

Designing and Developing a Model for Business Intelligence in Disease Surveillance for the Namibian Public Healthcare Sector

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Abstract: *Business Intelligence (BI) in the healthcare sector has taken up in recent years in many countries. This advanced intelligent technology approach is increasingly being adopted in Namibia as well. However, the adoption of this technology in Namibia's healthcare sector is still relatively new and facing challenges. BI is about analysing data for more informed decision-making. It would be an ideal technology to adopt in Namibia's healthcare sector, particularly because there are so much data stored in the silo health information systems (HIS) that Namibian public hospitals are hosting. With silo systems, real time access to up-to-date data is difficult when they are needed for decision-making. BI techniques have the potential to provide an effective computation environment in Namibia's healthcare sector, especially in the area of disease surveillance. The aim of this study is to come up with a BI model for disease surveillance in Namibia. The first phase of the study is qualitative, applying an interpretive approach. Interviews and questionnaires will be conducted with health administrators and decision-makers on the status quo on access to BI information in Namibia's healthcare institutions. In the second phase of the research, a Design Science Research approach will be adopted resulting in the design of a BI model for disease surveillance in Namibia.*

Keywords: Disease Surveillance, Business Intelligence, Health Information Systems

1. Introduction

Enterprise-wide business intelligence (BI) has the capacity to put more hospitals and health systems in a strong position to respond to the challenges of access to health information that are presented by today's world. In relation to the health sector, BI is the ability of a hospital or health system to gather data from across an enterprise, aggregate it, and analyze it in a way such that administrative, financial, clinical, and research information is accessible to decision makers when and how needed.

In Sabherwal & Becerra-Fernandez (2011), BI is defined as "providing decision makers with valuable information and knowledge by leveraging a variety of sources as well as structured and unstructured information". BI consists of technology-supported processes that enable people to discover patterns that are hidden to the human eye in the data in order to inform decision-making.

The quality of service delivery in healthcare is determined not only by evidence based on medicine but also on the proper utilisation of patients' data. The use of BI tools is the best to control, handle and analyze the data to provide decision-makers with information in real-time, in the right quality and to the right people. This will assist healthcare officials to know what data is available, to understand the data and actually make sense of that data and finally improve service delivery and performance in public hospitals in Namibia.

Nowadays, with new and emerging technologies, it is very important to implement BI technology in Namibia's public healthcare sector as they are dealing with massive amounts of data that needs to be analyzed to make informed decisions for forecasting, statistics and improvement of services in the overall healthcare sector. Adopting the use of BI tools in healthcare creates opportunities for the extraction and use of

relevant knowledge obtained from analyzing these large volumes of data. The BI tools for processing and analyzing these data includes transactional databases, data warehouses, online analytical processing (OLAP) and data mining tools and techniques (Laudon, Laudon, & Brabston, 2011)

The system of collection, analysis and interpretation of disease-related data is referred to as disease surveillance (Canton, 2005). This data is used in decision-making and planning. Since access to information is of critical importance in the practice of the public health service, having real-time, accurate and readily available information is essential in monitoring the health of communities and populations. The aim of this research is to design and develop a BI model for the Namibian healthcare sector that will enable decision-makers make effective and timely decisions.

2. Problem Statement

The healthcare institutions have been adopting several information and technology solutions, which provide consistency and uniformity by automating some of the business processes, in order to contribute to a better functioning of the health institutions and to improve the quality of the services provided (Thompson & Brailer, 2004). The issue at hand is that currently Namibian public healthcare does not have reliable BI to organize business, clinical, and operational data for the purpose of efficient decision-making purposes. Information on diseases is decentralized and handled manually (Hostmeir, 2017). The decentralization of information makes it difficult for decision makers to make timely decisions (Huber, 1990). The need for BI would be to enable better and efficient decision-making and providing better data management to the healthcare organizations (Koh & Tan, 2005). Having BI in the healthcare sector is a strategy that improves the

functioning of the health system and leads to better health through improvements on quality and efficiency (The World Health Report, 2000). There is a need to have suitable reporting capabilities that aggregate all the necessary diseases data from different public healthcare institutions and transform them into meaningful information and knowledge which decision makers can use when making advanced decisions in the health sector.

3. Aims and Objectives

The aim of this research is to design and develop a BI model that will enable decision makers in Namibia's public healthcare sector to make effective and timely decisions on disease surveillance.

