CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

With the growth in the use of computer systems for a number of functions in businesses, there is the challenge of processing and analysing huge amounts of data and turning them into profits. This has led to vendors upgrading their Business Intelligence (BI) products, which are sets of tools and technologies designed to efficiently extract useful information from oceans of data (Sixto, 2002). The process of gathering and utilizing gathered knowledge and information for decision making is becoming central for organizations, rather than in the past relying solely on past experience, inituition or knowledge of the decision maker. Today data is seen as one of the most if not the most important asset in modern organizations, used to support different activities, most important of them presumably being to support decision making (Pekka, 2017).

In recent times, Business Intelligence has gained momentum in real-world practice, and it has evolved as an important research subject of information systems within the decision support domain (Liu, 2014). Recent growing competitive pressure in business has led to increased needs for real-time analytics termed Operational Business Intelligence or Real-Time Business Intelligence. This is essentially true with respect to health industry which is quite dynamic in nature with new disease discoveries that would require varying treatment and prevention procedures based on clinical analysis of individual patients (customers) as well as administrative management decision based on government policies on health.

The health sector is one of the most dynamic sectors of the economy of any nation, hence it is a major priority in ensuring healthy citizens of a nation. The use of intelligent techniques provides an effective computational methods and robust environment for Business Intelligence (BI) in health sector domain. Presently, health systems are faced with challenges due to demographic changes, technological advances in medicine and the limited possibilities to increase health funding requiring more intensive search for effectiveness of the systems. Business Intelligence (BI) as a key technology used to build systems that integrates analytical data from different transactional systems is referred to decision making, information analysis, knowledge management and human computer interaction (Celina and Kornelia, 2012).

As it is well known, health industry is very dependent on information. But very few technologies are in real-time that take data and convert them into information has being

developed. These data are devoid of context and are only slightly more than useless. So far, only Business Intelligence (BI) technology is able to focus on key indicators easily and quickly to provide valuable information for health sector. With the health sector, swimming in an ever-deeper pool of data, it needs a system that would be responsible for collecting, providing and analyzing the most relevant data, so that its organizations can be able to use these data in practice, thereby being rich in data as well as in information (Celina and Kornelia, 2012). This is where the research developed hybrid model for an enhanced Business Intelligence (BI) process comes handy.

Furthermore, in the 21st century, the increased use of computing technology is driving a revolutionary change in the way business and decisions making is done. Despite its importance, many decisions in commercial and non-profit organizations are still based on intuition and experience rather than on automated and evidence-based fact processes (Ing.Dita, 2016). Business in all sectors of the economy; education, healthcare, science, state administration, research, and government, requires information to be able to run effectively and successfully. This has led to the demand by modern organization in expressing the need for an effective business information system that would enable them collect, preserve, process and find information when needed. The major characteristics facing the modern world today is vast uncertainties and rapid changes. So due to these, business managers are forced to look for instruments and mechanisms that will facilitate management decisions and create good conditions for business success. Again, this is where Business Intelligence (BI) comes handy as a mechanism to achieve the desires of business managers (Benjamin, 2013).

Business Intelligence (BI) can be seen to provide answers from what happened, to how, to why using a wide variety of analytical methods and tools to provide answers to organizational current questions and problems. With this trend, it is important for Business Intelligence (BI) professionals or management professionals working in Information Technology (IT) and business to stay informed about changes happening in the Business Intelligence (BI) industry, which is behind the organizations' ability to make the correct intelligent business decisions (Pekka, 2017).

With the challenges in the health sector, which is growing at a high speed, then comes the need for an evolution in computing technology that meets the needs of an effective personalized medicine and specific treatments, diagnosis and disease prevention procedures according to patients' individual characteristics. This leads to the demand to create more value in the health

sector in terms of efficient, reliable and accurate intelligent delivery of healthcare by its business executive's users when taking decisions (Mihaela and Manole, 2015). Using this information technology (IT) evolution means to analysis proper data at the right moment. This has being a long-term challenge for health sector generally.

Business Intelligence (BI) as a specialized tool that is a routine component of management practice in other sectors such as finance and manufacturing is yet to reach its full potential in the health sector because its availability (with respect to BI) is limited and factors such as data quality, complexity, data integration and access to data have been identified as barriers (Loewen, 2017). The deployment of Business Intelligence (BI) leads to support for better decision-making, with its ability to handle large variety of data. It can help identify and develop new business opportunities and insights, with this when implemented by business enterprises with effective strategy; it will consequently enhance such enterprise's competitive advantage, thereby leading to sustainable and profitable growth. Also, the technologies of Business Intelligence (BI) provide historical, current and predictive views of business operations with common functions such as querying, reporting, online analytical processing (OLAP), data mining, data integration, text mining, and business analytics (Liu, 2014).

The concept of Business Intelligence (BI) is defined as "the set of strategies, processes, applications, data, products, technologies and technical architectures which are used to support the collection, analysis, presentation and dissemination of business information" (Delic and Stanier, 2016; Elaheh and Mohammed, 2017). It is the result of natural evolution in terms of decision support systems (DSS) and Enterprise Systems (ESs), systems that aimed at replacing humans in the decision making process or at least at offering solutions to the issues they are concerned of. Its' process implies actions based on the decisions made (manually or automated). The latencies involved include the time it takes to initiate an action and the time it takes to execute and monitor the action. It is different from Management Information System (MIS), Decision Support System (DSS), Executive Information System (EIS) and Enterprise System (ES)) because it describes a set of concepts and methods that improves business decision making by using fact-based support system. It is a data-driven type of Decision Support System (DSS), which involves the update of data, and supports process-oriented organization. Also, it is used to solve sophisticated complex information needs, it has wider thematic range, it is multivariate in analysis, and it involves semi-structured data as well as multidimensional data, which originate from different sources.

It supports decision making at all levels of management structure. For the strategic level, it makes it possible to set objectives precisely and follow realization of such established objectives. It allows for performing different comparative reports such as on historical results, profitability of particular offers, and effectiveness of distribution channels along with carrying out simulations of development or forecasting future results on the basis of some assumptions (Celina and Ewa, 2004). At tactical level, it provides some basis for decision making within marketing, sales, finance, and capital management. It allows for optimizing future actions and for modifying organizational, financial or technological aspects of company performance appropriately in order to help enterprises realize their strategic objectives more effectively. In operational level, it is used to perform ad-hoc analyzes and answer questions related to departments' on-going operations, up-to-date financial standing, sales and co-operation with suppliers, and customers. While at the technical level, it offers an integrated set of tools, technologies and software products that are used to collect heterogenic data from dispersed sources in order to integrate and analyze data to make it commonly available (Celina and Ewa, 2007).

The research adopted the definition of Business Intelligence (BI) according to Sanja, et al., (2016) that states "Business Intelligence (BI) is that technology which enables organizations to make more informed, intelligent business decisions as well as to adapt to a changeable environment and to survive in the business world, while cooperating with patients, customers, suppliers, competitors and clients of various sector depending on domain area applied". It further states that modern Business Intelligence (BI) involves the integration of intelligence methodologies and information technology that are applied to the business world (Sanja, et al., 2016).

Worthy of note is that, Business Intelligence (BI) and Big Data are helping in the fight against the spread of epidemics, and researchers are using both technologies to find a cure for diseases such as cancer. It is believed that in the future, companies of various sectors would be forced to rely on Business Intelligence (BI) systems completely to keep up with the competition that is increasing on a daily basis. In modern economy, knowledge has become the most important business resource and modern business has become dependent on the concept of Business Intelligence (BI) as a process of gathering significant external and internal data and their conversion into useful information for business decision making. It is a field of building information that is conclusive, fact-based and actionable. So it expose the importance of data and information kept by various organization, which can be used to help in accurate and

efficient decision-making based on the facts rather than human reasonings (Tanko and Musiliudeen, 2012). Also, the value of real-time Business Intelligence (BI) rests in its' capability to reduce the three types of latency: Data latency (the time between business events and when the operational data is captured), Analysis latency (the time to analyze the data and when the findings are available for use), and Decision latency (the time to act upon the data). So, real-time Business Intelligence (BI) can enhance the agility of an organization to significantly increase the responsiveness to varying customer needs and ever-changing market situations (Liu, 2014).

With the concept of intelligent agents in conjunction with case-based reasoning (CBR) they offer a potential of increased production quality, flexibility, reliability and fast delivery times in health sector as well as other sectors such as manufacturing, production, electricity, transportation, banking and finance. Information from heterogeneous sources such as from the evolution of sensor and internet technologies, are becoming available for utilization, but the data received are frequently continuous and subject to more complex properties such as being dynamic, sequential unstructured, uncertain and imprecise. So with software agent (intelligent agent), solutions that can support the creation, processing and utilizing of these knowledge as defined in organizations would be achievable. Worthy of note is that intelligent techniques provide an effective computational methods and robust environment for Business Intelligence in the health sector domain. This is important because much of the data storage in all kinds of system used in the health sector organizations resides in proprietary silos thereby making access to such data difficult (Celina and Kornelia, 2012).

Case-based reasoning (CBR) implies an approach to model the way humans think as well as to build intelligent systems. It is an artificial intelligence (AI) technology that can be used to develop intelligent systems such as Expert system and Business Intelligence system. It is a technique suited for intelligent automated problem solving model designing. The intelligence provided by case-based reasoning (CBR) technique aids decision making in clinical areas of health sector such as in diagnosis, treatment, healing, monitoring and disease control.

One of the processes of designing Business Intelligence system is by providing the means for integrating data into information framework. With Ontology which helps in realizing reasoning, data integration in Business Intelligence can be implemented. Using Business Intelligence with Ontology-based and Virtual Data Integration technique, the development of semantic interoperability by integrating data warehouse (DW), Online Analytical Processing

(OLAP), data mining (DM) alongside structural interaction together is achievable. This type of integration will enhance Business Intelligence process to be more intelligent, business-oriented, adaptive and automatic, in the integration of Business Intelligence system in the real world. While, with virtual data integration (data virtualization), Business Intelligence (BI) data integration process would be enhanced in ways that, it would become easier to change systems, new reports can be developed and existing reports can be adapted easily and quickly. This agility is an important aspect for users of Business Intelligence systems. In essence, the enhanced Business Intelligence (BI) Integration process, aims at providing systematic analyzes and decision support by combining queries, reporting and analysis tools (Rick, 2012).

In summary, enhancing Business Intelligence (BI) with the hybridization of Ontology-based and Virtual Data Integration (VDI) techniques as well as intelligence technique using case-based reasoning (CBR) would give rise to a seamless transition from a practical work space into the virtual business-oriented analysis world that business persons expect. The collection of user-friendly supports will help users to modify, update, create or re-arrange ontological items and functionalities at different granularities on-demand, which is beneficial to business persons in a business-oriented rather than technology-centred interaction. It also results in run-time capabilities which will help business analyst to adapt to changing or new environment flexibly and adaptively in a user-friendly manner.

The Ontology-based aspect does the seamless transition, while the Virtual data integration technique does the hiding of the technical jargons. Also, the intelligence from case-based reasoning (CBR) technique would enhance the level of intelligence, accuracy and the speed rate for the delivery of decision on real-time basis. Thereby reducing cost of processing, increases availability, reduce time of processing and/or accessing data and it brings about adaptively, flexibility, intelligence and agility. The hybrid enhanced Business Intelligence (BI) process was developed to assist especially modern days' managers at all levels (operational, tactical or strategic) to make correct, and timely management decisions. So it would greatly improve and support the process of making decisions in organizations, particularly in the health sector.

Hence, the research "development of a hybrid model for enhanced Business Intelligence (BI) process (HMEBIP)" is geared towards hybridizing two data integration techniques; Ontology-based (OBDI) and Virtual Data Integration (VDI – data virtualization) using case-based reasoning (CBR) intelligence approach in developing an expert system Business Intelligence

(BI) process for effective disease control procedure in the health sector. This would bring about a better-performance model of the data integration process in Business Intelligence (BI) technology; which is a key process for the delivery of effective decision making in Business Intelligence (BI) applications, thereby improving the value and increasing the quality of Business Intelligence (BI) used in the health sector in particular for decision-making by physicians and health management (managers) as well as other sectors in general. It further tried to address the fact that hybridization of the two data integration techniques is feasible, as research question was asked "if it is possible to hybrid both types of data integration techniques in a Business Intelligence (BI) system model".

1.2 Statement of the Problem

Traditional Business Intelligence process is faced with the challenge of handling data integration in a BI environment; especially in the capability in producing analytics that would be meaningful from the heterogeneous data; the level of data completeness, cleansing, and intelligence, as well as the issue of real-time and up-to-date data accessibility and manipulative capabilities.

The possibility for the integration of Business Intelligence (BI) technology with already existing electronic medical record (EMR) and electronic health record (EHR) for the purpose of assisting health providers in knowledge discovery process thereby maximizing intelligent fact and evidence-based decision making practice among the medical practitioners in the health sector.

The research motivated question was coined from Ana-Ramona and Razvan (2011) that state "if the hybrid of both data integration techniques in a Business Intelligence domain is obtainable and if it would yield a better advantage compared to when each techniques is used individually?" was considered.

1.3 Aim and Objectives of the Study

Aim: The aim of the study is to develop a hybrid model for enhanced Business Intelligence (BI) process (HMEBIP).

Objective: The objective of the study includes:

1. Capturing a database for storing and tracking disease outbreak and control in order to resolve the disease registry historical data issue in real-time.

2. Provide an integrated patient medical record that would be accessible from any healthcare center across the country.
3. The use ontology-based, data virtualization techniques and case-based reasoning (CBR) technology to resolve the issue of latencies, redundancy, interoperability and intelligence.
4. Using ontology-based and virtualized data integration access, to provide a reliable and scalable data access framework for handling complex data sources.
5. Assist the medical experts in the health sector in achieving fact and evidence-based knowledge insight decision of the disease control procedure to be applied to patients' treatment.

1.4. Significance of the Study

The benefits and significance of the research study include but not limited to the following;

Decision making and the intelligence expertise service for quality delivery of disease control procedure and patients' medical records was improved with high level of accuracy and relevance in real-time for the health sector.

It brings about the importance of fact and evidence-based knowledge insight in health care practise generally. It also improved the analyzing of data in the health sector in order to transform it into relevant information, intelligent knowledge insight and then profitable action.

Information presentation was made easy by using an easy to understand user graphical interface. It reduces the issue of latencies such as data, analyzes and action latency in the existing model. Also, it analyzes clinical data based on structured, semi-structured and unstructured information or data.

It would assist medical researcher and practitioners with up-to-date clinical and medical information in carrying out research process. This helped track and manage population health more efficiently as well as significantly improve patients care across the health sector. And it enhances the ability to deliver preventive and predictive disease control in health care.

It simplified access to data, makes it to be of standard and be retrieved real-time from their original sources. Also, it increase business efficiency, agility, increase sales, provide better customer targeting, reduce customer service costs, identify fraud and generally increase profits while reducing costs.

With Ontology involved, it leads to seamless transition from a practical workspace into the virtual business oriented analysis world that business persons expect as well as reduce the technology-centred interaction of Business Intelligence process.

With the hybrid data integration technique, the quality of data distribution improved among independent data sources, thereby reducing structural, syntactic and semantic heterogeneity and interoperability as well as redundancy. This brings about increased availability and degree of completeness and result in run-time capabilities which helps business analyst to adapt to changing or new environment flexibly and adaptively in a user-friendly manner.

With the reduction in cost and time of processing, quicker results was retrieved from the data sources. Also, with the study, resources are encapsulated in such a way that all technical details become hidden and the application works with a simpler interface.

The study resolved to a great extent the complexities involved with bringing together all data related to a patient record that are spread out over multiple and heterogeneous data sources, formats and location (Intra-hospital wise). It also brings about order, efficiency and consistency to informational Information Technology (IT) so that users can manage their affairs with a single version of the facts.

The study helps to control the resources and the information flow of businesses, which exist in and around the organization. It would make a large contribution to the required intelligence and knowledge of organizations' management by identifying and processing data in order to explain hidden meanings (Saeed, et al., 2012).

Furthermore, the study brought about the abstracting of information related to technical aspect of shared data such as location, storage structure, access language, application programming interfaces, and so on. Also, the virtualization of data sources connection process (databases, web content and various application environments) would be made logically accessible from a single point, as if they were in one place so that a user can query data or report against it. More so, with the virtual data integration technique as part of the study, the issue of data security, data quality and data management requirements for queries optimization, caching, and so on, which are capabilities of data virtualization is feasible.

In summary, the study would bring about increase value through increased use, quality, merging, sharing of data, decoupling as well as on-demand transformation is achieved. Hence, the research study for the development of a hybrid model for enhanced Business Intelligence

process (HMEBIP) with the hybridization of Ontology-based and Virtual Data Integration technique using case-based reasoning (CBR) to improve its intelligence expertise service for quality delivery of disease control procedure and patients medical records in health sector, is quite significant in the world of today as the process of decision making is changing and the biggest change is that organization have to react faster, which means decisions have to be made faster with high level of accuracy, intelligence and relevance, since there is very less time available to make (sometimes crucial) decisions.

1.5. Scope of the Study

The scope of the research is the development of a hybrid model of ontology-based and virtual data Integration (OBDI and VDI) techniques for enhanced Business Intelligence process. It uses case-based reasoning (CBR) to improve the model's intelligence process quality. And it was tested in the health sector domain.

1.6. Definition of Terms

1. **Agent Technology:** the use of agents to improve expertise of a system model.
2. **Business Intelligence (BI):** is a set of tools, process, practices and people that are used to take advantage of information to support decision making in the organization.
3. **Business Intelligence System (BIS):** A set of integrated tools, technologies and programmed products used to collect, integrate, analyze and make data.
4. **Business Intelligence Process:** is the key activities that must be in a Business Intelligence application; data accessibility, data integration, analysis and actionable knowledge discovery.
5. **Case-Based Reasoning (CBR):** broadly constructed is the process of solving new problems based on the solutions of similar past problems.
6. **Clinical Data:** is a staple resource for most **health** and medical research. **Clinical data** is either collected during the course of ongoing patient care or as part of a formal **clinical** trial program.
7. **Clinical Data Registry:** records information about the **health** status of patients and the **health** care they receive over varying periods of time. Clinical data **registries** typically focus on patients who share a common reason for needing **health** care.
8. **Data Integration (DI):** is the act of combining data residing at different sources, and providing the user with a unified view of these data. The problem of designing data integration system is important in current real world applications.

9. **Data Warehouse (DW):** is defined as that which extracts current and historical data from multiple internal operational systems. This data is combined with data extracted from external sources and re-organized into a central database designed for management reporting and analysis purpose.
10. **Data Marts:** is a subset of a central data warehouse, in which a summarized or highly focused portion of the organization's data is placed in a separate database for a specific user's population. It focuses on a single business area or line of business area.
11. **Data Mining:** is more discovery driven as it provides insight into corporate data that cannot be obtained with online analytical processing (OLAP) or traditional database query. It also finds hidden patterns and relationships in large databases and inferring rules from them to predict future behaviour. These patterns and inferring rules are used to guide decision making and forecast the effect of these decisions.
12. **Disease Registries:** are clinical information systems that track a narrow range of key data for certain chronic conditions such as Alzheimer's disease, cancer, diabetes, heart disease, and asthma. Registries often provide critical information for managing patient conditions.
13. **EHR (Electronic Health Record):** Is a repository of information regarding the health status of a subject of care in computer process-able form, stored and transmitted securely, and accessible by multiple authorised users.
14. **Expert System:** are computer programs that exhibit intelligent behavior. They are concerned with the concepts and methods of symbolic inference, or reasoning, by a computer, and how the knowledge used to make those inferences will be represented.
15. **Hybridization:** means that several methods (soft-computing) are crafted to complement one another resulting in a better-performance model.
16. **Intelligent System:** is that system that employs its knowledge to become more self-aware. It is built on four fundamental elements; Data, Information, Knowledge and Wisdom.
17. **Ontology:** is "a formal, explicit specification of a shared conceptualization". **Conceptualization** refers to an abstract model of a phenomenon existing in the real world. This abstract model includes only relevant concepts of that phenomenon. **Explicit** means that the type of concepts used and the constraints on their use are explicitly defined. **Formal** means that ontology should be unambiguous and machine-readable. **Shared** refers to the fact that knowledge comprising an ontology is accepted and agreed on by a group of people, not just an individual.

18. **On-line analytical processing (OLAP):** Tools that allow us to analyze multidimensional data known as cubes. Cubes are data that are extracted from the data ware house and used by managers in decision-making situations.
19. **Patient Registry:** is an organized system that uses observational study methods to collect uniform data (clinical and other) to evaluate specified outcomes for a population defined by a particular disease, condition, or exposure, and that serves one or more predetermined scientific, clinical, or policy purposes.
20. **Registry:** is an organized system that uses observational study methods to collect uniform **data** (clinical and others) to evaluate specified outcomes for a population defined by a particular disease, condition, or exposure, and that serves one or more predetermined scientific, clinical, or policy purposes.
21. **Virtualization:** means that applications can use a resource without any concern for where it resides, what the technical interface is, how it has been implemented, which platform it uses and how much of it is available. Its solution encapsulates the resource in such a way that all those technical details become hidden and the application can work with a simpler interface.

CHAPTER TWO

LITERATURE REVIEW

2.1. History of Business Intelligence

Business Intelligence dates all the way back to 1958. It refers to technologies, application and practices for the collection, integration, analysis and presentation of business information and sometimes to the information itself. Its purpose is to support better business decision making. According to Power (2007), Business Intelligence describes a set of concepts and methods to improve business decision making by using fact-based systems. It is sometimes used interchangeably with briefing books, reports and query tools and executive information system. It is a system that is a data-driven Decision Support System (DSS). Before the information age in the late 20th century, businesses had to collect data from non-automated sources, and they lacked the computing resources to properly analyze data, and as a result companies often made business decisions mainly on the basis of intuition.

Howard Dresner of Gartner (2016) research, who is widely recognized as father of Business Intelligence termed it as a board category of software and solutions for gathering, consolidating, analyzing and providing access to data in a way that lets enterprise users make better business decisions (Preethi, 2015). With the increase in the use of automation system in businesses, more and more data became available, but collection was a challenge due to lack of infrastructure for data exchange or incompatibilities between systems. Analysing of data gathered and reports on the data most times took months to generate, this makes such reports to be useful only for long-term strategic decision-making. So, short-term decision-making continued to rely on intuition. Hence the need for Business Intelligence, a term with a definition that dates back to an October 1958 IBM Journal article by Hans Peter Luhn entitled "A Business Intelligence System". It reads "In the paper that, business is a collection of activities carried on for whatever purpose, be it science, technology, commerce, industry, law, government, and defence", the communication facility serving the conduct of a business in the broad sense maybe referred to as an intelligence system. The notion of intelligence is also defined here, in a more general sense, as "the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal" (Timothy, et al., 2009)

In modern businesses, increase in standards, automation and technologies have led to vast amounts of data becoming available and data-warehouse technologies have set-up repositories

to store these data. Improved Extract, Transform, Load (ETL) and even recently Enterprise Application Integration tools have increased the speed of collecting the data. On-line analytical processing (OLAP) reporting technologies have allowed faster generation of new reports which analyzes the data. Business Intelligence has now become the art of sifting through large amounts of data, extracting pertinent information, and turning that information into knowledge from which action can be taken.

Business Intelligence (BI) Software incorporates the ability to mine data, analyze and report, but some modern Business Intelligence software allows users to cross analyze and perform deep data research rapidly for better analysis of sales or performance on an individual, department, or company level. In modern applications of Business Intelligence software, managers are able to quickly compile reports from data for forecasting, analysis and business decision-making (Luhn, 1958).

Again Howard Dresner in 1989, later a Gartner group analyst, popularized Business Intelligence as an umbrella term to describe a set of concepts and methods to improve business decision-making by using fact-based decision support system (David, 2003).

Historically, Business Intelligence (BI) has been evolving over the last 35years. It began with the use of custom queries that data analysts developed at the request of key corporate personnel who needed to process large data sets to make decisions. It has evolved from custom, single-purpose, in-house application to pre-packaged, multipurpose, commercial products (Sixto, 2002). More so, intelligence has being in use since the 1950s by researchers in Artificial Intelligence, while in the 1990s, Business Intelligence (BI) became a popular term in the business and Information Technology communities.

In the 1970s, initial versions of analytical software packages appeared on the market. Then the 1980s saw the release of spreadsheet software such as Excel which is still widely used today. Around the mid-80s and early 1990s, Executive Information System (EIS) was introduced and speedily grew in popularity by promising to provide top management with easy access to internal and external information relevant to decision-making needs, placing "key information on the desktops of Executives". The "easy access" was due to user-friendly interfaces and powerful analytical functionalities. With similar factors as with Executive Information System (EIS), came the Decision Support System (DSS) popularity. It is software developed to support exception reporting, stop-light reporting, standard repository data analysis and rule-based analysis. Despite the fact that Executive Information System (EIS) and Decision Support

System (DSS) systems captured the attention of numerous researchers, which consolidate flourishing research areas for about two decades, their popularity continually decreased in practice. Reasons for this decline included the fact that Executive Information System (EIS) required a lot of manual work to convert and load data from data sources, and the view that Decision Support System (DSS's) scope was somehow narrow. In the 1990s, three technological improvements brought about a revolution in analytical applications scenarios, accounting for the emergence of Business Intelligence systems: Data warehouse technologies, Extraction, Transformation and Loading (ETL) tools and powerful end-user analytical software with Online Analytical Processing (OLAP) capabilities. More so, the impact of the internet is far from negligible; current version of analytical products are web-based and through internet or intranet connections, users can investigate and analyze data from home, while travelling or from any other location. Today, terms like decision support system (DSS) and executive information system (EIS) have virtually disappeared and Business Intelligence is the accepted term for analytical and strategic information systems, including an array of applications classified under three broad headings; Analysis (data mining and OLAP), Monitoring (dashboards, score-cards and alert systems) and Reporting (Maira and Marlei, 2009).

According to Howard Dresner of Gartner (2016) surveys, the research and analysis company constantly monitoring the changes that happens in BI-industry and reports them in their yearly Business Intelligence (BI) Magic Quadrant, "BI and Analytics" has been ranked as the top1 and 5 technology priority by Chief Information Officers (CIOs) between 2006-2009 and 2010-2016. Business Intelligence has been recognized as a strategic initiative and a key enabler for driving business effectiveness and innovation on the one hand. While on the other hand, the tremendous amount of structured, semi-structured and unstructured data collected in organization's transactional systems, operational systems, and from external data sources and social media has constantly challenged Business Intelligence (BI) practitioners and researchers (Liu, 2014).

Currently, Business Intelligence (BI) technologies integrate a large set of diversified resources (packages tools and platforms), and various products are being released aimed at fulfilling different needs related to the search for and use of information, ranging from report extractors; used on a more detailed informational level, to dashboards applications; used to consolidate within a single control panel the information linked to performance factors in a largely summarized level and sophisticated mining applications; used to build predictive business models (Maira and Marlei, 2009).

Furthermore, Business Intelligence (BI) has received much growth in the past two decades in the number of products and services offered and in the adoption of the technologies by industry. The growth is due to the decline in cost of acquiring and storing very large amounts of data arising from sources such as customer transactions in banking, retail as well as in e-business, email, and query logs for websites, blogs and product reviews. Enterprises collect data at a finer granularity that is of much larger volume and businesses are leveraging their data set aggressively by deploying and experimenting with more sophisticated data analysis techniques to drive business decisions and deliver new functionality such as personalized offers and services to customers. Figure 2.1 shows a typical Business Intelligence architecture.

Presently, most enterprise uses Business Intelligence technology for their businesses, like in the manufacturing in ordering of shipment and customer support, in financial services for claims analysis and fraud detection, in transportation for fleet management, in telecommunications for identifying reasons for customer churn, in utilities for power usage analysis and health care for outcome analysis (Surajit, et al., 2011).

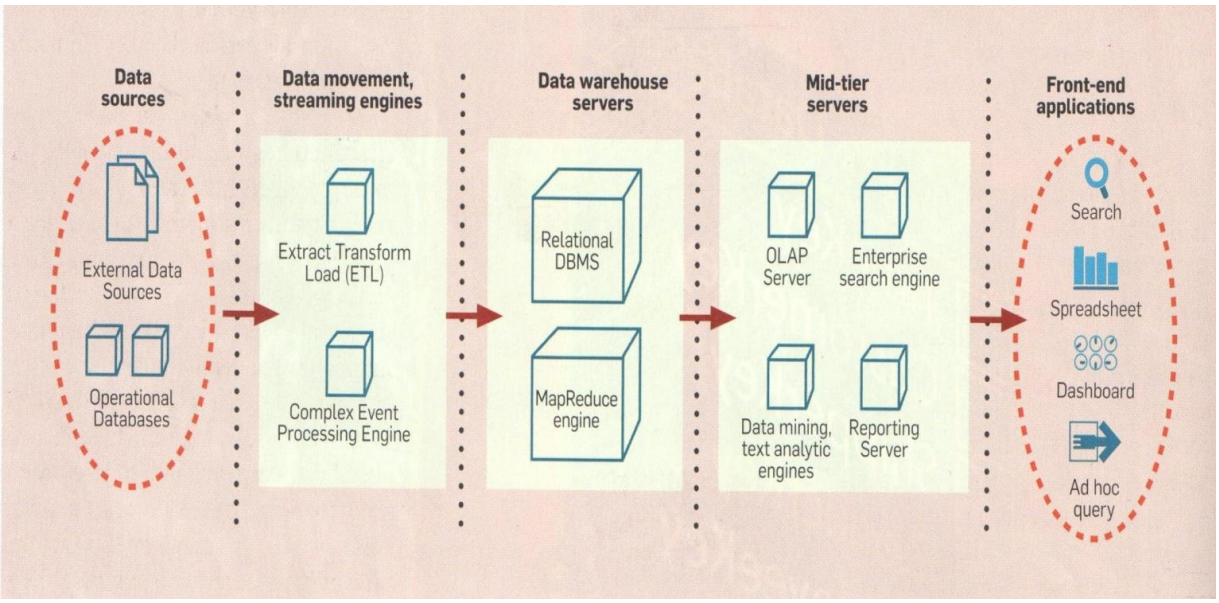


Figure 2.1 Typical Business Intelligence Architecture (Source: Surajit, et al., 2011)

The data over which Business Intelligence (BI) tasks are performed often comes from different sources, such as from multiple operational databases across departments within the organization as well as from external vendors. These various sources contain data of varying quality, use inconsistent representations, codes and formats that have to be reconciled. The challenge of integrating, cleansing, and standardizing data in preparation for Business Intelligence tasks is a problem of which the research would be solving. Data loading is

absolutely necessary for an efficient Business Intelligence, as well as the fact that Business Intelligence task needs to be performed incrementally as new data arrives. This will make for efficient and scalable data loading and refresh capabilities imperative for enterprise Business Intelligence (Surajit, et al., 2011).

The back-end technologies for preparing the data for Business Intelligence are called Extract-Transform-Load (ETL) tools as shown in figure 2.1. As earlier discussed, Business Intelligence is important in the following sense;

a. The cost of data acquisition and data storage has declined significantly. This has increased the appetite of businesses to acquire very large volumes of data in order to extract as much competitive advantage from it as possible.

b. New massively parallel data architectures and analytic tools go beyond traditional parallel structured query language (SQL), data warehouses (DWs) and online analystical process (OLAP) engines.

c. The need to shorten the time lag between data acquisition and decision making is spurring innovations in Business Intelligence technologies.

The complex event processing (CEP) engines is the scenarios used to support Business Intelligence (BI) aspect in ensuring that business decisions are based on operational data itself and its done in near real-time (that is as at when needed).

Next, is the repository called data warehouse in which the data over which Business Intelligence tasks are performed are loaded. These are managed by one or more data warehouse servers. The engine popularly used in storing and querying the data in the warehouse is the relational database management system (RDBMS). With increase in the volume of data , the term ‘big-data’ challenge; relational database management system (RDBMS) cannot handle it, so Map-Reduce paradigms which was originally built to analyze web documents and web search query logs is now being used for enterprise analytics (Surajit, et al., 2011). To complement the data warehouse servers, a set of mid-tier servers that provide specialized functionality are used for different Business Intelligence scenarios. Here comes the online analytic processing (OLAP) servers that efficiently expose the multidimensional view of data to applications or users are found and it enables common Business Intelligence operations such as filtering, aggregation, drill-down and pivoting.

The reporting server in the figure 2.1 enables definition, efficient execution and rendering of reports such as reporting total sales by region for the year and compare with sales of last year. With enterprise search engine, keyword search paradigm over text and structured data in the warehouse is supported. While, the data mining engines will enable in-depth analysis of data that goes well beyond what is offered by online analytical processing (OLAP) or reporting servers, and provides the ability to build predictive models to help answer questions such as; which existing customers are likely to respond to any upcoming catalogue mailing campaign? Text Analytic engine, analyze large amounts of text data (such as survey response or comments from customers) and extract valuable information that would otherwise require significant manual effort. While, front-end applications which are many are used by users to perform Business Intelligence tasks. Examples are Spread-sheets, Excels, Enterprise Portals for searching, performance management application that enable decision makers to track key performance indicators of the business using visual dashboards, tools that allow users to pose ad-hoc queries, and viewers for data mining models. With rapid ad-hoc visualization of data, dynamic exploration of patterns and outliers is enabled which helps to uncover relevant facts for Business Intelligence. Other Business Intelligence technology not shown in figure 2.1 include, web analytics that enables understanding of how visitors to a company's website interact with the pages. Also, vertical packaged applications like customer relationship management (CRM) which often support built-in analytics, and can provide functionality to segment customers into those most likely and least likely to re-purchase a particular product. Mobile Business Intelligence is also an important area that enables novel and rich Business Intelligence applications for knowledge workers on mobile devices (Surajit, et al., 2011).

Historically also, around late year 2000, Business Intelligence has become a revived hot topic in industry and practise. Its skills are highly pursued. As at 2009 Business Intelligence was the top application and technology under development. But in academic research they are empirically still scarce. Use of Business Intelligence to make better management decisions in these years has become more prevalent in organizations of different industries. The term Business Intelligence describes the technologies, applications and processes for gathering, storing, accessing and analysing data to help users make better decisions. In these years, Business Intelligence (BI)-based organization has been proposed though there is still a lack of empirical studies on why organizations need to be Business Intelligence (BI)-based and how other internal resources interact with Business Intelligence to deliver a superior return on investment (ROI). It has become a new information system fashion since the late year 2000 and

the lack of empirical research on why it is important, makes the rationale to invest in it weak, especially as researcher in the field show inconsistent returns on its investment (ROI).

Hence, it is worthy of note that Business Intelligence research conducted before year 2006 focused primarily on exploratory research, formal theory and literature review, very little on empirical was conducted. Also, prior research only addressed new technologies and issues in Business Intelligence without attempting to explain the fundamental issues of information system research as it relates to Business Intelligence (BI), such as generalize ability (external validity), precision of measurements (internal and construct validity) and realism of context (Xiaofeng, 2012).

2.1.1. The Concept of Business Intelligence

Intelligence concept was first proposed in 1967 by American Professor named Vilensky and he stated that intelligence indicates data collection and processing of information in order to determine the correct organization of things. He concluded that intelligence has a large impact on efficiency and effectiveness of the organization. It also support facilitation of the application of intelligence agencies and companies such as online analytical processing (OLAP), data mining, business analysis, implementation of enterprise networks and enterprise knowledge management application and other activities in an organization. He also, define organization intelligence agencies as that which can overall fit with the way information is, in data collection, data analysis arrangement, generation of new knowledge and learning to make better decisions in the enterprise (Fereydoon and Mohammad, 2012).

The concept of Business Intelligence (BI) is a management philosophy and tool that help organizations to manage and refine business information in order to make effective and intelligent decisions. It's used in relation to information and knowledge of organization that describes the business environment, organization itself, market conditions, customers, competitors and economic issues. It also, relates to a systemic and systematic processes by which organizations obtain analyze and distribute the information for making decisions about business operations. As earlier stated, the purpose is to help control the resources and the information flows of the business that exists in and around the organization. Business Intelligence makes a large contribution to the required intelligence and knowledge of the organizations' management by identifying and processing data in order to explain their hidden meanings. Is a process through which organizations take advantage of virtual and digital technology to collect, manage and analyze structural or non-structural data. This implies, the

technology and commercial processing procedures in the decision-making are supported through extraction, integration and analysis of data. It is seen also, as an instrument of analysis that provides automated decision-making about business conditions, sale, customers demand, and product preference. More so, it uses huge-database (data warehouse) analysis, as well as mathematical, statistical, Artificial Intelligence, data mining and on-line analystic processing (OLAP) (Saeed, et al., 2012).

Also, Business Intelligence is a business management tool, which consists of applications and technologies that are used to gather and analyze information about business. It can be defined as getting the right information to the right people at the right time. It is also seen as the processes, technologies and tools needed to turn data knowledge into plans that drive profitable business actions (Essam, et al., 2012). And according to Timothy, et al., (2009), Business Intelligence is seen from three main perspectives namely; the management aspect, the technological aspect and the product aspect. With this, researchers, practitioners and Business Intelligence vendors have a better idea of how different parties have approached Business Intelligence thus far as well as how it would be valuable in their design, planning, and implementation of contemporary Business Intelligence (BI) system in the future.

It can be seen to exist for organizations ever-changing business environment and has the ability to enable quick reaction to rapidly changing environments, which is seen as a key success factor and can remove guess work. It is often noted, that organizations require the ability to react and respond quickly to changing environments and adapt fast to appearing new situations. Business Intelligence (BI) today has evolved and become a very central method or tool to fulfil this central need for organizations. More accurate and wide-spread use of data collection, data processing (data integration) and analysis benefits the quality of decision making and helps the organization in unambiguous way at the correct time (Pekka, 2017).

Furthermore, Business Intelligence (BI) is that concept that converts raw data into intelligent information, and allows business users to access the right information speedily, at the right time as well as be able to transform the knowledge from the intelligent information into smart decisions and actions. Again, Business Intelligence (BI) implies the ability of an organization or business to reason, plan, predict, solve problems, think abstractly, comprehend, innovate and learn in ways that increase organizational knowledge, inform decision processes, enable effective actions and help to establish and achieve business goals (Dave, 2008). While Business Intelligence systems or its environment is seen as that system with quality

information in a well-designed data stores, coupled with business friendly software tools that provide knowledge workers timely access, effective analyzes and intuitive presentation of the right information which enables them to make the right decisions and take the right actions (Ales, et al., 2012).

The concept of Business Intelligence has experienced high growth because chief information officers (CIO's) of organization has realized that data is one of their most valuable assets as it is used to generate information as well as to increase the need for prompt (Real-time) decision-making, this has led to the generation of information at an increasing pace. With the components and/or tools of Business Intelligence such as data analysis, reporting and query tools, Business Intelligence system can help business users wade through an ocean of data to generate valuable information from it (Essam, et al., 2012).

Worthy of note is that Business Intelligence Systems do add value mainly at the beginning of the information value chain where, depending on the implemented technologies, it collects and structures the data then transforms it into information. Its implementation do contribute to improved information quality in ways such as faster access to information, easier querying and analyzing (that is determining patterns and relationship), a higher level of interactivity, improved data consistency due to data integration processes and other related data management activities like data cleansing. Business Intelligence (BI) systems also provide quick access to information for analyzing and reporting. The application of Business Intelligence (BI) systems in an organization is said to be successful if it uses correct, valid, integrated and in-time data, as well as the means that would transform the data into decision-making information. With data integration long-term benefits of enterprise intelligent system such as Business Intelligence (BI) is feasible as data integration is generally recognized as one of the factors that contributes to its success/benefits. With literatures on the review of management information quality, as well as information technology and information system (IT and IS), on the effect of Business Intelligence system and its access to information, it revealed the greater efficiency of knowledge workers, enhanced analytical capabilities, and improved timeliness to decision-making process, as information access quality features were valued the most by knowledge workers who used the system. With this information from Business Intelligence system acquired by knowledge workers through improved interactivity (that is access to quality information) they would be able to explore it and acquire more relevant information (that is information content quality) (Ales, et al., 2012).

The expectations of decision makers have not being met by existing Management Information System (MIS) like (Management Information System: MIS; Decision Support System: DSS; Executive System: ES; and Executive Information System: EIS). These expectations include;

a. Making decisions under time pressure.

b. Monitoring competition.

c. Possessing such information on their organizations that includes different points of views and

d. Carrying out constant analyzes of numerous data as well as considering different variants of organizations' performance.

In a nutshell, what it implies is that they do not handle integration of different, dispersed and heterogenic data well, cannot interpret such data in any broad contexts effectively and are not capable of sufficient discovering of new data inter-dependencies. For management at various levels in an organization to be able to react quickly to changes that take place on the market, organizations need management information systems that would make it possible to carry out different cause and effect analyzes of organization themselves and their environments (Celina and Ewa, 2007).

Management Information System (MIS) systems provide a proposal that faces needs of contemporary organizations. The needs to be faced by Management Information System (MIS) systems are intelligent exploration, integration, aggregation and a multidimensional analysis of data originating from various information resources. These standard systems of Management Information System (MIS) combine data from internal information systems of an organization and then integrate it with data coming from other particular environment like statistics, financial and investment portals as well as miscellaneous databases. The systems of this standard are meant to provide adequate and reliable up-to-date information on different aspects of enterprise activities. Figure 2.2 show the evolution development of management information system (MIS).

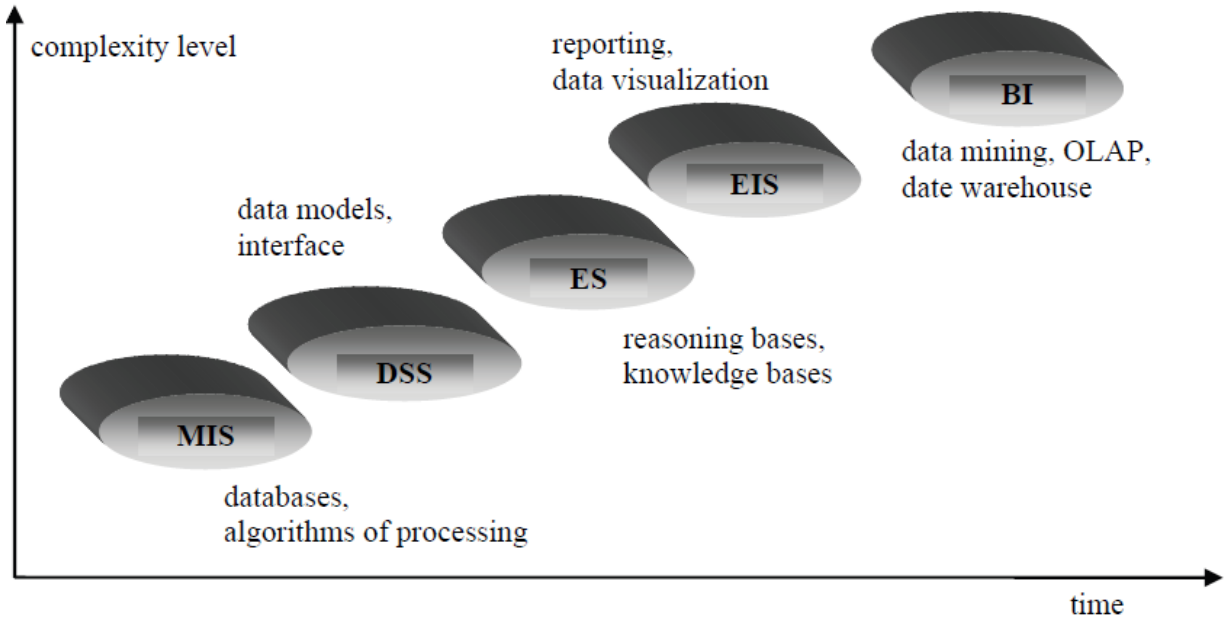


Figure 2.2 Development of Management Information Systems (Source: Celina and Ewa, 2007)

The question of creating and implementing Business Intelligence in organizations is still at its infancy stage as the discussions of Business Intelligence issues like online analytical processing (OLAP) techniques, data mining and data warehouses are rarely analyzed in categories of solutions that would facilitate effective decision making and strategic thinking (Celina and Ewa, 2007).

Business Intelligence (BI) concepts also imply that the right information has to be ready to the right people, at the right time, and in syntax and semantics that corresponds to the user's understanding. This right information is not only in its content correctness, but that it should be according to the user's needs. While in the right-time implies the information should be available on the moment the user needs it for making decisions. Of note is the fact that current Business Intelligence environments are still limited and heavy-weighted to fulfil the above stated requirements. The fact that organizations' need to make faster decision in all its hierarchical level in order to remain competitive and the delight of customer and business partners is of great importance, in the sense that there is a great amount of information available worldwide and so getting the right piece is not easy. So it is necessary that organizations' systems have the capacity to deliver the right piece of information in the appropriate form, in the right time and for the right person (Carlos, et al., 2009).

The corporate operational databases are becoming bigger and more complex, which makes it difficult to search and retrieve appropriate data in an efficient form the moment it is needed. Also, the issue in the abstraction level of which decision makers need to explore and to mine data, is different from the abstraction level presented by the interfaces of today's systems. These issues brought about the term Business Intelligence (BI), which is defined as a set of concept and methods to improve business decision making by using fact-based support systems. Data warehouse (DW) is one of the central technology (components) of Business Intelligence that has been used to reach Business Intelligence in organizations. It is a subject-oriented, integrated, time-variant and non-volatile collection of data in support of management's decision making process, it is in the warehouse that all data of the organization as par customers, suppliers and operations are available and accessible for consultations and analyzes. It is a fact that decision makers knows and works in a higher level of abstraction which is the business level. So the semantic queries should be mapped directly to the sources of the data to be executed because the decision maker generally doesn't know the details of the databases and necessary schemas involved in retrieving information. The use of ontology technology is a promising and already established technology that will raise the data abstraction level in the process of semantic information integration (Carlos, et al., 2009).

In the aspect of organizational agility, which is the ability to sense and respond to market opportunities and threats with speed, the concept of Business Intelligence can be of help in terms of sensing role of organizational agility. In business context, Business Intelligence is significant because information technology and systems have strategic values for organization as par it is used for better management decision.

The improvement on organizational agility has two source components that can help; first is the component that can help sense and detect market opportunities and threats in a timely manner and second is the component that can help act on or respond to market opportunities and threats in a timely manner. Based on existing literature, Business Intelligence can help in the above two source component. Also, flexible Information Technology infrastructure can help responds to market opportunities and threats by facilitating the integration and re-configuration of existing resources to develop new capabilities. So both Business Intelligence (BI) and Information Technology (IT) infrastructure flexibility are enabling source components that can help improve organizational agility. Of note, is that Business Intelligence (BI) can raise awareness on the trends of products and customer changes, so it will contribute to organizational agility by providing timely information to detect changing trends. For these

reasons Business Intelligence (BI) is a strategic component for an organization's competitive advantage. It is an Information Technology (IT)-enabled system that is built on top of an organization's Information Technology (IT) infrastructure. So a flexible Information Technology infrastructure will improve Business Intelligence (BI) performance by providing more accurate and timely data and information with easily integrated data sources. Agility is defined based on two factors the speed and capabilities of the firm to use resources to respond to changes. Also, two dimensions of agility are identified; alertness and responsiveness. In the business context this definition indicates that agility is an organization's ability to sense and/or detect (alertness) as well as act/respond (responsiveness) to changes with speed. The dimensions of agility in the business context are the ability to detect environmental changes and the ability to respond to the changes with speed (Xiaofeng, 2012).

In the context of Information System (IS), agility indicates the ability to sense and respond to opportunities and threats in business environments in timely and cost effective manner. The relationship therefore is that in Information System (IS) research organizational agility places emphasis on speed, while in strategic management research the term dynamic capability stresses less on speed. But agility is about speed to detect and/or sense or respond to opportunities and threats in the business context, while flexibility is about malleability and the ability to help respond to change requests quickly and economically, which makes it a key antecedent of agility in the business context (Xiaofeng, 2012). So Business Intelligence (BI) system has to be agile.

Business Intelligence (BI) is seen as a new business-driven phenomenon that can add values to organizations. So it is defined as that broad category of applications, technologies and processes for gathering, storing, accessing and analysing data to help business users make better decisions. At the conceptual level, Business Intelligence (BI) is seen as the term for systems and procedures that transform raw data into useful information for managers to make better decisions. While at the operational level, it is an information system that has three elements; technological element which collects stores and delivers information and also includes the general technology of Business Intelligence (BI) that performs basic functions to support generic actions such as gathering, storing, accessing and analyzing of data. Next is the human competencies element on the abilities of human beings to retrieve data and deliver it as information, to generate knowledge, and to make decisions based on the new knowledge. Though Business Intelligence (BI) basic functions are provided, human operators still need to have certain knowledge and competency in order to retrieve data and generate reports and

make decisions based on the reports. The third element is that which supports specific business processes and makes use of the information or the new knowledge in order to increase business values. This element includes special functions of Business Intelligence (BI) such as setting up an automatic response when certain conditions have been reached as in a supply-chain related information system like inventory. It is the advanced features of a Business Intelligence (BI) system that makes it more than just a reporting application (Carlos, et al., 2009).

In essence, Business Intelligence can help in organizational agility by detecting customer event patterns, identifying operational opportunities and bottlenecks, and revealing changes in partners' assets and competencies to managers so that they can sense, act or make timely decisions. As Business Intelligence (BI) is an information system which helps managers makes the right decisions at the right time, it is used across business units. It can create an environment for sharing newly found or created knowledge. They are built on top of existing Information Technology infrastructure in digitally enabled organizations. Business Intelligence (BI) require access to data from a variety of sources and distribute data to different user and data interfaces like web browsers on desktop computer, small screens on mobile devices, or as a data feed to other information systems. With a flexible Information Technology (IT) infrastructure, Business Intelligence (BI) can easily and quickly access or integrate existing and new data sources. As well its use can be increased because with it more information can readily be available when needed and coveted information can be available where and when it is needed. Also, with it rich and accurate information will make the systems to be perceived as more useful. It is paramount that Business Intelligence be treated as a strategic component of an organization because of its contribution to organizational agility. This shows that its use is more important to increasing an organization’s agility in a highly turbulent environment than in less once (Xiaofeng, 2012).

Also, Business Intelligence (BI) is a set of concepts, methods and processes to improve business decisions, which use information from multiple sources and apply experience and assumptions to develop an accurate understanding of business dynamics. It integrates the analysis of data with decision support system to provide information to people throughout the organization in order to improve strategic and tactical decisions. An organization will be able to develop an intelligent decision support system with appropriate Business Intelligence (BI) so as to gain competitive advantage of the industry. Enterprises that apply Business Intelligence (BI) had achieved two to three times’ return of investment (ROI) more than those who do not. With ever-changing business environment, it is imperative, that Business Intelligence (BI)

process should have continuous and systematic process that consists of identifying what information is needed, how it should be gathered, how it should be organized and stored and who should have access to it, plus reviewing periodically how the management has exploited the knowledge to gain significant competitive advantage (Shenge, et al., 2008).

With Business Intelligence (BI), it is possible to improve the decision making process of virtually any department, organization or industry. Most industries are aware of the changes that have occurred over time with Business Intelligence. Their tools have evolved offering more functionality to analysts and providing solutions for more users. More so, information requirement have grown exponentially as par the fact that a few gigabytes of data were needed some years back, but now data warehouses are populated with terabytes data and rapidly moving to peta-bytes and more range. The challenge of how to manage these increasing data in the data warehouses and application servers that reaches their limits within months due to the volume of data stored brings the need for a new flexible technological approach needed to address the challenge (Eumir, 2010).

The term Business Intelligence (BI) can be referred again to imply as various computerized methods and processes of turning data into information and then into knowledge, which is eventually used to enhance organizational decision making. It is also, still mostly understood as data-driven oriented system as managerial tasks are less frequently organized by means of well-defined processes. It provides quick access to information for analysing and reporting as against operational system, which focus on the fast and efficient processing of transactions. With the use of Business Intelligence especially on strategic and tactical level of decision making, a greater role of data integration on information quality, especially in information content quality and consequently on use of information would be expected (Ales, et al., 2012).

Furthermore, Business Intelligence (BI) is an analysis mechanism by which automated decision-making regarding business status, sales analysis, customer demand, product preference, and health services is provided for enterprises through large database system analysis as well as mathematical, statistical, artificial intelligence, data-mining, and on-line analytical processing (OLAP). It doesn't reflect tools only, but the management of transferring internal messages in the enterprise environment as well. When it is successfully implemented, its role is played in four aspect; assisting in understanding business status, measuring organizations' performance, improving stakeholders' relationship and creating profitable

opportunities. In all, its purpose is to provide users with the best possible assistance in the process of decision-making (Yu-Hsin, et al., 2009).

Again, Business Intelligence (BI) is seen from two broad perspective; Managerial and Technical approaches. The Managerial Approach sees Business Intelligence (BI) as a process in which data gathered from inside and outside the company are integrated in order to generate information relevant to the decision-making process. It is expected to create an informational environment in which operational data gathering from transactional system and external sources can be analyzed in order to reveal "strategic" business dimensions. While in the Technical aspect, it is a set of tools that support the process described above. The focus is not on the process itself, but on the technologies that allow the recording, recovery, manipulation and analysis of information (Maira and Marlei, 2009). Even though the technical and managerial approaches have some differences, they also, share two basic ideas that; the core of Business Intelligence (BI) is the gathering, analysing, and distribution of information and the goal is to support the strategic decision-making process. Strategic decision implies decisions related to implementation and evaluation of organizational vision, mission, goals and objectives that are expected to have medium to long-term impacts on the organization as against operational decisions, which are day-to-day in nature and more related to execution (Maira and Marlei, 2009).

The means to Business Intelligence are processes, technologies, tools, applications, data, databases, dashboards, scorecards and on-line analytical processing (OLAP) are all claimed to play a role in enabling the abilities that define Business Intelligence. The above are not the intelligence itself. The system success, do rely partially on executive and/or decision support system (DSS) which are application-oriented, but in itself it is data-driven oriented, centred on data warehousing which provide the analytical tools required to integrate and analyze organizational data (Ales, et al., 2012).

According to Tobias and Vivian (2008), Business Intelligence (BI) technology context is seen as the enabler for storing, analyzing, visualizing and giving access to a great amount of data and the purpose would entail a wide range of expert system (AI), online analytical processing (OLAP) and data mining tools that are used covertly in Business Intelligence (BI) system. Also, the technology is required to provide an integrated view of both the internal and external data; this is the focus of the research, enhancing the data integration process of Business

Intelligence. In summary the research would assist managers and practitioners in the health sector to begin to effectively support evidence-based practise.

More so, with customer expansion in companies, Business Intelligence is used to mine the customer relationship as it helps in consolidating, analysing, and providing access to vast amounts of data for business decision making. The major tools of Business Intelligence are online analytical processing (OLAP) which is a tool that supports multidimensional analysis, enabling users to view data in vast data warehouses in different dimensions that normal database queries would not be able to do as quickly. Next is data mining, which is the technology that allows searching through large amounts of data for meaningful patterns of consumer behaviour like switching behaviours, fraud patterns, market basket analysis, and consumer trends (Saeed, et al., 2012).

Traditional Business Intelligence (BI) methods encompass structure, components, activities, and deliverables that seek to put the right information into the hands of the right people at the right time. This traditionally technically focused method fall short of ensuring that Business Intelligence investments pay off. Presently, Business Intelligence (BI) presents business information in a timely and easily consumed way and provides the ability to reason and understand the meaning behind business information through, for example discovery, analysis and ad hoc querying (Cheung and Li, 2012).

Business Intelligence (BI) methods and tools exist to bring order, efficiency, and consistency to informational Information Technology. So that companies can manage their affairs with a single version of the facts. It can further provide better analytical tools and more structured, information-rich decision processes within core business processes, and that can improve profits. Its tools and methods also are used to enhance transactional applications. The data quality tools ensure that the quality of data feeding into the data warehouse (DW) is appropriate for the intended Business Intelligence application. The key from a Business Intelligence perspective is to understand the nature and frequency of data quality issues in order to determine whether the issues are materials for the usability and credibility of the business information bound to the data warehouse (DW) for the Business Intelligence (BI) applications (Saeed, et al., 2012).

It is imperative that Business Intelligence will surely become the tool enterprises would like to actively deploy as well as the solution that can bring enterprises competitive edge. But current Business Intelligence application is still at its fledging stage (infancy) and most of the

organization don't have sufficient understanding of Business Intelligence. More so, the application of Business Intelligence (BI) is the process through which enterprises take advantages of modern information technology to collect, manage and analyze structural or non-structural data. So through extraction, integration and analysis of data, technology and commercial processing procedures in decision-making are supported. This implies that problems and a huge amount of data of organization are input into data-mining system for data analysis to help decision makers make and obtain useful information promptly in order to make accurate judgement. That is in regard to organizations operating contents, abilities of fast understanding and deducing are provided and thus enhancing the quality of decision-making and improving performance and expediting processing speed (Yu-Hsin, et al., 2009).

It is seen as a response to current needs in terms of access to relevant information through intensive use of information technology. Is a system that potentially maximizes the use of information by improving organization's capacity to structure a large volume of information and make it accessible, thereby creating competitive advantage. Because of its high level of analytical ability, Business Intelligence (BI) is now the accepted term as Decision Support System (DSS) and Executive Information System (EIS) have virtually disappeared term-wise today. Business Intelligence is the accepted term for analytical and strategic information system, plus an array of application classified under three headings, namely; Analysis (Data-mining and OLAP), Monitoring (Dashboards, Scorecards and Alert system) and Reporting (Maria and Marlei, 2009).

In summary, Business Intelligence (BI) and its accompanying approaches to widespread analytics allow organization to identify new business trends, assess the spread of diseases, and even combat crime, among a plethora of other opportunities for creating value. With Business Intelligence, individuals over-whelmed with data and tend to succumb to analysis paralysis will be able to overcome such paralysis as trustworthy, actionable intelligence will be delivered to the right people when they need it, thereby short-circuiting analysis paralysis and encourages rational and confident decision-making by such individuals (David, 2013). This is why Business Intelligence is sometimes referred to as "On-line decision making" that is instant response or as "Shrinking the time frame" so that the intelligence is still useful to the decision maker when the decision times comes. Because of this Business Intelligence (BI) is viewed as being a proactive system.

In conclusion, as a general management task, Business Intelligence (BI) asset created should be managed in a way that it supports the company's overall business strategies. To accomplish this, it must recognize that Business Intelligence (BI) capabilities should be developed and managed in the same way that other services are managed so as to bring about delivering competitive advantage. Also, the key point of any Business Intelligence strategy is the ability to take action based on the intelligence it has learned. Which implies that Business Intelligence program provides benefits that increase business efficiency, increase sales, provide better customer targeting, reduce customer service costs, identify fraud and generally increase profits while reducing costs. If properly implemented Business Intelligence is an Information Technology area that can be a profit centre instead of the traditional cost centre (David, 2013).

2.1.2. Definitions of Business Intelligence

Business Intelligence is a set of theories, methodologies, processes, architecture and technologies that transform raw data into meaningful and useful information for business purposes; While dashboards reporting projects have a more limited scope and generally address current requirements rather than future ones (Irawen, 2018). Dashboard and reports tend to be static, created once and simply refreshed with updated data, as opposed to business analytics that allows an organization to create new reports and dashboards as required. Business Intelligence (BI) is solution-oriented while dashboard and report is project-specific (Elad, 2013).

Again, Business Intelligence (BI) is an automatic system that is being developed to disseminate information to the various sectors of any industrial, scientific or government organization. It is an Intelligence system that will utilize data-processing machines for auto-abstracting and auto-encoding of documents and for creating interest profile for each of the “action points” in an organization. According to Luhn (1958), the system should be flexible enough in identifying known information, in finding that which needs to know it and in disseminating it efficiently either in abstract form or as a complete document. So, Business Intelligence (BI) system is a comprehensive system assembled to accommodate all information problems of an organization.

It is viewed by some researchers differently in the sense that, some consider Business Intelligence (BI) to be a data driven decision support system; a strategic information system capable of providing actionable information through a centralized data repository, sourced from numerous sources, transformed into meaningful information via Business Intelligence

analytical tools, to facilitate business insights leading to informed decisions. It is also defined as a way and method of improving business performance by making actionable information available for decision makers in an organization; it is further defined as the communication facility serving the conduct of a business (Timo-Elliott, 2013).

With these definitions Business Intelligence (BI) can be said to be a process and method of improving decision-making through a combination of business processes and effective utilization of Information Technology (IT) to integrate data and information from various operating systems and into data warehouses, using data-mining to analyze the data, and generating high-level report in a timely and user-friendly manner for the decision makers in an organization. With Business Intelligence (BI), co-operate managers and decision makers can make relevant, accurate, timely and smart decision in an organization and thus lead to increase in productivity and profitability of the organization (Cheung and Li, 2012). In order words, it is the combination of business processes with the use of Information Technology (IT) system such as data warehouses (DWs), data marts, metadata, data mining, extract transform load (ETL), query and reporting software, online analytical processing (OLAP) and visualization to support decision-making in all organizations.

