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YEDITEPE UNIVERSITY

COLLABORATION OF BUSINESS INTELLIGENCE AND CLOUD COMPUTING AND SELECTING THE BEST CLOUD BUSINESS INTELLIGENCE SOLUTION

by
İPEK ASLAN

May, 2021

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SUPERVISOR
ASSOCIATE PROF. DR. AŞKIN DEMİRAĞ

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Date : 25/5/2021

Name/Surname: İpek Aslan

ABSTRACT

In this thesis, business intelligence concept and architecture were explained from data sources to reporting with many advantages provided to institutions in the first part. Then, both cloud computing technology with its service and deployment models and the characteristics of cloud computing experienced clarified in the second part of the thesis. The relationship between cloud computing and business intelligence and the concept arisen from this collaboration, cloud business intelligence, were represented with its benefits and obstacles experienced by companies using this technology in the third part. Four service providers as alternatives serving cloud business intelligence solutions were selected and criteria were determined according to the needs of the company, that would like to use a cloud business intelligence software. After all the criteria are prioritized and the alternatives are determined, the best software was chosen by using the Analytic Hierarchical Process software, called Expert Choice, for decision making.

Keywords: Business Intelligence, Cloud Computing, Cloud Business Intelligence

ÖZET

Bu tezde iş zekâsı konsepti ve mimarisi, veri kaynaklarından raporlama aşamasına kadar kurumlara sağladığı faydalar ile birlikte açıklandı. Ardından hem bulut bilişim teknolojisi geliştirme ve servis modelleri hem de tecrübe edilen bulut bilişim özellikleri incelendi. Bulut bilişim, iş zekâsı ve bu terimlerin birlikteliğinden doğan bulut iş zekası terimi, bu konsepti uygulayan şirketler tarafından tecrübe edilen faydaları ve aksak yönleriyle anlatıldı. Bulut iş zekâsı alanında hizmet veren dört servis sağlayıcı seçildi ve bulut tabanlı iş zekası yazılımı kullanmak isteyen şirketimizin ihtiyacına göre kriterler belirlendi. Bütün kriterler önceliklerine göre sıralandıktan ve alternatifler belirlendikten sonra karar vermek için "Expert Choice" adlı Analitik Hiyerarşi Süreci yazılımı kullanılarak şirket için en uygun olan bulut iş zekâsı yazılımı seçildi.

Anahtar Kelimeler: İş Zekası, Bulut Bilişim, Bulut İş Zekası

To my beloved son who kept company with me on my journey of graduate studies from the outset when he was still within me...

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ABBREVIATIONS

AI	Artificial Intelligence
ARPANET	Advanced Research Projects Agency Network
AWS	Amazon Web Services
BI	Business Intelligence
CC	Cloud Computing
CPU	Central Processing Unit
DSS	Decision Support System
DW	Data Warehouse
EC2	Amazon Elastic Compute Cloud
HTML	Hyper Text Markup Language
IaaS	Infrastructure as a Service
ML	Machine Learning
NIST	The National Institute of Standards and Technology
OLAP	Online Analytical Processing
PaaS	Platform as a Service
PC	Personal Computer
PDA	Personal Digital Assistant
PDF	Portable Document Format
SaaS	Software as a Service
SQL	Structured Query Language
VM	Virtual Machine
Apps	Applications

1. INTRODUCTION

In today's world a huge quantity of data is produced every passing second. Most organizations realize the necessity of using this data as efficient as possible in order to gain competitive advantage by making both strategic and tactical decisions. Trying to make decisions based on just recording and making basic reports is not enough in order to even survive any more. The organizations expect to extend their marketplace need to record thousands of transactions, process data and make detailed and complex analysis, so the significance of data is increasing day by day. Data can be analyzed, customized, and visualized instantly thanks to business intelligence tools.

Cloud computing means using various services like software developments platforms, storage, software, and servers over the internet rather than a local server. Cloud technologies provide users an agile way to access business intelligence applications.

In this thesis, business intelligence and cloud computing concepts are explained in detail and advantages of using cloud computing for business intelligence are expressed in order to remove barriers in organizations' mind and enable them to understand benefits that will be gained from this association, which is called cloud business intelligence.

1.1. Purpose of the Study and the Problem Statement

The aim of the study is explaining the terms of business intelligence, cloud computing and cloud business intelligence in detail, which is the term emerged from the collaboration of business intelligence and cloud computing, including their architectures, components, and fields of usage. These technologies have been become so popular for recent years and they will continue staying current as long as the organizations need to manage businesses more efficient and profitable as they help managers to make decisions based on the data analyzed in an agile and user-friendly way. As these terms are almost new and there is a confusion in minds, it is necessary to explain these technologies and the relationships between them in a regular form. This research can help to internalize these technologies and their uses in addition to gain an insight for an efficient

management. In can also help the organizations to design a road based on the new developments. After reading the thesis, benefits of the collaboration of business intelligence and cloud computing will be understood and how a cloud business intelligence works in the organizations as a new trend in the technological world and how it is selected by using analytical hierarchical process. The application of selecting the best Cloud BI software in the last part of the thesis will help readers about the procedures and the methods while choosing a Cloud BI software.

1.2. Importance and the Originality of the Study

The terms business intelligence and cloud computing are considered buzzwords in recent years and lots of information pollution wanders around us about them. The originality of the study comes from being a regular and accurate compilation of technologies of business intelligence, cloud computing and cloud business intelligence. It is necessary to clean redundant and wrong information and come accurate information together in order to help the businesses, which have no or little experience about them before, in understanding and applying these technologies clearly. This research indicates how the businesses take advantage of using these applications in their current operations with technical aspects. In addition, this thesis will help organizations for transforming historical data to efficient decisions, evaluating the current situation, and gaining an insight for the future.

The originality of the research also comes from developing a decision support system by applying the common methodology to the field not applied before. By using analytical hierarchy process a cloud business intelligence solution was selected as an application.

2. BUSINESS INTELLIGENCE

Increasing competition with the globalization in business world forces companies to make faster and more efficient decisions by processing raw data. In this stage businesses need more complex analysis and reporting tools. Business intelligence applications get involved in the process in order to serve this purpose.

2.1. Definition of Business Intelligence

The author, (Vercellis, 2009, p. 3) defined business intelligence (BI) "as a set of mathematical models and analysis methodologies that exploit the available data to generate information and knowledge useful for complex decision-making processes."

BI creates value for organizations by using data or facts and increases capabilities of decision making for managerial processes like budgeting, planning and controlling. The fact-based decision making with the strong computer technology enable managers to direct in confidence.

2.2. History of Business Intelligence

Although business intelligence is a popular term in recent years, business intelligence concept dated in 1950s. According to the author, (Cebotarean, 2009, p. 1) "IBM researcher Hans Peter Luhn used the term business intelligence in 1958 and he defined intelligence as: the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal."

Business Intelligence term is actually evolved from decision support systems (DSS), beginning in 1960s and developing through the mid-80s. DSS is originated to assist making decision and planning. In the progress of time, technology is evolved to business intelligence, Online Analytical Processing (OLAP) and executive information systems (Cebotarean, 2009, p. 1).

The author (Cebotarean, 2009, p. 1) expressed, "In 1989 Howard Dresner (later a Gartner Group analyst) proposed business intelligence as an umbrella term to describe concepts and methods to improve business decision making by using fact-based support systems."

Finding new ways to process data and extract meanings was an obligation for organizations in order to be competitive and successful while the volume and the importance of raw data was increasing day by day.

In 2000s, the term business analytics was introduced as the key analytical component in business intelligence. In order to describe the data sets and analytical techniques in applications so complex and large, big data analytics have been used including advanced and unique data storage, management analysis and visualization technologies (Chen, Chiang, & Storey, 2012, p. 1166).

2.3. Why Business Intelligence

The continuously increase in demand for business intelligence generate the question why business intelligence is important. There are several reasons why most companies prefer to use business intelligence.

Using business intelligence provides several advantages containing increased profitability, improved customer relationship management, and decreased risks. Business intelligence can help managers to evaluate customer lifetime value and estimate short-term profitability expectations. According to financial consultants, for instance, 20% of accounts in a retail bank sector generate profit that is equal 200% of the overall return while more than half of the accounts generate losses. It is so important to obtain this information and take an action by utilizing several business intelligence tools. BI also supports to make decisions about decreasing costs. With the help of the extensive processing of data, operational costs or investments required to make sales can be decreased (Loshin, 2003, p. 2).

BI takes the aggregated customer information in order to improve customer service responsiveness, to increase customer loyalty, and to discover cross-sell and up-sell opportunities. Therefore, BI can help organizations to improve customer relationship management. In addition, in banking sector making credit risk analysis by using BI applications provides banks to take an action in respect to the results (Loshin, 2003, p. 2).

In recent years, the number of organizations that consider their data as a corporate asset increased incrementally, and they gave a great importance to collect and analyzing their data. Utilizing from BI efficiently can lead companies to discover knowledge that provides better insight of customer behavior and profile.

2.4. Business Intelligence Architecture

With the desire to enhance business value and succeed in its overall goal, many organizations search for new ways to obtain valuable insights from organizational data. Businesses can increase their insight-driven capabilities by investing the appropriate BI systems. In this way, they have more control over their data.

The architecture of a business intelligence system, as shown in Figure 1, includes three major components.

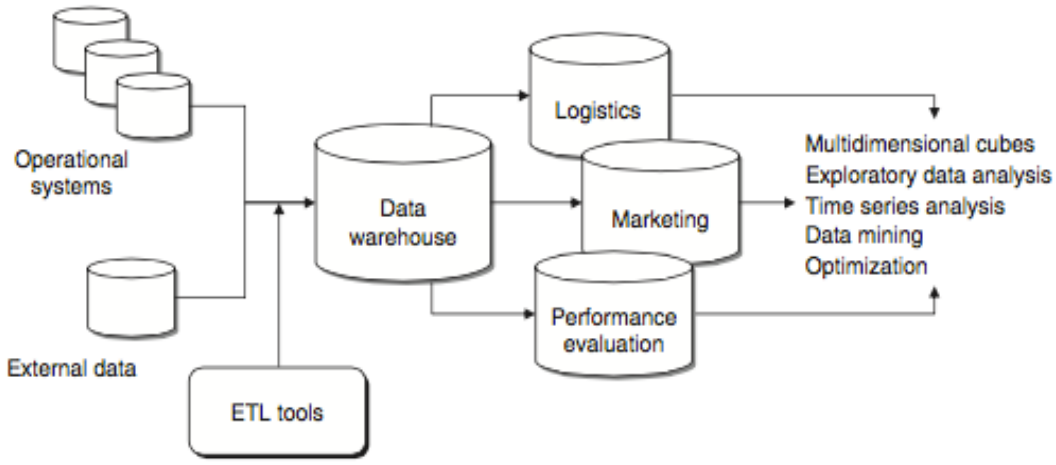

Figure 1. A Typical Business Intelligence Architecture (Vercellis, 2009, p. 9)

2.4.1. Data Sources

First stage comprises of collecting and integrating the data stored in a variety of internal and external sources of the organization. The data can be collected from the operational systems, or it can be unstructured documents like emails (Vercellis, 2009, p. 9).

2.4.1.1. Internal Data Sources

Internal data is the data from various operational systems located in the organization. For example, we can make a combination from internal data sources including customers, products, and re-purchases.

2.4.1.2. External Data Sources

Organizations can need to use external data sources in order to supply their data. The data coming from business partners or the internet are considered as external data sources, but validity and reliability of the data source is important for companies before using it.

2.4.2. Data Warehouse

Data warehouse is a type of database that is customized for making analysis-aimed queries on data. A data warehouse (DW) consists of both data from databases and the data from external sources including xls, csv and txt. DW is a structure of gathering and archiving of this data in order to be used for making periodical analysis, as shown in Figure 2.

