ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

SCHOOL OF INFORMATION SCIENCE

Assessing the status of Business Intelligence Information System: The case of Nib International Bank

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Advisor: Dereje Teferi (Ph.D.)

April 2021

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A Thesis Submitted to the College of Natural and Computational Sciences of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Information Science and Systems

(Information Systems Specialization**)**

By: Firehiwot Fekade

Advisor: Dereje Teferi (Ph.D.)

April 2021

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Declaration

I declare that this thesis entitled "Assessing the status of Business Intelligence Information System: The case of Nib International Bank" is my work and all the sources of materials used for this research have been recognized. I further declare that I have not previously submitted this work, or part of it, for examination at AAU for another qualification.

Name: Firehiwot Fekade

Place: Addis Ababa University, School of Information science

Date of Submission: April 2021

Signature_____

This thesis has been submitted for examination with my approval as university advisor.

Dr Dereje Teferi (PhD)

Signature _____

Date January 26, 2021

Approval of Examination

This thesis work entitled **"**Assessing the status of Business Intelligence Information System: The case of Nib International Bank**"** has been examined and approved for the award of the degree of Master of Science in Information Science from Addis Ababa University, College of Natural and Computational Sciences, School of Information Science.

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Abstract

Companies are having a hard time dealing with challenges such as Server capacity, information load, limited applications, data processing, and network interruptions. A good BI system infrastructure can improve their performance. Several researches contributed several methods of system development for better management of business intelligence. But none or only few of these researches specifically cover the banking sector in Ethiopia.

In 2013 Nib International Bank launched TEMENOS Insight system, the 2010 version, in order to deal with the business intelligence in decision making, queries, reports and online analytical processing (OLAP). This study tried to make extensive literature review and exploration of on-premise and cloud-based BI models and architecture with their respective benefits and challenges. Consequently, the survey concluded an integrated hybrid business intelligence model and related architecture are essential for better performance of the bank.

BI users and experts were targeted for the case study to evaluate the banking system, related hardware and their implementations in a quantitative survey. Some changes in the IT infrastructure are found to be essential in order to realize the full potentials of BI system. The survey suggested additional IT infrastructure components for the banking system; for example, Middleware for Data Warehouse Layer, Visualization MapReduce services for architecture Service layer & Business Process Execution Language (BPEL) for End User Layer.

Generally, the bank carries out on-premise BI deployment model with all the necessary hardware, software and application systems residing in the headquarter of the bank. But it was identified that, the bank is dealing with several difficulties in the existing deployment design consisting of separately arranged layers. The survey results recognized that the enhanced and integrated hybrid BI system was found to be appropriate for managing large volumes of data and classified information from various sources. Basically, IT systems need continuous development, checkup and upgrading. These changes can enhance the current level of skill in BI system operations. The IT infrastructure can also become easy to follow up for maintenance and update purposes in a well-organized way.

Keywords: Business Intelligence System, On-line Transaction Processing, Extract, Transform, and Load, Data Warehouse, On-line Analytical Processing, NIB

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Acronyms

ACID	Atomicity, Consistency, Isolation, Durability
BI	Business Intelligence
BPM	Business Performance Manager
CRM	Customer Relationship Manager

CSM	Customer Service Manager
CSO	Customer Service Officer
CEO	Chief Executive Officer
CIO	Chief Information Officer
CORE	Centralized Online Real-Time Exchange
CSFs	Critical Success Factors
DM	Database Management
EATS	Ethiopia Automated Transfer System
ERP	Enterprise Resource Planning
ETL	Extract-Transform-Load
HTTPS	Hypertext Transfer Protocol Secure
IaaS	Infrastructure as a Service
IS	Information System
IT	Information Technology
LAN	Local Area Network
NIB	Nib International Bank
ODS	Operational Data Store
OLAP	On-Line Analytic Processing
PaaS	Platform as a Service
R10	2010 Release
R20	2020 Release
RDMS	Relational Database Management Systems
SaaS	Software as a Service
SAP	Systems Applications and Products
SAS	Statistical Analysis System
SCM	Supply Chain Management
SQL	Structured Query Language
USI	United System Integrators
WAN	Wide Area Network

CHAPTER ONE

INTRODUCTION

Data is the foundation of decision-making process and is becoming the basic consumption of the awake generation (Vassakis, Petrakis & Kopanakis, 2018). The major challenges for Data Collection, Data Storage, and Data Analysis are Data Integration, Data Volume, Data Variety, Complex Analytics, Continuous Business changes, Professional specializations, Compliance, Security, Data Quality, and Computing (Venkatakrishnan, 2020). The collection of complex data, well-known as big data, are out flowing beyond the current capacity of IT servers making it difficult to store, process, and manage business data in-house (Mate, Llorens& De Gregorio 2012). Different companies are becoming overwhelmed by the production of large volumes data and struggling to properly operate business intelligence (BI) systems for real-time analytics and other essential tasks. Accordingly, many companies are suffering from poor recording system.

The enlargement of Big Data emphasizes the growth of data volume, variety, and velocity. Analytics evolve jointly with the development of information management from basic query and reporting, to business intelligence and advanced analytics(Chan, 2020).

BI applications deliver support to the function of decision support, reporting, online analytical processing, statistical analysis, forecasting, and data mining. Business Intelligence is a broad category of applications and technologies for gathering, storing, analysing, and providing access to data to help clients make better business decisions. Banking domains, such as evaluation of credit, the performance of branches, e-banking, segmentation of customer, and retention, are outstanding fields for the function of a broad range of BI ideas and execution, including data mining, data warehouses, and decision support systems. For a bank to stay alive and even shine in today's unstable business environment, managers at the bank need to have a permanent focus on solving demanding problems and exploiting opportunities (Smiles 2018).

Overview of Business Intelligence

Business intelligence flows through different cycles. The main task of BI is delivering decision support for specific goals well-defined in the context of business activities in various domain areas taking into account the organizational framework. BI decision support mainly relies on empirical

information based on data. In addition to this empirical background, BI also uses different types of knowledge and theories for information generation. The decision support has to be understood as a system using the actual capabilities in information and communication technologies (ICT). A BI system has to deliver information at the right time to the right people in an appropriate form (Grossmann, W. and Rinderle-Ma, S., 2015).

Different scholars use different definitions for BI, the most common ones are the following:

The world's BI application provider called The Statistical Analysis System (SAS) Institute defines "Business Intelligence (BI) as Business Intelligence is getting the right information to the right people at the right time to support better decision making and gain competitive advantages" (Waite, 2006). Business Intelligence (BI) is always an accessible technology that can be used to gather, improve, and analyze data. Therefore, the main function of BI techniques in dealing with data successfully is to be administrative support to increase the availability of relevant data when necessary (Farzaneh et al., 2018). Business Intelligence is a collection of tools and methods that supports the company to collect internal and external data, convert them to information, and based on information creates knowledge(Bakula et al., 2016). Business Intelligence (BI) is a kind of IT system that is made to process, record, and provide information with a related issue. The process of reaching, recording, and synthesizing information can be attained by using a BI application. The word BI includes a range of ideas for techniques, procedures, software, hardware, IT Systems, best methods to assist in business analysis(Pyae, 2019). These terminologies mainly focus on that the idea of synthesizing, processing, recording, and delivering on information analysis can be attained by the installation of a BI system that provides data to decision-makers to remain competitive in the market. Most BI systems contain various technical components such as visualization tools, on-line analytic processing (OLAP), and databases that assist decision-makers to observe and operate with subdivisions of data.

The top business intelligence challenges in an organization ensure data quality, absence of execution and training, unifying BI across all user groups, targeting big needs with a centralized team, self-service BI, huge infrastructure investment, unstructured data of BI and many more.

Generally, the process of BI assessment needs large scale investment. Because it deals with its basic components such as reporting, analyzing, decision making, Business Performance

Management (BPM), and software development. And nowadays companies are adopting these methods in order to meet their goals.

1.1 Background of the study

Nib International Bank (NIB) was established in 1999 and joined the banking industry as the sixth private bank licensed in the country of Ethiopia. Throughout its 20 years of banking experience, the bank is currently in the implementation stage of its 3rd strategic plan and putting a new structure in action starting from 2019 as shown in Appendix 1. NIB has accumulated a dynamic experience through its six districts and around 360 branches.

To accomplish its vision, mission and goals NIB has been making use of different IT solutions first DBase system since 2002, then StarBank system since 2006 for six years, and the current online, real-time, electronic (CORE) banking system Temenos' T24.

Temenos core banking system provides various banking functionality across retail, corporate, treasury, wealth, and payments. And Temenos Insight is a business intelligence, analytics, and reporting solution specially designed for banks. Insight allows financial institutions to access and benefit from the variety of data that exist in core banking, general ledger, profit and loss, and other systems.

Since 2013 NIB is using the Swiss-based system known as TEMENOS T24 R10(2010 Release) for e-commerce, mobile banking, internet banking as well as central managing of banking services. and TEMENOS Insight Business Intelligence R10(2010 Release) for the activities of decision support systems, query and reporting, online analytical processing (OLAP), statistical analysis, forecasting, and data mining. Currently, the bank and USI which is a certified Temenos upgrade partner signed a project now in progress to making a change of the existing T24 system from R10 to R20 (2020 release) which is planned to be fully implemented in the coming year 2022.

Utilization of older releases of applications frequently results in challenges regarding application availability due to problems related to technical inconsistency (Andreadis, & Bouzakis 2015). From the perspective of NIB, a BI system that is purchased through a license per user often fails to function in its old workplaces. This is because the operating system was not compatible with the recent system. Consequently, each consumer with incompatible operating system or

infrastructure who intends to make use of new technology is unable to access and operate the BI systems. Therefore, NIB is considering investing in technologies that enable legacy systems to work with the latest BI system. In this study, an assessment of the BI information system was made on NIB.

1.2 Statement of the Problem

This research tried to give basic information, perspective, and guidance about the importance of BI systems for big data management. It also examines some weaknesses and challenges that affect the performance of the BI system.

Bad BI systems can lead some companies into bankruptcy, or crisis or even failure. Some BI systems are not also uniformly compatible to different types of companies. Moreover, the world is generating large scale information instantly. Different findings show that, in practice, the way BI system is applied in different organizations varies a lot. For one organization BI system may use for single-market research forecasts, while for another organization it could mean a continuous process that produces several BI system outcomes and services that are used by several users. Case-specific issues are also likely to have an effect on how BI system can be successfully implemented (Taylor, 2013).

BI is an advanced system that can compute useful business decisions specified time, management, isolated, historical and price data. Generally, it is a set of insights and approaches to enhance business decisions. But several organizations are unaware of the potential benefits of BI. Some organizations do not know that such system exist (Brien, 2006).

Several companies are exploring several alternatives to deal with their big data problems. Some acquired it from vendors, others choose to develop it in-house and the rest depend on the cloud-based systems. BI system deployment usually needs a resilient management and maintenance of its complex applications. So, some companies prefer cloud based BI systems. But such kinds of systems have limited capacity to deal with big data.

Companies must identify their weaknesses and strengths before the deployment of BI systems. There is wide range of applications for BI system. So, any plan for any type of preliminary capital investment requires careful assessment of hardware compatibility.

After the deployment of the BI application, users must be trained in order to operate the system efficiently and effectively. The capacity level of either in-house or cloud BI system can be

measured by the skill level of its users. And a successful operation of BI system leads to a successful management of Big Data.

Companies must have the department for BI system administration. This department usually consists of professional BI experts who can record, process and analyze data and its application system. Nowadays companies must have an advanced knowledge, technologies, techniques, systems, programs, methodologies, and IT applications in order to make a good business analysis and succeed in the overall market.

In 2013 NIB launched its version of BI system (Insight), a 2010 release. The infrastructure layers are constructed and are operating separately. The servers are old and incompatible, and has limited storage space. Nowadays, data is overflowing from all sides of the world, its users are increasing and businesses are expanding. And companies such as NIB are facing challenges ranging from limited storage space, server and infrastructure. So, this study tries to make an assessment of ways on how a well-organized infrastructure can be introduced according to the perspectives of BI users and experts of the bank.

Various organizations have different working practices that depend on their culture and nature of business. Manyika et al (2011) agree that these kinds of studies can guide and encourage companies to procure and use appropriate BI applications for managing large volumes of data in order to make better decisions and remain competitive. Also, most of the existing studies have focused on a combination of industries rather than a specific focus on the banking sector.

In the context of Ethiopia, very limited research has been conducted in BI system. Amanuel (2020) conduct his study with specific focus on system features such as analytics, Publisher, dashboards, delivers and scorecards. His study was motivated by lack of literature resources for research on the nature of relationship between business intelligence and the performance of a company such as Commercial Bank of Ethiopia. So, more studies are needed on any particular technical aspect or specific BI system. Therefore, in this research assessment of BI information system in NIB infrastructure was made in order to fully utilized the existing features and effectively use the system for real-time decision-making.

1.3 Research Questions

Based on statement of the problem, this research tried to answer the following questions:

1. What are the services/features of BI system in the bank and what are the gaps?
2. What are the basic BI software and related hardware in the bank?
3. How can the suggested model be constructed successfully?

1.4 Objectives of the Study

1.4.1 General Objective

The general objective of this study is to identify the status of Business Intelligence Information System so as to design enhanced integrated hybrid architecture.

1.4.2 Specific Objectives

To address the general objective of this study, the following specific objectives were formed:

- To review literature and understand BI in general.
- To understand the current status of BI infrastructure in NIB according to users and evaluate power of the suggested BI system according to experts.
- To explore a series of BI infrastructure configuration methods and their related advantages and limitations.
- To develop enhanced integrated BI infrastructure.
- To validate the proposed enhanced architecture.

1.5 Significance of the study

The importance of this research is that:

- This assessment is useful for companies in making financial and business decisions.
- All the discussions raised in this study regarding the BI system, on-premise, and cloud-based BI infrastructure can serve as further reference on this field of study.
- Companies with plans for hybrid BI system deployment can have the basic information on key concepts regarding BI applications
- Companies can also learn that a good assessment of BI deployment methods is useful for a good customization design.

This study encourages other related research areas such as BI architecture and deployment models. This model can serve as a guidance for other companies planning on BI system deployment. This study assessed the most common methods of dealing with the most common problems of BI.

1.6 Scope and Limitation

This study covers issues related to the Assessing the development of Business Intelligence & the code of Information System in NIB. Despite the attempt to meet as much sampling size as possible, it was difficult to collect data from more than 72 participants from BI users and BI experts respectively. The research had to depend on online survey rather than face to face communication with all corners of the bank. It was suspected that the current pandemic of COVID-19 (coronavirus) hindered the level of participation from different professions.

The online survey questionnaire is created using Google Forms for both BI users and BI experts. And the result was analyzed using SPSS descriptive statistics and custom tables then BI expert questionnaire result was used to enhance the hybrid BI system architecture.

1.7 Structure of the Research

The research is organized into five main chapters. The introduction part describes the background of the study including the statement of the problem, objective, significance, scope and limitation of the study. After the introduction, relevant literature is reviewed in chapter two. Basic concepts and theories of the BI system are described. Chapter three deals with the description of the study area and also it discusses the methodology employed for data collection, analysis, and conceptual framework of the study are presented in this chapter. The main findings of the study are presented and discussed in chapter four. Finally, chapter five presents the conclusion and recommendations of the research work based on the results of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter reviews basic concepts of business intelligence and factors regarding its strengths and challenges. It begins with the description of BI, business Intelligence process flow, deployment models, BI system architecture. Then the three types of BI deployment models which is on-premise, cloud-base and hybrid BI architecture will be discussed thoroughly. The last part of this chapter presents the common theories on which the conceptual framework of this research was based, including a detail review of previous studies made on the Business Intelligence system.

2.2 Business Intelligence

In this era of high-tech, business intelligence turns out to be one of the popular software which is applied by the company or organization. Business intelligence is utilized to hold in-house data such as operational data or transactional data into information that could use in future decision making. Mainly, business intelligence systems get more concentration for its ability to analyze data by companies given precondition. It is currently deployed across various areas for instance airlines, finance, education, and health (Girsang et al, 2019).

In the recent age of technological developments and super-rich world, business intelligence (BI) systems have captivated CEOs and CIOs because of their capability to produce sophisticated & essential data for the analysis process. After years of experience and appraisal, the application and exercise of BI systems have progressed over the past twenty years. This review points out that many companies were generally unable to take maximum advantage of BI systems and are just trying to cope up with the available systems(Ain et al, 2019). BI solutions must to be flexible. As soon as business changes, organisations should upgrade their BI systems to new conditions (Olszak and Ziemba, 2007).

The use of business intelligence (BI) systems to provide support for the achievement of a firm's strategic business goals, business process reengineering, provision of a higher quality of information, and eventually better support for decision-making has made it a very popular technology recently for both researchers and experts. The application of Business Intelligence (BI)

in helping the accomplishment of a company's objectives, restructuring, creation of high standard data, and better business analysis has increased the significance of the technology for experts. Different parts of the BI system are applied by different people in different types of jobs to communicate with the company's information, exercise the application, and record the different activities of the company. This is also useful in enhancing the company's activities effectively. BI can help a company to identify different chances and is also useful in restructuring its business processes. So, this review shows that many companies have applied BI systems through maturity models and critical success factors (CSFs). As BI is still improving, new methods are always coming, many companies carry on developing and highly investing to advance their systems. (Owusu, 2017)

Significant Features of BI

- The task of BI - The main task of BI is delivering decision support for specific goals well-defined in the context of business activities in various domain areas taking into account the organizational framework.
- Foundation of BI - BI decision support mainly relies on empirical information based on data. In addition to this empirical background, BI also uses different types of knowledge and theories for information generation.
- Understanding of BI - The decision support has to be understood as a system using the actual capabilities in information and communication technologies (ICT).
- Delivery of BI - A BI system has to deliver information at the right time to the right people in an appropriate form (Grossmann, W. and Rinderle-Ma, S., 2015).

2.2 Challenges of BI system in Big Data analytics

Nowadays, many organizations are processing a vast number of transactions to administer, analyze and generate effective information for their business decisions to turn out to be better but these transactions take place in big data and difficult to manage(Pyae, 2019).

Big Data is a concept that deals with placing, storing, and analyzing huge data files (Krit & Bousty, H.el, & Kabrane, Bendaoud & Karimi, Khaoula & Oudani, 2018). One of the major applications of Big Data analytics is for business intelligence system to better utilize big data for enhancing customer satisfaction, understand customer needs, reducing customer complaints, to develop strategies for launching new products and services, managing supply chain risk, exploring new

markets, creating competitive intelligence, enhancing staff productivity and efficiency, delivering business real-time insights to assist make core decisions if it utilized appropriately.

Big data can help organizations accomplish a competitive advantage over their rivals through many features and yet it faces a variety of challenges. The major challenge of big data analytics consists of lack of intelligent big data sources, lack of scalable real-time analytics potentials, the availability of sufficient network resources for operating applications, the need for essential improvement for peer-to-peer networks, the concerns about data confidentiality and information security demands, the difficulties with data integration and disintegrated data and lack of obtainability of the cost-effective storage subsystem of high performance. Furthermore, the necessity of costly software and vast computational infrastructure to do the analysis cause problems in the operation of Big Data analytics for BI.

Furthermore, the hardware-technology that helps big data analytics creates challenges (data processing, networking, and storage technology). Primary, the technology is incapable to deliver a single computing configuration to operate on both real-time and scalable analysis. On the other hand, the networking technology nurtures a growing hole between bandwidth, which limits the network capability to support real-time applications. Also, there is no well-organized rule to forecast the growth in the storage size of magnetic drives. (Ram, Zhang and Koronios, 2016)

2.3 Business Intelligence Process Flow

BI is a structure, containing processes, tools, and different techniques designed to transfer from data to information and from information to knowledge and enhance the organization's effectiveness in decision making (Abusweilem and Abualoush, 2019). The efficiency of a Business Intelligence System is mostly dependent on essential components, such as Data Acquisition (ETL), Data Storage (Data Warehouse), and Data Analytics (OLAP) (Venkatakrishnan, 2020).In the perception of this study, a BI process flow holds model significance activities and elements required to obtain, use, and control the data crucial for improving business decision making. The significant activities and elements of the BI process flow are Gathering data, ETL (Extract-Transform-Load) Process, Data Warehousing, Data Analysis, and Data Visualization.

The next figure shows the general process flow of Business Intelligence with the description of each stage included in the Business Intelligence (BI) process (Borse, 2019).