Of note business is defined as a collection of activities carried on for whatever purpose, whether sciences, technology, commerce, industry, law, government, and defence. The communication facility serving the conduct of a business (in the broad sense) may be referred to as intelligence system. In general, the term Business Intelligence (BI) is defined as "*a set of processes, know-how, methodologies, practices, applications and technologies whose goal is to effectively and efficiently endorse management activities and make timely and optimized business decisions"* (Howard Dresner of Gartner, 2016; Novotný et al., 2005). Its goal is to present business information in a fast, simple and efficient way. It supports analytical, planning and decision-making activities at all levels and in all areas of corporate governance, enabling the viewing of reality from many possible angles (Ing.Dita, 2016).

According to Delic and Stanier, (2016) as well as Aneesha and Balajkarthik, (2017) it can further be defined as "the set of strategies, processes, applications, data, products, technologies and technical architectures which are used to support the collection, analysis, presentation and dissemination of business information".

Again according to Essam, et al., (2012), Business Intelligence (BI) is seen as a business management tool, which consists of application and technologies that are used to gather and

analyze (structural and non-structural data) information about business. It is defined as the processes, technologies, and tools needed to turn data into information, information into knowledge and knowledge into plans that drive profitable business actions. The system is adopted in various industries in order to meet their specific business requirements.

It is also, defined as getting the right information to the right people at the right time. It constitutes a broad category of application and technologies for gathering, storing, analysing and providing access to data to help people in the organization to make better business decisions (Cheung and Li, 2012).

Of note is that, business analytics is defined as a subset of Business Intelligence not a separate concept. It is defined as "a process of transforming data into actions through analysis and insights in the context of organizational decision making and problem solving. It is also seen as the extensive use of data, statistical, and quantitative analysis, explanatory and predictive models and fact-based management to drive decisions and actions (Liu, 2014). While, Business intelligence software is a collection of decision support technologies for the enterprise aimed at enabling knowledge workers such as executive managers and analysts to make better and faster decisions (Surajit, et al., 2011).

Business Intelligence (BI) acts as a decision support system (DSS) to foster decision making. It is a continuous process which gathers and stores data which gets transformed into information and later to knowledge that can be used in the decision-making process that leads to profitable, intelligent actions.

Data --Information -- Knowledge -- Decision (action)

Mission of management information system (MIS) sound very much like the mission of definition of Business Intelligence (BI) today in the sense that management information system (MIS) role is of keeping aware of the state of Business.

By some definition of Business Intelligence (BI) such as; "Business Intelligence being considered to be a process by which an organization systematically gathers, manages and analyzes information essential for its findings" it sounds same as Management Information System (MIS) definitions. In order to separate Management Information System (MIS) and Business Intelligence (BI) definitions, it is decided that whether informed findings are intelligence because they increase awareness, or does Business Intelligence (BI) have a clear separation from other informing findings? Separation criteria between Business Intelligence

(BI) and other Management Information System (MIS) have to be defined. So, in order to differentiate between Management Information System (MIS) and Business Intelligence (BI), let it be noted that, the mission of Business Intelligence becomes clearer if weighed against the types of served information needs. Regarding the positioning of these needs against the axis of simple-complex information needs, they usually fall into the more sophisticated part of the information needs complexity spectrum. Same can be said about the process of decision making that requires sophisticated tools to support awareness, communication, sense making and evaluation of risks often. The dimension of common and special information needs separates decision making from the rest of Business Intelligence (BI) in a sense that while decision support activities are directed towards a certain problem which has been recognized and has created a task for its solving. Business Intelligence (BI) can be considered an activity which, apart from encompassing decision support, has a permanent nature and allows the discovery of problems and general awareness about the state of activities (Rimvydas, et al., 2013). Table 2.1 highlights some of the differences.

Business Intelligence (BI) process takes cyclical nature and includes stages of information needs, definition, information collecting, information processing, analysis, information dissemination, information utilization and feedback. The cycle is justified of the received feedback as it helps to re-evaluate or re-define information needs. In Business Intelligence (BI) process, there is usually no clear concentration on a specific topic or problem; the resources of a Business Intelligence system are used for constant monitoring of internal and external business environment. Figure 2.3 shows the generic Business Intelligence model.

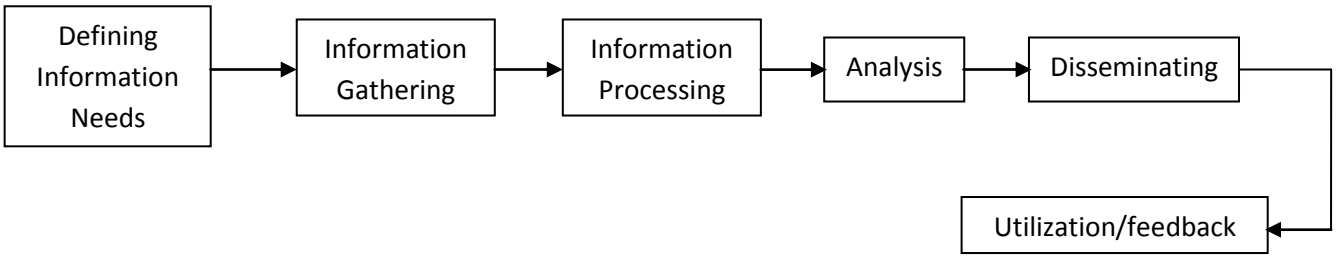


Figure 2.3: A Generic Business Intelligence (BI) Process Model (Source: Rimvydas, et al., 2013)

Furthermore, Business Intelligence (BI) enable organization to obtain faster and easier access to information, to improve business processes and decision making as well as to identify the opportunities and the threats, while cooperating with customers, suppliers and competitors (Henrike, et al., 2010).

In particular, Business Intelligence technologies provide historical, current, and predictive views of business operations. Common functions of business intelligence technologies include querying, reporting, online analytical processing (OLAP), data mining, text mining, process mining, complex event processing (CEP), business performance management (BPM), benchmarking, and business analytics. It is important to note that business analytics is defined as a subset of Business Intelligence, instead of as an extension of Business Intelligence (BI) or a separate concept. *Business analytics* has been defined as "a process of transforming data into actions through analysis and insights in the context of organizational decision making and problem solving" (Liu, 2014).

The value of real-time Business Intelligence (BI) rests in its capability to reduce the three types of latency: *data latency* (the time between business events and when the operational data is captured), *analysis latency* (the time to analyze the data and when the findings are available for use), and *decision latency* (the time to act upon the data), with this organization's agility is enhanced with respect to increased responsiveness to varying customers' needs and market situations.

In summary, the research adopted the definition of Business Intelligence (BI) according to Sanja, et al., (2016) that states "Business Intelligence (BI) is that technology which enables organizations to make more informed, intelligent business decisions as well as to adapt to a changeable environment and to survive in the business world, while cooperating with customers, suppliers and competitors". It further states that modern Business Intelligence (BI) involves the integration of intelligence methodologies and information technology (IT) that are applied to the business world (Sanja, et al., 2016). The tables 2.2 and 2.3 give the summary of various definitions of Business Intelligence and its approaches.

Table 2.1 Difference between BI and Other MIS/DSS

Business Intelligence (BI)	DSS and Other MIS Systems
It describes a set of concepts and method to improve business decision making by using fact-based support systems.	Decision support concept evolved from theoretical studies of organizational decision making, its focus is on providing managers with solutions structured periodic reports and most of its information is from acting and transaction systems.
It is a data-driven, solution-driven and object-oriented driven type of DSS. They are part of life system. And it supports process-oriented organization better.	Model-driven DSS are in the domain of operation research and are not part of life systems. Also, it is model-oriented or management system that came up during the late 1950s and early 60s.
It involves the update of data.	It does not involve updating of data.
It can be built for re-useable purpose.	The technical work is on interactive computer system.
It is defined as the technological framework which enables corporation to explore, analyzes and model large amounts of complex data towards one major goal; which is to improve business performance.	MIS is an integrated man/machine system for providing information to support operation, management and decision making in organization according to Gordon Davis.
It is the modern approach to decision making.	It is the old or traditional approach to decision making.
It involves several business processes, requires specialized human resources and a new model of interaction with the data store (DW).	DSS system support managerial decisions by involving the analysis of many units of data in a heuristic fashion and as a rule.
It is an intelligent system that utilizes data-processing machines for auto-abstracting and auto-encoding of documents and for creating interest profile for each of the "action points" in an organization.	They are specific process to decision making.
BI is used to solve sophisticated complex information needs. So it is in the sophisticated complexity spectrum range.	It is in the less complexity spectrum range in information needs solution requirement. That is it can not solve complex information needs.
BI is considered an activity which apart from encompassing decision support, has a permanent nature and allows the discovery of problems and general awareness about the state of activities.	DSS activities are directed towards a certain problem which has been recognized and has created a task of its solving or solution.
BI has a higher degree of integration of data which represents both its challenges and the potential. It goes beyond technical integration. It is the integration on a conceptual and organizational level that truly unlocks its potentials.	It has less degree of integration of data. It is just technical integration.
Data warehouse is core of a BI approach. It	No Data warehouse involved since analysis

provides a subject-oriented, non-volatile and integrated data repository for a variety of analysis and reporting application.	and reporting is on specific periodic processing of data.
It has only one version that gets updated in the same format for all users and thereby it reduces confusion of knowing the latest updated version.	It has several versions and its' not updated, so confusion is high (increases).
It can answer "what if and why" questions.	It cannot answer "what if and why" questions.
It reduces occurrence of errors in its decision-making.	Occurance of errors is high in its decision making.
It extracts data that is valuable and hard to access and used to find intelligent answer to several questions when handled with proper knowledge to interpret the obtained information.	It extracts data that is less valuable and easy to access and can't be used to find intelligent answer to several questions.
It is a continuous process which gathers and stores data that gets transformed into information and later to knowledge that can be used in the decision making process, which leads to profitable, intelligent actions.	Its solutions are structured periodic process from transaction systems.
It makes decision more substantial and improved.	It makes decision less substantial.

Table 2.2 Summary of Varied BI Definitions (Source: Timothy, et al., 2009)

BI Vendor / Author	Definition of BI
Turban et al., (2007)	An umbrella term that encompasses tools, architectures, databases, data warehouses, performance management, methodologies, and so forth, all of which are integrated into a unified software suite.
Moss and Atre (2003)	It is an architecture and a collection of integrated operational as well as decision-support applications and databases that provide the business community easy access to business data.
Chang (2006)	The accurate, timely, critical data, information and knowledge that supports strategic and operational decision making and risk assessment in uncertain and dynamic business environments. The source of the data, information and knowledge are both internal organizationally collected as well as externally supplied by partners, customers or third parties as a result of their own choice.
Gangadharan and Swami (2004)	The result of in-depth analysis of detailed business data, including database and application technologies, as well as analysis practice.
Kulkarni and King (1997)	A product of analyzing business data using business intelligence tools. It emerges as a result of this analysis.
Moss and Hoberman (2004)	The processes, technologies, and tools needed to turn data into information, information into knowledge and knowledge into plans that drive profitable business action. BI encompasses data warehousing, business analytics tools and content/knowledge management.
Adelman and Moss (2000)	A term that encompasses a broad range of analytical software and solutions for gathering, consolidating, analyzing and providing access to information in a way that is supposed to let an enterprise's users make better business decision.
Gartner Research (Hostmann, 2007)	An umbrella term that includes the analytic applications, the infrastructure and platforms, as well as the best practices.
IBM (Whitehorn and Whitehorn, 1999)	An umbrella term that broadly covering the processes involved in extracting valuable business information from the mass of data that exists within a typical enterprise.
Business Objects (Business Objects, 2007)	The use of an organization's disparate data to provide meaningful information and analysis to employees, customers, suppliers, and partners for more effective decision making.
Cognos (Cognos, 2007)	Business intelligence brings people and data together, offering a variety of ways to see the information that backs fact-based decision making.
SAS Institute (Ing, 2007)	Delivering the right information to the right people at the right time to support better decision making and to gain competitive advantage.
Oracle (Oracle, 2007)	A portfolio of technology and applications that provides an integrated, end-to-end Enterprise Performance Management System, including financial performance management applications, operational BI applications, BI foundation and tools, and data warehousing.
Informatica, Teradata, MicroStrategy (Markarian, Brobst and Bedell, 2007)	An interactive process for exploring and analyzing structured, domain-specific information (often stored in a data warehouse) to discern trends or patterns, thereby deriving insights and drawing conclusions.

Table 2.3: **Three Approaches to the Definitions of BI (Source: Timothy, et al., 2009)**

Approach	Managerial/Process	Technological	Product
Definition	Focus on the process of gathering data from internal and external sources and of analyzing them in order to generate relevant information for improved decision making.	Focus on the tools and technologies that allow the recording, recovery, manipulation and analysis of information.	Describe BI as the emerging result/product of in-depth analysis of detailed business data as well as analysis practices using BI tools.
Author	Whitehorn and Whitehorn (1999); Business Objects (2007); Cognos (2004); SAS Institute (2007); Moss and Hoberman (2005); Hostmann (2007); Oracle (2007); Turban et al., (2007); Markarian, Brobst and Bedell (2007)	Moss and Atre (2003); Moss and Hoberman (2004), Adelman and Moss (2000); Turban *et al*., (2007); Oracle (2007); Hostmann (2007) * Note: The definition of Hostmann (2007) and Moss and Hoberman (2005) spans across both process and technological approaches.	Chang (2006); Gangadharan and Swami (2004); Kulkarni and King, (1997); Turban et al., (2007) *Note: The definition of Turban et al., (2007) spans across all three approaches.

In conclusion, the objectives of the Business Intelligence system concepts are to enable business managers and analysts of all levels to readily access any data in the organization and to conduct appropriate manipulation and analysis. This implies a Business Intelligence system can improve the timeliness and quality of the input to the decision making process and thus corporate data is transformed from quantity to quality. This idea goes way back to more than 50years ago credited to Luhn (1958) of IBM who wrote that "Information is now being generated and utilized at an ever-increasing rate because of the accelerated pace and scope of human activities. At the same time the growth of organization and increased specialization and divisionalization has created new barriers to the flow of information". Intrinsically, he notes that "a comprehensive system may be assembled to accommodate all information problems of an organization". And it is called a Business Intelligence (BI) system (Luhn, 1958).

So a Business Intelligence system can be viewed as enterprise architecture for an integrated collection of operational and decision support application and databases, which provides various business stakeholders with easy access to the required information. It facilitates the analysis and sharing of information as well as helps with the making of informed business decisions (Timothy, et al., 2009).

2.1.3. Obstacles and Concerns with Respect to Business Intelligence

In spite of improvements that Business Intelligence has recorded recently, there is still obstacles and concerns to it widespread adoption, some of which the research would resolve.

a. Security: This is of great importance for Business Intelligence as companies are increasingly sharing data for Business Intelligence analysis outside their firewalls and over the internet to wireless users too. The approach for security in Business Intelligence include the use of passwords and encryption for many systems, as well as the secure sockets layer protocol for web transactions and wireless transportation layer security for wireless application protocol transaction.

b. Cost: This is another concern and obstacle to the adoption of Business Intelligence as its enterprise tools with multiple user and server licenses can be expensive. More so, the software must be able to interoperate with many data sources, the hardware must offer high performance, and the system must be able to implement complex mathematical algorithms.

c. Integration and Interoperability: With virtual data integration (data virtualization), this aspect of integration and interoperability is resolved as Business Intelligence systems need be able to integrate and interoperate flexibly with the growing number and types of corporate data sources with which they connect. Business Intelligence system thus must be able to effectively extract data in multiple formats that is stored in multiple sources hosted on multiple platforms. The interface of data virtualization server layer resolves this in Business Intelligence system architecture (Sixto, 2002).

2.1.4. Business Intelligence Development Process

To accomplish the goal of Business Intelligence portfolio and its need to deploy Business Intelligence applications as a series of releases, ideally in every four to eight months once an appropriate Business Intelligence infrastructure is in place, then the need for a suitable, repeatable and cost-effective Business Intelligence (BI) development process as in figure 2.4. The efficiency and effectiveness of the flows in the figure depends on having the appropriate tools, processes and people. The specific processes may vary, but they will generally be akin to the processes. In a dedicated Business Intelligence environment, the process is simple as the environment is entirely a developed process for the optimization of Business Intelligence.

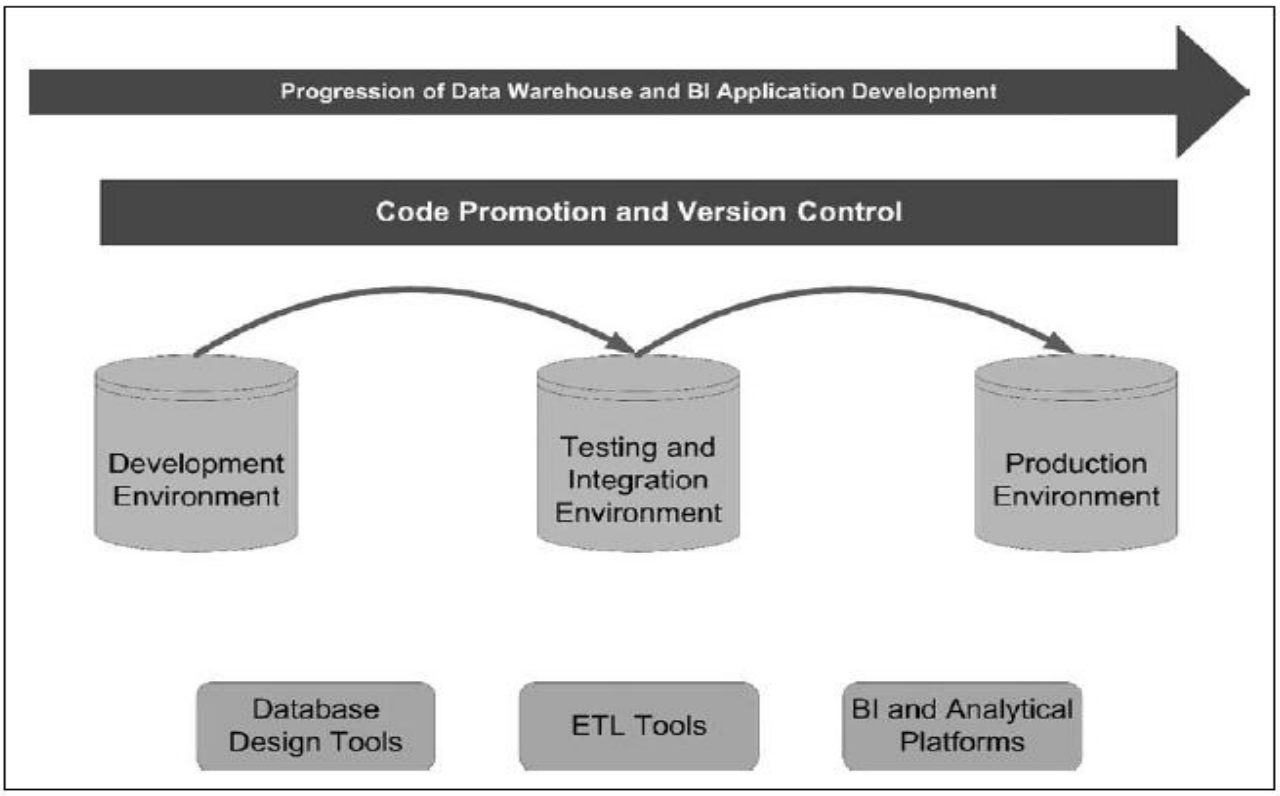


Figure 2.4 Business Intelligence Development Flow and Tools (Source: Alan, 2011)

But there is complication when it is a mixed Business Intelligence (BI) environment, whereby the development environment, testing and integration environment and production environment are shared among Business Intelligence, transactional system and enterprise applications. Its limitation for Business Intelligence development is that the respective environments are generally optimized around the needs of the transactional systems (Alan, 2011).

2.1.5. Components and Technologies of Business Intelligence

There are various components and technologies as indicated in most of the definitions of Business Intelligence (BI). The key components identified in the research are as follows; Data warehouse or Data storage, Data Integration (it is the aspect of the research enhanced by the hybrid model), Online Analytical Processing (OLAP), Data Mining and Knowledge Discovery.

1. Data Warehouse: Data warehouses provide an integrated view across historical data from multiple sources while retaining the depth of the data and summarized information on it. With this in Business Intelligence, analysts use these tools to mine the data and assist in decision making. A process of extracting, cleansing and transformation steps are applied to

data from multiple operational databases and external sources to identify relevant information and normalize their representation before being loaded into the warehouse. The consolidated view in the data warehouse is updated frequently to reflect the changes in the sources databases, and to maintain its consistency and timeliness (Yogesh, et al., 2005). Figure 2.5 shows sample of a traditional data warehouse.

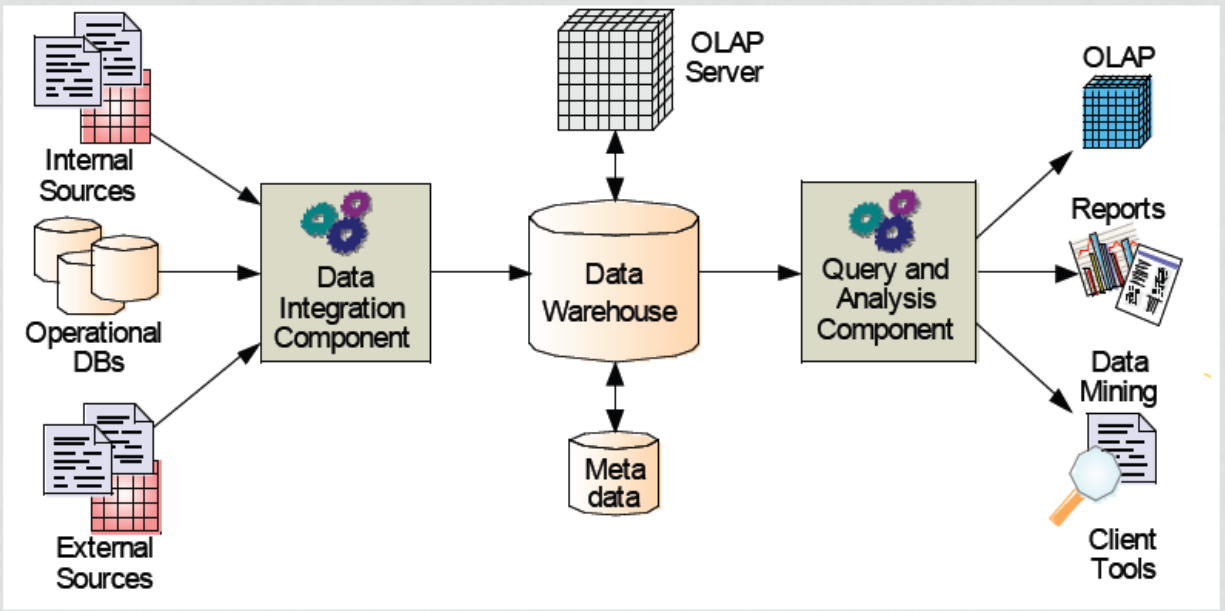


Figure 2.5 Traditional Data Warehouse (Source: Eltabakh, 2012)

Also, it is the physical repositories of selected data extracted from a collection of databases and other information sources. It is a very common approach of which data from multiple sources are copied and stored in a warehouse, materialized and then users can then query the warehouse database only. Here extract transform load (ETL) is totally performed outside the warehouse; the warehouse only stores the data (Eltabakh, 2012).

Furthermore, data warehouse (DW) as one of the technologies, technique or components used in Business Intelligence (BI), is a large repository of historical data that can be integrated for decision making. Unlike operational systems that contain the data required for the day-to-day operations of an organization, data warehouse is that storage that receives periodically the historical data in batches of an establishment and it grows over time. So it is of a vast size of up to hundreds of gigabytes and more. These pose design problem in the aspect of needing quick results to queries against its huge amount of data. Currently, however, industry is pushing forward for active data warehousing whereby the warehouse would receive data in continuous updates. With the above type of data warehousing, virtual data integration with the warehouse aspect of Business Intelligence design being active, increase the ability of the Business

Intelligence system to be more agile and to having speed in handling queries would be achieved in real-time for decision makers at all levels of management in an organization (Nancy and Steve, 2011).

2. Data Integration: Data integration is another component that involves many areas as par how it works, such as ensuring the quality of the information being stored or making sure that data is transformed and can be accessed within a reporting application in the most efficient way. The simplest form of data integration, for Business Intelligence (BI) is the extract transform load (ETL) as it implies, information is extracted from a data source like the enterprise resource planning (ERP), packaged software to help organizations run the transactional side of their business, or Customer Resource Management (CRM) application. These data once extracted, transformations occur so that when it is loaded within the data warehouse, it will be within a format that reflects the analytics required. Next form of integration is the Extract Load Transform (ELT), here instead of the transformations happening before being loaded into a data warehouse, they occur afterwards (Geneca, 2012).

3. Online Analytical Processing (OLAP): Online Analytical Processing was coined in the early 1990s by E.F. Codd, the pioneer of relational systems in order to clearly indicate that something different was needed for analytical processes. It is different from the well known On-line Transactional Processing (OLTP), the typical type of processing offered by database management system (DBMS) of old. Online analytical processing (OLAP) was first defined as the name given to the dynamic enterprise analysis required to create, manipulate, animate and synthesize information from the explanation and interpretation of a written work (exegetical), contemplative and formulaic data analysis models. It also, includes the ability to discern new or unanticipated relationships between variables, the ability to identify the parameters necessary to handle large amounts of data, to create an unlimited number of dimensions, and to specify cross-dimensional conditions and expressions (Surajit, et al., 2011).

Other definitions of online analytical processing (OLAP) are that, is a software category intended for the rapid exploration and analysis of data based on a multi-dimensional approach with several aggregation levels. It is also seen as a category of software technology that enables analysts, managers and executives to gain insight into data through fast, consistent, interactive access to a wide variety of possible views of information that has been transformed from raw data to reflect the real dimensionality of the enterprise as understood by the users (Rick, 2012). As the definition indicates, it is a technology that is based on the multidimensional database

approach, which introduces concepts that differ from the concepts found in the transactional database approach (Sonia, et al., 2005).

4. Data Mining: This aspect of Business Intelligence (BI) technology enables in-depth analysis of data including the ability to build predictive models. The algorithms offered in data mining are far beyond what aggregation functions offer in relational database management system (RDBMS) and in online analytical processing (OLAP) servers. Its analysis includes decision trees, market basket analysis, linear and logistic regression. Initially, data mining technology was packaged separately by statistical software company, example statistical analysis system (SAS) and statistical package for the social sciences (SPSS). The approach has to do with selecting a subset of data from the data warehouse, perform sophisticated data analysis on it, in order to identify key statistical characteristics and to build predictive models from such selected subset of data. It is deployed in operational database. There are challenges when moving statistical data to the data mining engine for analysis, this led to integrating the data mining functionality in the backend data warehouse architecture in order to overcome the limitation and challenges (example is Oracle Data Mining).

Generally, extracting knowledge from a database involves a user having a hypothesis to verify or disprove maybe the user would have to do the analysis using the normal standard database queries and statistical analysis. Another way the user can extract such knowledge is to have the computer search for correlations in the data and then present promising hypothesis to the user for consideration. This second method is what is referred to as data mining techniques developed in the field of machine learning and knowledge discovery. Data mining algorithm attempts to solve a number of common problems such as the general problem of categorization; that has to do with if given a set of cases with known values for some parameters, classification of the cases will be required. Example; given observations of patients, suggest a diagnosis. In the clustering problem such as finding natural groupings of a given set of cases, clustering is useful in identifying market segments. Also, businesses sometimes want to know what items are frequently purchased together, as the knowledge of such will help management make better decision about how to lay out a grocery store. Two main forms of data mining are forecasting and text mining (Surajit, et al., 2011).

Forecasting is a form of data mining in which trends are modelled over time using known data, and future trends are predicted based on the model. The simplest among so many different prediction models with varying levels of sophistication is the Least Squares Line model as the Best-Fit Line is calculated from known data points using this method. The line is projected into

the future to determine predictions. Of note, forecasting can be a useful tool, but the predictions must be taken only as indicators. While Text mining/analytics has to do with analysing text and their potential impact. For example in the area of automotive warranty claims, where should something go wrong in a customer's car, he brings it to the mechanic shop and then describe what he observed to be wrong with the car. This description is keyed into the computer as observation about your car and the action taken to remedy the problem. This information is useful (valuable) to the automotive companies and parts manufacturers. As analysing this information would help them catch problem on time, thereby building better cars. It also can reduce breakdowns, save them money and save their customers frustration (Surajit, et al., 2011).

5. **Knowledge Discovery:** is the process of automatically processing large amounts of data to identify patterns and extract useful new knowledge. It was traditionally applied on structured information in databases; however, as information is increasingly present in unstructured or weakly structured form, such as text, adequate techniques were developed. The shift from large, static, homogeneous data sets to huge, dynamic, heterogeneous repositories necessitates approaches involving both automatic processing and human intervention. Automatic methods put the burden on machines, but despite algorithmic advancements and hardware speed-ups, for certain tasks, such as pattern recognition, human capabilities remain unchallenged (Christin, et al., 2014).

2.1.6. Value and Benefit of Business Intelligence

- It helps to analyze the behaviour of the market sales to know if companies' additional products or services are profitable to customers.
- The above point will help managers to manage their customers better. It's important to note that the same behaviour with customers and each customer or group of customers will eventually have its own relations in addition to the above features and other information management.

The research model would solve the challenge of competition in the business environment in data management as it pertains to correct use of information and converting the data into useful knowledge. A business must analyze data and decide appropriate frequency, which should be used with an innovative approach in-order to advance towards its goals, so forecasting and strategizing along with data analysis is necessary. Of note, intelligence in business

organizations would bring about high quality decisions, along with speed of making quick decisions, as well as enhancing the productivity and quality in the organization. As defined, Business Intelligence in any organization is to increase profitability by using intelligence to bring about accurate decision-making (Fereydoon and Mohammad, 2012), and since it was conceived from companies' need to having more knowledge about themselves. It is also a set of concepts and methods to improve business decision making by using fact-based support systems, and the best way to get the most out of Business Intelligence is to align its use to organizational goals and overall operations (Power, 2007). Table 2.4 gives the summary of Business Intelligence benefits and area of applications.

Table 2.4 Summary of Applications Areas and Benefits of Business Intelligence (BI) (Source: Timothy, et al., 2009)

BI Applications	Benefits
Transportation Industry • Generally, transportation service providers utilize several tools and platforms provoked by Business Intelligence (BI) vendors which enabling the delivery of information to decision makers such as Query Tools Standard, Reporting Tools, Online Analytical Processing (OLAP) tools, Data Visualization Tools and Data Mining Tools. • Airline industry uses text mining to automatically extract useful information from different written resources such as incident reports.	• The direct benefits of the usage of a BI solution in transportation industry are reduction in the turnaround time for preparation of reports, direct and faster access to the data needed to support decision-making, analyze the flow of businesses across services, regions, clients, pricing, currencies, and market factors in time, etc. • The huge database maintained by airlines has limited human interpretation and the terminology appears different to a computer. Thus, discovery of new, previously unknown knowledge can be found in a timely manner by using text mining. • An incident report is prepared whenever an event occurs that might lead to a problem, Text mining of airline incident reports can identify potential dilemma Text mining can be used with this large set of incident data reported to validate predetermined theories and to cull new patterns of knowledge.
Banking Industry • Banking industry relies on the BI platform to make more effective decisions in a few areas such as Customer Analyzes, Operations and Financial Analysis, Sales and Marketing Analysis, and Promotion Analysis and Risk and Fraud Analysis.	• BI applications help management to improve operational and strategic decisions based on better and timely information. • Potential customers are identified through the analysis of purchasing data Cross-selling opportunities be recognized via analysis of customer behavior.
Health Care Industry • The implementation of BI in health care industry has enabled data to be delivered beyond administrative offices and directly to clinical staffs who can make the most use of it. • In order to foster a broader adoption, interactive and user-friendly interfaces have been designed to provide users with simple and relevant data like the number of patients treatments needed and their hospitalization period.	• Business decisions making process has become more effective where users can access any type of information with a fast and consistent response time, independent of the data volume analyzed or questions asked. • The inter-operability application in BI reduces the operation cost in health care industry by eliminating expensive custom-integration in the computing system.
Retail Industry • BI is implemented for demand forecasting	• When reliable estimates of customer demand are generated service and product

in the retail industry by generating reliable estimates for both short term and long term demand based on the available customer data. • Apart from demand forecasting. BI is also used to monitor customer loyalty by evaluating which customers are loyal and which are likely to leave.	distribution plans of a company would always be in place to meet its customer expectations. • By monitoring customer loyalty, factors that influence their decisions to stay or go could be determined in order to devise better strategies to retain them.
Manufacturing Industry • BI systems allow manufacturers to track their inventory usage across location and time by using alerts for instant notification of low inventory levels. • Besides this, BI systems allow manufacturers to analyze data from multiple sources in order to set performance goals and create sophisticated profitability and financial models.	• With the functionality of inventory monitoring, manufacturers can reduce over-capacity and ensure sufficient supplies for their production. • Apart from this, BI systems also help manufacturers in financial management by identifying areas where they can increase profits and improve efficiency.
Pharmaceuticals Industry • BI systems help pharmaceuticals companies to identify which products are most profitable and monitor customer behavior in purchasing products.	• By closely tracking sales performance and consumer behavior, pharmaceuticals companies are able to set better marketing strategies and ensure proper allocation of marketing funds.

2.1.7. Justifying the Use of Business Intelligence

1. Business Intelligence will help in business trends that will lead to organization not wasting time, money and energy in other directions other than their goals and fundamental macro-focus of in-depth market analysis.

2. It will help business predict market expansion share before competitors do.

3. It will help elevate the levels of customer satisfaction hierarchically, so that they can have business continuity and loss of confidence and satisfaction can be eliminated.

4. It helps in identifying of loyal customers who are consistent, can track their behaviour and their overall strategic direction and performance.

5. With Business Intelligence, customer segmentation and subsequently ways of dealing with each customer is feasible.

6. It increases efficiency and transparency in internal affairs which are the key process and procedures of organizations.

7. It brings about standardization and compatibility between structures in the organizations.
8. It facilitates decision making.
9. With Business Intelligence, early detection of risks before it becomes serious is averted and business opportunities are identified before other competitors take it.

Above all, the managers need timely and accurate data and/or information in order to make correct and intelligent decisions (Fereydoon and Mohammad, 2012).

2.1.8. Application and Role of Business Intelligence Systems in Decision Making

Business Intelligence systems are assumed to be solutions that are responsible for transcription of data into information and knowledge and they also create environment for effective decision making, strategic thinking and acting in organizations. Its value for business is predominantly expressed in the fact that such systems cast light on information that may serve as the basis for carrying out fundamental changes in a particular enterprise, such as establishing new cooperation, acquiring new customers, creating new markets, and offering products to customers. As earlier discussed, Business Intelligence (BI) differs from other Management Information System (MIS) in its wider thematic range, multivariate analysis, semi-structured data originating from different sources and multidimensional data presentations.

Business Intelligence (BI) cuts across all levels of management in terms of support in decision making, regardless of the level of their structure. In the strategic level, Business Intelligence (BI) makes it possible to set objectives precisely and to follow realization of such established objectives. It allows for performing different comparative reports such as on historical results, profitability of particular offers, and effectiveness of distribution channels along with carrying out simulations of development or forecasting future results on the basis of some assumptions (Celina and Ewa, 2004). At the tactical level, these systems can provide some basis for decision making within the marketing, sales, finance, capital management and services. Business Intelligence (BI) system allows for optimising future actions and for modifying organizational, financial or technological aspects of company performance appropriately in order to help enterprise realize their strategic objectives more effectively. As par the operational level, Business Intelligence systems are used to perform ad-hoc analyzes and answer questions related to departments on-going operations, up-to-date financial standing, sales and cooperation with suppliers, customers, and other services.

In summary, Business Intelligence (BI) system supports data analyzes and decision making in different areas of organizations performance, in particular that of financial analyzes that involves reviewing of costs, and revenues, calculation and comparative analyzes of corporate income statements, analyzes of cooperate balance sheet and profitability, analyzes of financial markets and sophisticated controlling in health and other sectors. In the area of market analyzes like analyzes of sales receipts, sales profitability, customer profitability, as well as modelling customers' behaviour and reactions. Also, in production management analyzes that make it possible to identify production "bottle-necks" and delayed orders, thus enabling organizations to examine production dynamics and to compare production results obtained by departments or plants. Logistic analyzes that enable us to identify partners of supply chain and the industry services quickly. The analyzes of wage related data including wage component reports made with reference to the type required, reports made from the perspective of a given enterprise, wage reports distinguishing employment types, payroll surcharges, and others. Finally, the aspect of personal data-analyzes that involve examination of employment turnover, employment types, presentation of information on individual employee's personal data, patients' records and other services (Celina and Ewa, 2007).

Business Intelligence (BI) system offer an integrated set of tools, technologies and software products that are used to collect heterogenic data from dispersed sources in order to integrate and analyze data to make it commonly available when viewed technically. Figure 2.6 show the role of Business Intelligence (BI) in decision making.

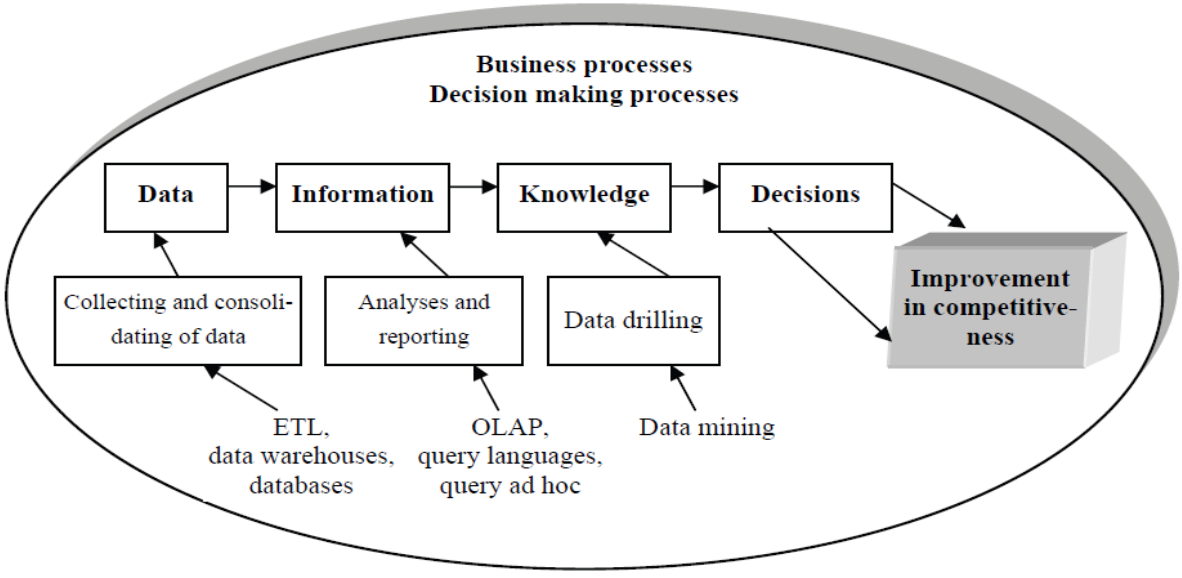


Figure 2.6 **The Role of Business Intelligence systems in Decision Making (Source: Celina and Ewa, 2004; 2007)**

The activities of Business Intelligence implicates its' system technological structure in the following modules;

a. Tools to extract transform and load data (ETL: Extract-Transformation-Load tools) which are mainly responsible for data transfer from transaction system and the internet to data warehouses.

b. The data warehouses module which provide some room for thematic storing of aggregated and already analyzed data.

c. The analytical tools online analytical processing (OLAP) which let users access, analyze and model business problems and share information that is stored in data warehouses.

d. Data mining tool that enables users to discover various patterns, generalizations, regularities and rules in data resources.

e. Tools for reporting and ad-hoc inquiry which allow for creating and utilizing different synthetic reports.

f. Finally the presentation layer which applications includes graphic and multimedia interfaces whose task is to provide users with information in a comfortable and accessible form.

2.2. History of Data Integration

Typical Information Technology (IT) assets of a modern company include Enterprise Resource Processing (ERP) systems, sales tracking systems, human resource (HR) systems, and others. Over the last twenty years these were implemented based on a client-server computing model where the Database Management System (DBMS) runs at the server level, accessed by a collection of applications which run on the client desktop. Recently, Client-Server computing has become obsolete: the client level moves inside a web browser, and three-tier architectures are built where the client may be thick or thin. In either case, the application is executed on the middle tier (Application Server), as shown in figure 2.7 (Letizia, 2006).

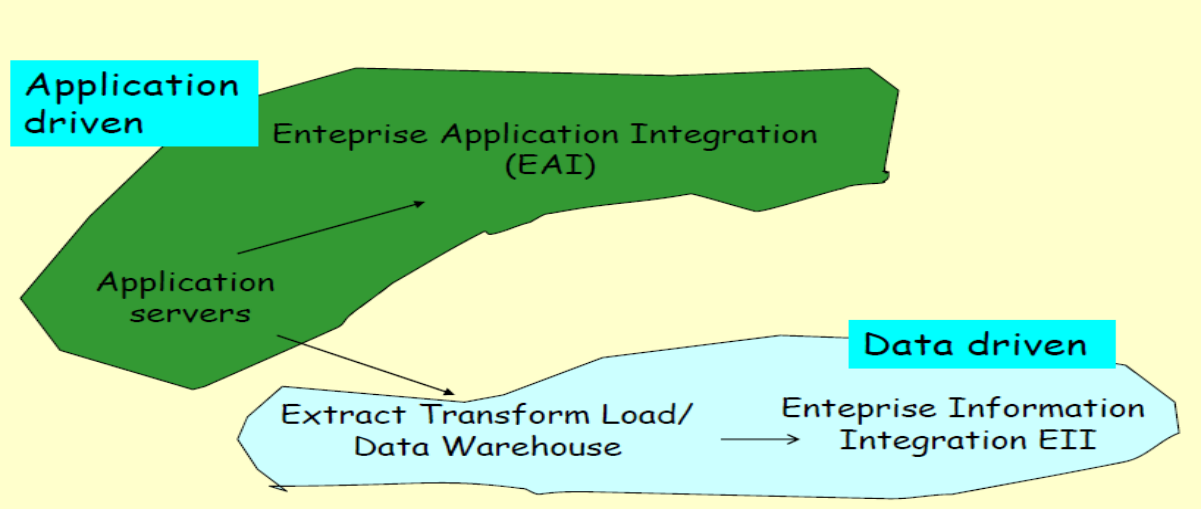


Figure 2.7 Evolution from Application Servers (Source: Letizia, 2006)

As of today crucial information is scattered throughout the separately developed data sources in a way that makes the "big picture" which is the relevant and important information difficult to obtain. With data integration a unified virtual view of all the scattered data within a domain is presented, allowing users to pose queries across the complete integrated schema as if they are interacting with a single data source. Virtual data integration technique as it applies to Business Intelligence is presented in the research. Other areas it has being applied are Biomedicine, Social Network and environment. Data integration refers to the organization's inventory of data and information assertions as well as the tools, strategies and philosophies by which fragmented data assets are aligned to support business goals. From software development patterns, there are three layers of software integration: Data Integration, Service Integration and Process Integration. The levels of complexity rise from data to process integration and the level of abstraction as well. Services and process integration lead to the completeness and coherence of integrated systems.

According to Maurizio Lenzerini (2002), data integration is the act of combining data residing at different sources, and providing the user with a unified view of these data (this view is called global schema). The problem of designing data integration system is important in current real world applications. The typical architecture of an integration system is described in two ways; wrappers and mediators. Wrapper's aim is to access a source, extract the relevant data, and present such data in a specified format. While mediator's aim is to collect wrappers (or mediators) so as to meet specific information (data) need of the integration system. The core problem in the design of an integration system is the specification and realization of mediators (Diego, et al., 2001). Figure 2.8 shows the sample structure of data integration.

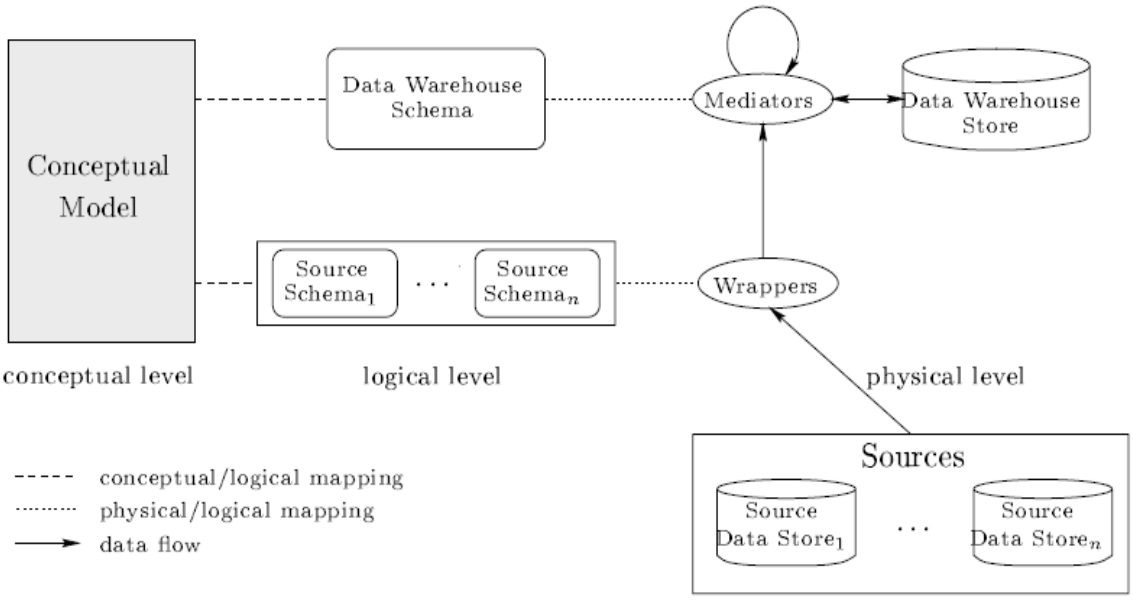


Figure 2.8 Sample Structure for Data Integration (Source: Diego, et al., 2001)

Hence, the ocean of data created with the advances of science and technology calls for integration of data coming from heterogeneous sources that are diverse in their purposes, business rules, underlying models and enabling technologies. From the challenge of technical management of huge data volumes, the focus is now on information value of the data. The huge data accumulated by science and business needs to be brought together and integrated in order to extract information and gain knowledge. Generally speaking, integration is pursued in either of two ways; firstly, when exactly the questions to be answered are known and what data are available. Here, the aim is at finding reliable sources and pulling the needed fields into a database designed for the purpose. Secondly, when the aim is at understanding the power of data at large, and if a number of data sources of varying reliability are available. Here the goal can be vaguely defined as "find correlation" or "discover new knowledge" using various data mining techniques. In both approaches, there must be the ability to analyze the same data with various methods and techniques and present results according to requirements of various user groups (Olga and John, 2007).

2.2.1. Concept of Data Integration

The concept of Data Integration is defined as the process of integrating data from multiple sources and having a single view over all these sources and answering queries using the combined information. It can be physical or virtual; physical implies copying the data to warehouse, while virtual implies keeping the data only at the sources. Data integration is valid

also within a single organization such as integrating data from different departments or sectors. (Eltabakh, 2012). Heterogeneity is integration's major challenge as data can be stored with different systems such as relational database, web database, extensible markup language (xml) database, and others. The problem of data integration was and still remains the extremely difficult part of data management field. Figure 2.9 show generic framework for integration.

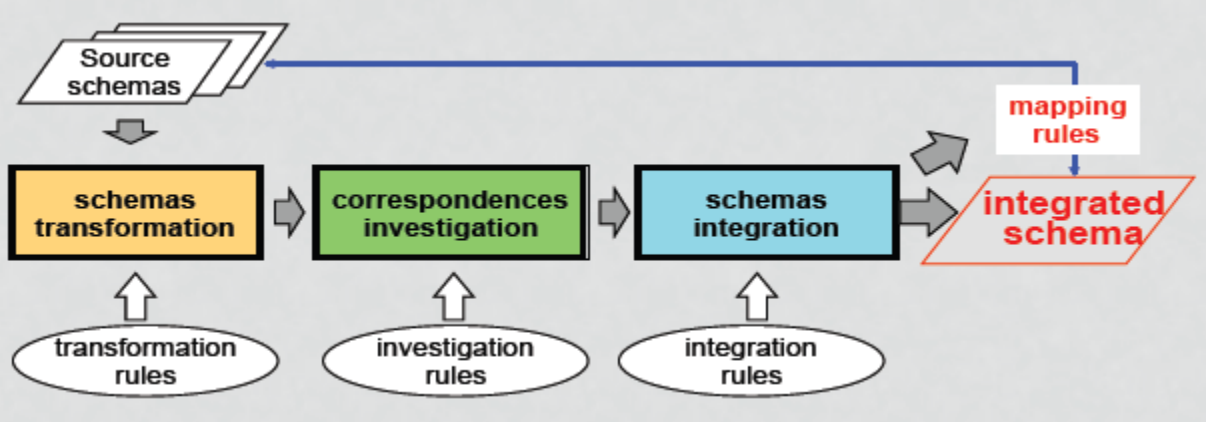


Figure 2.9 A Generic Framework for Integration (Source: Eltabakh, 2012)

Furthermore, data integration is concerned with unifying data that share some common semantics but originate from unrelated sources. In working with data integration, the complex concept of heterogeneity should be considered. Heterogeneity might be classified into four categories: (1) *structural heterogeneity,* involving different data models; (2) *syntactical heterogeneity*, involving different languages and data representations; (3) *systemic heterogeneity*, involving hardware and operating systems; and (4) *semantics heterogeneity*, involving different concepts and their interpretations. Generally speaking, the semantic heterogeneity deals with three types of concepts: the *semantically equivalent concepts*, the *semantically unrelated concepts*, and the *semantically related concepts.* In the first case – semantically equivalent concepts – a model uses different terms to refer the same concept, example synonymous, or some properties are modelled differently by different systems, for example the concept length may be "meter" in one system and "mile" in another. In the second case; semantically unrelated concepts – the same term may be used by different systems to denote completely different concepts; and in the last case; semantically related concepts – different classifications may be performed, for example one system classifies "person" as "male" and "female" and other system as "student" and "professor" (Augustina, et al., 2004).

With data integration, complex questions can be answered such as how a genetic background or exposure to some environmental factors influences development of certain diseases or in

terms of business how change in brand of a product will affect demand and supply. Integration varies from simple union of structurally similar data sets acquired at different locations and atimes to inter-disciplinary integration. These, however, bring together diverse data through mapping and merging of concepts, models, controlled vocabularies, data sets, data elements and data values. With Ontology's reference model, technologies efficient fusion of heterogeneous data is enabled, but an inherent danger is created as par producing unreliable information if the data are of varying quality or if the process of integration is based on erroneous assumptions. Normally, the organizational data resides in multiple data sources. For typical business intelligence (BI) data integration projects, the design and development of data integration processes involve collecting facts for the integration, analyzing data structures and their descriptions. However, it is inappropriate to focus on the management of data requirements only: it is very important to discern that integration is more than data (Virginja and Rimantas, 2011). It also covers:

Data sources: what data from where has to be integrated?

Business rules (BR): which BRs have to be evaluated for data processing and keeping in data sources?

Transformations: which transformations have to be done in order to avoid structural and semantic conflicts?

The integration of data ensures data management in the way that they would be unambiguously identified in information system (IS) and it is possible to transfer, transform, load and use them in other information system (IS) or source without changing program code. Ontology-guided data integration makes the process more efficient – reducing the cost, maintenance and risk of the project (Virginija and Rimantas, 2011).

In Data Integration concept there exist the following data integration types; Materialized, Data Warehouse, Virtual (Virtualization of Data – DV), Peer-to-Peer, and Ontology-Based Data Integration (OBDI). The research is on the hybrid of the Virtual and Ontology-Based types of data integration for an enhance Business Intelligence process. That is the hybrid of the two data integration techniques type is applied in the data integration process of health sector Business Intelligence (BI) domain, so as to enhance it, because these two types of techniques has the capacity of a better data integration process in any Business Intelligence domain, since they can resolve heterogeneity, interoperability, real-time, consistency, semantic, syntactic and structural issues as well as redundancy, seamless transition, user-friendliness, and agility issues

optimally. In the next two sections (2.3 and 2.4) both techniques of data integration (virtual data-VDI and ontology-based data integration-OBDI) was discussed.

In conclusion, the major issue today is that crucial information is scattered throughout the separately developed data sources, in a way that makes the "big picture" difficult to obtain. Data integration presents a unified virtual view of all these scattered data within a domain, using virtual data integration technique (VDI-Data Virtualization), allowing users to pose queries across the complete integrated schema as if they are interacting with a single data source, and ontology-based data integration technique (OBDI) resolves semantic, syntactic and structural heterogeneity issues among others (Munmun and Nashreen, 2016).

2.2.2. Components of Data Integration

Data integration is a fundamental, yet deceptively challenging, component of any organization's business intelligence and data warehousing strategy. Data integration involves combining data residing in different data repositories and providing business users with a unified view of this data. In addition, companies face a challenge of ensuring that data being reported is current and up-to-date. The following are the components of data integration system (Munmun and Nashreen, 2016);

Data Sources: These components do vary on many dimensions, such as the data model underlying them and the kinds of queries they support. Examples of structured sources include database systems with structured query language (SQL) capabilities, extensible markup language (XML) databases with an extensible query (X-Query) interface, and sources behind Web forms that support a limited set of queries. In some cases, the source can be an actual application that is driven by a database, such as an accounting system. In such a case, a query to the data source may actually involve an application processing some data stored in the source.

Mediated Schema: The user interacts with the data integration system through a single schema, called the mediated schema. It is built for the data integration application and contains only the aspects of the domain relevant to the application. It most probably will contain a subset of the attributes seen in sources (Leopoldo, 2007). In the virtual approach, the mediated schema is not meant to store any data at all. It is purely a logical schema that is used for posing queries by the users employing the data integration system.

Application dependent: Like in a normal, usual relational Database from the user point of view Data is not stored in "tables" of the global schema, but in the sources. The Database "instance" corresponding to the global schema is virtual, user poses queries in terms of the relations in the global schema, then the relationship between the global schema (and/or Database) plus the data sources (and their local schemas) is specified at the mediator level.

Source Description: This specifies the properties of the sources the system needs to know to use their data. It is the key to building a data integration application; it is connected to the mediated schema and the schemas of the sources.

Semantic Mappings: This is the main component of source description and it is that which specify how attributes in the sources correspond to attributes in the mediated schema, how to resolve differences in and how data values are specified in different sources. Thus a logical framework can be set up for data integration (Global Schema). That is, it is referred to data integration systems whose aim is combining the data residing at different sources, and providing the user with a unified view of these data. Such unified view is represented by the global schema, and provides a reconciled view of all data which can be queried by the user. The main task in the design of a data integration system is to establish the mapping between the data sources and the global schema.

Wrappers: This is the program whose role is to send queries to a data source, receive answers and possibly apply some basic transformation to the answer.

Reformation: This rewrites the user query that was posed in terms of the relations in the mediated schema, into queries referring to the schema data sources (Letizia, 2006).

Plan Generator: Here is where the result called a logical query plan from reformation is generated. Is a set of queries that refer to the schemata of the data sources and whose combination will yield the answer to the original query (Leopoldo, 2017).

Execution Engine: Here query optimization as well as query execution takes place. In the optimization, it accepts a logical query plan as input and produces a physical query plan which specifies the exact order in which sources are accessed, when results are combined, and which algorithm are used for performing operations on the data. While for the query execution aspect is responsible for the execution of the physical query plan. That is it dispatches the queries to individual sources through the wrappers and combines the result as specified by the query plan. It may also ask the optimizer to reconsider its plan based on its monitoring of the plan's

progress (Helena and Paulo, 2015). Figure 2.10 show the components of a data integration system.

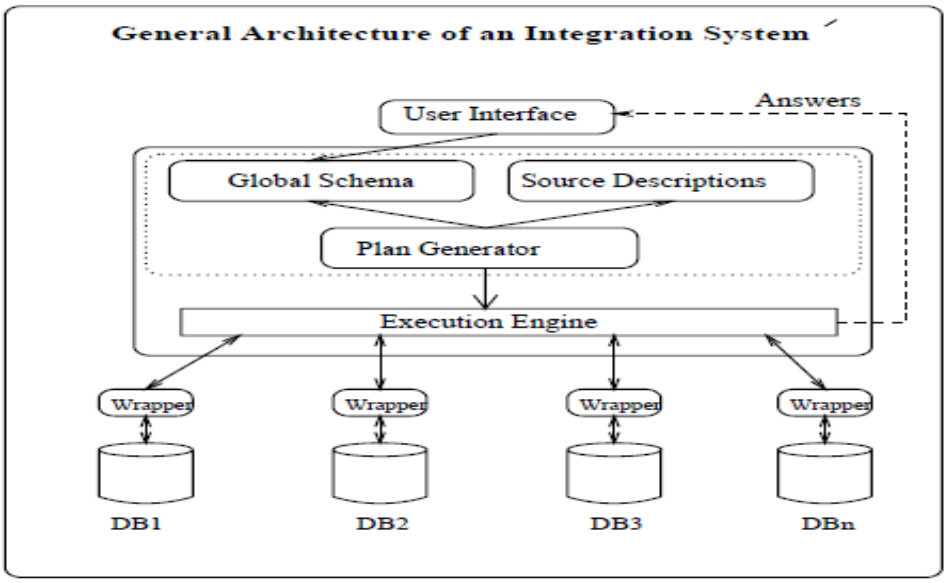


Figure 2.10 Components of a Data Integration System (Source: Leopoldo, 2007)

2.2.3. Data Modeling

Data Modeling was invented three decades ago to assist in the design of databases in particular relational databases. As it matured, the technique has become recognized as a tool for analyzing the semantics of an organization's information as it is used in carrying out its mission. Notably, companies are beginning to recognize that semantics is important if their systems (and their people, for that matter) are going to communicate with each other, and based on this recognition, they are also recognizing the importance of collecting "Ontologies", or glossaries that describe the language they use to carry out their activities.

Semantics is the Greek philosophic study of the nature of meaning, especially as it is expressed in language. It is the study of the significance of signs and symbols, as opposed to their formal relations (syntactic), while ontology is another branch of Greek philosophy, concerned with identifying in the most general terms, the kinds of things that actually exist. In other words, ontology tells us what exists, while semantics tells us how to describe it (David, 2006). And so, data model is a drawing that represents data "things" and relationships between them. The meaning of the model varies, depending on its purpose.

1. It can represent a database design, with boxes representing tables and the lines representing foreign keys. Also represented are the columns of the tables.

2. It can be a conceptual model representing the structure of a business, with the boxes representing things of significance to the business and the lines representing semantic relationships between them. Also, represented maybe the definition of data describing those things of significance.

A business (or conceptual) data model captures the semantics of an organization for the purpose of both communicating with the business community and providing architecture for database and system design. A database design describes artifacts that can be employed to store and manipulate data.

A conceptual data model is, of course, a kind of ontology. It is about defining *categories* of data. Its graphic nature provides an excellent basis for discussing and negotiating the meaning of those categories. Accompanied by business rules analysis, the two provide a basis for collecting data according to those categories, and its corresponding database design provides a mechanism for doing so. The point is that data models are to be understood by humans, with computers only serving as gateways to permit capture of "valid" data. In its latest incarnations, however, an ontology language begins with *instances* of actual data. Its' purpose is to classify them so that computers can make inferences from them (David, 2006).

The data modeling mindset is based upon the *closed world assumption:* Only that which is asserted is known. Ontology languages are based on the *open world assumption*: All assertions are assumed to be true until proven otherwise. This means that when you build a system using a data modeling approach:

i. You can only enter data that you know to be valid.

ii. You are "encouraged" to enter complete information.

iii. There are no other data.

iv. The data model entity classes and their derived tables are templates.

But with Ontology database:

i. You can enter what you know to be true.

ii. You can enter incomplete information.

iii. You (and the computer) can *infer* other things.

iv. Ontology classes are simply sets of things.

The web ontology language (OWL) tags that correspond to data modeling constructs include the following:

- ***Entity Class:*** **<owl:class rdf:id="…">**
- ***Attribute:*** **<owl:datatypeProperty rdf:id="…">**
- ***Relationship:*** **<owl:objectProperty rdf:ID="…">**

So, it is possible to convert an Ontology represented by a data model into one represented by an ontology language. The model assumes constraints that is not normally realized (like disjointedness), and it will be important to introduce any business rules that have been identified as well.

In summary, data modeling, database design, and business rule modeling are all part of a particular way of looking at the world. The semantic web and the ontology languages that support it are part of a new way of looking at the world. The differences are in terms of premises, the way classes are identified, and the implications of constraints (David, 2006).

2.3. History of Virtualization

Without virtualization, data integration which brings together all data related to a customer cannot be spread out over multiple systems, and this would mean that the reporting tool needs access to all those system and would be responsible for integrating all the data also. This whole integration process makes report development (in terms of access, availability, cost and agility) more complex and integration logic will be repeated in many reports, thereby leading to inconsistent results. Integrating data with virtualization termed virtual data integration, in any Business Intelligence domain of application such as that for the health sector, will solve to a great extent these complexities and stop or reduce to a great extent repetition and redundancies.

