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A Smart Diagnostic, e-Prescription and Cryptocurrency Billing System

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Abstract— ***This study focuses on the development of a smart e-prescription and billing system that integrates blockchain, artificial intelligence (AI), and analytics to enhance healthcare services. The system's core features include an AI-driven symptom checker, appointment scheduling, and cryptocurrency-based billing. A systematic review of secondary data from academic studies and industry-related articles was conducted to assess current practices in drug prescription, dispensation, and existing software solutions. The symptom-checker model was trained using a dataset of 4,963 entries, with an 80/20 split between training and testing sets. A Decision Tree Classifier was employed, showing promising performance. The findings suggest that the e-prescription (eRx) application can reduce healthcare costs, minimize prescription errors, and improve the overall quality and efficiency of care. The system was built using frontend web technologies, with Python supporting backend functionalities. Cryptocurrency was implemented as the primary payment method, while machine learning was used to support appointment scheduling. The study recommends reliable internet access and adequate hardware for optimal system performance.***

Index Terms— ***Artificial Intelligence, Blockchain, Cryptocurrency, Decision Tree Classifier, e-Prescription, Healthcare, Machine Learning, Appointment Scheduling.***

I. INTRODUCTION

The digital transformation of healthcare systems has introduced remarkable advancements in improving patient care and streamlining medical processes [1]. One of the significant shifts has been the automation of medical prescriptions and billing through e-prescription systems [2], which reduce the risk of manual errors, improve prescription accuracy, and enhance patient safety. However, traditional e-prescription systems face challenges in terms of security, transparency, and efficiency in payment processing [3]. To address these challenges, modern systems have begun integrating blockchain technology and machine learning (ML) algorithms [4].

Blockchain technology ensures transparency, data immutability, and security in medical billing and record-keeping, while machine learning models enhance diagnostic accuracy by detecting patterns in patient data that might otherwise go unnoticed [5]. This combination has the potential to revolutionize the way healthcare providers interact with patients and manage their information, from diagnosis to treatment and billing [6]. This study focuses on the development of an e-prescription billing system that incorporates blockchain, cryptocurrency, and AI-based diagnostic tools to provide an all-in-one solution for healthcare providers [7].

II. BACKGROUND AND SIGNIFICANCE

The advent of new technologies has positively impacted the medical sector, assisting in the development of new healthcare systems that benefit both patients and the industry [8]. These advancements have contributed to improvements in areas such as diagnosis, disease prevention, treatment, and more.

e-Prescription, which refers to the use of computing devices to enter, modify, review, and transmit medicine prescriptions [9], became widely recognized with the 2003 Medicare Modernisation Act (MMA) and was legalized for use in 2007. The implementation of e-prescriptions has significantly advanced the healthcare industry, moving it further into digitization [10].

Blockchain, which is likely to be the future of online financial transactions, was integrated into the e-prescription application for seamless payment processing and invoicing [11]. This study focused on cryptocurrency, a token issued via a cryptocurrency system, used as a medium of exchange between parties. The first electronic medical record (EMR) was developed in 1972 by the Regenstrief Institute in the United States, marking a major advancement in medicine [12]. EMRs store patients' medical histories, and appointments scheduled on the application, leading to diagnoses, are updated in these records.

The hospital dispensary, responsible for administering drugs, confirmed and dispensed the prescribed medications for delivery. A tracking system was developed to monitor the status of orders from the dispensary to the patient. Each step in the payment and delivery process was tracked, with notifications sent to patients via email, and they could also log in to track their orders. The payment status was updated immediately after an order was made, and the delivery status tracked the entire logistics process. Patients were allowed to request or change services, view, or pay bills online via a cryptocurrency-based payment system.

Business Analytics, defined as the application of analytics to solve business problems [13], was employed in the study.

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Data was gathered, analyzed, and used to predict outcomes, enabling decisions based on the best solutions derived from the analysis.