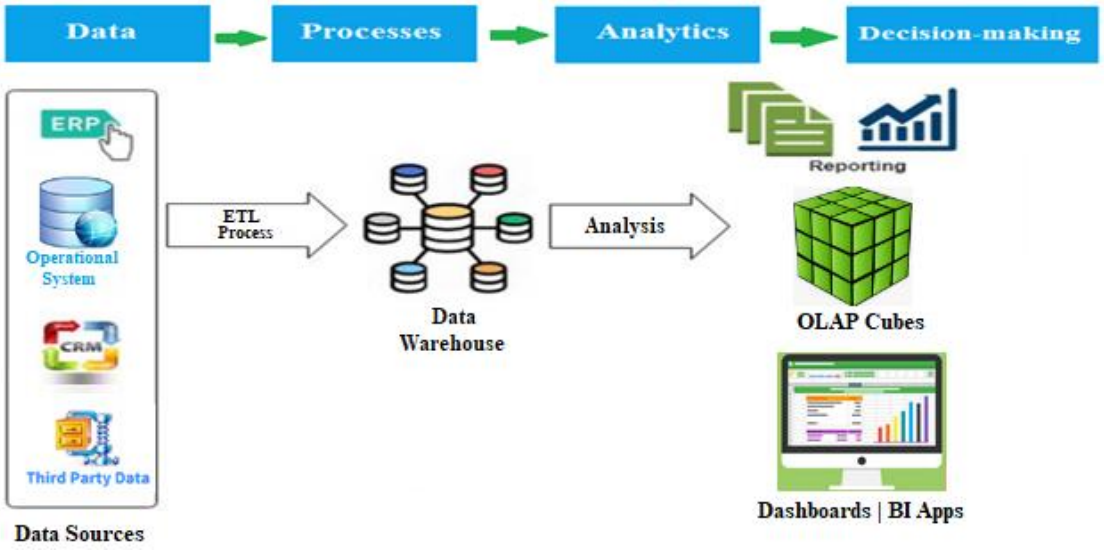


Figure 2. 1: Conceptual Business Intelligence System Process Flow (Source: Borse, 2019)

A. **Data Gathering:** This is the initial stage of Data Warehousing in which data is collected from different internal and external sources like ERP (Enterprise Resource Planning), CRM (Customer Relationship Management), SCM (Supply Chain Management), SAP (Systems Applications and Products), and many more. This data can be in different forms like structured, semi-structured, and unstructured.

B. **ETL Process:** ETL describes the processes used to copy data from source databases to the data warehouse, but it's more complicated than simply moving bits. Quite often, data is transformed and validated on the fly. The end-to-end ETL tasks are combined into packages, which are scheduled to run automatically at preset times. Microsoft's Data Transformation Services (DTS), part of SQL Server is an example of an ETL tool. Generally, it is responsible for extracting data from different sources, cleaning them up, and loading them into a data warehouse.

   Note - An efficient ETL process should be flexible enough to support the BI needs of an organization as the situation demands.

C. **Data Warehousing:** Data Warehouse is a large storehouse of collected data from different internal and external data sources. Data Warehousing is a process of storing or loading of the data into the data warehouse.

D. **Data Analysis:** Data Analysis is the process of choosing a cube of data from the data warehouse and using different algorithms for identifying suitable patterns in that data for obtaining insights for business development.
E. **Data Visualization:** Data Visualization is a technique and process of representing the raw data or accessible data into different comprehensible and/or interactive forms like graphs, charts, and forms. And these visualizations are jointly represented as Dashboards.

2.3.1 Data Mart

Data in a data warehouse is mostly utilized to assist several needs across the whole organization, it is not organized to support the requirements and needs of specific departments. Therefore, it is essential to have data marts to assist them. A data mart is part of the data warehouse that is designed to hold the analytical requirements of a specific department or business unit function in an organization. Similar to data warehouses, it holds historical data that can help users to access and analyze several data types. But it can only hold data for 60 to 90 days.

Data marts provide a subject-oriented view of the data system and contain much smaller amounts of data than OLTP or data warehouse systems and it is more flexible compared to a data warehouse. It is fast because it has special indexes created to enable users to extract the data quickly. Typically, a data mart contains all of the data that needs to satisfy the reporting requirements for a single business area. There can be several data marts within an organization (Armstrong-smith ., 2014).

2.3.2 OLTP and OLAP

Online Transaction Processing (OLTP) environments utilize database tools to operate and request data and assist the day-to-day active requests of the company. It is characterized by a large number of short on-line transactions (INSERT, MODIFY, DELETE). The main emphasis for OLTP systems is put on very fast query processing, maintaining data integrity in multi-access environments and effectiveness measured by some transactions per second. e.g., T24 is an OLTP system. On the other hand, Online Analytical Processing (OLAP) is characterized by a relatively low volume of transactions. Queries are often very complex and involve aggregations. For OLAP systems a response time is an effective measure. OLAP applications are widely used by Data Mining techniques. e.g. Datawarehouse is an OLAP system

(Pyae, 2019). OLAP environments use database tools to assist data analysis and data mining and to deliver data visualization for decision-makers from which to produce decision making information. The major disadvantage of the OLAP environment is the reliability of the data. Since the process by which data is extracted, transformed, and loaded into the OLAP environment can be relatively slow by transactional data standards, the ability to achieve "real-time" data analysis is lost (Conn, 2005).

	OLTP	OLAP
Time Scale	This stores current data	This stores History data for analysis
Organization	Data stored revolves around business functions	Data stored revolves around information topics
Stored Values	Stored typically coded data	Stored descriptive data
Homogeneity	Scattered among different databases or DBMS and using different coding schemes	Centralized in a data warehouse or a collection of subject-oriented data marts

Table 2. 1: Difference between OLTP and OLAP (Source: Singh & Sood, 2013)

2.4 Business Intelligence system Structure

BI system helps to improve raw data into relevant information for the business analysis process and develop business performance (Chan, Sim, and Yeoh, 2011). It can serve as a background for any BI purpose for helping businesses succeed in this competitive world. In this thesis, the BI structure in figure 2.2 shows the general picture of the BI system and how to apply the previously presented BI process flow.

The objective of the BI system is to deal with different ideas but the main point is to deal with recording techniques, data storage, and source systems(Ong, Siew, and Wong, 2011). Based on the description of BI process flow, the following general architecture in Figure 2.2 is suggested having four basic layers i.e.: the presentation layer, the service, the data warehouse, and data source layers. The next section describes each of the layers.

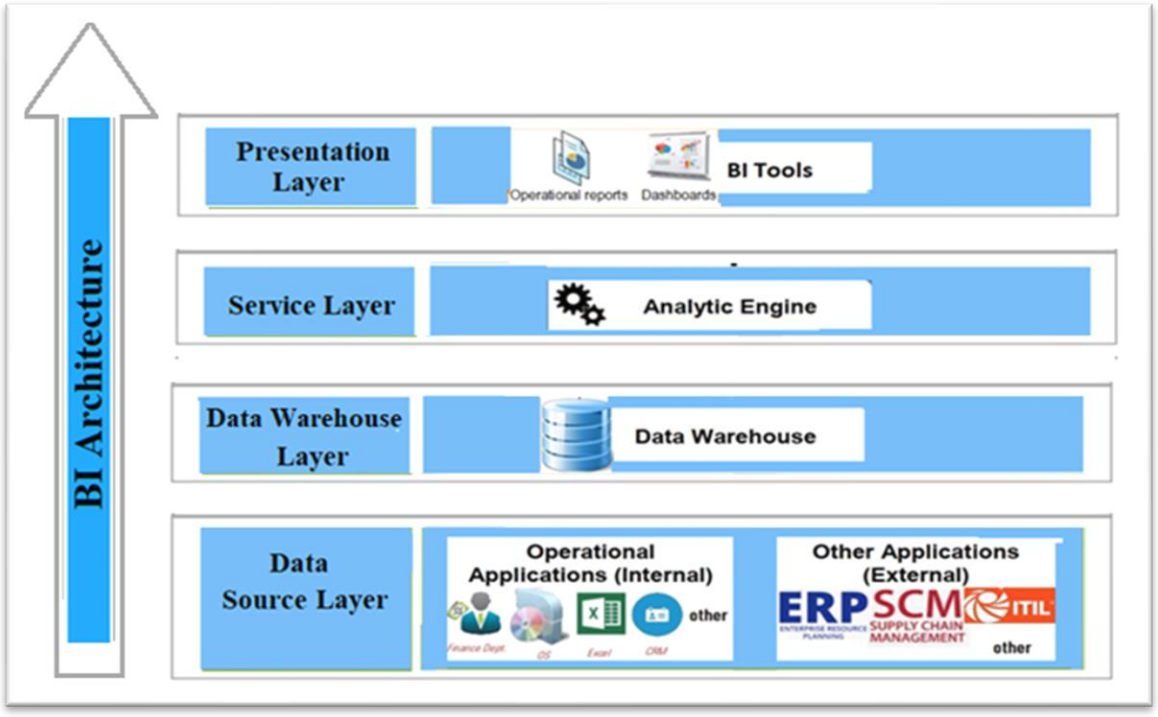


Figure 2. 2: BI System Layers (Source: Ong, Siew and Wong, 2011)

2.4.1 Presentation Layer

In BI system, the presentation layer consists of tools that shows information in several formats to different target group business users, for instance operational management (experts, system and business analysts, etc.) and top management (managers, directors, etc.) can access the data to generate different operational ad-hoc inquiries or prefabricated target-group-specific reports (Ong, Siew and Wong, 2011; Azeroual and Theel, 2018).

The presentation layer holds several reporting tools such as dashboards, records and reports etc. which are important tools that allow front-end users to access data quickly, and to generate reports for decision making and management purposes. In this layer, business users have a single and secure point of entry interface that allows business users to generate different types of reports from various types of information. All internal and external users can administer reports and other data easier and quicker over different sort of ways, for instance portals, web browsers, classic, mobile applications, etcetera. These are a powerful front-end user tools to provide information. (Ong, Siew and Wong, 2011).

2.4.2 Service layer

Service Layer delivers functionality for the users that authorize them to analyze structured or unstructured data and supports the delivery of significant knowledge among various users. The most common analytical tools in BI systems are reporting, data mining, and OLAP tools. Reporting tools deliver quantitative data in different report format that might contain statistics, tables, or business charts. OLAP represents a concept for supportive and multi-directional analysis of combined quantitative business realities. Data mining tools enable users to discover various hidden patterns, generalizations and rules in structured big data based on statistical methods like category, or group and association analysis. Data mining and related model-based tools are Advanced Analytics(Elmalah and Nasr, 2019).

2.4.3 Data warehouse layer

In BI architecture, the data layer provides one of the key components of the data warehouse. Data Layer is responsible for collecting structured and unstructured data for management support. Regarding structured data, the central component is the data warehouse. Data warehouse is "a subject-oriented, integrated data, has a time variant, and non-volatile collection of data used in support of management's decision-making process.(Darma *et al.*, 2019) The warehouse stores data that has been cleansed for reporting and multi-dimensional analysis that can ultimately help managerial decision-making(S. Krit & el Bousty, H.el, & Kabrane, M. & K.Bendaoud & Karimi, Khaoula & Oudani, H., 2018) .

The process of data cleansing operations is all organized under the Extraction, Transformation and Load (ETL) tools. ETL tools process includes the extraction of data from heterogeneous sources, transforming them into the new format in line with business needs and lastly put it in the target data structure. The function of ETL is to collect, filter, manipulate and join the relevant data from various sources to be stored into the data warehouse(Darma, 2019).

A good data warehouse design must consider the existing and future user needs of information, and simultaneously, it must be upgraded for fast and interactive access. Furthermore, the data warehouse has to be flexible enough to help the rapid data growth and changes in the organization (Reyes, 2010).

2.4.4 Data Source layer

The data source layer represents the various (internal or external) data sources that deliver structured or unstructured data to the data warehouse. Internal data source refers to data that is collected and stored by operational systems within organization such as Customer Relationship Management and Enterprise Resource Planning systems. Internal data source system consists of data associated to specific business operates within an organization (i.e., clients, products, and transactions data)(Ong, Siew and Wong, 2011).

These operational systems are also known as online transaction processing systems (OLTP) which include CORE banking system, such as different Enterprise Resource Planning, databases, or Customer Relationship Management, which may be internal or external to the organization. Operational systems handle large number of transactions in real time and update data when it is required. The data source can be of any format e.g., plain text file, relational database, other types of database, excel, CSV file, etc., can all act as a data source. Extract Transform and Load (ETL) tools deliver key functionalities essential for data collection and organization from a wide range of sources including on-premises Cloud, and hybrid environments. It is the major part of BI system. Generally, ETL are consists of three activities:

- Extract: Is the act of retrieving data from various source systems and storing it in a production area. The extraction activity may harm the operational transactions and trigger performance drop.
- Transform: Data gathered are cleansed, combined and structured to fit the needed format. The more this data load, the more time and capacities required to handle the task.
- Load: the final activity, taking the newly transformed data into the data warehouse (S. Krit & el Bousty, H.el, & Kabrane, M. & K.Bendaoud & Karimi, Khaoula & Oudani, H., 2018)

2.5 Business Intelligence System Deployment Models

A BI system delivery model represents the type of business intelligence system environment which hosts the BI service. The three types of BI deployment models which is on-premise, cloud and hybrid are explained in the following sections.

2.5.1 On-Premise

On premise BI system has been built on limited data storage and limited capacity infrastructure (S. Krit & el Bousty, H.el, & Kabrane, M. & K.Bendaoud & Karimi, Khaoula & Oudani, H., 2018). On-premise BI systems in an organization mean that the organization have all the servers, data processing ETL and databases in-house, which could be inside the building the company is located or an isolated system center. In this BI system, all functional services such as sorting, storage, archiving are maintained inside the organization. The on-premise system includes significant initial investments, ongoing maintenance costs, hardware and software costs and associated expenses. The company have full control of its server and can upgrade or change it, based on the specific company requirements and conditions (Srinivasan, 2012).

On-premise BI system is hosted in the data center of an organization and delivers its services only to users inside that organization or its partners. It has the potential to offer the organization better control on the infrastructure and computerized resources (Goyal, 2014).

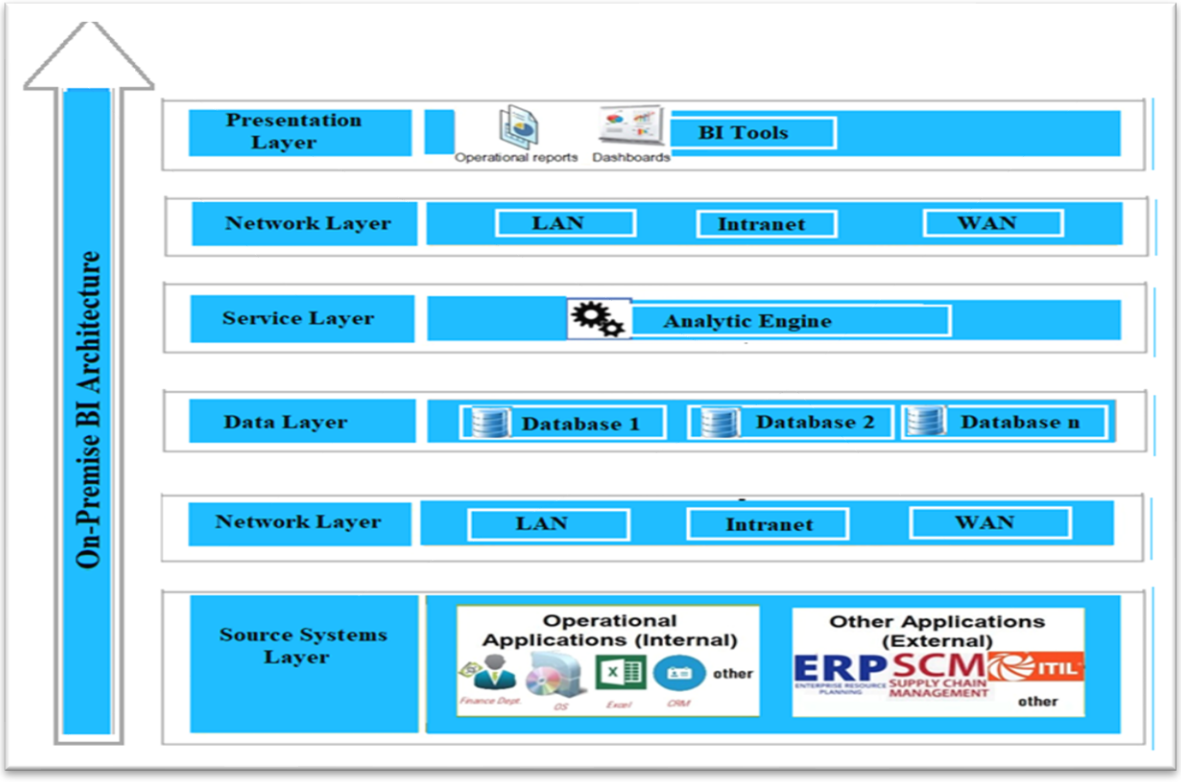


Figure 2. 3: On-Premise BI System Layers (Source: Ong, Siew and Wong, 2011)

Presentation layer: The presentation layer is the application containing dashboards, graphical reporting and multimedia interfaces that deliver users with information in a clear and accessible form (Olszak and Ziemba, 2007). Moreover, business users with the non-IT background are authorized to access or generate desired reports simply without depending on the support of power users or experts.

Network layer: The Network layer is responsible for connecting to different SmartThings, network devices, and servers. Its characteristics are also utilized for broadcasting and processing sensor data (Sethi and Sarangi, 2017). Network layer provides Switching and/or routing. The router can perform different tasks such as, Packet switching, Packet filtering, Internetwork communication and Path selection in a company LAN's (Awasthi, 2020). The network layer can offer logical paths, called virtual circuits, for broadcasting data using LAN infrastructure from source systems into the analytic engine. The task of this layer can involve routing, forwarding, addressing, internetworking, error handling, blocking control, and/or packet sequencing (Data, 2015).

Service layer: A layer for data analytics connecting what-if scenarios, reports, stored queries and data models. Service layer delivers services for business objects in layer. Generally, Services for business objects are familiar procedures that users need to interact effectively with the objects. Service layer for instance, may include generic Services, teamwork Services, guided procedure Services, and/or a container for application Services. By Separating the Services from the business objects, the Services may be more readily reused across business objects. A Service layer able to provide Services to multiple application (Beringer, 2004).

Data Layer: Data is isolated into operational and historical data. Data layer is a data-oriented place to store historical data, which has been organized so that it can be accessed and obtained for analysis process activities (Darma, 2019). As the data volumes are increased, the historical data is filtered from the data warehouse system for faster database queries(R.kune; P. Konugurthi, 2015).

It is designed to extract, process and present data in a suitable format for specific purpose and includes large amounts of data collected from sources of various systems and sites (Abusweilem and Abualoush, 2019). It contains database servers, legacy systems, transaction application and ftp servers and directory servers. This layer delivers an abstraction on the database and offers the core functionalities such as administration and retrieval of the data. This layer indexes the data and

classifies them over the distributed storage devices. The data is subdivided into groups and arranged onto the multiple warehouses. The data to organize can be any one of various forms; hence, different tools and techniques are working for effective preparation and retrieval of the data such as; column-oriented data, document database, Relational database, semi-structured XML data, raw formats, etc. (R.kune; P. Konugurthi, 2015).

Data Source layer: The data source layer is the basis of the BI system and is dependent on systems that have an interface with the operational systems to load data into the data warehouse. Data sources is a places where data employed in analysis is held and from where it is drawn for use(El-adaileh and Foster, 2019). Data is first inserted and administered by a day-to-day business operation that is based on Online Transaction Processing (OLTP) system type and stored in the operational database, such as Oracle, MySQL, DB2, MongoDB, Informix, SQL Server, etc. ETL (Extract, Transform, and Load) processes are required before data is loaded from the operational database and outside sources into the data warehouse or data marts for future analysis (Khan, 2012).

On-premise Business Intelligence	
Advantages	**Limitations**
Security of data	Managing and maintaining large numbers of BI applications
Ownership of BI systems	Costly IT infrastructure investment
Software license cost	Inconsistent reporting leading to manual interventions
Customization is easier	Managing Big data challenges
Easier integration	High maintenance and transaction costs
Reduced infrastructure cost	Unable to access critical business information on time
Enhanced business operations	

Table 2. 2: On-premise BI Advantages and Limitations (Source: Fisher, 2018)

2.5.2 Cloud-Based

Cloud-based BI architecture

The improving acceptance and success of the cloud has directed to the arrival of cloud-based Infrastructure-as-a-Service (IaaS) systems, a modern additional approach to traditional on-premise system(Eid, Mohamed and Mawgoud, 2019). Cloud BI is a revolutionary model of delivering a cost-effective business intelligence system as a service using a cloud-based architecture with faster deployment & flexibility (Gurjar and Rathore, 2013). Cloud service is managed by the provider therefore, the user needs to have a personal computer and Internet access.

Cloud-based BI system can be described as a service in IT that are delivered to a consumer on-demand over network access to shared configurable computing resources (i.e., applications, networks, servers, storage, services, and the like) that can be quickly prepared and released with service provider interaction(Al-Ruithe, M., 2018). As the data center stresses in need for additional storage and faster performance cloud computing and other emerging approaches are offered which require new ways to manage data and utilize IT services(Gurjar and Rathore, 2013). The cloud lets users avoid the necessity to upgrade the computing power of their on-premise systems to use BI (Olszak and Olszak, 2014).

