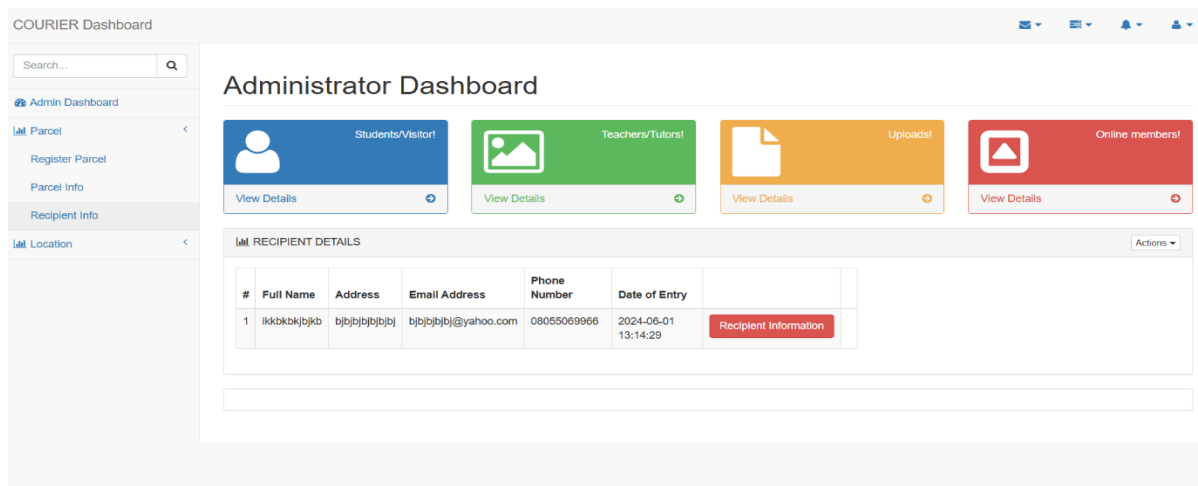**Figure 11**: Courier Dashboard for Location Information Page

Figure 12: Courier Dashboard for Recipient Details Page

Submenu implementation

In the e-WayBill-SMS system, the sub-menu plays a vital role in enhancing user navigation by offering quick access to specific features. The sub-menu is designed to be simple and user-friendly, allowing users to easily access different functions based on their role (admin, shipper, or courier). Each sub-menu is implemented using PHP and JavaScript, with backend support to handle user requests and return relevant data from the database. The main sub-menu options include:

i. **Waybill management**: This sub-menu allows users to create new waybills, view existing waybills, and update waybill details.
ii. **Shipment tracking**: Users access real-time tracking information by entering a Waybill ID. The system updates the shipment's status and location.
iii. **User management**: Admins manage system users, including adding new users, updating user roles, or removing inactive users.
iv. **SMS notifications**: This option allows users to view the status of SMS notifications sent to clients, including successful or failed delivery.

Program module implementation

The system is implemented in modules, each handling specific functionalities to ensure flexibility and ease of maintenance. Each module is implemented using PHP for backend processing and MySQL for data storage, with HTML/CSS and JavaScript managing the frontend interface. The following are the key program modules:

i. **Waybill module**: This module handles the creation, updating, and storage of waybill information. It interacts with the database to store waybill details such as sender, receiver, item description, and shipment status.
ii. **Tracking module**: This module retrieves shipment information based on the Waybill ID. It queries the database for the current status and sends this information back to the user via SMS or the web interface.
iii. **User management module**: This module is responsible for handling user registration, login, role assignment, and password management. It includes validation checks to ensure the security of user data.
iv. **SMS notification module**: This module is responsible for sending real-time SMS notifications to users. It interfaces with the SMS gateway API and logs the status of each message in the database.

Results

System testing is essential to ensure that all functionalities of the e-WayBill-SMS system work as intended and meet the research requirements. It involves testing the system under various conditions to see the result of what has been developed to identify bugs, inconsistencies, or areas that require improvement. The testing process includes:

i. **Unit testing**: Each module (Waybill, Tracking, User Management, SMS Notifications) was tested independently to ensure it functions as expected.
ii. **Integration testing**: After unit testing, the modules are integrated, and their interaction was tested to confirm that they work together seamlessly.

iii. **System testing**: The complete system was tested in a real-world environment, including testing on different desktop and checking SMS notifications via the GSM gateway.

The following test data was used during the testing process:

a) **Test case 1**: Create a new waybill with complete sender, receiver, and item details.
   i. **Expected result**: Waybill was successfully created, Waybill ID was generated, and confirmation SMS was sent to sender and receiver.

b) **Test case 2**: Attempt to create a waybill with missing receiver contact details.
   i. **Expected result**: System displays an error message requesting the missing information.

c) **Test case 3**: Track an existing waybill by entering its Waybill ID.
   i. **Expected result**: The system displays the current shipment status and location.

d) **Test case 4**: Send an SMS notification to the recipient of a waybill marked as "Delivered."
   i. **Expected result**: SMS notification was sent successfully, and the status was updated in the system.

e) **Test case 5**: Generate a report on the number of waybills created in the past month.
   i. **Expected result**: The system generates a report with the total number of waybills created and their status.

The results from the system testing phase showed that the e-WayBill-SMS system meets the functional and technical requirements. The system successfully created and tracked waybills, sent SMS notifications, and allowed users to manage their profiles. Specific findings include:

i. **Waybill creation**: The system could create waybills with valid input, and the Waybill ID was automatically generated and stored in the database. SMS notifications were sent to the sender and receiver, confirming successful waybill creation.

ii. **Tracking functionality**: The tracking module accurately retrieved shipment status and location when provided with a valid Waybill ID. The SMS notifications were sent without delays, and the system updated the status in real-time.

iii. **User management**: User accounts were created and managed efficiently, with appropriate role-based access control enforced for different users (admin, shipper, courier).

iv. **SMS notification**: The SMS module successfully communicated with the SMS gateway, and all test SMS notifications were sent and delivered as expected.

v. **Report generation**: The reporting module generated accurate reports on system activity, including the total number of waybills created and their status.

