

# Designing a Scalable Hospital Procurement System Using Object Oriented Paradigm

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## Abstract

*Hospital managers must consider ways to control costs without affected the quality of service delivery, this makes it necessary not only to have office automation tools that aid treatment and clinical operations but rather systems that streamline back office operations in hospitals. This paper exploits the capability of object-oriented programming in designing a procurement system that can accommodate the peculiarities of primary, secondary and tertiary hospitals. The study used basic building blocks, rules and common mechanism of Unified Modeling Language (UML) to model the behavior of the objects and Microsoft Visual studio was used to design the user interface inform of a window application. Based on this design procurement decisions are strictly guided by individual demand that arise from various ward/units of a hospital. It is recommended that future studies should implement the design using object-oriented programming language and look into the possibility of developing it a using mobile technology.*

**Keywords:** Hospital, Reusable, Procurement, Object Oriented.

## I. Introduction

The increasing need for a qualitative service in the health care sector makes it necessary to exploit the potential to store data efficiently, not just the clinical data and treatment, but also on hospital management, in order to minimize costs and improve the care given to patients. Database management contributes important benefits to the health sector [1]. Different organizations use different database process but aimed to achieve same goals. Quality improvement (QI) is an essential component of the medical enterprise. QI is a morally mandatory element of medical care, both for institutions to design and pursue and for patients to acknowledge and embrace; the need for QI is one facet of excellent medicine, a reality that physicians, patients, and medical organizations should integrate into the delivery of health-care services. Structures for implementing and testing advances in care and improved service-delivery systems demonstrate a commitment to excellence in medical practices and fidelity to patients' well-being. Institutions with robust systems for improving quality reflect ethical commitments to patients' best interests and support for integrity in clinical decision making [2].

The paper designed a system that handles the procurement process that is demand driven which can be used in different hospital system (primary, secondary, and tertiary).

Designing scalable hospital management system is of great importance. This also covers some critical parts that made up of the whole system such as registration, marking card, drug management and

dispensing, Meta data maintenance, reporting and database backup. Most hospital procurement systems have hindered care givers to access relevant information critical to healthcare delivery. Hospital stakeholders' information is routinely held in static paper storage and managed with a silo, mentality paper work is prone to high rate of errors. Thus, savings can be realized by more and better use of electronic record keeping, employing software that can detect mistakes and issue prompts [3]. According to [4] when healthcare providers rely on paper records, then information sharing and service delivery becomes often impossible.

However previous studies consider procurement system as one functionality of a sophisticated software technology which makes it too cumbersome for end users therefore there is need to have a single suite that handle procurement process in the hospital considering its significant role in hospital management.

The paper deals with development of interactive system for efficient record keeping and retrieval in relation to pharmacy. The proposed system concentrate on the following; simple flowchart for the system, defining classes of the system, designing UML Diagram showing relationship and multiplicities, queries for table creation, class declarations and attributes.

## **II. Literature review**

Innovation can be defined as —the intentional introduction and application within a role, group, or organization, of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, or wider society [5]. This definition is largely accepted among researchers in the field [6] as it captures the three most important characteristics of innovation: novelty, an application component and an intended benefit [4]. In line with this definition, innovation in healthcare organizations are typically new services, new ways of working and/or new technologies [4]. From the patient's point of view, the intended benefits are either improved health or reduced suffering due to illness [7]. Innovation was defined as the successful implementation of a novel idea in a way that creates compelling value for some or all of the stakeholders [8]. Recently [9] propose a narrower focus of impacting a company: —anything that creates new resources, processes, or values or improves a company's existing resources, processes, or values. What is important in defining innovation is the recognition that something new and hopefully better will emerge.

Innovations in health care are related to product, process, or structure. The product is what the customer pays for and typically consists of goods or services (for example, clinical procedure innovations). Process innovation entails innovations in the production or delivery method. A customer does not usually pay directly for process, but process is required in order to deliver a product or service. A process innovation, therefore, would be a novel change to the act of producing or delivering the product that allows for a significant increase in the value delivered to one or more stakeholders. Structural innovation usually affects the internal and external infrastructure, and creates new business models [10].