Data warehouse is a type of operational database, but simpler one as it just responses the need of addressing reporting and decision-making. The data in the warehouse grows in meantime as more operational data is available. This data is extracted, transformed and loaded to the data warehouse, but the data in the warehouse is not updated unlike in the operational database (Maheshwari, 2015, p. 10).

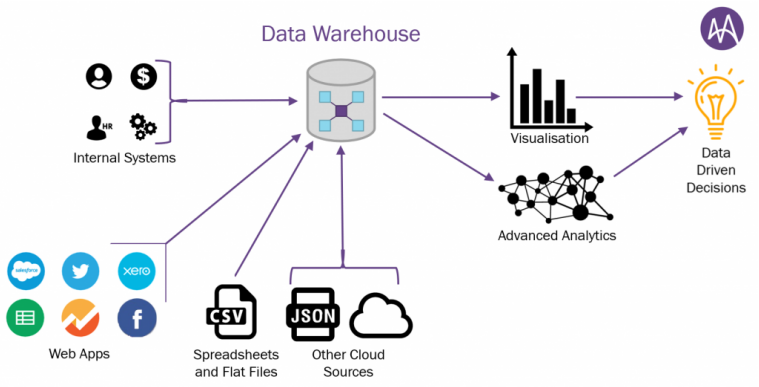

Figure 2. Components of Data Warehouse (Kautzner, 2017)

When the number of transactions closes millions or more, with a great number of attributes in each transaction, the data warehouse will be rich, so more detailed analysis can be made and meaningful patterns can be discovered successfully. Aggregating the data increases the speed of analysis. If a separate data warehouse is generated, analysis can be made in parallel without burdening the operational database systems (Maheshwari, 2015, p. 10).

It is necessary to explain the differences between database and data warehouse for better understanding as shown in the Table 1. First of all, data in database can be used for many purposes, whereas the data in warehouse is cleansed and prepared for making analysis and reporting. Secondly, the data in database is high granular as it contains all activity and transaction details while the data in warehouse is gathered for the interest, so it is lower granular.

Table 1

Comparing Database Systems and Data Warehousing Systems

Function	Database	Data Warehouse
Purpose	Data stored in databases can be used for many purposes including day to day operations	Data in data warehouses is cleaned data, which is useful for reporting and analysis
Granularity	Highly granular data including all activity and transaction details	Lower granularity data; rolled up to certain key dimensions of interest
Complexity	Highly complex with dozens or hundreds of data files, linked through common data fields	Typically organized around a large fact tables, and many lookup tables
Size	Databases grows with growing volumes of activity and transactions. Old completed transactions are deleted to reduce size	Grows as data from operational databases is rolled up and appended every day. Data is retained for long-term trend analyses.
Architectural Choices	Relational and object-oriented, databases	Star schema or Snowflake schema
Data Access Mechanisms	Primarily through high –level languages such as SQL. Traditional programming access database through Open Database Connectivity Interfaces (ODBC)	Accessed through SQL;SQL output is forwarded to reporting tools and data visualization tools

Note. Taken from (Maheshwari, 2015, p. 12)

Thirdly, databases are highly complex as they include large number of data files, whereas warehouses are organized around fact tables and many look up tables. As for the size, databases are growing with increasing volumes of activity and transactions while the warehouse grows as data from operational databases is rolled up and appended every day.

Databases can be relational or object-oriented while star schema and snowflake schema are accepted as architectural choices in data warehouse. Data access mechanism in database is primarily through high-level languages such as structured query language (SQL). Traditional programming has access database through Open Database Connectivity interfaces, whereas in data warehouse it is through SQL, whose output is forwarded to reporting and data visualization tools.

2.4.2.1. Data Warehouse Architecture

2.4.2.1.1. Data Quality

While starting to design a data warehouse, we face data from multiple sources and usually in different formats. In order to obtain accurate analysis results, data quality is so important. Data integrity is the one, affects the data quality, whose problems, causes, and remedies are shown in Table 2.

Table 2

Data Integrity: Problems, Causes and Remedies

Problem	Cause	Remedy
Incorrect data	data collected without due care data entered incorrectly uncontrolled modification of data	systematic checking of input data data entry automation implementation of a safety program for access and modifications
Data not updated	data collection does not match user needs	timely updating and collection of data retrieval of updated data from the web
Missing data	failure to collect the required data	identification of data needed via preliminary analysis and estimation of missing data

Note. Taken from (Vercellis, 2009, p. 50)

There are several factors which can also affect data quality including accuracy, completeness, consistency, timeliness, non-redundancy, relevance, interpretability, accessibility.

In order to be accurate, for instance, names and encoding are properly represented and values are within acceptable ranges. The data should not contain a great number of missing values. Completeness may harm the results of analysis even some data mining techniques can be capable of minimizing the effects of incompleteness in the data. The form of the data like currency or measurement units should be consistent through the different data sources after the integration. In addition, the data must be updated constantly, based on the objectives. Data redundancy and repetition should also be avoided in order not to waste memory and to prevent inconsistencies. In order to be sure that the data is relevant for our purposes of business intelligence system. Lastly, data stored should be accessible by decision support applications and analysts (Vercellis, 2009, p. 51).

2.4.2.1.2. Metadata

Metadata are data about data, which defines warehouse objects when used in a data warehouse. Metadata are constituted from the data names and definitions of the warehouse (Han, Kamber, & Pei, 2012, p. 134). The author defines it as follows: “Additional metadata are created and captured for timestamping any extracted data, the source of the extracted data, and missing fields that have been added by data cleaning or integration processes.” (Han, Kamber, & Pei, 2012, p. 134).

A metadata repository should contain many features including a description of the data warehouse structure containing the warehouse schema, dimensions, view, hierarchies, and derived data definitions, locations, and contents. The author (Han, Kamber, & Pei, 2012, p. 134) indicates the importance of metadata in his book as follows:

"Metadata are used as a directory to help the decision support system analyst locate the contents of the data warehouse, and as a guide to the data mapping when data are transformed from the operational environment to the data warehouse environment. Metadata also serve as a guide to the algorithms used for summarization between the current detailed data and the lightly summarized data. Metadata should be stored and managed persistently (i.e., on disk)."

2.4.2.1.3. Data Mart

A data mart is a basic form of a data warehouse, which focuses on a single subject, so the users draw data from restricted number of sources like finance, marketing, or sales.

Data marts are constantly formed and controlled by a single department in the organization. The sources may be an external data, internal operational systems, or a central data warehouse. Data marts usually cover only subset of the data in the data warehouse. They are easier and faster to be implemented (Bently, 2017, p. 137). In order to have better understanding it is important to know the differences between a data mart and a data warehouse, as shown in the Table 3.

Table 3

Difference Between Data Warehouse and Data Mart

Data Warehouse	Data Mart
enterprise-wide data	department-wide data
multiple subject areas	single subject area
difficult to build	easy to build
takes more time to build	less time to build
larger memory	limited memory

Note. Taken from (Bently, 2017, p. 130)

2.4.2.1.4. ETL Tools

Extract, transform and load (ETL) procedure includes the process of extracting data from sources, transforming data to the intended structure and loading this data to the warehouse.

Decisions about which data will be extracted should be made in the extracting process. While making these decisions, the structures of current data sources is researched, and these are correlated with the data warehouse model designed. The formats of the sources can be different including hypertext markup language (HTML), ms-word, portable document format (PDF) etc. The procedure of extracting data from each of sources will be different. In the transforming process data is transformed into the structure planned to be placed in the data warehouse model. This stage contains several techniques including data cleansing, parsing, correcting, standardizing, matching and consolidating. Loading is the process of loading data, which is prepared and cleaned, to the warehouse tables (Çağıltay, 2010, p. 123).

With the help of extracting, transforming, and loading stages, data will be available for detailed analysis. If the sensitivity of completing ETL process properly increases, the results of the analysis by using this data will be more accurate.

2.4.2.1.5. OLAP

The competitive business environment enforces the managers for effective information systems to make complex queries with a rapid response time. Thanks to On Line Analytical Processing (OLAP), analysts can examine and manipulate a huge amount of detailed data from various perspectives. Roll-up (consolidation), drill down, slicing &dicing are the basic analytical operations in OLAP.

The author , (O'Brien & Marakas, 2011, p. 401) defines OLAP as follows:

"OLAP involves analyzing complex relationships among thousands or even millions of data items stored in data marts, data warehouses, and other multidimensional databases to discover patterns, trends, and exception conditions. An OLAP session takes place online in real time, with rapid responses to a manager's or analyst's queries, so that the analytical or decision-making process is undisturbed."

OLAP may contain the use of specialized servers and multidimensional databases. Online analytical processing enables analysts, who use traditional and web-enable OLAP software, to get fast answers to complex queries as shown in Figure 3.

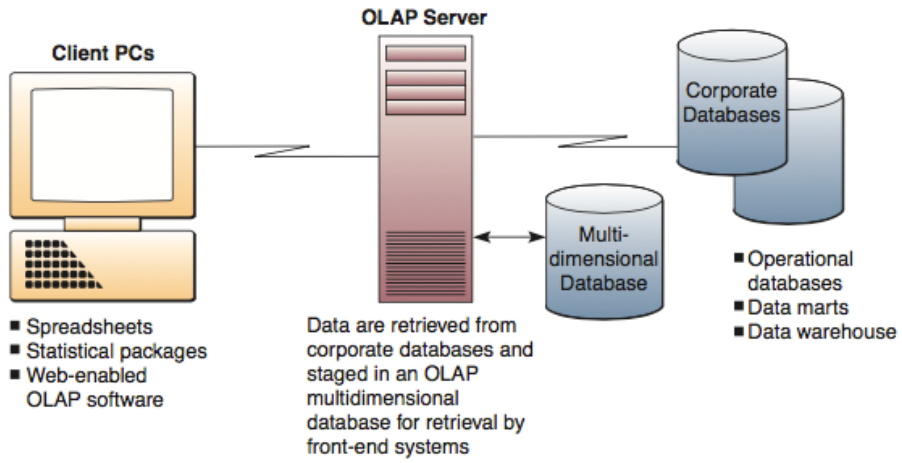

Figure 3. OLAP Architecture (O'Brien & Marakas, 2011, p. 402)

OLAP provides users to view the data with different filters and orders. For instance, a user can view the number of sales of a store for a particular period of time, while he can also view the number of purchases for a particular item in his store with OLAP.

2.4.2.1.6. Virtualization

Organizations have tried to overcome the silos by copying data from different operational systems to centralized data storage like data warehouse and data lakes for many years in order to analyze them. Thanks to data virtualization, lots of data can be queried without any need of copying the data and matching them. Therefore, the costs will decrease (IBM, 2020).

The author defines data virtualization, "as a technology, abstracts data such that the source of individual aspects of the data whether databases, fields, etc. are presented on a common data access layer and the end client is blind to the source. This allows a single methodology for data access regardless of how or where the data is stored (Scroggins, 2017, p. 3)."

Data virtualization allows to retrieve and manipulate data without any need of having details of data like the format and location. This is so important when data is presented from many multiple sources. In addition, it is also substantial for data integration. In contrast to ETL method, with the help of data virtualization layer, a user can access data with no requirement for the data to move anywhere (Scroggins, 2017, p. 11).

2.5. Knowledge Discovery

Some people regard data mining as a synonym for knowledge discovery from data while others think that data mining is an essential step in the knowledge discovery process. Actually, the second view is more appropriate in my opinion. Therefore, I treat data mining as a step in the knowledge discovery process while explaining the steps of knowledge discovery. Knowledge discovery process consists of seven steps, as shown in the Figure 4.