This is possible as consumers as well as users of Business Intelligence system with virtual data integration will be accessing, processing and getting results on time at low cost due to the fact that they do not access or process reports directly from the data stores (data ware house, and data marts), but via the data virtualization servers or virtual data integration servers, making it look as if they are accessing from one data store or integrated data store, but it is from a heterogeneous set of data stores (Rick, 2012).

Primarily, as earlier discussed the reason organizations have developed Business Intelligence system is to support and improve their decision processes. In making decisions, it has to be fast these days and it is a challenge. Virtualization is one of the ways to reduce or eliminate this challenge. Virtualization is not a new concept in Information Technology industry as its first application is probably in the 1960s by IBM who use the concept to split mainframes into separate virtual machines that made it possible for one machine to run multiple applications concurrently. Also, during those years virtual memory was introduced using a technique called paging. This memory virtualization was used to simulate more memory than was physically available in a machine. Presently, these days most things can be virtualized such as processors, storage, networks, data centres, operating systems (VMware) and Cloud is integrated also as virtualization technologies.

Data virtualization is quiet a young term. When it was first introduced is quiet unclear, but somehow is like Eric Bronghton used the term first in a paper published in 2005, but the concept, some of its products and research are much older. Due to its rich functionality, many technologies contributed to its development. So its history cannot be said without mentioning distributed database, data federation, extensible stylesheet language transformation (XSLT) and extensible query (X-Query) as well as Mash-Up techniques (Rick, 2012).

One key feature of data virtualization servers technologically is data federation as it is able to efficiently join data from a heterogeneous set of data stores. This data federation technique was first implemented in distributed database servers. In this server multiple independent database servers can operate as one logical database. This implies that a data consumer can enter a query in which multiple tables managed by different database servers are joined. The database server has the task of making the entire database to look like one big database. And to do this data federation technology has to be implemented. Importantly, this distributed join is processed as efficiently as possible. The initial research in data federation mostly was done by IBM in their famous system R* project that started way back in 1979. Then others like Ingres project, that later led to open source SQL database server contributed heavily to distributed queries. System R* led to the development of IBM's commercial structured query language (SQL) database servers, such as SQL/DS and DB2.

Most research at the beginning focus on optimizing access in a homogenous data store environment, then later there were products which now allowed distributed joins in the heterogeneous environments where other SQL-based or SQL like database servers become

involved. These distributed databases were the first to support data federation technology and the data virtualization came strongly from this technology.

IBM's Data Joiner and Information Builder's enterprise data access (EDA/SQL) can claim to be the first products to be a dedicated data federation servers, which was introduced in the early 1990s and later in 1991 they were products primarily for integrating data from different data sources and not data servers. These products were the first to be able to access non-SQL database (Rick, 2012).

Extensible Mark-up Language (XML) successes made more organizations data to be available on the internet, this brought about the transformation of the structure of extensible mark-up language (XML) document to a standard language in 2000 called extensible stylesheet language transformation (XSLT), which is managed by world wide web constorium (W3C) standardization organization. It is a powerful language for performing transformation.

Extensible Stylesheet Language Transformation (XSLT) is also tied to data virtualization history as the servers of data virtualization have to be able to manipulate data that is formatted with extensible mark-up language (XML), to do this a language is needed to flatten the hierarchical structures of extensible mark-up language (XML) documents and for assigning a hierarchical structure to relational tables, extensible stylesheet language transformation (XSLT) is more than suitable for it.

Another standard language tied to data virtualization is X-Query of 2001; it is a query and functional programming language for querying, inserting, updating and deleting collections of extensible mark-up language (XML) documents. Along with other things it is used to join extensible mark-up language (XML) documents, extract elements from documents, and select documents and to join relational data with extensible mark-up language (XML) data. X-Query is more powerful than extensible stylesheet language transformation (XSLT) in the aspect of functionality.

With Mash-ups technology that are web-based applications used to access data from different sources on the Internet, when integrated in data virtualization servers, it will be able to extract data from websites as well, and thus can benefit from all the development and research done in this area.

In the early 1990s when data virtualization was first introduced by IBM and Information Builders, they were still called data federation products. Also, data virtualization for a long

time was not considered as a strategic technology by most organizations, but it was seen as a technology for solving a particular technological problem, not as a technology for making information systems more agile, but purely a technological solution without a clear business benefit. But all this changed around the year 2008, as Business Intelligence specialist in particular started to see the potential value of data virtualization, as they were looking for a new, better and more agile form for doing data integration besides extract transform load (ETL), and so data virtualization became handy as it has become a mainstream technology worthy of being an alternative or to be combined with data integration.

Agility and ability to quickly develop new and change existing system is what has led organizations to seek for solutions based on data virtualization (DV-virtual data integration). As it is observed that after adopting data virtualization (DV) solution, the time required by organizations who have implemented this technology, in terms of implementing a new outsourcing customer, reduced by 50%, from six to nine months to three to six months. This data virtualization (DV) technology was implemented by Qualcom Inc. who is a global leader in next generation mobile technologies, its experience improved development speed and agility dramatically. As with data virtualization (DV), virtual tables presented the same data which was developed in a day. On like before were introducing a new application with the need to access five different system could take six months (Rick, 2012).

In conclusion, with advanced data virtualization an important progress in power and capabilities is feasible for Business Intelligence, as data virtualization capabilities delivery comes together with capabilities for data security, data quality and data management requirements, for queries optimization, caching, and others (Ana-Ramon and Razvan, 2011).

2.3.1. The Concept of Virtual Data Integration (Data Virtualization)

The integration is virtual (termed virtual integration) in the sense that the data stays in the sources, but the user who interacts with the mediator-feels like interacting with a single database.

The challenge of many applications needing to access and combine information from several databases, of which user (or application) is confronted with many different data sources can be solved by possibly bringing huge amount of data that might be required by the application into one single, physical, material site; and then making the application interact with only the data repository. This process is costly in terms of storage, design and refreshment, which would be necessary when the original sources are updated. That is, having complexities that are similar

to those involved in the processes associated to data warehouses but with the difference that updating the repository could be achieved without having completely up-to-date data.

Alternatively, a solution consisting in keeping the data in their sources is possible, in the sense that if the application needs answers to a query, it has to interact with collection of available sources by first determining and selecting those that contain the relevant information, then queries have to be posed to those sources, on an individual basis, and the different results have to be combined. This is quite tedious, long, and complex and error prone if performed in ad-hoc basis. But, it is better to have a general, robust and uniform implementation that supports the process on a permanent and regular basis. So the application will ideally interact with the data sources via a unique database like common interface. The line of solution that applies the above process is the virtual integration of data sources via a mediator, which is a software system that offers a common interface to a set of autonomous, independent and possibly heterogeneous data sources (Leopoldo and Loreto, 2004).

Furthermore, the concept of virtualization generally means that applications can use a resource without any concern for where it resides, what the technical interface is, how it has been implemented, which platform it uses, and how much of it is available. Virtualization solution encapsulates the resource in such a way that all technical details become hidden and the application can work with a simpler interface.

Data virtualization term is based on the word virtualization, as it is one of the forms of virtualization, and as the term indicates, the encapsulated resource is data. In applying data virtualization in Business Intelligence concept and consequently generally, an intermediate layer is provided which hides from applications most of the technical aspects of how and where data is stored. With this layer, applications don't need to know where all the data is stored physically, where the database servers run, what Application Processing Interface (API) is required, as well as which database language is used. As every application using data virtualization technology feels as if it is accessing one large database (Rick, 2012).

Also, the purpose of Business Intelligence (BI) with virtual data integration especially in the integration of information, is to support seamless access to data sources in such a way that users accesses the sources in a uniform way, that is, as if they are accessing one large database. Note, data integration is the problem of combining the data residing at different heterogeneous data sources, and providing to users a unified view of these data which is called global schema (that is the view). As shown in Figure 2.11, Data Virtualization is the process of abstraction of

data contained within a variety of information sources such as relational databases, data sources exposed through web services, extensible mark-up language (XML) repositories and others, so that they may be accessed without regard to their physical storage or heterogeneous structure (Ana-Ramon and Razvan, 2011).

A virtualization tool is better used to build a virtual data warehouse or data storage for mining of data, while extract transform load (ETL) tools are better used for building physical data warehouse. Data virtualization (VDI) is better for organizations that need rapid solutions, but does not have the money to spend for consultants and infrastructure needed by a data warehouse implementation project. With data virtualization, access to data is simplified and standardized plus the fact that data can be retrieved real-time from their original sources. So the original data sources are protected as they are only accessed through integrated views of data. It is better to combine it with physical data warehouse in designing, as data virtualization has disadvantage when applied alone in situations that involve large amounts of data or complex data transformation and cleansing as it could slow down the functioning of the source systems. Is also, not advantageous if there is not a single trusted source of data. As using unproven and uncorrected data can generate analysis errors that if it influence the decision making process, it can generate important, vital, as well as costly losses for the company or organization (Ana-Ramon and Razvan, 2011). So the research developed a hybrid of virtual data integration (VDI) technique with another data integration type (Ontology-based data integration-OBDI) to resolve the issue and make the model for enhanced Business Intelligence process perform better in the health sector domain that it was applied.

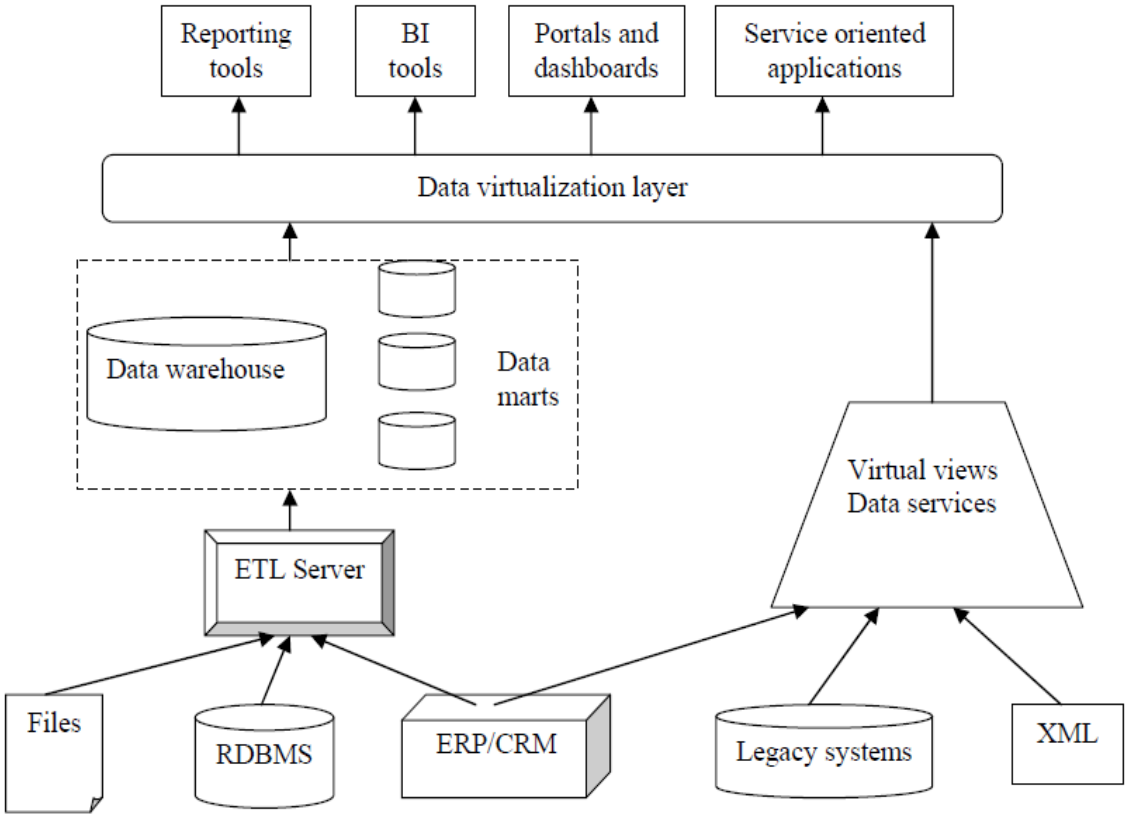


Figure 2.11 Data Virtualization (Source: Ana-Ramona and Razvan, 2011)

In effect, Data virtualization is an alternative technology of transforming available data into the form needed for reporting and analytics. It requires fewer databases and fewer transformation processes. It offers data consumers a unified, abstracted and encapsulated view for querying and manipulating data stored in a heterogeneous set of data stores.

The process of extracting data from production or any industry such as clinical registry record of health sector data stores, cleansing them, transforming them, correlating them is generally known as data integration. In data virtualization the data is not moved physically as part of data integration, but all the data cleansing, data transformation and data correlation is defined in a logical layer that is then applied to the data as if they are fetched from the original data source while generating reports. It has better agility and shorter implementation cycle thus enabling more analysis and hypothesis testing. It attempts to perform data cleansing, data transformation and data correlation as data moves out from production systems thus avoiding any intermediate storage. As oppose to data warehouse approach that physically changes data in each stage and loads it into some data store. The cleansing, transformation and correlation are defined programmatically using structured query language (SQL) like query language (Amineh, et al., 2008).

Application of data integration implies considering whether data needs to be physically moved or whether a virtual or “in-place” approach to accessing and aggregating data makes more sense. This virtual data integration is the approach the research is hybridizing in combination with ontology-based data integration technique for the enhancement of Business Intelligence (BI) process. Solid data integration strategy can help make more effective decisions based on trusted, complete data and transform the way business works. The need for systematic data integration is more eminent since the amount and heterogeneity of data is not declining but increasing constantly.

A data integration scenario starts with identifying the data sources that will participate in the applications and then build a virtual schema (often called a mediated schema), that would be queried by users or applications. Querying process would begin by reformulating a query posed over the virtual schema into queries over the data sources and then executing it efficiently with an engine that created plans that span multiple data sources and deal with the limitation and capabilities of each source as shown in figure 2.10 in section 2.2.2. The need for real-time analytics and reporting resulting from competitive and compliance pressures are driving the need for a virtual data warehouse approach to integrate and present disparate data.

According to Gareth (2016), data virtualization (DV) is any approach to data management that allows an application to retrieve and manipulate data without requiring technical details about the data, such as how it is formatted or where it is physically located. Unlike the traditional extract, transform, load ("ETL") process, the data remains in place, and real-time access is given to the source system for the data, thus reducing the risk of data errors and reducing the workload of moving data around that may never be used. Unlike Data Federation it does not attempt to impose a single data model on the data (heterogeneous data). The technology also supports the writing of transaction data updates back to the source systems.

Again according to Rick (2012), Data virtualization (virtual data integration) is defined as the process of offering data consumers a data access interface that hides the technical aspects of stored data, such as location, storage structure, application processing interface (API), access language, and storage technology. It provides an abstraction layer that data consumers can use to access data in a consistent manner, which hides all the technical aspects of data storage. The applications do not have to know where all the data has been stored physically, where the database servers run, what the source application processing interface (API) and database language is.

Again data virtualization (VDI) is an enabling technology which provides some or all of the following capabilities:

a. Abstraction – Abstract the technical aspects of stored data, such as location, storage structure, application processing interface (API), access language, and storage technology.

b. Virtualized Data Access – Connect to different data sources and make them accessible from a common logical data access point.

c. Transformation – Transform, improve quality, reformat, etc. source data for consumer use.

d. Data Federation – Combine result sets from across multiple source systems.

e. Data Delivery – Publish result sets as views and/or data services executed by client application or users when requested.

In conclusion, virtual data integration (VDI) is a type of data integration technique which applies the concept of data virtualization technology in achieving its integration purpose, both terminologies as used in the research means the same. That is, being virtual implies integration takes place on the fly as the data being queried remains at its' original data sources and is only accessed for integration purpose at query time. Which implies manipulation of the needed data at query time is done in the virtual source state using mediators like in the case of data sourced from the computer system read-only memory (RAM). This is faster, so too is data virtualization technology approach which is also about data management, whereby applications are allowed to retrieve and manipulate data without requiring technical details about the data being sought for integration purpose, such as how it is formatted at source, or where it is physically located and then it provides a single view of the entity of the overall data. So it was applied in the research model for the purpose of enhancing the data integration process of Business Intelligence as applied in the disease control procedure of the health sector, in order to hide the technical jargons from the users of the system.

2.3.2. Comparison of Virtualized (VDI) with Materialized (MDI) Data Integration

Integration systems are aimed at resolving heterogeneity and data quality problems (to a certain extent) thereby providing a single-system image to users. The fundamental Data Integration approaches are Virtual and Materialized (Data warehouse) integration. As in the figure 2.12

and 2.13, which is a high level abstraction diagram, indicates, the solid lines depict the flow of data, while dashed lines depict the flow of queries.

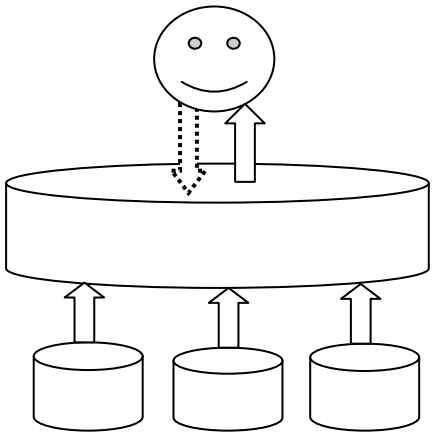


Figure 2.12 Materialized Data Integration (Source: Thomas, 2013)

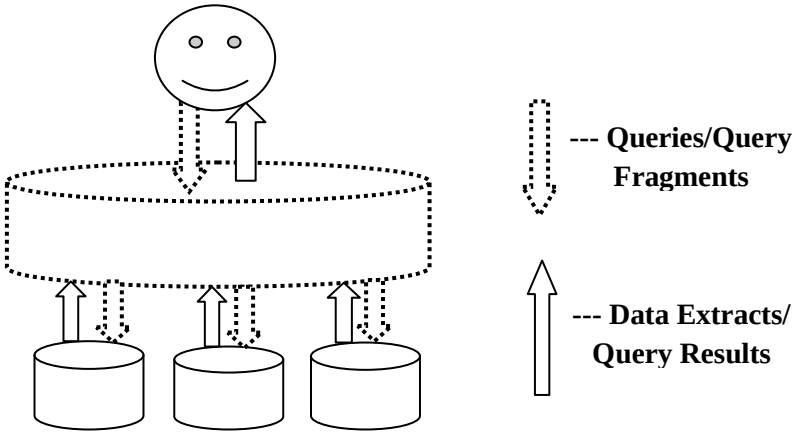


Figure 2.13 Virtual Data Integration (Source: Thomas, 2013)

The main difference between materialized and virtual data integration is with the place where data to be integrated is stored. As for materialized (DW) Data Integration, source data is copied to a central repository. But for the Virtual Data Integration, all data remains in the source systems (this makes for real-time as up-to-date data is always retrieved for querying purpose).

In the materialized data integration, data is continuously moved from the sources to the integration phase. And data movement is performed either periodically in an asynchronous manner or triggered by updates at the source systems. More so, query evaluation is done

locally at the integration phase and does not require any interaction with the sources (Thomas, 2013).

In contrast, Virtual Data Integration (VDI) systems do not store data centrally but provide an integrated view of the source data. In the evaluation of user's query, the integration phase identifies query fragments that involve the particular source, and then these query fragments are sent to the respective source systems and processed locally. Next, the fragment query results are sent back to the integration phase where the overall query result is then assembled. With the explanation above, it therefore implies that materialized data integration is continuously performed in the background, while Virtual Data Integration is performed on the fly at the time of query evaluation.

The materialized (DW) Data Integration has some advantages such as;

- The system generally achieves better query response time, since queries can be evaluated locally on pre-integrated data.
- The impact on the operational source systems is typically less strong and more predictable since it is independent from the query workload.
- Also, computationally expensive integration tasks such as data cleansing have no negative impact on the query response times as these tasks are performed off-line. Data cleansing is prohibitively expensive if done at the time of query evaluation, thus it is infeasible for Virtual Data Integration (VDI).
- Materialized (DW) Data Integration does keep historical data in the integration system even if it has been deleted at the sources.

Its disadvantage is that in asynchronous data integration pattern the integrated dataset is refreshed only periodically. Thus, the integration system will usually not contain most recent (up-to-date) data, so users' queries are evaluated on more or less stale data.

This is where Virtual Data Integration (VDI) comes handy as an advantage over Materialized Data Integration (MDI) and data warehouse (DW) integration system, since it has up-to-date data, as integration is done on the fly, thereby assisting decision makers that use Business Intelligence process enhanced with VDI integration system to make better queried business decision based on most recent information (data) source (Thomas, 2013).

2.3.3. Data Virtualization (VDI) Role in Improving the Process of Data Integration in Business Intelligence

Business Intelligence includes software application, technologies and analytical methodologies that perform analysis on data coming from all the significant data sources of an establishment. The major challenge of Business Intelligence project that the research is proffering solution to, is in resolving the issue of being able to provide a consistent and a single version of the truth that comes from multiple heterogeneous source of data.

Data Integration has helped a great deal in solving this challenge in this field (Business Intelligence-BI). Past research has shown that about 80 per cent of Business Intelligence efforts lie in data integration and the overall Business Intelligence finding, identifying and profiling source data that would ultimately feed the Business Intelligence (BI) application.

The classical solution to data integration problem in Business Intelligence (BI) is in developing an enterprise data warehouse that should store detailed data coming from the relevant data sources in the organization, as it will ensure a single view of business information and will be the consolidated data source used further for dynamic queries and advanced analysis of information. With data virtualization concept, the cost of implementing data warehouse based approach reduced and also getting solutions speedily and on-time is more feasible (Ana-Ramon and Razvan, 2011).

Virtual Integration (VDI) systems can be designed using various models such as Extensible Mark-up Language (XML) and Unified Modeling Language (UML). Business query (Biz-Query) is a virtual integration system based on Extensible Mark-up Language (XML) data model. Here the system maps local sources as views on the global schema and allows users to query data in terms of Extensible Mark-up Language (XML) and Unified Modeling Language (UML) via declarative languages X-Query (XML Query) and UQL (UML Query Language) in uniform way. Authors' have tried to justify that virtual data integration technique could be quite realistic and practical in a number of recent problems of modern business, using the Extensible Mark-up Language (XML) and Unified Modeling Language (UML) technology which makes it easier and simple to represent all kinds of integrated data in a uniform way. With this approach there is a new problem of more complex query optimization and processing (Konstantin, et al., 2003).

Also, despite the fact that virtual integration system can hardly ever become capable of showing performance comparable to warehouse like systems, but they seem to be practicable

for those business tasks requiring high actuality of data. Also, the principal performance constraints that may lead to unsatisfactory response times because of the lack of actual data statistics and data structures (indexes) which provide optimized access to the data was solved with the ontology aspect of the developed enhanced Business Intelligence process.

2.3.4. Benefits of Virtual Data Integration

In summary, according to Francesco, et al., (2015) the use of data virtualization layer brings a huge number of benefits that makes the technology well worth being considered as a key asset in the armoury of any Business Intelligence (BI) professional.

i. Abstraction and encapsulation.
ii. Significantly reduces and minimizes replication.
iii. Performance is guaranteed by advanced query optimization techniques and the use of caching when appropriate.
iv. Centralized management of security and Centralized data governance.
v. Support for multiple-sources and multiple-consumers: integration of virtually any data source, internal or external.
vi. Delivery of data services to multiple reporting tools and applications avoiding any tie to any specific technology or vendor.
vii. Less design effort as common data specifications are used for every reporting tool.
viii. Much less analysis time through the use of the prototyping and sandboxing approach.
ix. More flexibility to accommodate changes in data sources or in end-user requirements.
x. Enables real-time data for serving operational reporting needs.
xi. More comprehensive Business Intelligence thanks to the integration of external content (competitive information, partner data, and social media content) and also unstructured data.
xii. Shorter time-to-market for delivering reports to users and greater agility.

Furthermore, it;

i. Reduce risk of data errors
ii. Reduce systems workload through not moving data around
iii. Increase speed of access to data on a real-time basis
iv. Significantly reduce development and support time
v. Increase governance and reduce risk through the use of policies
vi. Reduce data storage required.

Despite these benefits it still has some drawbacks such as;

1. May impact operational systems response time, particularly if under-scaled to cope with unanticipated user queries or not tuned early on.
2. Does not impose a heterogeneous data model, meaning the user has to interpret the data, unless combined with data federation and business understanding of the data.
3. Requires a defined governance approach to avoid budgeting issues with the shared services.
4. Not suitable for recording the historic snapshots of data - data warehouse is better for this.
5. Change management "is a huge overhead, as any changes need to be accepted by all applications and users sharing the same virtualization kit" (Gareth, 2016).

2.4. History of Ontology

Ontology within Computer Science is seen as the identification of the right concepts for modelling the world for which one would like to do computations or knowledge management operations. It is a branch of philosophy concerned with the study of what exists. Formal Ontology has been proposed since the 18th century. Computationally, the benefits of this formalization has been the development of algorithms which support the generation of inference from a given sets of facts about the word or the ones that check for consistency. The business of ontology is to study the most general features of reality on like other specific scientific disciplines (such as Physics, and Biology), which deal only with entities that fall within their respective domain. In the works of Smith (2004), the term ontology appeared for the first time in 1967 in the computer and information science literature, in a work on the foundations of data modelling by S.H. Mealy (Giancarlo and Terry, 2008).

Again, ontology arises out of the branch of philosophy known as metaphysics according to history. And it deals with the nature of reality of what exists. As a fundamental branch of philosophy, it is concerned with analyzing various types or nodes of existence often with special attention to the relations between particulars and universals, between intrinsic and extrinsic properties, and between essence and existence. Ontological inquiry traditional goal or aim in particular is to divide the world at its joints in order to discover those fundamental categories or its kinds into which the world's objects naturally fall. During the second half of the 20th century, philosophers extensively debated on the possible methods and approaches to building ontology(s) without actually building any very elaborate ontology themselves. But

computer scientists on the contrary were building some large and robust ontology such as WorldNet and Cyc with comparatively little debate over how they were built (Gruber, 1995).

Also, since the mid-1970s, researchers in the field of Artificial Intelligence (AI) have recognized that capturing knowledge is the key to building large and powerful Artificial Intelligence systems. As Artificial Intelligence researchers argued that they could create new ontology as computational model which enable certain kinds of automated reasoning. Subsequently, the 1980s saw the Artificial Intelligence community making use of the term ontology to refer to both a theory of a modelled world and a component of knowledge systems. Above all, other researchers drew inspiration from philosophical ontology and so viewed computational ontology as a kind of applied philosophy. In the early 1990s, the widely cited webpage and paper "Towards Principles for the Design of Ontologies Used for Knowledge Sharing" by Tom Gruber (1995) was credited with a deliberate definition of ontology as a technical term in computer science. He (Gruber) introduced the term to mean a specification of conceptualization. He defined ontology as a description (like a formal specification of a program) of the concepts and relationships that can formally exist for an agent or community of agents. The definition is consistent with the usage of ontology as set of concept definitions, but more general.

In conclusion, according to Gruber (1993 and 1995), Ontologies are often equated with taxonomic hierarchies of classes, but Ontology need not be limited to these forms. Ontology definition are not just conservative as par being the traditional logic sense which only introduce terminology and do not add any knowledge about the world. In order to specify a conceptualization, axioms needs to be stated which constrain the possible interpretations for the defined terms.

2.4.1. The Concept of Ontology

In Computer Science, Ontology provides a shared understanding of knowledge about a particular domain such as Business Intelligence. In the context of knowledge sharing, Ontology means a specification of conceptualization. Which implies Ontology is a description of the concepts and relationships that can exist for a single technological applications or a reference on a decision making support system and can be designed for the purpose of enabling knowledge sharing and reuse; So, as a knowledge representation technique, when formalized in any kind of logic representation they can support inference mechanism, in which for a given collection of facts, the mechanism can be used to derive new facts or check for consistency

(Filipe, et al., 2009). Consequently, Ontology not only separate domain knowledge from operational knowledge, but it can also analyze the domain knowledge and make domain assumptions explicit. And by explicitly stating concepts, relations and axioms in a domain, it enables information sharing and bridges product designers with salesmen and customers (Ming, et al., 2011).

The concept of Ontology is defined as the theory of objects and their ties. It provides criteria for distinguishing different types of objects (concrete and abstract, existent and non-existent, real and ideal, independent and dependent) and their ties (relations, dependencies and prediction).

In philosophy, the word Ontology has four established meanings; pure philosophical ontology is different from applied scientific Ontology. Ontology in the applied sense is understood as either a discipline or a domain. Ontology as a discipline is a method or activity of enquiry into philosophical problems about the concept or facts of existence. As a domain is the outcome or subject matter of ontology as a discipline. Ontology was coined from Onto - Logos meaning the "Science of being". It is a late coinage. Latinly it is termed Ontologia invented in 1613 by two German philosophers Rudolf Gockel in his Lexicon philosophicum and Jacob Lorhard, in his Theatrum philosophicum. It was first entered generally into circulation when it was popularized by Christian Wolff in his Latin writings, especially his philosophia primasive Ontologia of 1730 and it was in 1720 the term ontology was first used and known as an English word. Presently, in Computer Science, it is a set of categories for programming and data representation which is independent of any particular hardware, software or implementations (Raul, 2014).

Ontology can be constructed for different purposes, such as to enable information sharing and to support specification. When enabling sharing and reuse, ontology is defined as a specification used for making ontological commitments. This commitment is an agreement to consistently use a vocabulary with respect to a theory specified by ontology. In order to support specification ontology is again defined as a conceptualization, that is, ontology defines entities and relationships among them. Every information base is based on either implicit or explicit conceptualization (Igor, et al., 1999).

Again, ontology is generally considered to be a formal explicit specification of a shared conceptualization, this definition sees the term *conceptualization* as an abstract modeling of some phenomenon and identification of its relevant concepts; the term *shared* represents that

the knowledge included in the ontology should be consensual and shared; the term *formal* entails to exclude the use of natural languages and to make the ontology machine readable: and the term *explicit* denoting that the concepts and the constraints on their use should be explicitly defined (Zlatko, 2013). The definition further describes the important concepts and relationships of a particular domain, providing a vocabulary for that domain as well as a computerized specification of the meaning of the terms used in the vocabulary. It consists of classes, properties and individuals. Class defines a concept; Instances are the element that link classes via properties. Properties are used to state relationships between individuals or between individuals and data values. Its aim is to formalize domain knowledge in a generic way and provide a common understanding of a domain; the understanding can then be used and shared by applications and groups. With Ontology reasoning is realized and then it can be used in data integration (Chuan-jun and Chun, 2012).

Furthermore, since Ontology provides views and navigation structures for manual browsing, facilitates natural language access, provide background knowledge for query expansion or query re-writing, enable management of non-textual media and support retrieval and integration of information from different distributed sources, it implies that Ontology are the basis for the articulation of information demands by information consumers or for characterisation offers by information providers. By nature they are multi-actors which make great demands with respect to flexibility, extensibility and maintainability in a changing world (Ludger and Andreas, 2002).

Again, the term "ontology" can be referred to as a machine-readable representation of knowledge, particularly for automated inference. Ontology is a data model which consists of these parts: classes, properties and relationships between them. The power of ontologies lies in the ability to represent relationships between the classes. The main benefit of using an ontology-based model is its runtime interpretation. One of the major advantages of the ontology model is an assumption of open-world. The reason for the popularity is its clearly successful way of interpreting and dissemination of knowledge between people and applications. Moreover, ontology supports integration task as it describes the exact content and semantics of data sources more explicitly. It ensures that if a highly descriptive semantic representation of the available knowledge could be built, it could be reused to power a variety of business applications without the need for repeated integration exercises. Furthermore, the new knowledge gathered from different sources can build upon the current knowledge because

all of it exists in a semantically consistent system. Thus it is concluded that knowledge is the foundation of all successful decisions (Virginija and Rimantas, 2011).

Also, as earlier discussed ontology has its origin in philosophy and has been applied in many different ways. In the area of computer science it is seen as a model for describing the world that consists of a set of types, properties and relationship types. It is generally expected that the features of the model in ontology should closely resemble the real world that is, it should be related to the object. As par Computer Science and philosophy many Ontology have certain things in common, such as the representation of entities, ideas and events, along with their properties and relations according to a system of categories. The difference in both fields are mostly in focus, as the computer scientist tends to be more concerned with establishing fixed, controlled vocabularies while philosophers are more concerned in first principles, such as whether there are such things as fixed essences or whether entities must be ontologically more primary than processes. In essence, Computer Science and Information Science see Ontology as a formal representation of a set of concepts within a domain and the relationship between those concepts. It is used to reason about the properties of that domain and may be used to define the domain. It provides a similar role for semantic web or semantic government as it is done in schema such as for relational databases (Gruber, 2001).

As for the philosopher Ontology is referring to the nature of being. More so, for Computer Science and information science Ontology formally represents knowledge as a hierarchy of concepts within a domain used as shared vocabulary to denote the types, properties and interrelationships of those concepts. They are the structural frame work for organizing information and are used in Artificial Intelligence, Semantic Web, System Engineering, Software Engineering, Biomedical Informatics, Library Science, Enterprise Bookmaking and Information Architecture as a form of knowledge representation about the world or some part of it. Of note is that creation of domain Ontology is also fundamental to the definition and use of an enterprise architecture framework (Gruber, 1995).

In conclusion, in the context of the research Ontology is defined as an explicit formal conceptualization of a shared understanding of the domain of interest (Business Intelligence in the health sector) which includes vocabulary of terms for describing the domain elements, semantics in order to define the relationships of the domain elements and pragmatics in order to define possible usages of these elements. An overview of the requirements which will be automatically satisfied by an ontology-based process is given in figure 2.14.

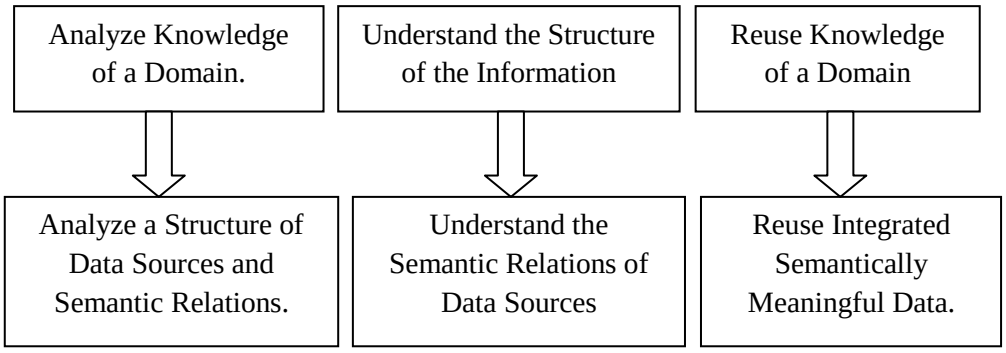


Figure 2.14 Transformation of Ontologies Features to Data Integration Systems Requirements (Source: Virginija and Rimantas, 2011)

2.4.2. Ontology-Based Data Integration

Ontology-based data integration (OBDI) involves the use of ontology(s) to effectively combine data or information from multiple heterogeneous sources. In applying Ontology-based integration as shown in figure 2.15, the raw data is a measurement, information adds place and time to its context information, then knowledge represents the domain rules that need to be followed in case of such a measurement. Lastly, wisdom indicates the situation when further processing of the information will not be necessary; Figure 2.16 outlined the steps involved in ontology-based data integration (OBDI) cycle.

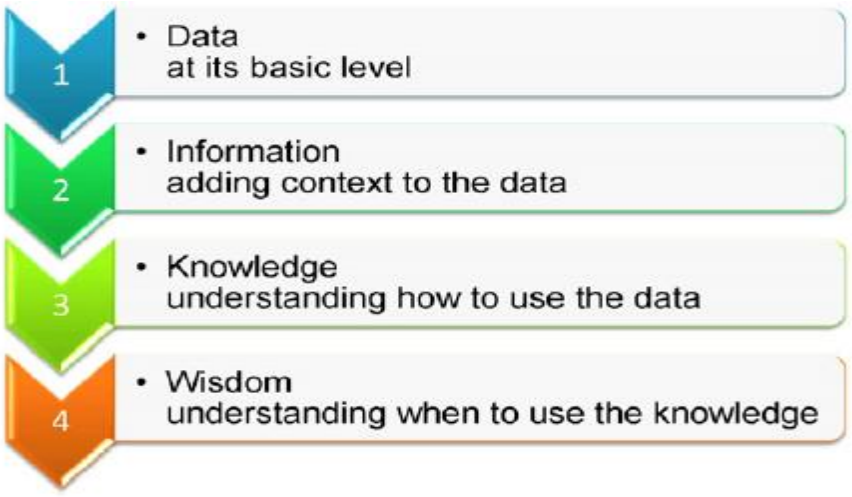


Figure 2.15 How to get from Raw Data to Intelligent Wisdom (Source: Stijn, et al., 2011)

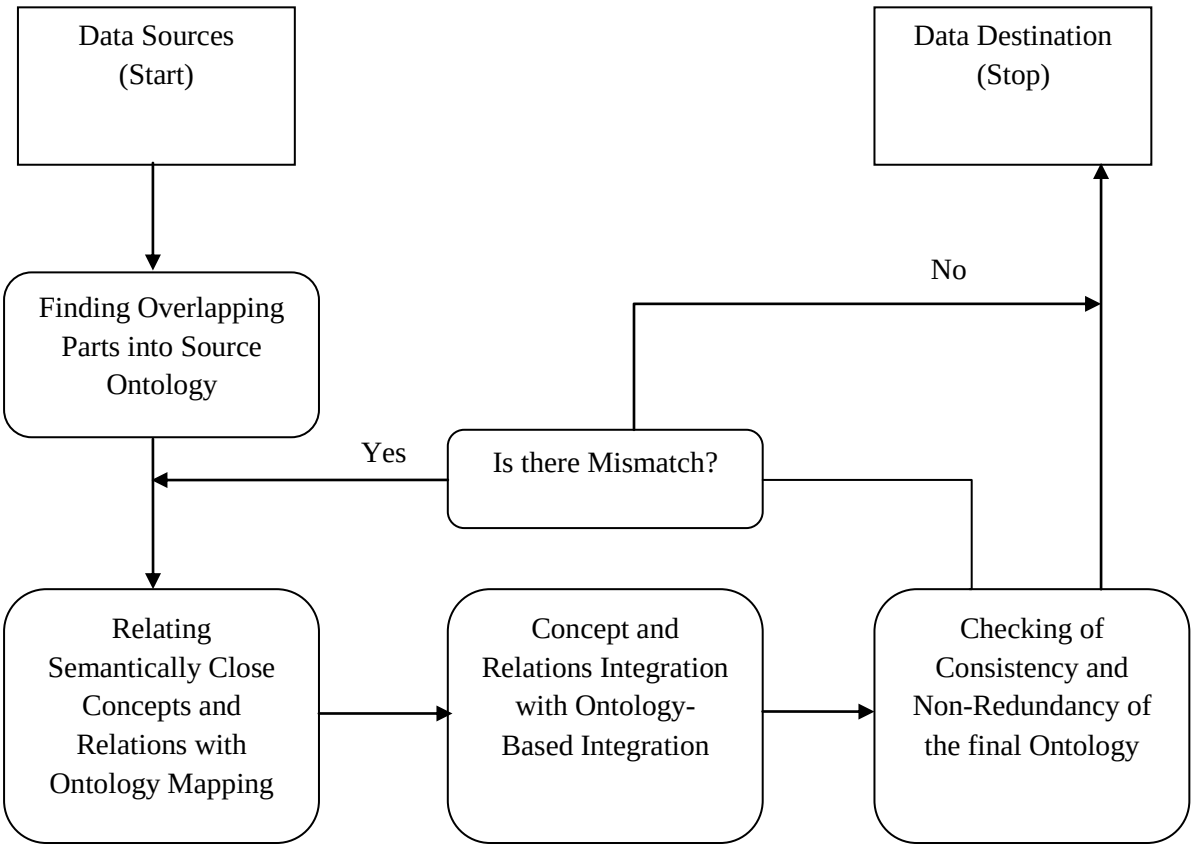


Figure 2.16 Ontology-Based Data integration Cycle (Source: Diego and Giusappe, 2009)

1. Finding the overlapping parts into source ontologies.
2. Relating concepts and relations that is semantically close with ontology mapping or aligning.
3. Integrating concepts and relations with ontology merging or integration.
4. Checking the consistency and non-redundancy of the final ontology. This step is strictly related to the second step because the complexity of the checking process is a function of the expressiveness of aligning relations.
5. If mismatches are found, repeat from step 2, otherwise, stop.

Integration of data is concerned generally with unifying data with some common semantics that originate from a set of heterogeneous, distributed and autonomous (unrelated) sources. This integration process provides the users with a unified view of this data (Stijn, et al., 2011). Using Ontology based data integration (OBDI) is important because of the following reasons;

Since ontology makes all knowledge about certain domain explicit, it can therefore be easily re-used by various information systems or application. Also, ontology (OWL: Web Ontology Language) has well-founded semantics that allows for reasoning to be performed, consistency

of model can be checked to automatically discover inconsistent data, class can be defined as logical constraints and their classification performed at run-time. This frees users from defining the whole classification tree that is often difficult and error-prone. It makes the data integration more future-proof.

More so, Ontology are more and more being picked up by the industry as tools have been developed to construct ontology, visualize it, query it and reason about it. Lastly, the main stream serialization of web ontology language (OWL); here ontology is an extensible mark-up language (XML-based), which allows its models to be easily manipulated and exchanged by applications, regardless of platform. The domain modelling and the data are sent so that the same model and semantics can be used. It is also easy to extract contents of a web ontology language (OWL) model into any format that would be more easily read by humans (Stijn, et al., 2011).

Ontology-based Data Integration (OBDI) helps in resolving the issue and/or challenge of bringing together heterogeneous and distributed computer system, which is termed an interoperability problem. It brings about the elimination of naming conflicts as well as the reduction of semantic conflicts. There is a fact that data integration in ontology(s) is a problem that is inherently different from the data integration challenge for databases. To overcome or solve some of the inherent challenges associated with the use of ontology for data integration, such as that of mapping complexities and maintenance, the need to consider the changes directly on the ontology level, rather than the database level, which is the first requirement for an ideal ontology-based data integration system is considered. With this approach, the fact can be exploited that schema and ontology evolution is rarely represented as mappings and is usually presented as a list of changes.

Interoperability is in nature multilateral and can be best understood as a shared value of the community. It is defined according to IEEE Computer Society in 1990 as the ability of two or more systems or components to use the information that has been exchanged. That is the ability of two or more system, components, teams or team members to use and exchange the information and methodology that have been created during the business application development process. The system would utilize both semantic and syntactic interoperability. The semantic interoperability has to do with the knowledge-level interoperability that will provide the interoperable systems with possibility to bridge the semantic conflicts, while

syntactic interoperability is the application-level interoperability that allows interoperable systems to cooperate regardless of their implementation techniques (Zlatko, 2013).

Business Intelligence with ontology-based and virtual data integration techniques is aimed at providing systematic analyzes and decision making supports with the hybrid of both techniques for the purpose of combining querying, reporting and analyzing tools.

Ontology-based Business Intelligence integration has to do with;

a. Structural linkage of existing information, such as schema-based information integration.
b. It designs ontology-based logical communication channel and architecture for integrating Executive Information Systems (EIS), Data Warehouse (DW) and reporting systems.
c. It identifies and develops relevant ontological engineering techniques such as ontology namespace, semantic relationships, ontological transformation, mapping, discovery and query for combining and transforming ontological items across systems.
d. With this integration unified knowledge portal is advocated, that is built to manage universal integration of all Business Intelligence packages, to support ontology oriented analysis, management and interaction, user-friendly and adaptively.

With the above advantages of ontology-based integration technique, the combination of traditional structural integration and semantic integration leads to predefined, user-friendly, adaptive and automatic interaction as well as integration, representation and management of Business Intelligence. These support seamless transition from a practical work space to a virtual business-oriented analysis world that business persons expect (Longbing, et al., 2005).

In summary, the following are the reasons for the use of ontology according to Zlatko (2013);

1. To share common understanding of the structure of information among people or software agents.
2. To enable reuse of domain knowledge. This is one of the strongest reasons for ontology usage. For example, if a detailed description of the Business Intelligence system is needed in ontology, it can simply reuse the existing ontology if one exists. Also, the research might consider using an existing general ontology and extending it to the knowledge describing the research domain.

3. To make domain assumptions explicit. Explicit assumptions bring several advantages in terms of understanding, improving or correcting knowledge.
4. To separate domain knowledge from the operational knowledge. This is another common use of Ontologies.
5. To analyze domain knowledge. The process of creating ontology(s) is possible only when the domain terms are declaratively specified. The ontological description thus enhances declarative description and makes the knowledge formal and reusable.

Furthermore, the main difference between ontology and a database schema is that the latter essentially constrains the possible states of the database, while the former (ontology) has typically a model theoretic semantics and thus allows inferring new knowledge (in a deductive fashion).

With the use of ontology the following advantages is feasible when used for data integration;

(1) The vocabulary provided by the ontology serves as a stable conceptual interface to the databases and is independent of the database schemas,
(2) The language used by the ontology is expressive enough to address the complexity of queries typical of decision-support applications,
(3) Knowledge represented by the ontology is sufficiently comprehensive to support translation of all the relevant information sources into its common frame of reference, and
(4) The ontology supports consistent management and recognition of inconsistent data.

Ontology gives the name and the description of the domain specific entities by using predicates that represent relationships between these entities. The ontology provides a vocabulary to represent and communicate domain knowledge along with a set of relationships containing the vocabulary's terms at a conceptual level. It is therefore possible to use ontology for data integration tasks.

The features for the building of the ontologies defined in a system are divided into three sub-features *reusability*, *changeability* and *scalability*. Reusability refers to the ability to reuse the ontologies, that is, ontologies defined to solve other problems can be used in the system because either the systems support different ontological languages and/or defines local ontology(s); Changeability refers to the ability of changing some structures within an information source, without producing substantial changes in the system components; Finally, scalability refers to how easy the integrated system can be extended with new information

sources. In general, systems use languages based on description logics, but some Web based ontology languages (OWL) have recently emerged and is quite better (Augustina, et al., 2004).

The interoperability of a system is seen as a consequence of technical, semantic, organizational, legal and political tools. It empowers transfer and usage of data in other information resources such as;

• Organizational- It specifies the regulation of resource interaction.
• Technical- It describes the compatibility of Information Technology (IT) tools, establishment and usage of open interfaces, standards and protocols in order to ensure effective data exchange.
• Semantic- This characteristic ensures that data from one information system are understood and interpreted in the same way in other systems.

In conclusion, it is important to note that ontology should not have a purpose in itself. The ontology(s) should be built with an existing idea of their application. The desired application always has an influence on the ontology structure and its final form.

The research enhanced the ontology-based data integration process from Virginija and Rimantas (2011) as shown in figure 2.17, in the data integration layer of the enhanced Business Intelligence process, by hybridizing it with virtual data integration (VDI-Data virtualization) technique and case-based reasoning (CBR).

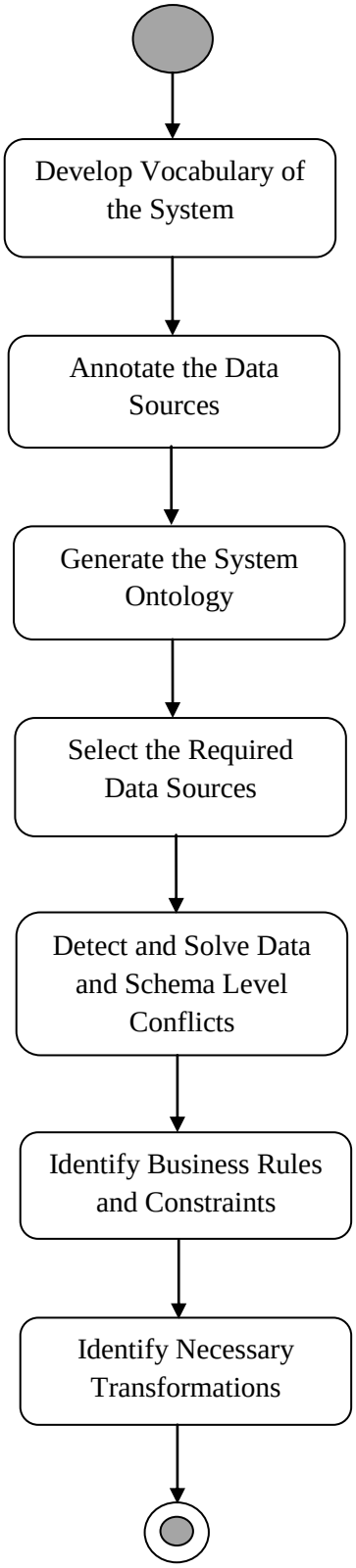


Figure 2.17 Process Model of OBDI (Source: Virginija and Rimantas, 2011)

2.4.3. Components of Ontology

The contemporary ontology share many structural similarities despite the language in which they are expressed. The common components of ontology include the following;

1. Individuals - These are instances or objects that are the basic or ground level objects.
2. Classes - These are sets collections, concepts, classes in programming, types of objects, or kinds of things.
3. Attributes - These are aspects, properties, features, characteristics or parameters that objects and classes can have.
4. Relations - These are ways in which classes and individuals can be related to one another.
5. Function Terms - These are complex structures formed from certain relations that can be used in place of an individual term in a statement.
6. Restrictions - These are formally stated descriptions of what must be true in order for some assertion to be accepted as input.
7. Rules - These are statements in the form of an if-then (antecedent-consequent) sentence that describes the logical inferences that can be drawn from an assertion in a particular form.
8. Axioms - They are assertions (including rules) in a logical form that together comprises the overall theory that the ontology describes in its domain of application. It's a different definition from that of "axioms" in generative grammar and formal logic. In those disciplines axioms include only statements asserted as a prior knowledge. As used here, "axioms" also include the theory derived from axiomatic statements.
9. Events - They are the changing of attributes or relations.

(Gruber, 1995 and 2001)

2.4.4. Types of Approaches to Ontology-Based Data Integration

Ontology-based data integration (OBDI) involves the use of Ontology(s) to effectively combine data or information from multiple heterogeneous sources. It is one of the multiple data integration approaches and may be classified as Global-As-View (GAV). The effectiveness of ontology based data integration is closely tied to the consistency and expressivity of the ontology used in the integration process (Wache, et al., 2001).

Inter-application interoperability has been long seen as schema mapping and data integration problem. In this manner integration requires mapping systems and integration systems that uses those mappings to answer queries or translate data across data sources. There are three different categories of ontology-based integration approaches; single ontology approaches (SOIA), multiply ontology approaches (MOIA), hybrid ontology approaches (HOIA) (Bostjan and Vili, 2010);

Single ontology approach: A single ontology is used as a global reference model in the system. This is the simplest approach as it can be simulated by other approaches. The Search in Multiple Sources (SIMS) system is a prominent example of this approach. The Structured Knowledge Source Integration component of Research Cyc is another prominent example of this approach. (Titled - Harnessing Cyc to Answer Clinical Researchers' Ad Hoc Queries)

Multiple ontology(s): Multiple ontology(s), each modelling an individual data source, and are then used in combination for integration. Though, this approach is more flexible than the single ontology approach, it requires creation of mappings between the multiple ontology(s). Ontology mapping is a challenging issue and it is focused on large number of research efforts in computer science. The Ontology Based System Enhanced with Relationship for Vocabulary hEterogeneity Resolution (OBSERVER) system is an example of this approach.

Hybrid approaches: The hybrid approach involves the use of multiple ontologies that subscribe to a common, top-level vocabulary. The top-level vocabulary defines the basic terms of the domain. Thus, the hybrid approach makes it easier to use multiple ontologies for integration in presence of the common vocabulary.

The global ontology as shown in figure 2.18a uses a single ontology which as a single main stage of building global ontology by domain expert that knows the semantics for all data sources. It can also be a combination of several specialized ontology(s). It describes data from heterogeneous data sources from which query is executed via the main ontology. Every data source in this approach is related. It is applied to integration solutions where all data sources to be integrated provide the same view on a domain.

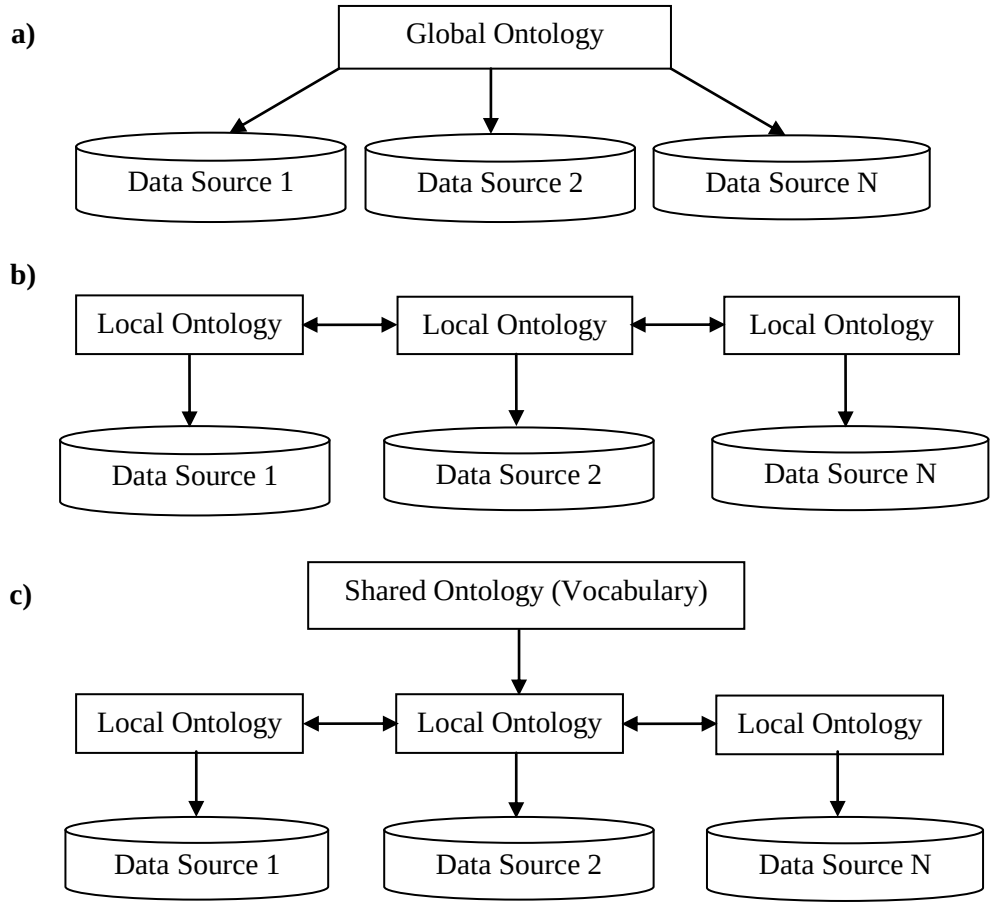


Figure 2.18: The Approaches: a) Global (Single), b) Multiple c) Hybrid. (Source: Virginija and Rimantas, 2011)

The figure 2.18b is the multiple ontology approach which uses local ontologies and mapping rules between them. Each data source is described by its own ontology and the mapping rules can be modified according to the dynamic change of the data source. It has two main stages; building local ontology(s) and defining mappings. This method of local ontology describes data from heterogeneous data sources such that integrated query is executed via the local ontologies. The essential feature of this method is that the ontology(s) for individual data source could be developed or changed without respect to other semantic relations, data sources or their ontology(s).

In the case of the hybrid ontology approach as shown in figure 2.18c, it uses a vocabulary of a domain to represent a shared ontology, a local ontology and mapping rules between them. The specification of a vocabulary includes definitions of classes, relations, functions, and other objects. The mapping rules can be modified according to the dynamic change in data source. That is, it integrates users' profiles, data warehouse, online analytical processing, data mining

and underlying executive information system (EIS). It aims to develop mechanisms for smooth mapping from user-defined keywords to meta-data items in data warehouse or physical attributes and entities dispersing in business system service or office system service (BSS/OSS). This architecture requires ontological engineering techniques for effective operation, such as building ontological namespace and semantic relationships for organising items in the domains; mechanisms for ontological transformation and mapping intra or inter domains; services for ontological query and search in the warehousing (Longbing, et al., 2005). The advantage of the hybrid approach is that new data sources can easily be added without the need to modify the mappings or the shared vocabulary. So this architecture gives more autonomy to data sources. The use of shared vocabulary makes the source ontologies comparable and avoids the disadvantages of single or multiple ontology approach.

Again, ontology(s) enable the unambiguous identification of entities in heterogeneous information systems and assertion of applicable named relationships that connect these entities together. Specifically, ontologies play the following roles;

a. Content Explication: The ontology enables accurate interpretation of data from multiple sources through the explicit definition of terms and relationships in the ontology.
b. Query Model: In some systems like Search in Multiple Sources (SIMS), the query is formulated using the ontology as a global query schema.
c. Verification: The ontology verifies the mappings used to integrate data from multiple sources. These mappings may either be user specified or generated by a system (Wache, et al., 2001).

Furthermore, ontology allows more complete and precise domain models. They are intended to be shared and reused and one of the main advantages of its design is that it has syntactically correct and semantically consistent model and reasoning over them also provides retrieval of additional rules that were possibly not recognized during the design phase. The issue of structural difference in the data warehouse integrates and stores (relational databases, Object databases, unstructured data, and others) as well as when sources have the same structure but with data integration problem of synonyms and homonyms, ontology(s) are used to describe them as truly equivalent despite their appearing in different databases, forms and names (that is they describe the same objects (Helena and Lidia, 2009).

In any domain such as that of Business Intelligence (BI) systems for health sector, ontology play the role of providing a common language to express the shared semantics and consensus knowledge developed in such domain. The shared semantics are typically captured in the form of various domain specific ontology(s) and classifications. The concepts provide the shared semantics to which various data objects and data interpretations can be mapped to enabling integration across multiple Business Intelligence (BI) data sources and domains (Vipul, et al., 2008).

Table 2.5 gives a summary of the benefits and drawbacks of ontology-based integration approach.

Table 2.5 Advantages and Disadvantages of ontology-based integration methods (Source: Virginija and Rimantas, 2011)

Criterions	Ontology-based Architectures		
	Global	**Multiple**	**Hybrid**
Evaluation of Semantic Heterogeneity	Useful for Systems which have the same view on a domain	Useful for Systems which have the same view on a domain	Useful for Systems which have different view on a domain.
Appending new data sources	Some modification is necessary in the global ontology.	Supports an opportunity to append the new data source with some adaption in other ontologies	New data sources can easily be added without the need of modification.
Elimination of data sources	Some modification is necessary in the global ontology	Supports an opportunity to remove the data source with some adaption in other ontologies (need to remove relation between ontologies)	Data sources can easily be removed without the need of modification.
Comparison of multiple ontologies	Impossible.	Difficult because of lack of a common vocabulary.	Simple because ontology(s) use a global shared vocabulary.

Ontology-based data integration is an effective method to cope with the heterogeneous data. This solution is based on the idea of decoupling information semantics from the data sources. Moreover, ontologies support dynamic domains better. For this reason, it is necessary to analyze data source elements: data schema, schema elements and content, values, entities and attributes, as well as query result classes. It is known that ontology-based search system gives the user more meaningful query results than the normal search system, which queries data with syntactic parameters. The query result is based on data retrieval methods (Virginija and Rimantas, 2011).

In summary, ontology integration is similar to ontology merging only that in ontology integration the integrated ontology is created reusing parts of source ontology(s) as they are. Both have a key task of in-consistency checking process which must ensure the absence of unforeseen or wrong implications into the integrated ontology. It can be created using either of the following languages, Resource Description Framework (RDF), Resource Description Framework Schema (RDFS), DARPA Mark-up Language (DAML), Ontology Interchange Layer (OIL) and Web Ontology Language (OWL). Among these, the web ontology language

(OWL) is more powerful than others. The web ontology language (OWL) has well defined semantics and highly optimized implementation system. They see to a unified view been created to resolve the semantic conflict among different heterogeneous databases by using ontology. This view is used for decision making support in the domain it is applied, such as Business Intelligence (BI) in health sector (Hema and Chandramathi, 2013).

2.5. Expert System

According to Viral and Bhushan (2014), expert system is a very special branch of Artificial intelligence that makes extensive use of specialised knowledge to solve problem at the level of human expert. There are different types of expert systems. They are rule based expert system, fuzzy expert system, frame based expert system, and hybrid expert systems. Hybrid expert system is the combination of two or more types of intelligent systems.

As well, Expert Systems are computer programs that exhibit intelligent behavior. They are concerned with the concepts and methods of symbolic inference, or reasoning, by a computer, and how the knowledge used to make those inferences will be represented. Achieving expert-level competence in solving problems in task areas by bringing to bear a body of knowledge about specific tasks is called *knowledge-based* or *expert system*. The term expert system is reserved for programs whose knowledge base contains the knowledge used by human experts. Expert systems and knowledge-based systems are used synonymously. The area of human intellectual endeavor to be captured in an expert system is called the *task domain*. *Task* refers to some goal-oriented, problem-solving activity. *Domain* refers to the area within which the task is being performed. Typical tasks are diagnosis, planning, scheduling, configuration and design (Samson and Lotfi, 2013).

