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Predictive Pharmacy Management System Using Machine Learning Algorithm

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ABSTRACT

Organizations growth depends heavily on the quality of decisions made. In the pharmaceutical industry, the ability to organize as well as make informed decisions is critical for effective drug management. This paper reported the development of a predictive pharmacy management system. Using the Structured System Analysis and Design Methodology, a pharmacy record management and predictive system was developed. The system predicted vital business patterns based on season using a polynomial regression machine-learning algorithm. PHP, Apache Web Server, and MySQL programming languages were used to entirely automate the Pharmacy Management process, among other functions. Implications for the sector include the system's capacity to forecast patient/customer demand patterns based on the time of the year utilizing Machine Learning Algorithms. The designed system would assists in promoting pharmaceutical industry's long-term viability, as it reduces the circulation of expired drugs and improves business turnover for the industry and the country as a whole.

Keywords: Predictive, Pharmacy, Management System, Machine Learning Algorithm, Drug Management

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1. INTRODUCTION

Organizations are looking at boosting productivity and efficiency by frequently investing in information systems to automate routine tasks and improve workflow. Such systems provide management with a comprehensive view of the business's operations, which improves decision-making. The consequence of such information systems is the amount of data that can be generated. This further necessitates the use of advanced algorithms to analyse, make sense of the data, and generate useful insights. Machine learning (ML) has been very useful in this regard. According to Sanjeev (2018), the fundamental premise of machine learning is to teach a computer to look for patterns in the data and to improve via experience and interaction with the data. Due to the convergence of three factors: data, hardware, and increased revenue, the usage of machine learning algorithms has become widespread. These variables contribute to a self-reinforcing phenomenon: insights from ML algorithms boost the customer base, the expanded customer base increases revenue, and the revenue earnings are utilized to research and build newer algorithms and advanced hardware (Smola & Vishwanathan 2008).

1.1 Problem statement

The non-computerization of most of the pharmaceutical enterprises in Nigeria has continued to serve as a major challenge to the development and sustenance of the industry (Gavin Edwards, 2020). Currently, the pharmacy at M3 Clinic and Maternity LTD is not automated. All the process has to be done manually. If the manager wants to get information about drugs, or other related records they have to find the data through the manual system.

Therefore, the difficulties or challenges faced include:

- Lack of centralized storage
- Is not automated and mistakes of record taking are vulnerable
- Information about daily work can't be accessed outside the pharmacy as compared to the proposed online system
- 100% possible to have duplicates of information in storage therefore the system needs attention by going across the list or file all the time to check duplicates.
- Prone to mistakes and financial leakages
- Prone to product wastage and mismanagement of resources

The absence of artificial intelligence in the existing developed systems is even making the case worse as most pharmacies fizzle out of business due to the absence of a predictive and sustainable model that guarantees that appropriate signals are generated to the management to ensure that appropriate drugs are stocked based on the demand and seasons (Osang and Umoren, 2020).

This research work focussed on overcoming the aforementioned setbacks as a new automated and predictive record system, with intelligent interactive features will be designed and implemented. The system has the following objectives:

a. Define the existing pharmaceutical companies concerning their automated status in Nigeria
b. Design record management and predictive system that can support the seasonal prediction of drugs availability
c. To implement the designed system in (b) above
d. To carry out performance evaluation of the developed predictive system vis-à-vis the old system.

This study described how a machine-learning algorithm was used to create a prediction system for the pharmaceutical industry. A predictive system is only one component of a broader endeavour to automate everyday procedures in the pharmaceutical setting. The work focussed on is a web-based inventory management system that allows them to manage their supplies, keep track of inventory, and offer suggestions to automatically buy goods. It will notify the administrator of the list of pharmaceuticals with low stock levels and highlight the drug's expiration date.