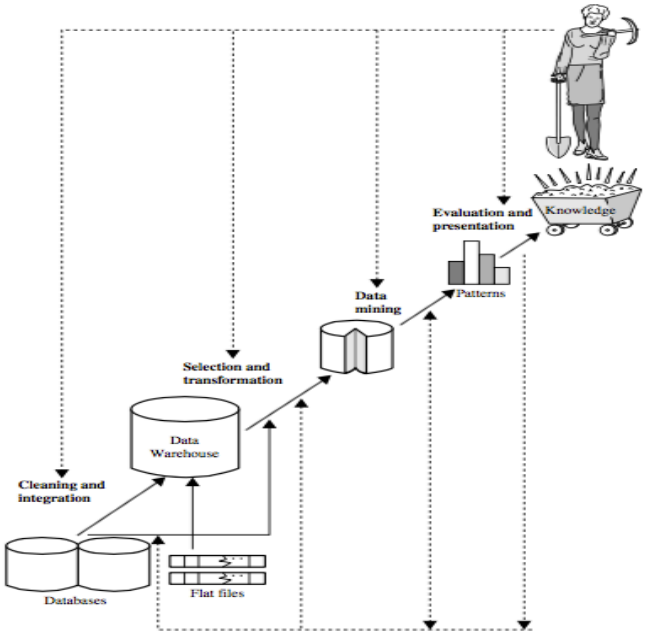

Figure 4. Knowledge Discovery Steps (Han, Kamber, & Pei, 2012, p. 7)

Data cleaning is the first step used to remove noise and inconsistent data. Multiple data sources are combined in the step of data integration. Appropriate data forms for mining by transforming and consolidating data are provided in the process of data transformation. Data mining is the process in which several intelligent methods are applied to extract data patterns. Interesting patterns are identified in pattern evaluation step. Lastly, in knowledge presentation step, visualization and knowledge representation techniques are used to present mined knowledge to users (Han, Kamber, & Pei, 2012, p. 7).

2.5.1.1. Data Mining

We are surrounded by a huge amount of data including scientific data, marketing data, financial data and so forth. Human attention is accepted as a substantial source in today's world. Therefore, we need systems to analyze, classify, summarize the data, and discover trends in it automatically. Data mining satisfies the need by applying several techniques on data.

The author (Maheshwari, 2015, p. 45) defined data mining as:

"The art and science of discovering knowledge, insights, and patterns in data. It is the act of extracting useful patterns from an organized collection of data. Patterns must be valid, novel, potentially useful, and understandable. The

implicit assumption is that data about the past can reveal patterns of activity that can be projected into the future."

2.5.1.2. Data Mining Techniques

In order to obtain knowledge, several data mining techniques should be applied to the data the organizations have. These techniques, including association rule mining, cluster analysis, decision-trees, artificial neural network, regression as shown in Table 4, are used to turn data into actionable insights.

Table 4

Important Data Mining Techniques

<table>
<tr><td colspan="3">Important Data Mining Techniques</td></tr>
<tr><td rowspan="3">Supervised Learning: Classification</td><td rowspan="2">Machine Learning Techniques</td><td>Decision Trees Techniques</td></tr>
<tr><td>Artificial Neural Networks</td></tr>
<tr><td>Statistical Techniques</td><td>Regression</td></tr>
<tr><td rowspan="2">Unsupervised Learning: Exploration</td><td rowspan="2">Machine Learning Techniques</td><td>Cluster Analysis</td></tr>
<tr><td>Association Rule Mining</td></tr>
</table>

Note. Taken from (Maheshwari, 2015, p. 52)

2.5.1.2.1. Association Rule

The association rule, as a well-known data mining technique, is mostly used among e-commerce sectors. Finch, (Finch, 2017, p. 59), in his book defined association rule as follows: "This technique discovers a pattern based on the data regarding relationships between data items in the same transaction. Association rules are mostly used in markets to predict strengths of relationships among items using predetermined rules."

Regular patterns and recurrences are identified within a huge set of transactions in this method. They are mostly simple and are often used to investigate navigation paths within websites and sales transactions in market basket analysis (Vercellis, 2009, p. 277).

2.5.1.2.2. Cluster Analysis

Cluster analysis is a kind of explorative analysis. The author, (Vercellis, 2009, p. 294), explains clustering and its aim as follows:

"The aim of clustering models is to subdivide the records of a dataset into homogeneous groups of observations, called clusters, so that observations belonging to one group are similar to one another and dissimilar from observations included in other groups. Grouping objects by affinity is a typical reasoning pattern applied by the human brain."

Cluster analysis is a type of explorative analysis taking a large collection of objects and then dividing them into smaller groups of objects that exhibit some similarity. When the organizations want to perform some kind of segmentation, but they are not really sure what they are looking for, clustering will be useful (Loshin, 2003, p. 210).

Clustering can be used for many purposes. For example, by the way of grouping customers based on their purchases can enable managers to address specific promotional actions to the corresponding market niche. In addition, making clustering is useful in order to find out outliers for reducing the dataset size.

2.5.1.2.3. Regression

Regression, as the most popular statistical data mining technique, whose objective is to find the well-defined curve for a dependent variable, models the predictive relationship between one dependent variable and many independent variables (Maheshwari, 2015, p. 77).

An organization may want to form a relation between price changes and the number of advertising activities. Marketing researchers and data scientists make use of such information in order to eliminate and evaluate best sets of variables for increasing the performance of the organization (Finch, 2017, p. 61).

2.5.1.2.4. Decision Tree

The author, (Loshin, 2003, p. 214), defines decision tree as: "A completed decision tree is a tree where each node represents a question and the decision as to which path to take from that node is dependent on the answer to the question." For instance, we may have a decision tree where one internal node asks whether the age of employee is greater than 45. If the answer is yes, the left-hand path is taken, but if the answer is no, the right-hand path is taken.

In decision tree, you move along the way in respect to the answers given. Each node represents a set of record which is represented by a question segmented that subdivides the current set into two smaller segments.

2.5.1.2.5. Artificial Neural Network

There are some problems which cannot be formulated as an algorithm. For instance, the price of a land in a particular place cannot be calculated by a computer without an algorithm, which is calculated by a human brain whose neural structure has been an inspiration to artificial neural networks.

The author, (Kohli, Miglani, & Rapariya, 2014, p. 745) make a statement about artificial neural network as follows:

"Computers have trouble recognizing even simple patterns much less generalizing those patterns of the past into actions of the future. Intelligence is the ability to think, to imagine, creating, memorizing, and understanding, recognizing patterns, making choices, adapting to change and learn from experience. This is the branch of computer science concerned with making computers behave like humans. Hence it is called as Artificial Intelligence."

2.6. Business Intelligence Reporting

Reporting is one of the most interactive parts among BI services as this feature allows users to realize the relationships analyzed by many analytics methods. There are many tools for reporting offered by different providers, but dashboard is the common feature frequently applied.

A dashboard provides an overview of the different features in the organization's BI. The dashboard means a personalized user interface that can be modified by the user and it contains many insights which are frequently needed. For instance, a sales manager sees the sales performance of her sales team by logging into her account every day (Froze, 2017, p. 47).

A user can visualize and analyze the data thanks to the dashboards. In addition to this, in order to track the organization's key performance indicators, a user can create insightful dashboards and share them with others who need it in the organization. The reports created can also be viewed on mobiles devices.

2.7. Trends and Future of BI

Big data technology will be the primary focus for companies. Analyzing big data and trying to make insightful predictions will stay as the most important concern. Therefore, new technologies can be developed in order to ease and accelerate this process.

Natural Language Processing including speech recognition, machine translation, semantic search will be smarter and more useful. The importance given to Data Governance and Data Quality Management will also increase as it helps data standardization which is necessary for getting accurate results of analysis.

Demand for mobile business intelligence will increase as it makes possible to response quickly to events when they happen. New technologies will be developed in order to empower the cloud security. Therefore, most companies will give up traditional storage methods and start to take advantage of cloud computing. Using artificial intelligence will continue to spread out and

companies will make more investments in this technology ever than before. It will ease our lives despite of its intervention to our privacy.

Embedded Analytics, which integrate analytical capabilities into business applications, websites, and products, will gain more importance as it provides relevant data and insights without switching and slowing down the system. Companies will take more advantage from Self Service BI as it enables end users to access the information directly without any involvement of IT team.

As time passed, companies will try to new ways to reach new customers, increase their sales and be competitive in their industry. Most institutions have started to reap the fruits of artificial intelligence, which enables to track activities of people and use it to offer new products and services.

3. CLOUD COMPUTING

In recent years most companies want to succeed in their business operations and corporate growth establish the necessary IT infrastructure and collect and process large amounts of data. However, if the system of the organization does not use shared resources, the data increasing incrementally day by day will be overwhelming. Cloud computing (CC) provides a solution for the need of a high-performance system with lower using cost.

3.1. Cloud Computing Definition

The author (Furht & Escalante, 2010, p. 3), defines cloud computing as follows:

"Cloud computing can be defined as a new style of computing in which dynamically scalable and often virtualized resources are provided as a services over the Internet. Cloud computing has become a significant technology trend, and many experts expect that cloud computing will reshape information technology (IT) processes and the IT marketplace."

The CC technology makes people to use various devices, like laptops, smartphones, personal computers (PCs) and personal digital assistants (PDAs) to access programs, application development platforms and storage over the internet with the help of the services offered by CC providers.

The author (The Art of Service, 2008, p. 6) defines cloud as follows:

"The origins of the term cloud can be traced to the concealing nature of this technology's framework; the system works for users, yet they really have no idea the inherent complexities that the system utilizes. What they do not realize is that there is a massive amount of data being pushed globally in real time to make these applications work for them, the scale of which is simply amazing."

3.2. Brief History of Cloud Computing

Although the term cloud computing became prominent in 1997 by the professor Ramnath Chellappa from University of Texas, the concept of "time sharing" in which multiple users can share access to data and CPU time was accepted as the premise of cloud computing in 1950s. Then, Advanced Research Projects Agency Network (ARPANET) was developed in 1969 that was the network which became the basis of the internet. IBM released a virtual machine (VM) which was an operating system allowing admins to have multiple virtual machines(VMs) or virtual systems on a single physical node (Pal, 2016, p. 101).

The arrival of salesforce.com in 1999 was one of the first milestones in the history of cloud computing. It was the first company that procured enterprise applications by the way of a simple website. Next development came from Amazon that launched Amazon Web Services (AWS) in 2002 which provided cloud-based services. Amazon continued its innovative working, and it launched its Elastic Compute Cloud (EC2) as a commercial website in 2006 that allows individuals and small companies to rent computers on which to run their own computer applications. With the launch of Web 2.0, Google and other companies started to offer browser-based applications like Google Apps (Pal, 2016, p. 101).

This decade witnessed major cloud technology improvements. In 2008 Open Nebula introduced an open-source software for deploying public and private clouds. Rackspace also launched an open-source cloud software, Open Stack, in 2008. Companies such as IBM, Microsoft, Oracle, and Amazon also came out with their own Cloud products and services (Dey, 2015).

3.3. Cloud Computing Architecture

3.3.1. Actors in Cloud Computing

There are some actors that have important duties and responsibilities in cloud computing (CC) including cloud consumer, cloud auditor, cloud provider, cloud broker, cloud carrier.

The cloud consumer is a client, a user or an organization carrying on a business relationship and using the cloud services provided by his/her cloud

provider. The cloud auditor is accepted as a party conducting autonomous appraisal of data framework operations, cloud administrations, performance and security of the cloud computing applications. The cloud provider is a company, an institution or any other agent being responsible for access to cloud computing service. Cloud Broker is an organization that manages the relationships between the cloud consumer and the cloud provider in terms of usage, performance, and the distribution of cloud services. A cloud carrier is an organization providing network and transport of cloud services from cloud providers to cloud consumers. A cloud carrier transfers cloud services from a related person to the client (Turan, 2017, p. 82).