In this context, a Cloud-based BI architecture containing the basic layers, that is, the presentation, security, network, and service layers are suggested (see Figure 2.4), considering the privacy, and quality of important data including information flow in the system. Figure 2.4 shows the Cloud-based BI architecture.

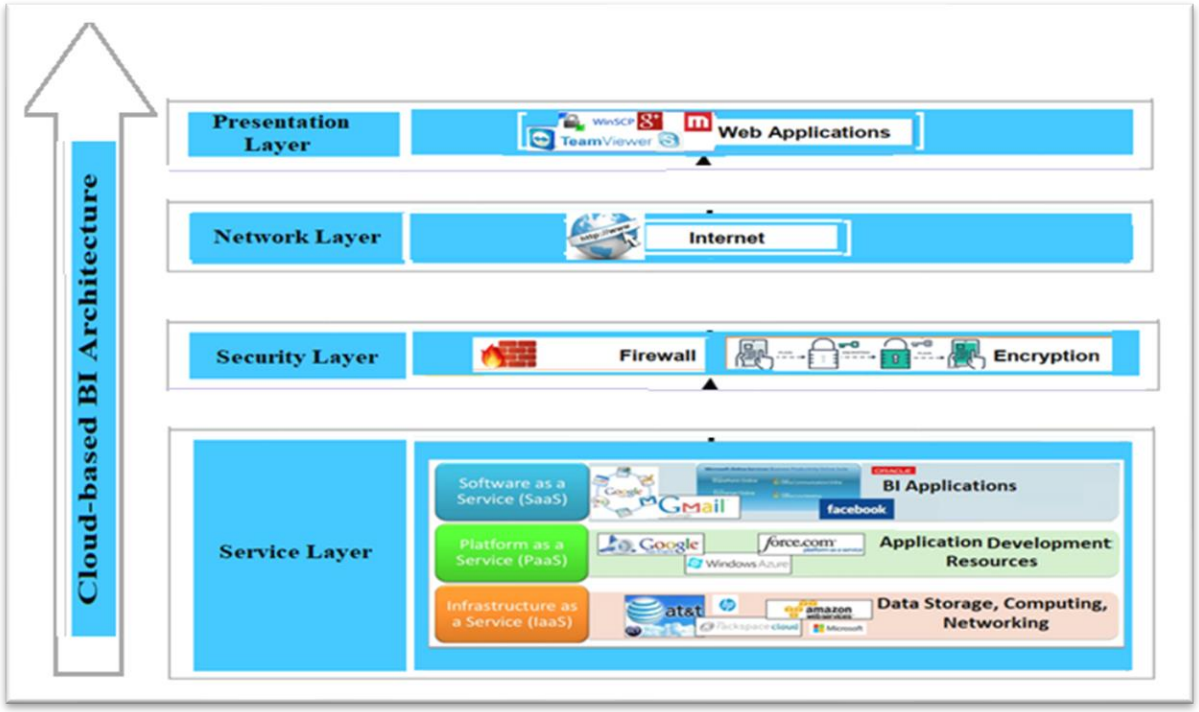


Figure 2. 4: Cloud-based BI System Layers. (Source: Elmalah, K. and Nasr, M., 2019)

The four layers are described as follows:

Presentation layer: The presentation layer is a logical layer in the architecture where business intelligence system is used by the business users. The function of these graphic tools is to show Dashboards, advanced visualization, ad-hoc query, data integration, production reporting, search interface, self-service data etc. clearly from a data warehouse or data mart to the user(Elmalah and Nasr, 2019).

Network layer: The main function of network layer is transmitting and processing information from different interconnected networks, such as, Personal Area Network (PAN), Local Area Networks (LANs), Metropolitan Area Networks (MANs) and Wide Area Networks (WANs). LANs are the shortest of the networks, and are described by Small geographical foot prints. LANs are primarily utilized to connect computers within an office; however, they may be used to link adjacent office buildings. MANs are the next largest kind of network, and normally operate at the city or regional level using Synchronous Optical Network (SO NET) architecture and technology, which is well known in the art as a standard for connecting fiber optic transmission systems. An

important difference between a WAN and a LAN is that while an organization generally own a LAN infrastructure, but they usually rent a WAN infrastructure from an internet service provider (Lysdal, 2007; Awasthi, 2020). The network layer contains an interconnecting networks and Internet network, network management center, information midpoint and BI processing center, etc. The network layer will transmit and process the information obtained from presentation as well as security layer (Miao Wu, 2010).

Security layer: It helps in subscribing privacy status to the data flow(Manoj and Kumar, 2018). All information moving through networks out of the organization (like Internet broadband) must be encrypted. This task has to be managed by the ETL tools, which are in charge of extracting data from data sources, encrypting it, sending it to the cloud, de-encrypting it, transforming it, and then loading it into the data warehouse.

In addition to encryption in the upload is starting a VPN (Virtual Private Network) connection from the company to the cloud. In such a way, data could securely travel on the network. VPNs are systems that are generally presented by cloud service providers and having a secure tunnel on which information can be transferred. Secure connections between application servers and internet browsers are broadly used via SSL (Secure Socket Layer) and TLS (Transport Layer Security) are connections. The objective of these security roles is that no intruder could get the information while is transferred on the network. (Reyes, 2010)

Service layer: The cloud-based service layer contained the cloud platform which provided data storage and computing resource for data application. The ontology model of packing line was built on the cloud platform, and a relationship between objects was established in two dimensions: structure and interaction. The organization data were uploaded to the cloud platform to form a logical data model (Chen, 2018). There are different cloud service delivery models, the three key cloud service models recommended based on the computing necessities of the consumers are Software as a Service (SaaS),Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) (Wachanga , 2018). All 3 service delivery models require users to either design, develop, build and deploy applications to cloud. Generally, to access all cloud-based services an environment with an internet connection is mandatory. The three key cloud service models are described as follows:

- **Software as a Service (SaaS):** SaaS model presents an on-demand cloud-based center for software, which is usually web-delivered content that users access analysis and reports through a web browser (Wachanga, 2018). In SaaS, a single application with customizable design can be utilized by several consumers. The benefit is that it needs no installation of the software and hardware structures (Sowmya, Deepika and Naren, 2014; Wachanga, 2018).
- **Platform as a Service (PaaS):** Platform as a service (PaaS) model involve services that obtain on IaaS services (Coyne ., 2018). It presents essential hardware and operating system technologies, such as, web server, file systems, database management systems, developer tools and network support for the users to install their own customized SaaS BI applications (Wachanga, 2018). The PaaS architype does not request consumers to setup any software, programming language, environment application, designer, tools or application. Developers utilize vendor's platform, library and programming language for developing their applications. PaaS minimizes the expense and complexity of application deployment by eliminating the demand to purchase and administer the necessary hardware and software and to provide hosting capacities (Sowmya, Deepika and Naren, 2014).
- **Infrastructure as a Service (IaaS):** IaaS is the base on which a cloud computing architecture is constructed. With the development of technologies in infrastructures, data processing, and database tools, IaaS has appeared as a very essential platform to make Software-as-a-Service and Platform-as-a-Service layer in addition to it (Goyal, 2014). IaaS offers infrastructure such as, unlimited storage (which allows users to store, retrieve and edit big data), network and computing capacity for developers without requesting any physical hardware. IaaS service models delivered to the consumers including virtual machines, storage, servers, networks, load balancers, etc. based on the consumer need (Sowmya, Deepika and Naren, 2014; Wachanga, 2018).

Cloud-based Business Intelligence	
Advantages	**Limitations**
Easy integration of cloud-based BI solutions	Unclear service level agreements (SLAs)
Advanced cloud technology resources	Vendor lock-in
Data an organization asset in the cloud	Data security concerns
Lower Total Cost of Ownership	The higher inherent risk in cloud integration and configuration
Access to unlimited cloud resources	Security concerns
Limited software and hardware investments required	Datastores performance issues
Limited use of special expertise to operate	Lack of standardized pricing models
Easier and quicker expansion on demand	Data ownership concerns
Least likely to have implementation cost overruns	Data volume concerns
Robust multi-tenant architecture model	Reliability concerns
Optimized cloud resource usage	Multi-tenant attacks on communication infrastructure
	Repetitive tasks

Table 2. 3: Cloud-based BI Advantages and Limitations (Source: Muntean, 2015)

2.5.3 Hybrid

Structure for a hybrid business intelligence

A hybrid business intelligence system, as the name indicates, is a combination of on-premise and cloud-based system(Coyne ., 2018) . They are site together to deliver the serves and benefits of a joined deployment model. The main objective of hybrid BI is to keep sensitive data in the organization (on-premise) and only move public or semipublic data to the cloud (Reyes ., 2010) .The proposed hybrid BI architecture in this study shows how to use a mixture of on-premise and cloud-based BI solutions, involving service models, for instance, SaaS, PaaS, and IaaS. The hybrid BI architecture complements the conversation on the hybrid BI model earlier to explain more on how a hybrid BI information system can best bring and achieve an organization's BI requirements.

The architecture in figure 2.5 below shows the ideal set-up for bringing companywide on-premise and cloud-based BI deployment.

The hybrid BI deployment model allows a business to gain the benefit from the flexibility and cost-effectiveness of cloud-based third-party devices without exposing applications and data outside the company intranet. The challenge for a hybrid BI system is the complexity in successfully designing and administering such a system. Services from different sources must be obtained and equipped as though they initiated from a single location, and connections between on-premises and cloud-based parts make the execution even more complex (Coyne, 2018).

The suggested hybrid architecture must consist of the five major layers i.e., presentation layer, application layer, network layer, service layer, and the data layer. In other words, the architecture must be presented with the front-end technologies, on premise and cloud-based services, data warehouse and the necessary processing applications and infrastructure facilities.

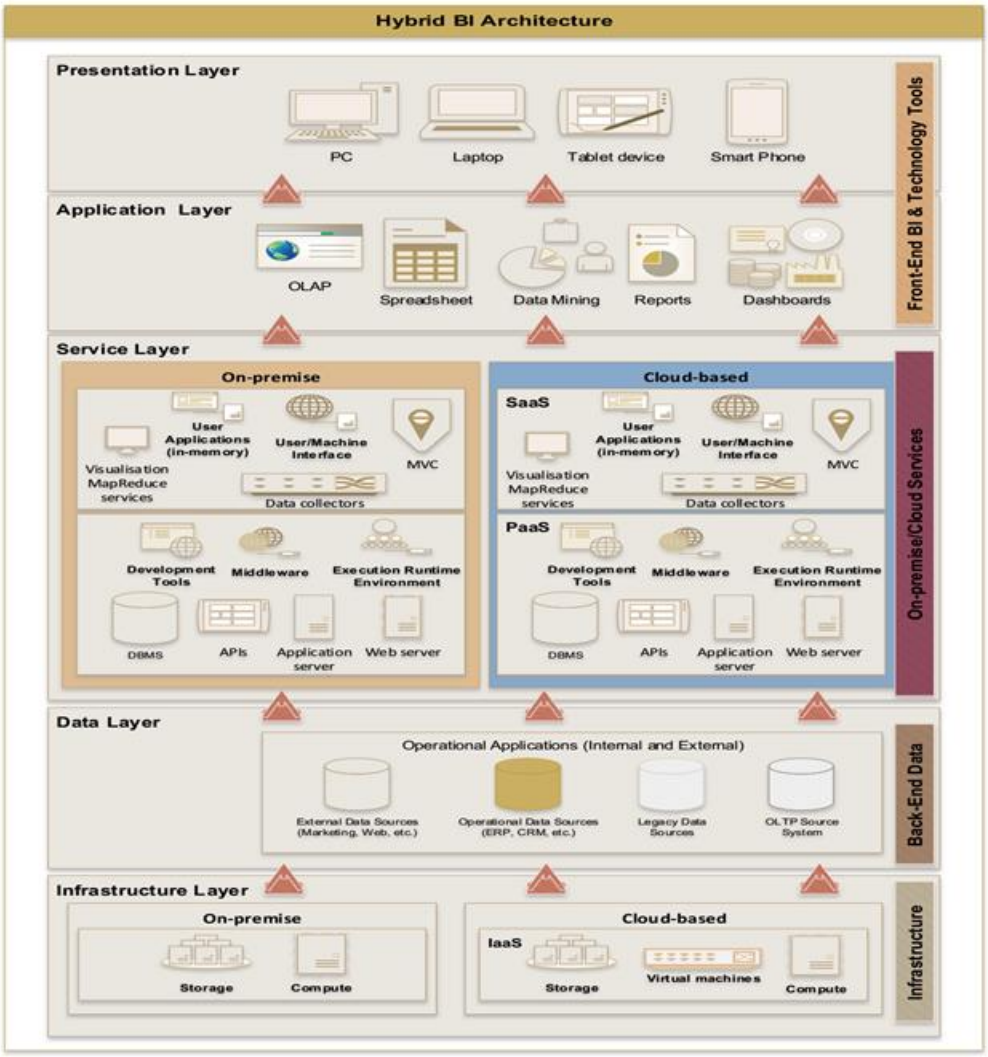


Figure 2. 5: Basic Layouts of Hybrid BI Architecture (Source: M. Banda (2017))

The following review each layer in further detail.

Presentation layer: The presentation layer allows users to access data stored in the data warehouse using devices (PC, thin clients, laptops, smartphones etc.) using different web applications such as browsers like Microsoft Edge, IE, Chrome, Maxthon etc. Since different tasks and profiles can be found in the organizations, not all the front-end tools have identical functionality, and they have to be selected depending on the end user's defined user roles and user rights. Some tools are concentrated on more operational analysts, who demand to go deep into the data to find specific metrics or forms. Other applications, like administrative dashboards, are

intended to managerial levels that require a general and united view of the organization current status (Reyes, 2010).

Application layer: The application layer contains devices that allow to process and analyze the data from the data layer. (Ereth, 2015). It delivers functionality to analyze structured data or unstructured content and helps the sharing of significant knowledge among distinct users. The application layer includes reporting, data mining, and OLAP tools: Reporting tools produce quantitative data in a report-oriented format that might contain statistics, charts, or business pictures. OLAP represents a concept for interactive and multidimensional analysis of merged quantitative business realities. Data mining tools which is one of the advanced Analytics tools are used to identify hidden patterns in large volumes of structured data based on statistical methods (Nasr, 2012).

Service layer: In the hybrid BI model, the service layer physical equipment needs to have support for real-time information acquisition, and communication devices should provide a high-speed transmission of heterogeneous information. Cloud-based BI service ensures fast reconfiguration and adaptability of PaaS and SaaS services (Chen , 2018).

Data layer: Hybrid BI storage supports various sites across the organization (on-premises and cloud-based system) for agility and effectiveness (Coyne, L.2018). The database on the cloud requests to be implemented in the form of a vastly parallel system to support high request movement of BI and OLAP structure(Al-aqrabi et al, 2015).

Infrastructure layer: The cloud-based infrastructure layer is accessed only by the staff of a particular organization and/or by authorized third parties. The objective is not to give cloud services to the general public, but to utilize it within the company(Goyal, 2014).

IT infrastructure relates to the ability for users to be delivered with information and data to appropriate levels of reliability, timeliness, accuracy, confidentiality and security, as well as capability for modifying processes to growing business directions and necessities and facility of general access and connectivity with sufficient range(El-adaileh and Foster, 2019).

Hybrid Business Intelligence	
Advantages	**Limitations**
Guaranteed data ownership	Technology adoption challenges
Business model transformation	High-priced up-front cost
Balance workload	Latency and delays in the data processing
Parallel Processing	Integration and data loading issues
Performance improvements	Additional cost for infrastructure deployment
Customer value creation	Slow disk-based DBMS
Real-time analytical processing of big data	Limited ACID guarantees
High-performance data-processing systems	Data is stored at an untrustworthy host
Lower costs	
In-memory BI engines	
Cloud-based DBMS	
Analytical data management applications	
Specialized cloud analytic data management convergence	
Cloud big data analytics	

Table 2. 4: Hybrid BI Advantages and Limitations (Source: Muntean, 2015)

2.6 Conceptual Framework

The conceptual framework of the research adopted and modified from literatures contains two categories. The first one focused on independent variables BI System Deployment (System Capabilities and Data Source/Generating Systems) and the second one focused on independent variables' familiarity with the existing BI deployments, front-end, service, back-end, and infrastructure layers.

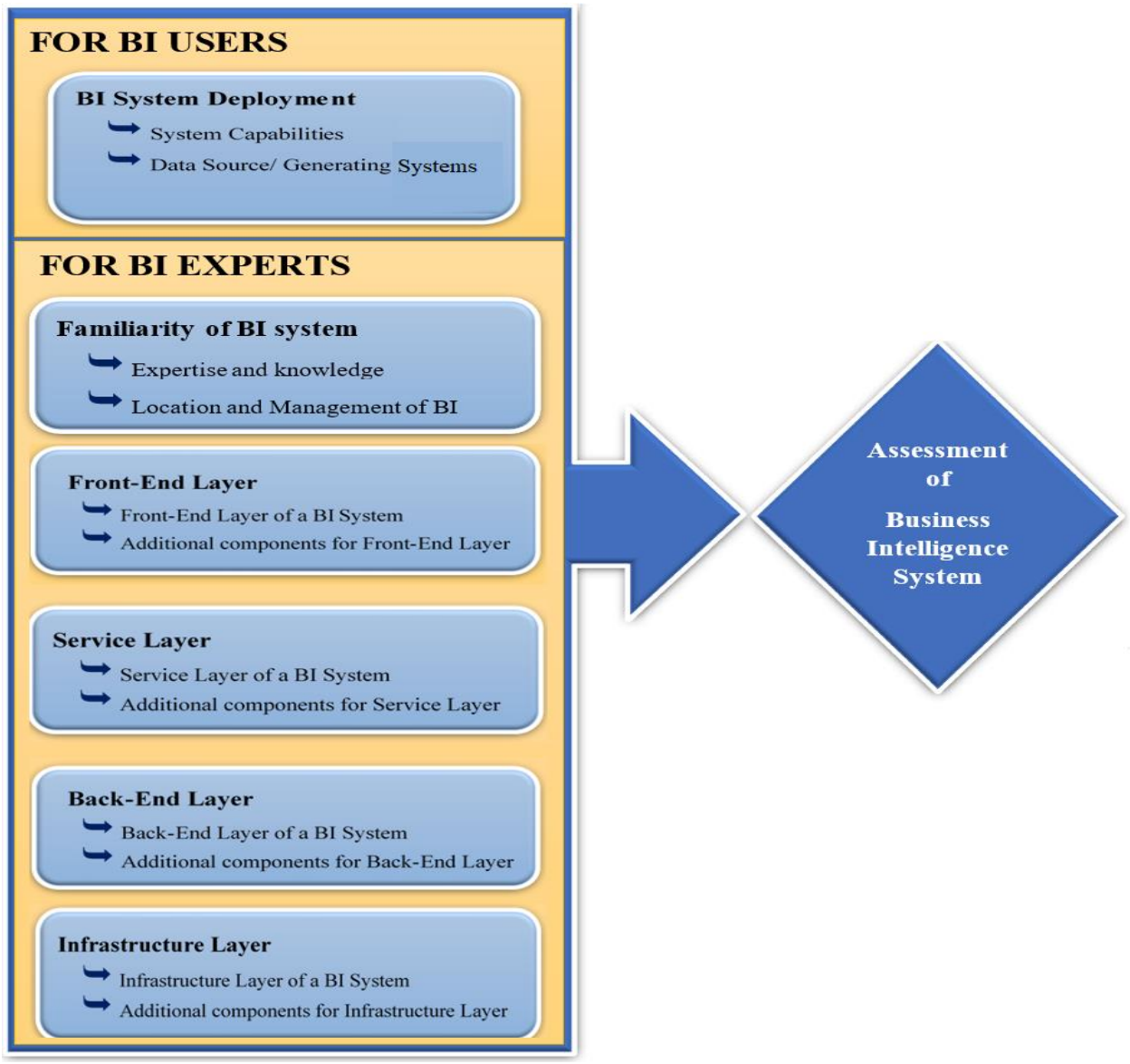


Figure 2. 6: Conceptual Framework (Adopted and Modified from Karen 2017 and Misheck 2017)

2.7 Related Works

Business Intelligence, its deployment and management are not new to the world. But there are no or very limited researches and literature on the subject. Some of the studies by different scholars lead to the development of BI perspectives such as analysis of business intelligence maturity, impacts of adopting BI systems and Impact of Implementing BI Project. They are summarized as follows:

Karen M. Walker (2017) conducted research entitled "An analysis of business intelligence maturity, enterprise size, and environmental factors", this study investigates the level of relationship between the size of a company, its environment and BI experience. He discovers that the expansion of a company depends on the level of development in its BI infrastructure. His study shows that companies in the service sector have more mature BI experience than companies in the nonservice sector.