In conclusion, this study utilized modern technology to enhance the safety, security, and efficiency of the healthcare system, benefiting all involved parties. The data produced aimed to improve patient safety and confidentiality, reduce administrative costs in hospitals, increase accessibility to prescriptions and medical records, and improve pharmacy workflows. Cryptocurrency as a payment option is a step toward the future of finance, providing an alternative to traditional credit card payments. This research also benefits healthcare institutions seeking alternatives to traditional drug prescriptions, and future studies may explore further applications of Blockchain in the healthcare industry.

III. MODEL OF AN E-PRESCRIPTION SYSTEM

- **Electronic Prescriber:** e-Prescribing, or electronic prescribing, was defined as a technology framework that allowed physicians and other medical practitioners to write and send prescriptions to participating pharmacies electronically [14], rather than using handwritten notes, faxed prescriptions, or calling in the orders.
- **Transaction Hub:** The transaction hub enabled communication between practitioners, pharmacy business managers, and pharmacies. It not only stored, but also kept track of the patient's file directory, allowing for easy access to health records. Additionally, it maintained a network of pharmacies in the area for efficient communication and processing of prescriptions.
- **Pharmacy:** When a pharmacy received medication orders from the transaction center, a confirmation message was sent to the prescriber. The system also allowed pharmacies to notify physicians that the e-prescribing system had been used to process the prescription order. The system was expected to undergo future development, allowing for additional communications, such as notifying a physician when a patient had not picked up their medication or was late in doing so, enhancing patient management.
- **Order Tracking:** Once an order was placed, couriers automatically generated a waybill package. This waybill came with a unique number, allowing both the courier company and the customer to track the progress of the delivery.

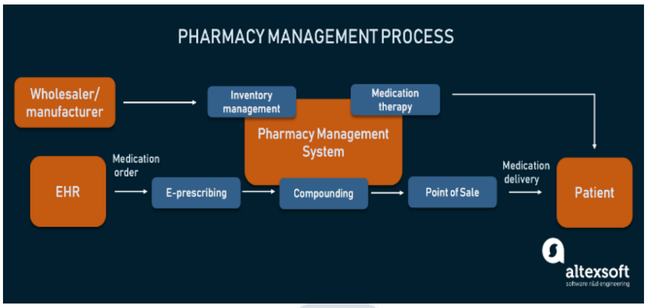

Fig. 1. Illustration of the Pharmacy Management

IV. MATERIALS AND METHODS

In this section, the authors collected, analyzed, and interpreted datasets. They also analyzed similar software and machine learning algorithms. The analysis of the proposed system included the identification of functional requirements, non-functional requirements, hardware, and software specifications. Lastly, the study covered the development of proposed machine learning models, which involved data cleaning (data transformation), identification of relevant datasets, and feature selection.

A. Justification Of Prototype Model

The prototype model was a software development life cycle model in which a prototype was built, tested, and reworked until it achieved acceptance. This model was best used when the details of the requirements were not fully known, as it employed a trial-and-error approach between clients and customers. Since the authors acted as both clients and customers in this study, the prototype model was chosen for development.

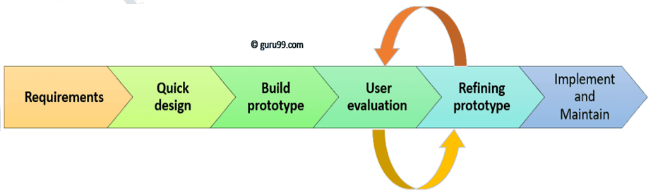

Fig. 2. Illustrates the prototype model, detailing all phases involved in system development, from the requirements phase to the implementation and maintenance phase.