3.4. Characteristics of Cloud

High scalability, multi-sharing, agility, high availability, and reliability can be described as the characteristics of cloud solutions. High scalability enables the use of resources for a large pool of users who have different needs. While the organizations can enjoy a high availability for their solutions, cloud infrastructure provides reliability continuously adapted to the user needs. The agility characteristic provides a very short response time. The multi-sharing is the main characteristic of cloud that enables users to share resources (Tole, 2014, p. 50).

Cloud computing technology contains innovative improvements including the development of virtualization, increasing internet capacity and internet-based technologies. According to author, (Attaran, 2017, p. 116)

"The National Institute of Standards and Technology (NIST) describes the five characteristics of a cloud computing model, paraphrased below:

- On-demand self-service. Computing resources such as server time and network storage are obtained as needed without requiring human interaction with the service provider.

- Broad network access. Resources are available over the network and accessed through standard mechanisms (e.g., mobile phones, tablets, laptops, and workstations).

- Resource pooling. Resources are pooled to serve multiple consumers, with different physical and virtual resources dynamically assigned and reassigned according to demand.

- Rapid elasticity. Resources are elastically provisioned and released, sometimes automatically, to scale rapidly up and down with demand.

- Measured service. Systems use metering to automatically optimize resource use (e.g. storage, processing, bandwidth).”

3.5. Cloud Computing Service Models

The collection of services including Software-as-a Service (SaaS), Platform-as-a-Service (PaaS), Infrastructure-as-a-Service (IaaS), virtualization constitute cloud computing. Cloud computing can be presented as a layered cloud computing architecture, as shown in Figure 5.

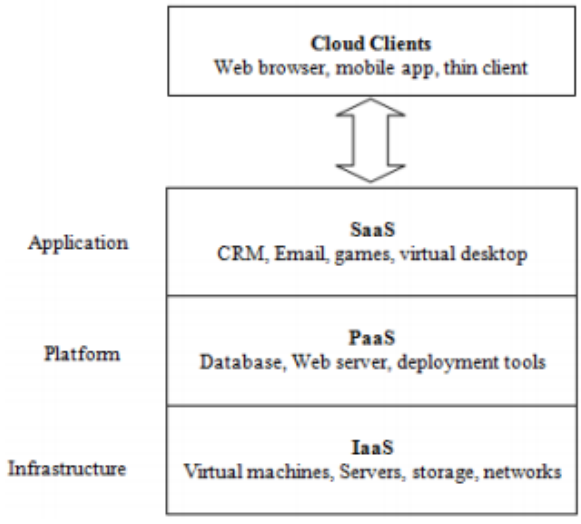

Figure 5. Cloud Computing Service Models (Pal, 2016, p. 102)

3.5.1. Software as a Service

This model offers clients a pay-per-use service and a fully configured solution (hardware and software). Clients have to pay a subscription fee in order to access the system. Providers take care of hardware, software, and maintenance for the clients. The SaaS provider enables the company to access a BI solution

with a monthly or yearly subscription pay (Tole, 2014, p. 51).

The software in traditional model is presented as a license-based product needed to be installed in the end user device. After SaaS is delivered as an on-demand service over the internet, the software installation process in devices is unnecessary. The user can access to SaaS services at any time with devices like laptops, tablets, and smartphones. Business services, social networks, mail services and document management are the services provided by a typical SaaS provider (Chandrasekaran, 2015, p. 83).

3.5.2. Platform as a Service

According to author, (Chandrasekaran, 2015, p. 77), "PaaS changes the way that the software is developed and deployed. In traditional application development, the application will be developed locally and will be hosted in the central location. Most of the applications developed by traditional development platforms result in a licensing-based software, whereas PaaS changes the application development from local machine to online."

PaaS provides a platform where a user can work on his own software and applications and develop new applications. It also provides the technological infrastructure and complement service needed. In addition to test and distribution services, it provides control and management over this infrastructure. However, the user does not have a right of control or management except for the application which is installed by him. In short, PaaS is being rented of structures including hardware, operating system, storage unit, and network capacity over the internet (Turan, 2017, p. 71).

3.5.3. Infrastructure as a Service

IaaS provides businesses to outsource all the computer hardware, software, operating systems, and support systems. With the help of IaaS companies do not need to invest in computer hardware and related staffing for security, upgrades and maintenance in technology and capacity (Gould, 2017, p. 49).

Businesses cannot control or manage the cloud infrastructure, but control over the networking components, operating systems, storage, and deployed applications when they use cloud infrastructure as a service (Turan, 2017, p. 71).

3.6. Cloud Computing Deployment Models

There are three types of cloud computing including public cloud, private cloud and hybrid cloud as shown in Figure 6.

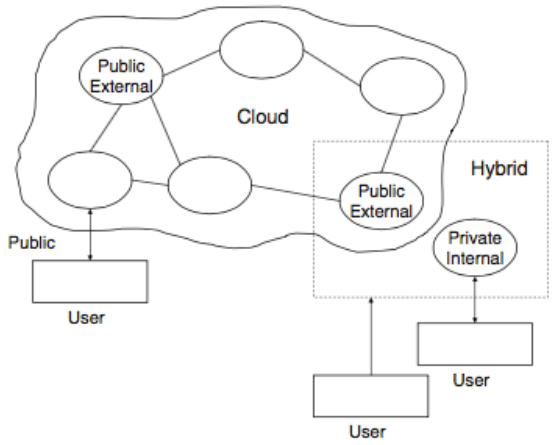

Figure 6. Types of Cloud Computing (Furht & Escalante, 2010, p. 7)

3.6.1. Public Cloud

Public cloud refers to the general cloud model. Its infrastructure is available for any organization, but it is owned and managed by a provider. Services of public cloud are sold on demand and customers pay for bandwidth, central processing unit (CPU) or the storage they consume. Amazon web services is the leading public cloud provider (Attaran, 2017, p. 6).

3.6.2. Private Cloud

In this model the cloud infrastructure is assigned to a single organization that contains lots of users. Private cloud infrastructure may authorize the organization for ownership, operation, and management. In addition, this authorization can be managed by a third party or a combination of a third party and the organization (Turan, 2017, p. 74).

The author, (Attaran, 2017, p. 6) explains the private cloud as: “It may exist on premise or off premise. Private clouds provide greater control over the cloud infrastructure and are often suitable for larger installations” (Attaran, 2017, p. 117).

3.6.3. Hybrid Cloud

According to Garcia, “Hybrid cloud is composed of public and private infrastructure. Typical aspects of applications running on a hybrid cloud is that they require more control over some services while needing bursting capabilities of the public cloud when needed” (Garcia, 2015, p. 20).

Public cloud is used for the applications where security and reliability is not much important while private cloud is used for conditions where the security and reliability is mainly important. Organizations using hybrid cloud usually accept the rule that public cloud is used for individual use whereas private cloud is used for corporate usage (Topaloğlu, 2017, p. 64).

3.6.4. Community Cloud

The author, (Attaran, 2017, p. 6), explains community cloud as “the shared cloud computing service environment that is available to a limited set of organizations or employees (such as banks or heads of trading firms). The members of the community generally share similar security, privacy, performance, and compliance requirements.”

3.7. Advantages of Cloud Computing

The advantages provided by cloud services can be listed below,

- Cost efficiency: The need of buying hardware and software licensing in traditional system increases costs a lot whereas the cloud system provides a pay-as-you-go model that lowers the company’s IT expenses significantly.
- Backup and Recovery: When a company uses cloud services, the service provider offers on-demand backups and faster recovery. When data is stored in the cloud, the service provider guarantees this data is

always available, even though its any or entire hardware system is damaged.

- Scalability: The need of a business can change over time. It can go downsizing or expand businesses. Cloud provides flexibility when the needs change. With respect to changing situations, suitable solutions are offered.
- Software integration: The software integration in cloud technology takes place automatically. That is, there is no extra effort for users to integrate the applications in the cloud.
- Easy access to information: The user registered in the cloud can access information at anytime from anywhere, as long as he has an internet connection. This characteristic provides users easy access to the system independently of time zone and geographical location.

3.8. Obstacles of Cloud Computing

There are main obstacles that can be met when using cloud services.

- Even if cloud providers offer a high security level with specific encryption, many companies keep worrying about their data as it is located on a shared infrastructure. They think that the precautions and security protocols are not enough.
- The fact that the provider can access the data and do what he wants with it is another security issue. Encrypting the sensitive data can be a solution so that the provider cannot read it.
- Businesses have to acquire a constant internet connection for cloud services, and the system does not work well with low-speed connections. High level connection essentials must be provided for effective use of cloud services.
- Although cloud service providers offer various packages for different needs and sizes, it may not be advantageous for small businesses to make an investment on cloud services because the system transition to the cloud and buying several features may cost more than predicted.

3.9. Popular Vendors of Cloud Computing

Nearly 80 providers carry on activities in cloud sector. Amazon Web Services, Microsoft and Google are leaders whereas Alibaba Cloud, Oracle, IBM, and Tencent Cloud are niche players in terms of ability to execute and completeness of vision as shown in Figure 7.

Figure 7. Magic Quadrant for Cloud Infrastructure and Platform Services (Amazon Web Services, 2020)

Microsoft carries on with cloud success through its deep involvement at all three layers of the cloud (IaaS, PaaS and SaaS) and its unmatched commitment to developing and helping customers deploy Artificial Intelligence (AI), Machine Learning (ML) and Blockchain in innovative production environments (Evans, 2017).

Amazon Web Services (AWS), which was the first to offer CC infrastructure as a service in 2008 (Wachsman, 2020), is Amazon's cloud web hosting platform that offers reliable, fast, cost-effective, and flexible solutions (Amazon, 2020).

IBM plays an active role in all three layers of the cloud including IaaS, PaaS, SaaS. Offering these services together are extremely important for elite cloud vendors due to the opportunity of giving customers more choices, better security, and more seamless integration. (Evans, 2017) The acquisition of Red Hat redefines the cloud market. Red Hat and IBM will accelerate innovation by the

way of offering a next generation hybrid multicloud platform. With the support of open-source technologies, the platform will enable businesses to securely deploy, manage and run data and applications on private, on premises and multiple public clouds (Armonk & Raleigh, 2019).

Oracle provides infrastructure as a service delivering on premises, high performance computing power. Oracle Cloud Infrastructure offers real time elasticity for applications by combining serverless compute, integrated security, and autonomous services of Oracle. However, the infrastructure is only available for public cloud (Oracle Cloud Infrastructure, 2021).

Although Alibaba is considered as a provider serving mostly to the companies in China, it has entered the foreign markets thanks to the partnership with Equinix, providing private data center interconnection access, whose platform has been extremely demanded by its enterprises who wants to go hybrid and multi-cloud (Dignan, 2021).

Google delivers an open, secure, and intelligent cloud platform through 15 global markets with the solutions including infrastructure modernization, smart business analytics, data management, artificial intelligence, and machine learning (Forbes, 2021).

Tencent Cloud offers a reliable, secure and high-performance cloud service. Tencent serving millions of people via its products such as QQ and WeChat is the largest internet company in Asia. Flexible pricing, user friendly structure and 24/7 online support let customers to select the service and use it with a peace of mind (Tencent, 2021).

3.10. Applications and Examples of Cloud Computing

3.10.1. Cloud Computing Applications

Cloud computing technologies play an active role in most industries. CC is an approach used in fields that efficiency and productivity is important. In education e-learning platform, that is often used worldwide, provides educational services which are scalable, reliable, and low cost in order to reach large mass.