The research chooses quantitative research method which deals with the size of a company and its environment as an independent variable. The factor of BI maturity is taken as dependent variable. The target population consisted of for-profit small and medium-sized enterprises (SMEs) with 1,000 or fewer employees located within the state of California. Respondents completed 102 survey questions, which served as the data source. Descriptive analysis and chi-square were conducted on a sample size of 102 participants. The results of the study revealed a significant relationship does not exist between either the organizational size, environment and SMEs' BI maturity. These findings strengthen the need for further BI research on SMEs.

Misheck Banda (2017) used triangulation method. The research focuses on some industries in South Africa in order to investigate the importance of data management, analytic architecture and BI system. In particular, 13 industries formed the survey population. A representative sample was selected carefully based on two units of measurement, namely, BI experts and BI users of the target population.

The result shows that there are a variety of BI models for companies to apply. Cloud based service model is the least costly of them. This research can serve as a guidance for companies with any plan of BI system deployment.

Acheampong Owusu (2017) applied quantitative approach to empirically evaluate the impacts of adopting BI systems on organizational performance of banks in Ghana. Data were collected through hand-administered survey questionnaires from the commercial banks in Ghana. 130 samples from executives were analyzed through partial least squares structural equation modelling (PLS-SEM).

The results indicate that BI Systems indeed have a positive significant effect on the learning and growth, internal process and customer performances of the banks. However, the findings proved that the adoption of BI systems does not directly lead to the financial competence of the banks, but rather through the indirect effects of learning and growth, internal process and customer service. This further supports the core premise of the balanced scorecard. In addition, the research recommended that bank managers should also encourage the use of BI systems in all their operations which with time can translate to the financial gains of the organization. The research also suggests that the findings of the quantitative analysis can be further validated with a qualitative study to confirm the findings of this empirical evidence in future study.

Amanuel Eyasu (2020) conducted a research entitled "Impact of Implementing Business Intelligence Project: The Case of Commercial Bank of Ethiopia". Its main focus was to assess the impact of Implementing Business Intelligence Project in CBE.

Descriptive research design was applied. Questionnaires and semi structured interviews are used as instrument to collect primary data. 17 items were taken from previous research for assessing the benefits and were grouped into four categories,7 items for assessing the critical success factors, 6 items for assessing challenges during implementation stage and 8 items for assessing challenges of using the Business Intelligence system. The finding showed that almost all the items assessed are essential for the bank to remain competitive. Lack of awareness about the system at managerial and customer level were the most challenging ones on the implementation stage. Poor data quality and Sluggish response time of the system were the other challenges for the BI users.

The research focuses on the challenges, critical success factors and benefits of implementing Business Intelligence system. The project covers only departments in the Head office even though the system is deployed to all districts and branches of the bank. Moreover, BI tools (software) and selection procedure for the case were not considered in this research, and does not specifically elaborate on the operational aspects of a basic BI system.

Author (Year)	Objective of the research	Methods/techniques	Key Findings
Karen M. Walker (2017)	This study examines the degree to which organizational size and environment affect an organization's preparedness to implement a BI system in South Africa	Quantitative	Organizations with a service environment was more likely to have a higher quality maturity level than the nonservice organizations.
Misheck Banda (2017)	This study tried to enhance a data management and analytic architecture that can help organizations in the execution of BI systems for specific industries in South Africa	Triangulation	BI model was proposed that contains interconnected layers that would allow effective sourcing of data, keeping data, and reporting.
Acheampong Owusu (2017)	This study focused on empirically evaluating the post-adoption impact of BI systems adoption on Ghanaian banks organizational performance.	quantitative	This study has shown that the adoption of BI systems can have both financial and nonfinancial effects on organizational performance.
Amanuel Eyasu (2020)	This study aimed to assess the impact of Implementing Business Intelligence in Commercial Bank of Ethiopia.	mixed research approach	The research reveals that even though technological issues have a lower influence on the implementation success, they can also lead to the failure of the BI implementation.

Table 2. 5: Summary of related works

All the above researches are conducted on a specific country or a specific company. This indicates that BI system and the associated infrastructure are not universally applicable for all kinds of companies. So, any company with the plan to develop/implement a BI system must first survey its legacy system and the nature of the company.

Naturally companies are constructed with different missions, visions, purposes and values. And the banking sector is one of them. So, the BI system has different techniques and methods of implementation. And this study tries to deal with the fundamentals of business intelligence and its application in NIB.

In Ethiopia, only few researches are conducted on BI system. Amanuel tried to investigate the impact of BI system in the case of Commercial Bank of Ethiopia. His study focuses on the challenges, critical success factors and benefits of business intelligence in decision making from the perspective of the bank's customers. So, the scope of the study is limited to the bank. In Ethiopia, there are different companies with different structure. So, more research is needed that shows how public and private companies can manage their business intelligence. And the banking sector is one of them.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

Research methodology is the major way of addressing the research questions and objectives. There is no standard methodology that is universally applicable to every research cases, but instead, the methodology has to be selected depending on the nature and scope of the issue at hand and the kind of available data (Ragab and Arisha, 2018). In this chapter, discussion points are made based on the assessment of the BI infrastructure in Nib International Bank, the significance of the hybrid BI system for NIB and the type of participants.

This chapter describes the research approach, sampling technique, and data collection methods implemented for the survey that was conducted on NIB to perform the research objectives. It also explains the methods that have been utilized to keep the reliability and validity of the research.

3.2 Research Approach

Depending on the research questions and the type of the research conducted, one can follow inductive approach, deductive or abductive approach. Inductive approach is used to formulate a general theory according to specific opinions. Deductive approach is used to apply a fundamental theory to different types of specific contexts. This study follows deductive approach. In this study several reasons make the deductive method the most suitable approach. The first reason to select deductive approach is that business intelligence is the most important concept of our time. Therefore, as Woiceshyn et al (2018) suggested deductive approach is regarded to be the most suitable way of assessing the different functioning of BI infrastructure from experts to user's level. Deductive approach is useful to understand the gaps of a research area. And the second reason is, it also allows to collect suggestions from the participants when the topics are raised for two or more parties. Deductive approach can be applied in software development research dealing with different sets of challenges.

3.3 Research Design

This research uses a quantitative approach in which a digital online form was made using Google Forms in a questionnaire type to attain the research objectives and answer the research questions (Karim and Box, 2011). Quantitative approach is used to quantify opinions, behaviors, and attitudes to generalize the result in terms of figures. The research process in general involves enlisting voluntary cooperation. Also, the responses to the questions are used to explain the experiences, opinions or ideas, attitudes, and further characteristics of those answering the questions, that is, BI experts and BI users (Fowler, F. J. 2014).

A questionnaire is a common title that contains methods in which each respondent is asked to answer the same set of questions in a prearranged order at a certain point in time(Ragab and Arisha, 2018).In this research, the questionnaires were tested to ensure that all the questions are well formulated. The questionnaire is initially checked over a pilot study.

3.4 Study population and Sampling

Almost all companies practice business intelligence in some form or another. Moreover, financial institutions greatly depend on their BI infrastructure in dealing with daily business activities.

In this research, the majority of the sample respondents are selected from the HR database of NIB with job titles, such as Business Intelligence Consultant, Accountants, Branch Managers, Project Manager, Product Manager, Data Analytics expert, Business Analyst, System Analyst, Management.

3.4.1 Sample Size

The size of a sample can be determined depending on the size of the population and the amount of heterogeneity in the population from which some form of statistical analysis can be formed (Cohen, L., Manion, L., & Morrison, K. 2018). The sample size for the survey study is formed on two way.

The first one is that hybrid BI system approach is proposed to advance BI deployment and, then, the intended branches and headquarter staffs of the bank are the ones likely to utilizing BI system. To assess the suggested architecture, all BI experts from the IS departments are targeted.

The second assumption is the assessment of the type of BI system currently utilized in NIB, the population for this target group (branches and headquarter staffs) utilizing BI in general.

In order to collect the required data, 30 selected branches proportionally from 6 districts with more than five years of experience were targeted. The sample tried to include branches with grade I, II, III, IV, V, VI & Special grade level. The measurement of the sample size was determined according to the level of their understanding about business intelligence. The conclusion about the capacity of the BI system in bank was drawn according to the perspective of the selected BI users and experts (Cooper & Schindler 2006). A list of BI professionals from the sample constitute the sampling frame for the research (Kothari 2004). This is achieved using probability sampling techniques, called random stratified sampling which ensures that the selected sample of the population constitute a representative sample of the whole population.

A sample of 52 BI users are selected from different branches and headquarter. From the total 52 BI users, 16 were from 8 departments of the head office (Accounts, Trade Finance, Credit Appraisal, Treasury, Electronic Channels, Interest Free Banking, Planning and Retail department) and 36 were from branches of the 6 districts with higher grade level (3, 4 and 5). The samples involve participants such as accountants and manager, because they are frequent users of BI for the purpose of planning, organizing and decision making.

3.5 Data source and Data Collection Method

Both primary and secondary sources were used in the study. The primary data was gathered from the results of the questionnaires. In this research, the questionnaire is prepared as closed-ended questions and five-point Likert-type scale. Closed-ended questions are easy to understand, code and analyze. The questions in the questionnaires of the research are taken from researches by Karen (2017) and Misheck (2017).

The secondary data were collected from systematic literature review. A review of literature is used to gain knowledge and understanding on different concepts of Business Intelligence according to several journals, manuals and reports of the bank.

This research uses probability (also known as a random sample) stratified sampling technique. A probability sample is a form of sampling used in randomized controlled trials. Random stratified sampling involves dividing the population into homogeneous groups, each group having subjects

with similar characteristics, and then randomly sampling within those groups (Ghauri, P. N., Grønhaug, K., & Strange, R. 2020). Stratified sampling was used to ensure that every part of the population, that is every stratum, gets satisfactory representation. Therefore, this research focuses on the response of both BI experts and BI users who are working on a BI system in the bank.

Initially, a broad literature review is prepared on BI in general, and specific BI processes are reviewed. On the other hand, to assess BI deployments and demonstrate the subsequent proposed BI architecture from the broad literature review, a case study was performed. The first case study focuses on BI users in which the current condition of the BI infrastructure in the bank was assessed, and the next focus on BI experts and their opinions on how the proposed architecture can be enhanced.

3.5.1 BI Users 'Questionnaire design

The questionnaire of BI users was divided into two sections. The first section focused on the general profile of the respondent including his/her age group, education level, experience, and profession. Then the second section deals with the categories of the independent variables BI System Deployment (System Capabilities and Data Source/Generating Systems). Check Appendix 3 for the entire questionnaire.

3.5.2 BI Expert Questionnaire Design

The questionnaire of BI Expert was divided into six sections, targeting at supporting to enhance the suggested hybrid BI architecture by experts. The first section focused on the general profile of the respondent including his/her age group, education level, and profession. experience, and deployment of BI in the Bank. The second section focused on the categories of the independent variables' familiarity with the existing BI deployments, Location and management, front-end, service, back-end, and infrastructure layers. For a detailed BI expert questionnaire check Appendix 2.

3.5.3 Questionnaire Administration

This research is conducted based on evidence as quantifiable data gathered over evidently defined survey questionnaires that are simple to control and hasty to respond. The online survey questionnaire is created using Google Forms and can be replied by every prospective respondent within the sampling frame operating in head office or any branch of the bank in Ethiopia. The

distribution of hard copies was difficult due to the current pandemic of COVID-19 (Coronavirus) for potential respondents who do not have internet connection and willing to participate.

All questionnaire that was sent out was linked with a consent letter asking the respondent's permission to contribute to the survey.

3.5.4 Data Collection procedure

In this research questionnaires were prepared using online Google form. It is found to be easy and interactive for the BI users and experts. Consequently, continuous follow ups and additional notifications were conducted through phone to increase response rate.

The questionnaire items were adopted from the literatures. The questionnaires were developed separately considering the experience of both BI users and experts of the bank. The questionnaires have two parts. The first part is about personal information. General questions such as work experience, and the bank's general BI services were included to recognize the summary of research situation. The second parts include questions subjected to the respondents to identify the efficiency of the BI models with respect to the 5-point Likert scale option ranging from Strongly Agree to Strongly Disagree. Some sections of the questionnaire cover comments on additional components to be included in the BI infrastructure layers according to BI experts of the bank.

3.6 Validity and Reliability of the research technique

Validity and Reliability are the two criteria by which researchers needs to evaluate their measurements. Validity and Reliability solve the effectiveness and reliability issues to ensure accurate measurement, which is, that they measure specifically what is aimed to be measured with accuracy and precision of the measuring instrument during the measurement process (Pyae, 2019).

Validity refers to the area to which an operationalization measures the assessment it purposes to measure. Two major effective validity are clarified, namely internal and external validity (Pyae, 2019). A research method that focuses on internal validity and external validity deliver a logical set of results, it improves not only the reliability of the outcome, but also leads to a better set of conclusions. (Ghauri, P. N., Grønhaug, K., & Strange, R. 2020).

Reliability is used to express the degree to which a system of measurement has no random errors and delivers consistent results. To keep the consistency and accuracy of research tools, reliability is stated in terms of regularity, equivalence and internal consistency (Pyae, 2019).

Cronbach's alpha is generally used to found internal consistency construct validity, with .60 considered acceptable for exploratory purposes, .70 considered adequate for confirmatory purposes, and .80 considered good for confirmatory purposes. Cronbach's alpha is both a validity coefficient and a reliability coefficient(G. David Garson, 2013). Therefore, Cronbach's alpha was calculated using SPSS software to show the internal consistency of the data collected from BI experts and BI users to measure all the constructs reliability as shown in table 3.1 and table 3.2 below.

Reliability Statistics

Group	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
System Capabilities and Data source/Generating Systems	.784	.788	20

Table 3. 1: Reliability statistics for BI Users (Source: own survey result 2020)

Reliability Statistics

Group	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
BI system Location and Management	.776	.774	6
Front End Layer	.826	.834	5
Service Layer	.888	.886	7
Back-End Layer	.838	.835	8
Infrastructure Layer	.765	.823	8

Table 3. 2: Reliability statistics for BI experts (Source: own survey result 2020)

3.6.1 Pilot Study

The pilot study represents a study of the practicability of the main study(Alsanea, 2015). With the purpose of confirming that the survey is valid and reliable, in this research a pilot study was conducted before the final distribution process. It made use of two types of participants from BI users and BI experts respectively and had two main purposes. The first purpose is to enhance the quality of questions, and the second was to examine the understanding level of the respondents as well as deliver clarity to the actual administration of the questionnaire. Then the questionnaires were reformed to ensure that all known concerns are resolved. This is done by re-structuring the questions in such a way that they concentrate on precise components of the model under assessment. The final result was good enough to deal with the planned objectives and make a comprehensive analysis.

3.7 Data Analysis Technique

The data collected were analyzed as per the objectives of the study. This research follows quantitative data analysis technique. The quantitative data which were collected through e-questionnaire was analyzed with descriptive statistics methods using statistical package for social scientists (SPSS) version 26 computer application. To analyze and summarize the collected data frequency distribution and percentage were used. Some of the responses were also analyzed using Google form analysis. From the Google form summary, responses summarized with graphical representations and percentages of responses were in use.

CHAPTER FOUR

DATA PRESENTATION, FINDINGS, AND DISCUSSION

4.1 Overview

This chapter presents the data collected from Nib international bank, discuss the data analysis and findings of the survey performed to describe the current state of BI system operation. The survey was carried out by two sections. Section one deals with the status of BI utilization by BI users with the categories of the independent variables BI System Deployment (System Capabilities, Data Source/Generating Systems, Location and management). And the second section stress on adjustment of the hybrid BI architecture by BI experts with the categories of the independent variables' (familiarity with the existing BI deployments, front-end, service, back-end, and infrastructure layers). Which was adopted and modified from the literatures as stated in the conceptual framework. A combined total of 105 online survey questionnaires were distributed to BI system users and BI system experts to collect data. At first, the survey was planned to target as many participants as possible, but the level of BI experience in the bank is not universally the same. So more BI experts from the head office than users from branches had to participate in the survey.

For BI users a total of 52 questionnaires was distributed and 32 questionnaires were returned from BI users and a total of 53 questionnaires for all 50 IS staffs and 3 IS consultants of the Bank and 40 were returned from BI experts. This chapter also tried to address the objective of the study according to the perspective of these participants. And they agreed hybrid BI architecture is the best model for the bank.

4.2 Data analysis

The analysis applies a quantitative research method to find various perspectives about the issues being analyzed. For data analysis, two research methods were used, namely, the literature review and quantitative data derived throughout the survey performed.

4.3 Analysis result based on BI System users

A total of 52 online questionnaires were distributed to Branches and Departments of the bank. Out of the 6 districts and headquarter, the majority 87% response rate were received from the headquarter. 32 individuals were involved in answering the 52 questionnaires, which is 62% response rate.

4.3.1 Demographic profiles of respondents

The focus group was from BI system users which guarantied sufficient information for the questions. It is possible to get basic information from the demographic perspective as follows:

		Frequency	Percentage %
Level of Education	Degree	19	59.4%
	MA/MSC	13	40.6%
	PHD	0	0.0%
	Other	0	0.0%

Table 4. 1: Level of Education (For Users) (Source: own survey result 2020)

Education: From a total of 32 BI users' respondents, the majority 59.4% of the respondents have bachelor degree. Then 40.6% MA/MSC holders, and no one have either PHD nor other.

User's years of experience: This part focuses on work experience in the field. Figure 4.1 demonstrates that the participants with two to four years' experience are only 3.1%, participants within four- and six-years' experience are 9.4% and 15.6% of the participants fall within a range of six- and eight-years' experience. 28.1% of the participants fall between a range of eight and ten-years' experience. 43.8% of the participants show more than 10 years' experience. All these ranges of experience enhanced the necessary information about the BI system.

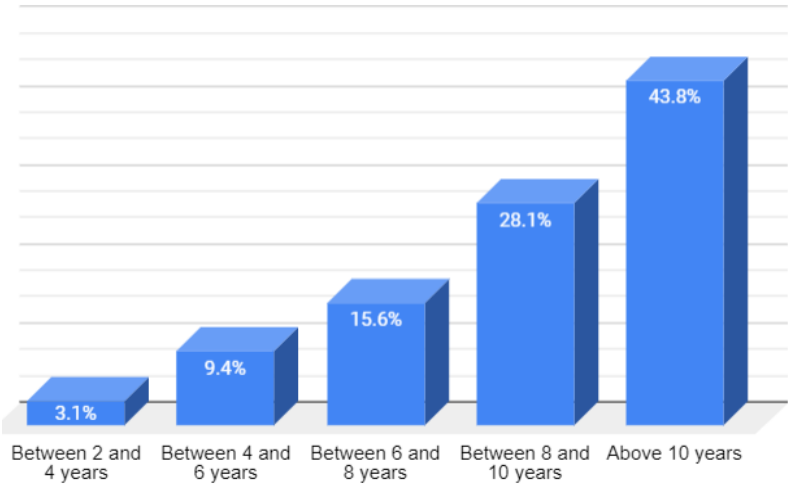


Figure 4. 1: Work experience (Source: own survey result 2020)

NIB Bank Districts: The question emphasized on the participants placement within the districts of the bank. As shown in Figure 4.2 (12.5%) of the participants were from regional districts of the bank. (37.5%) indicated that they are located in different Addis Ababa districts of the bank, and half of (50%) of the respondents were from head office and main branch. All these districts help to come up with different ideas about the features of the BI system. The analysis illustrates that the majority of BI application users are in the Addis Ababa region of the bank. Hossana and Hwassa districts of the bank made a small percentage of responses which indicates that they do not specifically depend on the BI system.

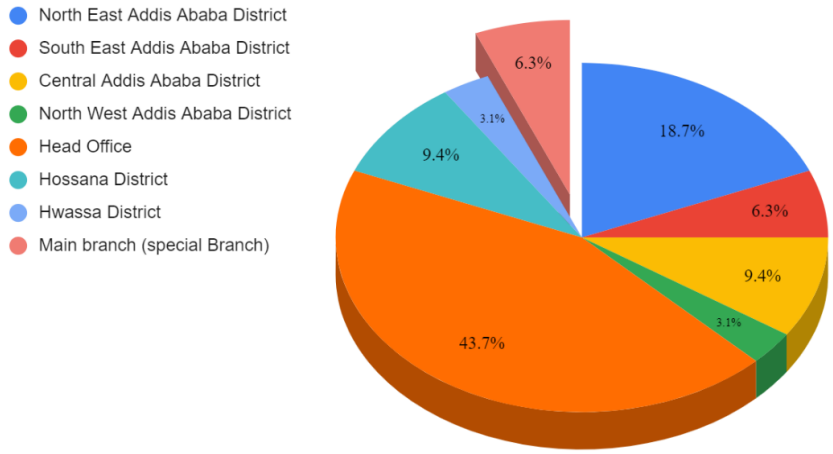


Figure 4. 2: Districts of the bank (Source: own survey result 2020)

Job position: This part deals with the job position of the employees. Table 4.2. demonstrates that 15.5% of the participants are at the position of the officer. More than half (59.4%) of the responses

were assigned in a managerial position. 22% of respondents were accountants. This analysis tried to collect the necessary data from different participants of different job position.