2.5.1. Components and Elements of Expert Systems

The main component and element of an expert system as depicted in figure 2.19 are knowledge-base and inference engine, others are working memory, agenda, explanation facility, knowledge acquisition facility, and user interface (Danny, 2019; Samson and Lotfi, 2013).

a. Knowledge Base

The knowledge base is a collection of rules or other information structures derived from the human expert. Rules are typically structured as If/Then statements of the form:

IF <antecedent> THEN <consequent>

The **antecedent** is the condition that must be satisfied. When the antecedent is satisfied, the rule is triggered and is said to "fire". The **consequent** is the action that is performed when the rule fires. That is, it contains essential information about the problem domain and is often represented as facts and rules.

b. Inference Engine

The inference engine is the main processing element of the expert system. The inference engine chooses rules from the agenda to fire. If there are no rules on the agenda, the inference engine must obtain information from the user in order to add more rules to the agenda. It makes use of knowledge base, in order to draw conclusions for situations. It is responsible for gathering the information from the user, by asking various questions and applying it wherever necessary. It seeks information and relationships from the knowledge base and to provide answers, predictions and suggestions the way a human expert would. It is the mechanism to derive new knowledge from the knowledge base and the information provided by the user and it is often based on the use of rules.

c. User Interface

This is the interaction with end users aspect as well as the development and maintenance of the knowledge base. According to Danny (2019), a user interface is the method by which the expert system interacts with a user. These can be through dialog boxes, command prompts, forms, or other input methods. Some expert systems interact with other computer applications, and do not interact directly with a human. In these cases, the expert system will have an interaction mechanism for transactions with the other application, and will not have a user interface.

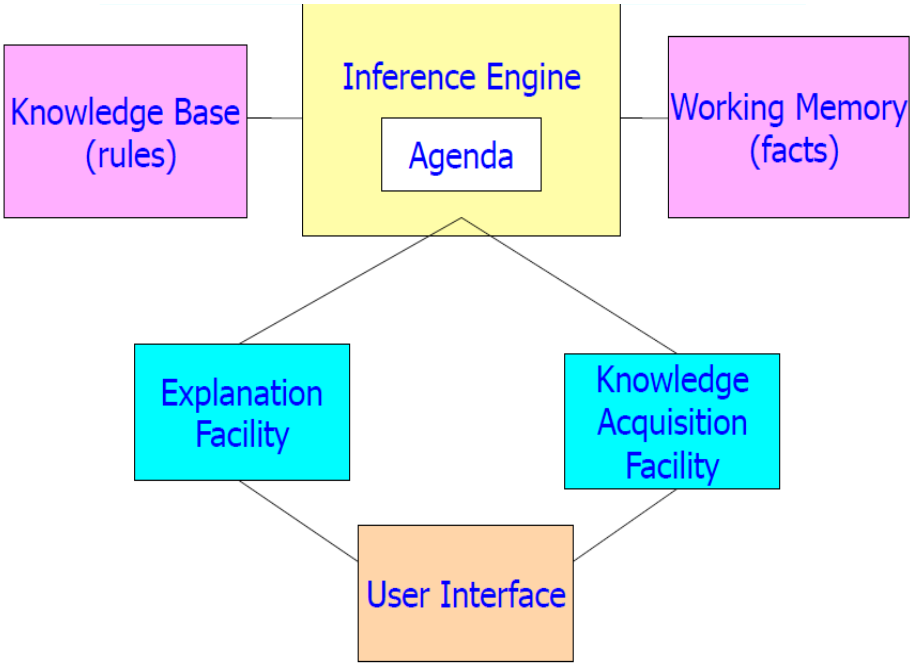


Figure 2.19 Components and Elements of Expert System (Source: Samson and Lotfi, 2013)

d. Agenda

When rules are satisfied by the program, they are added to a queue called the agenda. The agenda is an unordered list of all the rules whose antecedents are currently satisfied. Knowledge bases are typically not ordered, because order tends to play very little role in an expert system. Rules may be placed on the agenda in any order, and they may be fired in any order once they are on the agenda.

e. Working Memory

Working memory contains the data that is received from the user during the expert system session. Values in working memory are used to evaluate antecedents in the knowledge base. Consequences from rules in the knowledge base may create new values in working memory, update old values, or remove existing values.

f. Explanation Mechanism

The method by which an expert system reaches a conclusion may not be obvious to a human user, so many expert systems will include a method for explaining the reasoning process that lead to the final answer of the system.

Generally, an expert system is seen as a computer system that emulates, or acts in all respects, with the decision-making capabilities of a human expert. It has the following advantages of which some are similar to agent technology (Bai-Xiao, 2011);

- Increased availability
- Reduced cost
- Reduced danger
- Performance
- Multiple expertise
- Increased reliability
- Explanation
- Fast response
- Steady, unemotional, and complete responses at all times
- Intelligent tutor
- Intelligent database

Expert system came into existence summarily as follows;

- During the 20th Century when various definitions of artificial intelligence (AI) were proposed.
- In the 1960s, when a special type of artificial intelligence (AI) called expert systems dealt with complex problems in a narrow domain, example, medical disease diagnosis.
- Today, expert systems are used in a variety of fields.
- They are used to solve problems for which there are no known algorithms.
- They are knowledge-based – effective for solving real-world problems.
- They are not suited for all applications.
- Future advances in expert systems will hinge on the new quantum computers and those with massive computational abilities in conjunction with computers on the Internet.

Intelligence verses Expertise

a. Expertise and intelligence are not the same things (although they are related).
b. Expertise requires long time to learn (example it takes 6 years to become a doctor).
c. Expertise is a large amount of knowledge (in some domain).
d. Expertise is easily recalled.
e. Intelligence allows you to use your expertise (apply the knowledge).
f. Expertise enables you to find solutions much faster.

In summary, expert systems or knowledge based systems are used to represent and process knowledge in a format that is suitable for computers but still understandable by humans and it can be cheaper, faster, more accessible, and more reliable than humans (Samson and Lotfi, 2013).

2.5.2. Case-Based Reasoning

Case-based reasoning (CBR) systems are a particular type of analogical reasoning system which have a diversity of applications in many fields, such as in intelligent web based sales service and web-based planning as well as in multi-agent systems. With it as an agent in the research's developed hybrid model, just as in most intelligent or multi-agent system, its goal is to infer a solution for a current problem description in a special domain from solutions of a family of previously solved problems, the case base or case memory (Gavin and Zhaohao, 2003); The concept case-based reasoning (CBR), as an agent is widely used for the definition of the needs for the design and development of expert and intelligent systems (Paul-Eric, 2011).

Case-based reasoning means using old experiences to understand and solve new problems. In it, a reasoner remembers a previous situation similar to the current one and uses that to solve the new problem. Case based reasoning can mean adapting old solutions to meet new demands; using old cases to explain new situations; using old cases to critique new solutions; or reasoning from precedents to interpret a new situation (much like lawyers do) or create an equitable solution to a new problem (much like labor mediators do). The quality of a case-based reasoner solution depends on four things: The experiences it has, its ability to understand new situations in terms of those old experiences, its adeptness at adaptation, and its adeptness at evaluation. The less experienced reasoner will always have fewer experiences to work with than the more experienced one (Kolodner, 1992).

Furthermore, case-based reasoning, broadly construed, is the process of solving new problems based on the solutions of similar past problems. An auto mechanic who fixes an engine by recalling another car that exhibited similar symptoms is using case-based reasoning. When combined with information retrieval, rule-based reasoning (RBR), and fuzzy logic they offer decision support to health sector thereby bringing about more reliable and efficient management of stress. Also, case-based reasoning (CBR) can be applied as agent technology in diagnosing audible faults on industrial robots and package in such a system.

Again, the concept of case-based reasoning (CBR) presents an emerging innovative technique to support other capabilities of learning and self improvement in advanced Business Intelligence (BI). Nowadays, with the evolution of sensor and internet technologies, much richer data and information from heterogeneous sources are becoming available for utilization but the data received are frequently continuous and subject to more complex properties such as

being dynamic, sequential unstructured, uncertain and imprecise, so the concept of intelligent agents in conjunction with case-based reasoning (CBR) offer a potential of increased production quality, flexibility, reliability and fast delivery times in any industry (Matthijs, 2016), such as health sector that the research would be testing its enhance Business Intelligence (BI) model. As is known, an intelligent system can only serve to solve certain types of problems in a special domain. So any case-based reasoning (CBR) system can thus only give the solutions to problems in a possible world, which corresponds to a scenario in the real world (Gavin and Zhaohao, 2003).

More so, the concept case-base means a set of cases that are usually just flat files or relational databases. A robust case-base, containing a representative and well distributed set of cases, is the foundation for a good case-based reasoning (CBR) system. It is applied for classification issues, compiling solutions, accessing values, justifying with precedents and evaluating options. As earlier discussed, it solves new problems by using or adapting solutions that were used to solve old problems. It offers a reasoning paradigm that is similar to the way many people routinely solve problems.

Again, case-based reasoning (CBR) is a method for solving problems by comparing a problem situation to previously experienced ones. The aim is to store information about earlier situations, and when new ones arrive, find the situation that is most similar, and reuse it to match the new problem if the most similar problem does not match sufficiently. This may involve using background knowledge or asking a user. It is an approach that is a novel paradigm that solves a new problem by remembering a previous similar situation and reusing the information on and knowledge of that situation to bring out similar cases at a faster rate. With the rapid development of case-based reasoning (CBR) techniques, it has been widely applied to real-world applications such as agent-based systems for ship collision avoidance. Note, a successful agent based CBR relies on a high-quality case-base (Mythili, 2011).

The cycle of the case-based reasoning (CBR) is described by the following four processes according to Mythili (2011), with figures 2.20 and 2.21 depicting the cycle as well as a sample system diagram.

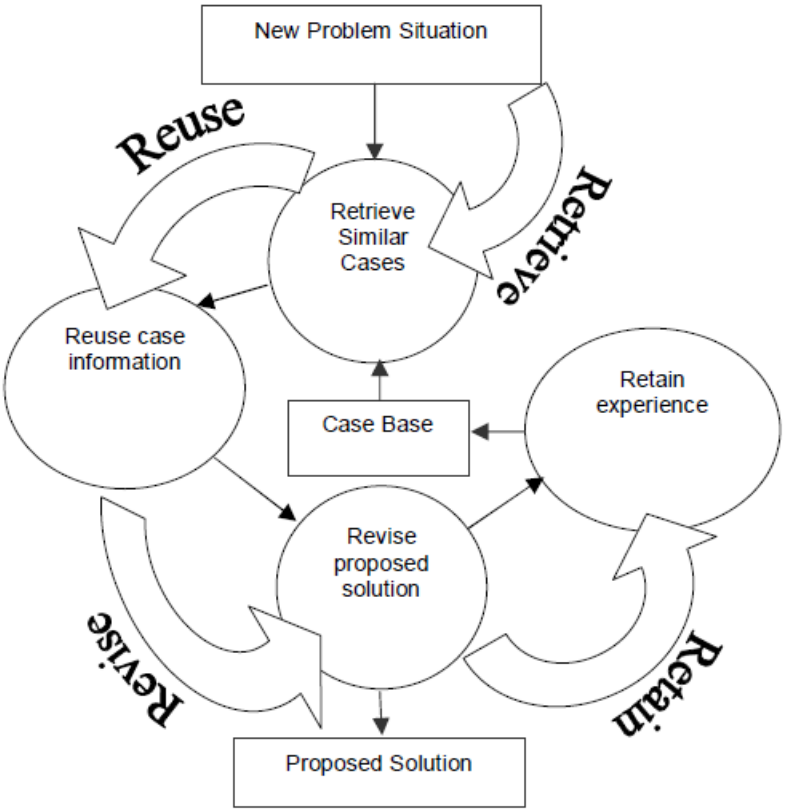


Figure 2.20 Case Based Reasoning Processing Cycle (Source: Mythili, 2011)

1) Retrieve: Retrieving a case means to start with a (partial) new case, and retrieve the best matching previous case. It involves the following subtasks:

Identify features - this may simply be to notice the feature values for a case. This can be filtering out noisy problem descriptors, infer other relevant problem features, check whether the feature values make sense in the given context, or generate expectations of other feature values.

Initially match - usually done in two parts, first an initial matching process which gives a list of possible candidates, which are then further examined to select the best. There are three ways of retrieving a case or a set of cases: By following direct index pointers from the problem features, by searching an index structure, or by searching in a model of domain knowledge.

Select - select a best match from the cases returned by the initially match. The reasoner tries to explain away non-identical features. If the match is not good enough, a better one is sought by using links to closely related cases. The selection process can generate consequences and expectations from each retrieved case, by using an internal model or by asking the user.

2) Reuse: The focus of reuse is to find the difference between the new and the old case, and find what part of the old case that can be used in the new case. It either involves copying the old solution or adapting it:

Copy - in simple classification, the differences between the old and new case are abstracted away, and the solution is simply copied from the old case.

Adapt - either the solution itself can be (transformed and) reused, or the past method that produced the solution can be used.

3) Revise: If the solution generated by the last phase is not correct, the system can learn from its failures. This involves:

Evaluate - try the solution proposed by the reuse-phase in the real environment, and evaluate it.

Repair fault - If the solution evaluated badly, find the errors or flaws of the solution, and generate explanations for them.

4) Retain: Incorporate what is useful to learn from the problem solving experience into the existing knowledge. Sub processes are:

Extract - if the problem was solved using an old case, the system can build a new case, or generalize an old case to include the new case as well. If the user was asked, a new case should be constructed. Explanations may be included in the case.

Index - decide what types of indexes to use for future retrieval.

Integrate - modify the indexing of existing cases after the experience, strengthen the weight of features that were relevant, and decrease the weight of features that lead to retrieval of irrelevant cases.

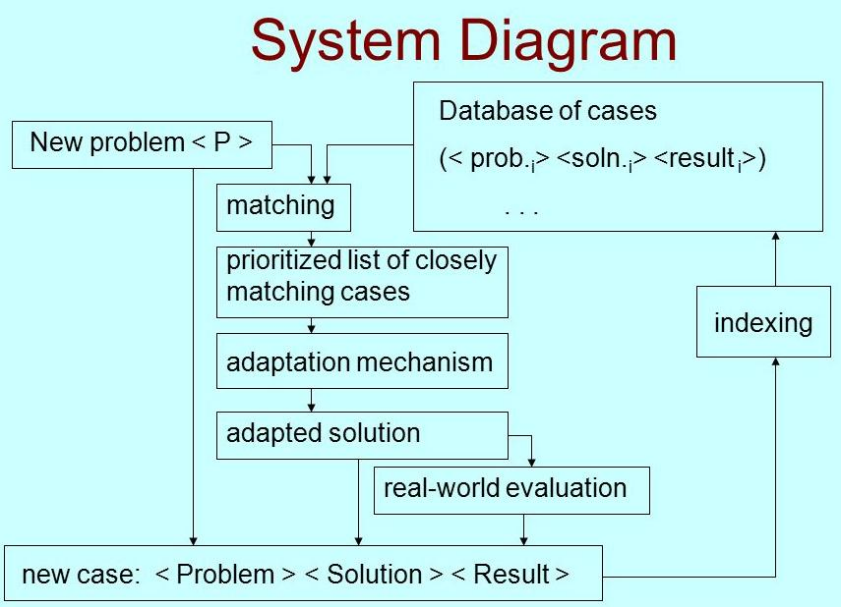


Figure 2.21 Sample of Case-Based Reasoning (CBR) System (Source: Tanimoto, 2004)

2.5.3. Application Areas of Case Based Reasoning

According to Kolodner (1992), the following scenarios are application areas of case-based reasoning (CBR). Lets' start by considering why a doctor, or anybody else trained in the practice of making logical decisions, would make case-based inferences. After all, the doctor is trained to use facts and knowledge, and case-based reasoning looks like it is based on hearsay. The answer is simple. The doctor is trained to recognize disorders in isolation and to recognize common combinations of disorders, He also knows the etiology of disorders, that is, and how they progress. But he cannot be trained to recognize every combination of disorders, and the knowledge he has of disease processes is time consuming to use for generation of plausible diagnoses. If he has used his knowledge of disease process to solve a hard problem once, it makes sense to cache the solution in such a way that it can be reused. That is, once he has learned to recognize a novel combination of disorders, if he remembers that experience, he will be able to recognize it again, just as he recognizes more common combinations, without the difficult reasoning necessary the first time. The logical medical judgment comes in later in deciding whether or not the patient does indeed have the proposed set of diseases.

Similarly, it cannot be expected that a computer program to be seeded with all the possible combinations of problems it might encounter. Nor can it be expected to have efficient algorithms for generating plausible solutions from scratch all the time. A model-based trouble shooting system, for example, might know very well how something functions. That does not necessarily mean that it can generate solutions to problems easily, especially when more than

one fault could be possible at any time. Similarly, while a causal model may be helpful in verifying a design, it may not provide enough information to be able to generate designs in under-constrained or over-constrained situations. Just as case-based reasoning provides a way for people to generate solutions easily; it also provides a way for a computer program to propose solutions efficiently when previous similar situations have been encountered. This does not mean that causal reasoning is without merit. On the contrary, it must play the role that the medical doctor's logic plays after a solution is proposed. The causal-model-based system needs to work along with the case-based system to identify changes that must be made in an old solution, to ensure valid adaptations, and to verify proposed solutions.

So, case-based reasoning (CBR) is useful to people and machines that know a lot about a task and domain because it gives them a way of reusing hard reasoning that they have done in the past. It is equally useful, however, to those who know little about a task or domain. Consider, for example, a person who has never done any entertaining yet has to plan the meal specified in the introduction. His own entertaining experience would not help him. But if he has been to dinner parties, he has a place to start. If he remembered meals he had been served under circumstances similar to those he has to deal with, he could use one of those to get started. For example, if he could generate a list of large dinner parties he has attended, he could, for each one, figure out whether it was easy to make and inexpensive, and when he remembers one, he adapts it to fit.

Again, case-based reasoning (CBR) is also useful when knowledge is incomplete and/or evidence is sparse. Logical systems have trouble dealing with either of these situations because they want to base their answers on what is well-known and sound. More traditional artificial intelligence (AI) systems use certainty factors and other methods of inexact reasoning to counter these problems, all of which require considerable effort on the part of the computer and none of which seem intuitively very plausible. Case-based reasoning provides another method for dealing with incomplete knowledge. A case-based reasoner makes assumptions to fill in incomplete or missing knowledge based on what its experience tells it, and goes on from there. Solutions generated this way would not always be optimal, or even right, but if the reasoner is careful about evaluating proposed answers, the case-based methodology gives him a way to generate answers easily.

In summary, as stated previously case-based reasoning (CBR) is an artificial intelligence (AI) technique incorporated with database technology that comprise of past knowledge as cases. It

uses reasoning procedures to memorize previous cases analogous to existing case problem, and then utilizes these cases to address current problem. It aids storage of cases in the case base library through case indexing; in it cases are retrieved through searching of previously indexed cases by comparing the case parameters and attributes similarities of cases problem and case solution residing in the case base library. In case indexing, cases are structured as components having parameter used to develop the case base library. Case-base reasoning (CBR), also allow learning from past and present experiences. Once any problem has been successfully solved by the domain expert, the case is subdivide into a series of tasks and then saved in a case based library to form a new case. Although learning in case-based reasoning (CBR) occurs after case adaptation. Hence, as a case is successfully applied, its feedback will be retained for future use (Bokolo, et al., 2017).

In conclusion, case-based reasoning (CBR) agent application aids decision making in clinical areas such as in diagnosis, treatment, healing monitoring and disease control. It is an artificial intelligence (AI) technology that can be used to develop intelligent systems suitable for automated problem solving. It comprises of case indexing which leads to retrieving best previous cases from the case-bases to the user who adapts the retrieved case solution to resolve present issues. Once the case has been adapted for reuse, it is evaluated to check if the applied case solution was successful and this leads to case-based reasoning (CBR) learning and case retention (Bokolo, et al., 2017). This intelligent agent (CBR) enables autonomous performance, necessary actions and aids humans in decision making process by providing necessary information needed to make an informed and validated decision.

Of note, artificial intelligence (AI) offers a number of powerful methods and techniques, which offers potential benefits if harnessed properly. The agent paradigm and agent architecture is one of them, and with the combination of case-based reasoning (CBR) the potential for building valuable system for health sector domain that is argued to be large and enables valuable properties, but it is difficult to achieve with traditional architecture and engineering (Funk, et al., 2006).

2.5.4. Advantages and Pitfalls of Case Based Reasoning (CBR)

1. Case-based reasoning allows the reasoner to propose solutions to problems quickly, avoiding the time necessary to derive those answers from scratch.
2. Case-based reasoning allows a reasoner to propose solutions in domains that it does not understand completely. Many domains are impossible to understand completely, often

because much depends on unpredictable human behavior, such as the economy. Others nobody understands yet, example how some medications and diseases operate.

3. Case-based reasoning gives a reasoner a means of evaluating solutions when no algorithmic method is available for evaluation. Using cases to aid in evaluation is particularly helpful when there are many unknowns, making any other kind of evaluation impossible or hard.
4. Cases are particularly useful for use in interpreting open-ended and ill-defined concepts.
5. Remembering previous experiences is particularly useful in warning of the potential for problems that have occurred in the past, alerting a reasoner to take actions to avoid repeating past mistakes.
6. Cases help a reasoner to focus its reasoning on important parts of a problem by pointing out what features of a problem are the important ones.

Pitfalls of Case-Based Reasoning;

1. A case-based reasoner might be tempted to use old cases blindly, relying on previous experience without validating it in the new situation.
2. A case-based reasoner might allow cases to bias it too much in solving a new problem. And, often people, especially novices, are not reminded of the most appropriate sets of cases when they are reasoning.

To resolve the pitfalls, steps such as despite the fact that people do find case-based reasoning a natural way to reason, it is good to endeavor to explain the processes involved in case-based reasoning this might help people to learn how to teach people to reason better using cases. In addition, the case memory technology developed might allow for the building of decision aiding systems that augment human memory by providing the appropriate cases while still allowing the human to reason in a natural and familiar way (Kolodner, 1992).

2.6. Review of Related Literature

2.6.1. Business Intelligence

According to Munoz J.M. (2017), the common functions of Business Intelligence technologies are reporting, online analytical processing (OLAP), analytics, data mining, process mining, complex event processing, business performance management, benchmarking, text mining, predictive and prescriptive analytics. They are also, capable of handling large amounts of

structured and sometimes unstructured data to help identify, develop and otherwise create new strategic business opportunities. The goal is to allow for easy interpretation of those big data.

Rick (2012) in chapter seven of his book, talked on Business value of Business Intelligence and it states that Business Intelligence is seen as business information, business analysis within the context of key business processes that leads to decisions and actions which results in improved business performance. The method used involves applying Business Intelligence techniques to data warehouse to achieve how data warehouse provides insight to business, its real-time analytics that enables for on-the-spot personalized service for valued customers, it emphasis that Business Intelligence has to be highly specific to the industry as well as how the company competes in that industry. With this, the kind of business information, business analyzes and business decisions that Business Intelligence must deliver or enable, and the way that Business Intelligence creates business value must be specifically determined for each company. In conclusion, the author says that Business Intelligence is about turning information into action and action into improved performance.

According to George Beaton (2015) in a white paper on Business Intelligence strategy, implementation and execution, it states that the main objective of Business Intelligence (BI) is to inform information technology (IT) and business executives of the best practices for the implementation of business intelligence strategy across an entire organization. This came about because it was observed that companies fail to take the full advantage of Business Intelligence projects due to a lack of complete integration and implementation throughout the organization. It is of note that the most important benefits of Business Intelligence (BI) are the power to distribute information throughout the organization in order to increase efficiency at all levels. With Business Intelligence strategy all individuals in the organization can have freedom to access information from a variety of systems in the organization. Standardization is the methodology term used to achieve Business Intelligence strategy and it uses the following steps; Determine Readiness, Anticipate and minimize problem, Ensures Business Intelligence strategy for a long run and then demonstrate the value of Business Intelligence strategy.

In essence, the white paper highlighted the very elements of Business Intelligence strategy that has to do with the establishment of Business Intelligence (BI) standards, corresponding methodologies and centre of excellence (COE) to guide the process as well as the steps that can lead an organization towards more efficient operations and better return on investment (ROI) through a more intelligent use of information.

In summary, according to Maynard, et al., (2008) Business intelligence requires the acquisition and aggregation of key pieces of knowledge from multiple sources in order to provide valuable information to customers or feed statistical business intelligence models and tools. Since the analyst of business intelligence has lots (massive) of information to extract and process, there is the challenge as par its acquisition and use of its semantic information, ontology-based data integration approach is applied in the research as an effective way to resolve the challenge. It implies the process of identifying in text or other sources, relevant concepts, properties, and relations expressed in ontology.

2.6.2. Ontology

Bostjan and Vili (2010) proposed an approach for the integration of information across heterogeneous information system due to the rise of information in the internet, globalization and the increasing number of application used inside organizations, the approach is intended to bridging the gap between ontology-based integration and service oriented architecture by enabling dynamic and transparent integration of information which is provided by services. Here ontology-based integration is one of the possible solutions to information integration challenge. The filling of the gap by automation of the data integration part is what the authors proposed a novel approach to ontology-based integration and is based on automated execution of web services and automated integration of data that they provide in a global data view. The approach is suitable for any heterogeneous information system, as long as a specific system is able to expose their data in form of services. The proposed architecture of ontology-based integration would enable fully transparent and dynamic integration of non-semantic data for the ontology-based data (information) integration. The algorithm and prototype were developed as a proof of concept and as a means for measuring the efficiency of the system as a whole.

Letizia (2006) used ontology-based data integration system to solve semantics inconsistencies. It is well known fact that interoperability among automatic systems is a well known problem, especially for information systems. Data warehousing is the most known approach to solving data integration problem and it involves the fact that data originating from different sources are submitted to a process called extraction transformation loading (ETL) and then stored into a new database with a single and usually de-normalized schema. Often the final database is structured and is to store various aggregations of the sources, in order to speedup data query processing. Architecturally, data warehousing can be seen as a tightly coupled approach because the integrated data reside in a single place at query time, but recent approaches to data

integration such as the ontology-based and virtual data integration approach are sometimes loosely coupled (that is distributed).

Wache, et al., (2001) on an article titled ontology-based data integration says that it involves the use of ontology(s) to effectively combine data or information from multiple heterogeneous sources. Its effectiveness is closely tied to the consistency and expressivity of the ontology used in the integration process. The approach of using ontology for data integration entails three main architecture that are implemented in the applications, namely single ontology, multiply and hybrid ontology.

Virginija and Rimantas, (2011) says the use of ontology for data integration is as a data model that consists of parts such as classes, properties and relationships between them. It says the term ontology refers to a machine readable representation of knowledge, particularly for automated inference. That is the power of ontology lies in its ability to represent relationships between the classes. Its' benefits, (that is the ontology-based model) is its run time interpretation. It also has the advantage of an assumption of open-world. This when implemented in the research Business Intelligence domain will be quite useful.

Hema and Chandramathi, (2013) stated that a unified view is created to resolve the semantic conflict among different heterogeneous databases by using ontology. This view is used by the user for shopping while business analysts use it for decision support.

Poonam and Singh, (2010) states that ontology technique will provide quick access to documents and information with the help of taxonomy created from the concepts, called a concept map, with the incorporation of ontology array indexing. The system will be adaptive as it will retrieve the most relevant information as well as documents which are close to the user's queries and the array-indexing is key to this concept as it helps in obtaining an inter-relation between the documents and information. It also, ensures the redundancy of concepts or document in the database.

In conclusion, in terms of the authors' views on ontology generally, it implies the fact that ontology supports the integration task as it describes the exact content and semantics of the data sources more explicitly, it brings us to the fact that knowledge is the foundation of all successful decisions because it focuses explicitly on the representation of knowledge rather than just its management. It also ensures that if a highly descriptive semantic representation of available knowledge could be built, it could be reused to power a variety of business applications without the need for repeated integration exercises. Also, the new knowledge

gathered from different sources can build upon the current knowledge because all of it exists in a semantically consistent system. The method proposed as per the applied idea of processes based on ontology for data integration used by the authors is the hybrid data integration process that is based on the use of ontology that explicitly captures knowledge about different types of data sources. The ontology schemas used here are typically assumed to be highly dynamic and evolving objects.

2.6.3. Virtual Integration

Munmum and Nashreen (2016) defines data integration as the technique of merging data residing at different sources at different locations, and providing users with an integrated, reconciled view of these data. The authors study the theoretical aspect of virtual data integration and its applications, of which the architecture of the virtual data integration system includes components such as data sources, mediated (Global) schema, source description and semantic mappings. Their system approach implies that all data is retrieved and processed on-the-fly based on formalized schema mappings and a declarative query language. The method is suited for the integration of a large number of data-intensive information repositories such as that commonly found in science.

Muhammed, et al., (2015) discuss the fact that there are different approaches and classification of integration and that integration approaches depends on data model and these data model as it concerns integration is of three types text based, structured data and linked data. The authors paper focus on using virtual data integration in heterogeneous genomic biological knowledge base. The paper described integration based on mediated approach as that which is about creating virtual integration environment system for multiple sources. That is data stays at the sources, but it creates an illusion on user of being working on real database. In virtual data integration, the main component according to these authors is mediator and it is responsible for providing effective reception for back and forth movement of data from multiple sources for user query interface and vice-versa. Most mediator system were designed in a manner that all the mediation functionality was adopted into a centralized system, but this does acquire the functionality like atomicity, decentralization, flexibility, scalable integration, and agility as with distributed system.

The proposed model of the authors, is defined for a generic architecture of virtual data integration for bioinformatics database and its main goal is to establish an environment for the people like biological and bioinformatics in which they can acquire knowledge from the bulk

of heterogeneous data sources, create their hypothesis and then test it for their reliabilities. In other words make maximum tasks to be automated for the community of scientists and researchers. It will also reduce the amount of time to process that data and such type of system will in fact help to achieve goals in minimum interaction, thereby leading to computational system being flexible and reliable enough to the users. The authors conclude that virtual data integration solutions will definitely ease the generation of the biological results and also helps to reduce the overall processing cost and time.

James, et al., (1993) says virtual data integration is an early example of the organization engine because it provides the appearance of integration at the desktop without modifying existing information. The key to virtual data integration in this article is, providing each user with a single view of all data regardless of such details as the data's location, storage format, and metadata model without disturbing the implementation of the various systems that manage the data. This virtual data integration approach as the authors observed represents an effective, low-risk means for health care institutions to improve dramatically the accessibility of critical information without jeopardizing existing technology investments.

Manos, et al., (2015), proposed a ViDa approach to solving data management problem and it draws inspiration and utilizes concepts from a wide range of research areas such as data exploration of which due to data sizes becoming larger and larger it has become necessary to quickly gain insight of vast amounts of data. With ViDa data is abstracted and manipulated regardless of its original format, while adapting the query engine to the underlying data. By using virtualization and performing the query processing directly on raw data files, ViDa approach can provide novel opportunities for low-over-head data exploration. This approach to virtual data integration envisions the transforming of databases into virtual instances of the raw data, with users spawning new instances as needed where they can access, manipulate and exchange data independently of its physical location, representation or resources used. In essence, the authors' made case for ViDa being a novel system focusing on virtualizing data; abstracting data out of its form and manipulating it regardless of the way it is stored or structured.

2.6.4. Business Intelligence with Case-based Reasoning:

Venkatadri, et al., (2010), proposed the development of complex systems with self organized multi-agent technology that would reduce the building cost without affecting the systems

scalability and reliability. This was presented as a novel framework based on Self Organized Multi Agent technology for building low cost Business Intelligence systems.

George (2002) proposed an agent based mediate-wrapper software architecture to solve the issue of integration for a multi-source data. It was found out that organizations have to integrate multiple, distributed data sources and repositories for making their business decisions, and the data sources are of various types and in various places such as object stores, knowledge bases, files systems, digital libraries and legacy systems, so data and system integration demand became increasingly important for the enterprise computing.

Kolodner (1992), discussed the concept of case-based reasoning (CBR), its meaning, purpose, application areas, advantages, pitfalls and most especially the author discussed the processes involved in case-based reasoning and the tasks for which it is useful.

Ana-Ramona and Razvan (2011), focused on specifically implementing a software agent-based system in Business Intelligence environment. So some basic ideas for developing real-time agent-based software system were proposed for Business Intelligence (BI) in supply-chain management, using case-based reasoning agent. The main objectives was to easy accessing and integrating of data from various data sources and storing it into a data warehouse, to analyze data in order to transform it into information and then into knowledge and to present information using an easy to understand and use of graphic interface.

Samo and Igor (2006), proposed the use of agent technology in order to advance Business Intelligence (BI) for the resolving of complex communication, integration and analysis problem. Research in the field of Business Intelligence (BI) and agent based system was synthesized and a model was built proposing three prospective fields for using intelligent agents in the field of Business Intelligence (BI); data acquisition, intelligent modeling and intelligent information brokerage for mediating information flow between users and disperse information sources. Due to the shortfall in data mining, data warehouse, and extract transform load (ETL) processes which mainly are only able to handle structured data in an organized environment, with the proposed model, unstructured and unorganized data that don't originate from well defined source problem would be handled.

Jon-Jang, et al., (2002), proposed agent-based architecture that supports a complete Business process in sending, integrating, predicting, automating and responding to business processes and it aims to decrease the time it takes to make business decision. It also aims towards zero-

latency between the cause and effect of a business decision. With the proposed architecture, Business Intelligence system and business processes gap are effectively closed.

Mythili (2011) gave a description of case based reasoning which is based on agents and how it was implemented in a decision support system. Its target is the implementation of a system which intends to help emergency planners to detect risks and to manage crisis situation by perceiving, representing and assessing current situation. Case-based reasoning (CBR) approach was used as a novel paradigm that solves a new problem by remembering a previous similar situation and reusing the information on and knowledge of that situation to bring out similar cases at a faster rate.

Bokolo, et al., (2017), the authors' research proposed to develop an intelligent Green software development model that presents the combined application of intelligent agents and case based reasoning (CBR) techniques for supporting decision making of software developers in achieving Green software development. So to support the Green software development, intelligent agents and CBR was used to assimilate Green process into traditional software development life cycle. The CBR utilizes past software expert knowledge derived from the extraction of similar software development cases thereby providing suggestions to software developers, while the intelligent agent brings flexibility for the CBR by enhancing the capability of adopting Green software development there by overcoming the shortcomings of inadequate information experienced in traditional software development lifecycle.

Funk, et al., (2006), proposed an efficient health monitoring, preventive, and corrective actions system for resolving the issue of knowledge loss, cost of monitoring systems repeatedly giving false alarms, that causes expensive loss of production capacity and resulting in technicians losing trust in the systems and in worst case, switch them off. So it was thought if monitoring systems could learn from previous experience for both correct and false alarms, the reliability and trust in the monitoring systems would increase. Also, connecting alarms to either equipment taking automatic actions or recommend actions based on the current situations and previous experience would be valuable. From the above a localized intelligent agents, that would be able to either autonomously perform the necessary actions or aid a human in the decision making process by providing the necessary information needed to make an informed and validated decision was proposed.

2.6.5. Business Intelligence in the Health Sector (Medical):

Sang (2018), highlights the advantages of big data analytics and Business Intelligence (BI) in the health care industry and the focus of the paper are around intelligent techniques and methodologies that are recently used for Business Intelligence in healthcare. These techniques and methodologies is geared towards achieving decision support, integration services, patient analysis, performance analysis, wait time analysis, electronic health record analysis, data mining, among others. Hence the author concludes that since many healthcare organizations struggle with the lack of access and ability to utilize data collected through non-integrated traditional systems for data mining and decision making, it is important to empower staff and management in the sector for strategic decision making through data warehousing based on critical thinking. The author then outlined a general architectural approach for Business Intelligence solution with its major components introduced in order to give readers a high level picture with some important details as regard to healthcare informatics.

Kulkarni, et al., (2017); the paper focus on the different approaches taken for data management and improving the outcomes of previous Business Intelligence (BI) systems such as providing up to date and accurate system performance (such as data warehouse model, analysis services and reporting services) with the use of Business Intelligence (BI) applications. It review that Business Intelligence (BI) in healthcare expects improve quality of care, improve clinical decisions among others. And its benefits with clinical data warehouse are enabling of a more efficient, scalable reporting process, ensuring consistent data that everyone can trust and enabling meaningful, targeted quality improvement. The purpose of the review was to study and understand the different research methodologies in the use of Business Intelligence (BI) in the healthcare sector.

Patti, et al., (2015), proposed that since Business Intelligence (BI) primary objectives is to improve timeliness and quality of input available for decision making process, a framework for developing a domain specific maturity model was proposed and applied in healthcare sector to demonstrate its efficacy. The proposal was made due to the fact that implementation of electronic health records has resulted in a rapid accumulation of data. Healthcare organizations can use business intelligence (BI) technologies to leverage the data and improve operational and clinical efficiency. Approaches to understanding Business Intelligence (BI) readiness are needed for organizations to develop an overall Business Intelligence (BI) strategy. While there are a number of Business Intelligence (BI) maturity models, they are often generic and do not

meet the industry specific requirements. The results indicate that the framework is able to address the needs of a domain specific Business Intelligence (BI) maturity model, and guide the development of such model that proved acceptable to expert practitioners in the field. The case study instantiation within a healthcare organization helped to demonstrate the process. It used an iterative process of model development performed using Delphi method with Business Intelligence (BI) participants.

Celina and Kornelia (2012), proposed an intelligent technique for an effective computational methods and robust environment for Business Intelligence as applied in the healthcare domain. In the paper, discussion was made showing the proposal was important as much data storage in all kinds of system used in healthcare organizations resides in proprietary silos which makes access difficult. So the use of Business Intelligence (BI) systems which is worth using is determined by its efficiency of its intelligent techniques, methodologies and tools. The authors' also discussed the essence of Business Intelligence (BI), characteristics of the healthcare sector and its potential application of Business Intelligence technology, which is so far the only technology that is able to focus on key indicators easily and quickly in providing valuable information for the healthcare organization. In summary, the authors' proposed a Business Intelligence (BI) healthcare system that would be responsible for collecting, providing and analyzing the most relevant data for improved and better healthcare information, given its' huge pool of available data, thereby assisting the sector to not just be rich in data, but also in information.

Mihaela and Manole (2015), highlighted the advantages of big data analytics and Business Intelligence in the healthcare industry, by reviewing the Real-Time Healthcare Analytics Solutions for Preventative Medicine that was provided by SAP and the paper further reviewed the different ideas realized by possible customers for new applications in Healthcare industry in order to demonstrate that healthcare system can and should benefit from the new opportunities provided by information technology (IT) in general and big data analytics in particular. It further states that the future of healthcare industry is under construction, but it is so clear the design of the healthcare information technology (IT) platform of tomorrow means imagining not only how data is used but also how healthcare is delivered. The authors' recommends that business intelligence (BI) and big data analytics can significantly assist healthcare research and ultimately improve the quality of life for patients from any domain. Hence, it is time for change in the health sector domain, as the use of analytics will enable

putting the right data at the fingertips of the people with the potential to generate life saving or life style improving insights.

Tobias and Vivian (2008) suggested in their paper the use of Business Intelligence (BI) as possible solution to the challenge of the healthcare sector decision makers that are facing a growing demand for both clinical and administrative information in order to comply with legal and customer-specific requirements. The aim was to contribute to the translating and amending the current findings that Business Intelligence (BI) is primarily focused on the industrial sector, to bringing the findings to be for the health care context. To achieve this, different definitions of Business Intelligence (BI) were examined and condensed in a framework. From the research a pragmatic conclusion therefore is for effective support for evidence-based practice, data management and to understand the correlations among them. This would lead to integration of information, organizations and measurement of outputs in real-time. Hence in the health sector, managers and users need real-time information to better manage data as well as to generate information and knowledge needed to improve health services quality and diminish risks. Health specific analytical capabilities however, have been built until recently into other core operational applications as well as embedded in medical equipment and devices. But seldom have they been successfully put forth as stand-alone intelligence applications. Such as with significant intelligence built into CPOE (computerized provider order entry) systems, CDS (clinical decision support) applications, telemedicine devices (example, remote vitals sensing appliances) and handheld computing tablets seen everywhere in hospitals, clinics and health care centres. These technologies central function is not analysis; they only employ analysis to make them more valuable.

Guangzhi, et al., (2014) developed a general curriculum framework and exemplar implementation strategies to demonstrate how Business Intelligence can be incorporated into a healthcare information technology (HIT) or health informatics (HI) program. The challenge that led to the framework development was the fact that Business Intelligence (BI) and healthcare analytics are emerging technologies that provide analytical capability to help healthcare industry improve service quality, reduce cost and manage risks, but these component on analytical healthcare data processing is largely missed from current healthcare information technology (HIT) or health informatics (HI) curricula. In conclusion, an educational framework for delivering business intelligence (BI) content in HIT curriculum and programs was developed, which can be used as a model for general HIT curriculum development and improvement.

Ishola and Azizah (2012), focused on the fact that medical screening being underwent by new students, staffs and returning students, that the result of the medical screening in terms of medical test from laboratory technologists and doctors such as patient diagnosis, treatment and medical prescription are currently kept in the health centre data repository (registry) for record purposes, but it is not explored further for managerial activities. The paper proposed and developed a Business Intelligence (BI) method for the exploration of the university health centre database repository to be applied. The method was a data warehouse which was built for the activities in the university health centre and a prototype was developed at the end of the research, while the system was evaluated by prospective users of the system. The developed Business Intelligence (BI) tagged PKUBI helped the university health centre management by simplifying the technique needed for managerial decision making and forecasting of future activities that would help the centre as well as it is useful to know the medical statistics of the patients in the university community and the drugs that need to be frequently ordered for.

Loewen (2017), the author's research study proposed a "Business Intelligence Benefits Model for Health" derived from frameworks used in other sectors and establishes health sector measures for two foundational constructs; Business Intelligence (BI) Assimilation and Health system organizational performance. This was achieved through an online Delphi consensus process involving 25 Canadian health leadership panellists from four provinces; the study establishes a total of 30 concept measures for the constructs. The model validated the need for sector specific measures. Its contribution to knowledge has to do with establishing that these Business Intelligence (BI) constructs for healthcare is a precursor to measuring Business Intelligence (BI) success and informs priorities and approaches for Business Intelligence (BI) implementation as well as further instrument development.

Wilfred (2013); this paper explored the importance of integrating the Business Intelligence (BI) technology with electronic health record (EHR) and electronic medical record (EMR). The benefit of the research is that it has the potential to benefit healthcare providers and stakeholders in determining the applicability of Business Intelligence (BI) technology in integrated healthcare information systems. So it is very important that healthcare providers and information technology (IT) vendors become aware of the wealth of information contained in the electronic health record (EHR) and take full advantage of the BI technology to assist in the knowledge discovery process and as an investment strategy to focus on maximizing evidence-based practice. Furthermore, the paper proposed a Business Intelligence (BI) solution to the corresponding need to apply data mining technologies which is a tool of Business Intelligence

(BI), to extract quality data and inference rules from the information stored in the electronic records so as to provide real-time decision supports and evidence-based practice to clinicians and healthcare providers. In exploring the key benefits, challenges and obstacles of incorporating the Business Intelligence (BI) technology into electronic health record (EHR), a literature review was used. With this review it is seen that Business Intelligence (BI) technology in electronic health record (EHR) would help in improving the quality and safety of healthcare delivery.

Thodoros and Daniele (2015), the paper focused on using Business Intelligence (BI) to deliver relevant and actionable information to the front-line staff of hospitals in order to assist them in their work. It was achieved via two story lines of the value of information and evidence in solving business problems and about the information systems methods toolbox utilized in establishing an effective BI program in an operating organization. It was found that through business modeling the information technology team converted from implementers to business problem solvers. A big enabler of delivering useful information was to fit data into a concept model that matches that of the information consumer using methods from business modeling, data semantics, data integration and data quality. In concluding the work, it was opinioned that the frameworks are broadly applicable to organizations that rely on evidence-based decision making in resource constrained environments.

Hence, the fact that Business Intelligence is aimed at turning information into action and action into improved performance, the research was geared towards ensuring that complex business process environment which is a driving force to improving Business Intelligence (BI) process of disease control procedure in the health sector which is an example of such complex process environment was achieved in real-time. Despite the existence of various health information systems, there is still a huge number of health care data to be accessed for intelligent and real-time decision making purpose, but accessibility is still a challenge to doctors and healthcare managers or administrators who need seamless access to the huge disease control registry data. Also, the health sector has a wealth of information that is contained in its electronic health records (EHR) therefore, they should take full advantage of the research enhanced data integration process of Business Intelligence (BI) to assist them in knowledge discovery process, and so be able to use the Business Intelligence (BI) technology as an investment strategy to focus on maximizing evidence-based practice. This is where the CBR becomes handy in performing effective, predictive and prescriptive analysis in the research developed hybrid model for the enhanced Business Intelligence (BI) process.

In conclusion, it is a fact that Business Intelligence (BI) is fast becoming inevitable in most field of endeavor especially the health sector, thereby leading to the demand for real-time, flexible, adaptable, and intelligent Business Intelligence (BI) solutions. As already enumerated by various authors' it is pertinent that data integration is of great importance in any Business Intelligence solution, so the application and implementation of ontology-based and virtual data integration techniques, as well as the use of case-based reasoning (CBR) as agent technology in a Business Intelligence solution as the research adopted in developing an expert hybrid model for enhancing Business Intelligence process using the health sector domain to demonstrate its applicability; the model would be beneficial to the users of Business Intelligence (BI) in the health sector for an integrated disease control procedure. The reason goes way back to the already discussed benefits of ontology-based data integration technique and that of virtual data integration technique as well as agent (case-based reasoning - CBR) technology.

2.7. Summary of Related Literature and Knowledge Gap

Business Intelligence (BI) technology usage in the health sector domain is still evolving and the process of data integration in the Business Intelligence environment is a key aspect in ensuring a unified view of the huge heterogeneous sources of data that would be analyzed on querying the database of the Business Intelligence model and the intelligence of the model gives the system process the ability to assist users of the technology intelligently.

From previous contribution towards improving Business Intelligence, it is clear that Business Intelligence (BI) is one of the most current reliable means of making intelligent, agile, accurate and real-time decisions among management in various levels of an organization. Existing enhanced Business Intelligence (BI) data analyzes as it pertains to data integration typically involves the use of either ontology-based, traditional data warehousing or virtual data only, in resolving data integration challenges exclusively. As highlighted in the review of related literature, it was seen that most of the authors used either of techniques to resolve data integration challenge in their proposed system architecture with Business Intelligence (BI) generally. But to the best of the research knowledge, none of them have hybrid both approach for data integration purpose in a Business Intelligence process (that is adopting both ontology-based and virtual-based data integration techniques).

The research combined both techniques of data integration to complement each other so that while the ontology phase provided a common language to express the shared semantics and consensus knowledge developed in the enhanced hybrid Business Intelligence process

explicitly and seamlessly, the data virtualization aspect (virtual data integration) technique allowed the enhanced Business Intelligence process of the health sector to retrieve and manipulate data in the system without requiring technical details about the data such as how it is formatted or where it is physically located.

These gaps as well as that suggested from the framework for the use of Business Intelligence in the health industry by Tobias and Vivian (2008) are what the research on the hybrid model closed and using case-based reasoning (CBR) in boosting the intelligence of the developed new system tagged "Development of a Hybrid Model for Enhanced Business Intelligence Process (HMEBIP). There was performance improvement as the two data integration techniques' merits was harnessed as well as that of case-based reasoning (CBR) in enhancing the Business Intelligence (BI) process, while the effects of their shortcomings was drastically minimized. And it was applied in the disease control procedure session of the health sector domain, which leads to having a positive impact in ensuring accurate, intelligent, fact and evidence-based knowledge insight in decision making and profitable action in the sector by its medical practitioners' experts (doctors, nurses, etc) in establishments such as the Nigeria Centre for Disease Control (NCDC) and other health care centres.

Hence, the research developed system model in effect, improved on seamless transition, agility, user-friendliness, intelligence and accuracy level in the data integration process of Business Intelligence technology. And as well addressed the motivated question coined from Ana-Ramona and Razvan (2011) "if the hybridization of the two data integration techniques is obtainable and if it is beneficial?" was addressed in affirmative by the research study.

CHAPTER THREE

SYSTEM ANALYSIS AND METHODOLOGY

3.1. Analysis of the Existing System

Research has it that close to 80% of Business Intelligence (BI) efforts lies in data integration. The existing solutions to the data integration problem in business intelligence consists of developing an enterprise data warehouse which should store details of data coming from relevant data sources in the enterprise or industry domain it is being applied.

Again this issue of integration in business intelligence environment has being seen as an effective means to enhance enterprise "soft power" and to add value in the re-construction and revolution of the traditional methods of business intelligence as acknowledged by business decision makers. Solutions that exist for business intelligence integration are structural integration that has to do with packing together data warehouse (DW), online analytical process (OLAP), data mining (DM) and reporting system from different vendors. This method delivers to business intelligence system users a reporting system in which reports, data models, dimensions and measures are pre-defined already by designers of the system, so the user-friendly, flexibility and adaptive business intelligence system expected by users are not met (Longbing, et al., 2005). Data integration is used to achieve a unified homogeneous view of the huge heterogeneous data at various locations and in different format. But the traditional structural integration (data warehouse/ETL)) is quite ineffective in handling ubiquitous complexities in the real world, especially as it relates to semantic heterogeneity, naming conflicts and other interoperability issues.

Furthermore, traditional Business Intelligence (BI) models are static, historic in nature, non-process-oriented and highly data-driven. So they have less user access and limited view of decision making information, therefore happenings in the current state of the business enterprise using such business intelligence model is not known. Also traditional business intelligence (BI) environment are monolithic, client-server and non-web-based architectures particular in the health sector which is yet to fully harness business intelligence (BI) for its decision making process. More so, as a data-driven based system there is high level of data latency.

In order to enhance the traditional Business Intelligence process that used data warehouse and extract, transform, load (ETL) approach for data integration, existing models proposed,

designed and implemented the use of ontology-based data integration technique as well as virtual data integration (data virtualization) techniques. This improved on the semantic, syntactic and structural resolution that leads to interoperability solution as well as resolving the issue of naming conflicts. While the data virtualization (VDI) technique, was used to resolve the issue of freshness, agility, accessibility, simplification and hiding of technical jargons. But it was used exclusively, not hybridized as this research developed.

In the health sector existing business intelligence solution still, employed data warehouse (DW) for its data integration process and it is not integrated intra-hospital-wise. Also, the health sector organizations have been lagging in the adoption of information technology (IT) compared to other industries. With the increase pressure from consumers, legal and regulatory requirements for healthcare information technology (HIT), there is the need for electronic records of healthcare to stay compliant and be able to prevent costly medical errors and as well lower the cost in healthcare for consumers. Figure 3.1 depict an existing health sector Business Intelligence environment.

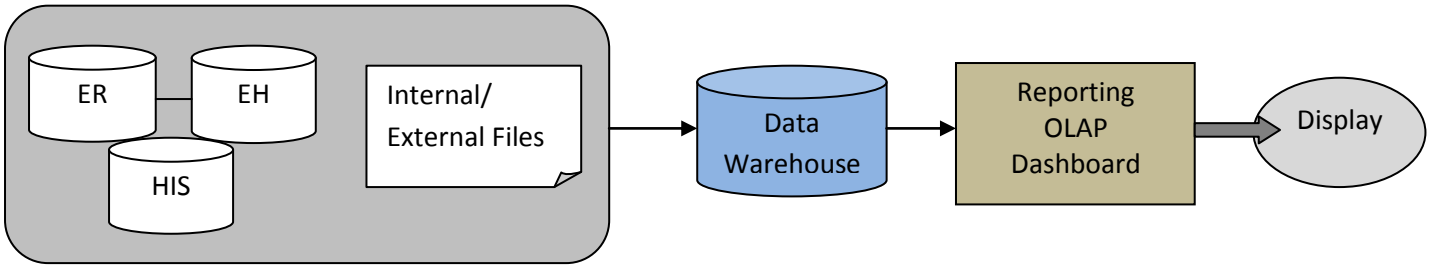


Figure 3.1 Existing Business Intelligence (BI) for Health Sector (Source: Kulkarni, et al., 2017)

To be effective, the disease registry must be an active tool used routinely by those within the practice who care for patients with chronic disease. When a patient is meeting with the physician, disease registries provide easy access to complete relevant patient information through printed patient report. The report presents a snapshot of the patient's condition, both reminding the physician that the patient has one or more chronic condition and saving them the time of searching for condition-specific information in the patient's medical record. The patient report also records updates to patient information tracked in the registry for subsequent data entry. Most existing registry applications rely almost exclusively on information available from other electronic systems to minimize the time devoted to these tasks.

From a number on the patient's card, the receptionist notes that the patient is on a registry, request for a printout of the patient report, and attaches it to the patient's folder. Patient might

also be identified in the scheduling application used at the front desk, and in some practices, the patient record is printed and filed in the medical record at the conclusion of each visit (to be referenced the next time) rather than printing a new one when the patient checks in.

The physician coordinates tasks to deliver service and update the patient report as required. Medical assistants and nurses use the registry report as they interview the patient take and record vital signs, and other necessary services according to protocols for standing order. Physicians can use the report for several purposes including to:

1. Communicate with care team members about new services to be arranged before the patient leaves.
2. Indicate to the receptionist when the next follow-up visit should be scheduled.
3. Serve as the encounter note to be filed in the patient's medical record.
4. Record updates to patient information for entry into the registry.

Usually patient reports are collected for batch entry by a central location, although sometimes a member of the care team performs this task.

Hence, data exchange that needs to be streamlined so as to cut through the bureaucracy of paper forms that still exists today needs to be reduce to the bearest minimum and patient data privacy challenges and information security needs to be addressed. So the need for interoperability in the automation of the data flow processes in business intelligence generally and specifically in the health sector, which is the test domain of the research. Also, the existing system lacks the ability to accurately ensure quick accessible electronic records to medical practitioners' experts, especially when time is of essence, so the need for paperless care facility.

In conclusion, Business Intelligence (BI) and health sector analytics are emerging technologies that provide analytical capabilities to help health sector improve service qualities, reduce costs and manage risks effectively. But these components on analytical health sector data processing are largely missed from current health sector information technology. The main disadvantage of not using this analytic feature is the inability of not making use of all available data, since the ability to manage such vast amount of data is getting difficult and stressful. Also, even when used (that is the analytics feature of Business Intelligence (BI) and Big Data); some still miss new insights, thereby not being able to imagine the potential of the vast amount of data. So, the health sector needs to use technology to explore its huge data.

3.1.1. Data Flow of the Existing System

The use of a registry in the existing health sector setting as described in figure 3.2 is not fully automated. It shows the flow of information from the point of patient's visit till the physician has attended to such patient. The processes are partially automated as some of the computerization makes use of a Stand-alone Disease Registry at the Point- of- care.

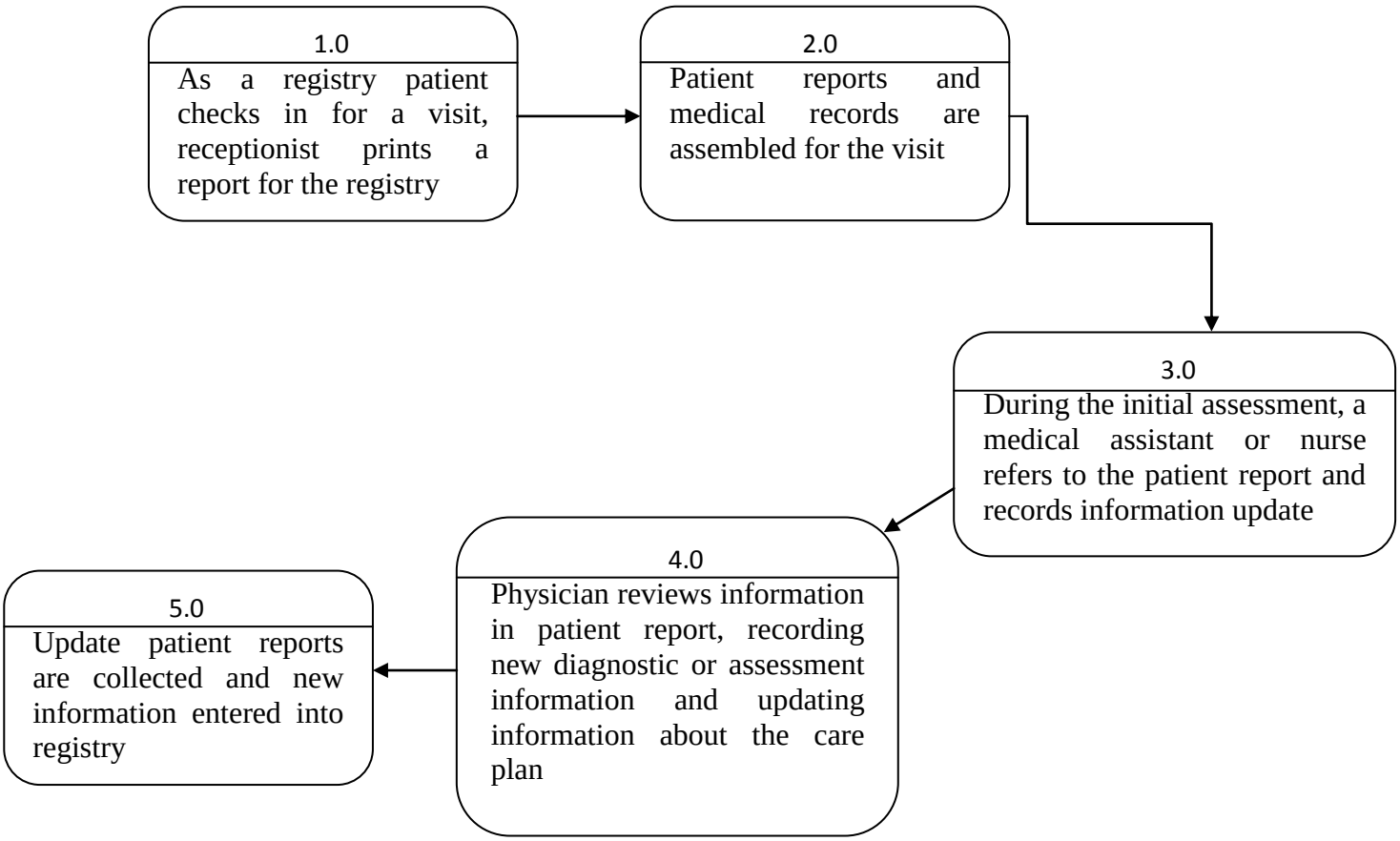


Figure 3.2 Data Flow Diagram for the Existing System

3.1.2. Advantages of the Existing System

The existing system has the following advantages:

1. It provides an electronic record of patients which assist physicians to easily retrieve previous medical records of patients.
2. Physicians can use the report to communicate with care team members about new services to arrange before the patient leaves.
3. It does not involve much intelligence for it to be developed when compared to the new model.

4. The existing system enables the receptionist to electronically schedule when the next follow-up visit should be.
5. It enables data sharing to some extent among health care team within a given hospital.

3.1.3. Disadvantages of the Existing System

The existing method has the following challenges.

1. Business intelligence process is impaired as the existing system does not have provision for data sharing globally or intra-hospitals. That is lack of cooperation of information systems as the existing model does not ensure interoperability, which adversely affects the accuracy, integrity, intelligence and completeness of data.
2. With increasing number of system interfaces, data formats to homogenize and integrating growth, applications becomes fat and then slows down the integrating process.
3. It lacks agility and timely access to its heterogeneous data, as well as extraction and retrieval of the documents. This leads to analysis and action latency.
4. There is the absence of dynamic real-time up-to-date data integration in the existing system. This leads to redundancy, inconsistency and inability to share information.
5. Also, building of data warehouse for integration purpose is very expensive in a Business Intelligence (BI) environment and it is time consuming to implement.
6. Most system deployed are developed primarily to support the work of administrative units, while only to a small extent is adjusted to the needs of patients, medical practitioners' experts and other health users.

3.2. Analysis of the New System

The new system is designed to bring together the benefits of ontology-based data integration technique as it relates to seamless transition, solving inconsistencies in semantics and accuracy issues in syntax; and that of virtual data integration technique as it relates to hiding of technical jargons from users and unifying integrated and reconciling views of data residing at different sources as well as at different location for users. These were implemented in a Business Intelligence (BI) process environment using health sector as test platform, thereby enhancing the existing models that adopted exclusively either of the two techniques.

Data integration is an important aspect of business intelligence, ensuring it, is quite challenging to researchers, designers and business users. Business intelligence systems need to be able to

help decision makers achieve real-time, intelligent, fact-evidence based knowledge insight and accurate decision which will promote their organizations goals and achievements. Data integration is the technique needed to help achieve the above. There are various data integration techniques, with ontology-based and virtual data integration among them; which was applied in the new hybrid enhanced business intelligence (BI) model in order to achieve seamless transition of data and the hiding of technical jargons from users of the model. With the combination of both types of data integration approach in the developed model, the data integration process of the business intelligence (BI) model was highly enhanced and agile.