2. RELATED LITERATURE

Thomas et al (2020) described automation as the use of machines to perform the majority of repeatable and significant operations in the pharmaceutical industry. Additionally, they stated that the history of integrating newer technology that replaces human power has been occurring in a variety of businesses around the world for many years now. The pharmaceutical industry has not been left behind. Goundry-Smith (2011) described and discussed the major areas of pharmacy IT innovation (e-prescribing, drug databases, electronic patient records, clinical decision support, pharmacy management systems, robots and automation, and so on) from a system and professional perspective. He examined how pharmacy and information technology are interconnected and may be utilized to facilitate and advance pharmacy professional practice.

Saha, Bhuiya, Masum, Islam & Chowdhury (2017) study discussed an updated hospital pharmacy management system in a Bangladesh Hospital. He stated that hospital pharmacies have long been regarded as the heart of any hospital, as they are connected to all other departments such as surgery, cardiology, nephrology, medicine, and paediatrics. He stated that development was necessary for hospital pharmacy to assure the right selection, preparation, storage, compounding, and dispensing of medications and medical equipment, as well as counselling for patient safety and compliance.

Bao, Wang, Shang, Ren & Ma (2013) reported on the deployment of a new clinical pharmacy management system to boost clinical pharmacist efficiency, undertake large-sample statistical analysis, and promote rational drug use. The department's 48,562 outpatient and 5776 inpatient prescriptions were studied. The job efficiency of clinical pharmacists, as well as the quality and qualifying rates of prescriptions, were compared before and after the adoption of the clinical pharmacy management system. The qualifying rates of inpatient and outpatient general surgery prescriptions increased, while antibiotic usage decreased. To encourage rational drug use and pharmacy information service in our hospital, this technique appears to have boosted work efficiency while standardizing medication consumption. Meanwhile, aseptic surgeries require fewer prophylactic antibiotics.

All these systems depend on the abundance of data generated when going online. Edwards (2018) stated that there has been an explosion of data during the last 50 years and that this deluge of data is meaningless unless we analyse it and uncover the underlying patterns. Mukherjee (2020) noted this data could be used in a variety of ways. He stated that predicting an outbreak is a crucial example of this issue. Globally, machine learning and artificial intelligence technologies are being used to monitor and forecast disease outbreaks and seasonal illnesses. A predictive forecast aids in the planning of our supply chain by ensuring that inventory is received at the appropriate time and in the appropriate quantity depending on the projected intensity.

3. METHODOLOGY

The methodology used for this research work was *Structured System Analysis and Design (SSADM)*. SSADM is a collection of procedural, technical, and documentation standards for the creation of information systems, consisting of five main modules: feasibility research, requirements analysis, requirements specification, logical systems specification, and physical design module (Skidmore, Farmer & Mills 1994). SSADM takes a product-oriented approach in which each element, whether a module, stage, or step, generates predictable outputs from given inputs (Rogerson, Weckert & Simpson, 2000).

3.1 System Design

For reference, a diagram of the complete predictive pharmacy management systems is shown in Figure 1. The entity-relationship and the data flow diagrams are shown in Figures 2 and 3 respectively.

