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Using Business Intelligence Tools to Make Data-Driven Decisions

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Using Business Intelligence Tools to Make Data-Driven Decisions

By

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Introduction

Business Intelligence (BI)[1] has become a powerful tool that various organizations are using to make decisions and to understand the power of Business Intelligence, and the reason why companies rely on it is fundamental. The primary advantage associated with Business Intelligence is that it helps organizations make better and smarter decisions about data. Business Intelligence is a set of tools and technologies that are used not only to leverage software and services but also and more importantly to transform companies' data into insights. Information is becoming more valuable every day and companies need to use the right tools and techniques to extract the data and make informed decisions. Organizations need to know how to use Business Intelligence tools to make the right decisions and gain a competitive advantage over competitors. This is of prime importance because Business Intelligence tools are popular and finding the right tools to make the right decisions is problematic.

Research questions:

Research question 1: What role do data storage and data warehouse play in data-driven decision making?

Research question 2: How to use modern Business Intelligence tools to make effective business decisions and maintain a competitive advantage?

Research question 3: What are the cybersecurity implications associated with data storage and Business Intelligence tools and how do they affect business decision making?

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[1] Business Intelligence: Strategies and technologies that organizations use to analysis business data and make data-driven decisions.

Topic's Importance

The importance of this topic comes from the high value of information because the need of having appropriate tools to extract data from disparate systems and gain information from it is exemplified. As people in the Information Systems field, we must recognize not only the value of business information but also how to manage the information in the best interest of the business. Understanding how companies use Business Intelligence tools[2] to make informed decisions is critical these days not only because technology has become an integral part of every company but also and more critically because of big data which requires the use of sophisticated Business Intelligence tools such as Python, R, or Power Bi to process different types of data and extract valuable information.

A lot of companies now experience problems with big data[3] - an extremely large set of unstructured data that may be processed and analyzed with data mining tools to reveal trends, patterns, and associations - because their data keeps growing exponentially with time (Gandomi & Haider, 2015). The big volume of data makes it difficult or impossible for traditional data management tools such as Microsoft Excel, SQL (Structured Query Language), and Access to store and process the data efficiently because these tools are effective with structured data types only. Managing big data is complex because Big data may be structured[4], semi-structured[5] and

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[2] Business Intelligence Tools: Types of application software for the collection and processing of unstructured data.
[3] Big data: data that is extremely large and needs to be analyzed to reveal trends, patterns, and associations for decision making.
[4] Structured data: data that is easy to analyze and adheres to predefined data model.
[5] Semi-structured data: data with tags and marks to enforce hierarchies of fields and records within the data but which does not conform to the formal data structure.

unstructured[6] and processing the data requires sophisticated big data technologies such as Artificial Intelligence[7] to improve decision making, customer service, and the overall operation of the business. The use of Business Intelligence and Artificial Intelligence tools to make the best decisions is also required due to the increasing volume of dark data which often compromises the information assets of organizations. Even though dark data can be used to unlock business value, many companies do not use it due to the lack of the right tools to process the data. Dark data is largely unstructured and is a threat or an opportunity for every company depending on how the company processes it (Hobart, 2020). Up to fifty-six (56) percent of decision-makers report not knowing how to use dark data due to the lack of technology and expertise within the company and as such, it is important to note that companies that cannot use Business Intelligence tools will never be able to take full advantage of their data. (Tully, 2019).

The use of Business Intelligence tools has shaped how companies use their existing data to make predictions, yet the question remains on how to use these tools to solve modern complex business problems. To answer this question requires a thorough analysis of Business Intelligence and Analytics[8] tools. There are many tools, software, and technologies that are used to analyze data, and to make the best out of their data, businesses should identify and be able to use the right tools and technologies to their advantage. This is saying that in decision making, specific Business Analytics tools and visualization software should be aligned with business goals and objectives for optimum results.

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[6] Unstructured data: data not organized in a predefined manner or does not follow a predefined data model.
[7] Artificial Intelligence: Simulation of human intelligence in robots and machines that are programmed to think like humans and mimic humans' actions.
[8] Business Analytics: The use of statistical technologies, processes, and methods to analyze historical data and gain new insight to improve decision making.

History of Business Intelligence

One of the most controversial questions relates to defining the "date of birth" of Business Intelligence. Since Business Intelligence relies on information technology tools and is often used in this sense, many people believe that Business Intelligence is an innovation from information technology. However, Business Intelligence was used before technology and therefore preceded it.