3.1 The Objectives

The objectives of this research are to:

- Assess and understand the impact of BI in the Namibian public healthcare sector.
- Investigate BI frameworks and their status in the Namibian public healthcare sector.
- Design a model for BI implementation in the Namibian public healthcare sector.

3.2 The Research Questions

The main question is, "What should be the features of a BI model that will enable decision makers in Namibia's healthcare sector to make effective and timely decisions on disease surveillance"

The sub-research questions are:

- What is the impact of BI in the Namibian public healthcare sector?
- What BI frameworks are available and what is their status in the Namibian public healthcare?
- How should the conceptual BI model of the proposed solution be structured?

4. Literature Review

The preliminary literature review is conducted under the following main concepts: Business Intelligence, BI model design, BI implementation, disease surveillances, BI benefits and challenges.

4.1 Business Intelligence

As technology changes, so does the business environment. For organizations to meet customers' needs and remain competitive for growth and sustainability they need reliable, accurate and effective businesses which are driven by BI. According to Audrey (2013), the term BI evolved from information systems such as decision support systems (DSS), executive information systems (EIS), and management information systems (MIS) (Audrey, 2013). Audrey (2013), firstly defined "BI as a method employed by companies to assist in analyzing and presenting data for more informed decision making". Audrey (2013), later defined BI as "applications and technologies for consolidating, analyzing,

and providing access to vast amounts of data to help users make better operational and strategic decisions". He then added that through BI, an organisation can be assisted in better business decision- making and improved business performance and in the process optimize value for the organization by adopting BI. Negash (2004, pg. 178) also defined BI as "BI systems combine data gathering, data storage, and knowledge management with analytical tools to present complex internal and competitive information to planners and decision makers" (Negash, 2004). The advantage of BI therefore is on improved timeliness and quality of inputs to the decision process, an assurance that information reaches the decision makers at the right time, and that information is in the right format and quality for them to make informed decisions that improve service delivery (Prikrylova, 2016).



Figure 1: BI life cycle (Adapted from Walailak University (2011))

Figure 1 shows the steps involved in BI and their processes

4.2 Business Intelligence Benefits

BI is one of the best technology-based approaches that is being used to harness data that can be used for decision making and help improve patient's outcomes and reduce costs in the healthcare sector. Ashrafi (2014) posits that effective healthcare practice relies not only on how data sources are made available but also on the tools that are being used to communicate that information to responsible stakeholders. Since information is the key success factor to any successful business and the healthcare sector is no different from any other business in the successful processing of organizational data into useful and actionable information.

The potential benefits of BI solutions include the following: improved decision making; optimising internal business processes; improved operational efficiency; enhanced revenue; and gaining competitive advantage over business rivals. BI systems assist organizations identify market trends and identify business challenges that need to be addressed. It also helps save executive time by providing extremely visual and flexible data presentations. BI also helps executives to view highly complex key performance indicators (KPIs) which would otherwise require long hours of repetitive work or experts. It ensures that the data comes automatically directly from the sources without any manual intervention ensuring that the chances of data manipulation are minimized.

4.3 Challenges to BI Application

Although implementing BI in healthcare comes with a multitude of challenges, healthcare IT management names data complexities and a lack of resources/skills as the biggest challenges to reaching their BI goals (Chaudhuri, Dayal, & Narassaya, 2011). The complexity associated with data includes diverse data types, a lack of standards for data entry and multiple systems producing data which may be electronic or paper-based. Where there are large numbers of systems and an increased amount of data collected, information cannot easily be shared and compared across systems in different locations, when insightful reports are required. A lack of standardized data structures impact on report accuracy and interoperability. The standardization of data from multiple sources also poses big challenge if the required data is available in a common data warehouse. (Cakici, 2010).

Skilled resources to help make sense of data complexities are required. For BI implementations, the roles in highest demand are solution architects, data analysts and data scientists. These highly skilled IT professionals not only need the technical capabilities, they also need the healthcare experience to understand the distinctions of the industry. Having an inexperienced and unskilled BI implementation team will likely result project failure, because BI projects have aggressive timelines and short delivery cycles (Atre, 2017).

The use of Predictive Analysis which is not commonly used by health institutions on their current and historical data to predict future trends and occurrences in operations stand out as one of the challenge. There is a need of a mindset change in end users to get them to be more interested in prediction rather than reaction and most end users had little interest in knowledge of, predictive analysis.

While the large number of systems increases the amount of data collected, it also introduces problems when the information cannot easily be shared and compared across systems, which is necessary to create robust, insightful reports.