There are some applications like Edu Cloud, Zoom for students, teachers and directors for sharing information each other actively and communication.

Health sector takes advantages of cloud computing by using health applications. Hospitals can reach the patients' information from their medicines to blood type by writing only their identity number. It is important for businesses and economy sector to use resources economical and efficient. Cloud computing takes this responsibility by providing fast reach to the information with the cost saving methods. The scope of scientific studies done by using cloud computing technologies is considerable extensive. Physical hardware usage decreases to a minimum level thanks to cloud computing technologies like especially virtualization systems.

3.10.2. Common Examples and Uses of Cloud Computing

Thanks to the scalable resources offered through many subscription models, users only pay for the resources they use. Netflix, for example, takes advantage of its on-demand streaming service. Moving in-house data centers to cloud provides the company to increase its customer without investing in setup and maintenance of infrastructure. Chatbots like Siri, Alexa and Google Assistant, which are cloud-based natural-language intelligent bots, strengthen the computing capabilities of the cloud in order to provide personalized context-relevant customer experiences (Newgenapps, 2020).

There are lots of calling and messaging applications including WhatsApp and Skype use cloud infrastructure. All messages are located in the hardware of service provider. That is, you can access your information from anywhere if you have an internet connection. Social Media is also the most popular application of cloud computing. Many social networking sites including Facebook, LinkedIn, Twitter are the examples of it. In addition, office tools including Google Docs and Microsoft Office 365 make use of cloud computing. The users can reach their documents and work on it from anywhere at any time. Even if their device is stolen or damaged, the data will not be lost. Cloud services also allow different users to work on the same document at the same time and share documents (Newgenapps, 2020).

Most business management applications including customer relationship management and enterprise resource planning are also based on cloud services. Salesforce is a popular example as a company taking advantage of SaaS.

Dropbox, Amazon S3, Google Drive are the examples that provide cloud backup solutions. They are responsible for securing your information. The users can enjoy large storage and on-demand backups thanks to cloud and recovery is faster as the data is stored over a network of physical servers. Cloud is also useful for developing an application for mobile and web. Amazon Lumberyard is a popular mobile game development tool. In addition, test and development is possible in the cloud environment. Blaze Meter and Load Storm are popular testing tools. Cloud services also let users at mining large amount of data by providing sophisticated tools and higher processing power. Hadoop and Cassandra are the examples of open-source big data tools using cloud infrastructure (Newgenapps, 2020).

4. CLOUD BUSINESS INTELLIGENCE

The data or the analysis was transferred to the user via internal networks traditionally, from a central platform to a PC. However, new technologies have been developed in recent years. With the explosion of tablets, smartphones and cloud solutions provided, the distribution of business intelligence to managers or other decision-makers has been changed incredibly.

Business intelligence and cloud computing are the terms complementing each other. The infrastructure of cloud makes accessing to the business intelligence applications agile with any device restrictions.

As time progressed, more data is available in the cloud as the number of organizations utilized from cloud is increasing day by day, so the popularity of Cloud BI or BI-as-a-service is multiplying.

4.1. Cloud Computing and Business Intelligence

The term, Cloud Business Intelligence (Cloud BI), is used to define the concept of delivering business intelligence capabilities as a service. In the competitive business world, managers need reliable and qualified insights driven by accurate data more than ever (Al-Aqrabi et al., 2020).

Cloud based business intelligence services are especially valuable when the user wants to access the data and analysis by using a smartphone or a tablet. Mobile BI provides data analysis in static reporting or interactive modes thanks to the capabilities of mobile devices such as natural language query, touchscreen, camera location awareness. It offers opportunities for targeting customers related to their current activities, and location as a part of broader interactive marketing campaign (DOMO, 2020).

4.2. Cloud BI Industry

Using Cloud BI is considered as a key factor for success in businesses. Nearly 66% of successful organizations in BI has already used cloud in 2018. When the characteristics of business intelligence and cloud are integrated successfully, these technologies can be used to strengthen each other’s advantages and

eliminate each other's weaknesses (Elmalah & Nasr, 2019).

According to author, (Rao, 2019, p. 4), "BARC research shows the adoption of cloud BI was 29% and it has risen to 43% in 2016. The survey results finding reveals that most of executives use BI tools on the premises of their jobs (54%) as compared to cloud–based BI tools (20%) or a mix of two (26%).The BARC research also shows that sentiment mean increased from 2.68 to 3.22 (above the level of important) between 2017 and 2018, this finds indicates that companies show more importance to cloud BI compared to last year."

4.3. Difference between Cloud BI and Traditional BI

The right combination of business intelligence and cloud computing helps businesses to provide right information to the right people in real-time. Cloud BI possesses properties including easy to use, install and maintain. Cloud based applications consume less time to setup, cost less and have the ability to share information with others. In addition, they provide opportunity of easy setup and maintain whereas traditional BI tools, are usually on premise, need more time to setup the application, design, develop and install. In addition to this, the traditional BI tools need expensive hardware, software, and experts to install and maintain it. The only advantage of using traditional BI is that the data is under your control and this feels some businesses safer and more comfortable (Rao, 2019, p. 4).

4.4. Advantages of Cloud BI

Institutions prefer to use Cloud Business Intelligence solutions as they offer many advantages as illustrated below.

- Cloud BI solutions have flexibility to be altered quickly to give technical users access to new data analysis and reporting features.
- Easy, fast and low-cost deployment are provided thanks to the lack of infrastructure set up. That means faster return on investment and because of lacking hardware and setup expenditure, cost of implementation is lower.

- Independence from maintenance and upgrade expenses enable companies to control over IT projects fiscally and flexibility provided by cloud enables institutions to scale up or down the usage.
- Users can access and share remote data because it is deployed via internet and outside a company's firewall.
- Low total cost of ownership and overall resource investment make Cloud BI a low-risk venture and it contains high reward potential.

4.5. Cloud BI Vendors

Cloud BI usage among organizations is gaining popularity day by day due to several factors including budget, volume of data, number of users, ease of use, business need etc. Cloud BI market became highly competitive and in order to gain the advantages institutions need to collaborate with service providers. There are several companies in this sector, but we will talk about some of well-established players that lead the market including Tableau, Power BI, SAP, and IBM.

4.5.1. Tableau

Tableau has a huge customer base across many industries thanks to its simplicity of use and ability of producing interactive visualizations far beyond those provided by general BI solutions. Tableau can handle the large and very fast changing data sets that are used in Big Data operations like machine learning applications and artificial intelligence with the help of the integration with advanced database solutions like AWS, SAP, Hadoop. Thanks to its extensive research and testing, Tableau can create efficient graphics and visualizations for users (Marr, 2017).

4.5.2. SAP Analytics Cloud

The innovative technology of SAP Analytics Cloud supports all levels of decision-making and intelligent use of cross-organizational data. (SAP, 2020) SAP Analytics Cloud is the first cloud solution that includes the ability to connect to on premise data sources. With the support of cloud-based data sources, the solution is attractive for businesses with complex data environments, especially

SAP BW, SAP BW/4HANA or SAP HANA (SAP, 2020).

4.5.3. Power BI

Thanks to the library of data connectors provided by Microsoft, users can access popular cloud and on-premise sources such as SharePoint, Azure SQL Database, Excel, Salesforce. This BI platform offers powerful, self-service analytical and enterprise BI tools driving better and faster decision making (Microsoft Azure, 2020).

Businesses can take advantage of creating reports which identify trends and key performance indicators moving your business forward by using the Power BI desktop as shown in the Figure 8 (Microsoft, 2020).

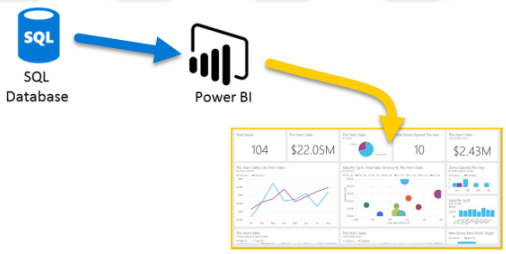

Figure 8. Creating Reports with Power BI (Microsoft, 2020)

4.5.4. IBM Cognos

Cognos Analytics offered by IBM corporation is an AI-fueled business intelligence platform which supports the entire analytics cycle from discovery to operationalization. With the help of this platform, the businesses can create effective dashboards and reports with AI recommendations that also help them to uncover the hidden patterns in the data (IBM, 2020).

Cognos Analytics on cloud enables users to develop dashboards, ad-hoc queries, interactive reports, view scheduled reports, , custom analysis and consume active reports via a web browser (IBM, 2019).

According to the company, (IBM, 2019), “This Cloud Service provides interactive OLAP exploration and allows you to create and format a wide variety of report types, including lists, cross tabs, charts, and financial statement style, and can be updated to the latest cloud version upon availability.” This cloud service also provides users to access the software via mobile devices including Android, Apple iPhone, and tablets (IBM, 2019).

5. SELECTION OF THE CLOUD BI SOLUTION

Every organization that wants to take advantage of the power of data should make detailed analysis based on their needs and objectives. Business intelligence solutions help organizations to transform the raw data to a meaningful information by making some analysis in order to shorten the process of decision making.

5.1. Company Description

We have a company, Sunorganic, established in Bodrum in Turkey that attaches a great importance to organic nutrition and life. Air pollution and the radiation around us is increasing day by day, so people are losing their health so fast both physically and psychologically. The enterprise went into action for decreasing the negative effects of this situation and increasing the quality of in terms of health. Therefore, the founder decided to establish the company on 4th January 2014. Sunorganic produces variety of soaps, balms, shampoos and detergents whose ingredients contain only organic herbal essences and oils.

In progress of time, people conscious about nutrition started to interest in the products and the company drummed up the business. Today the firm collaborates with thirty-seven vendors and sells products online. As for the structure of the organization, it compromises six departments including research & development, production, sales & marketing, human resources, finance & administration, and information technology with 37 employees.

5.2. Need for BI Solution

The company is assertive about their products. Lots of brands arisen claiming to contain organic ingredients and no harmful chemicals in recent years. While some of them produce qualified products, dishonesty of most brands becomes apparent day by day. Both the desire of introducing their beneficial products to the customer and wiping the poor-quality brands from the market enable the firm to go a step further. The company wants to grow business by managing the data and serving its customers in an efficient manner. It expects to predict customer behavior, so it can develop new marketing strategies, offer new

products, or promote some products based on the customer transactions. It can reduce costs and increase sales by evaluating reports that provide gaining an insight.

Employees in information technology department are responsible for network, technical support, and e-commerce infrastructure. The operational data is stored in excel tables, but it will not be enough for making detailed analysis and getting an insight from it, so the founder decided to make an investment in business intelligence software. In order to take advantage of independence from the place and the platform at small expense provided by cloud technology, the company decided to use cloud-based business intelligence software.

5.3. Research Questions

This research intends to select the best Cloud BI software by using multi-criteria decision making. In order to complete the project successfully many research questions need to be clarified, that will be comprehended at the end of the project, are shown in Table 5.

Table 5

Research Questions

Research Questions
Q1 - What are the criteria to select the best software?
Q2 - What should be the procedure for selecting the best software?
Q3 - Which is the best software offered by Cloud BI providers?

5.4. Method & Methodology

One of the best suitable methodology for multi-criteria decision making is analytical hierarchy process(AHP), which will be used for this thesis as a valuable technique for choosing the best software among alternatives. It is extensively used in making complex decisions for many years.

