information more portable than it was in the past. In the same vein, the management of inventory and taking stock of goods and services in different organizations have become so much easier with the growth of the computer system [10]. These days, even phones and tablets have faster processing power than the early generation computers, which has made it easier to perform tasksAbbas, Alhasan, and Hamza [11] described our economy as the "learning economy", because of the rate at which new innovations come to light. In China, a text message system was developed to help in general patient pharmaceutical care, and promote mobile systems [12]. Onuiri *et al*. [9] in their work reviewed some of the existing related systems such as the management of inventory which has taken various shapes and forms, one of which is called a Vendor-Managed Inventory (VMI) system. According to Onuiri *et al*. [9] the VMI gives a supplier full discretion to deliver goods and services, as long as the customer can fully optimize these goods and services and this method or level under the VMI system is called the Maximum Level; the other level in the system is called Order-up-to policy which allows the supplier to get the inventory of the customer to its maximum capacity at every delivery [13]cited in [9]. Various computerized management systems have been useful in helping to save lives around the world. The earthquake in Haiti in 2010 brought about a need for medicines for the injured, and also aid for them. Due to the high influx of medicines into the country at the time, an inventory management system was developed to help the cause. The hospitals in the country did not at the time have the means to provide medicines to the needy without losing track of what has been given to who, and what has not been given. Also, the management systems that were proposed and later implemented helped in tackling shortage problems, thereby saving countless lives in the process. The Pharmacy Computerized Inventory Program (PCIP) had four processes which include: needs assessment, the development of the PCIP, implementation of the PCIP, and outcomes and data analysis with the program proving to be a success and greatly reduced the turmoil going on in the land at the time of the earthquake [14]. Other parts of the world such as the Middle East have not been left out of the trend. A group of individuals in King Saud Bin Abdulaziz University for Health Sciences in Saudi Arabia came together to study and report findings on a pharmacy inventory management system in a hospital in Saudi Arabia and the software controlled and monitored existing stock levels, which allowed them to decide how much quantity of drugs to order in order to be at full capacity[15]. The application was installed on all computers of the staff in the hospital which was used and information was directly updated to the database [15]. These various systems have allowed ease of work at the hospitals and pharmacies, and reduction of errors in drug related practices[15]. Also, with the introduction of these practices, the prescription drug abuse trend has been curbed to a considerable extent. These days, applications make use of large databases and verification processes [9].

Kumar and Himanshu [16] in their paper, describe the data warehousing process for the Pharmaceutical and the Healthcare industries. They examined the reasons and needs for the data warehouses and the expected benefits. Based on this, a general process for data warehousing emerges that utilized a host of tools and techniques. These are then illustrated by two case studies as follows [16]: (i) A Clinical Trials Data Warehouse for the Pharmaceuticals and Biotech companies, (ii) A Utilization and Claims Warehouse for the Drug Manufacturers and the HMOs. Each of these warehouses has different design philosophies, objectives and utilization and uses a different set of tools for populating the warehouse, data transformation and data extraction. While discussing these case studies, Kumar and Himanshu [16] also delved into the subjects of: (1) User Requirements (2) Design Specifications (3) Validation and Testing (4) Documentation (5) User Training and Setup. They opined that "a data warehouse will allow seamless access to all the data and allow us to analyze it in a time series fashion. Briefly stated, following were the objectives: Supports data loads from a variety of sources such as HMOs, Pharmacy Claims Processors and metadata vendors, can partition data in related subsets using predefined algorithms, provides library functions for code reuse, maintenance, and development , can integrate with SAS for data analysis Data Warehousing and reporting, using SAS/Access, provides data security and management, is easy to maintain, upgrade, and administer, is scalable, robust, and dependable, can provide long-term strategic benefits in terms of information storage, retrieval, analysis, and presentation [16]. They concluded that "such a data warehouse can provide invaluable intelligence in terms of: Drug Positioning Information,

Patient Population Characteristics, Indications drug is being used for, Prescribing Physician Characteristics, Regional Preferences, Prevalence of Diseases, Preferred Drugs for Diseases, Procedures being performed, Disease related Information" [16](Table 1).

3. THE DATA WAREHOUSE

Osama and Ahmed [17] posited that data warehouses are not only deployed extensively in banking and finance, consumer goods and retail distribution and demand-based manufacturing, it has also become a hot topic in noncommercial sector, mainly in medical fields, government, military services, education and research community etc.