		Frequency	Percent
Valid	Manager	14	43.8
	Accountant	7	22.0
	CRM	4	12.5
	CSO	1	3.1
	Acquiring Officer	1	3.1
	CSM	1	3.1
	Director	1	3.1
	Junior Customer Service Officer	1	3.1
	Officer	1	3.1
	Principal Officer	1	3.1
	Total	32	100.0

Table 4. 2: Job position (Source: own survey result 2020)

4.3.2 Number of BI system users

This part deals with the number of BI system users. Figure 4.3 demonstrates that 53.13% of the participants consisted of five or fewer BI users. 34.37% of participants had five to ten BI users, 6.25% were made up of eleven to fifteen BI users, and 6.25% included more than fifteen BI users. This shows that most branches/departments operate with less than five BI system users.

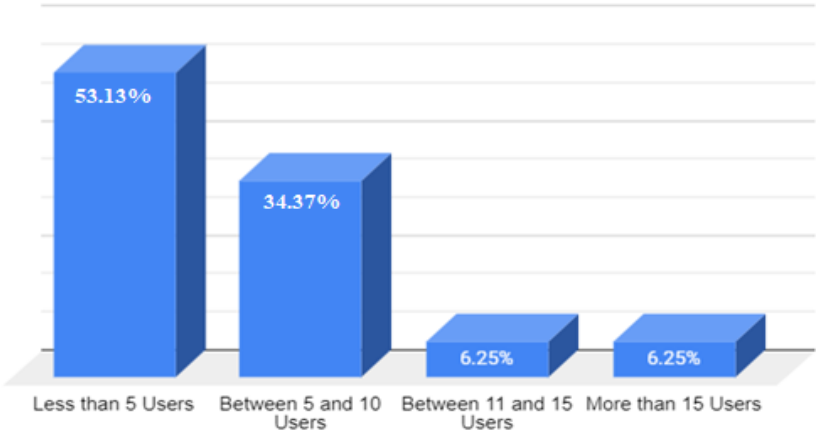


Figure 4. 3: BI system users (Source: own survey result 2020)

4.3.3 BI system deployment

This part investigates the state of the BI system in the bank by using options such as agreed or disagreed with some statements.

4.3.3.1 Assessment of Software facilities for BI System

This part investigates software features that support the BI system of the bank. Table 4.3 demonstrates that (43.8%) of the participants indicated that you don't need to be specialized in BI to use the system. This indicates that the rest of the percentage (40.6%) disagreed, needs supportive training to operate the system easily. However, an equal percentage of participants (31.3%) agree as well as disagree that they have specialized BI users. 40.7% of the participants indicated that BI application enhances the performance of the bank compared to (31.3%) disagreed. Concerning the different operational features of the BI system, the majority (53.1%) showed that the current level of BI system is sufficient for their performance. When it comes to the level of BI development, only 15.6% of the participants use a high level of BI systems, such as Oracle BI, SAP BI, and SAS BI, and the majority 84.3% indicated that they use simple tools, for instance, Google Sheet, Microsoft Excel, and SPSS to hold data, produce reports, analyze and retrieve. More than half (53.1%) of the participants indicated that they don't have many users and data generating system, and 62.4% have one user and system. When it comes to BI system access, 81.3% specified that they have one user access to their BI system. These participants mention that Branches/departments of the bank depend on a single form of BI system. That also means the bank depends on a simple BI system, with limited structured and, or advanced BI systems, for instance, OLAP server, SAS BI, and the like.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
	%	%	%	%	%	%
1. We use a single point of entry to access our BI IS such as T24 and the like.	0.0%	6.2%	12.5%	47.0%	34.3%	100.0%
2. We only have one data generating system and one user performing all our BI related functions.	0.0%	22.0%	15.6%	31.2%	31.2%	100.0%
3. We have multiple data generating systems and multiple users performing complex BI related functions.	12.5%	40.6%	18.7%	21.9%	6.3%	100.0%
4. We use simple tools such as Microsoft Excel, Google Sheets, etc. to store data, retrieve, analyze and produce reports	0.0%	9.4%	6.3%	56.3%	28.0%	100.0%
5. We use complex BI tools such as OLAP (Online Analytical Processing) server SAS BI, SAP BI, Oracle BI, etc. to store data, retrieve, analyze and produce reports.	18.8%	40.6%	25.0%	12.5%	3.1%	100.0%
6. Our reporting and analysis tool allows us to perform analytical functions.	6.3%	28.1%	12.5%	53.1%	0.0%	100.0%
7. Our reporting and analysis tool produce information that assist us to make informed decisions.	6.3%	21.9%	18.8%	53.0%	0.0%	100.0%
8. We use self-service BI solution with timely insight and decision making	6.3%	25.0%	28.0%	34.4%	6.3%	100.0%
9. We have experienced BI professionals that use our BI information system	9.3%	25.0%	31.3%	31.3%	3.1%	100.0%
10. You do not need to be a BI professional or expert in order to use our BI information	9.3%	31.3%	15.6%	37.5%	6.3%	100.0%

Table 4. 3: Software facilities for BI Information system (Source: own survey result 2020)

4.3.3.2 Data Sources/Generating System assessment

This part deals with the way the participants manage their BI system facilities or data processing. Table 4.4. demonstrates that most (75%) of the participants use OLTP systems and internal sources. With regards to access privilege, (59.4%) indicated that they have the privilege to generate a report for real-time decision making. However, (40.6%) of the respondents indicated that they don't have full BI privilege to run their tasks compared to (40.6%) agreed. (75%) agreed that data source systems are managed internally.

For data storage, about two-third (62.5%) indicated that they are unaware of the simplicity of the database. Similarly (65.6%) indicated that they are also unaware of the complexity of the data warehouse. 75% of the participants indicated that data stores are centrally located on-premise. But, 62.5% of the participants use data repository residing at the data center. As far as data accessibility is concerned, 50% indicated that the system has a difficulty to launch big data immediately. For the data to be available, 50% preferred data cleansing (ETL).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
	%	%	%	%	%	%
1. Our data is managed through the use of Online Transaction Processing Systems such as T24, ATS, Insight, CRB, etc.	6.2%	9.4%	9.4%	62.5%	12.5%	100.0%
2. Our access privilege allows to generate report for real time decision making	6.2%	21.9%	12.5%	59.4%	0.0%	100.0%
3. We have full BI privilege to run our task	6.2%	34.4%	18.8%	37.5%	3.1%	100.0%
4. Data source systems are managed internally	0.0%	9.4%	15.6%	62.5%	12.5%	100.0%
5. Data from our source systems is stored in a simple database.	3.1%	18.8%	62.5%	15.6%	0.0%	100.0%
6. Data from our source systems is stored in a complex data warehouse.	0.0%	9.4%	65.6%	25.0%	0.0%	100.0%
7. Data is accessed from a central repository at our office.	6.2%	9.4%	12.5%	59.4%	12.5%	100.0%
8. Data is easily accessible from the data repository residing at our data center.	3.1%	21.9%	12.5%	56.3%	6.2%	100.0%
9. Our data goes through a data cleansing (Extract, Transform, Load) before we gain access to it.	6.2%	12.5%	31.3%	46.9%	3.1%	100.0%
10. Our BI system is able to launch big data immediately	6.2%	43.8%	40.6%	9.4%	0.0%	100.0%

Table 4. 4: Data source or generating systems (Source: own survey result 2020)

4.3.4 Discussion of Result

This part presents a brief analysis of the existing performance of the BI system in NIB.

4.3.4.1 Level of BI system in NIB

For BI system analysis, participants were examined to describe the level of BI system infrastructure in NIB. The main results are shown as follows:

- Most of the participants are from the Addis Ababa region. It was discovered that NIB uses two different parts of the BI system through TEMENOS T24 insight which are known as OLTP and OLAP. OLAP is accessed by different departments of the head office can access both OLTP and OLAP parts of the system whereas branches can access only the OLTP part of the BI system but they still can access the OLAP part of the BI system through IT teams. NIB operates a high or low level of BI system through OLTP or OLAP.
- The findings confirm that the BI system is being utilized but not to the fullest potential. It is vital that an organization can access the information it needs, at the moment that this information is required. Analysis must be driven by the organization's needs and goals and must result in beneficial outcomes.
- It was discovered that the application of BI system infrastructure simplifies for the bank to store data, retrieve, analyze, and produce reports. The BI system generates the necessary data which contributes to the development of the bank's performance. The bank also allows some users to access the BI system.

Generally, the BI system is widely used by NIB head office. The analysis shows that NIB has a BI model with separately organized layers for the BI system so it must develop high tech on-premise and the cloud system. These BI systems include the necessary IT infrastructure such as data source systems, information delivery, reporting, data analysis services, and storage capabilities (Popovi, 2010).

4.3.4.2 BI system in NIB and its significance

Participant tried to express their perspectives with regards to BI system and its performance in NIB as follows:

- According to the analysis, the Bank uses OLTP systems such as TEMENOS T24 (EATS, Select and Admin consul, etc.) to manage CORE Banking system data sources and OLAP

system TEMENOS insight as BI system. Moreover, before data is utilized, it goes through a full data cleansing (ETL) routine in formation for OLAP system (Insight) reporting and analysis purpose.

- Moreover, the data created by the OLTP systems is stored in the intended naive or diverse database. Databases were installed and located in a central data repository that exist in on-premise or in the cloud.
- Therefore, to gather BI requirements the bank essentially needs to control its sources of data, OLTP systems, ETLs, and various database such as, naive or diverse databases exist in a data repository

4.3.4.3 Users understanding of the BI system

Participants tried to express their perspectives with regards to location and management of their BI system as follows:

Generally, BI system is securely installed in a setting that reaches the constraints of the bank. The analysis shows that the bank primarily holds its BI system installed on-premise and in the cloud.

- Notably, the technology resources that holds the BI system in an on-premise deployment, are owned by the bank and generally IT teams (experts) have the awareness and full supervision of resources, for instance, application development environment, data processing applications, database, servers, computing, and the like.
- The analysis also shows that in a cloud-based deployment, parallel possession uses are involved, and the bank can operate supervision of its technology resources.

Therefore, users understanding of the BI system was found to be low because the bank mostly depends on its IT team, and IT team control all the technological infrastructure. In addition, it was also revealed that the BI system is confronting shortage of timely resource and system upgrade so as to execute the required operation.

4.4 Analysis result based on BI system Experts'

This section points out the results of the analysis on the questionnaires for BI experts from quantitative and statistical perspective as follows.

4.4.1 Response rate

Generally, 53 questionnaires were prepared for BI experts in all 50 IS staffs and 3 IS consultants of the Bank. Of the 50 IS staff approached, 39 IS staff responded making it a 78% response rate. For the 53 questionnaires, 40 respondents participated with 75% response rate.

Part 1: Demographic profiles of respondents

Only BI expert professionals are selected for this part of questionnaire in order to collect the best data on the issue as follows.

		Frequency	Percentage %
Level of Education	Degree	33	82.5%
	MA/MSC	7	17.5%
	PHD	0	0.0%
	Other	0	0.0%

Table 4. 5: Level of Education (For Experts) (Source: own survey result 2020)

Education: From a total of 40 BI expert respondents, the vast majority 82.5% of the respondents have bachelor degree. Then 17.5% MA/MSC holders, and no one have either PHD nor other.

Expert's Experience: The respondents were asked their years of experience in the bank. Figure 4.4 shows 90% of the respondents with more than four years of experience in the bank. These respondents were essential in providing the best data on the cycle of the suggested BI architecture. This helps to prove that the prepared questionnaire on BI deployments in the bank was easy to understand.

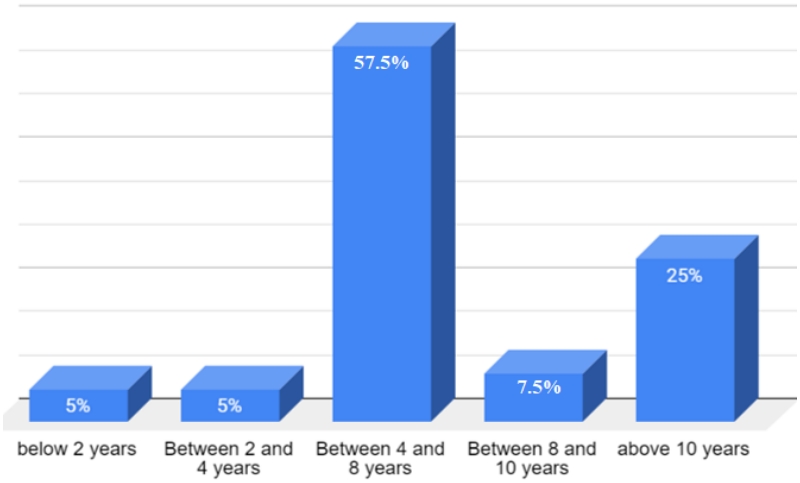


Figure 4. 4: Expert's years of Experience (Source: own survey result 2020)

Job Division: The questionnaire dealt with the kind of division the respondents represented. One-fourth (25%) of the respondents represented the Business system division (System Administrator, Database Administrator, and Software Developer), with only 10% assigned in IT security division, from IT infrastructure and core application support division, 35% in (hardware, network, and Datacenter Administrator), 22.5% from (Help desk and system analyst) and 7.5% of the respondents represented a combination of managers (consultant, IT project and others but not listed namely "system administrator and database") as shown in Table 4.6 below. Involving all IS staff helps to obtain a broad understanding of the views of BI experts.

		Frequency	Percent
Valid	System Administrator	4	10.0
	Database Administrator	3	7.5
	Datacenter Administrator	1	2.5
	Software Developer	3	7.5
	Hardware and Network	13	32.5
	Help Desk	5	12.5
	System Analyst	4	10.0
	IT Security	4	10.0
	consultant	1	2.5
	IT Projects Manager	1	2.5
	None	1	2.5
	Total	40	100.0

Table 4. 6: Job Division (Source: own survey result 2020)

4.4.2 Level of BI Deployment in NIB

This part asks respondents to evaluate the level of BI system deployment in NIB. Figure 4.5 shows that the bank depends on a centralized level of BI deployment as indicated by more than three-fourth (80%) of the respondents. 12.5% of the participants considered distributed BI systems, on the other hand 2.5% suppose an isolated system. The rest concluded no level of BI deployment or no idea of the presence of BI deployment in the bank. From this analysis, it could be concluded that the bank generally uses a centralized BI system to meet BI requirements and expectations.

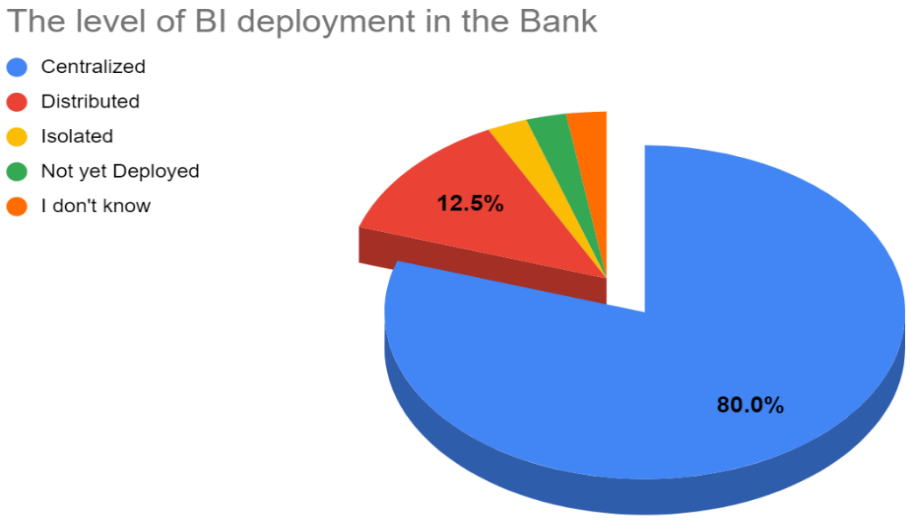


Figure 4. 5: Level of BI Deployment in the bank (Source: own survey result 2020)

4.4.3 Insight of BI deployment

The bank operates on a variety of BI systems, that is on-premise, cloud-based, and, or hybrid systems for data storage, analysis and its better performance. With regards to BI deployment participants tried to share their experience and view of BI deployment levels as presented below.

4.4.3.1 Expertise and knowledge assessment of BI deployment options

Table 4.7 shows that, 75% of the participants reveal that the bank applied an on-premise BI system and 80% consider an on-premise BI system is useful for the security of business data. 80% consider cloud-based BI systems provide faster and easier BI services. 85% participants concluded that a hybrid BI must include a combination both and 82.5% agreed that a hybrid BI system helps for critical information to be stored on-premise. These results confirmed that a deployment of hybrid or a combination of on-premise and cloud-based BI is good for NIB and its performance.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
	%	%	%	%	%	%
1. An on-premise BI deployment has all the hardware, software and application systems located inside the Bank's premise	0.0%	12.5%	12.5%	37.5%	37.5%	100.0%
2. An on-premise BI deployment ensures ownership of business data.	0.0%	5.0%	15.0%	47.5%	32.5%	100.0%
3. A cloud-based BI deployment promotes the use of faster and cheaper BI services.	0.0%	5.0%	15.0%	40.0%	40.0%	100.0%
4. A Hybrid BI deployment is a combination of on premise and cloud-based BI solutions.	0.0%	2.5%	12.5%	55.0%	30.0%	100.0%
5. A Hybrid BI allows for sensitive information to be kept on-premise and the rest to be managed in the cloud.	0.0%	0.0%	17.5%	40.0%	42.5%	100.0%

Table 4. 7: BI Deployment Skill (Source: own survey result 2020)

4.4.3.2 BI System Location and Management assessment

In this part, the participants tried to evaluate where and how the BI system of the bank operates. In table 4.8, 67.5% of the participants categorize the operation of the bank as on-premise BI system, whereas 45% as cloud BI system. In terms of BI system facilities, 75% of the respondents agreed that the bank owns all the hardware and software. More than three-fourth (77.5%) of the participants discovered that the facilities of the bank are able to operate on-premise BI system and a half (50%) also identified as having full control in a hosted environment. Concerning the hosted storage and computing resources, 40% identified that the bank has full control of its resources compares to 37.5% who are unaware of the level of control over the remote data center. 77.5% of the respondents indicated that the bank has full control of the on-premise database and infrastructure.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
	%	%	%	%	%	%
1. All of our BI Information system is installed and run-on computers located in our building.	5.0%	12.5%	15.0%	40.0%	27.5%	100.0%
2. All of our BI Information system is installed and run-on servers located at our service provider.	10.0%	35.0%	20.0%	17.5%	17.5%	100.0%
3. We own all the hardware and software used to support our BI solution.	0.0%	12.5%	12.5%	40.0%	35.0%	100.0%
4. We have full control of our in-house data processing applications and development environment.	2.5%	10.0%	10.0%	25.0%	52.5%	100.0%
5. We have full control of our remote data processing applications and development environment.	5.0%	20.0%	25.0%	37.5%	12.5%	100.0%
6. We have full control of our storage and computing resources that reside at a remote data center.	7.5%	15.0%	37.5%	20.0%	20.0%	100.0%
7. We have full control of our storage and computing resources that reside at our office.	5.0%	7.5%	10.0%	40.0%	37.5%	100.0%

Table 4. 8: BI system and its space (Source: own survey result 2020)

4.4.4 End User Layer

BI architecture End User Layer is the first access structure or interface in data analysis process through all BI system facilities operating either on-premise or in the cloud. Accordingly, participants tried to suggest all the necessary system facilities for an End User Layer of a BI architecture as follows.

4.4.4.1 BI architectural End User Layer Assessment

In table 4.9, 77.5% of the participants prefer an interface layer for the End User Layer whereas 85% favored the presentation layer. More than three-fourth (82.5%) suggested BI tools for the End User Layer. Majority (92.5%) recommended applications, such as OLAP, Data Mining, etc. for the End User Layer. Most (90%) notified the participation of devices in the development of End User Layer. This analysis concluded that the development of an effective End User Layer BI architecture includes presentation layer, interface layer, BI tools and applications, and devices.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
	%	%	%	%	%	%
FL1. A good BI architecture must consider devices (e.g., Desktop Computers, Laptops, Tablets, and Smartphones) in their architecture front end.	0.0%	2.5%	7.5%	47.5%	42.5%	100.0%
FL2. A good BI architecture must consider applications (e.g., Online Analytical Processing, Spreadsheets, Data Mining, Reports, and Dashboards) in their architecture front-end.	0.0%	0.0%	7.5%	55.0%	37.5%	100.0%
FL3. A good BI architecture must consider BI Tools (e.g., Microsoft Power BI, IBM Cognos, MicroStrategy, Oracle BI, and SAP BI/BO) in their architecture front-end.	0.0%	10.0%	7.5%	50.0%	32.5%	100.0%
FL4. A good BI architecture must consider Presentation layer in their architecture front-end.	0.0%	2.5%	12.5%	52.5%	32.5%	100.0%
FL5. A good BI architecture must consider Interface layer in their architecture front-end.	0.0%	5.0%	17.5%	45.0%	32.5%	100.0%

Table 4. 9: Proposed Components for End User Layer (Source: own survey result 2020)

4.4.4.2 End User Layer - Additional Components

Figure 4.6 shows, the additional components recommended, such as 42.5% of the participants suggested Business Process Execution Language, business process tools are recommended by 77.5% of the respondents, also 65% of the respondent suggested preferred Workflow tools, and 5% other components (Business Query (ad-hoc query tools), reporting and Dashboards in addition to fixed reports, OLAP). These analysis shows that the bank has flexible alternatives with the types of components to meet the requirement of the BI architecture End User Layer.