B. Analysis Of Proposed System

The e-Prescription app was designed to not only improve and bridge the gap between patients and healthcare systems, but also, with the use of an artificial intelligence model, assist in diagnosing a patient based on their symptoms, automatically referring them to a specialist. When new data was received from the user (patient), it was used to further train the model. The prescriber was able to prescribe medications to the user, and the system directed the user to pharmacies with the prescribed drugs available. The entire process, including purchasing and tracking the order, was monitored through a tracking system, with payments processed through cryptocurrency. All data was secured using Blockchain technology.

The web application was divided into three user categories: Consultant, Dispensary, and Patient. A REST API was employed to facilitate communication with the database. Additionally, the API communicated with a third-party API from Coinbase to handle the cryptocurrency payment process.

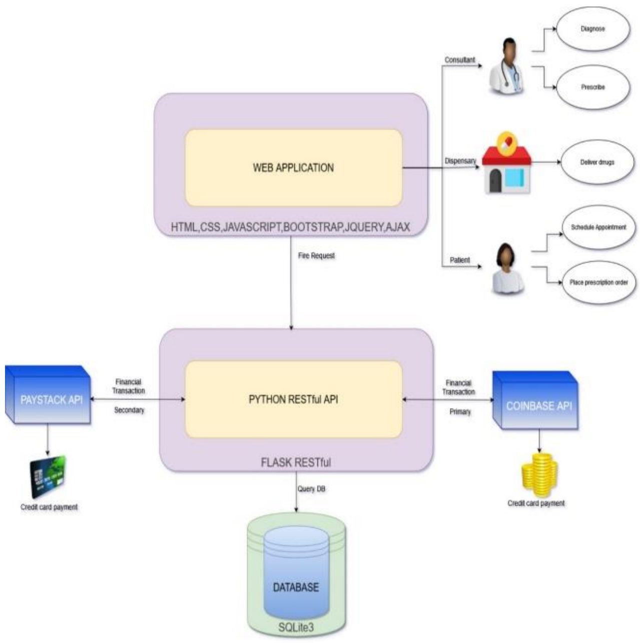

Fig. 3. Illustrates how the web application was split into three user categories: Consultant, Dispensary, and Patient.

Fig. 4. Depicts the use case diagram of the eRx billing application system.

C. Functional Requirements

The functional requirements of the e-Prescription system defined what the system was expected to do and the functions required for the system to be considered complete. They specified the study deliverables that needed to be provided to achieve the goal. The requirements were as follows:

i. The system allowed medical consultants to prescribe drugs for patients.
ii. The system enabled patients to schedule appointments with medical consultants.
iii. The system recommended the symptom checker algorithm as an alternative for choosing an appointment category.
iv. The system provided access to patients' medical records for both medical consultants and their patients.
v. The system included payment options with cryptocurrency and credit card use.
vi. Appointment, prescription, and order history were made available within the system.
vii. The system generated a receipt after every financial transaction.

D. Non-Functional Requirements

Non-functional requirements specified the criteria used to judge the operation of the system, focusing on how the system behaved rather than specific behaviors. These requirements established constraints on the system's functionality and were crucial for its operation but did not necessarily affect its development.

Table 1: Non-Functional Requirements

Property	Requirements	Measure
Availability	The system was expected to be online and running at all times	Server uptime
Usability	The system needed to be user-friendly, allowing users to navigate it easily.	Ease of use
Security	Only users with accounts on the platform and access granted by the user could use the model and access data.	User account
Speed	The system was required to run efficiently even on slow internet speeds.	Load time
Website responsiveness	The website needed to render well on a variety of devices and screen sizes, from maximum to minimum display sizes.	Cascading Style Sheets (CSS)

E. Hardware Requirements

The application was a web-based system designed to run seamlessly on a browser. However, for optimal performance, certain hardware requirements needed to be met:

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Administration/Server:

i. RAM: 8GB (minimum), 16GB (recommended)
ii. Hard drive space: 500GB (minimum), 1TB (recommended)

Client/User:

i. RAM: 512MB (minimum), 1GB (recommended)
ii. Hard drive space: 1GB (minimum), 5GB (recommended)

F. Software Requirements

Administrator/Server:

i. Operating system: Windows
ii. Node.js must be installed
iii. MySQL
iv. Python must be installed
v. Parcel Bundler must be installed

Client/User:

i. Operating system: Windows Vista, 7, 8, 9, 10, 11, Mac OS, Linux, iOS, Android
ii. A browser capable of running JavaScript

G. Dataset

A dataset is a collection of pieces of data gathered together and treated by a computer as a single unit for analytic and prediction purposes [15]. The dataset used in this system was intended for predicting 42 illnesses and included all the necessary attributes and values.