A data warehouse is typically a read-only dedicated database system created by integrating data from multiple databases and other information sources. A data warehouse is separate from the organization's transactional databases (i.e., OLTP – On-Line Transactional Processing databases) but rather uses On-Line Analytical Processing (OLAP) database It differs from transaction systems in that [18]:

• It covers a much longer time horizon (several years to decades) than do transaction systems.
• It includes multiple databases that have been processed so that the warehouse's data are subject oriented and defined uniformly (i.e., ''clean prearranged data'').
• It contains non-volatile data (i.e., read-only data) which are updated in planned periodic cycles, not frequently.
• It is optimized for answering complex queries from direct users (decision makers) and applications.

According to Ahmad [19], the transactional databases are designed to answer who and what type questions, they are not very good in answering what-if, why and what-next type questions. The reason is that data in transactional databases are not necessarily organized to support analytical processing. Laura [20] defined data warehouse architecture as a description of the components of the warehouse, with details showing how the components will fit together. Data is imported from several sources and transformed within a staging area before it is integrated and stored in the production data warehouse for further analysis [21]. Since a data warehouse is used for decision making, it is important that the data extracted from multiple sources should be corrected and tools for data extraction, data cleaning, data integration and data load are often deployed to reduce errors during data integration into data warehouse [22]. Data are stored and managed in the warehouse which presents multidimensional views of data to a variety of front end tools: query tools, report writers, analysis tools, and data mining tools [23], [18], and [24]; cited in [17].

3.1 The Data Warehouse Architecture

A majority of database management systems used in most organizations execute online transaction processing (OLTP) that direct answer to queries at the executive level, such as the what-if and what-next type queries. Decision makers at executive level would like to quickly analyze existing drug data and in time to aid in the decision making process. However, stand-alone databases cannot provide such information quickly and efficiently. The concept of warehousing provides a powerful solution for data integration and information access problems. Data warehousing idea is based on the online analytical processing (OLAP). Basically, this technology supports reorganization, integration and analysis of data that enable users to access information quickly and accurately [25]. Finally, OLAP is a tool that used by analyst for planning and decision making. In traditional information systems, businesses have relied on paper-based reports regarding performance in order to make important business decisions. Most of the

reports that are created are out dated; these have come as a result of extracting data from operational systems and collating with other sources of data to come up with them.

Author & Year	Title	Type
Onuiri *et al.*, (2016)	Online pharmaceutical management System	OLTP- Could not meet the several demand of the ever growing industry
Goldberg *et al*., (1991)	Inventory and Stock Management	OLTP – Stock Management Only
Mao, Zhang, and Zhai, 2008). Onuiri *et al*., (2016)	Vendor-Managed Inventory (VMI) system	OLTP-Product Delivery and Services system
Haiti Health Ministry (2010)	Pharmacy Computerized Inventory Program (PCIP)	OLTP-inventory management system
Muallem, *et al.*, 2015	Pharmacy Inventory Management System	OLTP-Pharmacy IMS/Stock Control

Kumar and Himanshu (2006)	(i) (ii)	Clinical Trials Data WH for the Pharma Utilization and Claims WH for the Drug Manufacturers	OLTP and OLAP using Data warehouse technology.

Table 1: Table showing related works

Managers want and need more information, but analysts can provide only minimal information at a high cost within the desired time frames [26]. A drug data warehouse designed for this particular purpose is needed. OLTP databases are designed to process individual records of drugs, procedures and other similar operations. These databases are updated continually and are suitable to support daily operations.

Pharmacists and Pharmaceutical companies deal with a large volume of data containing valuable information in respect of several types of drugs and their usage even data from researchers in the field of drug administration. these data are stored in most cases in operational database that are not useful for decision makers and executives of these organisations. Osama and Elden [27] defined data warehouse as a system that extracts, cleans, conforms and delivers source data into a dimensional data store and then supports and implements querying and analysis for the purpose of decision making process. Data warehouse was defined According to Inmon [28], a "subject-oriented, integrated, time variant and non-volatile collection of data in support of management's decision making process" (see Figure 1).

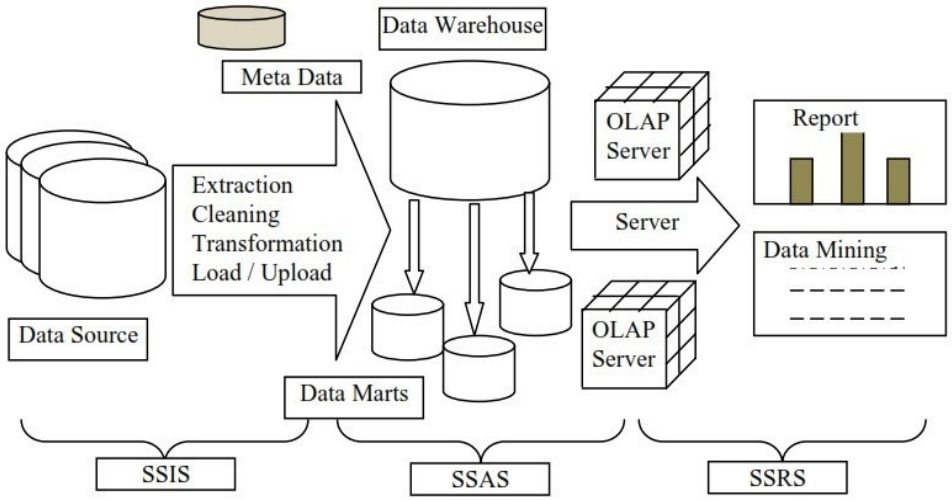

Figure 1: Data Warehouse Architecture

(source: [17])