A study conducted by [11] to assess the effect of e-procurement on efficient procurement in public hospitals, how e-procurement improves quality of service and goods and ensures value for money in public hospitals. Activities of procurement can be grouped and defined in three ways: direct procurement, indirect procurement and sourcing [12] They argue that direct procurement involves buying goods and organizing activities to manufacture finished products, while indirect procurement deals with selecting, buying and management of suppliers for the day-to-day running of an organization. However sourcing can be applied to both direct and indirect procurement and it involves a four phase model (information, negotiation, settlement, and after sales) [13].

Computers are applied in almost all spheres of human life. Large amount of data stored in a computer is called a database. The basic software that supports the management of these data is called database management systems (dbms) which is accompanied by application software that accesses and modifies the

stored information. The separation of logical definition of data from its physical implementation is central to the field of database. The major direction is the study of abstract, human-oriented models and interfaces for specifying the structure of stored data and for manipulating it [14]. Several models were developed which include; Data Definition Language (DDL) for defining the structural aspect of the data and Data Manipulation Language (DML) for accessing and updating the data. The separation of logical aspects from physical levels made database usable and programmer productivity and also called data independence principle. Object-oriented database have emerged from the merging of database technology, object-oriented language (e.g., C++) and artificial intelligence (via semantic models). Providing richer logical data structure allows corporation of information into the database schema. This leads to better interfaces and modular perspective on application software [14].

In [15] to improve hospitals, management system needs to be given top priority as it is critical part of nowadays cost and quality crisis in health care. For this reason hospitals need an innovative management system to deliver their services. According to [16] an efficient hospital management system should accommodate all actors in the health care delivery process such that both clinical and management needs will be aligned.

### III. Method

This paper is based on object oriented principle therefore the system designed has passed through object oriented methodology which involves definition of the context of the system through both primary and secondary sources, Designing system architecture using diagram designer tool, Identification of the objects in the system, Construction of design models, Specification of object interfaces the object design was archived through; Identifying and refining the classes in each subsystem, Defining the links and associations between the classes, Designing the hierarchical associations among the classes, i.e., the generalization/specialization/inheritances and Designing aggregations

### IV. System design

Figure: 1 shows sequence of activity of the class “Contract” has also been expanded to handle all the procurement processes starting from need, invitation for quotations, evaluation of quotation, award of contract, follow-up, delivery, inspection, acceptance/rejection, if accepted, then receive and making payment.

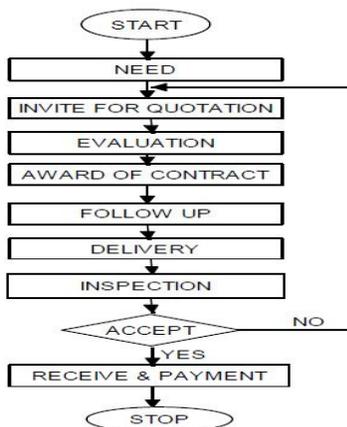


Figure 1: Sequence of activity of class “Contract”

The Database has six classes (Contracts, Pharmacy, Doctors, Patients, Company and Drug) with their respective fields as shown in figure 2.

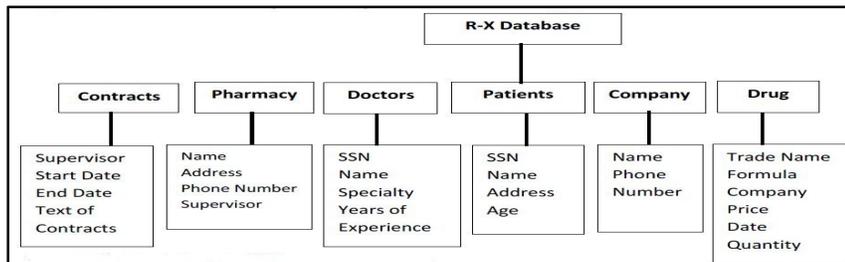


Figure 2: Database Class

Figure 3 shows the extended UML diagram showing the interface process of the class “Contract” with the ten sub-classes showing their names and variables, but the methods must be inherited completely from the main class interface.