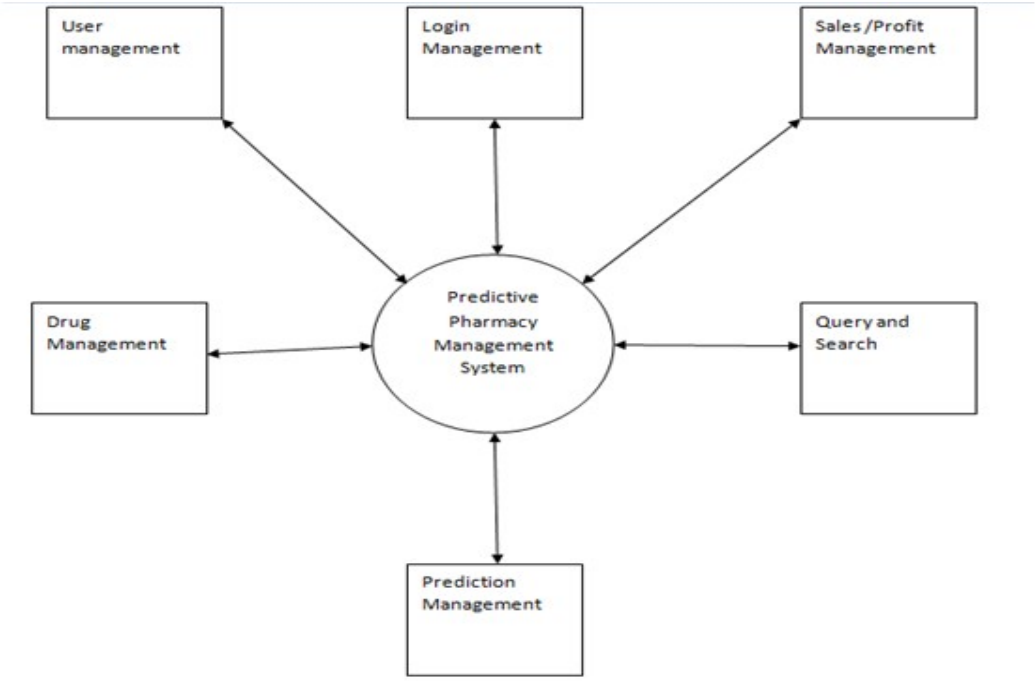

Fig. 1: System diagram of the Predictive Pharmacy Management System

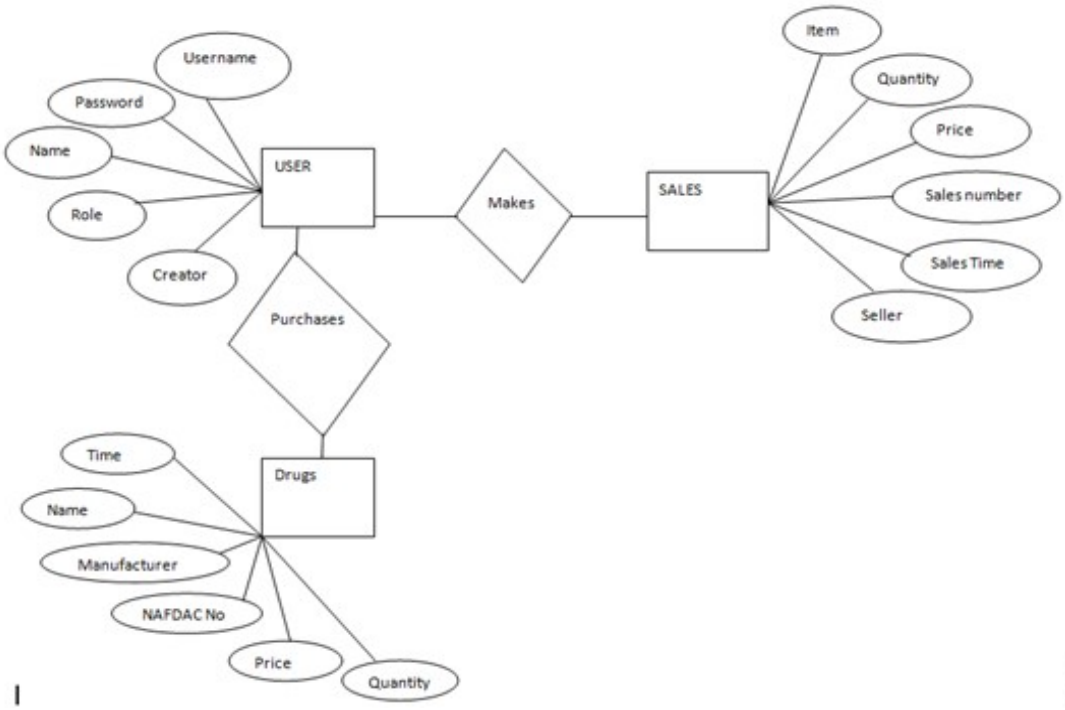

Fig. 2: Entity relationship diagram of the Predictive Pharmacy Management System

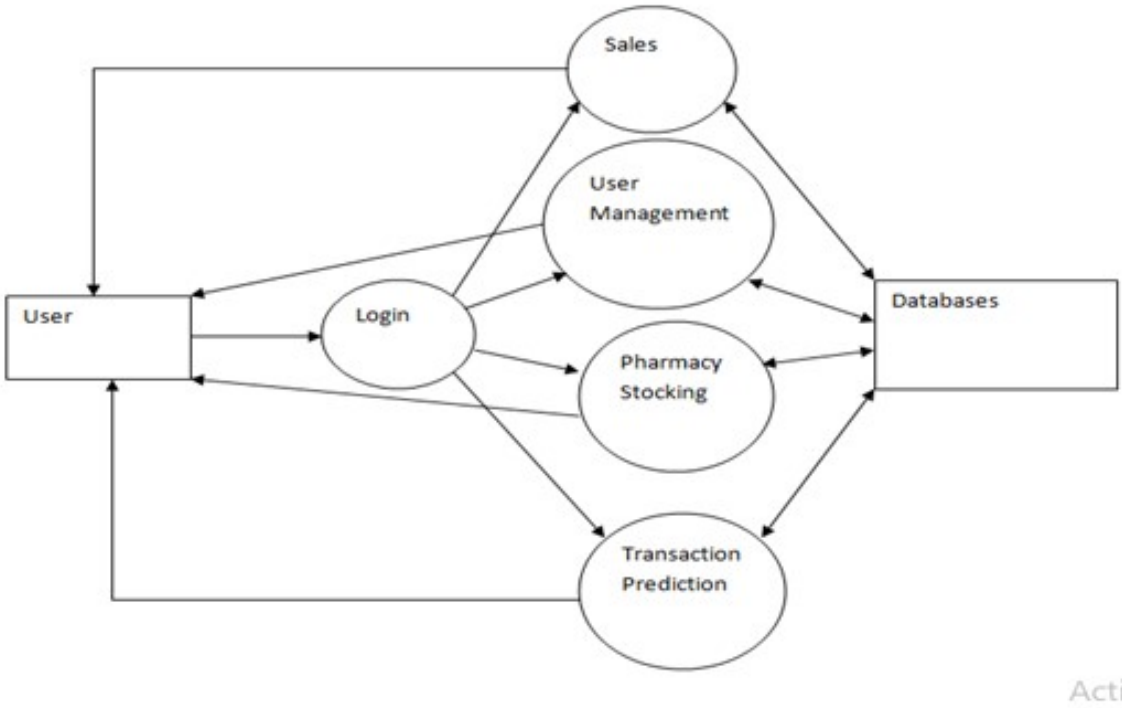

Fig. 3: Data Flow Diagram of the Predictive Pharmacy Management System

The Predictive Pharmacy Management System comprised of modules that perform the usual pharmacy management except that an additional module for prediction was introduced. The prediction module is the most important in this work because it converts the information gathered to knowledge that can be used to make an informed business decision.

Login Module: This module ensures that only authorized persons gain access to the application to use. It is by itself not only for security purposes but also for supervision and audit trail.

User Management: This module allows for some users to manage other users. Different levels of privilege can be granted and withdrawn at the instance of management.

Query and Search: A complex search algorithm was used to ensure that the search for items on the platform was seamless and easy.

Drug Management: This entails taking stock and performing some managerial tasks such as monitoring drug expiration state and quantity in an automated fashion taking into consideration logical and mathematical accuracies.

Sales Module: In this module, sales a recorded to provide vital data in the computation of periodic profit and cashier daily balancing functionalities. These modules also prepare the grounds for predictions capabilities.

Prediction Module: The machine learning algorithm, the Regressive Polynomial forms the basis of prediction.