The symptom checker dataset contained 133 categories, including diagnosis, itching, chills, joint pain, acidity, vomiting, fatigue, anxiety, headache, dehydration, sweating, and more. It included numerical values of 0 for NO and 1 for YES, along with a string datatype column for prognosis, which contained the predicted diseases.

Data Source

The data was sourced from **Kaggle**, a subsidiary of Google LLC that provides a community of data scientists and machine learning practitioners. Kaggle offers a customizable, no-setup Jupyter Notebook environment, access to GPUs, and a vast repository of community-published data and code.

Sample Size

The dataset had a total of 133 columns and 4963 entries. Two sample sizes were developed for disease prediction:

- **Training Sample Size:** This sample consisted of 133 columns and 3,970 entries, with 132 columns representing the symptoms of each patient and the last column containing the diagnosis. It was used to train the machine to accurately and efficiently predict diseases. A larger amount of training data generally improves the accuracy of the machine.
- **Testing Sample Size:** This sample comprised 133 columns and 993 entries, with 132 columns representing the symptoms of each patient and the last column containing the diagnosis. After training, the machine was tested with this sample to measure its accuracy and assess how well it had learned.

Data Types

The data types used in the algorithm included integers and strings. Integers were used as Boolean values, with 1 representing YES and 0 representing NO. Strings were used as outputs to denote the prognosis of the result.

H. Data Cleaning

In this section, the authors discussed the cleaning of data, also known as data transformation. Data cleaning involved the identification and correction of errors in a dataset that could negatively impact a predictive model. The cleaning process focused on datasets with empty entries or inconsistencies in data types.

I. Feature Selection

Feature selection was the process of reducing the number of input variables used in developing a predictive model. It aimed to not only save computational resources and costs but also to improve the accuracy of the model. Techniques involved in feature selection included:

i. Univariate selection
ii. Feature importance
iii. Correlation matrix with heat map

J. Design Tools

The design of the e-Prescription and Billing Application using Blockchain Technology and Analytics employed various tools. As a web-based system, the development required web-based tools for the user interface. A server-side language was used to run scripts, manage the artificial intelligence system, and ensure efficient communication with the database. The following tools were utilized in the development:

Client-Side Tools

The client-side, or frontend, is the part of the system with which users interact. It includes the Graphical User Interface (GUI), system functionality and features, and user experience (UX). The languages used to build the client-side of the application were HTML5, CSS3, and JavaScript.

Server-Side Tools

The server-side, or back-end, of the web-based system is not directly accessible or interactable by users. It processes data, communicates with the database, and stores user data and the artificial intelligence algorithm. The languages used for building the server-side of the application included MySQL, Python, Flask, AJAX, and jQuery.

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V. FEATURES OF PROPOSED SYSTEM

The system incorporated the following features:

i. A convenient user interface that allowed each user to sign up, log in, and perform all necessary activities.
ii. Ease of access between patients, doctors, prescribers, and pharmacies.
iii. A fast and secure means of payment.
iv. The ability to monitor and track orders.
v. A symptom checker algorithm to help direct patients to specialists.

VI. RESULTS

A fully functioning smart e-Prescription system was built using Python-Flask and other front-end web technologies. The e-Prescription system enabled patients to schedule appointments with their preferred consultants and obtain authentic prescriptions. Patients could place orders from the hospital's dispensary. During development, challenges such as connecting the frontend to the database through the API and training the symptom-checker machine model were encountered. However, the developers successfully overcame these issues.