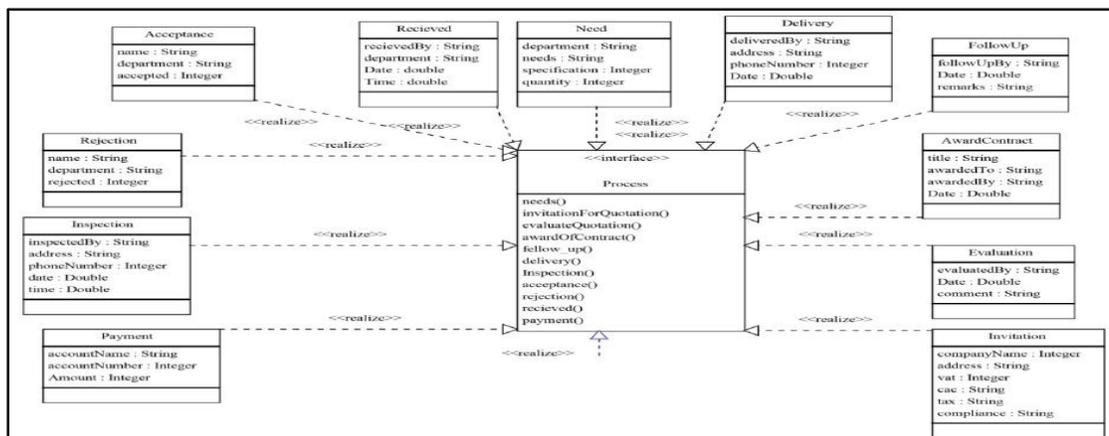


Figure 3: UML for class “Contract”

Figure 4 is the aggregates UML diagram for Rx Database and the class “Contract” has also been expanded to handle all the procurement processes starting from need, invitation for quotations, evaluation of quotation, award of contract, follow-up, delivery, inspection, acceptance/rejection, if accepted, then receive and making payment. While the Rx database showing functional dependencies and multiplicities with sub-classes (Contract inclusive).