3.2 Implementation of the Prediction Module

By providing data from the sales table, this module executes several machine language algorithms. The two columns of importance are the drug class of the sold products and the months of the transaction. The frequency of occurrence of the values in the 'drugclass' column of the sales table becomes the dependent variable (Y) (Y). The month of transaction becomes the independent variable (X) a link is created between the two variables with the equation shown in Fig 4 The expression developed gives a strong relation to predicting the likelihood of the occurrence in a given month of the year.

$Y = \Theta_0 + \Theta_1 X + \Theta_2 X^2 + \ldots\ldots\Theta_m X^m +$ residual errors ……..(1)

4. RESULTS AND DISCUSSIONS

Fig. 5 shows the polynomial regression graph of three drug classes in any given year (January to December). The scattered dots represented the transaction of drugs grouped by their drug classes and was differentiated by the colors: red, green and blue.

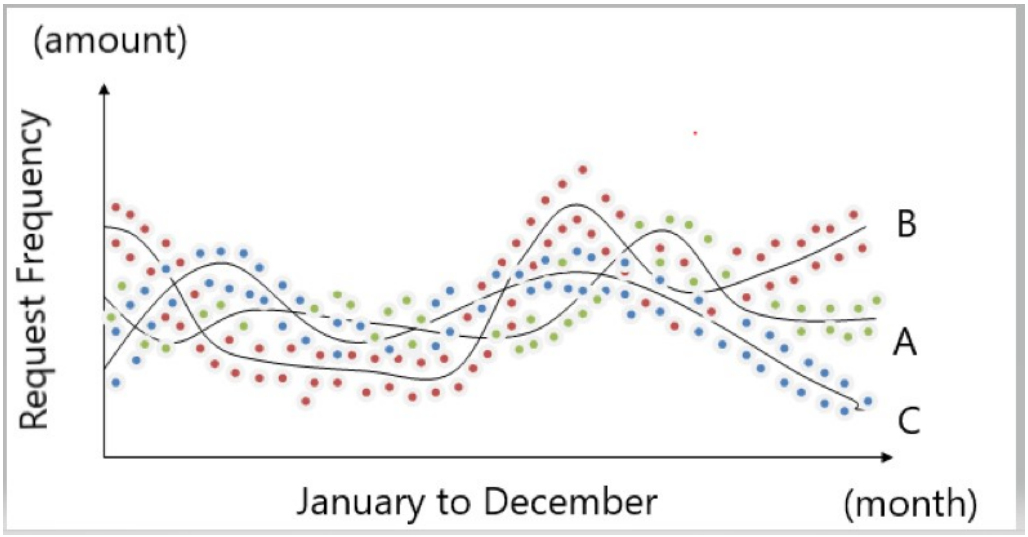

Fig 5: Graph of polynomial regression of the Predictive Pharmacy Management System
(Note: A, B and C are the lines of regression representing the predictive pattern of drug classes)

The prediction module allows the user to select from two options:

i. Transaction forecast by month'
ii. Drugs most likely to be requested.

Upon selection, the algorithm observed the pattern and establishes a relationship between the transaction rate of a drug class and the period of the year, it occurs. This module can display the expected transaction rate of the top three drug classes in any specified month of the year. In addition to the transaction rate prediction, this system predicted the top most requested items in the pharmacy. The accuracy of the polynomial regression algorithm is heavily dependent on a large amount of data from the pharmacy management system.

4.1 Significance of Prediction Module

The prediction information will guide in making business decisions on what items or drugs to make available at any time in the pharmacy. This ability will ensure that capital is not tied down on stock that will not likely be in demand Osang, Fayemi,. & Oluyide, (2019). In addition to financial management, the chances of ending up with expired drugs will be greatly reduced.

5. CONCLUSION

Automation prediction has several theoretical benefits in the pharmaceutical industry, including increased technologists' productivity, decreased financial loss, and improved overall image quality. Using machine-learning algorithms to develop a predictive pharmacy management system will increase the pharmaceutical industry's effectiveness. Given the near- and long-term implications of prediction, blind decision making will become obsolete, and corporate choices will be decided by software. This will assist proprietors of pharmacies and pharmaceutical makers in general.

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