4.4 Business Intelligence Frameworks

Negash (2004) describes a BI framework as “a design that combines data organisation, information management and technology components to build BI systems for reporting and data analytics”. A BI framework plays the role of projects providing a layered structure indicating how the different components interconnect (Negash, 2004).

Gartner (2009), defined a framework as “the people, processes and technologies that need to be integrated and aligned to take a more strategic approach to BI analytics and performance management (PM) initiatives” (Gartner, 2009). A number of organizations use a combination of customised products and services to provide BI analytics and performance management solutions. Even though there are some limitations, these solutions provide essential reporting, planning and analysis capabilities.

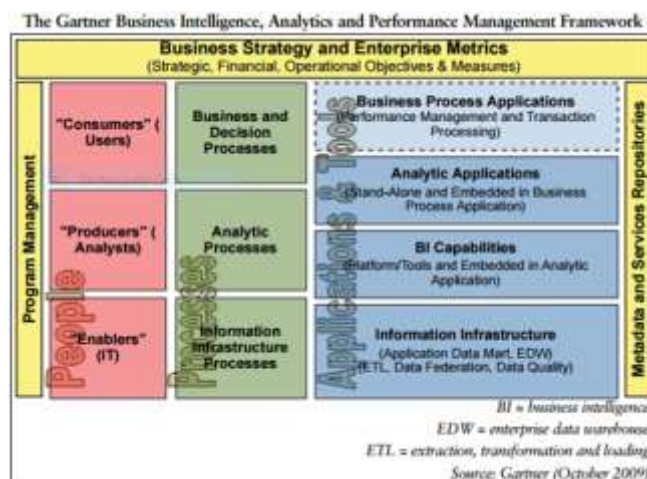


Figure 1: Adapted from Gartner (2009)

4.5 Disease Surveillance

Surveillance, in general, from a health perspective is the collection, analysis, and interpretation of health-related data. This data is used in planning, implementing and evaluating public health policies and practices. A disease surveillance system serves two key functions, namely, giving an early warning of potential threats to public health and monitoring programme functions which may be disease-related. The early warning functions of disease surveillance are fundamental for health security at national, regional and global levels. Outbreaks of diseases demonstrate the importance of effective national disease surveillance and disease response systems. The International Health Regulations (IHR) 2005 emphasises the need for all its member states to establish and implement effective disease surveillance and disease response systems to detect and contain public health threats of national and international importance (Cakici, 2010).

4.6 Disease Surveillance in Namibia

Since disease surveillance has become a common practice of monitoring infectious disease, Namibia has also recognized disease surveillance as a cornerstone for decision-making purposes by public health institutions. Namibia's Ministry of Health and Social Services (MOHSS) is using the Center of Disease Control and Prevention (CDC) in surveilling diseases and providing comprehensive support for it in all its surveillance activities. This was according to the factsheet that was published in August 2013. MOHSS uses CDC to perform data triangulation and to provide them with support for biological and behavioral surveillance activities. Such surveillance practice has been used in priority setting up, planning, resource mobilization and early epidemics detection. Namibia recognizes disease surveillance as one of the most important pillars of effective control tools for communicable diseases. The surveilling of disease by the CDC covers all diseases of public health importance such as HIV, Tuberculosis, Diabetes, Diarrheal Diseases, Malaria etc. by monitoring their trends.

Namibia uses the National Notifiable Diseases Surveillance System (NNDSS) (National Notifiable Disease Surveillance System (NNDSS), 2015) for surveillance, which is a nationwide collaboration that enables all levels of public

healthcare, that is, local, state, territorial, federal, and international to share notifiable disease-related health information. Public healthcare uses this information to monitor, control, and prevent the occurrence and spread of state-reportable and nationally notifiable infectious and non-infectious diseases and conditions and outbreaks.

5. Gap identified in the research

The following gaps were identified in the research:

- Namibian public healthcare does not have sound BI to organize clinical, business and operational data for decision-making purposes.
- Information on diseases in Namibia is still decentralized.
- There is a need to have suitable reporting capabilities that aggregate all the necessary disease data from different public healthcare institutions.

6. Guiding Theory of the Research

The research will be conducted in two-phases. The first phase is the collection of data on BI in the healthcare sector while the second phase is the design and development of the BI model based on the data collected. The first phase is guided by the Grounded Theory, while the second phase is guided by the Design Science Research theory which is guidelines that help information systems researchers conduct, evaluate and present the design-of an artefact. The Design Science framework explains how the regulative cycle (problem investigation, solution design, design validation, solution implementation, and implementation evaluation) fits in the framework.