Analytical Hierarchy Process, developed by Thomas L. Saaty in 1970s, is a method for complex decision making where many variables are considered in the prioritization and selection of alternatives. An AHP process consists of three steps. It begins with structuring a problem that is decomposed into manageable sub-problems. That is, the objective is branched into a hierarchy of criteria. After the construction of logical hierarchy, the alternatives are assessed by making pair-wise comparisons for each selected criteria. The hierarchy of criteria and alternatives for a problem is shown in Figure 9 (Vargas, Ricardo, 2019).

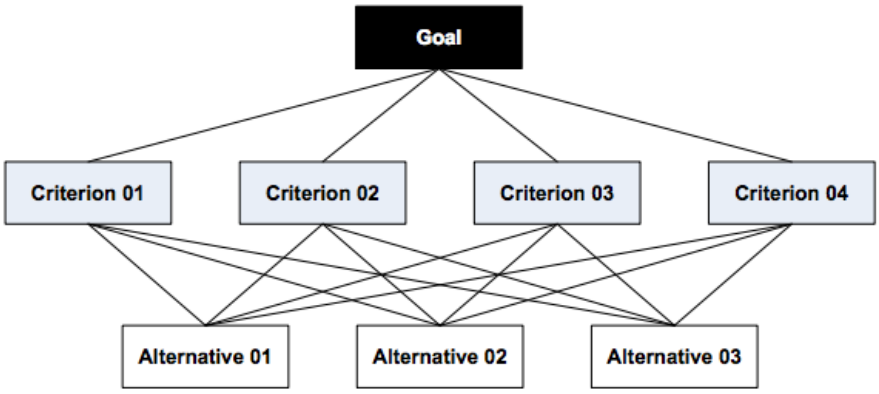

Figure 9. Example for a Hierarchy of Criteria and Objects (Vargas, Ricardo, 2019)

In order to make comparisons between elements Saaty's scale is widely used, which is the scale determining the relative importance of an alternative when compared to another by attributing values from one to nine as shown in Table 6.

Table 6

Saaty's Fundamental Scale

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak	
3	Moderate Importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong Importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated Importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is one of the highest possible order of affirmation
Reciprocals of above	If activity I has one of the above A nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with I	A reasonable assumption
Rationale	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

Note. Taken from (Saaty, 2000)

Decision makers determine the relative weights of the criteria by assigning a value from one and nine. The responsible person fills the related cells with the values from the numeric scale in the comparison matrix for the group of criteria. Pairwise comparisons of the decision maker are collected in a comparison matrix at each node of the hierarchy. Comparing two alternatives allows consistency and cross checking between the different pair-wise comparisons. In AHP a ratio scale is used that requires no units in the comparison. The judgment can be a relative value or a quotient a/b of two quantities where a and b have the same units such as intensity, meters, or utility. When making pairwise comparisons for each node of the hierarchy, it is necessary to determine whether the decision maker is consistent in their choices. For example, if he

confirms that A is more important than B, and that B is more important than C, it would be inconsistent to confirm that C is more important than A. According to Saaty, the matrix is considered consistent if the resulting ratio is less than 10% (Vargas, Ricardo, 2019).

After making pair-wise comparisons for alternatives in respect to each criteria, the input data are modified to get the results with the help of the software, which gives the overall synthesized priorities for the alternatives. If the decision maker wants to change the weights of the criteria, the graphical interface offered by the software allows the user to get new results within seconds (Ishizaka & Labib, 2009).

The AHP method provides many advantages like being possible to use quantitative and qualitative criteria, the ordered fashion of the decision making allowing a good traceability of the decision and the assurance given by the consistency indices (Egger, Wolfgang, & Manfred, 2017, p. 3).

In this thesis the software called “Expert Choice” will be used for analytical hierarchy process. The software makes the necessary calculations to reach the goal based on the hierarchy structured and prioritization between criteria. In order to determine the priorities between criteria a survey will be made whose questions will be answered by the experts working on the field of information technology. With the help of the software output, the decision will be made to reach the goal.

5.5. Using a Decision Support System

The company took a step for acquiring a BI system, but it should choose the right software that fits the company’ needs. In order to select the best solution for the company, the AHP (Analytic Hierarchy Process) software, “Expert Choice”, will be used to produce an output for easy decision making.

5.5.1. Determination of the Criteria and the Alternatives

There are many cloud-based BI providers in the market. After the long meetings, with the help of Magic Quadrant for Analytics and BI Platforms,

published by Gartner, four BI solutions were selected as alternatives that serve in high standards including Tableau, SAP Analytics Cloud, Power BI, and IBM Cognos. They are the most successful software in business intelligence market for years.

Microsoft and Tableau are considered as leaders by a long way as illustrated in Figure 10. They are succesfull providers in terms of completeness of vision and ability to execute. SAP is also so popular in Turkey in recent years. SAP has been in collaboration with businesses from all levels. SAP analytics Cloud as solid and stable platform provides powerful, agile analytics with an effective security. IBM is also a long-established company carrying out activities accomplishedly for many years in Turkey. It is one of the most valuable and widely esteemed brands. It is selected as the 18th most innovative company by Fast Company which is a monthly American business magazine focusing on technology, business, and design (Fast Company, 2021).

Figure 10. Gartner Magic Quadrant for Analytics and BI Platforms (Stellar Consulting, 2021)

5.5.2. Prioritization of the Criteria

Before prioritizing the criteria, I investigated the services in detail provided by BI software vendors. Capterra, the business reviews website is a valuable source for me whose members share their software experiences they used. This website whose reviews are verified provides scores for each criteria corresponds to each alternative. The real users of the software gave scores based on their satisfaction from the services of each product.

In order to prioritize the criteria, a survey was made. Points were given to each criteria by respondents, who are experts in information technology sector. The averages of the points are shown in Table 7.

Table 7

Averages of the Survey Points

Criteria	**Average Points**
Features & Functionality	91,8
Ease of Use	70,8
Training & Support	70,6
Price	69,0
Customer Service	68,6

Features & functionality was selected as the most important criteria. As the main purpose of acquiring a BI solution is gaining more information from data, obtained from several analysis and other steps, and use this for decision making, the features have to be functional and practical as much as possible. The second one is -ease of use- which is necessary for the system to be user friendly. Training & Support is the third, which has to be so helpful as the system is new and the users will need more help for understanding the technology and its usage. Price is the fourth one where customer service is the last.

5.5.3. Comparing Relative Importance

According to the prioritization, the values defined were placed in related fields in the AHP software in order to observe the relative importance between criteria as shown in Table 7. “Features & functionality” is the most important criteria where “ease of use” is on the second rank. The third one is “training & support”, and it is followed by “price” and “customer service”. The points were given to these criteria based on the points given in the survey.

Figure 11, created in Expert Choice, indicates that “features & functionality” is slightly more important than “ease of use”. It is also strongly important than “price” which has approximately equal importance with “customer service”.

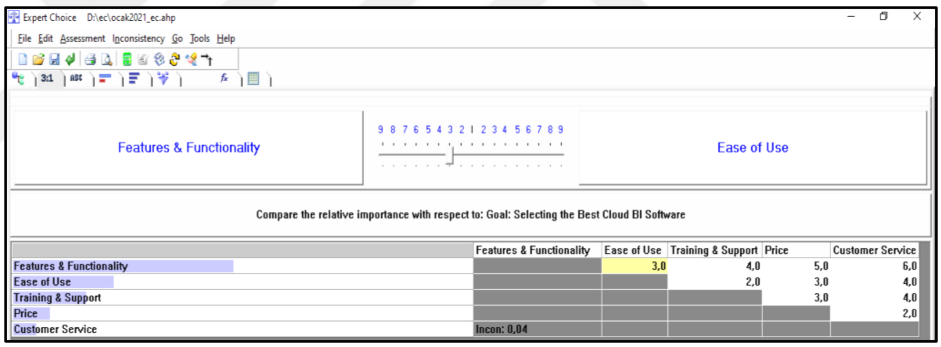

Figure 11. Relative Importance with Respect to Goal

5.5.4. Criteria Information

Making criteria information clear is necessary as the points will be placed in related cells according to this information.

- Features & Functionality should be as good as possible.
- Customer Service should be as good as possible.
- Ease of use should be as much as possible.
- Price should be as low as possible.
- Support &Training should be as good as possible.

5.5.5. Data Matrix

The scores of three criteria including “features & functionality”, “ease of use” and “customer service” obtained from the Capterra (Capterra, 2020), business reviews website. The criteria of “training & support” was scored in accordance with the quality and the diversity of the services provided by alternatives and the “prices” were obtained from the official web sites of each provider. All scores are illustrated in Table 8.

Table 8

Data Matrix

	Tableau	**Power BI Pro**	**IBM Cognos**	**SAP Analytics Cloud**
Features & Functionality	4,5	4,4	4,1	4
Training & support	4,5	3,5	4,5	4
Customer Service	4,2	4,1	3,7	4,2
Ease of Use	4	4	3,8	3,8
Price(dollar/month)	70	9,99	40	35,4

5.5.5.1. Features & Functionality Matrix

According to the reviews, data related to “features & functionality” of selected providers are shown in Table 9.

Table 9

Points for Features & Functionality

Features & Functionality	Tableau	Power BI Pro	IBM	SAP
	4,5	4,4	4,1	4

When the data is evaluated, Tableau is 1,02 times more advantageous than Power BI. Tableau is also 1,09 times more functional than SAP. The value of inconsistency ratio should be smaller than 0,1, therefore there is no conflict in comparing criteria between each other as the ratio is 0 as shown in Figure 12.

Figure 12. Relative Importance with Respect to Features & Functionality

5.5.5.2. Training & Support Matrix

According to the training facilities illustrated in Table 10, as Tableau, SAP and IBM provide almost the same capabilities, they get 4 points as none of them is perfect. As documentation and webinars are not enough for the company in order to train the users, Power BI had 3 points.

Table 10

Training & Support Services of the Providers

	IBM Cognos	Power BI Pro	SAP Analytics Cloud	Tableau
Training	Documentation In person Webinars	Documentation Webinars	Documentation Webinars Live online	Live online In person
Support	24/7 (live rep)	Business Hours Online	Business Hours Online	7/24 (live rep) Online

As for the support of providers, IBM Cognos and Tableau took advantage of its 24/7 service, so they had 5 points while 4 points were given to others. Calculating the average of the points given to training and support individually for each provider gives us the values for the criteria of “training & support”, which are shown in Table 11.

Table 11

Points for Training & Support

Training & Support	Tableau	Power BI Pro	IBM	SAP
	4,5	3,5	4,5	4

As indicated in the Figure 13, Tableau is 1,28 times more advantageous than Power BI, whose ratio is calculated by dividing 4,5 to 3,5. Tableau and IBM offer the same satisfaction in terms of "training & support", which is 1,12 times more preferable than SAP.

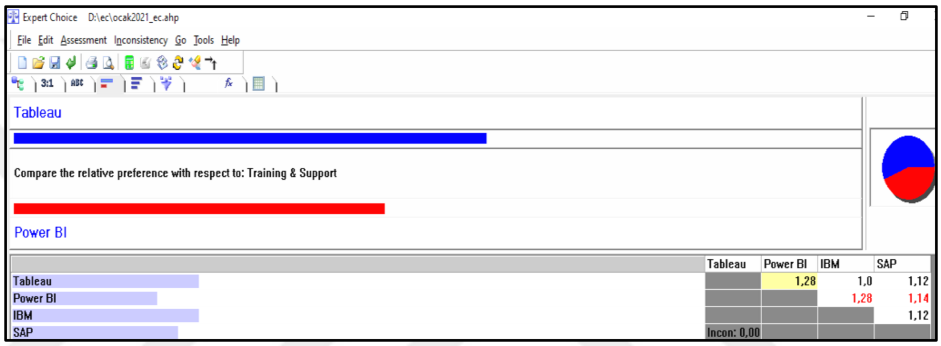

Figure 13. Relative Importance with Respect to Training & Support

SAP serves 1,14 times better than Power BI in "training & support". The reason for writing the value with red font is that when dividing 3,5 to 4, the result is less than 1. In this case, numerator and denominator should be reversed and the output should be red when placed into the related cell. In the same way, 1,28 in red means that IBM is 1,28 times more rewarding than Power BI. As the value of inconsistency ratio is smaller than 0,1, there is no problem with the table above.