VII. DISCUSSION

The software was categorized into three user types: Patient, Consultant, and Dispenser.

Upon arrival on the web application, users were first greeted with the login page. Users were required to log in using their User-IDs and passwords, along with selecting their appropriate user type: Patient, Consultant, or Dispensary.

The patient dashboard page included a navigation bar, a few of the patient's vitals, patient-ID, name, and any upcoming appointments. The activities box recorded and displayed activities performed by the patient on the application, along with the timestamp of when these activities occurred.

The patient medical record page provided access to the electronic medical record of the patient. This record was available and accessible to the patient but immutable from this view. It included the patient's diagnoses, hospital visits, most recent vitals taken, and allergies.

The prescriptions page displayed the drugs prescribed to the patient following a diagnosis from an appointment. Details such as the drug name, serving, price, and prescription ID were shown on a card, along with the appointment ID that led to the prescription.

The billing and payments page appeared as a pop-up modal once the order button was clicked. This page requested a mode of payment from users, offering Cryptocurrency (primary) and Credit card (alternative) options. When cryptocurrency was selected, patients were redirected to a Coinbase checkout page. The page offered various coins and included a webhook to return the payment status based on Coinbase's confirmation. Patients had one hour to complete the transaction before the coin addresses became invalid. If credit card payment was selected, a Paystack checkout popup appeared, prepopulated with the patient's email and prescription payment details. The checkout was displayed in test mode for transaction testing without real money. In live mode, the popup included a section for entering credit card details for payment. A receipt was sent to the patient's email upon successful transaction.

Initially, when the appointment scheduling page was visited without prior appointments, it displayed an icon to allow patients to add a new appointment. Clicking the 'add new appointment' button brought up a modal with a list of specialists and consultants available under that specialization. Patients could select a consultant and provide a description for scheduling or use the symptom checker feature. Clicking 'submit request' sends the appointment request to the selected consultant for approval.

The symptom checker was a machine learning algorithm that used symptoms provided by the patient to predict possible conditions and suggest the appropriate consultant for the diagnosis.

The consultant dashboard page featured a navigation bar, total appointments, total prescriptions given, consultant-ID, name, and upcoming appointments. The activities box recorded and displayed activities performed by the consultant, with timestamps. The consultant appointment page displayed pending requests and scheduled appointments. When approving a pending appointment request, a modal appeared for providing date, time, and venue for the meeting, either virtually or in person. Once an appointment was approved and completed, the consultant could click "mark as completed" to indicate the session's end. A modal then appeared to retrieve the consultant's diagnosis and make a prescription if necessary.

VIII. CONCLUSION

Cryptocurrency is a technology that is rapidly developing, with applications spanning finance, health, transportation, and security. This technology was employed to modernize the traditional prescription and billing process used in institutions like Babcock University. By facilitating a reasonable level of convenience in acquiring drugs post-prescription and handling payments within the same system, the e-Prescription and billing application aimed to integrate Blockchain and analytics effectively. This approach sought to streamline and enhance the efficiency of the prescription and billing process.

IX. COMPETING INTEREST STATEMENT

The authors declare no competing interest.

X. DATA AVAILABILITY STATEMENT

The data underlying this article will be made available on request to the corresponding author.

REFERENCES

[1] A. Garcia-Perez, J. G. Cegarra-Navarro, M. P. Sallos, E. Martinez-Caro, and A. Chinnaswamy, "Resilience in healthcare systems: Cyber security and digital transfor mation," Technovation, vol. 121, no. 14, p. 102583, 2022, doi: 10.1016/j.technovation.2022.102583.

[2] M. Vejdani, M. Varmaghani, M. Meraji, J. Jamali, E. Hooshmand, and A. Vafaee-Najar, "Electronic prescription system requirements: a scoping review," BMC Med. Inform. Decis. Mak., vol. 22, no. 1, 2022, doi: 10.1186/s12911-022-01948-w.