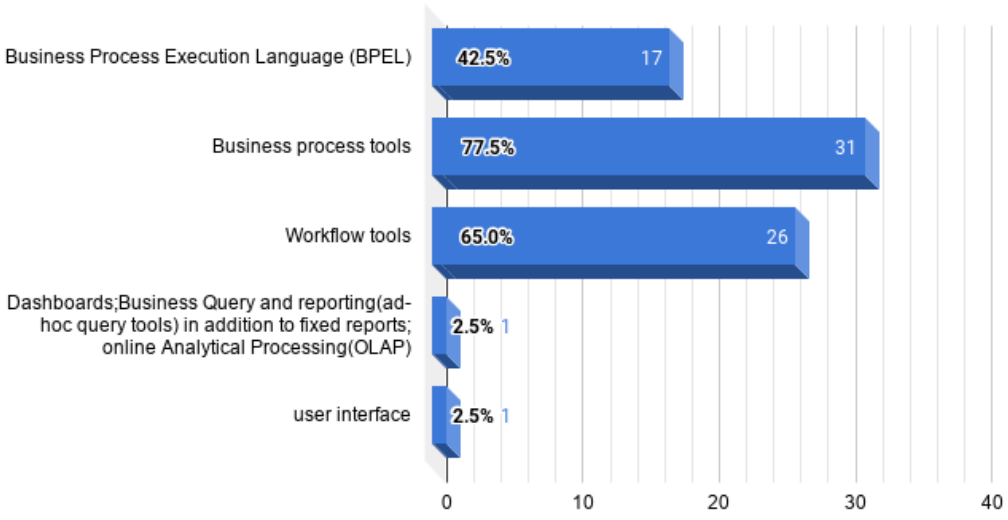


Figure 4. 6: Additional Components of End User Layer (Source: own survey result 2020)

4.4.5 Service layer

BI system architectures service layer must include all the necessary system facilities for better performance of the bank. Participants tried to address some questions about the BI system architectural service layer as follows:

4.4.5.1 BI architectural Service Layer Assessment

In table 4. 10, majority (95%) of the participants understand the importance of service layer for BI architecture and dedicated layer is suggested by 75% of the respondents. 80% of the participants recognized the importance of an Enterprise Service Bus or Service-oriented Architecture for service layer. 75% of the respondents also suggested ESB, BI services, PaaS, DBMS, and application server for service layer. These analysis shows the participation of various servers, and services as a group of the service layer.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
	%	%	%	%	%	%
SL1. A good BI architecture must consider a Service layer in their architecture.	0.0%	0.0%	5.0%	52.5%	42.5%	100.0%
SL2. The Enterprise Service Bus (ESB) usually referred to as middleware or Service-oriented Architecture (SOA) should be positioned in the Service layer.	0.0%	2.5%	17.5%	62.5%	17.5%	100.0%
SL3. BI services must have a dedicated layer referred to as the Service layer.	0.0%	5.0%	20.0%	50.0%	25.0%	100.0%
SL4. The ESB and BI services must have a dedicated layer referred to as the Service layer.	0.0%	2.5%	35.0%	47.5%	15.0%	100.0%
SL5. The Service layer should consist of ESB, BI, Platform-as-a-Service (PaaS), Database Management System (DBMS), and Application Servers.	0.0%	0.0%	25.0%	50.0%	25.0%	100.0%
SL6. The services layer should consist of ESB, BI services, and DBMS	0.0%	2.5%	22.5%	42.5%	32.5%	100.0%
SL7.The services layer should consist of ESB, BI services and PaaS	0.0%	2.5%	22.5%	50.0%	25.0%	100.0%

Table 4. 10: Proposed Components of Service Layer (Source: own survey result 2020)

4.4.5.2 Service layer Additional Components

In figure 4.7, 42.5% of the participants recognized visualization MapReduce services as part of the Service layer. 50% preferred user applications ,7.5% preferred User and, or Machine interface, 52.5% preferred Model-View-Controller and 50% preferred data collectors as necessary parts for the service layer. These analysis shows that the bank must make the necessary arrangement in the development of BI architecture service layer.

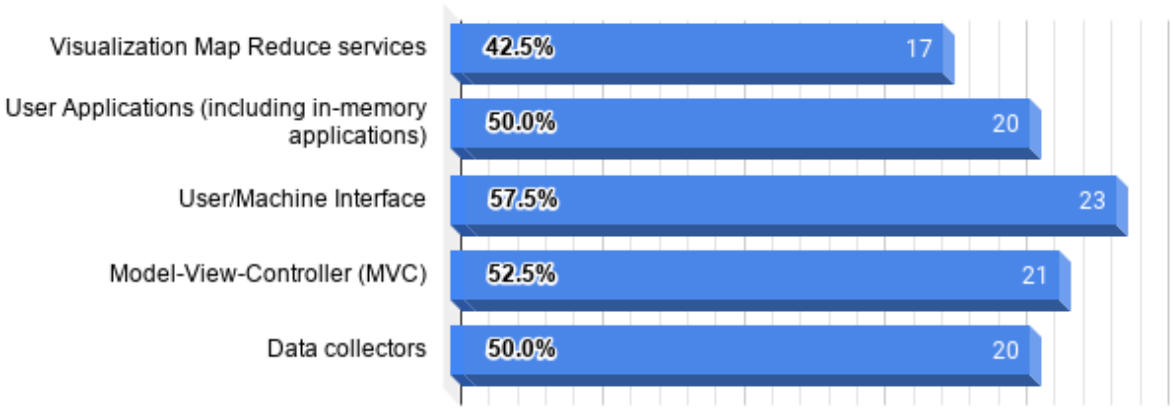


Figure 4. 7: Additional Components of Service Layer (Source: own survey result 2020)

4.4.6 Data Warehouse Layer

This part deals with the question of how to develop the proposed data warehouse layer. A Data Warehouse Layer in a hybrid BI architecture is the server which operates background applications behind the client or user knowledge. Participants tried to address some questions about the architectural Data Warehouse Layer of a BI system as follows:

4.4.6.1 BI architectural Data Warehouse Layer Assessment

In table 4.11, 97.5% of participants recognized the importance of a Data Warehouse Layer for the BI architecture. 70% of participants suggested PaaS for the Data Warehouse Layer, and 72% of the participants considered its importance in the layer. 80% recommended a combination of application servers, PaaS and DBMS for the Data Warehouse Layer. Whereas, 78% proposed DBMS as a dedicated layer. Most (80%) added the application layer as another dedicated layer. Finally, 85% suggested data source systems (e.g., OLTP, legacy data systems, etc.) for the Data Warehouse Layer. These analysis shows that the proposed Data Warehouse Layer applications and systems must be involved in the development of the BI system.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
	%	%	%	%	%	%
BL1. A good BI architecture must consider a Back-end layer in their architecture.	0.0%	0.0%	2.5%	45.0%	52.5%	100.0%
BL2. The PaaS should be part of the Back-end layer.	0.0%	0.0%	30.0%	47.5%	22.5%	100.0%
BL3. The PaaS must have a dedicated layer.	0.0%	7.5%	20.0%	50.0%	22.5%	100.0%
BL4. The Back-end layer should consist of PaaS, DBMS, and Application Servers.	0.0%	2.5%	17.5%	57.5%	22.5%	100.0%
BL5. The Back-end layer should consist of DBMS and Application servers.	0.0%	2.5%	15.0%	57.5%	25.0%	100.0%
BL6. The DBMS must have a dedicated layer.	0.0%	5.0%	17.5%	52.5%	25.0%	100.0%
BL7. The Application servers must have a dedicated layer.	0.0%	2.5%	17.5%	30.0%	50.0%	100.0%
BL8. A good BI architecture must consider data source systems such as External data sources, Operational data sources, Legacy data sources, OLTP source systems, etc. in their Back-end layer.	0.0%	0.0%	15.0%	52.5%	32.5%	100.0%

Table 4. 11: Proposed Components of Data Warehouse Layer (Source: own survey result 2020)

4.4.6.2 Data Warehouse Layer - Additional components

Participants tried to make their suggestions about the additional components for the Data Warehouse Layer of the BI architecture. In figure 4.8, 52.5% recommended development tools and execution runtime environment respectively, 30% proposed middleware, 42.5% preferred In-house API, 47.5% favored third party API, 65% suggested web server and application server respectively. These analysis shows the importance of many applications or servers in the development of the Data Warehouse Layer according to the business requirements.

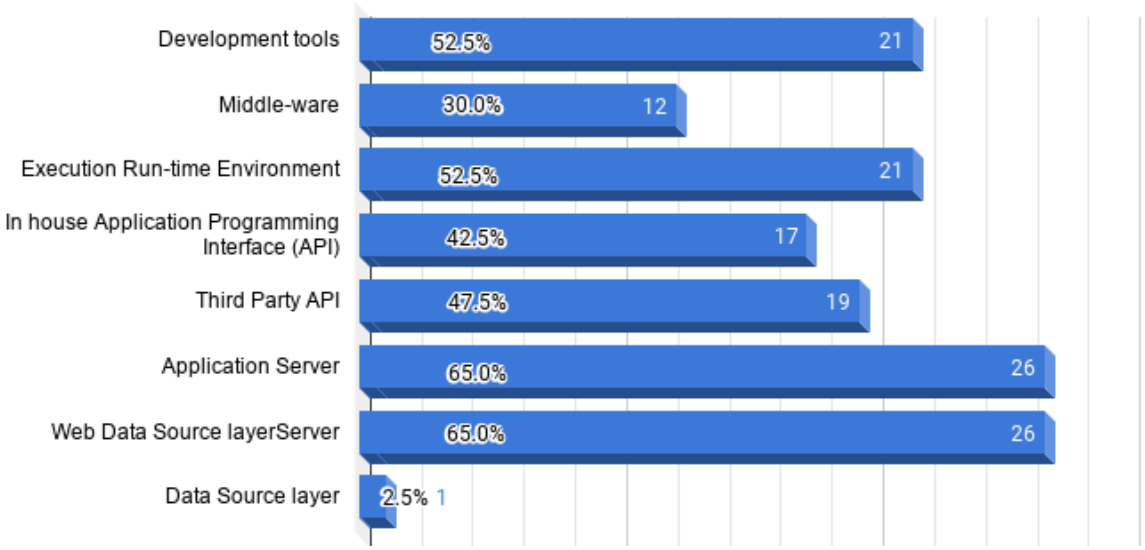


Figure 4. 8: Additional Components of Data Warehouse Layer (Source: own survey result 2020)

4.4.7 Infrastructure Layer

This part deals with the necessary infrastructure resources for the development of the recommended hybrid BI architecture (layer 5) infrastructure layer. In a BI architecture, the Infrastructure layer must include the essential BI resources, the data management systems and the hardware as indicated by the participants as follows:

4.4.7.1 BI Architecture- Infrastructure Layer Assessment

Participants tried to make some suggestions about the necessary components for the infrastructure layer. In table 4.12, majority (90%) of the participants recognized the importance of infrastructure layer in the BI architecture. Almost all participants suggested database technologies (92.5%) and hardware resources (95%) for the infrastructure layer. 80% of the participants insisted a dedicated layer for the data management layer. And, 80% suggested the network layer outside or inside the infrastructure layer as hinted by 85% of the participants. These analyses showed that the development of infrastructure layer in a BI architecture needs the basic database technology resources, hardware resources, and network resources.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
	%	%	%	%	%	%
IL1. A good BI architecture must consider an Infrastructure layer in their architecture.	0.0%	5.0%	5.0%	45.0%	45.0%	100.0%
IL2. A good BI architecture must consider hardware resources such as Storage resources, Computing resources, Virtual machines, etc. in their architecture.	0.0%	0.0%	5.0%	50.0%	45.0%	100.0%
IL3. A good BI architecture must consider database technologies such as Cloud/hosted storage, Disk drives, Solid-state drives, Optical disks, etc. in their architecture.	0.0%	0.0%	7.5%	57.5%	35.0%	100.0%
IL4. A good BI architecture should have a dedicated Data Management layer.	0.0%	5.0%	15.0%	45.0%	35.0%	100.0%
IL5. A good BI architecture should have a dedicated bandwidth.	0.0%	5.0%	15.0%	37.5%	42.5%	100.0%
IL6. A good BI architecture should have a dedicated Network layer.	0.0%	2.5%	17.5%	35.0%	45.0%	100.0%
IL7. A Network layer should be part of the Infrastructure layer.	0.0%	0.0%	15.0%	37.5%	47.5%	100.0%
IL8. An Infrastructure layer should not be part of the BI architecture.	15.0%	15.0%	22.5%	30.0%	17.5%	100.0%

Table 4. 12: Proposed Components for Infrastructure Layer (Source: own survey result 2020)

4.4.7.2 Infrastructure Layer - Additional components

Here participants tried to make their suggestion about additional components for the infrastructure layer architecture. In figure 4.9, 80% of the participants proposed IaaS for the infrastructure layer, then 72.5% suggested routers and switches, 65% preferred Virtual Private Network and 47.5% favored Access Point Name respectively. This analysis tried to deal with the necessary additional infrastructure resources for better performance of the banking system.

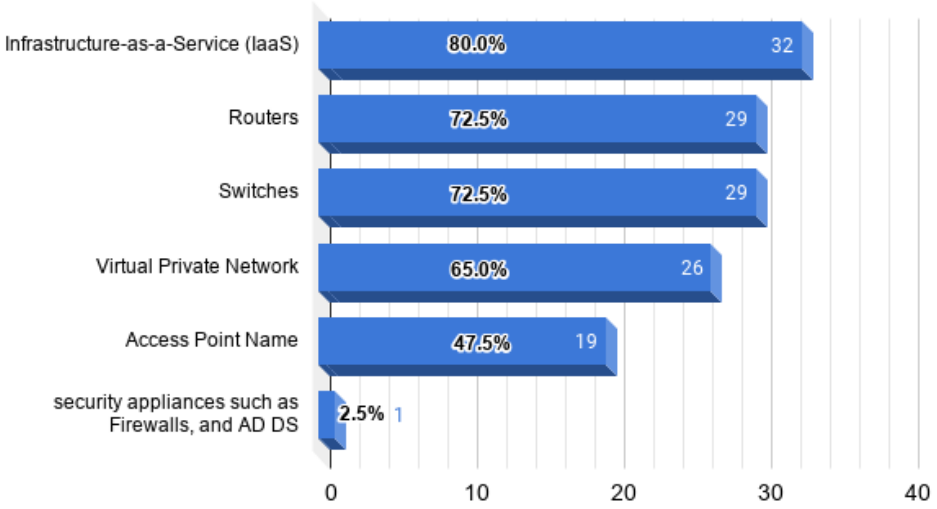


Figure 4. 9: Infrastructure Tools (Source: own survey result 2020)

4.4.8 Results and Discussions

This part tried to present the major results of all the relevant research questions for the development of the proposed hybrid BI architecture as suggested by experts and users of the bank as follows:

4.4.8.1 Level of BI experience and relevant Resources

As a level of BI experience and relevant resources of the bank, participants tried to share their knowledge and expertise of the BI system as stated below:

- The analysis shows that on-premise and cloud-based BI systems are widely available in the IS divisions and different head office departments. On-premise deployment of BI system showed that BI resources, for instance hardware, software applications and systems found within the bank is also good for the security of all system data. The analysis also shows that cloud-based deployment handled basic cloud operational models, i.e., PaaS, SaaS, and IaaS which is capable of delivering real-time and compatible BI system.
- The analysis found that hybrid BI system is essential for the management of big data both on-premise and cloud-based deployments. It was also discovered that a good management of BI system makes big data controllable, secure, and accessible.

In general, a good BI system needs a hybrid deployment in order to take advantage of both on-premise and cloud-based BI system. So, a hybrid BI deployment is better than a naive BI deployment.

4.4.8.2 Deployment of the End User Layer applications and devices

Participants tried to make some suggestions about the necessary components, devices and applications for End User Layer BI architecture as follows:

- The analysis shows that a good model for a BI architecture needs to have an End User Layer.
- The analysis also shows that applications, devices, and interface layers were very essential, so all the above-mentioned components must be involved in simplifying the performance of End User Layer of BI system.

In general, the analysis showed that a good BI architecture must include a combination of presentation layer and application layer with other components.

4.4.8.3 Deployment of the BI service layer

Participants tried to make some suggestions about the appropriate services for BI architecture service layer as follows:

- The analysis shows that the service layer serves as a dedicated layer for the BI architecture.
- The analysis also shows that ESB/SOA was essential for the application of BI services and systems in the bank.

In general, these results support the suggestions about the necessary components for the service layer, but the results discovered that the service layer must still be enhanced with additional components.

4.4.8.4 Deployment of the Data Warehouse Layer

Participants tried to make some suggestions about the necessary applications or systems for the BI architecture of Data Warehouse Layer as listed next:

- The analysis shows that the Data Warehouse Layer serves as a dedicated layer for the BI architecture.
- The analysis also shows that the necessary data source systems for BI system are operational data sources, Legacy data sources, OLTP systems, external data sources etc.…

In general, the result shows that a good Data Warehouse Layer must include data layer and service layer.

4.4.8.5 Deployment of the infrastructure layer

Participants tried to make some suggestions about the necessary hardware resources and data management systems for the BI architecture infrastructure layer as stated below:

- The analysis showed that a good BI architecture must have both infrastructure layer and data management layer (internal and external).
- The analysis also shows that the necessary tools for the infrastructure layer are hardware resources, database, Network layer, VPN, Access Point Name, Routers, and Switches.

Accordingly, the analysis tried to deal with all the initial questions of how to enhance the necessary layers and components of BI architecture. It was also concluded that the proposed architecture must apply the input and ideas of BI experts. So, hybrid BI architecture is found to be essential according to the literature review and the results of the survey.

4.5 Enhanced BI architecture

This part deals with enhanced BI architecture. Participants tried to make important suggestion about the deployment of the proposed architecture. Figure 4.10 shows the phase of enhanced BI architecture after considerations of important changes and recommendations of additional components for the research.