5.5.5.3. Customer Service Matrix

After the values in Table 12 were calculated, they were placed into the corresponding cells in the AHP software.

Table 12

Points for Customer Service

Customer Service	Tableau	Power BI Pro	IBM	SAP
	4,2	4,1	3,7	4,2

Tableau has 1,02 times better customer service than Power BI whereas Tableau and SAP serve the same customer service quality. Power BI is 1,1 times more advantageous than IBM while SAP offers 1,02 times more satisfying service than Power BI. Lastly, SAP provides 1,13 times superior customer experience than IBM as illustrated in Figure 14.

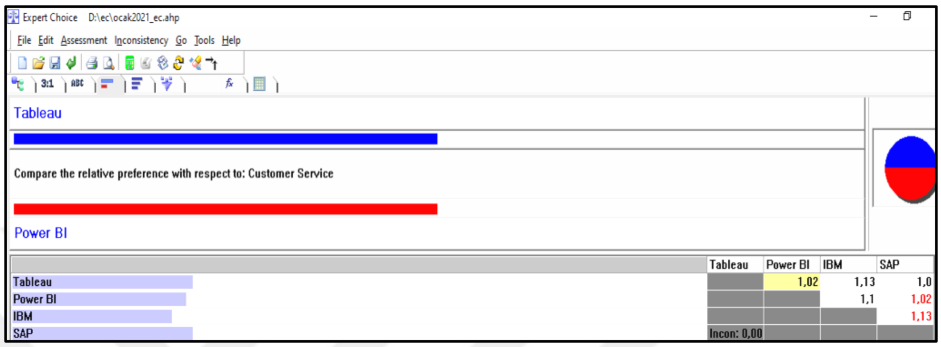

Figure 14. Relative Importance with Respect to Customer Service

5.5.5.4. Ease of Use Matrix

According to the real customers' reviews, the points related to ease of use for each provider are shown in Table 13.

Table 13

Points for Ease of Use

Ease of Use	Tableau	Power BI Pro	IBM	SAP
	4	4	3,8	3,8

When the data in Figure 15 is evaluated, Tableau and Power BI serve in the same manner in terms of "ease of use". Tableau and Power BI are 1,05 times more advantageous than IBM and SAP. IBM and SAP offer the same quality of service that is worse than Tableau and Power BI.

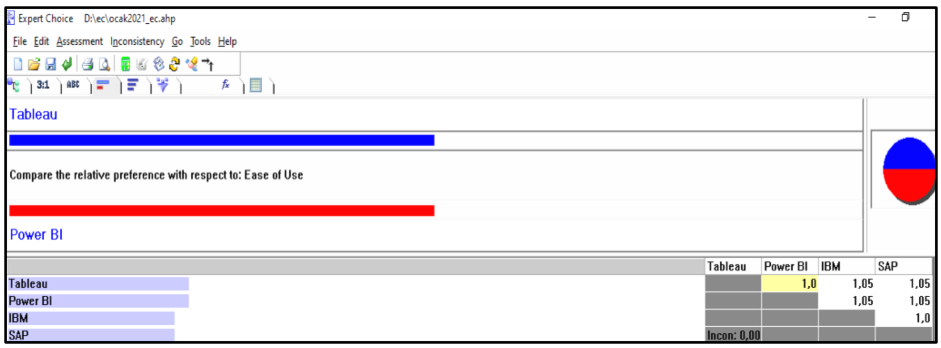

Figure 15. Relative Importance with Respect to Ease of Use

5.5.5.5. Price Matrix

The prices shown in Table 14 obtained from the providers' official web sites. They demand different prices for their cloud based BI solutions on a monthly basis. Tableau charges 70 dollars per user monthly (Tableau, 2020) whereas Power BI requests 9,99 dollars per user monthly (Microsoft Power BI, 2020).

IBM Cognos charges 40 dollars per user for a month (IBM, 2020) while SAP charges 30 euro per user monthly that corresponds to 35,4 dollar (SAP, 2020).

Table 14

The Prices of the Software Providers

Price (dollar)	Tableau	Power BI Pro	IBM	SAP
	70	9,99	40	35,4

When interpreted the Figure 16, Power BI is 7 times more profitable than Tableau. IBM is 1,75 times more economical than Tableau while SAP charges 1,97 times lower price than Tableau demands.

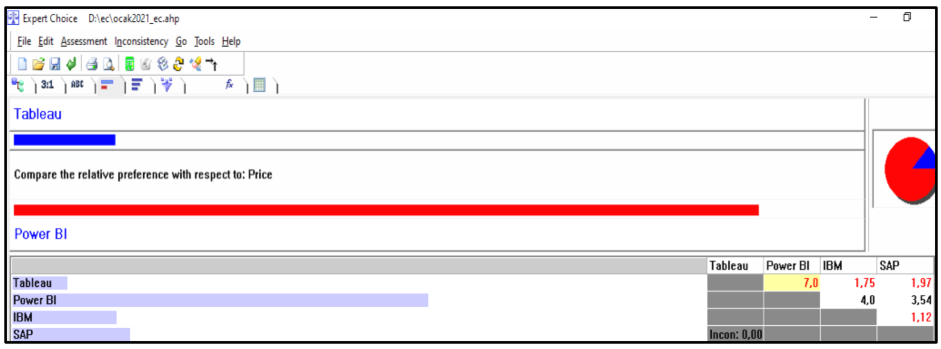

Figure 16. Relative Importance with Respect to Price

Power BI is 4 times more advantageous than IBM and 3,54 times more profitable than SAP while SAP charges more reasonable price than IBM does. The value of inconsistency ratio is 0.

5.5.6. Synthesis the Results

When the results are synthesized with respect to the goal, the percentages of each alternative shown in Figure 17 were produced. According to the output, the company should select the product of Power BI with the 26,1 %. It is the most appropriate software in terms of the criteria prioritized by the company including features & functionality, training & support, customer service, ease of use and price.

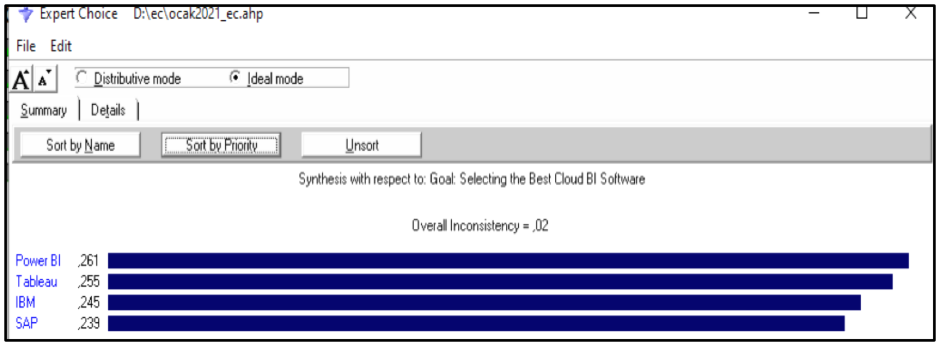

Figure 17. Synthesis the Result with Respect to Goal

Figure 18 shows the dynamic sensitivity for nodes, which shows the criteria, ordered by priorities on the left side, and the alternatives on the right side. If the weights of the criteria change, the result will also change. The software will automatically make a new calculation at the same time the user drags the relevant bar.

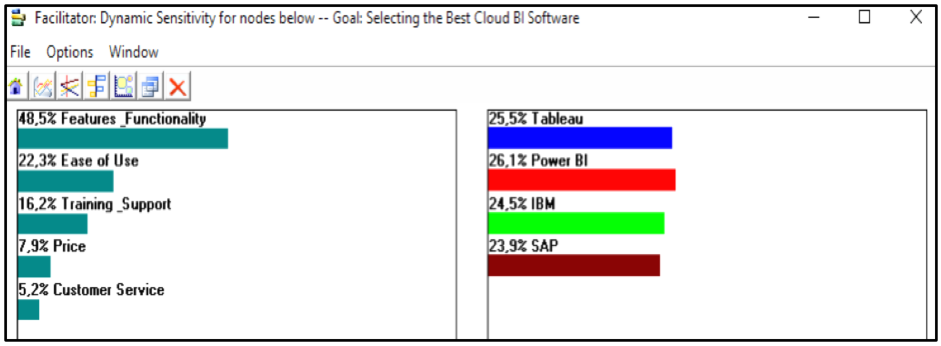

Figure 18. Dynamic Sensitivity for Nodes

"Features and functionality" is the criteria which has the greatest importance among other alternatives at present, but if the company still wants to increase the weight of the criteria much more, the result will remain the same as illustrated in Figure 19.

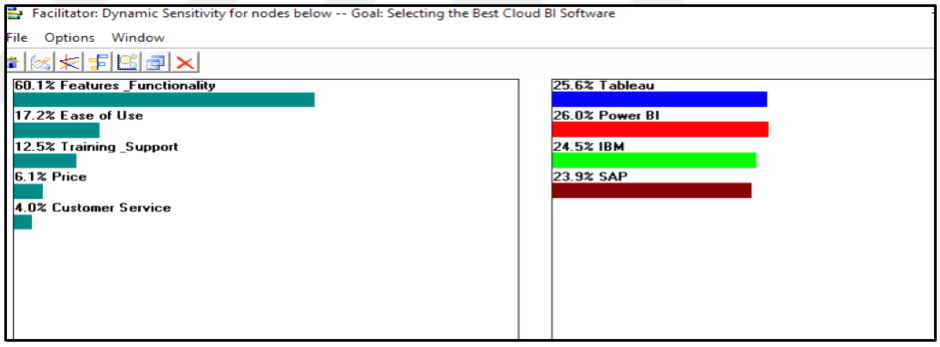

Figure 19. Dynamic Sensitivity with High Priority of Features and Functionality

If the need of "ease of use" becomes significant, when the weight for "ease of use" is increased considerably, the result will not change. Power BI will remain as the most appropriate alternative as illustrated in Figure 20.

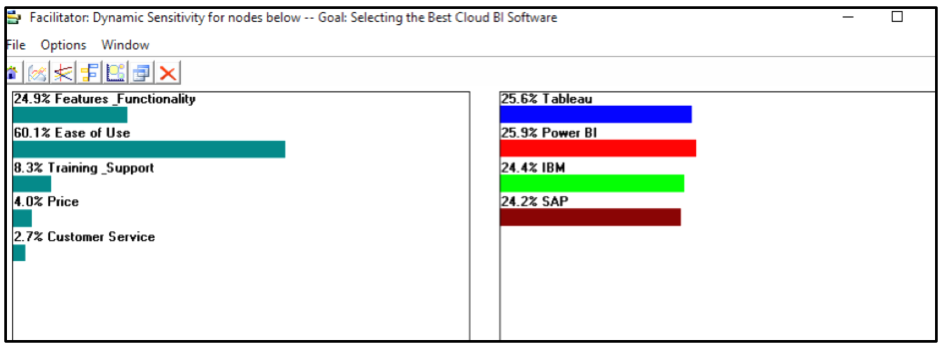

Figure 20. Dynamic Sensitivity with High Priority of Ease of Use

If "features and functionality" offered by all providers satisfy the needs, "training & support" may be the most important criteria for the firm, so it can see the new result by only pulling the "training & support" bar as much as it wants. When the priority given to "training & support" is increased, Tableau will be the winner as shown in Figure 20.