The interoperable regional healthcare system lies in the maximum usage of medical and health resources by integrating important medical technologies and sharing the medical resource and information. This includes three specific objectives as follows:

- A new digital medical service pattern and service process standard with a complete modern medical information system.
- The integration of national healthcare sharing platform to achieve the unified procedure, and service sharing among medical institutes in certain area combined with the monitoring and evaluating of the system for the sharing services.
- Provision of services, such as two-way referral, telemedicine imaging consultation, online medical consultation, remote medical record and test result query, online medication consultation and patient‘s following-visit, in the community and hospitals of intermediate and advanced level.

The mentioned objectives demand a sophisticated information structure that features the following four core requirements:

1. The integration of existing information systems of the medical institutions in the country for the capability of medical resource sharing.
2. The integration platform of medical institutions for public information service to government, medical organization, community and citizen on disease control.
3. The data center of medical information in the hospitals as the main data source for the integration platform realizing the medical information sharing.
4. The process and rules for the operation of hospitals and interoperable healthcare service platform to keep the system efficient and stable.

Since the information of healthcare domain is diversified and dynamic because of the heterogeneous and distributed information resources and the large amount of daily updated data produced by many information systems from medical institution, the key problem for constructing integrated healthcare system is the efficient management of medical workflow and the effective integration of mass data resources. Therefore the modularization design and expansibility with the hierarchy structure are essential to this system.

In the new system, the healthcare centers are responsible for the medical data from each regional data center to monitor disease. Each regional information integration platform is composed of hospital, clinics and community healthcare center by which different levels of medical institutions are able to share the data from data centers and realize two-way referral and medical record lending.

The information sharing among different medical systems not only needs to provide full accessibility to the data but also requires the interoperability among these systems. The main problems caused by bringing together heterogeneous and distributed computer systems are summarized as semantic heterogeneity and structural heterogeneity.

Semantic heterogeneity refers to the variation of semantic meaning in medical information resources which will lead to the semantic conflicts and complication for data integration. Structural heterogeneity means that the same data will be described in different structures by different systems because of various application systems, database management system (DBMS) and operating systems.

In the new enhanced business intelligence (BI) process system, the research took advantage of ontology(s) for the explication of medical knowledge as a possible approach to overcome the problem of semantic heterogeneity and the problem of structural heterogeneity; this was solved with the use of extensible mark-up language (XML) based data integration together with data warehouse.

In the realm of knowledge management, ontology provides both the theoretical basis and the applied methods to morph the different knowledge modalities to form a unified knowledge object since they can be used for the identification and association of semantically corresponding information concepts.

In the healthcare sharing platform, ontology(s) was used for describing semantic meaning of information source explicitly in order to solve semantic heterogeneity. Hybrid ontology was

adopted in the research. In effect, the new system ontology-based and virtual data integration architectural process was based on the use of ontology which explicitly captures knowledge about different types of data sources and the virtual aspect which uses mediators to bring about the real-time and agility aspect of the new system. Generally, database schemas are regarded as static, but ontology schemas are typically assumed to be highly dynamic and are an evolving object(s). Figure 3.3 show the complete model of the new system ontology and their relationships between the sub-ontology(s).

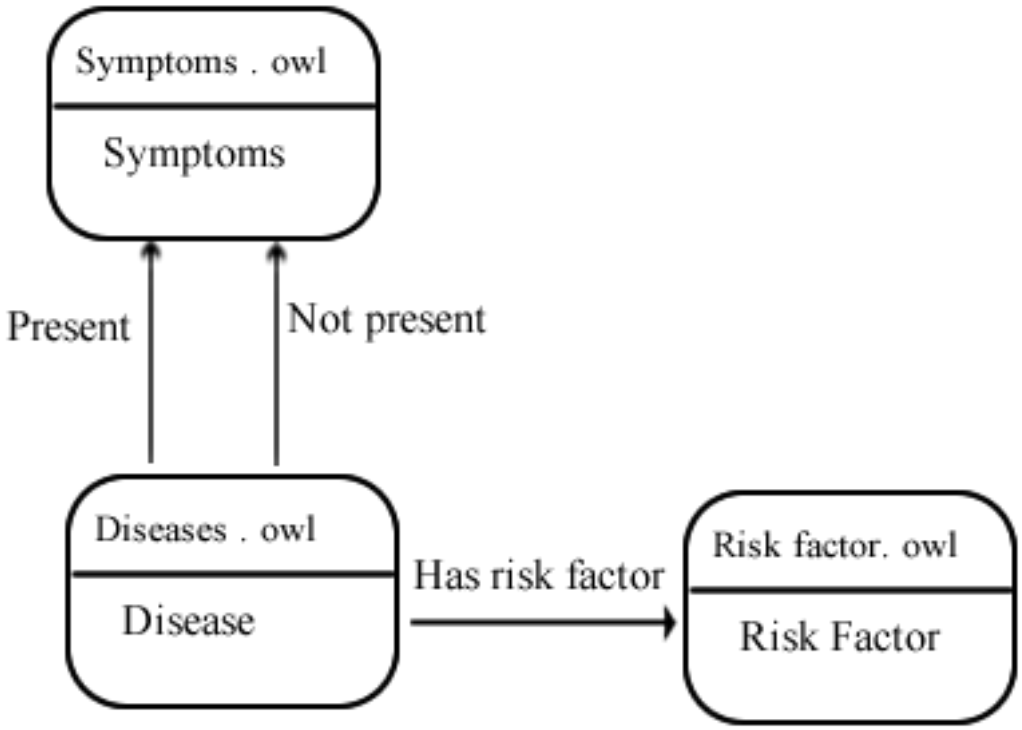


Figure 3.3 Ontology Model of the New System

The new system ontological model is presented in a modular fashion, which has been divided into the following sections: diseases (age group and gender); symptoms with anatomy, intensity and evolution, and risk factors. A control procedure must be an instance of the disease concept and it is governed by the Catalogue of Disease. Therefore, three sub-ontology(s) are created that shape the complete model: *Diseases, Symptoms and* Risk Factors.
The main features of the hybrid enhanced Business Intelligence (BI) integration process model is that it evaluates business rules, constraints and transformations for identification of semantic conflict and solving processes at data and schema levels respectively as well as virtually integrating its data sources thereby hiding the technical jargons from the business user (health care personnel and the physician) whose focus is mainly profit (intelligent decision making that

leads to profitable actions to solving patients healthcare challenges on time), speed as per real-time, agility and accuracy, and other related benefits of decision made via analysis of the trend in the business environment that the organization (healthcare) is located.

The new system will add the following features to the existing system:

1. Integration of data across various hospitals to aid in data sharing and decision making
2. To provide support by integrating clinical guideline-based prompts into the patient report such as guideline based interval for assessment of test for diseases, interventions that are overdue for disease control and guidelines for medical care.
3. More advanced rule-based prompting that incorporates patient-specific information and is able to generate customized care recommendations such as treatment prescriptions, recommendation of next test if patients' health is falling short of the desired outcome.

To design the healthcare sharing platform, the research identifies three levels of knowledge in ontology as follows according to the types of healthcare knowledge that directly contribute to the medical services:

1. Operational knowledge: represents the operational regulation and patterns of business process of each healthcare institution.
2. Organizational knowledge: concerns the organizational structure and policies exercised by a healthcare institution, patterns of organization's services and regulation.
3. Social knowledge: reflects the social and cultural norms of the overall medical service environment that influence the behavioral models of all involved humans.

The research choose to use web ontology language (OWL) to describe its ontology aspect because of its' particular role in information and data integration and because it relies on extensible markup language (XML) schema data types. Furthermore, based on the hybrid ontology approach, the semantic heterogeneity was solved for information and data integration. The basic structure of medical information provided the interface and logic to manipulate the data in a unified way based on the results of the data integration.

Apart from the ontology method for heterogeneous information integration on semantic level, the research also, presented a virtual database to realize the virtual data integration aspect using extensible markup language (XML). The main source of data in actual hospital institutions for integration is the different source database, as shown in figure 3.4.

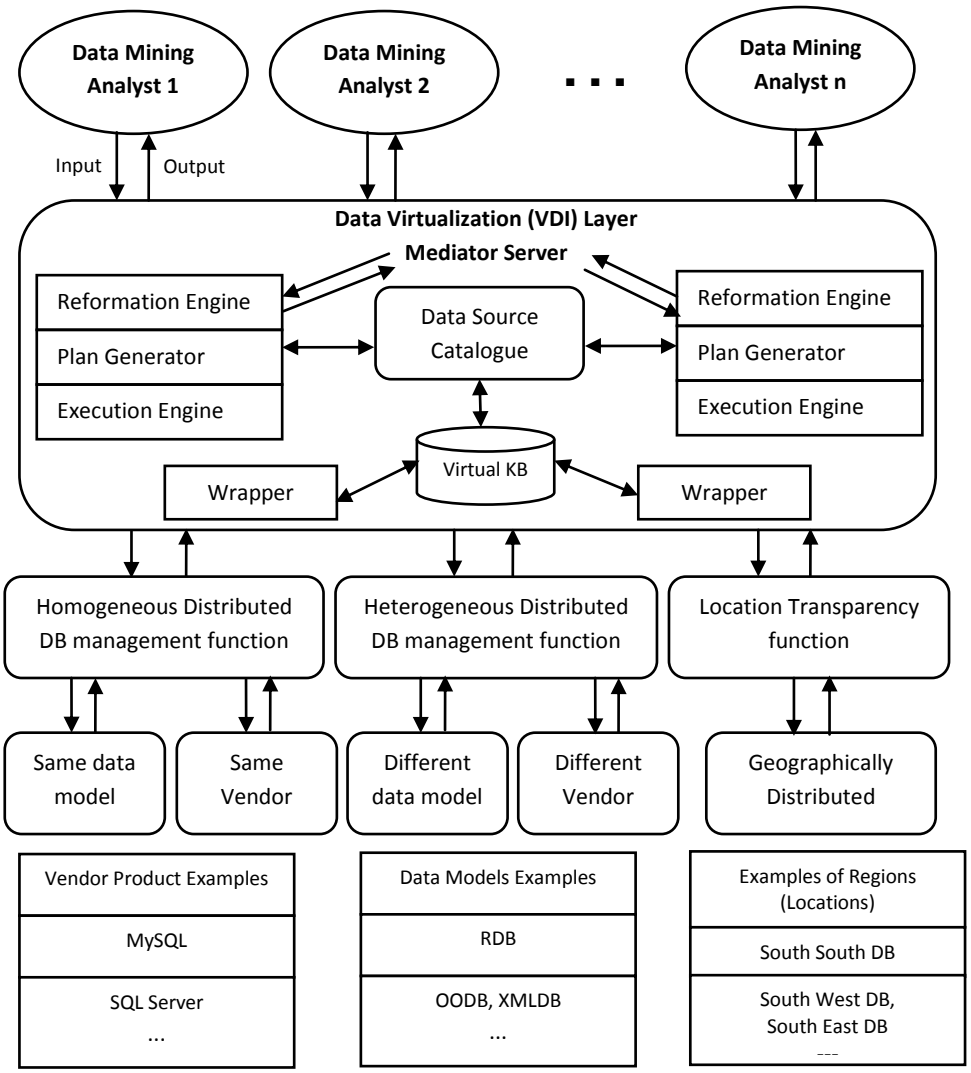


Figure 3.4 Data Virtualization (VDI) Technique of the New System

Utilizing the ontology approach to solve the semantic heterogeneity, the extensible markup language (XML) based data integration of hospital information systems provides a unified interface of data manipulation for practical application to deal with structural heterogeneity. Extensible Markup Language (XML) schema serves as the global data model and extensible query (X-Query) is the unified transformation language for operation of the data source. The integration result is in the unified form of extensible markup language (XML) which can be shared by application programs and systems. Together with ontology for semantic integration, the extensible markup language (XML) based virtual database of hospital information system is composed of four parts: query processor, integration service manager, semantic part and structural part.

1. The query processor manages the query request and control request respectively according to user's data request and return the results in the form of extensible markup language (XML).

2. The integration service manager manages the metadata, local view and global view of the data source for integration by the definition of integration task and cooperates with global ontology and query processor.
3. The semantic part deal with the semantic heterogeneity by ontologies. This part gets the extensible markup language (XML) based source information from structural part and provides knowledge to integration service manager.
4. The structural part concerns the structural heterogeneity. The Wrapper is responsible for interacting with low-level data source, packaging heterogeneous data source and operating the database using standard structured query language (SQL) with the aim of realizing the transparency of data location and visiting.

The data integration provides the basis for middle service layer by sharing the information; however the shared data must be transported to medical information systems in a proper way. The new system is suitable for the mass information exchange among hospitals, insurance company and super administrative departments. It will also, track patient's visits and will generate a reminder for patient or physician of the needed follow-up or preventive care against a discovered disease. The typical work flow begins with the physician reviewing a patient's information from a computer terminal to view the information online. The physician can also retrieve patients list with similar disease. The richer the medical registry's data set, the greater the possibilities for examining subgroups of patients with related cases and how it was treated. The registries include standard reports and permit user to query the system for specific data ranges and interventions or patient status indicator.

In the new system, medical practitioners'experts can use the patient's information to take decision and to develop a strategy for treatment of each patient. It can allow the physician to contact the patient via short message system (SMS) to advice the patient on the need to come for follow up or take certain medication. During this process, physician become aware of problems with registry information if any such as finding that the patient is no longer coming for treatment or has changed health service provider.

The disease registry can generate report with different views of aggregating information about the process or outcome of health care management. It can show the population of patients suffering from a particular disease, the number treated successfully, and a feedback to physicians about the status of their patients, and the possible treatment to apply or take accurate, intelligent, and real-time decision about patients.

3.2.1. Components of Ontology-based and Virtual Data Integration of the New System

The components of the new system ontology-based and virtual data integration are as shown in figure 3.5a and 3.5b.

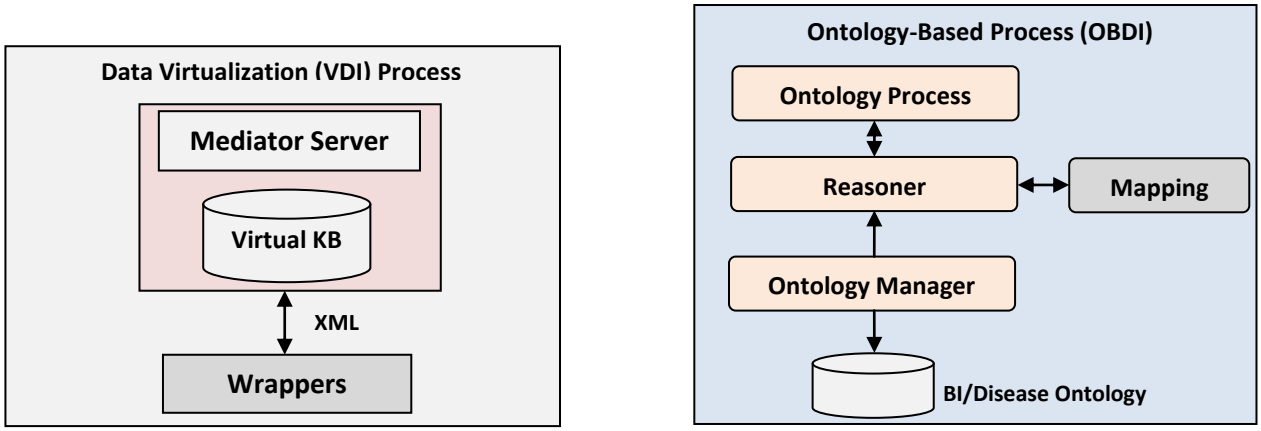


Figure 3.5 Data Virtualization (VDI) & OBDI Components of the New System

Wrappers – Aim is to access a source, extract the relevant data, and present such data in a specified format. This is the program whose role is to send queries to the data source receive answers and possibly apply some basic transformation to the answer.

Mediators – Aim is to collect wrappers or mediators so as to meet specific information (data) need of the integration system. The user interacts with the data integration system through a single schema, called the mediated schema. It is built for the data integration application and contains only the aspects of the domain relevant to the application. It most probably will contain a subset of the attributes seen in sources. In the virtual approach, the mediated schema is not meant to store any data at all. It is purely a logical schema that is used for posing queries by the users employing the data integration system.

Mediator Server- With this users have an illusion of the real database created by the mediator. On querying data in the form of global scheme through the use interface, the mediator server receives the request and broadcast it to all mediators (including the agent mediator). This component is responsible for registering name of the sub-mediator when new mediator is added and it also contains the information about the location of the mediator and other relevant data of sub-mediator. It also, provides the inter-communication between peer mediators for achieving consistency and hearing or exchanging of data.

Mapping- At this stage we define the mappings (and relations) between the concepts defined in the global ontology and the local ontologies. It is the layer that houses the ontology-based aspect of the data integration process of the system.

Reasoner- This supports on-the-fly and batch based inferences over business semantics. The inferences make semantic driven slice and drill to be based on business rules to be possible.

Ontology Manager- This is the module that provides access for business semantics to be captured and to enable the definition of necessary knowledge models for generating flexible and exploratory functionalities in analytical tools. Manipulates the BI ontology and retrieves the necessary information to support the information of data requests.

Ontology Process/Query Manager- The ontology uses this to parse analytical tools and data requests, and to execute such requests on heterogeneous data sources, thereby enabling the combination of unstructured and structured data on the very same analysis. It hides data sources complexities from analytical tools.

Domain (Disease) Ontology- This ontology provides a formally specified terminology of the business domain that is being supported by the framework. This enables data sources annotation, which enables users to be able to explore information repositories by using business concepts instead of technical descriptions.

BI Ontology- This models the concepts used to describe how the data is organized in data sources and to map such data to the concepts described in the domain ontology. The main concept related to BI is modeled in the BI ontology.

3.2.2. Components of Case-Based Reasoning and the Knowledge Base of the New System

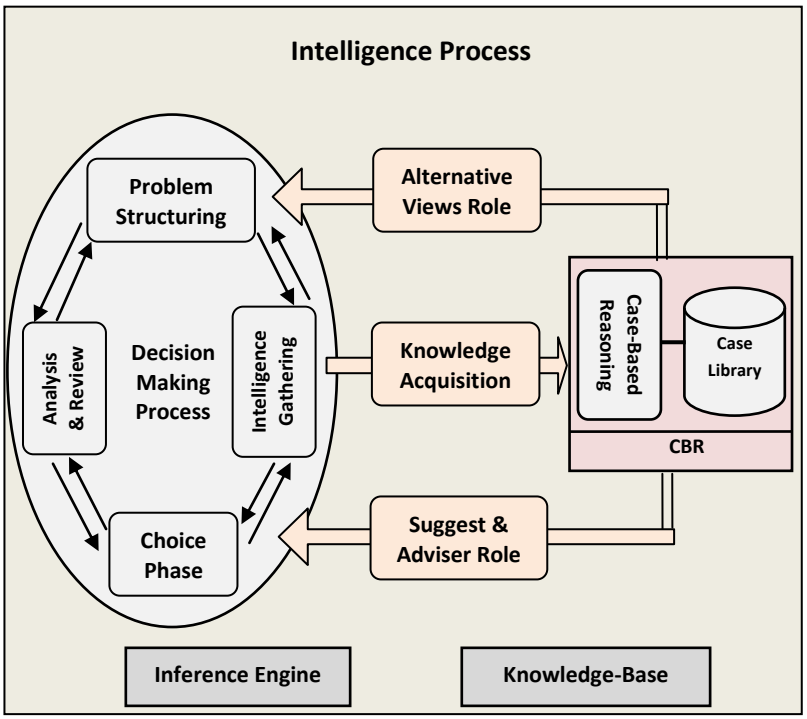
The components of case-based reasoning (CBR) and the knowledge base of the new system are as shown in figure 3.6a and 3.6b.

Knowledge Base: The knowledge base is a collection of rules (cases) or other information structures derived from the human expert. Rules are typically structured as If/Then statements of the form:

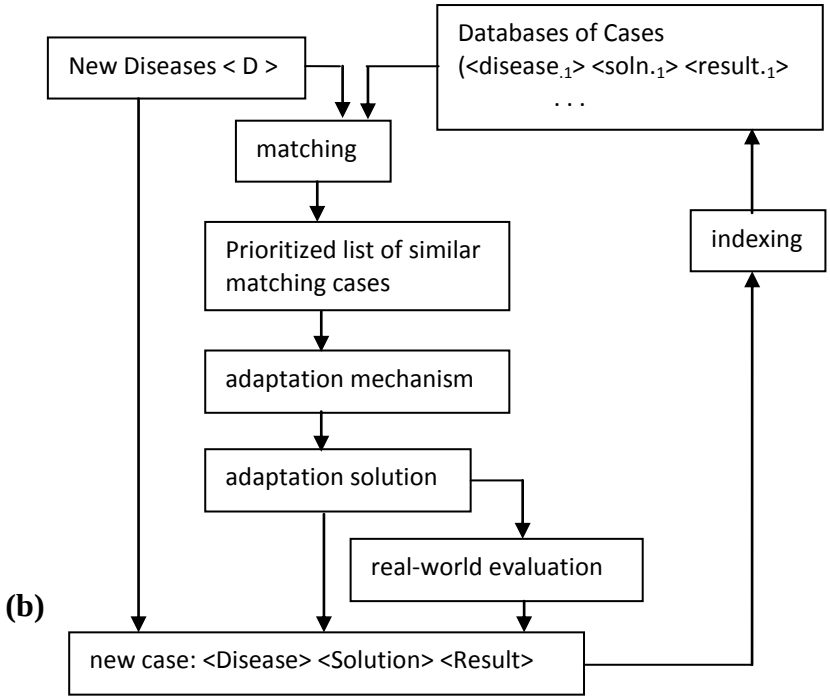
IF <antecedent> THEN <consequent>

The **antecedent** is the condition that must be satisfied. When the antecedent is satisfied, the rule is triggered and is said to "fire". The **consequent** is the action that is performed when the

rule fires (Danny, 2019). That is it contains essential information about the problem domain and is often represented as facts and rules (Samson and Lotfi, 2013).



(a)



(b)

Figure 3.6 CBR and Knowledge Base Components of the New System

Inference Engine: The inference engine is the main processing element of the new system expert Business Intelligence process. It chooses rules (similar cases) from the agenda (the case

library of knowledge base) to fire. If there are no marching rules (similar cases) on the agenda, the inference engine would obtain information from the user (medical expert such as the doctor) in order to add more rules to the agenda. It makes use of knowledge base (the case library database), in order to draw conclusions for situations (present cases). It is responsible for gathering the information from the user, by suggesting various similar treatment procedures for the present case and applying it wherever necessary. It seeks information and relationships from the knowledge base and to provide answers, predictions and suggestions the way a human expert would. It is the mechanism to derive and add new knowledge to and from the knowledge base.

Case Library: is where cases (rules) are stored and updated for future use. As well it is searched for suggestion purpose to solve new cases or situations.

The User Interface: This the method by which the expert system interacts with the user. It is also the development and maintenance avenue for the knowledge base. It carries out these functions through dialog boxes, command prompts, forms or other input methods. In the research, forms and dialog boxes was used. Figure 3.7 depicts the user interface.

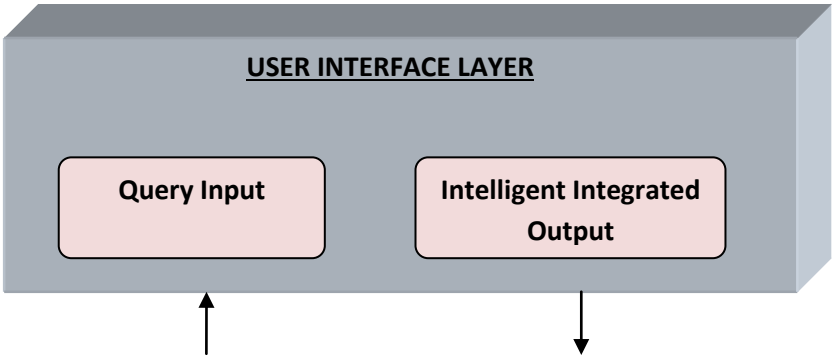


Figure 3.7 User Interface of the New System

Data Source Layer: This is the data warehouse, which is defined as a subject-oriented, integrated, time-variant, non-volatile collection of data in support of management's decision making process. It is where the different and various heterogeneous sources of data either structured, unstructured or semi-structured, are stored and accessed either internally or externally such as via the web. Figure 3.8 shows the architectural model of the layer.

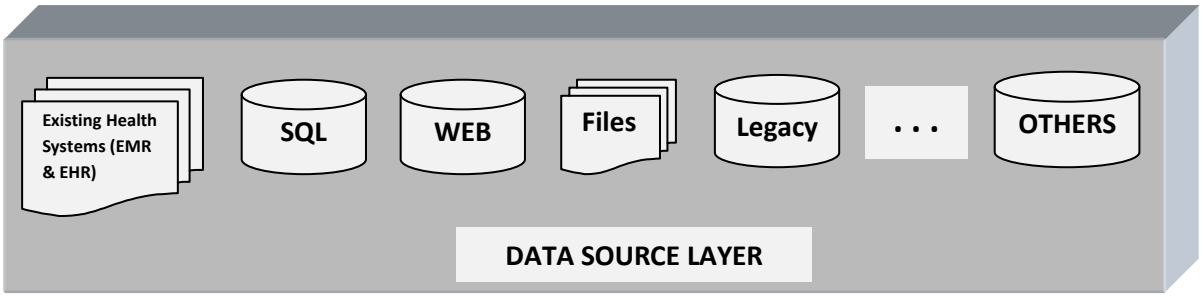


Figure 3.8 Data Source Layer of the New System

3.2.3. Advantages of the New System

In support of the new system justification, the following are the advantages;

1. The system ensures seamless transition from a practical workspace into a virtual business-oriented analysis world, expected by business users.
2. The system is based on hybrid architecture and also relies on elements such as system vocabulary and local ontology per each heterogeneous data source.
3. The system reduces syntax errors, structural and semantic heterogeneity and redundancy which leads to increased availability and degree of completeness.
4. With the layers of ontology-based and virtual data integration both implemented in the system, seamless transition and hiding of technical jargons from users was feasible.
5. With both approach to data integration in the system, reduced cost of processing, maintenance and risk in the system as well as increased availability will be feasible.
6. The system would assist medical researcher and practitioners' experts to comprise up-to-date clinical and medical information into research process. This ensures real-time processing, analyzing and accessing of data across organizational boundaries.
7. The system would be intelligent, reliable, adaptive, flexible and agile. This would improve patients' satisfaction with the use of business intelligence technology in addressing decision making in their treatment and care.
8. The system would be robust as it ensures data security as well as ensures managers at all levels in an organization (operational, tactical or strategic) make intelligent, correct and timely management decisions.
9. The ontology aspect sees to the reduction in latencies (data, analysis, and action latencies) in the decision process which allow users to take and make faster or fastest business decisions accessing current business data in its proper level of abstraction, thereby enhancing the ability of organization to adapt it as new necessities or in business changes.
10. The system delivers real-time performance analysis directly on the desktops of all levels of business managers which enable them become more knowledgeable and proactive.

11. The system would bring about reduction in medical errors; improved patients' safety, improved efficiency as well as it would consolidate data quality, integration and protect data which would help the health sector organizations stay proactive and be able to make decision with confidence.
12. It would enable analyzes of clinical data based on structured, semi-structured and unstructured information.

These justify the implementation of the new system to help health sector manage and control diseases and patients record.

3.3 Justification of the New System

Business intelligence and analytics are about integrating all the information streams produced by a firm into a single coherent enterprise-wide set of data and then using modeling, statistical analysis tools (such as normal distribution, correlation, cluster analysis, etc) and data mining tools (pattern discovering and machine learning), to make sense out of all the data so managers can make better intelligent decisions, plans or at least know quickly when their firms are failing to meet planned targets. So the research's enhanced Business Intelligence technology would assist to a great extend the health sector decision makers who are facing a growing demand for both clinical and administrative information in order to comply with customer-specific requirements. With information and communication technology (ICT), the sector have the opportunity to improve not only its effectiveness, efficiency and quality of health services, but also its transparency of its economic activities and the availability of fact-based evidence information in real-time; And Business Intelligence (BI) technology is seen as the possible solution to meet this demand. So the research goal of enhancing the Business Intelligence (BI) process would assist experienced providers' of health services in the treatment of various diseases, sickness as well as in-beds availability and pricing of health services efficiently and in real-time.

So the key concept of the new system business intelligence (BI) hybrid model adopting ontology-based (OBDI) and virtual data integration (VDI) techniques have the ability to ensure abstraction of data that comes from multiple sources in varying schemas, syntactic accuracy and to have a seamless transition from data into information then into action. Hence, the hybrid data integration technique better enhanced the Business Intelligence (BI) process performance.

Also, the hybrid model of the research encapsulates an application layer that implement business rules, analytical processes, middleware functions and reporting to deliver a scalable

and reliable enhanced Business Intelligence (BI) process model for accurately and intelligently guiding medical practitioners' experts in carrying out disease control procedures effectively.

As well, with the use of case-based reasoning intelligent agent for improving the decision making process, the developed model harnessed its potentials as to how it plays a central role in assisting human expert judgement. So with it, the developed model embody both an outcome oriented view in which emphasis is on why a solution works better in resolving a particular problem (query) without ignoring the process that lead to how the solution was obtained.

Hence, the research "development of a Hybrid Model for Enhanced Business Intelligence Process (HMEBIP)", was applied in the health sector, whereby the medical practitioners' experts use the platform to take decision on prescriptions accuracy and on-time treatment for patient care and decision on disease control prevention as well as prediction. This was operational in nature, as it outperformed the existing models in terms of accuracy, lower latencies, access availability time, real-time alerts notification, accommodates larger numbers of users, it is process-oriented and event-driven.

3.4. Methodology

Research is a scientific and systematic search for pertinent information on a specific topic. Research methodology is a way to systematically solve the research problem. It can be understood as a science of studying how research is done scientifically. Research methods can be understood as all those methods or techniques that are used for conduction of research. It thus implies the method the researchers use in performing research operations.

Methodology can be said to be the systematic and theoretical analysis of the methods applied to a field of study. That is it comprises of the theoretical analysis of the body of methods and principles associated with a branch of knowledge. It is also seen as a collection of procedures, tools and documentation aids.

A structured design implies that the design process follows a path through several stages which can be incremental or sequential in nature. There are various methodologies that have incorporated a variety of techniques which has been developed to make analysis and design stages more manageable in the last 30years. Most methodology has at its heart at least one modeling technique. The best well known among those methodologies is the Structured Systems Analysis and Design Methodology (SSADM) which was developed in the early

1980s. Some other structured design methodology includes Information Engineering (IE), Jackson System Development (JSD) and Soft Systems Methodology (SSM). These follow the same process of documenting the current systems, specify the requirements of the required system and create the required system. In essence, methods are the tools, while methodologies are theoretical discussions of these tools.

The section consists of the approach used in achieving the research on developing a hybrid model for enhancing business intelligence process by hybridizing ontology-based and virtual data integration technique. The methodology represents knowledge of a certain kind and is a combination of know-how and knows-what. The four basic types of system methodology include:

1. Prototyping System Methodology.
2. Expert System Methodology
3. OOADM - Object-Oriented Analysis and Design Methodology.
4. SSADM - Structured Systems Analysis and Design Methodology.

The research used the Object-Oriented Analysis and Design method (OOADM).

3.4.1. Object-Oriented Analysis and Design Methodology (OOADM)

According to Tsichriteis and Nierstrasz (1989), Object-Oriented system as an approach, has inherited concepts, methods and tools from many other areas in computer science. The system (OOADM) in a short period has evolved from an esoteric, exotic way of programming in certain artificial intelligence applications to a diverse and expanding area of research. It sometimes to some extent follow the direction of the researcher as it relates to programming language, to operating systems, to databases, and other related concepts.

Object-Oriented approach has proven its value in enhancing reusability, maintainability and reliability. This approach has to do with the exotic direction that emphasizes the societal problems in a population of objects, which implies getting a set of objects to do something together. The approach in terms of distributed object-oriented applications considers objects as active entities themselves. Thus objects replace the notion of a “process”. Passive objects are effectively “server” processes that do nothing except wait for and serve incoming requests. Object communicate by passing “message”, and so synchronize themselves without the aid of an object manager.

Also, it is a set of standards for system analysis and application design. It uses a formal methodical approach to the analysis and design of information system. Object-oriented design (OOD) elaborates the analysis models to produce implementation specifications.

The object-oriented analysis and design methodology (OOADM) approach is motivated by the kind of system that is to be developed. The research model developed was built as a usable and evolvable application. The very nature of the new system, in which navigation is combined with the inherent difficulties of dealing with multimedia data, needs an object-oriented analysis and design methodology (OOADM) approach. The interface of web applications (Web Apps) is more complex than in traditional software systems, navigation and functionality should be seamlessly integrated and the navigational structure should be decoupled from the domain model of the application (App), therefore object-oriented analysis and design methodology (OOADM) was chosen for its functionalities, in that it allows object oriented abstractions for analysis and design of information-intensive web applications. Besides the modeling abstractions, it also provides a methodology which guides a developer through different activities in the web application development.

Unlike Structured System Analysis and Design Methodology (SSADM), the object-oriented approach combines data and processes (termed Methods) into single entities termed objects. Object usually corresponds to the real things a system deals with, such as patients, customers, suppliers, contracts and invoices, with these, the model Object-Oriented Analysis and Design Methodology (OOADM) are able to thoroughly represent complex relationships which in turn represent data and data processing with a reliable notation that allows an easier mix of analysis and design in a growth process. The aim of the approach Object-Oriented Analysis and Design Methodology (OOADM) is to make system elements more modular, thus improving system quality and efficiency of systems analysis and design. The focus on this model is tends more towards the behavior of the system and the main feature documented here is the class and object. This methodology will be applied to the research as the research intends to bring to light the behavior in terms of the benefits of hybridizing ontology-based and virtual data integration techniques as applied in Business Intelligence (BI) environment or systems.

In other analysis methodologies, the aspects of processes and data are considered separately. For example, data may be modeled by entity relationship (ER) diagrams, and behaviors by flow charts or structure charts. The primary tasks in object-oriented analysis (OOA) are:

1. Find the objects

2. Organize the objects
3. Describe how the objects interact
4. Define the behaviors (characterization) of the objects
5. Define the internals of the objects

Common models used in it are Use-Cases and Object models. Use-Cases describe scenarios for standard domain functions that the system must accomplish. Object models describe the names, class, relations (example Circle is a subclass of Shape), operations, and properties of the main objects.

3.4.2. Organization and Its Environment

The figures 3.9 and 3.10 depict a hospital organization chart.

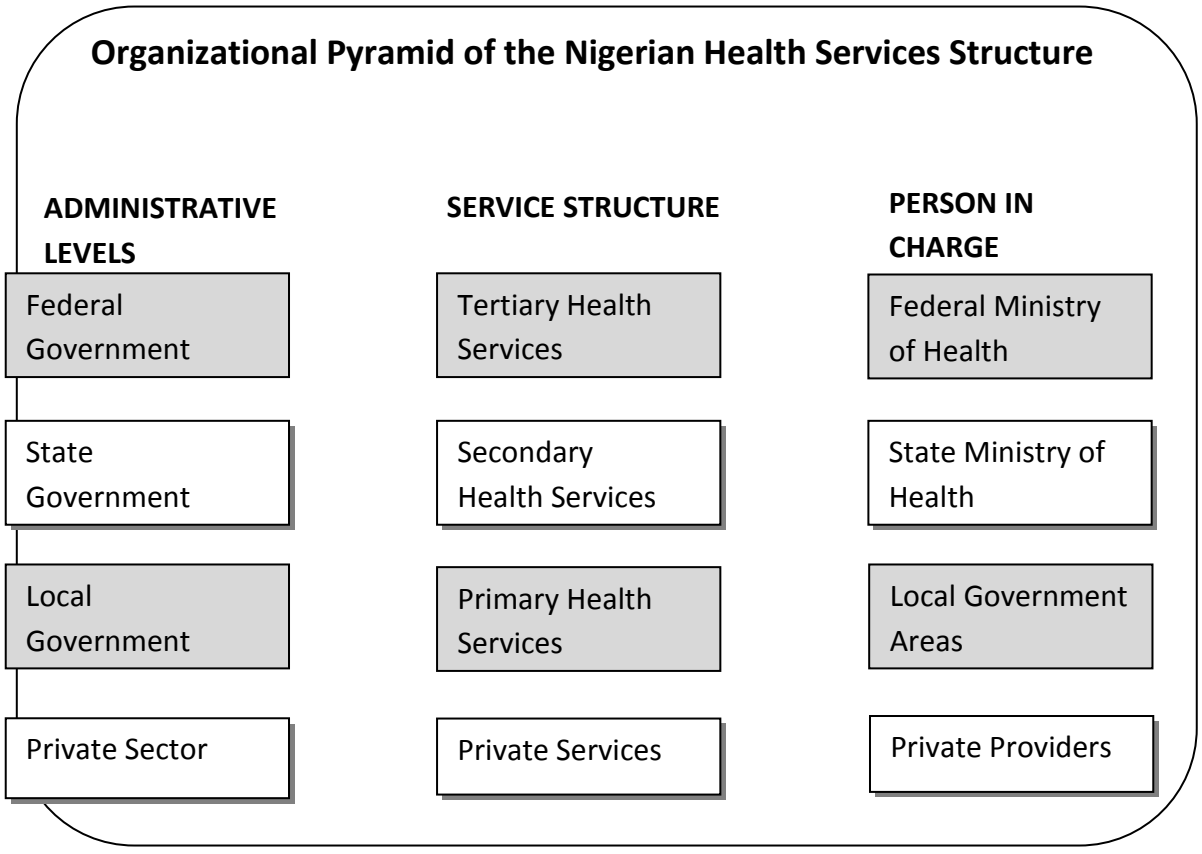


Figure 3.9 Nigeria Health Services Structure

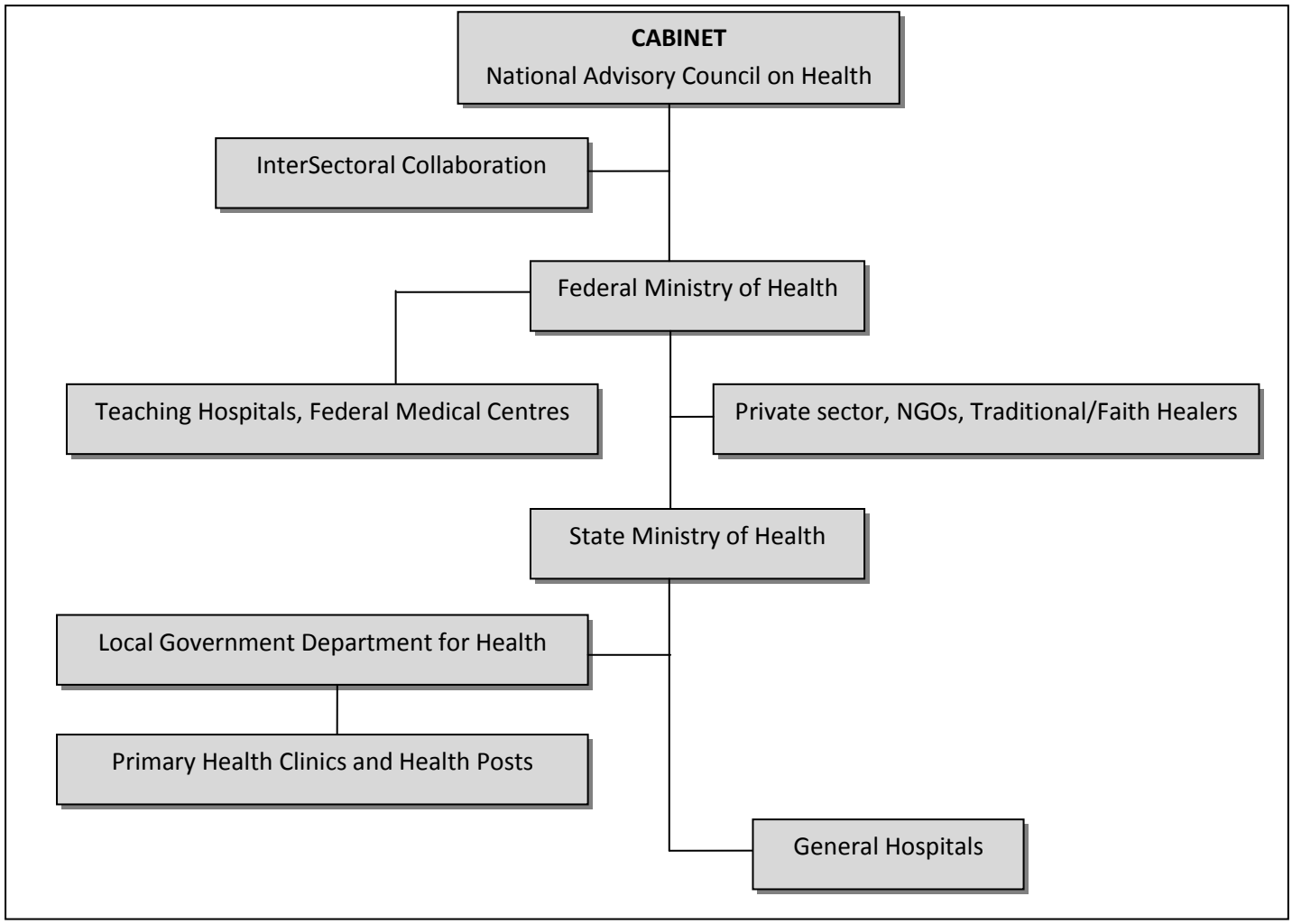


Figure 3.10 A Health Organization Structure

3.5. High Level Model of the New System

The high level model of the new system as shown in figure 3.11 applied the hybrid of ontology-based data integration (OBDI) technique as it relates to seamless transition, solving inconsistencies in semantics and accuracy issues in syntax.

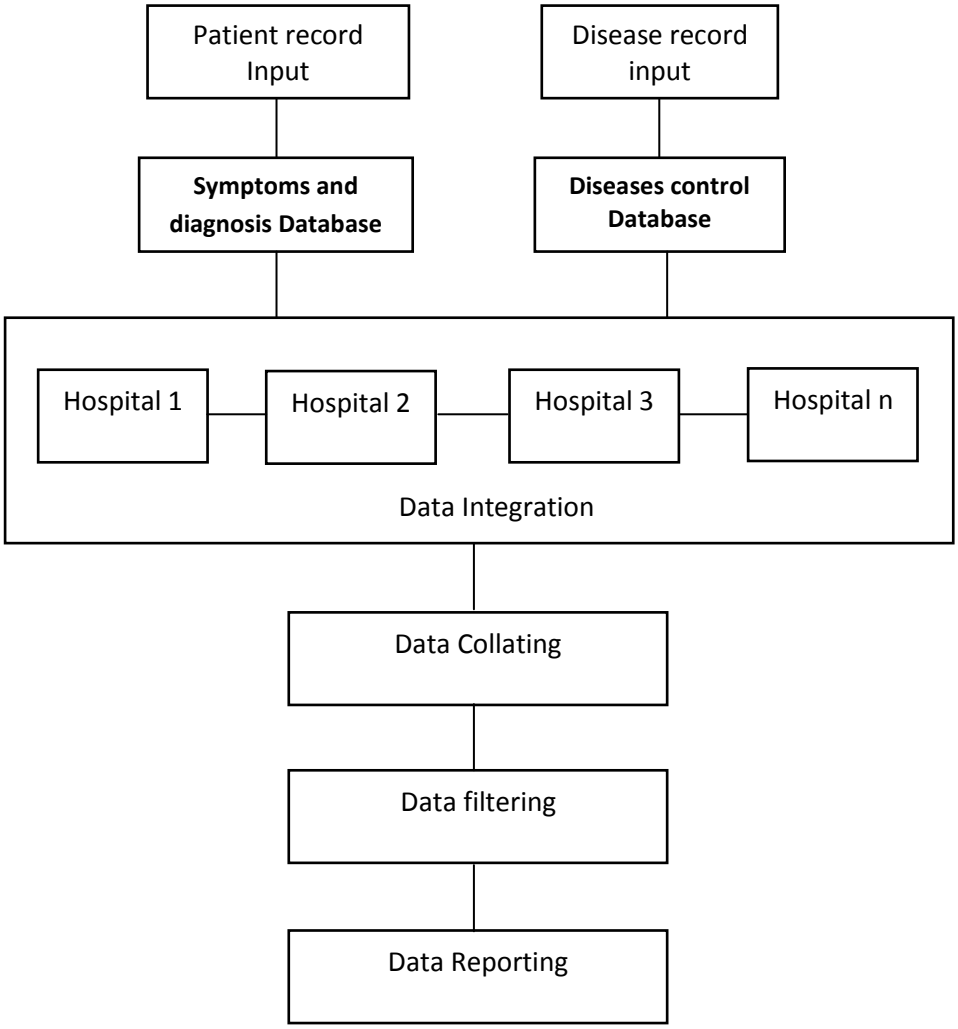


Figure 3.11 High Level Model of the New System

Also, that of virtual data integration (VDI) technique as it relates to hiding of technical jargons from users and unifying integrated and reconciling views of data residing at different sources as well as at different location for users. It improved on the intelligence of the enhanced Business Intelligence (BI) process model with the use of case-based reasoning (CBR) intelligent agent technology.

CHAPTER FOUR

SYSTEM DESIGN AND IMPLEMENTATION

4.1 Objective of the New System Design

The objective of the developed hybrid model for enhanced business intelligence (BI) process is to create ontology-based data integration (OBDI) and data virtualization (VDI) techniques in a system process model that uses intelligent agent to guide doctors in accurately carrying out disease control procedures. The objective of the design includes:

1. Provide a platform for ontology-based and virtualized data integration access that connect to different data sources and make them accessible from a common logical data access point.
2. Integrate patients' medical records and make them accessible from any healthcare center across Nigeria.
3. Design an intelligent system that uses case-based reasoning (CBR) for determining the disease control procedure to be applied to patient treatment for effective control of the disease in a patient.
4. Develop a database for storing and tracking disease outbreak and control procedure.
5. Maintain a statistical report (data mining process) of disease treatment records according to states or the country as a whole.

4.1.1. Architecture of the New System

The architecture of the new system is as depicted in figure 4.1.

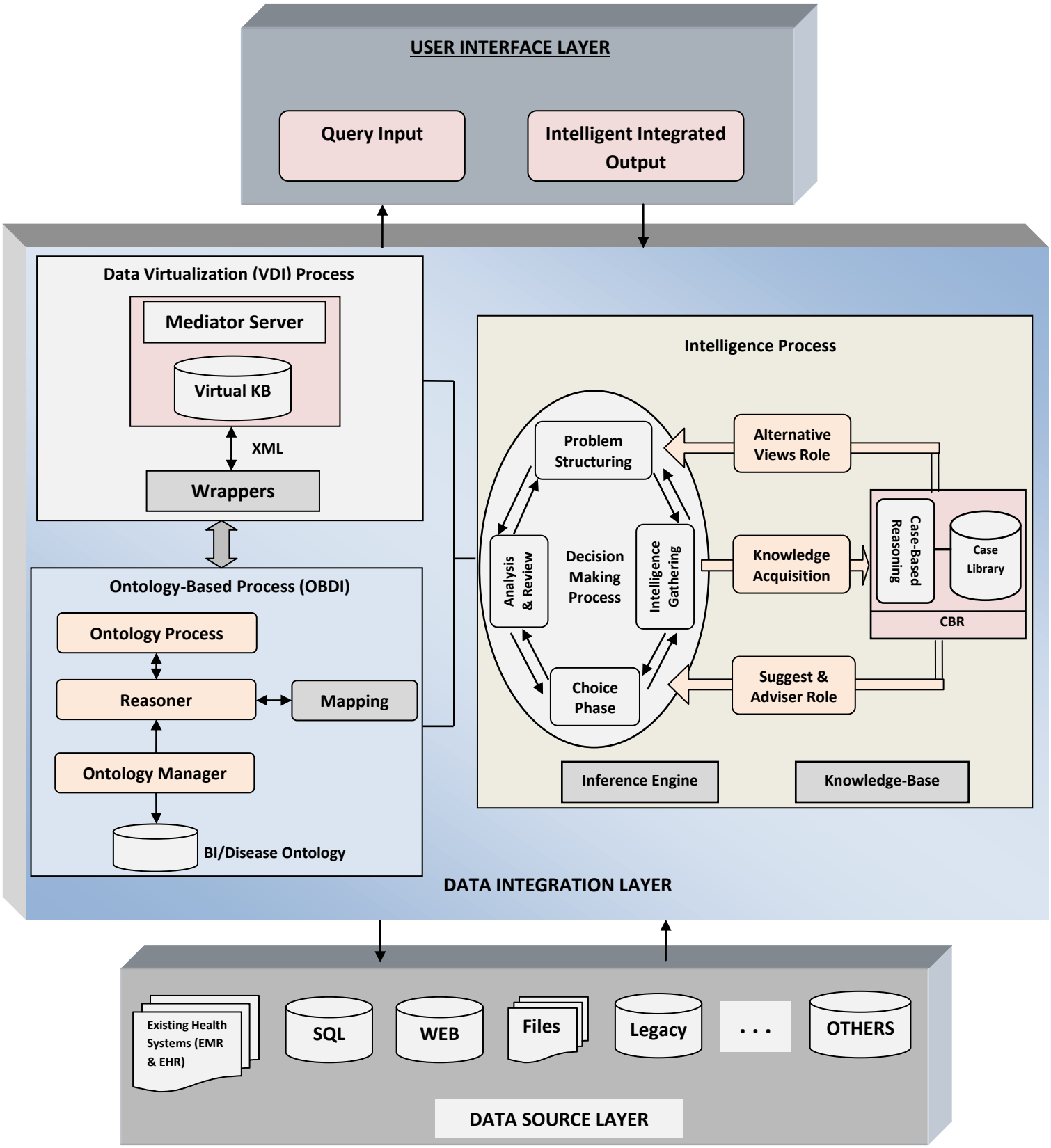


Figure 4.1 Architecture of the New System (HMEBIP)

The aspect of the Business Intelligence (BI) process the research enhanced is the data integration phase. This was enhanced with the hybrid of two data integration techniques (ontology-based data integration - OBDI and virtual data integration - VDI) implemented in the model as well as using case-based reasoning (CBR) intelligent agent technology to enhance the intelligence of the model. It was built using the programming codes of Java, Java script, XML, PhP and MySQL. The architecture of the new system model as depicted in figure 4.9 is tagged development of a Hybrid Model for Enhanced Business Intelligence Process "HMEBIP".

It comprises of all the various phases of the system design. The User Interface phase, Data Integration phase which houses the virtual data integration and ontology-based data integration hybrid aspect, and the data source access (data warehouse) phase. Also, it has an intelligent agent termed case-based reasoning (CBR) used to enhance the intelligence of the system as a whole, thereby making it act as an expert system in suggesting treatment to the medical expert or team that would be using the enhanced Business Intelligence system model. This it does based on previously stored experience cases. In all it assists in speeding up and simplifying the process in the module.

The ontology-based aspect in the data integration phase of the Business Intelligence process represents the domain knowledge of the model testing platform (disease control procedure in health sector). And it resolves the semantic heterogeneities and brings about interoperability in the data integration process of the system. It comprises the names for important concepts in the test domain and the background knowledge or constraints on the domain such as attributes, classification and constraints. The ontology-based integration was created using web ontology language (OWL) because it has a well defined semantics and it is highly optimized for implementation in systems compared to others. It was built using Java and Java script programming codes. This aspect of the research, is used to give the clients (medical experts) that are the users of the model, a unified conceptual global view of the domain data even if it is incomplete, and since ontology are logical theories, they are perfectly suited to deal with incomplete information which are present in unstructured data.

The virtual data aspect is accessed via a mediator, which creates the illusion on users of interacting with a real database. The users' queries are posted and answered via the mediator as it accepts the participation of different data sources, collects the data from the sources upon request at query time, as well as logically integrates the different data sources by means of a unifying, global or mediated schema. It was built using XML, Java script and MySQL.

The case-based reasoning (CBR) agent, acts as an intelligent agent in the system model to enhance the accuracy of the medical expert in solving new problems in the test platform (disease control procedure of the health sector) by using the knowledge acquired from previously stored similar cases. Also, as a software agent, it enhances the intelligence of the Business Intelligence process by assisting in gaining alternative perspectives on the query at hand by intervening autonomously during decision making with suggestions for treatments already successfully administered to patients with similar cases from within the local hospital or global across other medical centres, so that the medical experts can select the best from the displayed suggestions. This stimulates lateral thinking for the medical practitioners' experts and serves as aid for the inexperienced medical personnel. More so the advisory role it places is to exploit the knowledge stored in the case library in order to provide specific context-related suggestions during the decision making process. It was built using Java, Java script and PhP.

In the data source layer, they can be structured, semi-structured or unstructured, so the data quality and integration process is responsible for converting the data into a format readable by the database. With the data sources of the health sector, data is stored in a database for access by the Business Intelligence engine and the user-interface portal display the results cum report for the health sector consumers or medical practitioners to view and select from in making fact-evidence based knowledge insight diagnosis and treatment of diseases on their patients. It was built using MySQL and PhP.

In summary, the hybridizing of these two data integration techniques in the system model's data integration process enhanced the Business Intelligence process as a whole by improving the experts' performance of the test domain in accurately delivering treatment based on knowledge of cases of previously stored disease control treatment. Also, the system model reduced the amount of time taken to process data; it assisted in achieving experts' desired goals of minimum interaction which leads to the system model being flexible and reliable, because the technical jargon was obscured. So with the hybridizing of these techniques and intelligent agent, the generation of disease control procedure Business Intelligent results and the overall cost and time of processing was reduced, which implies it acted intelligently, is on-the-fly and is in real-time compare to the existing design of enhancing Business Intelligence with exclusively either of the data integration techniques (ontology-based data integration - OBDI or virtual data integration - VDI).

4.1.2. Data Flow of the New System

The health sector is responsible for the medical data from each regional data centre to monitor disease. Each regional information and data integration platform is composed of tertiary hospital, clinics and community healthcare centre by which different levels of medical institutions in a region are able to share the data from data centres and realize two-way referral and medical record lending. The data flow of the new system is as shown in figure 4.2.

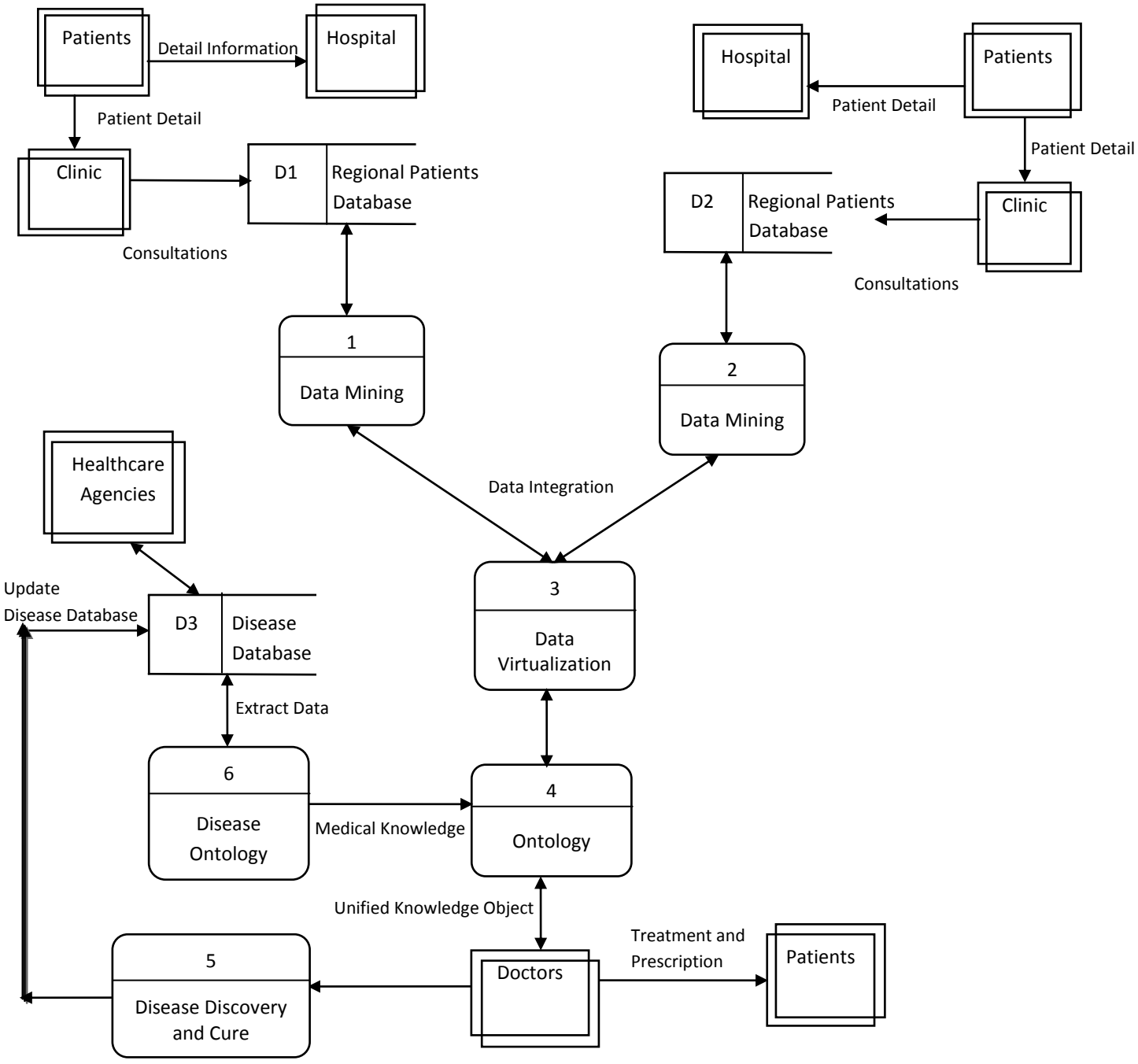


Figure 4.2 Data Flow of the New System

Note: different regionally integrated information platforms can exchange the resource data and perform remote consultation.

4.1.3. Use-Case Diagram of the New System

The model designed in the research is divided into several modules that needs access restrictions. Different Use-Cases were described in the way they were applicable in the software designed. Use cases are as listed in figures 4.3 to 4.5.

The Use-Case diagram for the clerks in the hospital is as shown in figure 4.3. They can register patients for consultation in the clinic; they can also edit or print the patient's record.

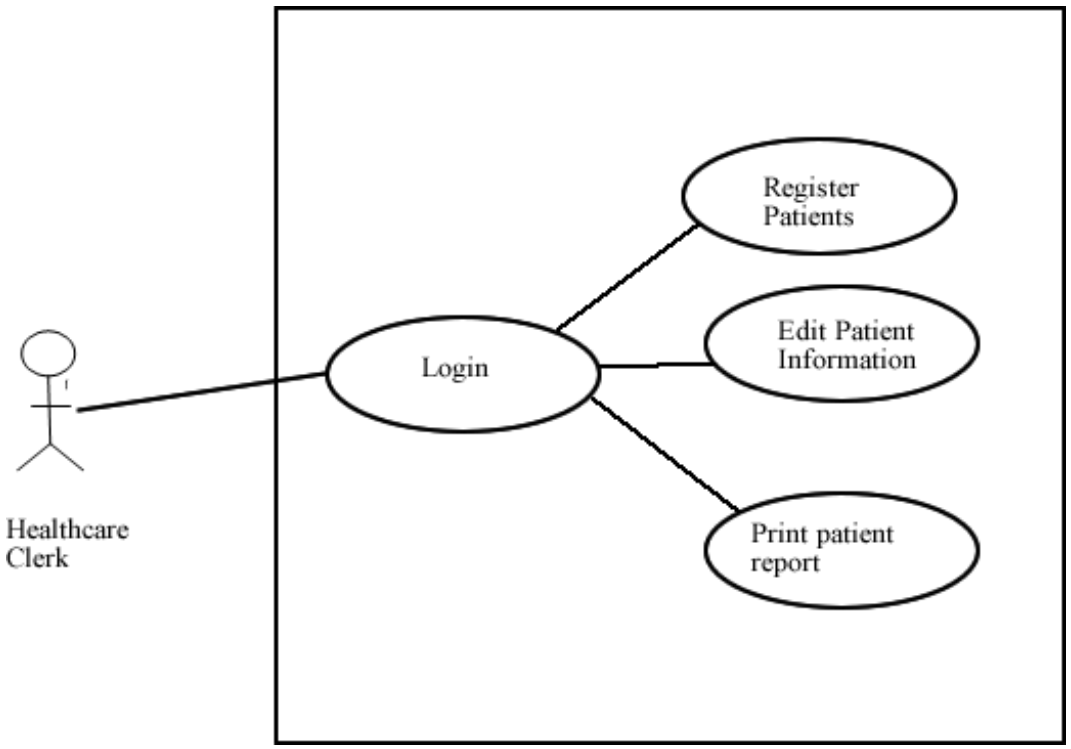


Figure 4.3 Healthcare Clerk Use-Case Diagram

The Use-Case diagram for doctors is as shown in figure 4.4. They offer consultations, recommend diagnosis, treatments and access integrated data warehouse from other clinics or hospitals.