A Pharma data warehouse is aimed at providing information for Pharmacists and Executive manager in the drug administration and manufacturing sector to analyze situation, stocks and make decisions. Put in another way, a Pharma data warehouse provides information for Pharmacists and Executives in the sector to make decisions and do their jobs more effectively [29]. The top level of decision making involves strategic decision making. At this level, managers make decisions about the overall goals of the organization. For instance, types of decisions made on this level include which services need to be provided (such as drug expiation limit, quantity, manufacturers and strategic marketing and management decisions) and at which geographical location to fulfil the goal of the Company in terms of expansion (such as local, state, national and international). The second level concerns tactical decision making. The decisions made on this level relate to the tactical units of the organization such as customer and patient services. The third level concerns the day to day decisions of the organization such as hiring employees, ordering supplies and manufacturing, processing bills [30]. Good systems provide the information needed, so that Managers are making more efficient decisions.

4.0 METHODOLOGY

The method used in the design of the Pharma Data warehouse consists of two techniques incorporating the Data Warehouse In-Table and In-Table Load Programs component into the operational systems (OLAP). A multidimensional table is implemented which allow queries join with more tables and more computation in data warehousing environment. The data warehouse In-Table contained information extracted, cleansed and transformed for the purpose of reporting and analysis.

4.1 Data Gathering Technique

The technique used for data gathering was through consultation and interrogation with/of pharmaceutical companies and outlets in Ogun State.The database management System chosen was MySql – a freeware – and used to create the Pharma database. The frontend is the HTML/PHP Scripting languages and used to create the client frontend.

4.2The architecture of the Proposed Pharma Data Warehouse

The architecture of the proposed system is based on the client server model. The server consists of the pharma database and the in-load warehouse. The clients are workstations connected via the internet or Local Area Network geographically dispersed locations (see Figure 2). The Pharma Data Warehouse is based on the Client-Server architecture model.

4.2.1 The Pharma Data Warehouse

The Pharma Data Warehouse is made up of two types of database; Pharma OLTP database and Pharma OLAP database. The OLTP databasesare the transactional databasesof the Pharma system that contain data from various sources exclusively for interrogation purposes. The Pharma data warehouse (OLAP) is typically a read-only dedicated database system created by integrating data from the multiple OLTP databases and other information sources loaded into the data warehouse in-table. In-Table is the central table where all in-coming data is received and then segmented and dispatched on to the various production tables.

4.3.2 The OLTP Database of the Pharma System

It consists of a number of MySql programs to process the data loaded in the In-Table to partition it in segments and populate the production tables with these data. There are Five (5) identified tables in the proposed architecture of the OLTP database and are descried as follows (see Table 2).