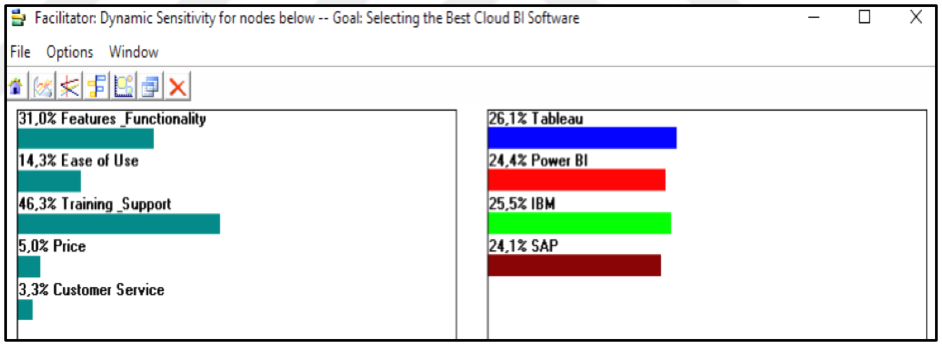

Figure 21. Dynamic Sensitivity with High Priority of Training & Support

If the company is in a financial difficulty and the price is the most important factor in selecting the best software, Power BI will be by far the best alternative among others as illustrated in Figure 21.

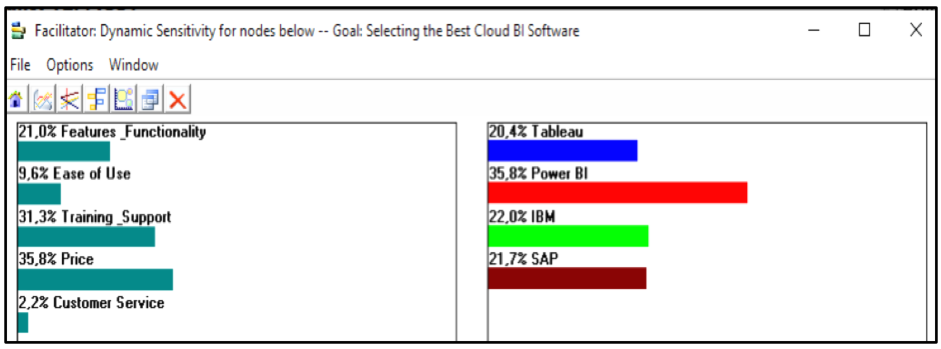

Figure 22. Dynamic Sensitivity with High Priority of Price

If the company wants to attach great importance to customer service and increase the weight of the criterion to 60%, Tableau will be the alternative which needs to be selected as shown in Figure 22.

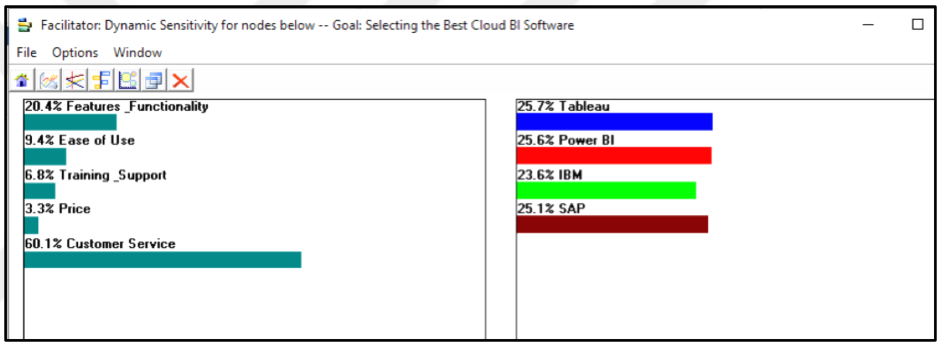

Figure 23. Dynamic Sensitivity with High Priority of Customer Service

5.6. DISCUSSION

5.6.1. Research Results

There are many specifications offered by the software providers for cloud business intelligence. Every company can give different weights to them. In this project features & functionality, training & support, ease of use, customer service and price are selected by the company as criteria, and the analysis made relied on these specifications. Even add or drop among criteria can be possible in order to meet the changing needs, they are accepted as valid and inclusive for most organizations.

Analytical hierarchy process was used as a powerful method for multi-criteria decision making. AHP technique makes comparisons and gives the best alternative by comparing criteria weighted relatively between each other. In addition, this method offers an algorithm in order to check if your input is consistent. The software called Expert Choice, accepted as the leader in multi criteria decision making market, was used to make the best selection.

After prioritizing the criteria and making comparisons in respect to relative importance of alternatives, the results were synthesized. The company should select the Power BI with 26,1 %. It is the most appropriate software in terms of the criteria prioritized by the company including features & functionality, training & support, customer service, ease of use and price. Tableau is in the second place with 25,5 % where IBM is on the third rank. The last is SAP with the lowest percentage. Even the percentages of the alternatives are close, Power BI will offer the optimum benefit when it is chosen.

After synthesizing the results, the organization may want to change priorities of the criteria. With the help of the analysis of dynamic sensitivity, the company can experience whether the best alternative changes or not when the priority of a criterion changes. When the company increase the priorities of criteria including “features & functionality”, “ease of use” and “price”, the result will not change. As for the criteria of “training & support” and “customer service”, when the weights of these criteria are increased, the result will go in Tableau’s favor. It is sensitive to the changes of weights. The result is affected when the priority for these criteria changes.

5.6.2. Research Limitations

There are some limitations faced while making the research. One of them is related to sample size of the survey, which may be counted a constraint for the research. It was difficult to reach to the respondents. People are not willing to response to the survey. I found many specialist working on my subject of the research thanks to my valuable instructors, but although my connections were added to the list, the number of respondents were lower than expected. I supposed

that most of them do not want to waste time for surveys. They have also probably other concerns in this environment, in which it is very hard to cope with the pandemic and its effects both psychologically and physiologically. Although this limitation, I believe that the research result will not change if the number of respondents increases as I tried to select one person, who is an expert or a manager in information technology department, from each corporation.

5.6.3. Suggestions for Future Researches

This research is predicated on selecting the best software for a firm that fits the company objectives. In order to make comparisons and find the best alternative among others an imaginary company was created realistically. The researcher, who will want to make a similar research, may find a company available which needs a cloud business intelligence software. It will be more realistic and helpful for both the researcher and the company. Most commercial undertakes had to change the way of working or close the shops in the period of Covid-19 pandemic. Businesses were usually blindsided against this extraordinary condition. The most important priority was given to people' health naturally. This is the period in which people cannot make important investments and cannot see their future accurately in the short term. Therefore, I had to make my research on the scenario inspired by the real enterprises, which make sales of organic products. The application developed by using Expert Choice is adaptable for any organizations, so it is valid and compatible. I suggest that when the pandemic ends, the researchers may find businesses from the market and they may apply this application to them. In addition, the number of criteria can be increased in respect to the needs and the demands of the organization in order to make detailed analysis and contribute to decision making process.

5.7. Conclusion

Business intelligence, which is the term arisen in 1950s, became prominent in recent years as a developed decision support system helping corporations to make faster, more accurate and insightful decisions. Many companies experienced this intelligence and enhanced the demand for business intelligence applications which are accepted as powerful ways to benefit from advantages like

improving business process, becoming competitive, gaining accurate insights from the customer and so on.

As the amount of data increases, it is getting difficult for companies to handle it. Therefore, the industry has started to look for new technologies to analyze data without the burden of centralized systems. Cloud computing is getting involved in this stage, which provides computing services such as databases, servers, storage, networking, software, analytics, and intelligence through the internet. Rather than storing files on a local storage device, using cloud-based storage for saving them is getting popular thanks to several advantages including speed, productivity, performance, security and efficiency. The feature of location independence makes data access and processing possible remotely.

This study explained the business intelligence from the history to its architecture. In addition, the advantages of using BI and the upcoming developments in the future were represented. Then, cloud computing and its advantages with its service and deployment models were stated. The term, cloud business intelligence, was defined and the difference between traditional business intelligence and cloud business intelligence was explained together with the important cloud business intelligence vendors.

The collaboration between business intelligence and cloud computing satisfies the needs and provides extra advantages. Even some of institutions concern about the cloud security and integration, many of them are pleasure with using this technology with enhanced security protocols and advantages from broad network access.

The study is a valuable source for everyone who wants to learn business intelligence, cloud computing and the affiliation between them briefly. The terms and the subtitles associated with them presented in order for better understanding.

This thesis defends the concept of using cloud business intelligence for companies from small to big sized in order to become competitive. As time passed, new technologies and opportunities have been developed. Instead of adhering to old and strict rules, it is necessary to keep up with times and make use of all resources provided by new technologies as long as it is reliable and

appropriate for businesses. With this consciousness a growing number of businesses will need to select a cloud business intelligence software and services offered in respect to its structure and needs.

In this thesis a decision support system was developed by applying the common methodology to the field not applied before in order to select the best software for the company. Analytical hierarchy process, which is one of the multi-criteria decision-making method, was involved in the selection of cloud business intelligence solution. The criteria and the alternatives were selected by the company in order to be used in AHP. A survey was made for prioritizing the criteria whose respondents are experts in information technology. The survey result showed us “features and functionality” is the most important factor for selecting the cloud business intelligence solution provided by companies whereas price is the least important factor affecting the result of the study. Therefore, price differences among alternatives have a little effect on decision making in this study. According to the survey results, the criteria was scaled in respect to priorities and the ratios of alternatives calculated for each criterion placed into the software called Expert Choice. After checking inconsistency ratio that should be less than 0,1, the results were synthesized. I found that Power BI provides the best software as it best fits the company needs and objectives.

This study presents an example of selecting the best Cloud BI solution by using analytical hierarchical process, making several calculations over the alternatives chosen and the criteria prioritized. The application also can be adjustable for changing demands. If the company wants to change the priorities defined in the beginning of the project, we can reach the new result within a few seconds by making small adjustments. Cloud technology has started to shape our lives for a while. If the key to the future is hidden in cloud, moving business intelligence applications into cloud is the key to the success in the business world.

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Appendix

Survey

1. According to your prioritization, please give points to the criteria that the software providers of Cloud Business Intelligence offer to their customers. (Please give points between 0 and 100 for each criteria)

   - Features & Functionality
   - Training & Support
   - Customer Service
   - Ease of Use
   - Price

Survey Results

			POINTS				
Number	**Name**	**Title & Institution**	**Features & Functionality**	**Training & Support**	**Customer Service**	**Ease of Use**	**Price**
1	Mustafa Ozan Nesanır	Sustainability Process Expert at Ekol Logistics	90	70	70	80	95
2	Refikcan Ertekin	Data Engineer at HelloFresh,Berlin	90	65	80	70	60
3	Özge Öğücü	Executive Assistant of CEO at Akbank	100	90	90	80	60
4	Barış Seçen	Software Engineer at Coca Cola	90	70	80	80	90
5	Engin Yavuz	Warehouse manager at Mantis Software	80	85	75	60	60
6	Barbaros Özdemir	Data Center CEO at Radore	100	60	20	40	80
7	Göksel Sanbay	Deputy General Manager at IFS	90	20	40	70	60

			POINTS				
Number	**Name**	**Title & Institution**	**Features & Functionality**	**Training & Support**	**Customer Service**	**Ease of Use**	**Price**
8	Osman Bora	Computer Engineer at Anatolian Courthouse in Istanbul	78	76	61	88	55
9	Baybars Karabekir	Software Manager at Halkbank	100	80	90	70	70
10	Elçin Nur Demirkol	Business Analyst at THY Technic	100	90	80	70	60