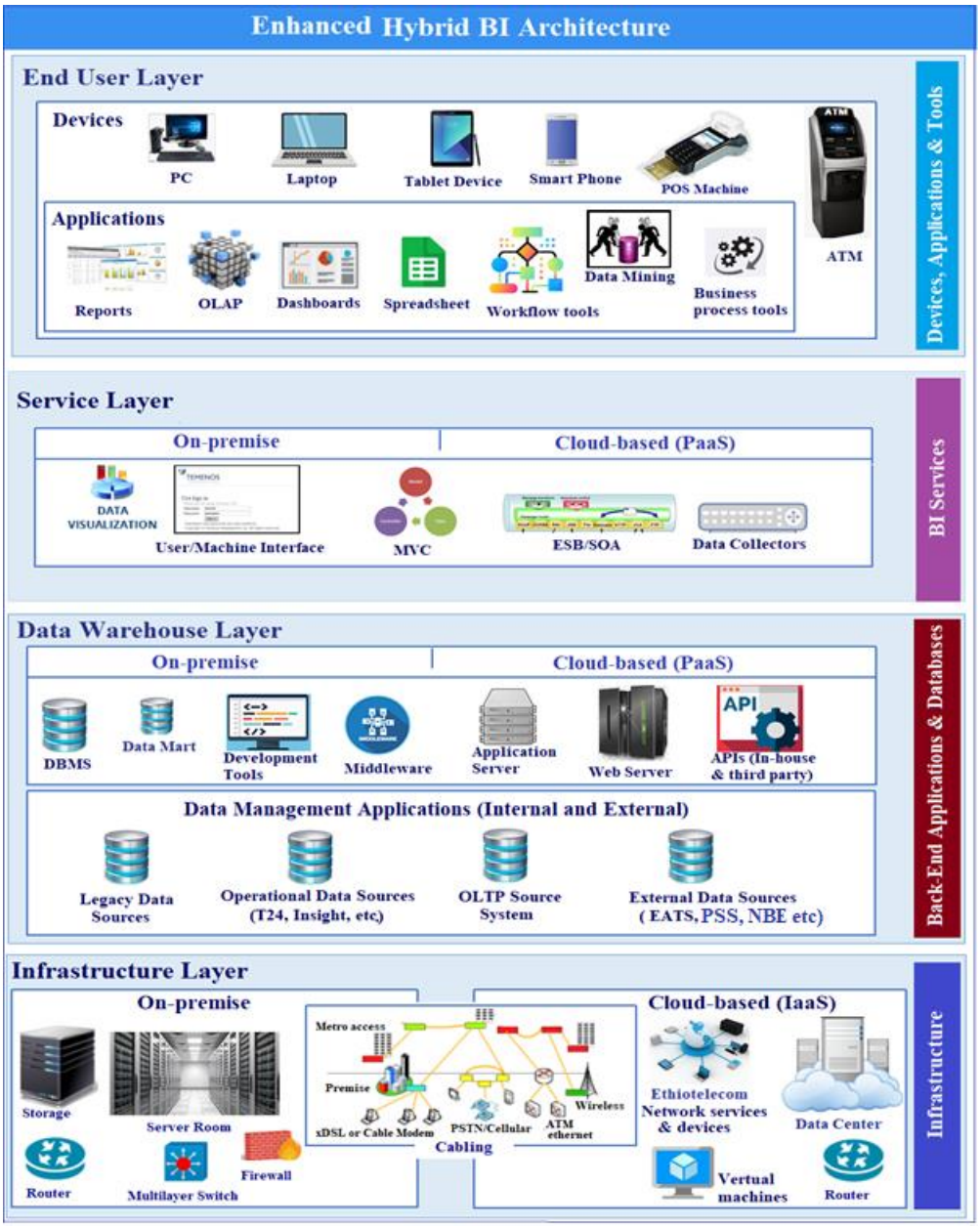


Figure 4. 10: Enhanced Hybrid BI Architecture (Source: own survey result 2020)

The Enhanced Hybrid BI Architecture layers can be briefly discussed as follows:

- **End User Layer:** is the first part of BI system architecture, which holds two independent layers i.e., the presentation and application layers. The result of the survey suggests that both layers constitute a well-organized End User Layer. The End User Layer includes different technological devices, like, PCs, laptops, smartphones, tablets, POS machines, ATM, etc. to handle both on-premise and cloud-based portal services for the existing BI system.

- **Service layer:** the necessary components for service layer are MVC, data collector, user and or machine interface, and Enterprise Service Bus (ESB), etc. ESB supports Service-oriented Architecture (SOA) for various BI services on-premise and cloud-based environments.
- **Data Warehouse Layer:** is a combination of both data layer and service layer. The result of the survey recommended that DBMS, APIS, Middleware, and development tools, etc. must be included in the Data Warehouse Layer. Data management applications are also a part of Data Warehouse Layer that helps to hide activities behind the scene in the on-premise and cloud-based BI system.
- **Infrastructure layer:** A good infrastructure layer must have well-organized Ethio-telecom network devices and services, firewall, Routers, and multilayer switches etc. All the devices help to transfer safe, secure and readily available data for the business users with in the BI system.

Integration of the layers with all the necessary hardware, software, storage, server, infrastructure, bandwidth, and devices in the enhanced BI architecture improves the performance of the bank and opens the horizon for more progress. This enhanced integrated BI architecture can serve as a guide for the deployment of a hybrid BI system depending on the business goals, visions and missions of the bank.

4.5.1 Practical demonstration of BI architecture by T24 Insight in NIB

Insight is Microsoft's Business Intelligence based application used to build, run, and electronically distribute reports throughout a bank. Insight Reports can be viewed in the Insight browser, as well as made available as spreadsheets and as multi-dimensional PivotTables. The Insight Server is the server that both stores the data and acts as the webserver to the users.

- **T24 Insight Server software** is a PC application that processes files produced by the T24 Banking Server.

Types of Data Used Insight

a. Transactional Data - On-Line Transactional Processing (OLTP) -is a run-time data, current, and Detail. Source of Transactional Data is Application

b. Analytical Data - On-Line Analytic Processing (OLAP) is Historical and Summarized data. And stored in the Data warehouse. Source of Analytic Data is OLTP

Transformed source data is consolidated into a single relational database called a data warehouse. The warehouse physically resides on an industrial-strength relational system, such as Microsoft's SQL Server, Oracle, or IBM's DB2.BI Application Temenos Insight uses data gathered from Data Warehouse.

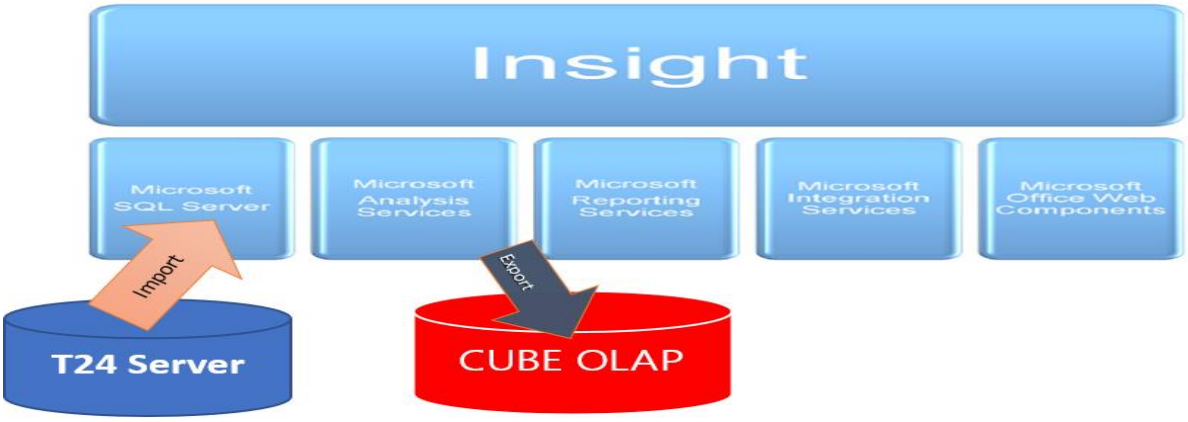


Figure 4. 11: Overview of Insight Components (Temenos 2010)

A cube is a complex, efficient, and proprietary data structure that includes data and data aggregations (precalculated summary information), as well as security information that controls who can access what.

Insight Base Procedures

Through the use of interactive dashboards and reports, the system allows financial and non-financial data to be combined into a series of metrics and key performance indicators (KPIs) that can be used to monitor the banks' performance against defined goals and strategies.

In addition to several standard reports, a set of standard KPI reports and dashboards are delivered with Insight covering measures most commonly used in banks. These KPIs can be viewed as soon as the system has been implemented, delivering an immediate benefit to the bank. Dashboard and KPIs can be tailored to the end-user, highlighting the KPIs that are most significant to their role and responsibilities.

Insight presents combinations of information in ways that ensure the most significant items are easily seen and understood.

The Insight Server software performs the following functions:

- Builds tables in SQL Server 2012 using the CSV data files produced by the T24 system.
- Creates PivotTables over the tables created from the CSV files.
- Updates the tables, which support the Insight Explorer web page so that users can locate reports and PivotTables for the date being processed.
- Runs user defined SQL Server 2012 Integration Services (SSIS) packages to import or export data.
- Runs user defined SQL Stored procedures, programs (EXE, BAT VBS etc.) or VBA Functions.
- Builds multi-dimensional cube files in SQL Server 2012 Analysis Services (SSAS) used by PivotTables for OLAP reporting.

4.5.1.1 Validation of the proposed enhanced hybrid BI architecture

The analysis result of BI users shows that NIB has a BI model with separately organized layers for the BI system so it must develop high tech on-premise and the cloud system. These BI systems must include the necessary IT infrastructure such as data source systems, information delivery, reporting, data analysis services, and storage capabilities.

The conceptual framework tried to cover various literature and suggestions of BI experts in the bank. In order to realize the full potential of the BI system, the bank needs to adopt the enhanced integrated Hybrid BI architectures which includes:

The front-end layer with continuously updated PC, Laptop, operating system, browsers, Insight Publisher, dashboards, to clearly show KPIs, duties and responsibilities.

The Service Layer with good components such as MVC, data collector, user and or machine interface, and Enterprise Service Bus (ESB), etc. as suggested by BI experts.

The back-end layer with good components such as DBMS, APIS, Middleware, and development tools, JBASE, DB2, Oracle or SQL Server, utilization of ETL tools, such as, part of SQL server to process data appropriately.

The infrastructure layers with the right Ethio-telecom network bandwidth, devices and services, firewall, Routers, and multilayer switches etc. to analyze data properly.

Generally, the enhanced hybrid BI architecture has various advantages such as formulating business strategy, providing business services, simplifying major ETL processes.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This study tried to analyze in detail the data collected from the survey, and evaluate the practicality of the suggested hybrid BI model. It also presented an enhanced architecture based on the findings. The purpose of this chapter is to summarize and conclude this research conducted on the assessment of Business Intelligence Information System of Nib International Bank.

5.1 Summary

This study deals with the general objective based on five specific objectives. Chapter 2 focuses on the first objective of the research which is reviewing BI in general. The purpose of this chapter was to provide a general understanding of BI, its use and the associated business value. It tried to cover key concepts and terminologies that are commonly used in order to comprehend the overall BI infrastructure. A BI process flow was developed to demonstrate the value generated through the use of BI. This process includes key functions of a BI infrastructure; i.e., sources of data, ETL, data warehouse, recording, analyzing and reporting data, and decision making. This process also lead to the development of an ideal BI architecture consisting of a presentation layer, service layer, data layer, and source systems layer. The review of BI in general was further supported by detailed discussions on OLTP, OLAP and Data mart. Considering the detailed discussion on the above-mentioned aspects in chapter 2, and the findings from the survey conducted on the state of BI infrastructure in chapter 4, the outcomes support the validate the proposed enhanced architecture.

To explore a series of BI infrastructure configuration methods and their related advantages and limitations. This objective was explored in Chapter 2. This chapter deals with more specific aspects of BI. It investigates on-premise and cloud-based deployment of BI infrastructure and the business value that can be realized from such implementation. It also presented the advantages and limitations of implementing on-premise and cloud-based BI deployment.

Chapter 4 presented the findings from the survey conducted on the state of BI and, the outcomes of the research have been acknowledged to have answered the research question, that is: What are the services/features of BI system in the bank and what are the gaps?

To develop enhanced and integrated BI infrastructure. A hybrid BI deployment was defined as a combination of on-premise BI deployment and a cloud-based BI deployment. This hybrid BI infrastructure needs its own data warehouse for a successful deployment of hybrid BI infrastructure according to the business requirement of the bank. This model also needs key components, such as, interface, multiple data sources and, or storage systems. Many literatures were presented to further support this conceptual hybrid BI architecture. The architecture consists of five layers, namely, the presentation layer, application layer, network layer, service layer, and data layer. A hybrid BI deployment was further explained with discussions on its advantages and limitations. Having discussed the above-mentioned aspects in detail in chapter 4, the outcomes of the research have been acknowledged to have answered the research question, that is: What are the basic BI software and related hardware in the bank?

To assess the current status of BI infrastructure in NIB according to users and evaluate power of the suggested BI system according to experts. Chapter 4 discussed in detail the history of business intelligence, its development, various techniques of data management and their experience and the level of public awareness about the idea of business intelligence. It also presented the analysis and results of the survey that lead to the development of the proposed hybrid BI architecture. It discussed in detail various techniques of enhancing a BI architecture. The enhanced architecture consists of four layers, namely, the front-end layer, service layer, backend layer, and infrastructure layer.

Therefore, the findings from the survey conducted in chapter 4, the outcomes of the research have been declared to have answered the research question, that is: How can the suggested model be constructed successfully?

5.2 Conclusion

The findings on the state of BI utilization in the bank were reported and it was discovered that the bank utilize BI system that are either deployed on-premise, in the cloud, or as hybrid system. Enhanced hybrid BI system was found to be appropriate for managing large volumes of data and critical information residing in various locations. The benefits of using a hybrid BI system were found to outshine existing solutions.

The enhanced and proposed hybrid BI architecture has been recommended to serve as a guide when implementing a hybrid BI system in the bank. The design for the hybrid BI architecture includes the most significant technological aspects required for implementing a comprehensive and robust BI system.

This research can be summarized as its discussion mainly focuses on investigating BI in general, on-premise BI deployment, cloud-based BI deployment, and the development of the hybrid BI system as well as the resulting business value.

In conclusion, enhanced hybrid BI system architecture is highly recommended for addressing a number of BI challenges faced by the bank with a more organized system. The implementation of such a system can be successfully achieved by considering the hybrid BI architecture recommended in this study.

Based on the guide lines presented in the introduction the results of the analysis and perspectives from BI users and experts are organized as follows:

- The research shows that BI system has all the potential to help businesses succeed and make good business decision with capable BI users who have good IT knowhow, BI modelling, project management, and its applications. The knowledge and skills of a BI experts and BI systems users are of major importance.
- BI system must be part of the bank business plan. All BI users must be able to participate in the decision-making process of the management cycle (planning, organizing, directing and controlling).
- BI system is a method of generating business data collected by the bank to control ways and means that contribute to good decision making for the bank. A well-organized BI architecture can successfully operate any type of BI system products. It was observed that a good and practical operation can be performed by BI system depending on a BI architecture that is based on BI process flow model.
- A compatible BI architecture was restructured to include interconnected layers that support a simple collection, storing, reporting and analyzing of data. It was also observed that major BI system operations, essential in analyzing and administering the data of the bank are found to be OLTP (TEMENOS T24 R10) and OLAP (Insight R10) systems.

- Regarding BI system deployment it was identified that, the bank is dealing with several difficulties in the existing deployment design consisting of separately arranged layers. The on-premise BI deployment model of the bank with all the necessary hardware, software and application systems are available within the headquarter of the bank. Accordingly, the bank is actively searching for different ways of enhancing the centralization of its BI system.
- It was observed that the deployment of on-promise BI architecture is mainly applied in the head quarter of the bank. But an overall deployment of BI systems with the necessary facilities is essential for better performance and management of any department and branch of the bank.
- It was also observed that a good cloud-based model must possess cloud computing facilities, i.e., PaaS, SaaS and IaaS. A good cloud computing services needs a high-level cloud-based BI architecture for Internet security and cloud services purposes than on-premise BI architecture.
- The enhancement of BI system architecture is essential for the management of complex on-premise and cloud-based BI systems. It was clearly observed that hybrid BI system includes various basic components that affect the operation of BI system. These components contain storage data administration, big data processing, storage analytical and transactional processing, and hybrid data processing.
- It is essential for users to be able to use the BI system. This can be achieved by users training and a user-friendly system.
- Administration of the BI system implementation should be centralized, but each of its users should participate in the implementation. This kind of situation will allow users to familiarize themselves with the BI system operation and its specific needs.
- The number of users influence the performance of proposed BI system basic layers. so, whenever the organization tend to add the number of users, the magnitude of devices in the BI system basic layers must be checked and updated.
- The benefit of BI system deployment must be shown in business progress, and encourage investment in customization team, change management, technical support, functional support, users training together with maintaining and upgrading the BI system in the future. Or else, unnecessary technologies will lead to unnecessary expenses.

5.3 Recommendations

This research tried to assess the status of business intelligence system in the bank. Most BI experts preferred enhanced hybrid BI system architecture. But this does not represent the perspective of external sources such as vendors. It also does not demonstrate any practical screenings of providing & optimizing BI services.

Based on the findings and the proposed BI system architecture the following suggestions is given:

- The BI system must be applied throughout head office and branch level for successful performance of the bank, customer management, risk assessment, profit and loss analysis, credit portfolio and good business decision making by users.
- The bank must continuously test the conditions of the BI system in its daily business activities. And the bank must arrange administrative personnel specialized in the management of business intelligence.
- All the necessary hardware, software, storage, server, infrastructure, Ethio Telecom network bandwidth, and devices must be available to fully utilize the existing features and to avoid technical inconsistency of the BI system.
- Weaknesses in the implementation of BI system must be evaluated. High level of management must check the performance of the BI system through regular follow up of the responsible persons and with relevant penalties for targets that are not met. This could be supplemented with frequent training sessions to ensure that all employees are up to date with current trends.
- It is also mandatory to have a well-known schedule for upgrading the system and servers and expand database storage size to use on all the features of the BI system as needed.
- The hardware and software performance of each layer must be checked constantly to do the required maintenance on time and to have an unreserved BI system service. Generally, if there is any change or update within a device in any one of the suggested Hybrid layers, all the other layers must be tested and checked in order to prevent the BI system from any potential competence issue, delay or failure.
- Whenever the number of branches increases the existing BI system infrastructure and Ethio Telecom bandwidth services must be revised to manage all the business data.

- BI system user training and manual must be prepared with a frequent update to know the current condition of the system and to use the system without dependency on IT experts.
- BI systems must be spread through all departments and branches of the bank. Everyone has to know the relevance of the BI system. Only then the bank will have the most advantage of the system.

5.4 Recommendations for future study

After discussing the objectives of this research, literature review, limitations, and findings some of the research areas for further study are highlighted as follows:

- Future researchers can advance this research by exploring all the operational potentials of the proposed architecture and challenging its technical boundaries.
- Business opportunities for a specific BI software vendor must be explored in the deployment of BI system packages.
- Further studies are needed to solve the complex question of how to manage big data on large project level.
- Other areas of research include licensing for software development, upgrading for product diversification and maintenance for compatible hardware innovations in the IT infrastructure.

References

Abusweilem, M. & Abualous, S. (2019). The impact of knowledge management process and business intelligence on organizational performance. Management Science Letters Quarterly Publication. 2143-2156. 10.5267/j.msl.2019.6.020.

Ain, N., Vaia, G., DeLone, W.H., & Waheed, M. (2019). 'Two decades of research on business intelligence system adoption, utilization and success – A systematic literature review', Decision Support Systems. Elsevier, 125(June), p. 113113. doi: 10.1016/j.dss.2019.113113.

Al-Aqrabi, H., Liu, L., Hill, R., & Antonopoulos, N. (2015). Cloud BI: Future of business intelligence in the Cloud. Journal of Computer and System Sciences, 81(1), 85-96. https://doi.org/10.1016/j.jcss.2014.06.013.

Alsanea, M. (2015). Factors Affecting the Adoption of Cloud Computing in Saudi Arabia' s Government Sector. Doctoral thesis, Goldsmiths, University of London [Thesis].

Antti Lönnqvist, & Pirttimäki, Virpi. (2006). The Measurement of Business Intelligence. IS Management. 23. 32-40. 10.1201/1078.10580530/45769.23.1.20061201/91770.4.

Armstrong-smith, M. (2014) Oracle Business Intelligence Discoverer 11 g Handbook Run Effective Queries and Generate Meaningful Reports Oracle Business Intelligence Discoverer 11 g Handbook.

Awasthi, A. (2020). Network Classification for an Enterprise. International Journal of Science and Research (IJSR). 9. 635-637. 10.21275/SR20210035306.

Azeroual, O. & Theel, H. (2018). The Effects of Using Business Intelligence Systems on an Excellence Management and Decision-Making Process by Start-Up Companies: A Case Study. International Journal of Management Science and Business Administration. 4. 30-40. 10.18775/ijmsba.1849-5664-5419.2014.43.1004.

Bakula, I., Ćurko, K., Bach, M.P., & Vukšić, V. (2016). Application of Business Intelligence System in Company Restructuring Process: The Case of Croatia. International Association for Development of the Information Society.

Beringer, J. (2004) '(12) Patent Application Publication (10) Pub. No.: US 2004 / 0187140 A1 "N Obect Modeler Enterprise Base', 1(19), Pub. No.: US 2004/0123650 Al.

Borse, A. A. (2019) 'Service Oriented Architecture paradigm for Business Intelligence: A survey', International Journal of Advance Research, Ideas and Innovations in Technology, 5(1), pp. 1–4.

Brien, J. O. (2006) ‘Business intelligence and the telecommunications industry: can business intelligence lead to higher profits?’, SA Journal of Information Management, 8(September).

Chen, B. (2018) ‘Smart Factory of Industry 4. 0: Key Technologies, Application Case, and Challenges’, IEEE Access. IEEE, 6, pp. 6505–6519. doi: 10.1109/ACCESS.2017.2783682.

Chan, J. O. (2020) ‘Digital Transformation in the Era of Big Data and Cloud Computing’, International Journal of Intelligent Information Systems. 9(3), pp. 16–23. doi: 10.11648/j.ijiis.20200903.11.

Chan, L., Sim, Y. and Yeoh, W. (2011). A SOA-Driven Business Intelligence Architecture. Communications of the IBIMA. 10.5171/2011.216423.

Conn, S.S. (2005). OLTP and OLAP data integration: a review of feasible implementation methods and architectures for real time data analysis. Proceedings. IEEE SoutheastCon, 2005., 515-520.