Table Label	Table content

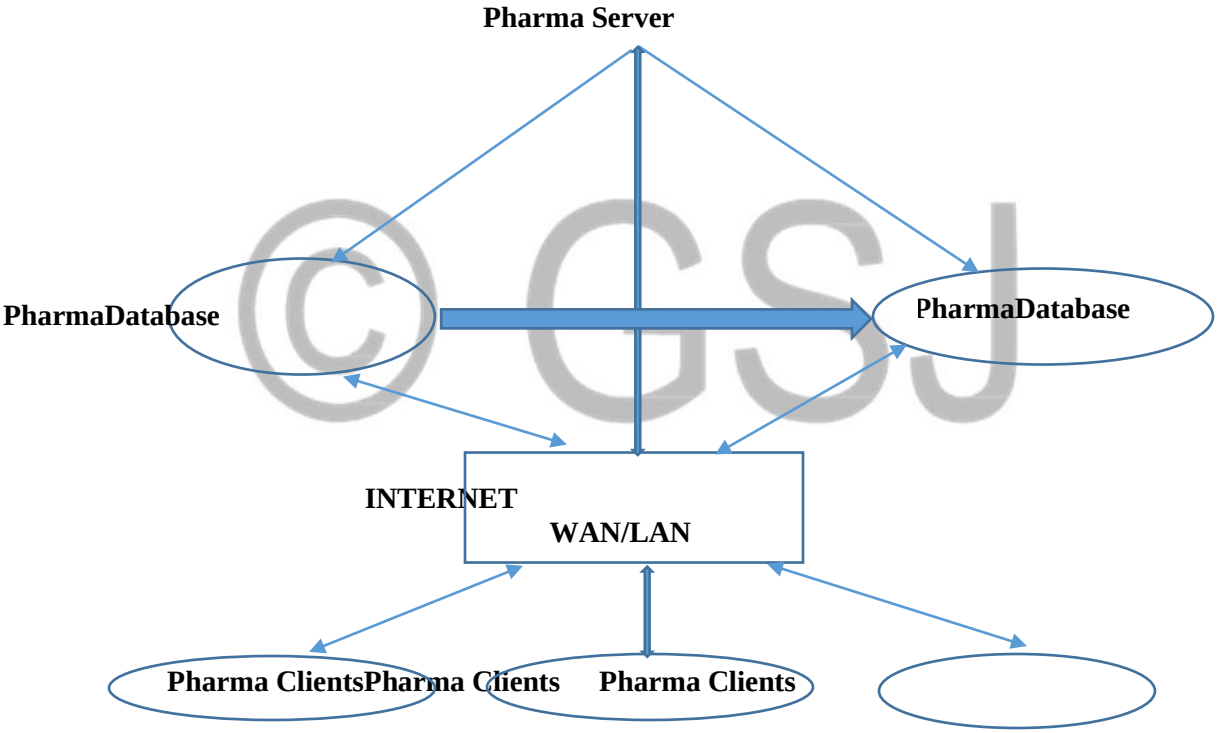

Figure 2: Schematic Representation of the proposed PHARMA DATA WAREHOUSE

Table 2: Multi-dimensional tables in Pharma DataBase (OLTP)

PharmaInfo	A table that stores Drug information; i.e Manufacturer Name, Branch/Outlet, Drugs, etc.
CustInfo	Customer data; company Name, Id, Location and outlets
ProdInfo	This table stores all the processes for the manufacture of such drugs, location, distribution and other needed information.
FeedbackInfo	This stores all the feedbacks from outlets or customers in respect of the drugs and the manufacturers. Sales etc.
DimDate	This table contains all dates; Mfg, expiry, delivery dates

Table 3: Structure of the Data Warehouse (Fact Table)

Id_Drug	Drug Identification code
DrugInfo	Drug Information
PatCharact	Patient Population Characteristics
DrugAdmin	Prescribing Physician/Hospital Charact.
DrugIndicat	Indications drug is being used for
DrugPreval	Prevalence of Diseases / in an Area
AssocDisea	Preferred Drugs for Diseases
DrugProc	Procedures being performed
DrugDisInfo	Disease related Information
DrugDistrInfo	Drug Distribution Info

5.0 IMPLEMENTATION

The first step was the preparation of the server – Personal Computer machine running Windows 8 Operating system and MySql 5.1. The OLTP databases – PhrmaDB, and the data warehouse OLAP – PharmaAP fact table were created. The second step was implemented in stages, with the first stage populating the transaction (OLTP) tables for one category of drug using the corresponding user interface. This was then repeated for other drugs. The second stage consisted of a number of MySql/PHP/HTML programs to process the data to be loaded into the In-Table to partition it in segments and populate the production tables with these data using the Extraction, Transformation and Loading processes ETL[31]. There are two approaches to getting data into the OLTP; getting from an existing file or excel database with the use of CSV data file or directly getting data from the screen input. Populating the Fact table is different in this case and the only available option in this regard was to use the ETL model – Extraction,

Transformation and Loading. The procedure entails selection of the required columns from the multidimensional tables in the PharmaDB using the SELECT statement: a typical sample code is as follows:

```
INSERT INTO PharmaDW VALUES (// loading
Select DimPharma.ManID, DimPharma.IDdrug, columns, DimFeedback.FeedbkInd,
    DimFeedback.PotencyRate FROM DimPharma, DimFeedback  .// Extraction
    Where DimFeedback.IDdrug = DimPharma.IDdrug    // Transformation
        )
```

Figure 3: An example ETL Instruction Code

The Pharma Data Warehouse could only be updated whenever there are changes in the multi-dimensional table.

6.0 CONCLUSION

The prototype Pharma Data Warehouse developed and presented in this paper has demonstrated the advantages and benefits accruable from the application the data warehousing technique to manage a large industry such as the Pharma industry with large volume of data and increasing number of outlets in geographically dispersed location. Although, this could involve several high-end servers with several desktop systems which might make the system costlier, the verifiable benefits to the decision making process by the management would be very high.

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