[3] S. Alsahali et al., "Perceptions of Community Pharmacists toward the National E-Prescribing Service (Wasfaty) and Exploring the Benefits and Challenges of the Service: A Descriptive Study from Qassim Region, Saudi Arabia," Pharmacy, vol. 11, no. 5, p. 152, 2023, doi: 10.3390/pharmacy 11050152.

[4] J. Li, X. Luo, and H. Lei, "TrustHealth: Enhancing eHealth Security with Blockchain and Trusted Execution Environments," Electronics, vol. 13, no. 12, p. 2425, 2024, doi: 10.3390/electronics13122425.

[5] D. Wang, J. Mo, G. Zhou, L. Xu, and Y. Liu, "An efficient mixture of deep and machine learning models for COVID-19 diagnosis in chest X-ray images," PLoS One, vol. 15, no. 11, p. e0242535, 2020, doi: 10.1371/journal.pone.0242535.

[6] M. J. Iqbal et al., "Clinical Applications of Artificial Intelligence and Machine Learning in Cancer diagnosis: Looking into the Future," Cancer Cell Int., vol. 21, no. 1, 2021, doi: 10.1186/s12935-021-01981-1.

[7] A. Kumar Tyagi and A. Abraham, "Integrating Blockchain Technology and Artificial Intelligence: Synergies, Perspectives, Challenges and Research Directions," 2020. [Online]. Available: https://www.softcomputing.net/tyagi 2020jias.pdf

[8] U. Nzenwata, O. Bakare, and O. Ukandu, "Artificial Intelligence: Positive or Negative Innovation," Int. J. Emerg. Trends Eng. Res., vol. 11, no. 7, pp. 245–252, 2023, doi: 10.30534/ijeter/2023/031172023.

[9] J. Froger-Lefebvre, Q. Lade, E. Vallier, and C. Bourgain, "E-prescription and invisible work in genomics in France," Front. Sociol., vol. 8, no. 15, 2023, doi: 10.3389/fsoc.2023. 1152364.

[10] R. C. Widyantoro and P. Oktamianti, "E-Prescription Implementation: An Analytical Study On The Transformation Of Medical Records From Physical To Electronic," J. EduHealth, vol. 15, no. 03, pp. 421–438, 2024, [Online]. Available: https://ejournal.seaninstitute.or.id/index.php/healt/ article/view/4901

[11] R. K. Alhassoun and S. A. AlDossary, "Utilization of remote e-prescription (Anat) in Saudi Arabia during COVID-19: Factors associated with primary adherence and antibiotic prescription," Digit. Heal., vol. 9, 2023, doi: 10.1177/2055207 6231194925.

[12] M. Samadbeik et al., "Education and Training on Electronic Medical Records (EMRs) for health care professionals and students: A Scoping Review," Int. J. Med. Inform., vol. 142, no. 1, p. 104238, 2020, doi: 10.1016/j.ijmedinf.2020.104238.

[13] P. Mikalef, "Big data and business analytics: A research agenda for realizing business value," Inf. Manag., vol. 57, no. 1, p. 103237, 2020, doi: 10.1016/j.im.2019.103237.

[14] F. Alshahrani, J. F. Marriott, and A. R. Cox, "A qualitative study of prescribing errors among multi-professional prescribers within an e-prescribing system," Int. J. Clin. Pharm., vol. 43, no. 11, pp. 884–892, 2020, doi: 10.1007/s 11096-020-01192-0.

[15] F. S. Daniş, A. T. Naskali, A. T. Cemgil, and C. Ersoy, "An indoor localization dataset and data collection framework with high precision position annotation," Pervasive Mob. Comput., vol. 81, no. 15, p. 101554, 2022, doi: 10.1016/j.pmcj.2022. 101554.

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