7. Significance of the research

The significance of the research is as follows:

- The study will contribute to the growing body of literature on BI systems in Namibia and to the possible solutions that might help eradicate or eliminate the spread of communicable diseases.
- The research will highlight the available BI models and how they can be used in disease surveillance.
- The study will contribute to the materials that may be used in finding the best solution for implementing such a BI system in the near future and this research will promote further study on the matter.

8. Research Methodology

This section will cover research design, characteristics of the study population, sampling techniques, data collection instruments as well as data presentation and data analysis.

8.1 Research Design

The research is in two phases. The first phase is the collection of data for on BI tools and processes in the healthcare sector. The second phase is the design and development of the BI model. The study will adopt a case study setting. The intention to develop a model for BI to

improve service delivery in public hospitals by surveilling diseases starts with data collection. A survey will be conducted to a random group of employees currently working in different Namibian public healthcare to be specific. The case study will aimed at generating an ecosystem in which data flows through different actors and then recycled to fulfil the set goals and objectives, making use of the BI tools. The design and development of the model will adopt a Design Science Research approach.

8.2 Data Collection

Data will be collected through structured questionnaires that will be distributed to the sample groups identified. Follow up face-to-face interviews will be conducted to round up individual data collected in questionnaires.

8.3 Research Sample

To keep research costs reasonable, only a sample of the total population groups will be used in this research by selecting Central Hospital, Khomas region as the research area. For the purpose of this research, the researcher has identified 4 (four) population clusters from which the sample is to be selected, namely the Center for Disease Control and Prevention (CDC) management, Central Hospital management, IT department, and nurses. The stratified and purposive sampling method is to be used for this study. The samples for the different groups are as below:

- 1) Hospitals management = 4
- 2) CDC management = 5
- 3) IT department = 4
- 4) Nurses = 30

8.4 Data Analysis

A mixed method approach will be adopted for data analysis. Both qualitative and quantitative techniques will be used to analyse the data. SPSS will be used for data analytics and Atlas.ti. The data collected from the sample will be used to define the comprehensive strategy of collecting data from several health institutions. Data that will be gathered will also be used to determine the data source (i.e. type of system) with the focus on where (i.e. geographic area), and when (the time period) as well as the amount of data that needs to be collected. Gathered information will also be used to determine the content of data that is to be collected and will also be used in evaluating the usefulness of data to be extracted and from which data source.

9. Limitations of the Study

Gathering information to build on the literature of the proposed research, interpreting this literature to understand the problem and the proposed solution to the said problem and eventually realizing the successful designing of the proposed BI model has some limitations as described below:

- One limitation would be the fact that due to the confidentiality of health information, many officers would be reluctant to provide information that reflects the actual situation in the Namibian public health.

- Furthermore, health personnel might be reluctant to provide sincere opinions about their daily operations, especially those who are resistant to change.
- It will not be possible for the researcher to visit all public health institutions in Namibia for the purpose of gathering data, assessing the ICT infrastructure setup and interviewing and administering questionnaires at all these respective institutions as the research is mainly funded by the researcher. There is a need for funds to cover for transport costs, stationeries, printing of questionnaires, data analysis, and data interpretation and communication.

10. Assumptions

The following assumptions are made:

- That decision makers and all affected parties will provide the necessary information.
- The Namibian public health personnel will welcome the idea of diseases surveillance with the help of BI capabilities and the advancement in technology.

11. Ethical Considerations

Conducting research has its own problems which include accessibility, funding, timing and other factors. There are ethical concerns at every step of the research process (Bickman and Rog, 2009:129). For this study, ethics clearance will be sought from NUST and the Ministry of Health and Social Services (MoHSS) initially. For privacy purposes, participant details will be kept confidential. Data from the interviews will not be used for any other purposes other than for this research. The study will ensure that it adheres to the principles of no harm to participants. Interview questions will be generalized and will have no thread to any participant (Kimmel, 2009).

12. Conclusion

This study will be on designing and developing a model for business intelligence (BI) in disease surveillance for the Namibian public health sector. The public hospitals in Namibia process large amounts of information that need to be analysed for informed decision-making. Unfortunately the Namibian BI system is currently manual, meaning its impacting on access to timely information for decision-making on disease surveillance. This model will be of great benefit to decision-making.

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