Coyne, L. (2018) ‘Front cover IBM Private, Public, and Hybrid Cloud Storage Solutions’. An IBM Redpaper publication.

Darma, I. G. W. (2019) ‘Data Warehouse Analysis to Support UMKM Decisions using the Nine-step Kimball Method’, International Journal of Engineering and Emerging Technology 4(1), pp. 2–5.

Data, R. U. S. A. (2015) ‘(12) United States Patent’, publication. doi : 10.1115 / 1.4028725 , 2(12).

Eid & Eid Ahmed Mohamed, Mina, Mina & KadyMahmoud & A. Mawgoud, Ahmed & Taha, Mohamed. (2019). Cloud Migration Strategy for Legacy Systems using AWS Platform. Cairo University. 10.13140/RG.2.2.12301.28649.

El-adaileh, N. A. and Foster, S. (2019) ‘Successful business intelligence implementation: a systematic literature review’, Published in Journal of Work-Applied Management. 11(2), pp. 121–132. doi: 10.1108/JWAM-09-2019-0027.

Elmalah, K. and Nasr, M. (2019). Cloud Business Intelligence. International Journal of Advanced Networking Applications. 10. 4120-4124. 10.35444/IJANA.2019.100612.

Ereth, J., & Baars, H. (2015). Cloud-Based Business Intelligence and Analytics Applications - Business Value and Feasibility. Published in PACIS 2015 Computer Science.

Fisher, C. (2018) Cloud versus On-Premise Computing. American Journal of Industrial and Business Management, 8, 1991-2006. https://doi.org/10.4236/ajibm.2018.89133.

Girsang, A.S. & Isa, S.M. & Puspita, A.D. & Putri, F.A. & Hutagaol, N. (2019). Business intelligence for evaluation e-voucher airline report. International Journal of Mechanical Engineering and Technology. 10. 213-220.

Goyal, S. (2014). Public vs Private vs Hybrid vs Community - Cloud Computing: A Critical Review. International Journal of Computer Network and Information Security. 6. 20-29. 10.5815/ijcnis.2014.03.03.

Grossmann, W. and Rinderle-Ma, S. (2015). Fundamentals of Business Intelligence. Publisher: Springer-Verlag Berlin Heidelberg, 10.1007/978-3-662-46531-8.

Gurjar, Y. S., & Rathore, V. S. (2013). Cloud Business Intelligence – Is What Business Need Today. International Journal of Recent Technology and Engineering, 1(6), 81–86.

Khan, R. A. (2012) 'Business Intelligence: An Integrated approach', University of Kashmir 5(1), pp. 64–70.

Nasr, M.M. & Ouf, S., (2011). Business Intelligence in the Cloud. 2011 IEEE 3rd International Conference on Communication Software and Networks, 650-655.

Majid Al-Ruithe (2018) Development and Evaluation of a Holistic Framework and Maturity Assessment Tools for Data Governance in Cloud Computing Environments, Staffordshire University.

Manyika, James & Chui, Michael & Brown, Brad & Bughin, Jacques & Dobbs, Richard & Roxburgh, Charles & Byers, Angela. (2011). Big data: The next frontier for innovation, competition, and productivity. McKinsey Global Institute.

Miao Wu, Ting-Jie Lu, Fei-Yang Ling, Jing Sun and Hui-Ying Du, "Research on the architecture of Internet of Things," 2010 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE), Chengdu, China, 2010, pp. V5-484-V5-487, doi: 10.1109/ICACTE.2010.5579493.

Muntean, M. (2015). Considerations Regarding Business Intelligence in Cloud Context. Informatica Economica. 19. 55-67. 10.12948/issn14531305/19.4.2015.05.

Olszak, C.M. (2014). Business intelligence in cloud. Polish Journal of Management Studies. 10. 115-125.

Olszak, C. M., & Ziemba, E. (2007). Approach to Building and Implementing Business Intelligence Systems. Interdisciplinary Journal of Information, Knowledge and Management.

Ong, I. L., Siew, P. H. and Wong, S. F. (2011). A Five-Layered Business Intelligence Architecture. Communications of the IBIMA. 10.5171/2011.695619.

Owusu, A. (2017) 'Business intelligence systems and bank performance in Ghana: The balanced scorecard approach', Cogent Business & Management. Cogent, 27(1), pp. 1–22. doi: 10.1080/23311975.2017.1364056.

Pyae, A. (2019) 'Cloud Computing in Business Intelligence, https://www.researchgate.net/publication/333037033.

Ragab, M. A. F. and Arisha, A. (2018) 'Research Methodology in Business: A Starter' s Guide', Management and Organizational Studies, 5(1), pp. 1–23. doi: https://doi.org/10.5430/mos.v5n1p1

Ram, J., Zhang, C. and Koronios, A. (2016) 'The implications of Big Data analytics on Business Intelligence: A qualitative study in China', Procedia - Procedia Computer Science, 87, pp. 221–226. doi: 10.1016/j.procs.2016.05.152.

Reyes, E. P. (2010). A Systems Thinking Approach to Business Intelligence Solutions Based on Cloud Computing, Publisher: Massachusetts Institute of Technology.

Ridder, H. (2017) 'The theory contribution of case study research designs', Business Research. Springer International Publishing, 10(2), pp. 281–305. doi: 10.1007/s40685-017-0045-z.

Raghavendra, Kune, & Konugurthi, Pramod & Agarwal, Arun & Rao, C. & Buyya, Rajkumar. (2015). The Anatomy of Big Data Computing. Software: Practice and Experience. 46. 10.1002/spe.2374.

S. Krit & el Bousty, H.el, & Kabrane, M. & K.Bendaoud & Karimi, Khaoula & Oudani, H. (2018). Investigating Business Intelligence in The Era of Big Data: Concepts, Benefits and Challenges. International Journal of Engineering Science.

Sciencedirect, P., Manoj, N. and Kumar, P. (2018) 'ScienceDirect The Internet of Things: Insights into the building blocks, component interactions, and architecture layers', Procedia Computer Science. Elsevier B.V., 132, pp. 109–117. doi: 10.1016/j.procs.2018.05.170.

Sethi, Pallavi & Sarangi, Smruti. (2017). Internet of Things: Architectures, Protocols, and Applications. Journal of Electrical and Computer Engineering. 2017. 1-25. 10.1155/2017/9324035.

Singh, J., & Sood, A. (2013). A Comparative Study of OLTP and OLAP Technologies. Semanticscholar.org

Sowmya, S. K., Deepika, P. and Naren, J. (2014). Layers of Cloud – IaaS, PaaS and SaaS: A Survey. International Journal of Computer Science and Information Technology. Vol. 5 (3). 4477 - 4480.

Srinivasan, M. (2012). Cloud-Based Email Architecture for Higher Education Institutions. Issues in Information Systems. 12.

Taylor,P. (2013) 'The Measurement of Business Intelligence', pp. 37–41. doi: 10.1201/1078.10580530/45769.23.1.20061201/91770.4.

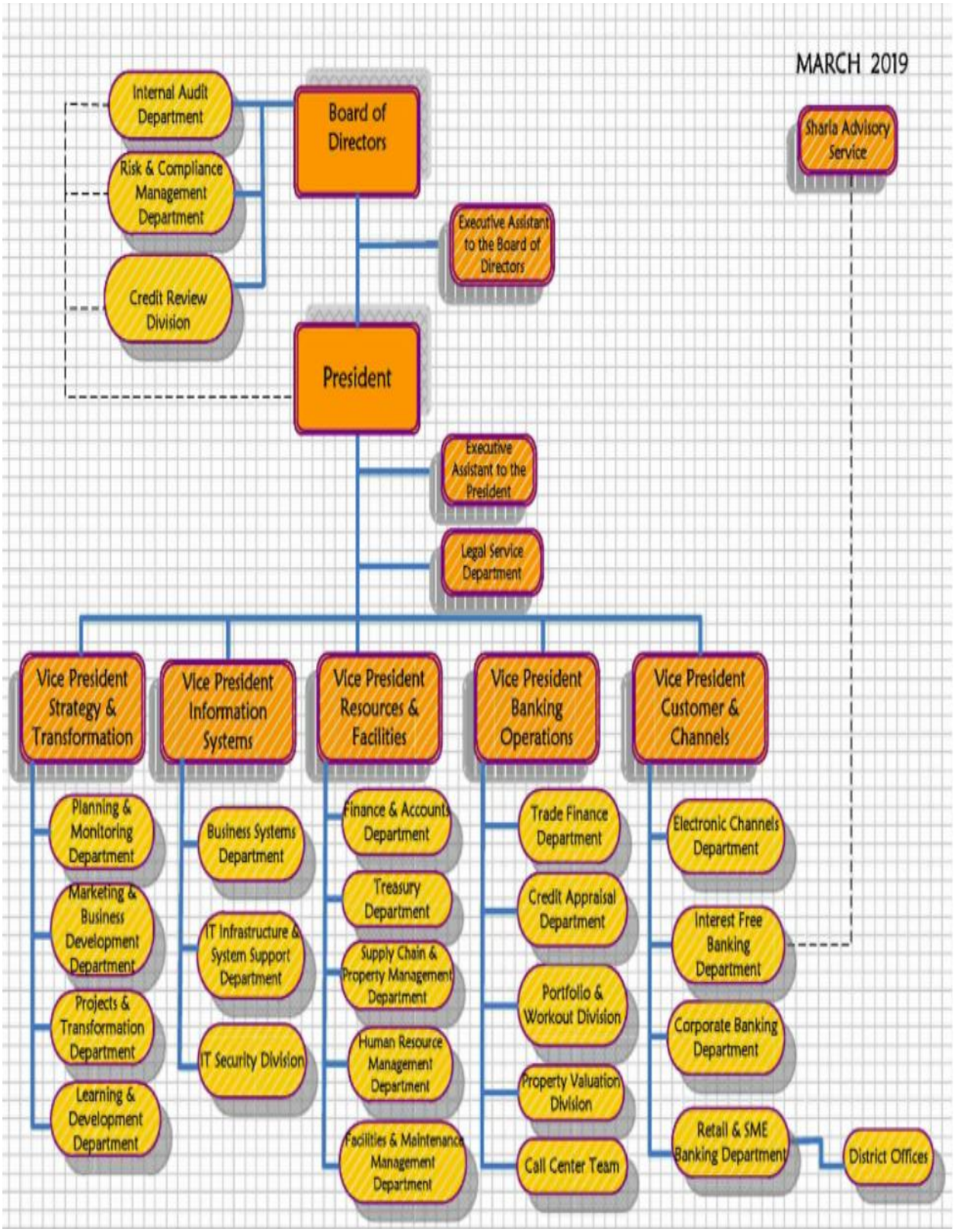
Temenos, (2010) 'Temenos Insight Keith Waterman Commercial Director'.TEMENOS

Venkatakrishnan, R. (2020). Design, Implementation, and Assessment of Innovative Data Warehousing; Extract, Transformation, and Load (ETL); and Online Analytical Processing (OLAP) on BI. International Journal of Database Management Systems, 12, 1-6.

Wachanga, A & Ndiege, J (2018). Adoption of Cloud Computing By Small and Medium Enterprises in Nairobi County, Kenya. 10.13140/RG.2.2.12989.97768.

Woiceshyn, Jaana & Daellenbach, Urs. (2018). Evaluating Inductive versus Deductive Research in Management Studies: Implications for Authors, Editors, and Reviewers. Qualitative Research in Organizations and Management: An International Journal. 13. 00-00. 10.1108/QROM-06-2017-1538.

Appendix 1: **Organizational Structure of NIB**



Appendix 2: RESEARCH QUESTIONNAIRE – FOR BI EXPERTS

Dear Respondents

This is an invitation to consider participating in study I, Firehiwot Fekade, am conducting as part of my research as a Master's student entitled Assessment of Business Intelligence Information System at Addis Ababa University. I have purposefully identified you as a possible participant because of your valuable experience and expertise related to my research topic.

This questionnaire is designed to collect data about Business Intelligence system deployment from system users and experts in NIB. Business Intelligence (BI) is a readily available tool that enables the collection, storage, and processing of business information e.g., TEMENOS Insight & T24. Hence, the soundness and validity of the findings highly depend on your kind and genuine responses. The information that you provide will be confidential and exclusively be used for academic purposes only. I look forward to receiving our response and thank you in advance for your cooperation. Please click below to See the Google form.

https://docs.google.com/forms/d/e/1FAIpQLSd3bWEiaamrTnSVDeTXfoL2Pv_-sOW3nTFkk-vuq9jC-cDLYA/viewform

Part I: Demographic Information

1. Please indicate the level of academic qualification reached
   - A. Degree
   - B. MA/MSC
   - C. PHD
   - D. Other_____
2. Years of experience in the Bank:
   - A. Below 2 years
   - B. Between 2 and 4 years
   - C. Between 4 and 8 years
   - D. Between 8 and 10 years
   - E. More than 10 years
3. Please indicate the division you are assigned to:
   - A. System Administrator
   - B. Database
   - C. Data center
   - D. Software Developer
   - E. Network
   - F. Hardware

G. System Analyst
I. Help Desk
H. System Security
J. Other _____

4. Please indicate the level of deployment of BI in the Bank:
   A. Centralized
   B. Distributed
   C. Isolated
   D. Other If other, please specify: _____

Part II: Familiarity Business Intelligence Deployment

A. **Please provide your assessment for each of the following statements to your expertise and knowledge of BI deployment options in the Bank:**

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. An on-premise BI deployment has all the hardware, software, and application systems located inside the Bank's premises.					
2. An on-premise BI deployment ensures ownership of business data.					
3. A cloud-based BI deployment promotes the use of faster and cheaper BI services.					
4. A Hybrid BI deployment is a combination of on-premise and cloud-based BI solutions.					
5. A Hybrid BI allows for sensitive information to be kept on-premise and the rest to be managed in the cloud.					

B. **Please provide your assessment for each of the following statements to the location and management of the bank BI Information system.**

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
1. All of our BI Information systems are installed and run-on computers located in our building.					
2. All of our BI Information systems are installed and run-on servers located at our service provider.					
3. We own all the hardware and software used to support our BI solution.					
4. We have full control of our in-house data processing applications and development environment.					
5. We have full control of our remote data processing applications and development environment.					
6. We have full control of our storage and computing resources that reside at a remote data center.					
7. We have full control of our storage and computing resources that reside at our office.					

1. Front-End (End User) Layer

Please assess the following statements to an architectural End User Layer of a BI Information System.

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
FL1. A good BI architecture must consider devices (e.g., Desktop Computers, Laptops, Tablets, and smartphones) in their architecture front end.					
FL2. A good BI architecture must consider applications (e.g., Online Analytical Processing, Spreadsheets, Data Mining, Reports, and Dashboards) in their architecture front-end.					

FL3. A good BI architecture must consider BI Tools (e.g., Microsoft Power BI, IBM Cognos, MicroStrategy, Oracle BI, and SAPBI/BO) in their architecture front-end.					
FL4. A good BI architecture must consider the presentation layer in its architecture front-end.					
FL5. A good BI architecture must consider the Interface layer in their architecture front-end.					

Please indicate which additional components could be part of the architecture End User Layer:

A. Business Process Execution Language (BPEL)
B. Business process tools
C. Workflow tools
D. Other

If other, please specify: _____

2. Service Layer

Please assess the following statements to an architectural Service layer of a BI Information system.

Statement	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
SL1. A good BI architecture must consider a Service layer in its architecture.					
SL2. The Enterprise Service Bus (ESB) usually referred to as middleware or Service-oriented architecture (SOA) should be positioned in the Service layer.					
SL3. BI services must have a dedicated layer referred to as the Service layer.					
SL4. The ESB and BI services must have a dedicated layer referred to as the Service layer.					

SL5. The Service layer should consist of ESB, BI, Platform-as-a-Service (PaaS), Database Management System (DBMS), and application servers.					
SL6. The services layer should consist of ESB, BI services, and DBMS					
SL7.The services layer should consist of ESB, BI services, and PaaS					

Please indicate which additional components could be part of the architecture Service layer:

A. Visualization MapReduce services
B. User Applications (including in-memory applications)
C. User/Machine Interface
D. Model-View-Controller (MVC)
E. Data collectors
F. other

If other, please give examples: _____

3. Back-End (Data Warehouse) Layer

Please assess the following statements to an architectural Data Warehouse Layer of a BI Information system.

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
BL1. A good BI architecture must consider a Data Warehouse Layer in their architecture.					
BL2. The PaaS should be part of the Data Warehouse Layer.					
BL3. The PaaS must have a dedicated layer.					
BL4. The Data Warehouse Layer should consist of PaaS, DBMS, and Application Servers.					
BL5. The Data Warehouse Layer should consist of DBMS and application servers.					
BL6. The DBMS must have a dedicated layer.					
BL7. The Application servers must have a dedicated layer.					
BL8. A good BI architecture must consider data source systems such as External data sources, Operational data sources, Legacy data sources, OLTP source systems, etc. in their Data Warehouse Layer.					

Please indicate which additional components could be part of the architecture Data Warehouse Layer:

A. Development tools
B. Middleware
C. Execution Runtime Environment
D. In house Application Programming Interface (API)
E. Third-Party API
F. Application Server
G. Web Server
H. If other, please give examples: _____

4. Infrastructure layer

Please assess the following statements to an architectural Infrastructure layer of a BI Information system.

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
IL1. A good BI architecture must consider an infrastructure layer in its architecture.					
IL2. A good BI architecture must consider hardware resources such as Storage resources, Computing resources, Virtual machines, etc. in their architecture.					
IL3. A good BI architecture must consider database technologies such as Cloud/hosted storage, Disk drives, Solid-state drives, Optical disks, etc. in their architecture.					
IL4. A good BI architecture should have a dedicated Data Management layer.					
IL5. A good BI architecture should have a dedicated bandwidth.					
IL6. A good BI architecture should have a dedicated Network layer.					
IL7. A Network layer should be part of the infrastructure layer.					
IL8. An Infrastructure layer should not be part of the BI architecture.					

Please indicate which additional components could be part of the architecture Infrastructure layer:

A. Infrastructure-as-a-Service (IaaS)
B. Routers
C. Switches
D. Virtual Private Network
E. Access Point Name
F. If other, please give examples: _____

Appendix 3: RESEARCH QUESTIONNAIRE – FOR BI USERS

Please click below to See the Google form.

https://docs.google.com/forms/d/e/1FAIpQLSeY5JYB33PPUrwYWIvfhGrmlWFyghj2gPz2KP2kShD--ePNhQ/viewform

Part I: Demographic Information

1. Please indicate the level of academic qualification reached:
   A. Degree
   B. MA/MSC
   C. PhD
   D. Other
2. Years of experience in the Bank:
   A. Below 2 years
   B. Between 2 and 4 years
   C. Between 4 and 6 years
   D. Between 6 and 8 years
   E. Above 10 years
3. The District of the Bank you are located
   A. Central A.A District
   B. South East A.A District
   C. North East A.A District
   D. Hosanna District
   E. Hwassa District
   F. North West A.A District
4. Please indicate the position you are assigned to:
   A. Manager
   B. Accountant
   C. CRO
   D. Casher
   E. CSO
   F. Other_____
5. Please indicate the number of business users that have access to BI services in the branch:
   A. Less than 5 Users
   B. Between 5 and 10 Users
   C. Between 11 and 15 Users
   D. More than 15 Users

Part II: Business Intelligence Deployment

1. Please provide your assessment for each of the following statements to software capabilities that support your BI Information System.

Statement	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1.1 We use a single point of entry to access our BI Information System.					
1.2 We only have one data generating system and one user performing all our BI-related functions.					
1.3 We have multiple data generating systems and multiple users performing complex BI-related functions.					
1.4 We use simple tools such as Microsoft Excel, Google Sheets, etc. to store data, retrieve, analyze, and produce reports.					
1.5 We use complex BI tools such as OLAP server, SAS BI, SAP BI, Oracle BI, etc. to store data, retrieve, analyze, and produce reports.					
1.6 Our reporting and analysis tool allows us to perform analytical functions.					
1.7 Our reporting and analysis tool produces information that assists us to make informed decisions.					
1.8 We use a self-service BI solution with timely insight and decision making.					
1.9 We have experienced BI professionals that use our BI information system.					
1.10 You do not need to be a BI professional or expert to use our BI information system.					

2. Please provide your assessment for each of the following statements to the management of data source/generating systems for your BI Information System.

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
2.1 Our data is managed through the use of Online Transaction Processing systems such as T24, ATS, T Insight, CRB, etc.					
2.2 Our access privilege allows generating a report for real-time decision making					
2.3 We have full BI privilege to run our task					
2.4 Data source systems are managed internally.					
2.5 Data from our source systems is stored in a simple database.					
2.6 Data from our source systems is stored in a complex data warehouse.					
2.7 Data is accessed from a central repository at our office.					
2.8 Data is easily accessible from the data repository residing at our data center.					
2.9 Our data goes through a data cleansing process (Extract, Transform, Load) before we gain access to it.					
2.10 Our BI system can launch big data immediately					