The performance of the e-WayBill-SMS system was evaluated based on several criteria, including speed, accuracy, and reliability. The system demonstrated good performance across the board:

i. **Speed**: Waybill creation, shipment tracking, and SMS notifications were processed in under a second, ensuring a seamless user experience. The system responded swiftly to user inputs, with no noticeable delays in transaction handling.

ii. **Accuracy**: The system provided accurate waybill details, shipment status updates, and notifications. All data entered into the system was correctly stored and retrieved without errors.

iii. **Reliability**: The system remained stable under varying levels of traffic and no major issues such as crashes or data loss occurred during testing. The SMS notification feature, which is a core component of the system, performed consistently without failure.

These results indicate that the system is efficient and reliable for real-world deployment.

While the system performed well during testing, there were a few limitations to note. One key limitation was related to the SMS notification feature. The system relies on third-party SMS gateways for sending messages, which could potentially lead to delays or failures in areas with poor network coverage. Additionally, the system's performance may degrade if the number of transactions grows significantly, as it would require scaling both the database and SMS services. Another limitation is the system's dependency on user input, meaning that errors in data entry could lead to inaccurate waybill information or missed SMS notifications.

Discussion

The testing results confirmed that the e-WayBill-SMS system meets the functional requirements set forth at the beginning of the research. The system was able to create waybills, track shipments, and send SMS notifications as expected. Its speed, accuracy, and reliability make it a practical solution for businesses looking to streamline their waybill management process. One important point of discussion is the reliance on SMS notifications. While this feature improves communication between shippers and receivers, it is subject to the availability and quality of mobile network services. Future improvements could include alternative communication methods, such as email or app-based notifications, to offer more flexibility. The results show that the system is ready for deployment, but scalability concerns and network dependency should be addressed in future updates.

The security of the e-WayBill-SMS system is critical, as it handles sensitive shipment and user information. Several security measures was implemented to safeguard the system (and to ensure that the system remains protected against unauthorized access and data breaches) such as:

i. The system uses role-based authentication to ensure that only authorized users (admin and users) have access to sensitive features. Users must log in with a secure username and password to access the system.

ii. All data transmitted between the client and server, including waybill details and SMS notifications, is encrypted using secure socket layer (SSL) to prevent interception by unauthorized parties.

iii. Regular backups of the database are scheduled to prevent data loss in the event of a system failure or cyber-attack. Backup files are stored on secure external servers.

iv. Access to different modules is controlled based on user roles. Admins have full access, while other users have limited access to functions based on their roles, preventing unauthorized modifications to waybill data.

The e-WayBill-SMS system was designed to integrate seamlessly with existing logistics and shipment processes. The system's integration capabilities include: a third-party SMS gatewaynto send notifications (SMS gateway integration); the system uses a MySQL database to store all waybill-related data (database integration); the system provides a web-based interface that can be accessed through various devices, including desktops, laptops, and smartphones (Web-based integration).

Conclusion

The e-WayBill-SMS system provides a practical solution to common challenges in logistics, including slow and error-prone manual waybill processing and poor communication between shippers and receivers. This research focused on the design and implementation of the e-WayBill-SMS, aimed at improving the efficiency of waybill management in logistics operations. The system was developed to streamline the creation, tracking, and notification processes associated with shipments. Using an SMS-based notification feature, users can receive real-time updates on shipment statuses, ensuring better communication between senders and receivers. The development process involved defining system requirements, choosing appropriate hardware and software tools, implementing key modules (such as waybill creation, shipment tracking, and SMS notifications), and integrating with third-party services like an SMS gateway. The system was tested extensively to ensure it met functional and technical requirements, with successful results in most cases. The system's web-based interface and SMS notification feature significantly enhance the waybill management process, ensuring timely and accurate updates on shipment statuses. While the proposed Integrated E-Waybill System with Real-Time SMS Notification has the potential to significantly improve the efficiency and transparency of goods movement and tracking, there are several limitations that need to be acknowledged. One potential limitation of the system is its scalability. As the number of users and transactions increases, the system may face challenges in handling large volumes of data, potentially impacting performance. Furthermore, integrating the system with existing logistics and transportation systems could be complex, potentially limiting its scalability. To mitigate this, a scalable architecture should be designed to accommodate growing demands and reduce the need for significant infrastructure upgrades. Another potential limitation is user adoption. Some users may resist adopting the new system due to familiarity with existing processes or concerns about the system's usability. Providing adequate training and support to users could be time-consuming and costly, potentially impacting adoption rates. Additionally, technical issues, such as connectivity problems or system downtime, could negatively impact user adoption and satisfaction. To address this, user-centered design principles should be incorporated to improve the system's usability, and comprehensive training and support should be provided to users.Nonetheless, the research achieved its goal of creating an efficient and reliable system for managing waybills electronically.

Recommendations

Based on the results of this research, the following recommendations are made:
a) Future versions of the system could incorporate additional communication methods, such as email notifications or app-based alerts, to reduce dependency on SMS and mobile networks.
b) As the system grows, it will be important to invest in more robust database solutions and potentially migrate to cloud-based infrastructure to handle increased transactions.
c) While the current system implements basic security measures, continuous updates and security audits should be carried out to protect against evolving cyber threats.
d) Adequate training should be provided to logistics personnel to ensure smooth adoption of the system, as well as ongoing technical support for users.

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