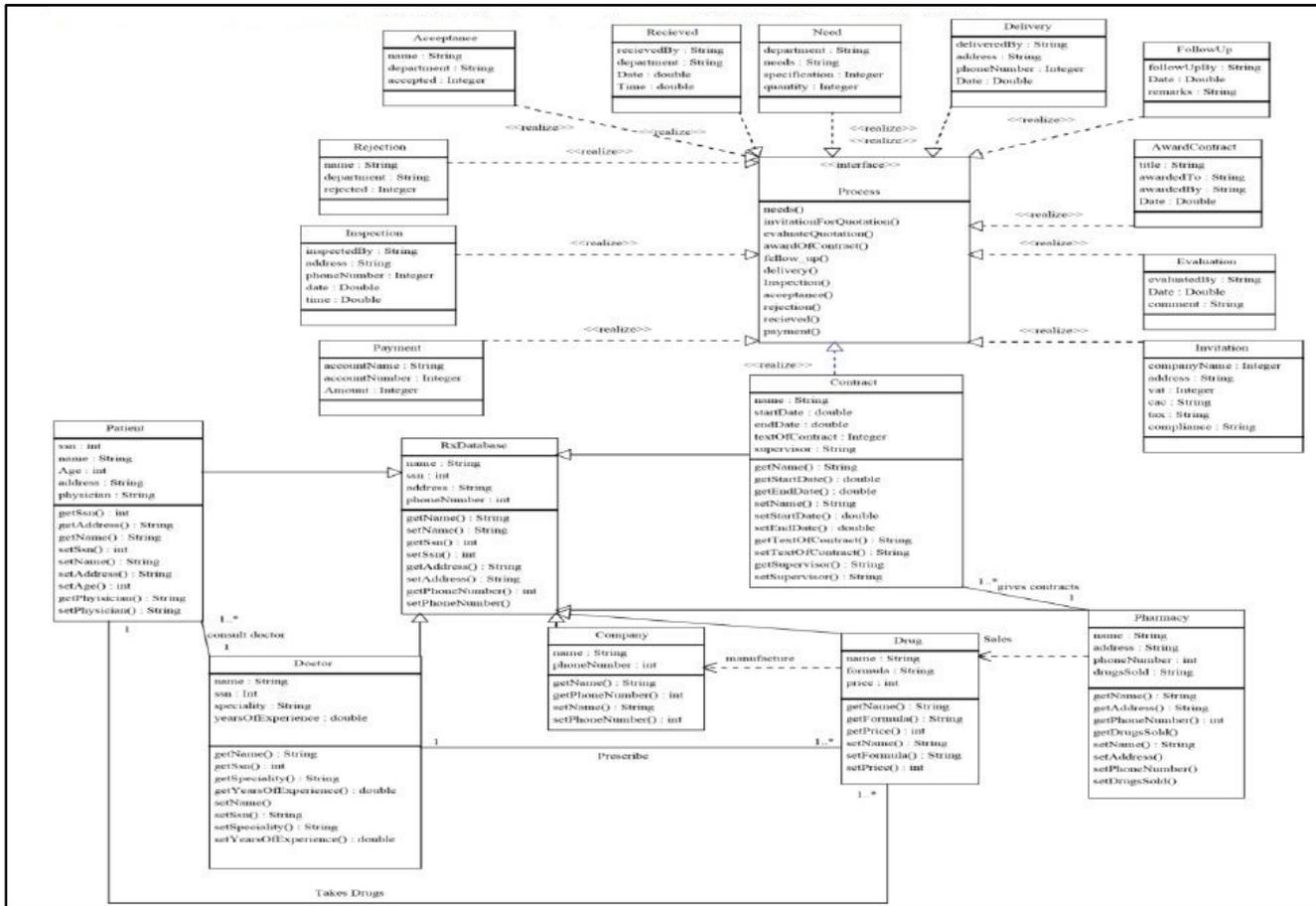


Figure 4: UML for Rx Database

### Interface Design

The design comprises of seven different interfaces that allow users to interact with the system. In figure 5, needs in form of request must arise from a particular unit/department within the hospital. The need must be followed by quantity and specification/description of the drugs needed within the department.

The screenshot shows the 'PHARMACY PROCUREMENT SYSTEM' interface. At the top, there are navigation tabs: REQUEST, INVITATION FOR QUOTATION, EVALUATION OF QUOTATION, AWARD OF CONTRACT, FOLLOW UP, DELIVERY, and RECEIVED/PAYMENT. The 'REQUEST' tab is active, displaying a 'REQUISITION FORM'. A dropdown menu for 'Department/Unit' is set to 'SURGICAL'. Below this is a table with three columns: 'Drug Type', 'Description', and 'Quantity'. The table has five empty rows for data entry. At the bottom left is an 'ADD ROW' button, and at the bottom right is a 'SUBMIT' button.

Figure 5: Requisition form

Figure 6 shows the interface for invitation for quotations/bids which requires any interesting company to fill. The details include name of the interested companies, their address and Registration code then the companies must state at which price they would supply a particular drug of a given quantity.

**Figure 6: Invitation for Quotation/Bid Form**

Figure 7 is an interface to be used by a staff of procurement department/unit to evaluate the participating companies and make recommendation to the pharmacy inform of remarks.