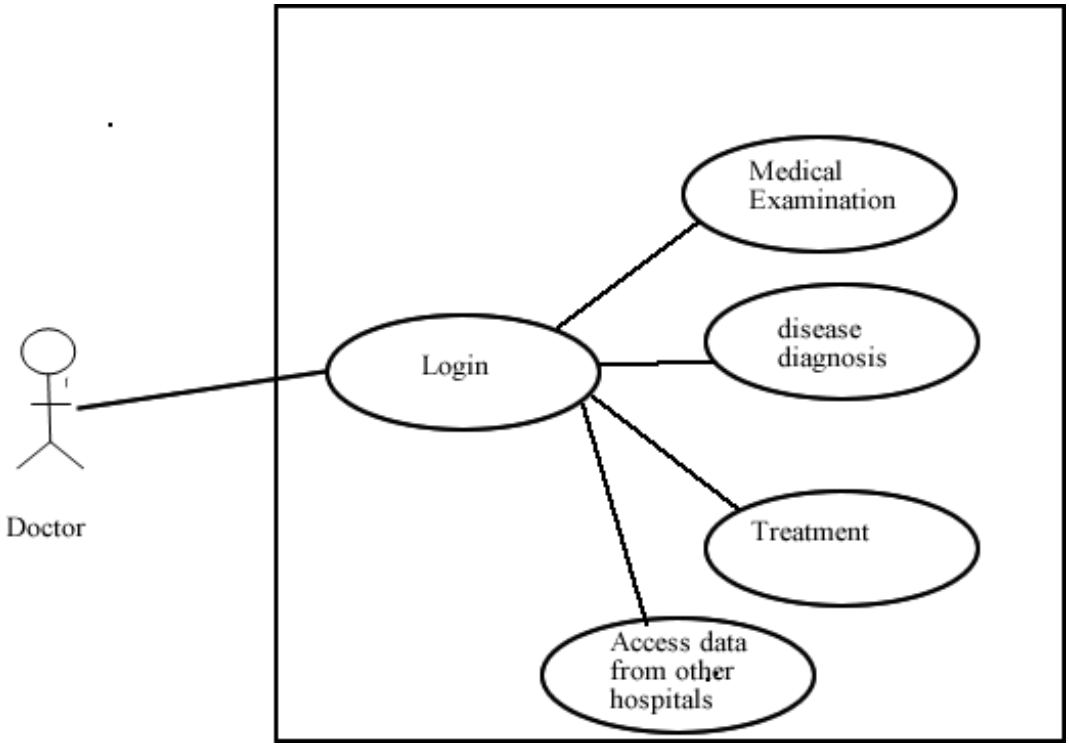


Figure 4.4 Doctors Use-Case Diagram

The agencies can view the integrated disease database, update the database, and update the procedures for disease control as shown in figure 4.5.

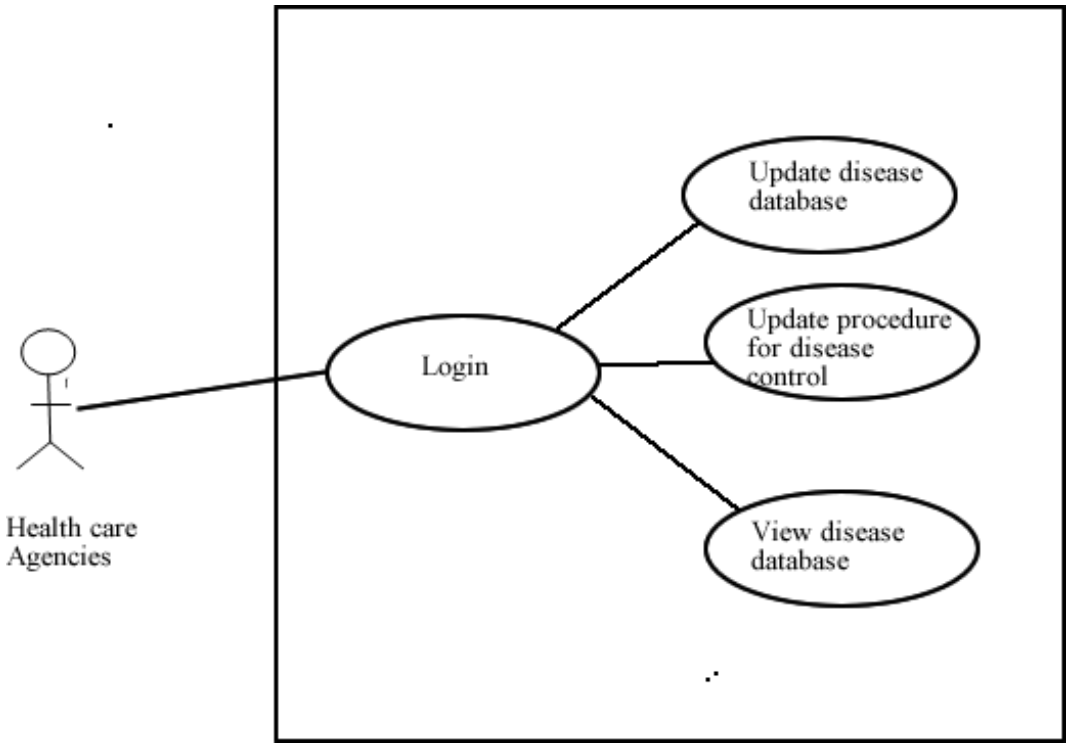


Fig. 4.5 Healthcare Agencies Use-Case diagram

4.1.4. Activity Diagram

The activity diagram in figure 4.6 shows the objects interaction with one another and in what order. It depicts the objects and classes involved in the scenario.

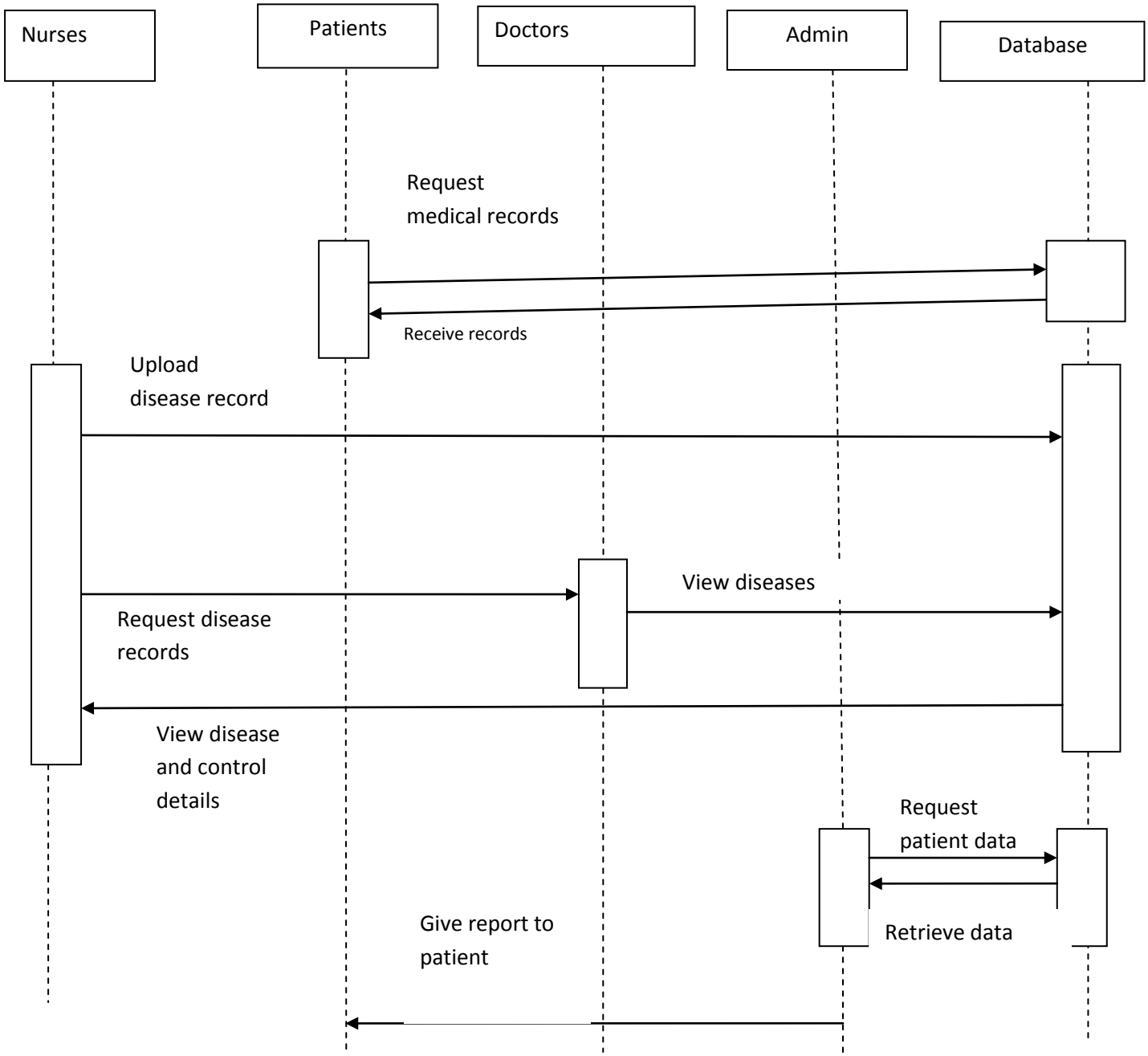


Fig. 4.6 Activity Diagram of the New System

Legend:
- ------- Entity
- ← → Interaction/Connecting
- ▭ Activity the entity can perform

4.1.5. Class Diagram

The class diagram of the hybrid model for enhanced business intelligence (BI) process is as shown in figure 4.7.

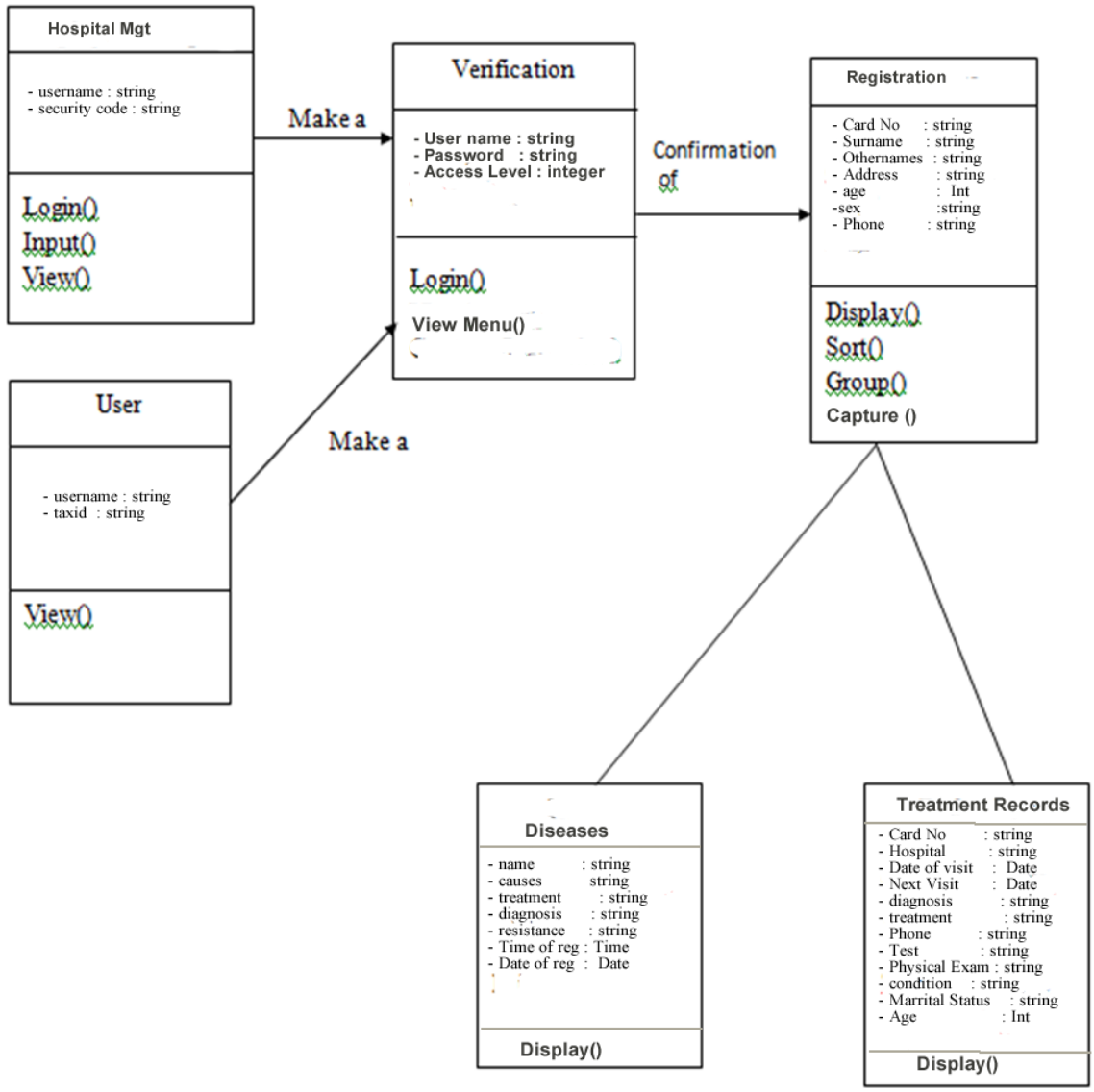


Figure 4.7 Class Diagram of the New System

Class diagrams are one of the most useful types of diagrams in unified modeling language (UML) as they clearly map out the structure of a particular system by modeling its classes, attributes, operations, and relationships between objects. The standard class diagram is composed of three sections:

1. **Upper section:** Contains the name of the class. This section is always required, whether you are talking about the classifier or an object.

2. **Middle section:** Contains the attributes of the class. Use this section to describe the qualities of the class. This is only required when describing a specific instance of a class.

3. **Lower section:** Includes class operations (methods). Displayed in list format, each operation takes up its own line. The operations describe how a class interacts with data.

4.1.6. System Flowchart

The new system process model flowchart entails the hybrid of the ontology-based and virtual data integration process. The system flowchart is as shown in figure 4.8.

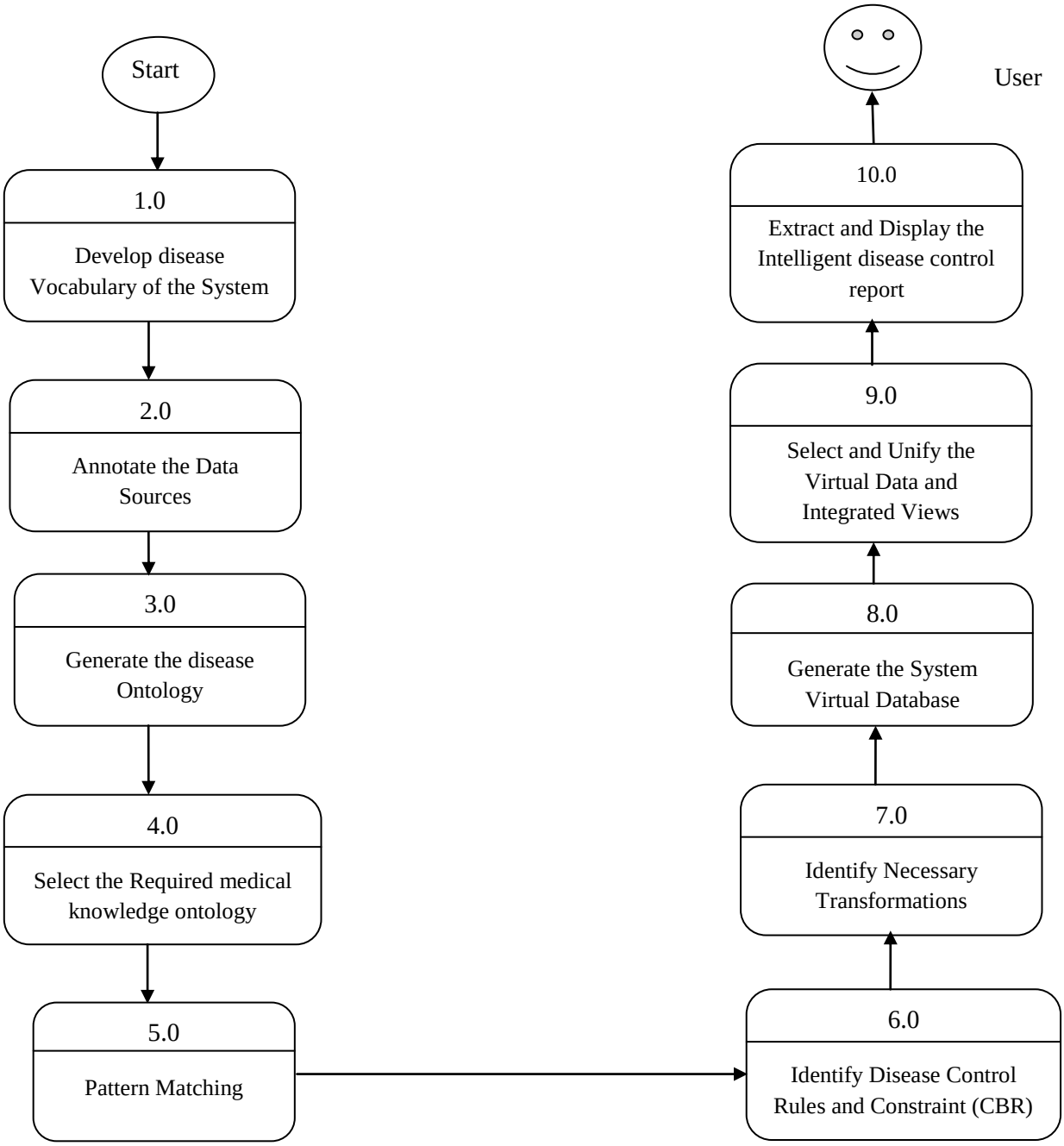


Figure 4.8 Process Model of the New System

The process flow of the system was boosted with the software (intelligent) agent case-based reasoning (CBR) as indicated in the data integration layer of the system architectural design. The data integration layer is where the ontology-based and virtual data integration process

takes place and it is the aspect of the Business Intelligence (BI) process that the research enhanced.

4.2. Algorithm

The algorithm for the new system is as follows;

1. Algorithm to set up the disease control dataset

Step 1- Start
Step 2- Input the disease symptoms
Step 3- Input the procedure for treatment
Step 4- Create/Build the dataset
Step 5- Store in database
Step 6- Stop

2. Algorithm for data integration layer (the hybrid of OBDI, VDI and CBR/KB process)

Step 1- Start
Step 2- Input the symptoms
Step 3- Query the disease db
Step 4- Integrate all the dataset found
Step 5- Match the input symptoms with the ones in the database (case library)
Step 6- Call the intelligence process
Step 7- Use the intelligence process to filter the database
Step 8- Apply disease ontology to the filtered database
Step 9- Search for best matching similar case(s)
Step 10- Call Virtual data integration process
Step 11- Search the knowledge base
Step 12- Apply the inference engine
Step 13- Is the disease a new case?
Step 14- IF yes
Step 15- Then
Step 16- Store in the disease dictionary
Step 17- Else
Step 18- Find the matching case(s)
Step 19- Is similar case(s) found?

Step 20- IF yes

Step 21- Then

Step 22- Search for the disease control procedure in local view

Step 23- Else

Step 24- Search other dataset from global view

Step 25- Extract the suggested disease control procedure treatment that matched the disease symptoms found from case library

Step 26- Display the suggested disease control procedure treatment

Step 27- Stop

4.2.1. Data Dictionary

The table 4.1 contains some of the data variables used in the program design and their full meaning.

Table 4.1 Data Dictionary

Variables	**Meaning/Functions**
Db	This is the database object used to access and transact with the disease registry and patient's database
OntoConn	This is the connection object used by the database object to connect to the physical database
datRecord	This is the object used to display the Record from dataset
mnuRecord	This is the object used to display program menu
mnuChangePass	This is the object used to change password of user
mnuUser	This object is used to manage the user of the system
mnuLogin	This is the object that gives access to authorized users of the system
mnuID	This is the object used to display the patients ID number
mnudisease	This is the object used to display the diseases
mnusymptoms	This is the object used to display the disease symptoms
mnutreat	This is the object used to display the suggested treatment
mnuname	This is the object used to display the patient's name
mnuExit	This is the object used to exit the application
LoadPicture	This is the object that helps in loading pictures /images from the directories into the program.

mnuaddress	This is the object used to display patients address
mnuhospital	This is the object used to display the name of the hospital
mnustate	This is the object used to display the name of the state
frmpatient	This is the object used to display the form for patients registration
frmdiseases	This is the object used to display the form for disease registry
frmontology	This is the object used to display the form for disease ontology
frmvirtual	This is the object used to display the form for record virtualization
frmalert	This is the object used to display the form for generating patient's reminder alert
frmclose	This is the object used to display the form for closing disease case file

4.3. Decomposition and Cohesion of the New System High Level Model

The new system high level model decomposition and cohesion is as shown figures 4.9 to 4.12.

4.3.1. Control Centre/Main Menu

The main menu contains the server side used by the system administrator, the client side used by hospitals, clinics and health facilities, and also the home page from where access to other subsystems can be granted. As shown in figure 4.9.

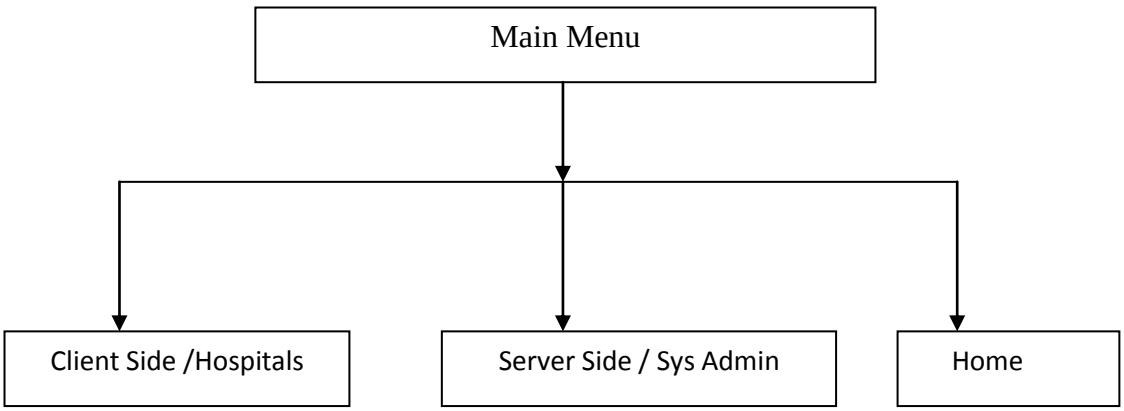


Fig 4.9 Main menu of the New System

4.3.2. The Submenus/Subsystems

Top-Down Approach was applied in the design of the hybrid model for enhanced business intelligence process. The system is structured in a way that each subsystem is accessed from the main menu and executed independently. The submenus/subsystems are as follows:

4.3.2.1. Home Sub System

The content of the home page basically contains the login links for different users of the system developed. It has other links like about us which contains information about the software developer and the exit button. As shown in figure 4.10.

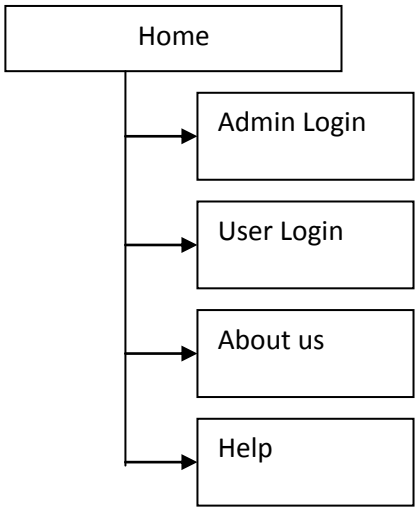


Fig 4.10 Home Sub system

4.3.2.2. Server Side / Administrator Sub System

The administrator sub system as shown in figure 4.11 is accessible by system administrator and can perform functions ranging from creating password for various hospitals, deleting and changing passwords, creating disease registry, deleting disease records, view registered patients from different hospitals, deleting patient's record and managing users access.

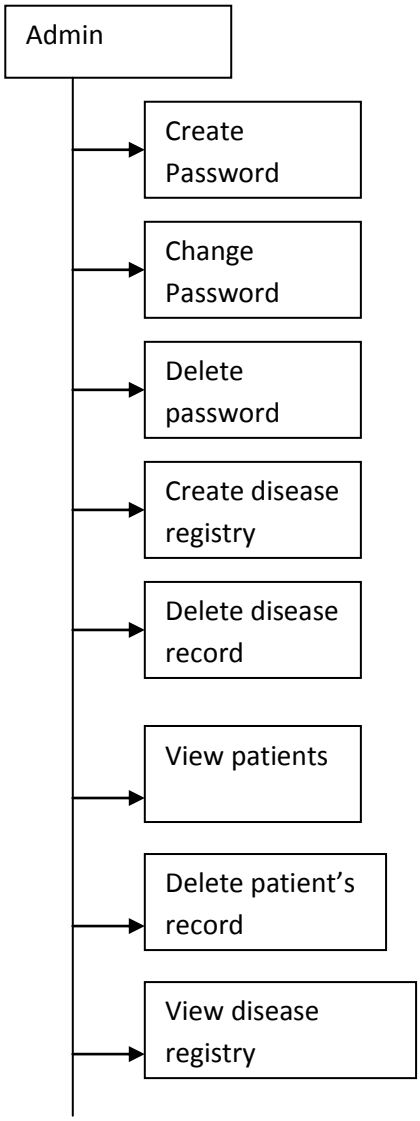


Fig 4.11 Administrator Sub-System

4.3.2.3. Client Side / Hospitals Sub System

The subsystem is used by hospitals, clinics, health centers to manage disease diagnosis and treatment based on intelligent agent. As shown in figure 4.12, they can register patients, use ontology based data integration (OBDI) for disease treatment options, use intelligent agent through case-based reasoning (CBR) for finding disease treatment, view patients history through data virtualization, send short message system (SMS) alert to patients, close case of patients, and view some statistical report on disease control.

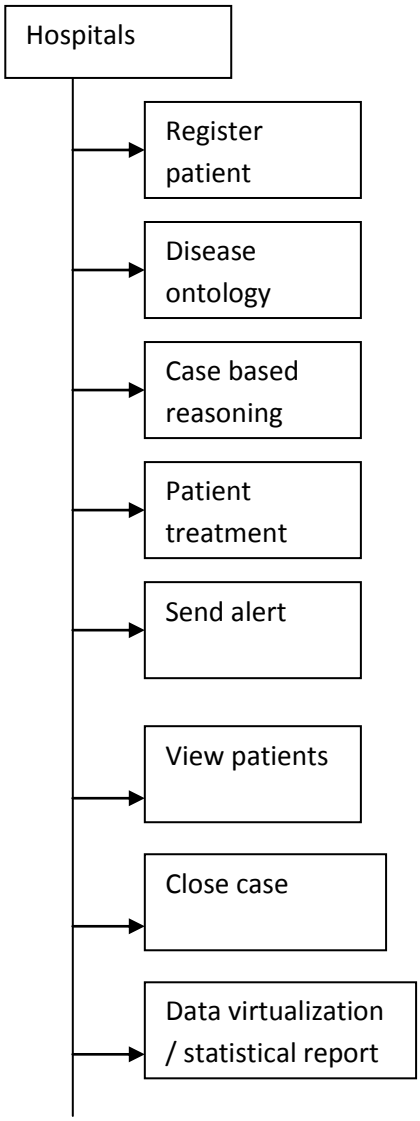


Fig 4.12 Client side / Hospitals sub-system

4.4. Specifications of the New System

The sections 4.4.1 to 4.4.5 give the specification of the new system.

4.4.1 Database Development Tool

The database server that was adopted for the project is the My Structured Query Language (MYSQL) database server. This is mainly because of its easy interaction with Hypertext Preprocessor (PHP)-enabled web servers, ability to serve many parallel client requests, its Secured Socket Layer (SSL) and security plug-ins. The Database Management System (DBMS) described entails web browsers like Mozilla Firefox, Internet Explorer, Netscape, web server and database server, these provides sufficient security functionality; works well in a multi-user environment and it is stable with large volumes of data. The system delivers

decision support information to managers using a ”thin client” Web browser like Mozilla Firefox, Netscape Navigator or Internet Explorer. The server-class computer that is to host the application is to be linked to the user’s computer by a network with the Transmission Control Protocol and the Internet Protocol (TCP/IP) protocol.

4.4.2 **Database Design and Structure**

The database schema was designed preferring more tables in the database in favour of fewer columns in each table. All table names start with the tbl_* prefix in order to avoid cluttering other tables already defined in the current namespace. Tables 4.2 to 4.6 show the physical model of the set of tables. The physical model is based on a concrete database product, as can be seen with the types of the attributes.

Table 4.2 Users Login Table Structure

Field	**Data Type(Size)**	**Description**
username	varchar(12)	The Users name.
password	varchar(12)	The password of the user
level	varchar(5)	Access privileges
hospital	varchar(100)	The hospital assigned the password to

Table 4.3 Disease Cases Table Structure

Field	**Data Type (Size)**	**Description**
tdate	date	Treatment date
ttime	varchar(15)	Time of the treatment
symptoms	varchar(2000)	Disease symptoms
disease	varchar(2000)	Diagnosed disease
patientid	varchar(20)	Patient registration identification number

type	varchar(50)	Type of disease
treatment	varchar(2000)	Treatment recommended
nurse	varchar(50)	Nurse to administer the treatment
hospital	varchar(100)	Hospital where the patient was treated
status	varchar(50)	The health state of the patient at the point of discharge
rating	varchar(50)	The drug performance rating

Table 4.4 Disease Registry Table Structure

Field	**Data Type (Size)**	**Description**
disease	varchar(500)	Disease name
symptoms	varchar(5000)	Disease symptoms
type	varchar(100)	Disease type
treatment	varchar(5000)	Recommended treatment
gender	varchar(50)	The sex most affected by the disease
agegroup	varchar(30)	The age group most affected by the disease

Table 4.5 Patient Table Structure

Field	**Data Type (Size)**	**Description**
surname	varchar(15)	Surname of the patient
firstname	varchar(15)	First name of the patient

lastname	varchar(15)	Last name of the patient
sex	varchar(8)	Gender of the patient
phone	varchar(12)	Phone number of the patient
email	varchar(40)	Email of the patient
address	varchar(150)	Address of the patient
hospital	varchar(150)	Hospital where the patient is treated
state	varchar(50)	State where the hospital is located
id	varchar(20)	Patient identification number
pic	varchar(200)	Picture of the patient
nextvisit	varchar(20)	Date of next visit
symptoms	varchar(2000)	Symptoms reported by the patient
disease	varchar(2000)	Disease diagnosed
treatment	varchar(2000)	Recommended drugs for the treatment

Table 4.6 Treatment Table Structure

Field	**Data Type (Size)**	**Description**
tdate	date	Date the patient was treated
ttime	varchar(15)	Time of the treatment
patientid	varchar(20)	Patient identification number
treatment	varchar(2000)	Drugs administered to patient
nurse	varchar(50)	The nurse in charge

hospital	varchar(100)	Hospital where the patient was treated
nextvisit	date	Date of the treatment
remark	varchar(20000)	Comments by the nurse

4.4.3. Mathematical Specification

The system model had features and factors as it processes its' data for integration, such as reliability, scalability, efficiency, completeness, integrity, correctness, and accuracy. But within the scope of the research the performance evaluation carried out in section 4.7.5, was accuracy and its equation as given in equation (4.1) was applied.

$$\boldsymbol{Accuracy\ (A\ or\ AC)} = \frac{\boldsymbol{tp+tn}}{\boldsymbol{tp+tn+fp+fn}} \quad \textbf{(4.1)}$$

where;

tp is True Positive equals accurate records

tn is True Negative

fp is False Positive

fn is False Negative equals weak accurate records

Note: if tn is zero as data sources it does not provide any true negative values.

4.4.4. Program Module Specification

The hybrid model for enhanced business intelligence process contains some modules which handles specified functions in the application. The following are some of the modules designed and their specifications.

Login Module

The Login module presents users with a form with username and password fields. If the user enters a valid username and password combination they will be granted access to the system application otherwise access will be denied the user.

Password creation Module

The administrators use this form to create hospital name, user name and password with access level. The name of the hospital and the login details is compulsory.

Patient Registration Module

Hospitals register patients on the platform using this module. Unified medical identification number is generated during the registration for the patient. All other information must be completed on the form before submission.

Disease Registry Module

The administrator uses this form to register diseases, their symptoms, treatment and type.

Disease Ontology Module

This module integrates database from different locations or hospitals for the purpose of suggesting the disease associated with the selected symptoms and also the suggested treatment.

Case-base reasoning module

This module uses knowledge base to find the treatment that will work better based on the symptoms reported by the patient.

Treatment Module

This module requires entry of patients' personal data, the disease diagnosed and the treatment that was given to the patient including the next date of visit.

Patient report Module

This module displays report on all the patients treated for one disease or the other. The module integrates data from all the hospitals.

Alert Module

This module sends short message system (SMS) to patients reminding them that they have appointment with the hospital so as to follow up their disease control.

History Module

This module requires entry of the patient identification (ID) and the system will display the treatment history of the patient irrespective of the hospital where the treatment was received.

Delete Module

The administrator uses this module to delete unwanted record from the disease registry or patient's treatment record. All that is required is the patient identification (ID) or the disease serial number.

4.4.5. Input / Output Format

The following forms in figures 4.13 to 4.18 show the format of input and output forms as designed in the system:

Login Form

This form contains the login specification for user on the platform which includes the username and the password. Once the specification is entered, clicking on the login button validate the data before launching the user on the assigned subsystem, is as shown in figure 4.13.

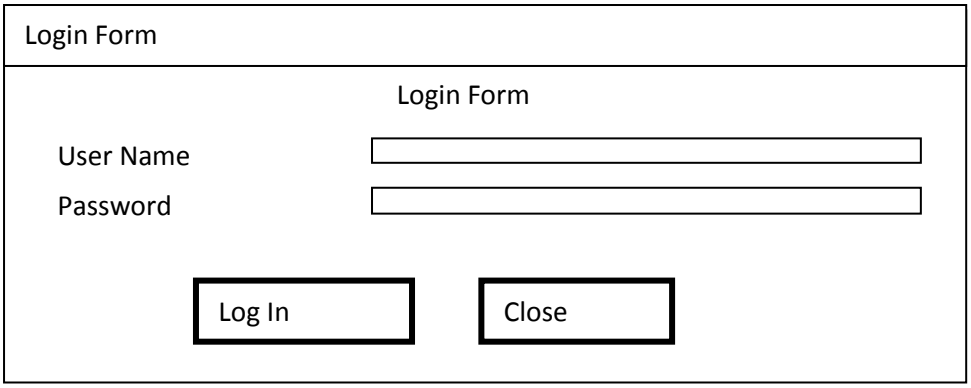


Figure 4.13 Login Form

Password registration Form

This is used to create a new hospital record on the database. It registers the hospital and create access password for the hospital (that is it enables the creation of users password), is as shown in figure 4.14.

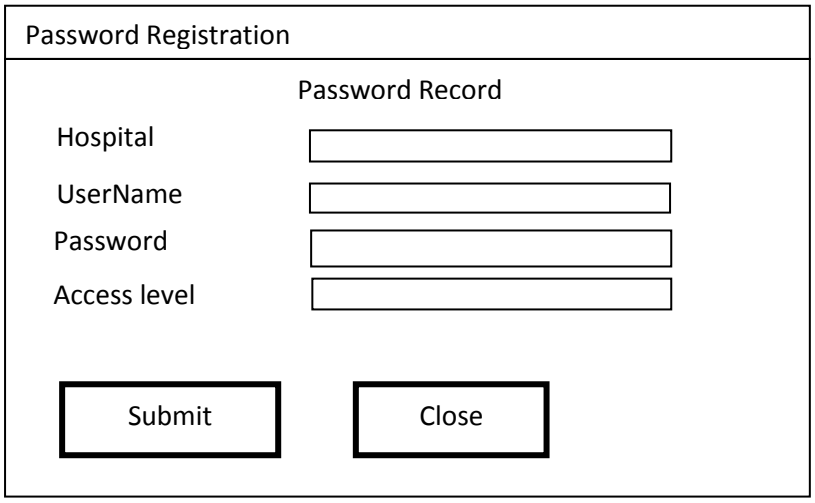


Figure 4.14 Password registration Form

Disease Registry Form

The disease name, symptoms, type, treatment, and other information are required to be entered and submitted to the disease registry database is as shown in figure 4.15.

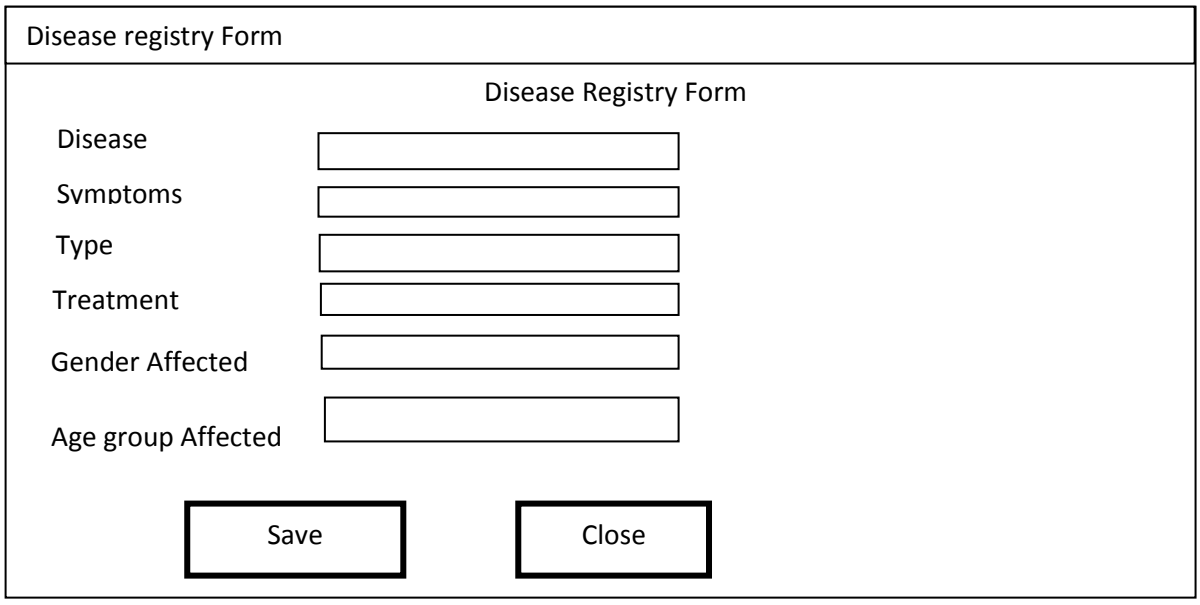


Figure 4.15 Disease Registry Form

Patient's registration Form

This form captures the details of the patient and the hospital where the registration took place. Figure 4.16 shows the form used to record patient's data in the hospital.

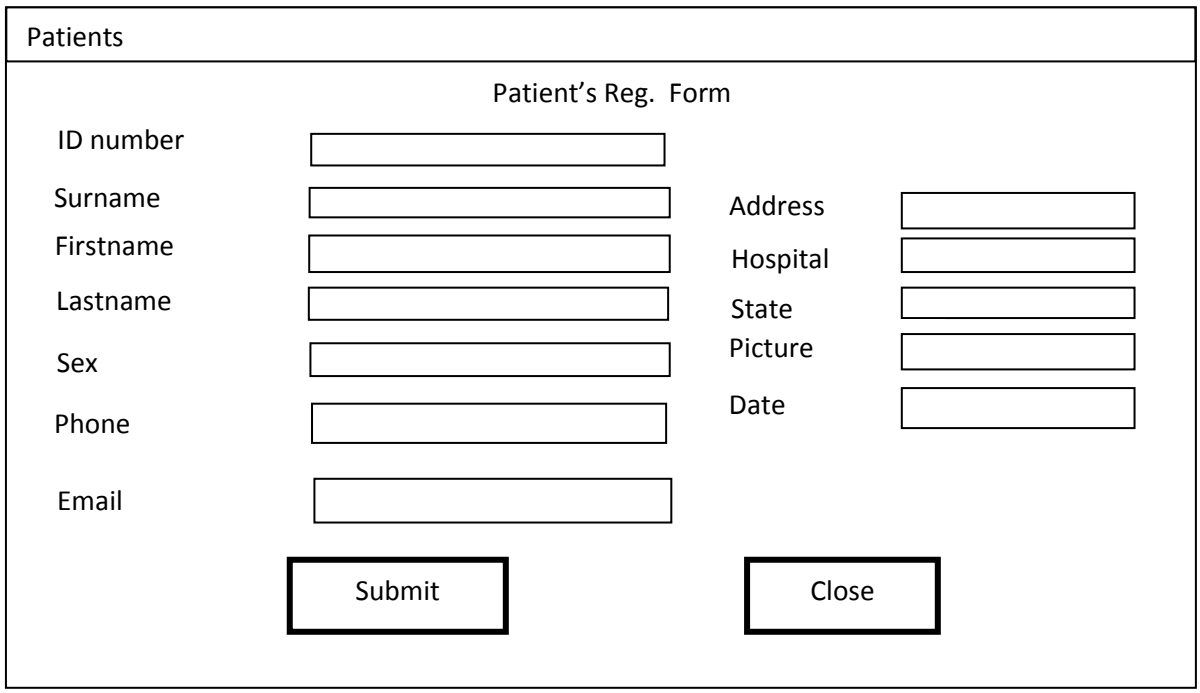


Figure 4.16 Patient's registration Form

Disease Ontology Form

The form is used to capture the patient symptoms and disease ontology data integration is used to find the type of disease, the suggested treatment as recommended and other patient's details. Figure 4.17 show the form.

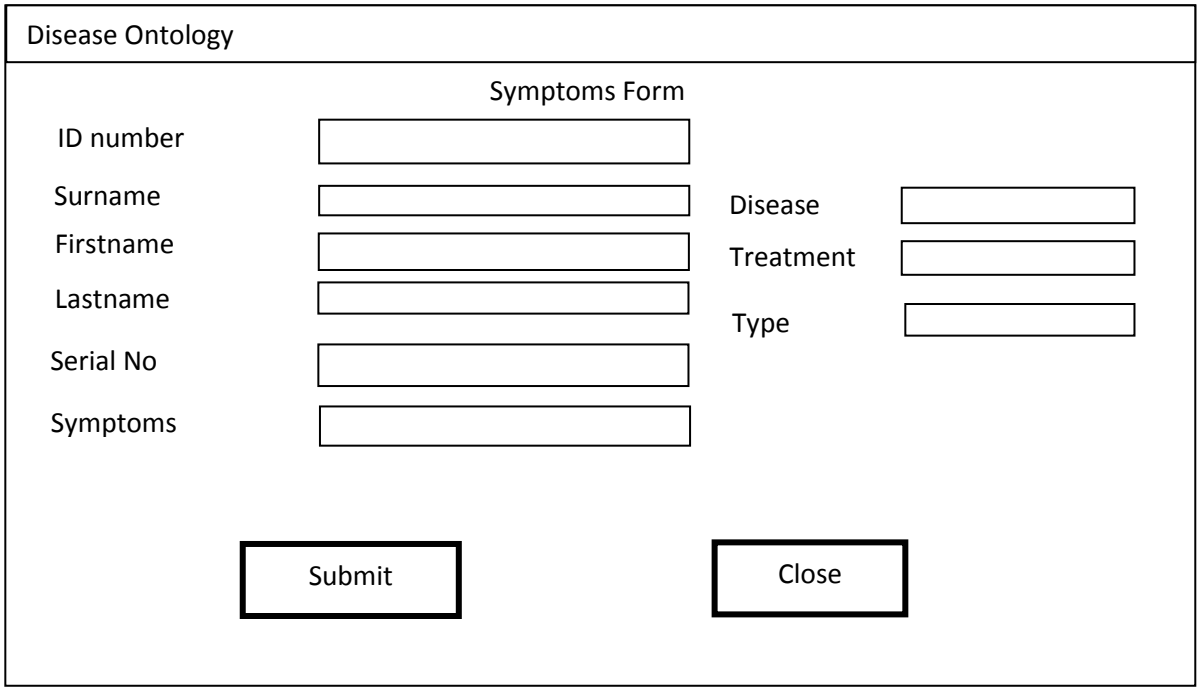


Figure 4.17 Disease Ontology Form

Patient's Treatment Form

The patient's treatment form as shown in figure 4.18 is used to record each drug of treatment given to a patient and the time and date it was administered on the patient.

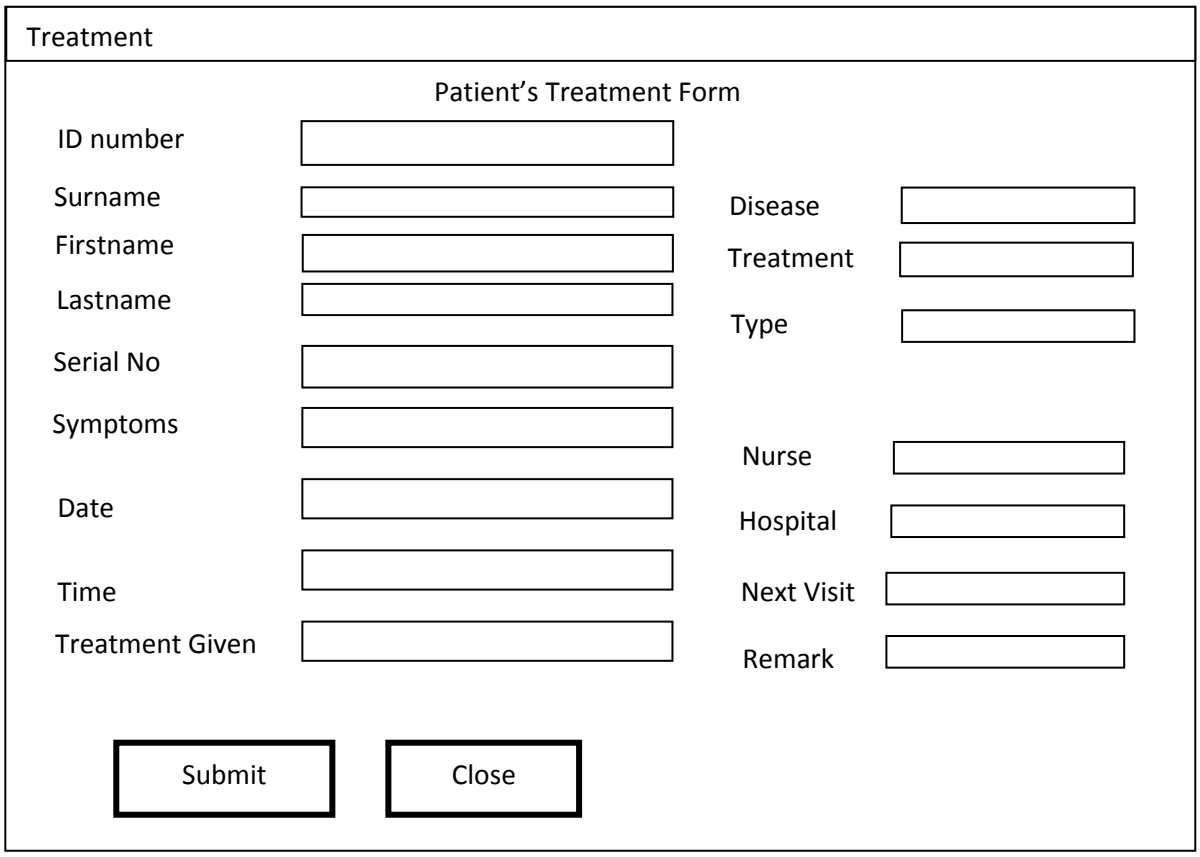


Figure 4.18 Patient's Treatment Form

Close Patient's Treatment File

This is the form used to close patient's case once the treatment is completed. It contains information on how effective the treatment procedure is and the rating. Figure 4.19 show the form.

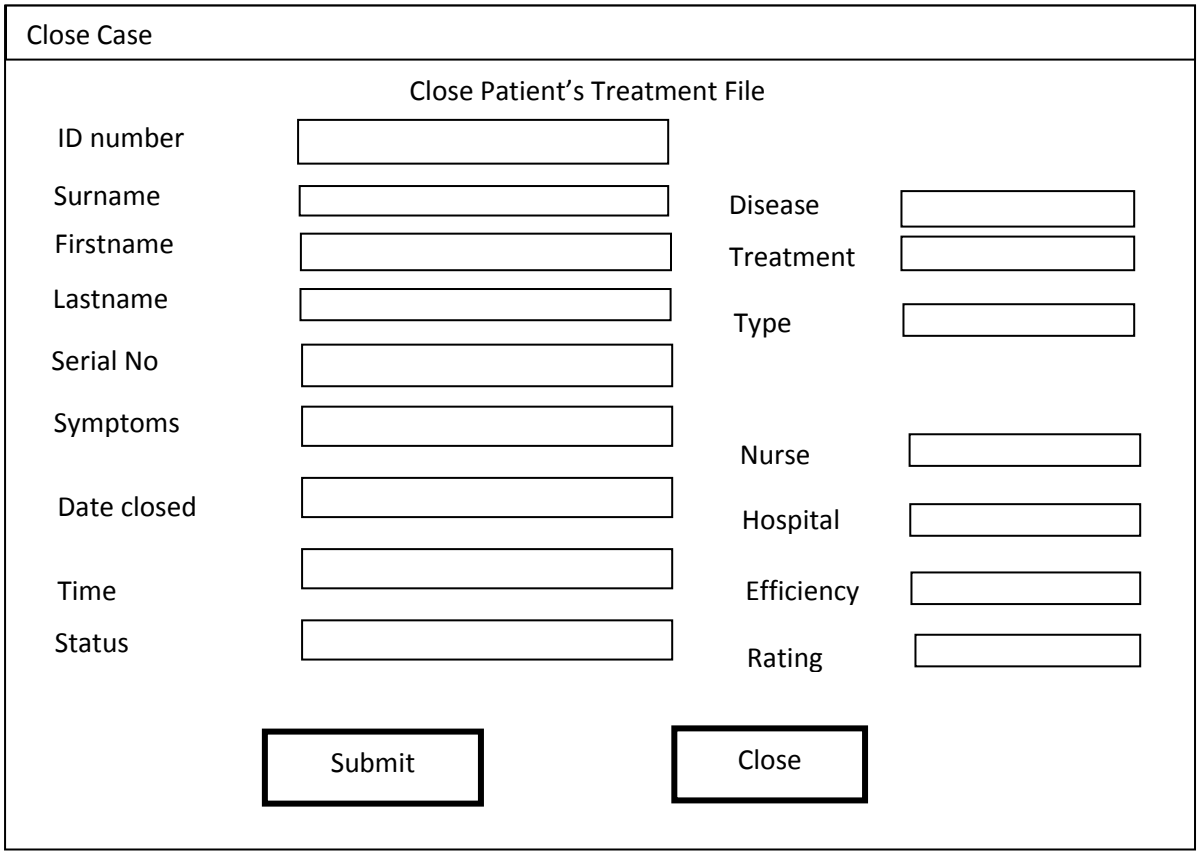


Figure 4.19 Close Patient's Treatment File

Patient's File

The patient's registry showing the records of patients in the hospital is as shown in Figure 4.20.

Patient's Registered Report

Surname	Lastname	Firstname	Address	Email	Phone	Hospital	Patient ID

Figure 4.20 Patient's File

Disease Registry File

The disease registry file as shown in figure 4.21 contains known diseases, their symptoms, and recommended treatments.

Disease Registry Report				
Serial No	Symptoms	Disease	Disease Type	Treatment

Figure 4.21 Disease Registry File

Disease Control knowledge base

This form contains the dataset of all the treatments conducted in various clinics and hospitals with the rating in terms of the disease control performance, is as shown in figure 4.22.

Disease Control Knowledge Base				
Serial No	Treatment	Disease	Status at Discharge	Rating

Figure 4.22 Disease Control knowledge base

Disease Statistical Report

This form presents the statistical report of disease control according to states in Nigeria. It shows the number of cases recorded and the overall percentage indicating states where there are more outbreaks of diseases is as shown in figure 4.23.

Disease Statistical Report			
State	Disease	No of Cases	Percentage

Figure 4.23 Disease Statistical Report

4.5. System Implementation

The new system implementation requires is presented in this section.

4.5.1. Hardware Requirements

For the implementation of the hybrid model for enhanced business intelligence process, the following minimum hardware is required:

- 2.4 GHZ of processor speed
- 4GB RAM
- 180 GB Hard disk
- Internet Modem
- Coloured Monitor
- Printer

4.5.2. Software Requirements

The following software has to be installed on the computer system to run the new system developed.

- window 7, Window 8 or windows 10
- Microsoft Dream Weaver 8
- Wamp Server
- JQuery
- Fireworks
- Php-Mysql
- Java Virtual Machine

4.6. Program Development

The new system program development is presented in this section.

4.6.1. Choice of Programming Environment

Hypertext Preprocessor-My Structured Query Language (Php-Mysql) programming language and Java Script was used during the program development. It consists of all necessary tools required to build main stream server Applications. The features of Hypertext Preprocessor-My Structured Query Language (Php-Mysql) and Java Script are as follows:-

i. GUI Interface
ii. Modularization
iii. Object Oriented
iv. Debugging
v. My-Sql Data access feature
vi. Scripting

4.6.2. Language Justification

The above programming language was chosen because the programming language has the advantage of easy development, flexibility and it has the ability of providing the developer with possible hints and it produces a graphical user interface. Moreover, Hypertext Preprocessor-My Structured Query Language (PHP-MySql) is very user friendly and enables the design of an interface that can be modified programmatically.

4.7. System Testing and Evaluation

The new system testing and evaluation is presented in this section.

4.7.1. System Testing

System testing is the testing to ensure that by putting the software in different environments (example Operating Systems) it still works. System testing is done with full system implementation and environment. In this system testing, test has been done in both Windows 7, 8 and 10 operating system and it still function effectively.

4.7.2. Test Plan

A primary purpose of testing is to detect software failures so that defects could be discovered and corrected. Testing cannot establish that a product functions properly under all conditions

but can only establish that it does not function properly under specific conditions. The research therefore employed the following testing and debugging method to check for errors in the new system.

i. Unit/Module Testing
ii. Intergrated Testing
iii. Performance Testing

Unit/Module Testing

Unit/Module testing is the testing of the individual unit or group of related units. It is often done to test that the unit is producing expected output against given input. This method shall ensure and confirm the efficiency and reliability of the system. So far, the various units/modules have been tested and each has proved efficient as an entity.

Integration Testing

Integration testing is the testing in which a group of components are combined to produce output and the interaction between software and hardware is also tested. The essence of this integration is to check how these modules when they are integrated into subsystem stand as main system. Therefore, the test carried out here is to ascertain that those modules do not lose their efficiency and reliability (which has been proved in the module testing above) due to the integration into subsystem and system. The coordination and linking relationship existing between the form and procedure retained and performed the primary function for which they were designed.

Performance Testing

Performance testing is the testing to assess the speed and effectiveness of the system and to make sure it is generating results within a specified time as in performance requirements

4.7.3. Test Data

For the purpose of the research, test data was collected from selected dataset for diseases and their control procedure as obtained from online. A prototype of the data needed was collected from the hospitals as they cannot disclose the patients' disease treatment details.

4.7.4. Actual Test Result versus Expected Test Result

The table presents the actual versus the expected test results of the new system modules indicating if it performed as expected during run time testing of the software.

Table 4.7 Actual Test Result versus Expected Test Result

Module	Expected Test Result	Actual Test Result
The Splash Form	Expected to see the splash form of this project with the introduction to the software at its background.	The splash form for this project appeared with the introduction to this software at the background.
Log In Form	Expected to see the Log In command button so that one can log in.	When clicked on log in, a form appeared where you can enter your username and password.
Disease Form	Is expected to be used to register diseases and their control procedures	When clicked on the disease registry, a form for registering the disease name, type, symptoms and treatment appeared and enabled the user to store the record on the disease registry dataset
Patient Registration	Expected to be used to register patients	This form allowed the user to enter the patients record and stored in the hospital patient's database
Disease ontology	Expected to allow for the integration of diseases and the possible symptoms and treatments	The form allows the user to view integrated disease records linking their symptoms and recommended treatments
Query	Expected to be used to retrieve information from patients database	This query form was able to retrieve related patient's record from the database using data virtualization
Report	In this module, it is expected to be used to view report	When you go to this module, disease registry dataset, patient's records, disease control knowledge base and statistical reports can be viewed

4.7.5. Performance Evaluation

A performance metrics was derived from the confusion matrix as show in table 4.8 and equation 4.2 coined from equation 4.1 in section 4.4.3, show the accuracy (AC) of the developed hybrid model for enhanced Business Intelligence (BI) process.

Table 4.8 Confusion Matrix

		Observed	
		True	**False**
Predicted	**True**	TP	FP
	False	FN	TN

$$AC = \frac{a+d}{a+b+c+d} \quad (4.2)$$

a = True Positive

b = False Positive

c = False Negative

d = True Negative

During the testing, 20 different disease control procedure (appendix C) were performed on the system to see how it can accurately identify the disease based on the symptoms and at the same time prescribe the treatment process. Three stages were followed in the performance testing; the stages are:

1. Ontology-based data integration (OBDI) technique for disease control procedure
2. Virtual data integration (VDI) technique for disease control procedure
3. Hybrid technique using both Ontology-based data integration (OBDI) and virtual data integration (VDI) technique for disease control procedure

Table 4.9 Confusion matrix applied to test dataset of Disease Control using Ontology-Based Data Integration (OBDI) technique

		Observed	
		True	**False**
Predicted	**True**	13	2
	False	3	2

Table 4.9 shows that out of 20 disease control test carried out using ontology-based data integration technique for disease control procedure; 13 diagnoses are True Positive and was predicted correctly, 2 diagnoses were true while they are not, 3 diagnoses was detected to be False while it is not thereby allowing the disease to go undetected. Finally, 2 False was detected where no disease was found and it was correct. A model of performance metrics can be derived from the confusion matrix as show in equation 4.2, which show the level of accuracy of the ontology-based data integration technique for disease control procedure.

Substituting the values it becomes

AC = (13+2) / (13+2+3+2)

AC = 0.75 that is 75% accuracy in predicting the disease control procedure using ontology-based data integration (OBDI) technique.

Table 4.10 Confusion matrix applied to test dataset of Disease Control using Virtual Data Integration (VDI) technique

		Observed	
		True	**False**
Predicted	**True**	12	3
	False	4	1

Table 4.10 shows that out of 20 disease control test carried out using Virtual data integration technique for disease control procedure; 12 diagnoses are True Positive and was predicted correctly, 3 diagnoses were true while they are not, 4 diagnoses was detected to be False while it is not thereby allowing the disease to go undetected. Finally, 1 False was detected where no disease was found and it was correct. A model of performance metrics can be derived from the confusion matrix as show in equation 4.2, which show the level of accuracy of the Virtual data integration technique for disease control procedure.

Substituting the values it becomes

AC = (12+1) / (15+3+4+1)

AC = 0.65 that is 65% accuracy in predicting the disease control procedure using Virtual data integration (VDI) technique.

Table 4.11 Confusion matrix applied to test dataset of Disease Control using the Hybrid Model of both Techniques

		Observed	
		True	**False**
Predicted	**True**	18	0
	False	1	1

Table 4.11 shows that out of 20 transactions, 18 diagnoses are True Positive and was predicted correctly. One diagnosis was detected to be False Negative while it is not. Finally, 1 False Positive was detected. A model of performance metrics can be derived from the confusion matrix as show in equation 4.2, which show the accuracy of the system.

Substituting the values it becomes

AC = (18+1) / (18+0+1+1)

AC = 0.95 that is 95% accuracy in predicting the disease control procedure.

4.7.6. Comparison of Existing Model with the Developed New System Model (HMEBIP)

The developed new model comparison with the existing model was in terms of the accurarcy level in predicting and prescribing treatment for diagnosed diseases and symptoms for effective disease control procedure. The accuracy evaluation criteria demonstrated the effectiveness of

the hybridized data integration techniques and intra-hospital-wise integration of data across medical practitioners' experts. It further shows that it has better improved intelligent, fact-evidence-based knowledge insight decision making capability as depicted in the graph shown in figure 4.24.

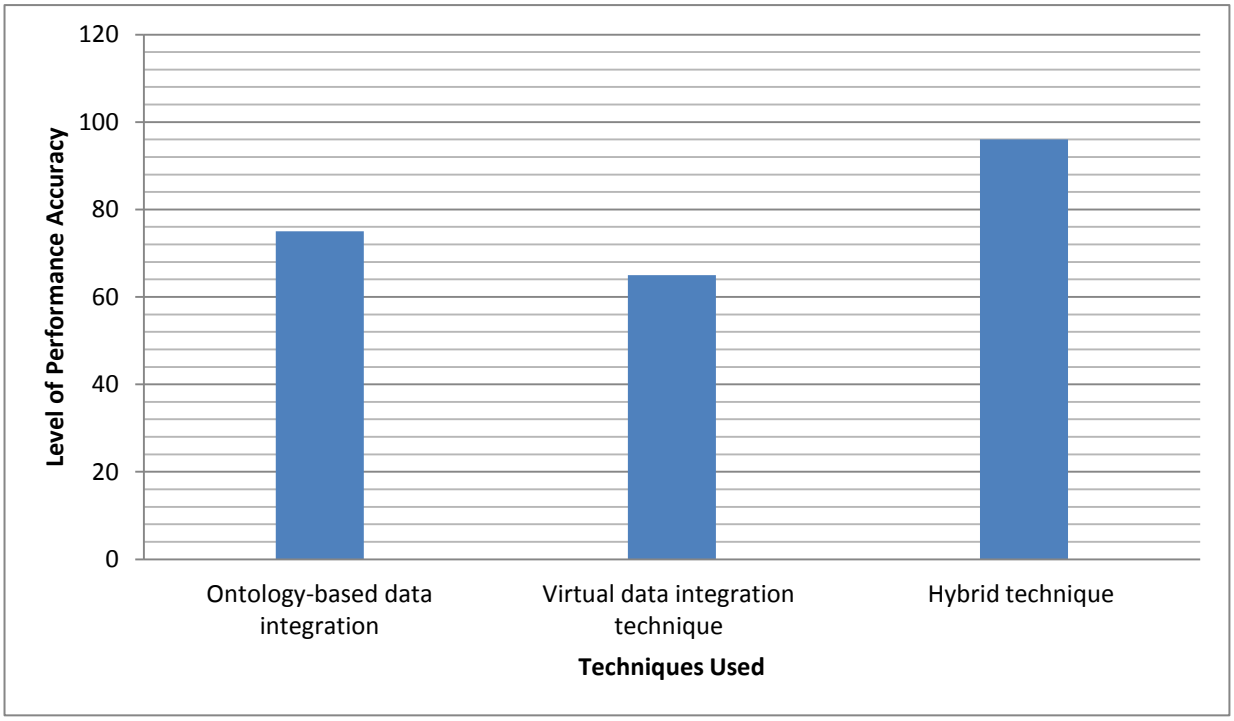


Figure 4.24 Comparison of level of prediction accuracy using various techniques

Other comparison criteria as it pertain to Operation; Compared to the existing model, the new developed model handling operational wise was more user-friendily, Availability; The model was considered robust and scalable compared to the existing models as it did not decrease reliability which can result in loss of revenue and accessibility speed in real-time, and Deployment; The new system was considered easy to use as it fits seamlessly into the health sector disease control procedure operation.

Hence, from figure 4.24, it can be deduced that the Ontology-based data integration (OBDI) technique for disease control procedure has 75% accuracy in predicting the disease control procedure; Virtual data integration technique for disease control procedure has 65% accuracy in predicting the disease control procedure; while Hybrid technique using both ontology-based data integration and virtual data integration technique for disease control procedure has 95% accuracy in predicting the disease control procedure. This shows that the Hybrid technique outperforms the existing techniques with (95 – 75) equals 20%, that is there is 20% improvement from the existing technique. The percentages were obtained from tables' 4.8 - 11.

4.7.7. Limitations of the System

In the test running of the new developed system model, where there is existence of a lot of treatment procedure for a given disease, the system selects one out of the recommended treatment and it may turn out not to be the best out of all options as the age difference of the patients involved may be a barrier for maximum efficiency of the treatment procedure. This forms the limitation of the new developed system model.

4.8. System Conversion

The new system conversion is presented in this section.

4.8.1. Changeover Procedures

A system can be implemented after it has been tested and this is known as system conversion. It is a process of changing over from the old system to a new secured system. It can be performed in any of the following ways:

i. Pilot Conversion
ii. Phased Conversion
iii. Parallel Conversion
iv. Direct Conversion

Pilot Conversion

This approach involves the trial of the new system in only one part of the organization. Once the system is working out smoothly in that part, focus is then shifted to other parts of the organization.

Parallel Conversion

In this approach, old and new systems are operated side by side until the new one has shown that it is reliable. This approach is low risk. If the new system fails, the organization can just switch to the old system to keep going. This method, however, is expensive as it keeps people and equipment active to manage the two systems.

Phased Conversion

This approach is similar to the parallel approach except that initially, only a portion of the current data is run in parallel on the new system for instance, that pertaining to one department or unit only. During the following weeks, more sections are transferred onto the new system. In

each case, the old system runs in parallel for one processing cycle only. Thus, the old system is phased out as the new system builds up.

Direct conversion

This involves taking the old system offline and putting the new system online within a day or over a weekend or holiday period. This is cheap and also quick, allowing the new features to be put to use immediately. However if there is a problem with the new system there is not anything to fall back on.

4.8.2. Recommended Procedure

Parallel change over is recommended for this system in which both the old and new system are operated concurrently for a period of time until the new system is certified functional. This is to enable the management fall back to the old system should the new system pose some challenges in its usage.

4.9. System Security

The system security was taken care of as users login with their user name and password which is always encrypted to avoid people spying on it.

4.10. Training

It is recommended that the user of the new system be trained on its functionality and parameters needed so as to enable them make maximum usage of the new system.

4.11. Documentation

The documentation in the dissertation is mainly on how the application can be used and how it can be installed. To install it on the system to run from the hard disk, follow the procedure below.

i. Install Micro media Dreamweaver 8 on the Computer
ii. Install Wamp Server on the computer
iii. Install My-SQL
iv. Install Java Virtual Machine
v. Install jQuery files
vi. Click Start Button on the desktop
vii. Select program

viii. Click Windows explorer

ix. Click Drive D:

x. Select the folder “businessintelligence”

xi. Click Edit

xii. Click Copy

xiii. Select drive C:

xiv. Select Wamp

xv. Select www

xvi. Click paste to Copy the Folder “businessintelligence” from drive D: to Drive C:

xvii. The folder contains the entire sub-program that makes up the software developed to be copied to the www root

xviii. Open internet explorer

xix. Type http://localhost/businessintelligence

xx. Select the login page

xxi. Enter the user name and password and click login

xxii. Select options from the menu

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. Summary

In this research, a hybrid model for enhanced business intelligence process (HMEBIP), tested in the disease control procedure aspect of health sector domain was developed using case-based reasoning (CBR) intelligent agent technology to boost the intelligence expertise of the Business Intelligence process. The system model developed focused on enhancing the data integration phase of a Business Intelligence process with the hybridization of two data integration techniques – ontology-based data integration (OBDI) and virtual data integration (VDI) with the aim of harnessing the merits of both techniques and reducing the demerits as applied in a single Business Intelligence (BI) environment.

Also, it focused on assisting medical practitioners' experts with the intelligent agent technology of case-based reasoning (CBR) involved in the model, in guiding the experts in the health sector to accurately and intelligently carry out fact and evidence based knowledge insight decision making for disease control procedures treatment for their daily life saving and life style diagnosis, prevention, prediction and prescription service operation.

5.2. Conclusion

In a developing nation like Nigeria, data are rarely collected and stored at a single entry point especially in the health sector. Integration from multiple heterogeneous sources is a prerequisite step for many applications; examples, decision aids such as data and information fusion as well as data mining. It is also a prevailing task by many organizations in order to improve their knowledge sharing as well as the efficiency of their operations. This will be of immense benefit to physicians who are in need of these vast amounts of knowledge for their daily life saving operations.

Utilizing a Business Intelligence (BI) technology with the hybrid of ontology-based data integration and virtual data integration in its data integration process, is an attractive avenue as it is also a key factor for enabling interoperability. However, integrating vast amount of information and data from different heterogeneous sources is a difficult, complex and demanding task. The use of the hybrid of both ontology-based data integration (OBDI) and virtual data integration (VDI-data virtualization) techniques to automate the data integration

process in a Business Intelligence (BI) task and environment to reduce the time effort for the processing, analyzing, and querying of data in the vast heterogeneous sources of data was achieved in the research.

Again, advances in intelligent systems, example, "Intelligent Information Agents" for the Internet, will assist medical practitioners' experts in accurately and intelligently with fact and evidence-based knowledge insights carry out disease control procedures in the healthcare industry. Emerging and more mature standards such as "Extensible Markup Language" (XML), "Web Ontology Language" (OWL) and Web Services based on "Simple Object Access Protocol" (SOAP), "Universal, Description, Discovery, and Integration" (UDDI) and "Web Service Description Language" (WSDL), will also help to resolve many software-level interoperability problems. The system model developed in the research relied on these web interoperability standards in order to integrate information and data dynamically. As well it was used to develop the case-based reasoning (CBR) intelligent agent technology that boosted the intelligence of the developed hybrid model of the research study.

5.3. Recommendations

In order to get started with Business Intelligence (BI) a solid infrastructure foundation must exist with it, therefore

1. It is recommended that the health sector in Nigeria should integrate the model developed in the research into their electronic health records (HER) and other clinical as well as administrative records in order to assist medical practitioners' experts (doctors, nurses, etc) in accurately carrying out disease control procedures.
2. Also, government through the ministry of health should encourage the medical practitioners such as those in the Nigeria Centre for Disease Control (NCDC) by providing the necessary funds to implement an automation of this magnitude. This would help to improve the health sectors performance and as a result restore hope to the Nigeria medical system.
3. The research suggest for further work development of a more enhanced Business Intelligence (BI) process using the hybrid of other data integration techniques and boosting the intelligence of the Business Intelligence (BI) model using other intelligent (software) agent technology. As well as testing such model on a different industry domain or other aspect of the health industry.

5.4. Contribution to Knowledge

The major contribution of the dissertation to knowledge is the development of a hybrid model for an enhanced Business Intelligence process which uses case-based reasoning intelligent agent to guide medical practitioners' experts (doctors, nurses, etc) in the health sector in accurately carrying out disease control procedures.

1. It contributed greatly to knowledge sharing across board (intra-hospital-wise) for medical practitioners. As well, the hybrid of ontology-based data integration (OBDI) and virtual data integration (VDI) approaches appear as a promising way to resolve semantic issues in information interoperability in medical disease control procedure record management.
2. It affirms the possibility of hybridizing the two data integration techniques in a Business Intelligence process for health care decision making. And contributed to real-time Business Intelligence enterprise architecture for enhancing management's capacity on real-time decision making in the health sector.
3. It further contributed to prescriptive analytics through agent-based (case-based reasoning - CBR) modeling for disease control procedure of health sector. As well as providing managerial implication for the support of health sector disease control procedure decision making process for effective and efficient treatment of patients.
4. Also, the research enhanced hybrid Business Intelligence model as applied in the health sector would therefore not primarily be in simplifying communication and information provision, but it would enable new ways of working, allow to integrate information, organizations and to measure outputs in real-time.
5. Finally, it added to the empirical knowledge to the landscope of a wide body of practice in the health sector domain, Business Intelligence, data integration and agent technology research communities.

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APPENDIX A

Program Coding

```
<?php
$username = $_POST['username'];
$password = $_POST['password'];
mysql_connect("localhost","root")
or die (mysql_error());
mysql_select_db("symptoms");
$select = "select * from admin_login where username = '$username' and password = '$password' and level='2'";
$query = mysql_query($select);
if (mysql_num_rows($query)!=1)
{
 header("Location: login_error.php");
echo 'Invalid Password <br />';
}
else
{
$cmp= mysql_fetch_object($query);
$hsp = "$cmp->hospital";
$welcome = "Welcome ".$username;
$msg = $welcome . ' to ' . $hsp.' platform';
}
?>
<!DOCTYPE html>
<html lang="en-US"><head>
<meta http-equiv="content-type" content="text/html; charset=UTF-8">
<meta charset="UTF-8">
<meta name="viewport" content="width=device-width">
<title>Admin Home page</title>
<link rel="profile" href="http://gmpg.org/xfn/11">
<link rel="pingback" href="http:///xmlrpc.php">
<script type="text/javascript" src="jQuery.js"></script>
<script type="text/javascript" src="js.js"></script>
<script language="javascript" src="mootools/mootools.svn.js" type="text/javascript"></script>
<!--[if lt IE 9]>
<script src="http://www.gjgoodiesbag.com.ng/wp-content/themes/sunrain/js/html5.js" type="text/javascript"></script>
<![endif]-->
<link rel="dns-prefetch" href="http://fonts.googleapis.com/">
<link rel="dns-prefetch" href="http://s.w.org/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » Feed" href="http://www.gjgoodiesbag.com.ng/feed/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » Comments Feed" href="http://www.gjgoodiesbag.com.ng/comments/feed/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » About Us Comments Feed" href="http://www.gjgoodiesbag.com.ng/about-us/feed/">
<script crossorigin="*" charset="UTF-8" src="include/default.js" async=""></script><script type="text/javascript">

window._wpemojiSettings = {"baseUrl":"https:\/\/s.w.org\/images\/core\/emoji\/2.2.1\/72x72\/","ext":".png","svgUrl":"https:\/\/s.w.org\/images\/core\/emoji\/2.2.1\/svg\/","svgExt":".svg","source":{"concatemoji":"http:\/\/www.gjgoodiesbag.com.ng\/wp-includes\/js\/wp-emoji-release.min.js?ver=4.7"}};

!function(a,b,c){function d(a){var b,c,d,e,f=String.fromCharCode;if(!k||!k.fillText)return!1;switch(k.clearRect(0,0,j.width,j.height),k.textBaseline="top",k.font="600 32px Arial",a){case"flag":return k.fillText(f(55356,56826,55356,56819),0,0),!(j.toDataURL().length<3e3)&&(k.clearRect(0,0,j.width,j.height),k.fillText(f(55356,57331,65039,8205,55356,57096),0,0),b=j.toDataURL(),k.clearRect(0,0,j.width,j.height),k.fillText(f(55356,5
```

```
7331,55356,57096),0,0),c=j.toDataURL(),b!==
c);case"emoji4":return
k.fillText(f(55357,56425,55356,57341,8205,55
357,56507),0,0),d=j.toDataURL(),k.clearRect(0
,0,j.width,j.height),k.fillText(f(55357,56425,55
356,57341,55357,56507),0,0),e=j.toDataURL()
,d!==e}return!1}function e(a){var
c=b.createElement("script");c.src=a,c.defer=c.t
ype="text/javascript",b.getElementsByTagNam
e("head")[0].appendChild(c)}var
f,g,h,i,j=b.createElement("canvas"),k=j.getCont
ext&&j.getContext("2d");for(i=Array("flag","e
moji4"),c.supports={everything:!0,everythingE
xceptFlag:!0},h=0;h<i.length;h++)c.supports[i[
h]]=d(i[h]),c.supports.everything=c.supports.ev
erything&&c.supports[i[h]],"flag"!==i[h]&&(c.
supports.everythingExceptFlag=c.supports.ever
ythingExceptFlag&&c.supports[i[h]]);c.support
s.everythingExceptFlag=c.supports.everythingE
xceptFlag&&!c.supports.flag,c.DOMReady=!1,
c.readyCallback=function(){c.DOMReady=!0},
c.supports.everything||(g=function(){c.readyCal
lback()},b.addEventListener?(b.addEventListen
er("DOMContentLoaded",g,!1),a.addEventList
ener("load",g,!1)):(a.attachEvent("onload",g),b.
attachEvent("onreadystatechange",function(){"
complete"===b.readyState&&c.readyCallback(
)})),f=c.source||{},f.concatemoji?e(f.concatemo
ji):f.wpemoji&&f.twemoji&&(e(f.twemoji),e(f.
wpemoji)))}(window,document,window._wpe
mojiSettings);
		</script><script defer="defer"
type="text/javascript" src="include/wp-emoji-
release.js"></script>
		<style type="text/css">
img.wp-smiley,
img.emoji {
	display: inline !important;
	border: none !important;
	box-shadow: none !important;
	height: 1em !important;
	width: 1em !important;
	margin: 0 .07em !important;
	vertical-align: -0.1em !important;
	background: none !important;
	padding: 0 !important;
}
	</style>
<link rel="stylesheet" id="sunrain-style-css"
href="include/style.css" type="text/css"
media="all">
<link rel="stylesheet" id="sunrain-gfonts1-css"
href="include/css.css" type="text/css"
media="all">
<link rel="stylesheet" id="sunrain-responsive-
css" href="include/style-responsive.css"
type="text/css" media="all">
<link rel="stylesheet"
id="counterize_stylesheet-css"
href="include/counterize.css" type="text/css"
media="all">
<script type="text/javascript"
src="include/jquery.js"></script>
<script type="text/javascript"
src="include/jquery-migrate.js"></script>
<script type="text/javascript"
src="include/menu.js"></script>
<script type="text/javascript"
src="include/counterize.php"></script>
<link rel="https://api.w.org/" href="http:///wp-
json/">
<link rel="EditURI"
type="application/rsd+xml" title="RSD"
href=xmlrpc.php?rsd">
<link rel="wlwmanifest"
type="application/wlwmanifest+xml"
href="/wp-includes/wlwmanifest.xml">
<meta name="generator" content="WordPress
4.7">
<link rel="canonical"
href="include/a_003.htm">
<link rel="shortlink" href="http:///?p=35">
<link rel="alternate"
type="application/json+oembed" href="">
<link rel="alternate" type="text/xml+oembed"
href="">
	<style type="text/css">
	.site-title a,
	.site-title a:active,
	.site-title a:hover {

	color: #000000;
	}
<style type="text/css" id="custom-background-
css">
```

```
body.custom-background { background-image: url("http:\/\/\/wp-content\/themes\/sunrain\/images\/back1.png"); background-position: left top; background-size: auto; background-repeat: repeat; background-attachment: scroll; }
.style28 {font-size: 14px; font-weight: bold; }
.style29 {font-size: 12px; color: #0000FF; }
   </style>
</head>
<body class="page-template page-template-fullwidth page-template-fullwidth-php page page-id-35 custom-background">
  <table width="600" border="0">
  <tr>
  <td><form id="userForm" name="userForm" method="post" action="">
            <input name="username" type="hidden" id="username" value="<?php echo $username ?>" />
            <input name="password" type="hidden" id="password" value="<?php echo $password ?>" />
          </form></td>
  </tr>
</table>
    <div id="header">
    <div id="header-content">
                <!-- Site Titele and Description Goes Here -->
      <a href="/"><img class="site-logo" src="images/cropped-ourlogonslogan.png"></a>
      <h1 class="site-title-hidden"></h1>
                <h2 class="site-title-hidden"></h2>
      <nav id="sunrain-top-menu">
                <div class="menu-topmenu-container"><ul id="menu-topmenu" class="menu"><li id="menu-item-108" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-108"><a href="#" onClick="adminTransfer('personnelreg.php');">Patient Registration</a></li>
<li id="menu-item-33" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-33"><a href="#" onClick="adminTransfer('symptomsreg.php');">Disease Ontology </a></li>
<li id="menu-item-34" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-34"><a href="#" onClick="adminTransfer('amunreg.php');">Case based Reasoning</a></li>
<li id="menu-item-34" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-34"><a href="#" onClick="adminTransfer('expycheck.php');">Close Case</a></li>
<li id="menu-item-34" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-34"><a href="#" onClick="adminTransfer('maintcheck.php');">Alert </a></li>
</ul></div>      </nav>
      <!-- Site Main Menu Goes Here -->
      <nav id="sunrain-main-menu">
                <div class="menu-mainmenu-container"><ul id="menu-mainmenu" class="menu"><li id="menu-item-23" class="menu-item menu-item-type-custom menu-item-object-custom current-menu-item current_page_item menu-item-home menu-item-23"><a href="index.php">Log Out</a></li>
                <li id="menu-item-25" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-25"><a href="#" onClick="adminTransfer('adminhome.php');">Home </a></li>
<li id="menu-item-39" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-39"><a href="#" onClick="adminTransfer('personsymptomscheck.php');">Treatment</a></li>
<li id="menu-item-24" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-24"><a href="#" onClick="adminTransfer('personnel.php');">Patients</a></li>
<li id="menu-item-24" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-24"><a href="#"
```

```
onClick="adminTransfer('symptomsreport.php'
);">History</a></li>
<li id="menu-item-24" class="menu-item
menu-item-type-post_type menu-item-object-
page menu-item-24"><a href="#"
onClick="adminTransfer('ammunireport.php');"
>Statistical Report</a></li>

</ul></div>    </nav>
    </div><!-- header-content -->
    </div><!-- header -->
          <div id="container">
<div id="content-full">
<h1 id="post-35" class="page-title">Disease
Ontology / Data Integration </h1>
 <div class="content-ver-sep"> </div>
 <div class="entrytext">
  <p><strong>Welcome to User Platform
</strong></p>
  <p align="center"><img src="images/1 -
Copy.jpg" width="360" height="270"></p>
  <p> </p>
 <p><strong> </strong></p>
<p> </p>
</div><div class="clear"><?php echo $msg; ?>
</div>
 <br>
<div id="commentsbox">
          </div>
</div>
</div><!-- container -->
<div id="footer">
<div id="footer-content">
<div id="creditline"></div>
</div> <!-- footer-content -->
</div> <!-- footer -->
<div                    id="topdirection"><a
href="#">^</a></div>
<div class="clear"> </div>
<!--Start of Tawk.to Script-->
<script type="text/javascript">
var  $_Tawk_API={},$_Tawk_LoadStart=new
Date();
(function(){
var
s1=document.createElement("script"),s0=docu
ment.getElementsByTagName("script")[0];
s1.async=true;
s1.src='https://embed.tawk.to/556736fb7e314cc
25508388b/default';
s1.charset='UTF-8';
s1.setAttribute('crossorigin','*');
s0.parentNode.insertBefore(s1,s0);
})();
</script>
<!--End of Tawk.to Script--><script
type="text/javascript"          src="include/wp-
embed.js"></script>
<?php

mysql_connect("localhost","root")
or die (mysql_error());
mysql_select_db("symptoms");

if(!($_POST['username2']))
{
$username = $_POST['username'];
$password = $_POST['password'];
}
else
{
$username = $_POST['username2'];
$password = $_POST['password2'];
}

$select = "select * from admin_login where
username = '$username' and password =
'$password' and level='2'";
$login = mysql_query($select) ;//or
die(mysql_error());
if (mysql_num_rows($login)!=1)
{
        header("Location: login_error.php");
echo 'Invalid Password <br />';
}
else
{

$welcome = "Welcome ".$username;

$serviceno = $_POST['serviceno'];
$sy = $_POST['sy'];
$ds = $_POST['ds'];
$sg = $_POST['sg'];
$serialno= $_POST['serialno'];
if ($serviceno)
```

```
{
$create = "update tblpatient set symptoms ='$sy', disease='$ds' , treatment='$sg' where id ='$serviceno'";
mysql_query($create) or die("error");
$mss = "Record Posted Successfully";
}
else
{
$mss = "Fill the Form and Click Post";
}
}

?>
<!DOCTYPE html>
<html lang="en-US"><head>
<meta http-equiv="content-type" content="text/html; charset=UTF-8">
<meta charset="UTF-8">
<meta name="viewport" content="width=device-width">
<title>Admin Home page</title>
<link rel="profile" href="http://gmpg.org/xfn/11">
<link rel="pingback" href="http:///xmlrpc.php">
<script type="text/javascript" src="jQuery.js"></script>
<script type="text/javascript" src="js.js"></script>
<script language="javascript" src="mootools/mootools.svn.js" type="text/javascript"></script>
<script type="text/javascript" src="js/jquery-3.2.0.min.js"></script>

<script type="text/javascript">

$(document).ready(function(){

        $("#serviceno").on('blur' , function(){

                var serviceno = $("#serviceno").val();
                $("#status").html("Pleas wait. Loading ... ");
                $.post("code/search.php" , { serviceno : serviceno } , function(r){

                        if(r==0)
                        {
                                $("#surname , #firstname , #lastname ").val('');


        $("#status").html("Record not found ");
                        }
                        else
                        {

        $("#status").html("Record found ");
                                var arr = JSON.parse(r);

        $("#surname").val(arr['surname']);

        $("#firstname").val(arr['firstname']);

        $("#lastname").val(arr['lastname']);

                        }
                });
        });

        $("#serialno").on('blur' , function(){

                var serialno = $("#serialno").val();
                $("#status").html("Pleas wait. Loading ... ");
                $.post("code/search2.php" , { serialno : serialno } , function(r){

                        if(r==0)
                        {
                                $("#tp , #sy , #ds, #sg ").val('');


        $("#status").html("Record not found ");
                        }
                        else
                        {

        $("#status").html("Record found ");
```

```
                var arr = JSON.parse(r);

        $("#ds").val(arr['ds']);

        $("#sy").val(arr['sy']);

        $("#tp").val(arr['tp']);

        $("#sg").val(arr['sg']);


                }
            });
        });

});

</script>

<!--[if lt IE 9]>
<script src="http:///wp-content/themes/sunrain/js/html5.js" type="text/javascript"></script>
<![endif]-->
<link rel="dns-prefetch" href="http://fonts.googleapis.com/">
<link rel="dns-prefetch" href="http://s.w.org/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » Feed" href="http:///feed/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » Comments Feed" href="http://www.gjgoodiesbag.com.ng/comments/feed/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » About Us Comments Feed" href="http://www.gjgoodiesbag.com.ng/about-us/feed/">
            <script crossorigin="*" charset="UTF-8" src="include/default.js" async=""></script><script type="text/javascript">

        window._wpemojiSettings = {"baseUrl":"https:\/\/s.w.org\/images\/core\/emoji\/2.2.1\/72x72\/","ext":".png","svgUrl":"https:\/\/s.w.org\/images\/core\/emoji\/2.2.1\/svg\/","svgExt":".svg","source":{"concatemoji":"http:\/\/www.gjgoodiesbag.com.ng\/wp-includes\/js\/wp-emoji-release.min.js?ver=4.7"}};

            !function(a,b,c){function d(a){var b,c,d,e,f=String.fromCharCode;if(!k||!k.fillText)return!1;switch(k.clearRect(0,0,j.width,j.height),k.textBaseline="top",k.font="600 32px Arial",a){case"flag":return k.fillText(f(55356,56826,55356,56819),0,0),!(j.toDataURL().length<3e3)&&(k.clearRect(0,0,j.width,j.height),k.fillText(f(55356,57331,65039,8205,55356,57096),0,0),b=j.toDataURL(),k.clearRect(0,0,j.width,j.height),k.fillText(f(55356,57331,55356,57096),0,0),c=j.toDataURL(),b!==c);case"emoji4":return k.fillText(f(55357,56425,55356,57341,8205,55357,56507),0,0),d=j.toDataURL(),k.clearRect(0,0,j.width,j.height),k.fillText(f(55357,56425,55356,57341,55357,56507),0,0),e=j.toDataURL(),d!==e}return!1}function e(a){var c=b.createElement("script");c.src=a,c.defer=c.type="text/javascript",b.getElementsByTagName("head")[0].appendChild(c)}var f,g,h,i,j=b.createElement("canvas"),k=j.getContext&&j.getContext("2d");for(i=Array("flag","emoji4"),c.supports={everything:!0,everythingExceptFlag:!0},h=0;h<i.length;h++)c.supports[i[h]]=d(i[h]),c.supports.everything=c.supports.everything&&c.supports[i[h]],"flag"!==i[h]&&(c.supports.everythingExceptFlag=c.supports.everythingExceptFlag&&c.supports[i[h]]);c.supports.everythingExceptFlag=c.supports.everythingExceptFlag&&!c.supports.flag,c.DOMReady=!1,c.readyCallback=function(){c.DOMReady=!0},c.supports.everything||(g=function(){c.readyCallback()},b.addEventListener?(b.addEventListener("DOMContentLoaded",g,!1),a.addEventListener("load",g,!1)):(a.attachEvent("onload",g),b.attachEvent("onreadystatechange",function(){"complete"===b.readyState&&c.readyCallback()})),f=c.source||{},f.concatemoji?e(f.concatemoji):f.wpemoji&&f.twemoji&&(e(f.twemoji),e(f.wpemoji))})(window,document,window._wpemojiSettings);
```

```
                </script><script defer="defer" type="text/javascript" src="include/wp-emoji-release.js"></script>
                <style type="text/css">
img.wp-smiley,
img.emoji {
        display: inline !important;
        border: none !important;
        box-shadow: none !important;
        height: 1em !important;
        width: 1em !important;
        margin: 0 .07em !important;
        vertical-align: -0.1em !important;
        background: none !important;
        padding: 0 !important;
}
    </style>
<link rel="stylesheet" id="sunrain-style-css" href="include/style.css" type="text/css" media="all">
<link rel="stylesheet" id="sunrain-gfonts1-css" href="include/css.css" type="text/css" media="all">
<link rel="stylesheet" id="sunrain-responsive-css" href="include/style-responsive.css" type="text/css" media="all">
<link rel="stylesheet" id="counterize_stylesheet-css" href="include/counterize.css" type="text/css" media="all">
<script type="text/javascript" src="include/jquery.js"></script>
<script type="text/javascript" src="include/jquery-migrate.js"></script>
<script type="text/javascript" src="include/menu.js"></script>
<script type="text/javascript" src="include/counterize.php"></script>
<link rel="https://api.w.org/" href="http:///wp-json/">
<link rel="EditURI" type="application/rsd+xml" title="RSD" href=xmlrpc.php?rsd">
<link rel="wlwmanifest" type="application/wlwmanifest+xml" href="/wp-includes/wlwmanifest.xml">
<meta name="generator" content="WordPress 4.7">
<link rel="canonical" href="include/a_003.htm">
<link rel="shortlink" href="http:///?p=35">
<link rel="alternate" type="application/json+oembed" href="">
<link rel="alternate" type="text/xml+oembed" href="">

        <style type="text/css">
        .site-title a,
        .site-title a:active,
        .site-title a:hover {

        color: #000000;
        }

<style type="text/css" id="custom-background-css">
body.custom-background { background-image: url("http:\/\/\/wp-content\/themes\/sunrain\/images\/back1.png"); background-position: left top; background-size: auto; background-repeat: repeat; background-attachment: scroll; }
   .style12 {font-family: Georgia, "Times New Roman", Times, serif;
        font-size: 16px;
}
.style30 {font-family: Georgia, "Times New Roman", Times, serif; font-size: 12px; }
   </style>

</head>

<body class="page-template page-template-fullwidth page-template-fullwidth-php page page-id-35 custom-background">
  <table width="600" border="0">
  <tr>
  <td><form id="userForm" name="userForm" method="post" action="">
            <input name="username" type="hidden" id="username" value="<?php echo $username ?>" />
            <input name="password" type="hidden" id="password" value="<?php echo $password ?>" />
        </form></td>
```

```
  </tr>
</table>
    <div id="header">
    <div id="header-content">
                <!-- Site Titele and Description Goes Here -->
      <a href="/"><img class="site-logo" src="images/cropped-ourlogonslogan.png"></a>
      <h1 class="site-title-hidden"></h1>
                <h2 class="site-title-hidden"></h2>

      <nav id="sunrain-top-menu">
      <div class="menu-topmenu-container"><ul id="menu-topmenu" class="menu"><li id="menu-item-108" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-108"><a href="#" onClick="adminTransfer('personnelreg.php');">Patient Registration</a></li>
<li id="menu-item-33" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-33"><a href="#" onClick="adminTransfer('symptomsreg.php');">Disease Ontology </a></li>
<li id="menu-item-34" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-34"><a href="#" onClick="adminTransfer('amunreg.php');">Case based Reasoning</a></li>
<li id="menu-item-34" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-34"><a href="#" onClick="adminTransfer('expycheck.php');">Close Case</a></li>
<li id="menu-item-34" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-34"><a href="#" onClick="adminTransfer('maintcheck.php');">Alert </a></li>

</ul></div>      </nav>

      <!-- Site Main Menu Goes Here -->
      <nav id="sunrain-main-menu">
                <div class="menu-mainmenu-container"><ul id="menu-mainmenu" class="menu"><li id="menu-item-23" class="menu-item menu-item-type-custom menu-item-object-custom current-menu-item current_page_item menu-item-home menu-item-23"><a href="index.php">Log Out</a></li>
                <li id="menu-item-25" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-25"><a href="#" onClick="adminTransfer('adminhome.php');">Home </a></li>
<li id="menu-item-39" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-39"><a href="#" onClick="adminTransfer('personsymptomscheck.php');">Treatment</a></li>
<li id="menu-item-24" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-24"><a href="#" onClick="adminTransfer('personnel.php');">Patients</a></li>
<li id="menu-item-24" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-24"><a href="#" onClick="adminTransfer('symptomsreport.php');">History</a></li>
<li id="menu-item-24" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-24"><a href="#" onClick="adminTransfer('ammunireport.php');">Statistical Report</a></li>
</ul></div>      </nav>

    </div><!-- header-content -->
    </div><!-- header -->
          <div id="container">
<div id="content-full">
<div class="entrytext">
  <table width="900" border="0" cellspacing="0" cellpadding="0">
    <tr>
     <td width="300">

          <table width="300" border="0">
                <tr>
```

```
                    <td width="50" ><div
align="center" class="style7"><span
class="style5">Serial no</span></div></td>

                    <td width="250" ><div
align="left" class="style7"><span
class="style5">Symptoms</span></div></td>
                  </tr>
                                        <?php

        $select2 = "select * from tbldisease";
$result = mysql_query($select2) ;
                    $sn=1;
                    while ($display =
mysql_fetch_object($result))
                    {
                    ?>

                  <tr>



                    <td class="style5"><div
align="center"><strong><?php echo "$display-
>snum"; ?></strong></div></td>
                    <td class="style5"><div
align="left"><?php echo "$display-
>symptoms"; ?></div></td>
                  </tr>

            <?php

             $sn++;
                    }

            ?>
                  </table>
             </td>
    <td width="600"><form action=""
method="post" enctype="multipart/form-data"
name="form1">
      <table width="600" height="200"
border="0" cellpadding="0" cellspacing="0">
        <tr>
         <td height="20" colspan="4"
align="center" valign="middle"
background="images/form_top_bg.jpg"><div
align="center"><strong><span class="slide-
text1">Symptoms
Form</span></strong></div></td>
        </tr>
        <tr>
         <td height="20" align="left"><span
class="style30">Patient ID </span></td>
         <td align="left"><input
name="serviceno" type="text" class="textbox"
id="serviceno" /></td>
         <td align="left" class="style30">Midle
Name </td>
         <td align="left"><input
name="lastname" type="text" class="textbox"
id="lastname" tabindex="8" /></td>
        </tr>
        <tr>
         <td width="113" height="20"
align="left"><span
class="style30">Surname</span></td>
         <td width="202" align="left"><label>
          <input name="surname" type="text"
class="textbox" id="surname" tabindex="0" />
         </label></td>
         <td width="94" align="left"
class="style30">First name </td>
         <td width="191" align="left"><a
href="finger/FingerCapture.exe">
          <input name="firstname" type="text"
class="textbox" id="firstname" tabindex="1" />
         </a></td>
        </tr>
        <tr>
         <td height="20"
align="left">&amp;nbsp;</td>
         <td colspan="2" align="left"><div
align="left">Symptoms Observed </div></td>
         <td align="left">
          <label></label></td>
        </tr>
        <tr>
         <td height="20" align="left"><span
class="style30">Serial No </span></td>
         <td align="left"><label>
          <input name="serialno" type="text"
id="serialno">
         </label></td>
```

```
        <td align="center" background="images/form_top_bg.jpg" class="style30">Symptoms</td>
        <td rowspan="3" align="center" background="images/form_top_bg.jpg" class="style30"><label>
          <textarea name="sy" rows="8" id="sy"></textarea>
        </label></td>
      </tr>
      <tr>
        <td height="20" align="left"><span class="style30">Type </span></td>
        <td align="left"><input name="tp" type="text" class="textbox" id="tp" tabindex="4" /></td>
        <td align="left" class="style30"> </td>
      </tr>
      <tr>
        <td height="20" align="left"><span class="style30">Disease</span></td>
        <td align="left"><input name="ds" type="text" id="ds"></td>
        <td align="left"><input name="username2" type="hidden" id="username2" value="<?php echo $username ?>" />
          <input name="password2" type="hidden" id="password2" value="<?php echo $password?>" /></td>
      </tr>
      <tr>
        <td height="20" align="left"> </td>
        <td align="left"><label></label>
          <input name="user_Submit" type="submit" class="button" id="user_Submit" value="Post" /></td>
        <td align="left">Sugested Treatment </td>
        <td align="left"><label>
          <textarea name="sg" rows="3" id="sg"></textarea>
        </label></td>
      </tr>
      <tr>
        <td height="20" colspan="4" align="center" valign="middle" background="images/form_top_bg.jpg"><div id="acc_msg" class="style12">
          <div align="center"><?php echo $mss; ?></div>
        </div></td>
      </tr>
    </table>
    </form>
  </td>
 </tr>
</table>
<p align="center"> </p>
<p align="center"> </p>
<p> </p>
<p><strong> </strong></p>

<p> </p>
</div><div class="clear"> </div>
<br>

<div id="commentsbox">
</div>
</div>
</div><!-- container -->
<div id="footer">
<div id="footer-content">
<div id="creditline"></div>
</div> <!-- footer-content -->
</div> <!-- footer -->
<div id="topdirection"><a href="#">^</a></div>
<div class="clear"> </div>
<!--Start of Tawk.to Script-->
<script type="text/javascript">
var $_Tawk_API={},$_Tawk_LoadStart=new Date();
(function(){
var s1=document.createElement("script"),s0=document.getElementsByTagName("script")[0];
s1.async=true;
s1.src='https://embed.tawk.to/556736fb7e314cc25508388b/default';
s1.charset='UTF-8';
s1.setAttribute('crossorigin','*');
s0.parentNode.insertBefore(s1,s0);
```

```
})();
</script>
<!--End of Tawk.to Script--><script type="text/javascript" src="include/wp-embed.js"></script>
<?php
if(!($_POST['username2']))
{
$username = $_POST['username'];
$password = $_POST['password'];
}
else
{
$username = $_POST['username2'];
$password = $_POST['password2'];
}
mysql_connect("localhost","root")
or die (mysql_error());
mysql_select_db("symptoms");
$select = "select * from admin_login where username = '$username' and password = '$password' and level='1' ";
$query = mysql_query($select)
or die("Query failed");
if (mysql_num_rows($query)<1):
        header("Location: login_error2.php");
endif;
$na = $_POST['textfield'];
$pa = $_POST['textfield2'];
$hp = $_POST['textfield3'];
$lv = $_POST['select'];

if ($na)
{

$create = "insert into admin_login (username, password, level, hospital) values ('$na', '$pa', '$lv', '$hp')";

mysql_query($create) or die("error");

}

?>
<!DOCTYPE html>
<html lang="en-US"><head>
<meta http-equiv="content-type" content="text/html; charset=UTF-8">
<meta charset="UTF-8">
<meta name="viewport" content="width=device-width">
<title>Admin Home page</title>
<link rel="profile" href="http://gmpg.org/xfn/11">
<link rel="pingback" href="http:///xmlrpc.php">
<script type="text/javascript" src="jQuery.js"></script>
<script type="text/javascript" src="js.js"></script>
<script language="javascript" src="mootools/mootools.svn.js" type="text/javascript"></script>
<!--[if lt IE 9]>
<script src="http://www.gjgoodiesbag.com.ng/wp-content/themes/sunrain/js/html5.js" type="text/javascript"></script>
<![endif]-->
<link rel="dns-prefetch" href="http://fonts.googleapis.com/">
<link rel="dns-prefetch" href="http://s.w.org/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » Feed" href="http://www.gjgoodiesbag.com.ng/feed/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » Comments Feed" href="http://www.gjgoodiesbag.com.ng/comments/feed/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » About Us Comments Feed" href="http://www.gjgoodiesbag.com.ng/about-us/feed/">
        <script crossorigin="*" charset="UTF-8" src="include/default.js" async=""></script><script type="text/javascript">

        window._wpemojiSettings = {"baseUrl":"https:\/\/s.w.org\/images\/core\/emoji\/2.2.1\/72x72\/","ext":".png","svgUrl":"https:\/\/s.w.org\/images\/core\/emoji\/2.2.1\/svg\/","svgExt":".svg","source":{"concatemoji":"http:\/
```

```
\/www.gjgoodiesbag.com.ng\/wp-includes\/js\/wp-emoji-release.min.js?ver=4.7"}};

		!function(a,b,c){function d(a){var b,c,d,e,f=String.fromCharCode;if(!k||!k.fillText)return!1;switch(k.clearRect(0,0,j.width,j.height),k.textBaseline="top",k.font="600 32px Arial",a){case"flag":return k.fillText(f(55356,56826,55356,56819),0,0),!(j.toDataURL().length<3e3)&&(k.clearRect(0,0,j.width,j.height),k.fillText(f(55356,57331,65039,8205,55356,57096),0,0),b=j.toDataURL(),k.clearRect(0,0,j.width,j.height),k.fillText(f(55356,57331,55356,57096),0,0),c=j.toDataURL(),b!==c);case"emoji4":return k.fillText(f(55357,56425,55356,57341,8205,55357,56507),0,0),d=j.toDataURL(),k.clearRect(0,0,j.width,j.height),k.fillText(f(55357,56425,55356,57341,55357,56507),0,0),e=j.toDataURL(),d!==e}return!1}function e(a){var c=b.createElement("script");c.src=a,c.defer=c.type="text/javascript",b.getElementsByTagName("head")[0].appendChild(c)}var f,g,h,i,j=b.createElement("canvas"),k=j.getContext&&j.getContext("2d");for(i=Array("flag","emoji4"),c.supports={everything:!0,everythingExceptFlag:!0},h=0;h<i.length;h++)c.supports[i[h]]=d(i[h]),c.supports.everything=c.supports.everything&&c.supports[i[h]],"flag"!==i[h]&&(c.supports.everythingExceptFlag=c.supports.everythingExceptFlag&&c.supports[i[h]]);c.supports.everythingExceptFlag=c.supports.everythingExceptFlag&&!c.supports.flag,c.DOMReady=!1,c.readyCallback=function(){c.DOMReady=!0},c.supports.everything||(g=function(){c.readyCallback()},b.addEventListener?(b.addEventListener("DOMContentLoaded",g,!1),a.addEventListener("load",g,!1)):(a.attachEvent("onload",g),b.attachEvent("onreadystatechange",function(){"complete"===b.readyState&&c.readyCallback()})),f=c.source||{},f.concatemoji?e(f.concatemoji):f.wpemoji&&f.twemoji&&(e(f.twemoji),e(f.wpemoji)))}(window,document,window._wpemojiSettings);
		</script><script defer="defer" type="text/javascript" src="include/wp-emoji-release.js"></script>

		<style type="text/css">
img.wp-smiley,
img.emoji {
	display: inline !important;
	border: none !important;
	box-shadow: none !important;
	height: 1em !important;
	width: 1em !important;
	margin: 0 .07em !important;
	vertical-align: -0.1em !important;
	background: none !important;
	padding: 0 !important;
}
	</style>
<link rel="stylesheet" id="sunrain-style-css" href="include/style.css" type="text/css" media="all">
<link rel="stylesheet" id="sunrain-gfonts1-css" href="include/css.css" type="text/css" media="all">
<link rel="stylesheet" id="sunrain-responsive-css" href="include/style-responsive.css" type="text/css" media="all">
<link rel="stylesheet" id="counterize_stylesheet-css" href="include/counterize.css" type="text/css" media="all">
<script type="text/javascript" src="include/jquery.js"></script>
<script type="text/javascript" src="include/jquery-migrate.js"></script>
<script type="text/javascript" src="include/menu.js"></script>
<script type="text/javascript" src="include/counterize.php"></script>
<link rel="https://api.w.org/" href="http:///wp-json/">
<link rel="EditURI" type="application/rsd+xml" title="RSD" href=xmlrpc.php?rsd">
<link rel="wlwmanifest" type="application/wlwmanifest+xml" href="/wp-includes/wlwmanifest.xml">
<meta name="generator" content="WordPress 4.7">
<link rel="canonical" href="include/a_003.htm">
<link rel="shortlink" href="http:///?p=35">
```

```
<link rel="alternate" type="application/json+oembed" href="">
<link rel="alternate" type="text/xml+oembed" href="">
        <style type="text/css">
        .site-title a,
        .site-title a:active,
        .site-title a:hover {

        color: #000000;
        }
<style type="text/css" id="custom-background-css">
body.custom-background { background-image: url("http:\/\/wp-content\/themes\/sunrain\/images\/back1.png"); background-position: left top; background-size: auto; background-repeat: repeat; background-attachment: scroll; }
.style28 {font-size: 14px; font-weight: bold; }
.style29 {font-size: 12px; color: #0000FF; }
   </style>
</head>
<body class="page-template page-template-fullwidth page-template-fullwidth-php page page-id-35 custom-background">
  <table width="600" border="0">
  <tr>
  <td><form id="userForm" name="userForm" method="post" action="">
            <input name="username" type="hidden" id="username" value="<?php echo $username ?>" />
            <input name="password" type="hidden" id="password" value="<?php echo $password ?>" />
          </form></td>
  </tr>
</table>
    <div id="header">
    <div id="header-content">
                <!-- Site Titele and Description Goes Here -->
      <a href="/"><img class="site-logo" src="images/cropped-ourlogonslogan.png"></a>
      <h1 class="site-title-hidden"></h1>
                <h2 class="site-title-hidden"></h2>
      <nav id="sunrain-top-menu">
                <div class="menu-topmenu-container"><ul id="menu-topmenu" class="menu"><li id="menu-item-108" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-108"><a href="#" onClick="adminTransfer('userreg.php');">Create Password</a></li>
<li id="menu-item-33" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-33"><a href="#" onClick="adminTransfer('userchange.php');">Change Password</a></li>
<li id="menu-item-34" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-34"><a href="#" onClick="adminTransfer('userdel.php');">Delete Password</a></li>
<li id="menu-item-34" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-34"><a href="#" onClick="adminTransfer('trackreport.php');">Disease Registry Report</a></li>
<li id="menu-item-34" class="menu-item menu-item-type-custom menu-item-object-custom menu-item-34"><a href="#" onClick="adminTransfer('outreport.php');">Patients Report</a></li>
</ul></div>      </nav>

      <!-- Site Main Menu Goes Here -->
      <nav id="sunrain-main-menu">
                <div class="menu-mainmenu-container"><ul id="menu-mainmenu" class="menu"><li id="menu-item-25" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-25"><a href="#" onClick="adminTransfer('adminhome2.php');" >Home</a></li>
<li id="menu-item-23" class="menu-item menu-item-type-custom menu-item-object-custom current-menu-item current_page_item menu-item-home menu-item-23"><a href="index.php">Log Out</a></li>
```

```
<li id="menu-item-25" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-25"><a href="#" onClick="adminTransfer('updatedata.php');">Disease Registry</a></li>
<li id="menu-item-24" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-24"><a href="#" onClick="adminTransfer('personnel2.php');">Delete Patient</a></li>

<li id="menu-item-24" class="menu-item menu-item-type-post_type menu-item-object-page menu-item-24"><a href="#" onClick="adminTransfer('ammunireport2.php');">Delete Disease Record</a></li>
</ul></div>    </nav>
    </div><!-- header-content -->
    </div><!-- header -->
        <div id="container">
<div id="content-full">

 <h1 id="post-35" class="page-title">Hospital / Disease Registry</h1>
 <div class="content-ver-sep"> </div>
 <div class="entrytext">
  <p><strong>Welcome to Admin Platform </strong></p>
  <p align="left" class="counterize_history_killbutton">Create Password</p>
  <form name="form1" method="post" action="">
    <table width="400" border="0" align="center" cellpadding="0" cellspacing="0">
     <tr>
      <td width="150">User Name </td>
      <td>
       <input type="text" name="textfield"></td>
     </tr>
     <tr>
      <td>Password</td>
      <td>
       <input type="password" name="textfield2">    </td>
     </tr>
     <tr>
      <td>Access Level </td>
      <td>
       <select name="select">
        <option>1</option>
        <option>2</option>
       </select>    </td>
     </tr>
     <tr>
      <td> </td>
      <td>1 - Admin, 2 - Hospitals </td>
     </tr>
     <tr>
      <td>Name of Hospital </td>
      <td><label>
       <input type="text" name="textfield3">
      </label></td>
     </tr>
     <tr>
      <td><div align="right">
       <label>
       <input type="submit" name="Submit" value="Submit">
       </label>
      </div></td>
      <td><input name="username2" type="hidden" id="username2" value="<?php echo $username ?>" />
       <input name="password2" type="hidden" id="password2" value="<?php echo $password?>" /></td>
     </tr>
    </table>
    </form>
  <p align="center">  </p>
  <p> </p>
 <p><strong> </strong></p>
<p> </p>
</div><div class="clear"> </div>
 <br>
<div id="commentsbox">
        </div>
</div>
</div><!-- container -->
<div id="footer">
<div id="footer-content">
<div id="creditline"></div>
</div> <!-- footer-content -->
```

```
</div> <!-- footer -->
<div id="topdirection"><a href="#">^</a></div>
<div class="clear"> </div>
<!--Start of Tawk.to Script-->
<script type="text/javascript">
var $_Tawk_API={},$_Tawk_LoadStart=new Date();
(function(){
var s1=document.createElement("script"),s0=document.getElementsByTagName("script")[0];
s1.async=true;
s1.src='https://embed.tawk.to/556736fb7e314cc25508388b/default';
s1.charset='UTF-8';
s1.setAttribute('crossorigin','*');
s0.parentNode.insertBefore(s1,s0);
})();
</script>
<!--End of Tawk.to Script--><script type="text/javascript" src="include/wp-embed.js"></script>
<?php
//sleep(2);
mysql_connect("localhost","root")
or die (mysql_error());
mysql_select_db("symptoms");

$serialno = $_POST['serialno'];

$query = "select * from tbldisease where snum = '$serialno'";
$q = mysql_query($query) or die(0);

$count = mysql_num_rows($q);
if($count >=1)
{
        $row = mysql_fetch_object($q);
        $ds = $row->disease;
        $sy = $row->symptoms;
        $tp = $row->type;
        $sg = $row->treatment;
         $array = array("ds" => $ds , "sy" => $sy , "tp" => $tp , "sg" => $sg );

         print json_encode($array);
}
else
{
        print 0;
}
?>
<?php

//sleep(2);
mysql_connect("localhost","root")
or die (mysql_error());
mysql_select_db("symptoms");

$serviceno = $_POST['serviceno'];

$query = "select * from tblpatient where id = '$serviceno'";
$q = mysql_query($query) or die(0);

$count = mysql_num_rows($q);
if($count >=1)
{
        $row = mysql_fetch_object($q);
        $surname = $row->surname;
        $firstname = $row->firstname;
        $lastname = $row->lastname;
        $sy = $row->symptoms;
        $ds = $row->disease;
        $tr = $row->treatment;
$query = "select * from tbldisease where disease = '$ds'";
$q = mysql_query($query) or die(0);

$count = mysql_num_rows($q);
$row = mysql_fetch_object($q);
        $tp = $row->type;
         $array = array("firstname" => $firstname , "lastname" => $lastname , "surname" => $surname, "sy" => $sy , "ds" => $ds , "tp" => $tp , "tr" => $tr );
         print json_encode($array);
}
else
{
        print 0;
}
?>
<?php
```

```
mysql_connect("localhost","root")
or die (mysql_error());
mysql_select_db("symptoms");
if(!($_POST['username2']))
{
$username = $_POST['username'];
$password = $_POST['password'];
}
else
{
$username = $_POST['username2'];
$password = $_POST['password2'];
}

$select = "select * from admin_login where username = '$username' and password = '$password' and level='2'";
$login = mysql_query($select) ;//or die(mysql_error());
if (mysql_num_rows($login)!=1)
{
        header("Location: login_error.php");
echo 'Invalid Password <br />';
}
else
{

$welcome = "Welcome ".$username;

$serviceno = $_POST['serviceno'];
$sy = $_POST['sy'];
$ds = $_POST['ds'];
$sg = $_POST['sg'];
$serialno= $_POST['serialno'];

$opt = $_POST['opt'];
$selectc = "select * from tblcbr where disease = '$ds'";
$resultc = mysql_query($selectc) ;
if ($serviceno)
{

if ($opt =='1')
{

$selectc = "select * from tblcbr where disease = '$ds'";
$resultc = mysql_query($selectc) ;
}
else
{
$create = "update tblpatient set symptoms ='$sy', disease='$ds' , treatment='$sg' where id ='$serviceno'";
mysql_query($create) or die("error");
$mss = "Record Posted Successfully";
}

}
else
{
$mss = "Fill the Form and Click Post";

}

}

?>
<!DOCTYPE html>
<html lang="en-US"><head>
<meta http-equiv="content-type" content="text/html; charset=UTF-8">
<meta charset="UTF-8">
<meta name="viewport" content="width=device-width">
<title>Admin Home page</title>
<link rel="profile" href="http://gmpg.org/xfn/11">
<link rel="pingback" href="http:///xmlrpc.php">
<script type="text/javascript" src="jQuery.js"></script>
<script type="text/javascript" src="js.js"></script>
<script language="javascript" src="mootools/mootools.svn.js" type="text/javascript"></script>
<script type="text/javascript" src="js/jquery-3.2.0.min.js"></script>

<script type="text/javascript">
$(document).ready(function(){

        $("#serviceno").on('blur' , function(){
```

```
		var serviceno = $("#serviceno").val();
		$("#status").html("Pleas wait. Loading ... ");
		$.post("code/search.php" , { serviceno : serviceno } , function(r){

			if(r==0)
			{
				$("#surname , #firstname , #lastname ").val('');


	$("#status").html("Record not found ");
			}
			else
			{

	$("#status").html("Record found ");
				var arr = JSON.parse(r);

	$("#surname").val(arr['surname']);

	$("#firstname").val(arr['firstname']);

	$("#lastname").val(arr['lastname']);

			}
		});
	});

	$("#sns").on('blur' , function(){

		var sns = $("#sns").val();
		$("#status").html("Pleas wait. Loading ... ");
		$.post("code/search4.php" , { sns : sns } , function(r){

			if(r==0)
			{
				$("#sg ").val('');


	$("#status").html("Record not found ");
			}
			else
			{

	$("#status").html("Record found ");
				var arr = JSON.parse(r);

	$("#sg").val(arr['trt']);

			}
		});
	});

	$("#serialno").on('blur' , function(){

		var serialno = $("#serialno").val();
		$("#status").html("Pleas wait. Loading ... ");
		$.post("code/search2.php" , { serialno : serialno } , function(r){

			if(r==0)
			{
				$("#tp , #sy , #ds, #sg ").val('');


	$("#status").html("Record not found ");
			}
			else
			{

	$("#status").html("Record found ");
				var arr = JSON.parse(r);

	$("#ds").val(arr['ds']);

	$("#sy").val(arr['sy']);

	$("#tp").val(arr['tp']);

			}
		});
	});

});
```

```
</script>

<!--[if lt IE 9]>
<script src="http:///wp-content/themes/sunrain/js/html5.js" type="text/javascript"></script>
<![endif]-->
<link rel="dns-prefetch" href="http://fonts.googleapis.com/">
<link rel="dns-prefetch" href="http://s.w.org/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » Feed" href="http:///feed/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » Comments Feed" href="http://www.gjgoodiesbag.com.ng/comments/feed/">
<link rel="alternate" type="application/rss+xml" title="G&amp;J Goodiesbag » About Us Comments Feed" href="http://www.gjgoodiesbag.com.ng/about-us/feed/">
                <script crossorigin="*" charset="UTF-8" src="include/default.js" async=""></script><script type="text/javascript">

        window._wpemojiSettings = {"baseUrl":"https:\/\/s.w.org\/images\/core\/emoji\/2.2.1\/72x72\/","ext":".png","svgUrl":"https:\/\/s.w.org\/images\/core\/emoji\/2.2.1\/svg\/","svgExt":".svg","source":{"concatemoji":"http:\/\/www.gjgoodiesbag.com.ng\/wp-includes\/js\/wp-emoji-release.min.js?ver=4.7"}};

        !function(a,b,c){function d(a){var b,c,d,e,f=String.fromCharCode;if(!k||!k.fillText)return!1;switch(k.clearRect(0,0,j.width,j.height),k.textBaseline="top",k.font="600 32px Arial",a){case"flag":return k.fillText(f(55356,56826,55356,56819),0,0),!(j.toDataURL().length<3e3)&&(k.clearRect(0,0,j.width,j.height),k.fillText(f(55356,57331,65039,8205,55356,57096),0,0),b=j.toDataURL(),k.clearRect(0,0,j.width,j.height),k.fillText(f(55356,57331,55356,57096),0,0),c=j.toDataURL(),b!==c);case"emoji4":return k.fillText(f(55357,56425,55356,57341,8205,55357,56507),0,0),d=j.toDataURL(),k.clearRect(0,0,j.width,j.height),k.fillText(f(55357,56425,55356,57341,55357,56507),0,0),e=j.toDataURL(),d!==e}return!1}function e(a){var c=b.createElement("script");c.src=a,c.defer=c.type="text/javascript",b.getElementsByTagName("head")[0].appendChild(c)}var f,g,h,i,j=b.createElement("canvas"),k=j.getContext&&j.getContext("2d");for(i=Array("flag","emoji4"),c.supports={everything:!0,everythingExceptFlag:!0},h=0;h<i.length;h++)c.supports[i[h]]=d(i[h]),c.supports.everything=c.supports.everything&&c.supports[i[h]],"flag"!==i[h]&&(c.supports.everythingExceptFlag=c.supports.everythingExceptFlag&&c.supports[i[h]]);c.supports.everythingExceptFlag=c.supports.everythingExceptFlag&&!c.supports.flag,c.DOMReady=!1,c.readyCallback=function(){c.DOMReady=!0},c.supports.everything||(g=function(){c.readyCallback()},b.addEventListener?(b.addEventListener("DOMContentLoaded",g,!1),a.addEventListener("load",g,!1)):(a.attachEvent("onload",g),b.attachEvent("onreadystatechange",function(){"complete"===b.readyState&&c.readyCallback()})),f=c.source||{},f.concatemoji?e(f.concatemoji):f.wpemoji&&f.twemoji&&(e(f.twemoji),e(f.wpemoji))})(window,document,window._wpemojiSettings);
                </script><script defer="defer" type="text/javascript" src="include/wp-emoji-release.js"></script>
                <style type="text/css">
img.wp-smiley,
img.emoji {
        display: inline !important;
        border: none !important;
        box-shadow: none !important;
        height: 1em !important;
        width: 1em !important;
        margin: 0 .07em !important;
        vertical-align: -0.1em !important;
        background: none !important;
        padding: 0 !important;
}
    </style>
```

```
<link rel="stylesheet" id="sunrain-style-css" href="include/style.css" type="text/css" media="all">
<link rel="stylesheet" id="sunrain-gfonts1-css" href="include/css.css" type="text/css" media="all">
<link rel="stylesheet" id="sunrain-responsive-css" href="include/style-responsive.css" type="text/css" media="all">
<link rel="stylesheet" id="counterize_stylesheet-css" href="include/counterize.css" type="text/css" media="all">
<script type="text/javascript" src="include/jquery.js"></script>
<script type="text/javascript" src="include/jquery-migrate.js"></script>
<script type="text/javascript" src="include/menu.js"></script>
<script type="text/javascript" src="include/counterize.php"></script>
<link rel="https://api.w.org/" href="http:///wp-json/">
<link rel="EditURI" type="application/rsd+xml" title="RSD" href=xmlrpc.php?rsd">
<link rel="wlwmanifest" type="application/wlwmanifest+xml" href="/wp-includes/wlwmanifest.xml">
<meta name="generator" content="WordPress 4.7">
<link rel="canonical" href="include/a_003.htm">
<link rel="shortlink" href="http:///?p=35">
<link rel="alternate" type="application/json+oembed" href="">
<link rel="alternate" type="text/xml+oembed" href="">
        <style type="text/css">
        .site-title a,
        .site-title a:active,
        .site-title a:hover {

        color: #000000;
        }

<style type="text/css" id="custom-background-css">
body.custom-background { background-image: url("http:\/\/\/wp-content\/themes\/sunrain\/images\/back1.png"); background-position: left top; background-size: auto; background-repeat: repeat; background-attachment: scroll; }
   .style12 {font-family: Georgia, "Times New Roman", Times, serif;
          font-size: 16px;
}
.style30 {font-family: Georgia, "Times New Roman", Times, serif; font-size: 12px; }
   </style>

</head>

<body class="page-template page-template-fullwidth page-template-fullwidth-php page page-id-35 custom-background">
  <table width="600" border="0">
  <tr>
  <td><form id="userForm" name="userForm" method="post" action="">
            <input name="username" type="hidden" id="username" value="<?php echo $username ?>" />
            <input name="password" type="hidden" id="password" value="<?php echo $password ?>" />
          </form></td>
  </tr>
</table>
    <div id="header">
    <div id="header-content">
                <!-- Site Titele and Description Goes Here -->
     <a href="/"><img class="site-logo" src="images/cropped-ourlogonslogan.png"></a>
      <h1 class="site-title-hidden"></h1>
                <h2 class="site-title-hidden"></h2>

      <nav id="sunrain-top-menu">
      <div class="menu-topmenu-container"><ul id="menu-topmenu" class="menu"><li id="menu-item-108" class="menu-item menu-item-type-post_type
```

```
menu-item-object-page menu-item-108"><a
href="#"
onClick="adminTransfer('personnelreg.php');">
Patient Registration</a></li>
<li id="menu-item-33" class="menu-item
menu-item-type-custom menu-item-object-
custom menu-item-33"><a href="#"
onClick="adminTransfer('symptomsreg.php');"
>Disease Ontology </a></li>
<li id="menu-item-34" class="menu-item
menu-item-type-custom menu-item-object-
custom menu-item-34"><a href="#"
onClick="adminTransfer('amunreg.php');">Cas
e based Reasoning</a></li>
<li id="menu-item-34" class="menu-item
menu-item-type-custom menu-item-object-
custom menu-item-34"><a href="#"
onClick="adminTransfer('expycheck.php');">C
lose Case</a></li>
<li id="menu-item-34" class="menu-item
menu-item-type-custom menu-item-object-
custom menu-item-34"><a href="#"
onClick="adminTransfer('maintcheck.php');">
Alert </a></li>

</ul></div>      </nav>

      <!-- Site Main Menu Goes Here -->
      <nav id="sunrain-main-menu">
                <div class="menu-mainmenu-
container"><ul id="menu-mainmenu"
class="menu"><li id="menu-item-23"
class="menu-item menu-item-type-custom
menu-item-object-custom current-menu-item
current_page_item menu-item-home menu-
item-23"><a href="index.php">Log
Out</a></li>
                <li id="menu-item-25"
class="menu-item menu-item-type-post_type
menu-item-object-page menu-item-25"><a
href="#"
onClick="adminTransfer('adminhome.php');">
Home </a></li>
<li id="menu-item-39" class="menu-item
menu-item-type-post_type menu-item-object-
page menu-item-39"><a href="#"
onClick="adminTransfer('personsymptomschec
k.php');">Treatment</a></li>
<li id="menu-item-24" class="menu-item
menu-item-type-post_type menu-item-object-
page menu-item-24"><a href="#"
onClick="adminTransfer('personnel.php');">Pat
ients</a></li>
<li id="menu-item-24" class="menu-item
menu-item-type-post_type menu-item-object-
page menu-item-24"><a href="#"
onClick="adminTransfer('symptomsreport.php'
);">History</a></li>
<li id="menu-item-24" class="menu-item
menu-item-type-post_type menu-item-object-
page menu-item-24"><a href="#"
onClick="adminTransfer('ammunireport.php');"
>Statistical Report</a></li>

</ul></div>      </nav>

    </div><!-- header-content -->
    </div><!-- header -->

          <div id="container">
<div id="content-full">

 <div class="entrytext">
  <table width="900" border="0"
cellspacing="0" cellpadding="0">
   <tr>
    <td width="300">

          <table width="300" border="0">
                <tr>
                 <td width="50" ><div
align="center" class="style7"><span
class="style5">Serial no</span></div></td>

                 <td width="250" ><div
align="left" class="style7"><span
class="style5">Symptoms</span></div></td>


                </tr>




                                    <?php

        $select2 = "select * from tbldisease";
```

```
$result = mysql_query($select2) ;

                $sn=1;

                while ($display = mysql_fetch_object($result))

                {

                ?>

               <tr>


                <td class="style5"><div align="center"><strong><?php echo "$display->snum"; ?></strong></div></td>
                <td class="style5"><div align="left"><?php echo "$display->symptoms"; ?></div></td>

               </tr>

          <?php

           $sn++;
                }

          ?>
               </table>

           </td>
    <td width="600"><form action="" method="post" enctype="multipart/form-data" name="form1">
      <table width="600" height="260" border="0" cellpadding="0" cellspacing="0">
        <tr>
         <td height="20" colspan="4" align="center" valign="middle" background="images/form_top_bg.jpg"><div align="center"><strong><span class="slide-text1">Case Base Reasoning Symptoms Form</span></strong></div></td>
        </tr>
        <tr>
         <td height="20" align="left"><span class="style30">Patient ID </span></td>
         <td align="left"><input name="serviceno" type="text" class="textbox" id="serviceno" /></td>
         <td align="left" class="style30">Midle Name </td>
         <td align="left"><input name="lastname" type="text" class="textbox" id="lastname" tabindex="8" /></td>
        </tr>
        <tr>
         <td width="113" height="20" align="left"><span class="style30">Surname</span></td>
         <td width="202" align="left"><label>
          <input name="surname" type="text" class="textbox" id="surname" tabindex="0" />
         </label></td>
         <td width="94" align="left" class="style30">First name </td>
         <td width="191" align="left"><a href="finger/FingerCapture.exe">
          <input name="firstname" type="text" class="textbox" id="firstname" tabindex="1" />
         </a></td>
        </tr>
        <tr>
         <td height="20" align="left"> </td>
         <td colspan="2" align="left"><div align="left">Symptoms Observed </div></td>
         <td align="left">

          <label></label></td>
        </tr>
        <tr>
         <td height="20" align="left"><span class="style30">Serial No </span></td>
         <td align="left"><label>
          <input name="serialno" type="text" id="serialno">
         </label></td>
         <td align="center" background="images/form_top_bg.jpg" class="style30">Symptoms</td>
         <td rowspan="3" align="center" background="images/form_top_bg.jpg" class="style30"><label>
```

```
          <textarea name="sy" rows="8" id="sy"></textarea>
          </label></td>
        </tr>
        <tr>
          <td height="20" align="left"><span class="style30">Type </span></td>
          <td align="left"><input name="tp" type="text" class="textbox" id="tp" tabindex="4" /></td>
          <td align="left" class="style30"> </td>
          </tr>
        <tr>
          <td height="20" align="left"><span class="style30">Disease</span></td>
          <td align="left"><input name="ds" type="text" id="ds"></td>
          <td align="left"><input name="username2" type="hidden" id="username2" value="<?php echo $username ?>" />
          <input name="password2" type="hidden" id="password2" value="<?php echo $password?>" /></td>
          </tr>

        <tr>
          <td height="20" align="left"> </td>
          <td align="left"><label></label>
          <input name="user_Submit" type="submit" class="button" id="user_Submit" value="Post" /></td>
          <td align="left">Selected Treatment Option from CBR </td>
          <td align="left"><label>
          <textarea name="sg" rows="3" id="sg"></textarea>
          </label></td>
        </tr>
        <tr>
          <td height="20" align="center" valign="middle" background="images/form_top_bg.jpg"> </td>
          <td height="20" align="center" valign="middle" background="images/form_top_bg.jpg"> </td>
          <td height="20" align="center" valign="middle" background="images/form_top_bg.jpg">Serial No selected </td>
          <td height="20" align="center" valign="middle" background="images/form_top_bg.jpg"><label>
          <input name="sns" type="text" id="sns">
          </label></td>
        </tr>
        <tr>
          <td height="20" colspan="4" align="center" valign="middle" background="images/form_top_bg.jpg"><div id="acc_msg" class="style12">
          <div align="center"><?php echo $mss; ?></div>
          </div></td>
          </tr>
        <tr>
          <td height="20" colspan="4" align="center" valign="middle" background="images/form_top_bg.jpg">1 - View CBR, 2 - Post Record </td>
        </tr>
        <tr>
          <td height="20" colspan="4" align="center" valign="middle" background="images/form_top_bg.jpg">Select Option
          <label>
          <input name="opt" type="text" id="opt">
          </label></td>
        </tr>
        <tr>
          <td height="20" colspan="4" align="center" valign="middle" background="images/form_top_bg.jpg">Suggestions for treatment based on existing cases </td>
        </tr>
        <tr>
          <td colspan="4" >
```

```
                    <table width="500" border="0">
                <tr>
                 <td width="50" ><div align="center" class="style7"><span class="style5">Serial no</span></div></td>

                 <td width="150" ><div align="left" class="style7"><span class="style5">Treatment</span></div></td>

                <td width="100" ><div align="left" class="style7"><span class="style5">Hospital</span></div></td>

                <td width="100" ><div align="left" class="style7"><span class="style5">Status at Discharge</span></div></td>

                <td width="100" ><div align="left" class="style7"><span class="style5">Treatment Rating</span></div></td>
                </tr>
<?php

                 while ($displayc = mysql_fetch_object($resultc))

                 {
          ?>

                <tr>


                 <td class="style5"><div align="center"><?php echo "$displayc->snum"; ?></div></td>
                 <td class="style5"><div align="left"><?php echo "$displayc->treatment"; ?></div></td>
                 <td class="style5"><div align="left"><?php echo "$displayc->hospital"; ?></div></td>

          <td class="style5"><div align="left"><?php echo "$displayc->status"; ?></div></td>

                 <td class="style5"><div align="left"><?php echo "$displayc->rating"; ?></div></td>
                </tr>

          <?php

           $sn++;
                }

          ?>
                </table>                    </td>
          </tr>
         </table>
            </form>
       </td>
      </tr>
     </table>
     <p align="center"> </p>
    <p align="center"> </p>
    <p> </p>
   <p><strong> </strong></p>

<p> </p>
</div><div class="clear"> </div>
 <br>

<div id="commentsbox">

          </div>

</div>

</div><!-- container -->

<div id="footer">

<div id="footer-content">

<div id="creditline"></div>

</div> <!-- footer-content -->
</div> <!-- footer -->
<div id="topdirection"><a href="#">^</a></div>
```

```
<div class="clear"> </div>
<!--Start of Tawk.to Script-->
<script type="text/javascript">
var    $_Tawk_API={},$_Tawk_LoadStart=new
Date();
(function(){
var
s1=document.createElement("script"),s0=docu
ment.getElementsByTagName("script")[0];
s1.async=true;
s1.src='https://embed.tawk.to/556736fb7e314cc
25508388b/default';
s1.charset='UTF-8';
s1.setAttribute('crossorigin','*');
s0.parentNode.insertBefore(s1,s0);
})();
</script>
```