**Figure 7: Evaluation of Quotation form**

The interface in figure 8 is for the award of the contract advertised comprising of the contract code, name of the company that won the award of the contract, name of the awarding officer and finally date of the

award.

**Figure 8: Award of Contract form**

Figure 9 depicts the interface of one of the crucial step in the procurement process. It contains name of the officer that supervise the contract, list of dates he used to contact the company to be sure if the supply is possible or not depending on the urgency of the need of the drugs, then finally make remark.

The screenshot shows a web browser window titled "PHARMACY PROCUREMENT SYSTEM". The navigation menu includes: REQUEST, INVITATION FOR QUOTATION, EVALUATION OF QUOTATION, AWARD OF CONTRACT, FOLLOW UP, DELIVERY, and RECEIVED/PAYMENT. The active page is "CONTRACT FOLLOW UP". The form contains the following elements:

- Followed up By:** A text input field.
- Date:** A date selector showing "Wednesday, January 29, 2020".
- Remark:** Three stacked text input fields.
- SUBMIT** button.

**Figure 9: Contract Follow-up Form**

Figure 10 is a displays the delivery form that contains contract code, name of the company/person who delivered the product, phone number and delivery date. The right side of the form is to be filled by the staff that inspects the delivery to select “Yes” if the supply meets contract specification as stated during invitation for quotation and select “No” if it does not meet the specification and the pharmacy will reject the supplies.

The screenshot shows a web browser window titled "PHARMACY PROCUREMENT SYSTEM". The navigation menu includes: REQUEST, INVITATION FOR QUOTATION, EVALUATION OF QUOTATION, AWARD OF CONTRACT, FOLLOW UP, DELIVERY, and RECEIVED/PAYMENT. The active page is "DELIVERY/INSPECTION FORM". The form is divided into two main sections:

- Left Section:**
  - Contract Code:** Text input field.
  - Delivered By:** Text input field.
  - Phone Number:** Text input field.
  - Date:** Date selector showing "Friday, January 31, 2020".
- Right Section:**
  - Inspected By:** Text input field.
  - Did the Supply meet Specification ?**
    - Yes/Accept
    - No/Reject

A **SUBMIT** button is located at the bottom center of the form.

**Figure 10: Delivery Form and Inspection Form**

Figure 11 shows Receive and payment interface. Payment section comprises of the account name of the supplier, name of the account, and the amount paid to the company to enforce accountability the “Amount” column is designed such that it gets its value from “Total” column as calculated by the system. The Payment Gate Way button allows users to make online payment through interswich and payU.

The screenshot shows a software window titled "PHARMACY PROCUREMENT SYSTEM" with several tabs: REQUEST, INVITATION FOR QUOTATION, EVALUATION OF QUOTATION, AWARD OF CONTRACT, FOLLOW UP, DELIVERY, and RECEIVED/PAYMENT. The "RECEIVED/PAYMENT" tab is active, displaying a form titled "Received and Payment".

The form contains two main sections:

- Table:** A table with four columns: "Quantity:", "Description of Drugs:", "Unit Price:", and "Amount:". Below the table are buttons for "ADD ROW" and "TOTAL:".
- PAYMENT DETAILS:** A section with four input fields: "Account Name", "Account Number", "Bank Name", and "Amount". Below these fields is a button labeled "Payment Gate Way".

**Figure 14: Receive and Payment Form**

### Conclusion

Healthcare automation is very expensive in terms of its requirements ranging from the system modeling through implementing and keeping the system lively, by providing solutions to both medical personnel and Administrative staff in the healthcare system. Adoption of a dynamic system as such could result to a qualitative and innovative healthcare delivery at not only tertiary but also primary and secondary level and can also help to have genuine auditing process and prudence. It can provide rapid response to queries for information retrieval and sharing. Further researches should implement the design using appropriate object oriented programming language, investigate on the reasons for bureaucratic habits of hospital management not willing to embrace automation of the healthcare systems and how to eliminate or minimize technophobia among hospital stakeholders.

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