APPENDIX B

Sample Outputs

Program Input / Output Forms

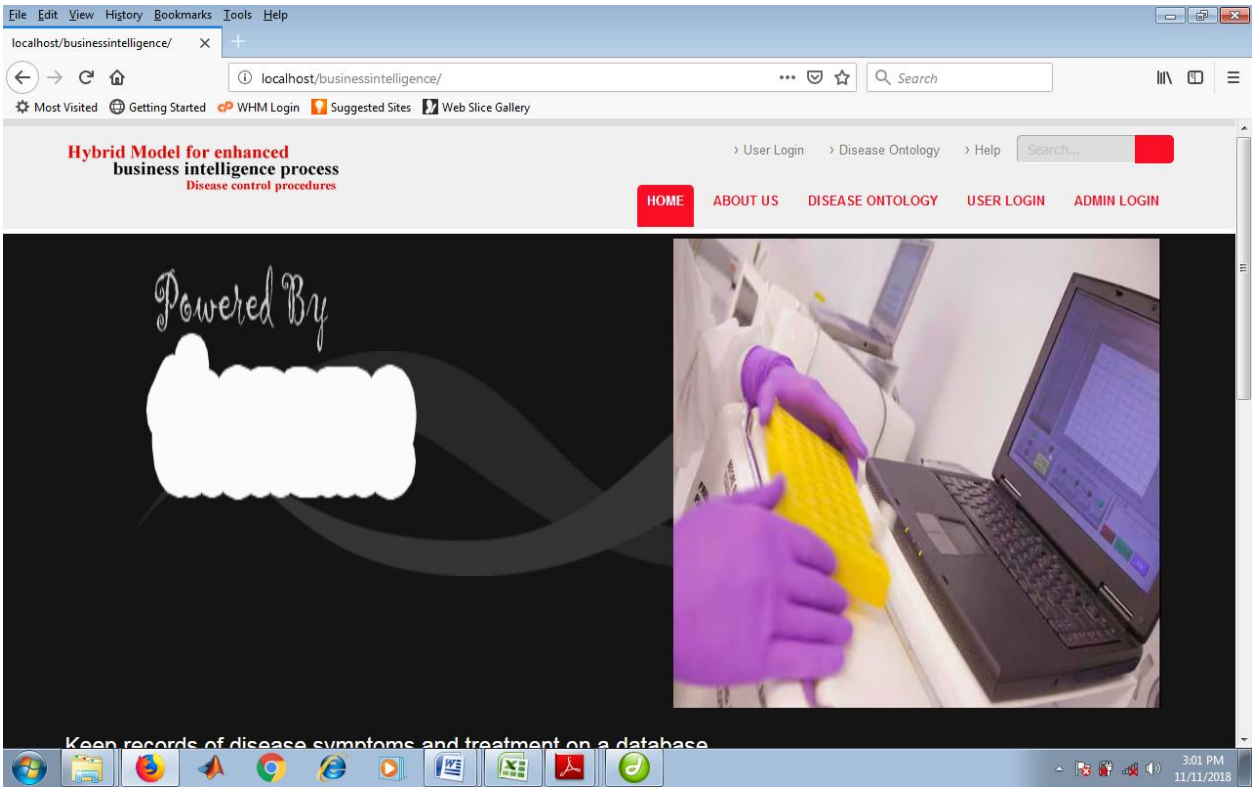

Figure 1: Home Page

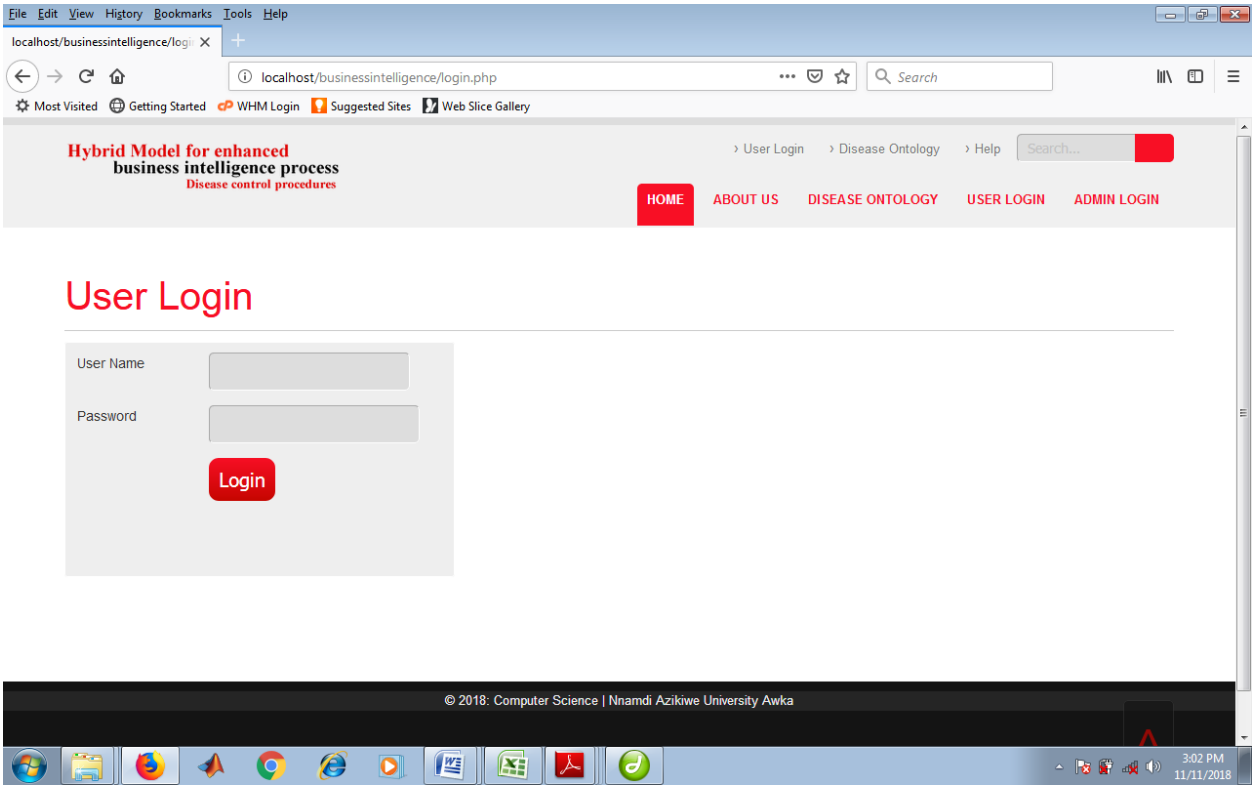

Figure 2: User Login Form

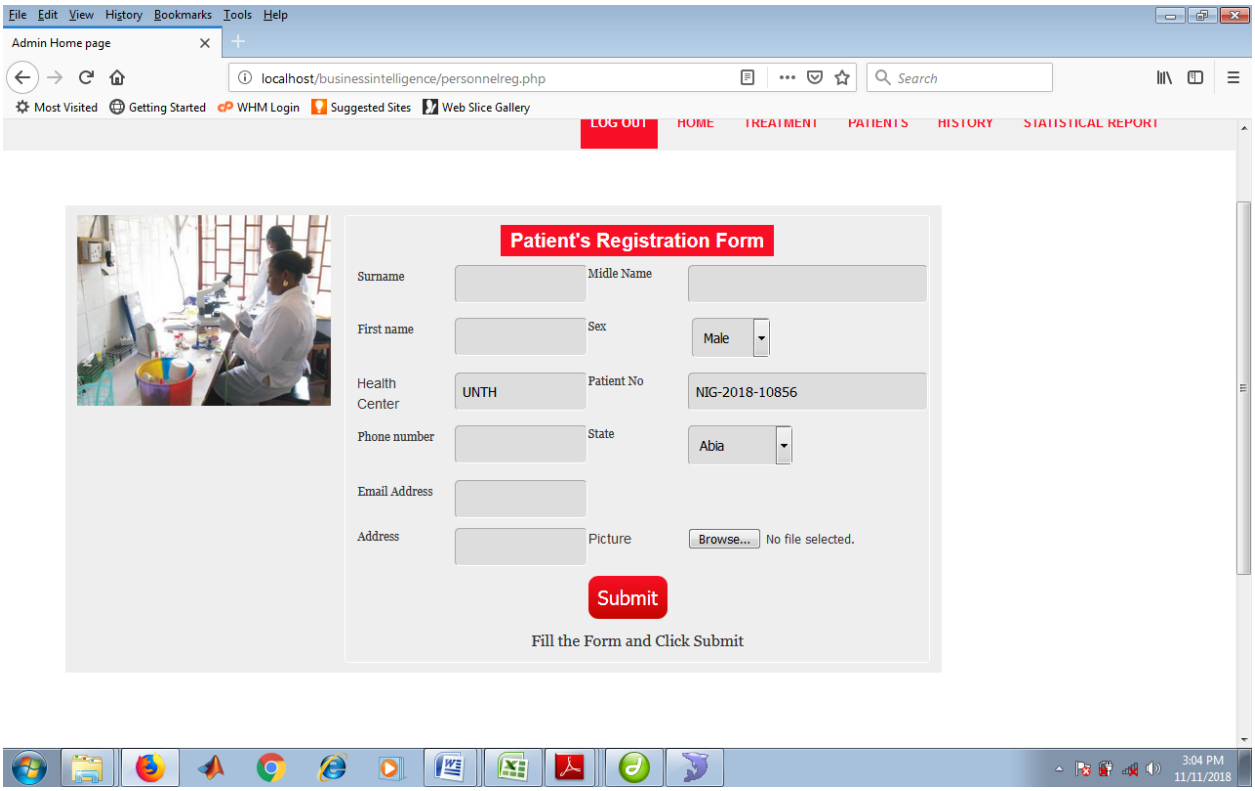

Figure 3: Patients registration form

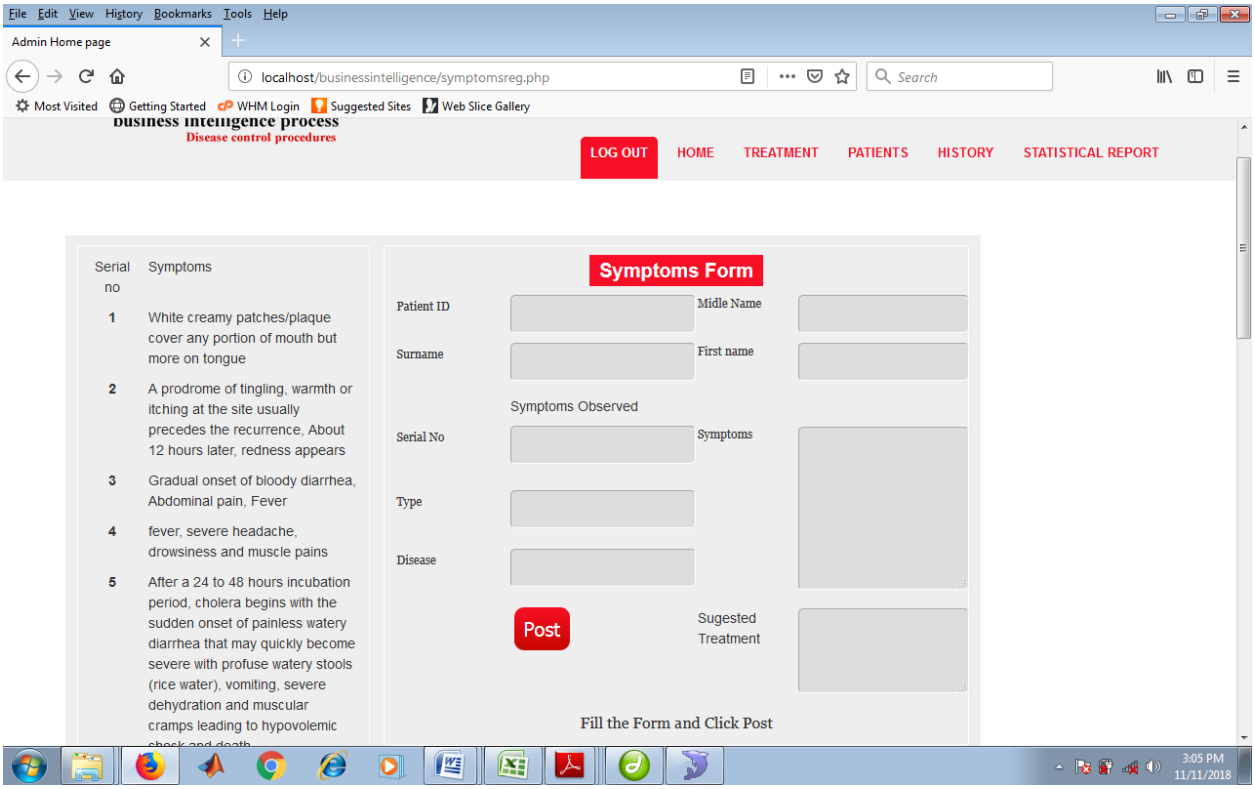

Figure 4: Disease Ontology Form

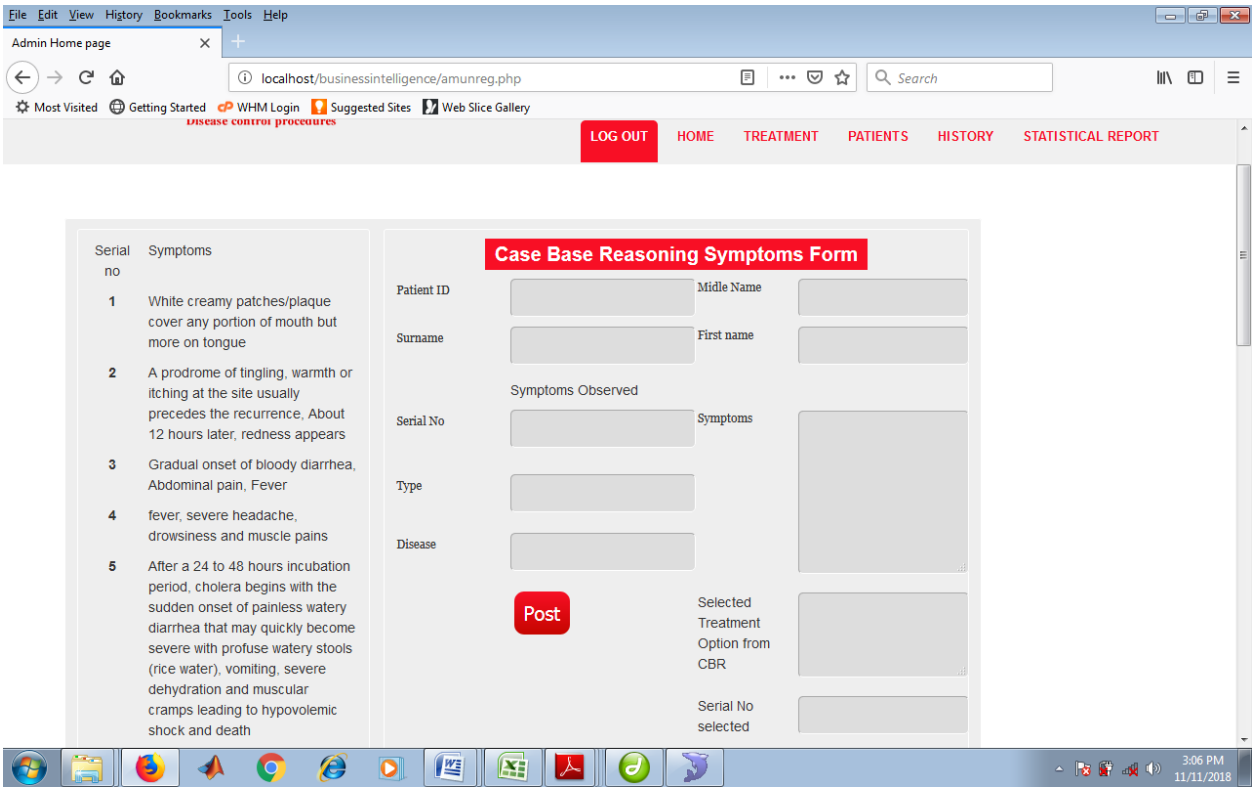

Figure 5: Case-based Reasoning / Data Virtualization Form

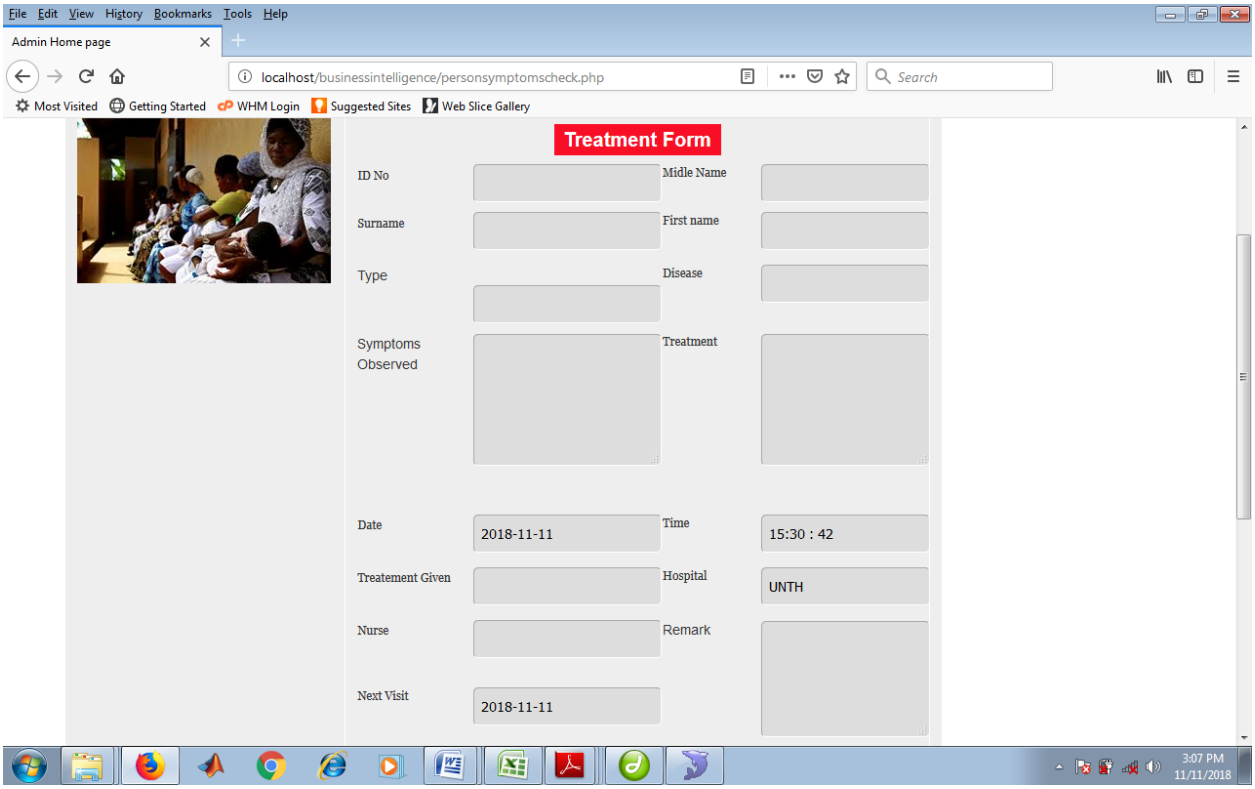

Figure 6: Disease Control Form

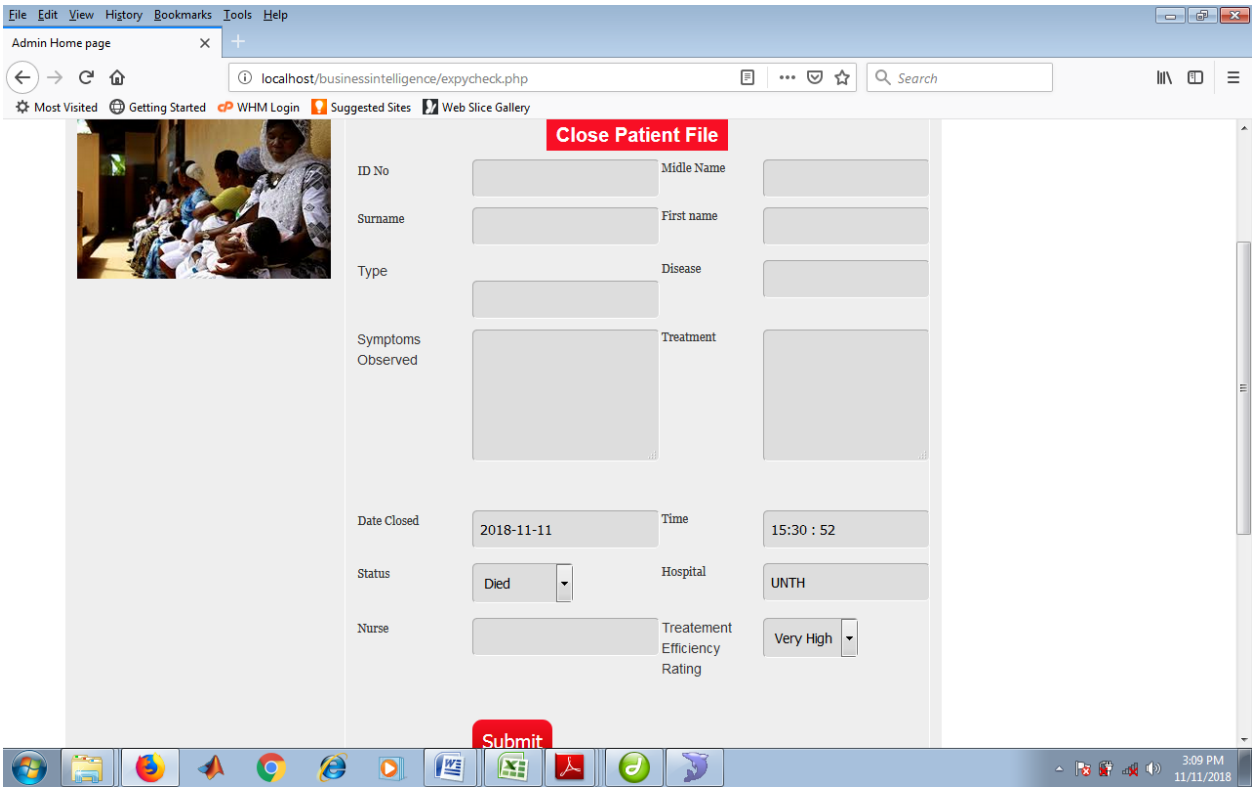

Figure 7: Close Disease Case Form

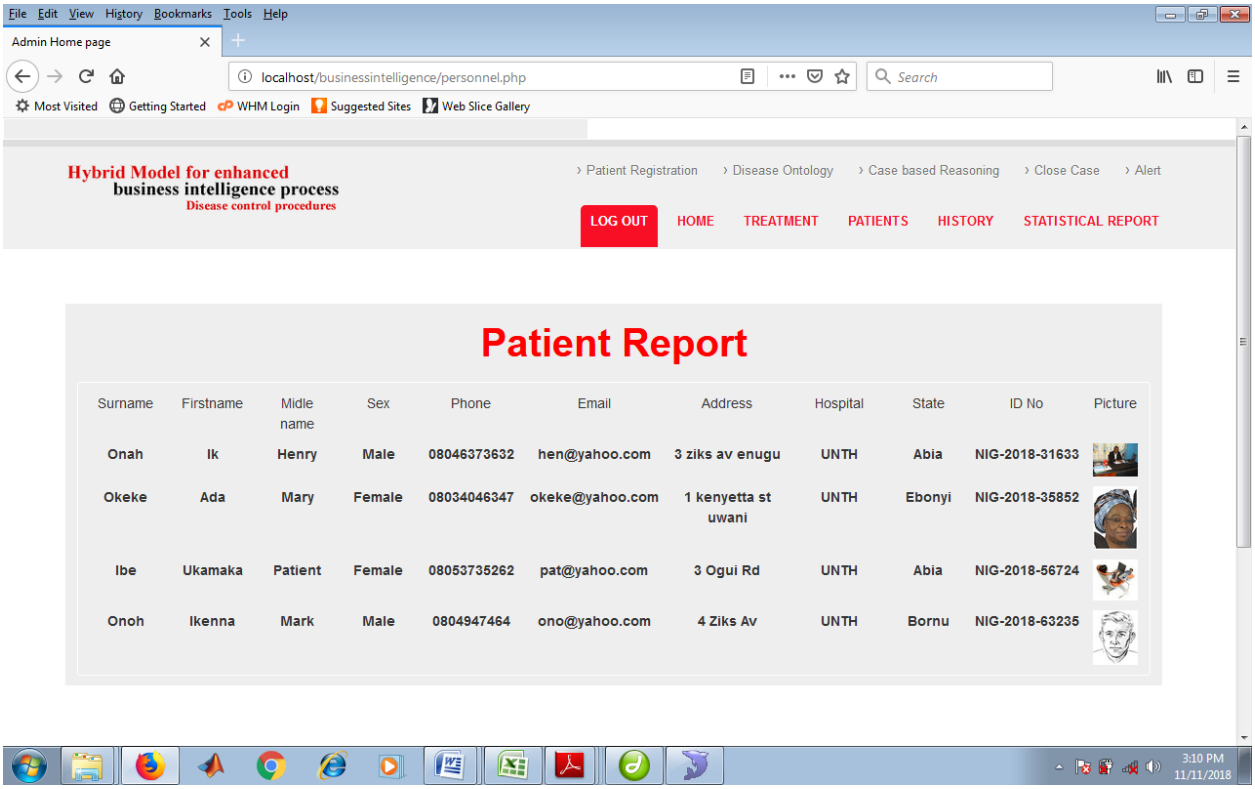

Figure 8: Patient's Report

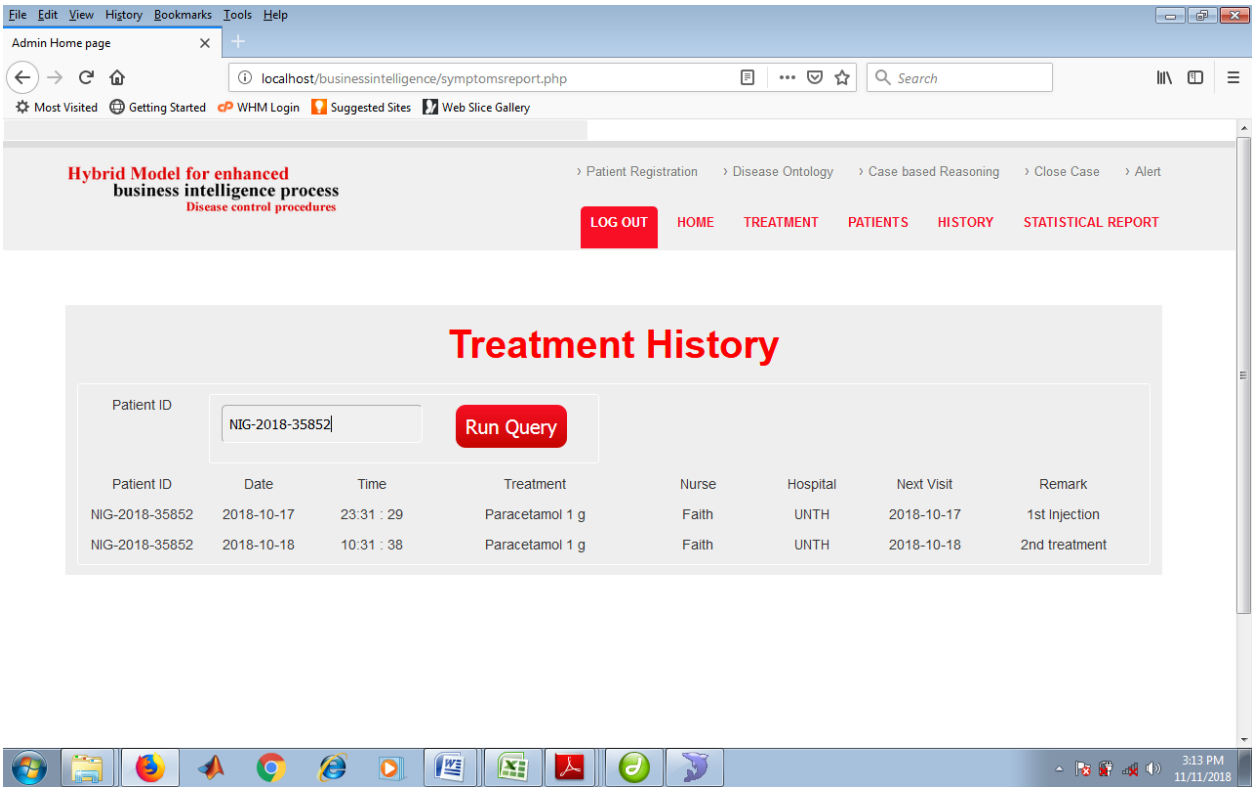

Figure 9: Patient's Disease Treatment Report

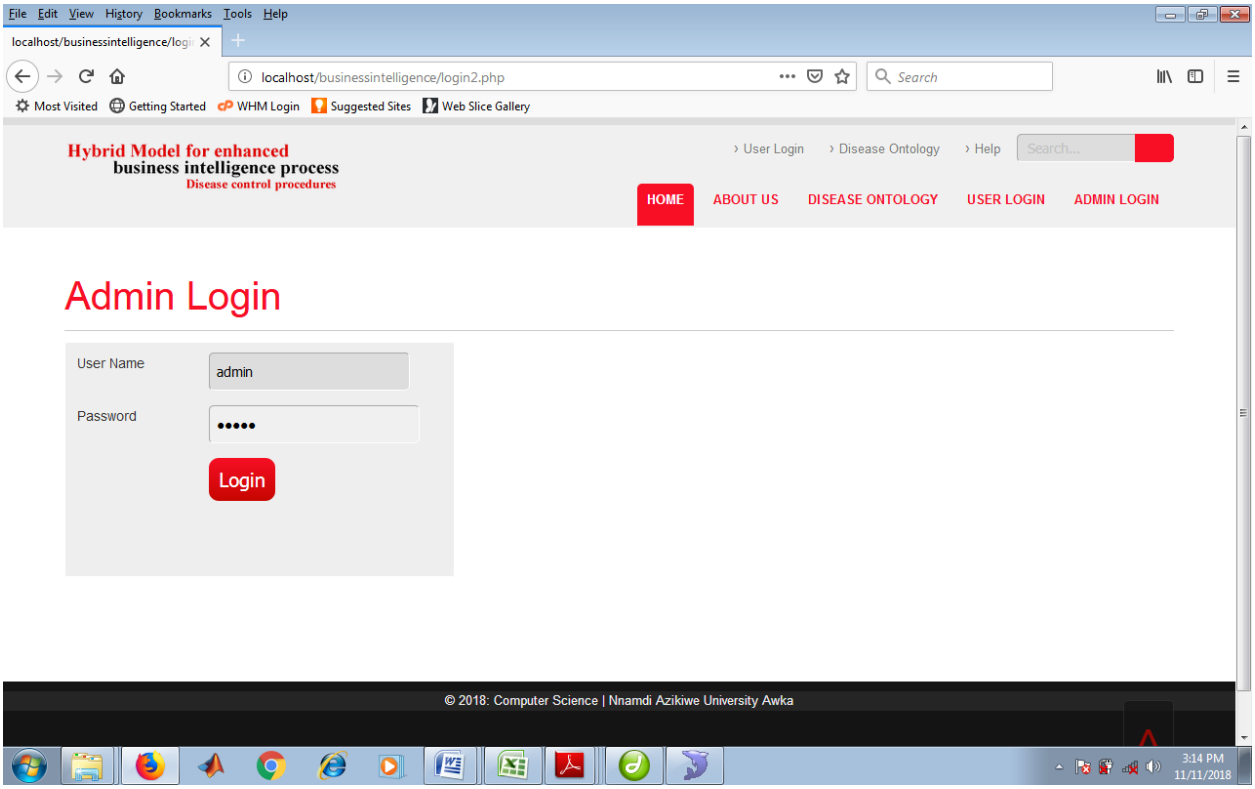

Figure 10: Admin Login Form

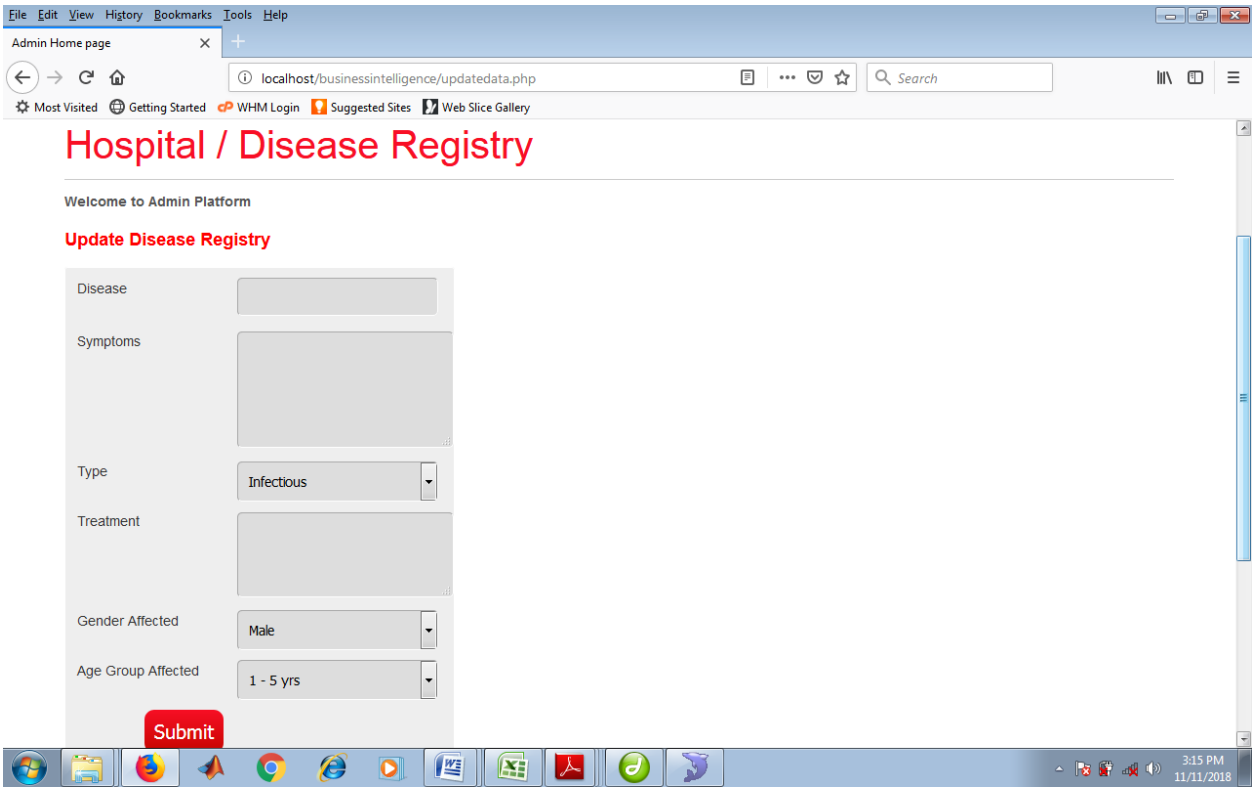

Figure 11: Disease Registry Form

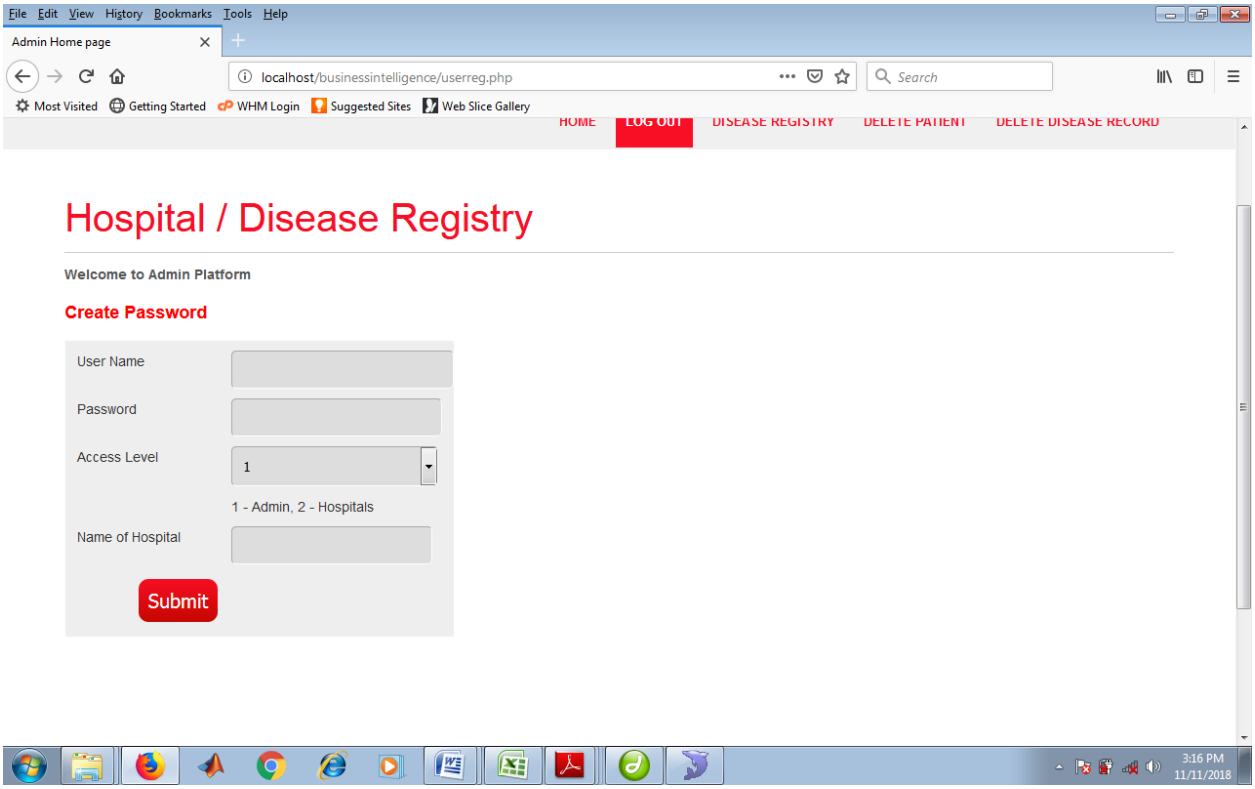

Figure 12: Users Setup Form

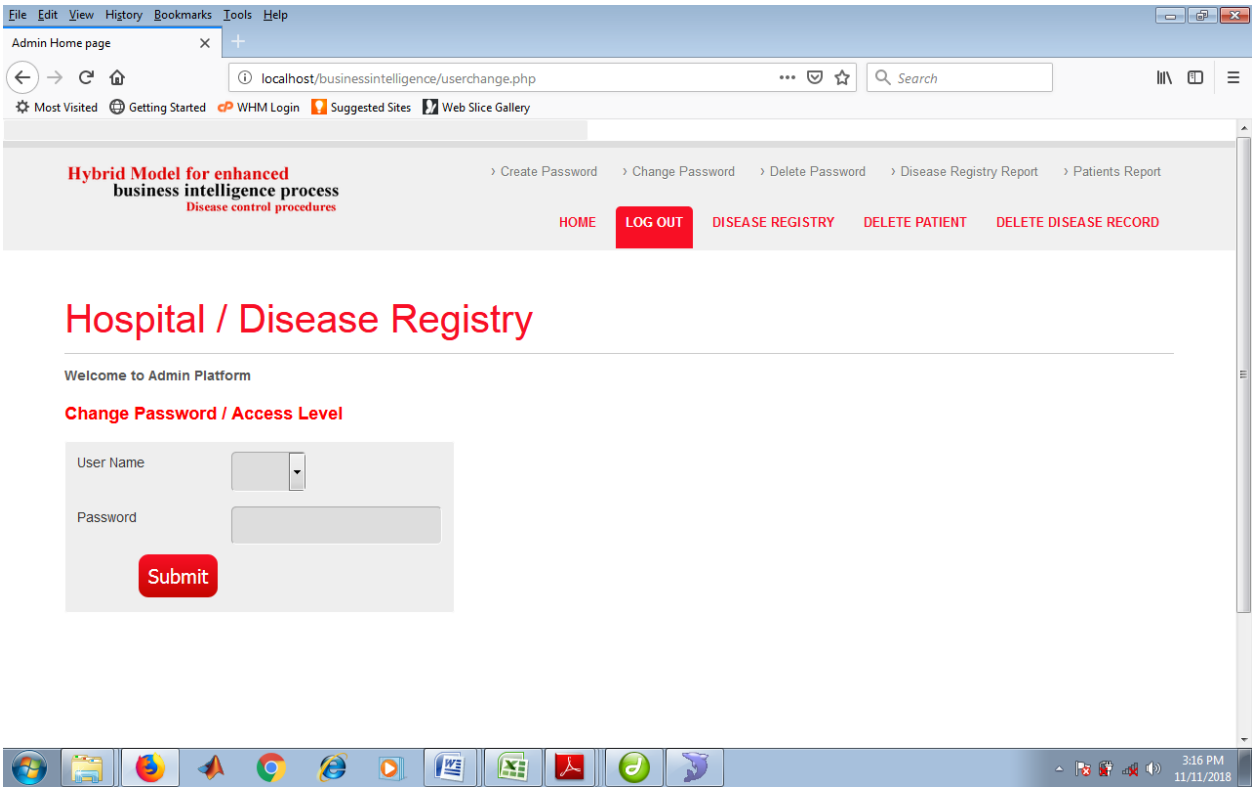

Figure 13: Change User's Password Form

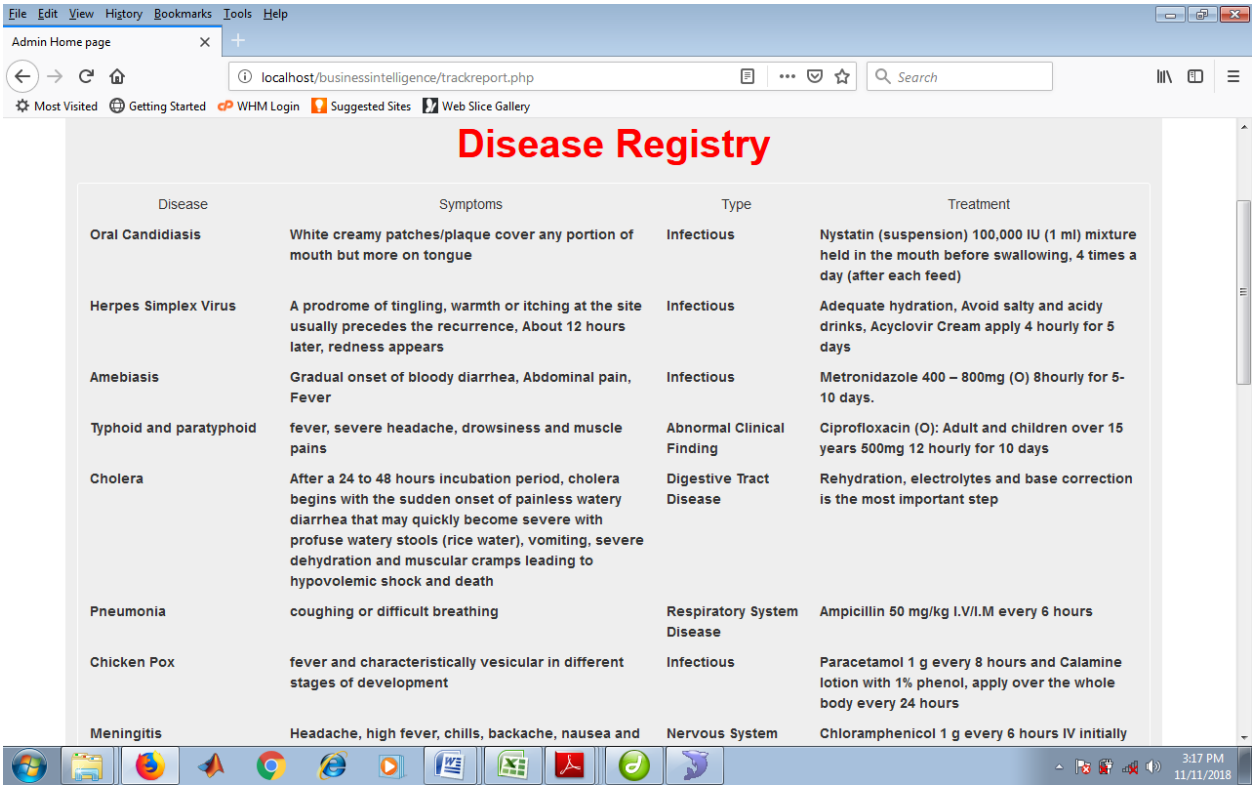

Figure 14: Disease Registry Report

APPENDIX C

The Test DataSet

S/N	DISEASE TYPE	SYMPTOMS	TREATMENT
1.	Sore Throat	Pain when swallowing food or liquid or talking. Coughing and sneezing is painful.	For babies if caused by virus no antibiotic is needed, it is expected to heal within 7 to 10 days for babies. If caused by streptococcal bacteria (strep throat), do lab test or in-office rapid strep test, and then prescribe antibiotics.
2.	Ear Pain (Otitis Media and others)	Severe earache, fever, nausea and vomiting, and diarrhea	Give Amoxicillin antibiotic. If its virus caused, give instruction on how to relieve the pain.
3.	Urinary Tract Infection (UTIs)	Pain or Burning sensation during urination, bedwetting, frequent urination, abdominal pain and side or back pain.	Urine sample test will determine treatment based on bacteria found in the child's or patient urine.
4.	Common Cold	Runny nose, congestion and cough	If caused by virus doctor give advice on managing it. If caused by bacteria, prescribe antibiotics.
5.	Uncomplicated Malaria	Feverish, fatigue, cold, and mild joint pains.	Treat with a first-line anti-malarial agent, Treat for 3 days with one of the recommended artemisinin-based combination therapy options; Artemether–lumefantrine, Artesunate plus amodiaquine, etc.
6.	Tuberculous Meningitis	Usually non-specific, including headache, vomiting, photophobia and fever.	Four-drug regimen (HRZE) for 2 months, followed by a two-drug regimen. (HR) for 10 months, the total duration of treatment being 12 months. Dexamethasone (0.6 mg/kg per day for 2–3 weeks, reducing the dose over a further 2–3 weeks), Children with proven or suspected tuberculous meningitis caused by MDR bacilli can be treated with a fluoroquinolone and other second-line drugs in the context of a well-functioning MDR TB control programme and within an appropriate MDR TB regimen.
7.	Conjunctivitis	Itching, redness, tearing in the eye, worse case; worsening pain, acute visual change, photophobia.	Erythromycin:(0.5% ophthalmic ointment) q4h x7---10 days • Gentamicin: (0.3% ophthalmic ointment, solution) 1---2gn x7d • Chlamydia: Erythromycin (50mg/kg/day) po divided q6h x14d • Gonococcal---------Rocephinn IV x7 days • F/U with PCP and optometrist.
8.	Gastroenteritis	Diarrhea, vomiting, dehydration, lethargy, anorexia, weight loss,	Give fluids; Antibiotics if caused by a bacterial infection

		fever and decreased urination	
9.	Typhoid and paratyphoid	fever, severe headache, drowsiness and muscle pains (myalgia) The course of paratyphoid tend be to shorter and less severe compared to typhoid	Ciprofloxacin (O): Adult and children over 15 years 500mg 12 hourly for 10 days Alternatively: Chloramphenicol (PO): Adult 500mg 6 hourly for 14 days Children above 1 years 12.5mg/kg/dose, 6 hourly for 14 days. CAUTION: Ciprofloxacin is contraindicated in children below 15 years and pregnant women. Chloramphenicol is contraindicated in the third trimester of pregnancy; it may also cause aplastic anaemia which is irreversible.
10.	Shigellosis	Sudden onset of severe abdominal cramping, high-grade fever, emesis, anorexia, and large-volume watery diarrhea; seizures may be an early manifestation. Abdominal pain, tenesmus, urgency, fecal incontinence, and small-volume mucoid diarrhea with frank blood (fractional stools) may subsequently occur.	Ciprofloxacin (O): Adult, 500mg 12 hourly for 5 days Children (where the benefit outweighs the risk); 5-10mg/kg/dose. Maximum dose 500mg, 12 hourly for 5 days OR Nalidixic acid (O): Adult, 1g 6 hourly for 7 days Children over 3months old; 12.5mg/dose 6 hourly for 7 days OR Erythomycin (O): Adult, 250mg 6 hourly for 5 days Children, 10mg/kg/dose 6 hourly for 5 days. Note Nalidixic acid is neurotoxic so should be used with caution in older patients; it is contraindicated in epilepsy and renal failure.
11.	Cholera	Sudden onset of painless watery diarrhea that may quickly become severe with profuse watery stools (rice water), vomiting, severe dehydration and muscular cramps leading to hypovolemic shock and death. The stool has a characteristic "rice water" appearance (non bilious, gray, slightly cloudy fluid with flecks of mucus, no blood and inoffensive odor)	Treatment based on severity; Rehydration, electrolytes and base correction is the most important step Management of severely dehydrated patient, IV fluid replacement is preferable Oral rehydration is indicated in moderate forms of dehydration but is ineffective in the presence of significant vomiting, etc. Doxycycline (O): Adult and child above 12 years; 300 mg as a single dose or 5mg/kg single dose, Ciprofloxacin (O): Adult: 30mg/kg single dose (not to exceed 1g) or 15mg/kg 12 hourly for 3 days.
12.	Hepatitis	Fever, anorexia, malaise, jaundice, abdominal pain after specific incubation periods; and in severe forms signs of acute liver failure including altered consciousness may be present.	Refer all cases of suspected Hepatitis to referral centers for expertise management. Alternate drugs; Lamuvidine 150mg (O) once daily. OR Tenofovir 300mg (O) once daily Treatment is long term (48- 96 weeks) Combination therapy is indicated in HIV co infected patients.
13.	Diabetes Mellitus	thirst, polydipsia, polyuria, tiredness, loss of weight, blurring of vision, white marks on	Dietary Control; If dietary control on its own fails or the blood glucose levels are persistently high initiate Glibenclamide

		clothing, pruritus vulvae, balanitis, paraesthesia or pain in the limbs and recurrent bacterial infection	2.5- 15mg (O) once daily for non obese patients OR Metformin 500-2000mg (O) in 2-3 divided doses with or after meals for obese patients. Review the blood glucose at diabetic clinic and adjust medicines as needed until blood glucose is controlled.
14.	Iron deficiency anaemia	fatigue, palpitation, dizziness, koinlokia and pica.	Treat the cause of blood loss, for example upper GI bleeding due to peptic ulcer and lower GI bleeding secondary to hookworm infections and malignancy. Oral Iron supplementation, Blood transfusion is only indicated if it is life threatening. Ferrous sulphate 200 mg (O) every 8 hours; Children5 mg/kg body weight every 8 hours. Continue for 3 months after the normal haemoglobin has been achieved.
15.	Severe Malaria	Unable to stand or sit up without support, Altered level of consciousness, Acute confusional state, coma, Repetitive abnormal muscular movements, Acidotic breathing: deep and laboured breathing, Pulmonary oedema: laboured breathing, restlessness, blood stained frothy sputum especially in adults, Throwing up after every feed/drink, Not able to swallow, etc.	Artesunate IM/rectal OR Quinine IM, Rectal artesunate is the recommended pre-referral treatment at the community level. At a health facility the pre-referral dose of parenteral therapy should be initiated without delay. Pre-referral rectal artesunate: Available as suppository containing 50mg or 100mg or 400mg. Artesunate 2.4 mg/kg body weight IV or IM given on admission (time = 0), then at 12 hours and 24 hours, then once a day.