The term Business Intelligence was used for the first time by Richard Miller Devens in 1865 in *Cyclopaedia of Commercial and Business Anecdotes* to describe the way that Henry Furnese successfully used this tool in the banking industry to beat his competitors. To make informed decisions and beat his competitors, the banker Henry Furnese gathered information and acted on it instead of using gut instinct to make business decisions. The idea of Henry Furnese is later enhanced by people who understood and saw value in collecting and using data in decision making.

The improvement of Business Intelligence continued with the adoption and introduction of the first formalized Business Analytics system in the United States by Frederick Taylor in the last decade of the 1800s. The work of Frederick Taylor in Business Intelligence and analytics led to his system of scientific management which started with the analysis of production techniques and the body movement of workers to find greater efficiencies to boost productivity (Taylor, 1914). In the early 1900s, he started to measure the time it took each component of the Ford Model T to complete on the assembly line, and even though he was using just a pen and paper, Taylor was efficient in using the information to make business decisions and by doing so, he revolutionized the manufacturing industry and became a consultant to Henry Ford.

Even though people started to understand the value of using information to drive business decisions, only highly skilled people could translate data into useful information until 1968 because multiple sources of data were stored in silos. Recognizing the difficulty of interpreting data, Edgar Codd addressed the problem in a paper published in 1970 with a proposal to adopt and develop a relational database model[9]. Following this proposal was the development of Decision Support Systems[10] (DSS) which were the first database management systems. Recognizing the value of information and the use of specific tools and systems to make data-related decisions, Business Intelligence vendors grew up in popularity in the 1980s, and tools were developed to organize data in logical and simple ways for decision making. The improvement of the new database management system is that it can be used to manipulate large databases and its interface provides specific language to assist all users (Fry & Sibley, 1976).

The use of computers boosted the power of Business Intelligence in decision-making. In the paper *A Business Intelligence System* written by Hans Peter Luhn in 1958, the author described the ability and importance of information and decision-making systems in supplying information that supports specific business activities carried out by people, groups of people, departments, and organizations (Luhn, 1958). Hans Peter Luhn, recognized as the father of Business Intelligence, predicted business trends that are cutting edge as the basics of machine learning. Even with the explosion of the use of computers and the proliferation of supercomputers in the next decade, business professionals found it more challenging to extract information from data due to the lack of a centralized system to bring all the data from multiple sources together. Since data cannot by itself generate any value, the first

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[9] Relational Database Model: Database system based on a straightforward and intuitive way of representing data in a table with the ability of storing and providing access to data that are related to one another.
[10] Decision Support System (DSS): Computer application used to collect, analyze, and organize business data for efficient decision making.

solution was the development of database systems that allowed the extraction of information using binary trees. Albeit using binary in the development of database systems and the use of binary trees solved several business problems and companies that could afford and used the new database approach derived more value from information and made better and smarter conclusions from the available data, it is inefficient and too heavy nowadays.

Business Intelligence has become a powerful tool that organizations use to leverage their software and services in the transformation of data into actionable insights with its ability to access and analyze both structured and unstructured data sets and using visualization to present a high-level intelligence about the business (Fruhlinger, 2019). By using Business Intelligence tools, business decision-makers start to understand trends in data and derive insights that assist in searching for, merging, and querying the data to make informed decisions. Business Intelligence went through some transformation over the years and started with Business Intelligence 1.0 in the 1990s. Business Intelligence 1.0 is characterized by the decline of the cost of data warehouses and the ability of corporations to access commonly accessed data, but data cannot be used to answer business questions effectively. This required the development of Extract, Transform, Load[11] (ETL) tools to design the flow of data within the data warehouse more efficiently and Online Analytical Processing (OLAP)[12] tools which enabled analysts to use visualization tools and to present technical information in an easy and meaningful way. OLAP systems were major progress in information management because they use a multidimensional data model and support not only complex analysis but also ad hoc queries. OLAP-based systems were mostly used in marketing,

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[11] ETL: The process that enables businesses to gather business data from multiple sources and to consolidate it in a centralized location.
[12] Online Analytical Processing Tools: software or tools that allow users to analyze information from many database systems concurrently. It also enables to extract and view business data from many viewpoints.

business reporting for sales, budgeting and forecasting, financial reporting and similar areas, management reporting, business process management, as well as in new applications.

Over the years, other systems such as Enterprise Resource Planning[13] (ERP) systems were developed with the ability to automate aspects of the business. ERP Systems are important because they help companies plan their resources by integrating all the processes such as finance, planning, purchasing, and sales needed to run a business into a single system. It is important to note that even though implementing ERP Systems is very complex, ERP Systems can be used to gain a competitive advantage and meet the ever-increasing expectations of customers (Umble et al., 2003). In the early 2000s, Business Intelligence systems have become a must-have for many medium and large businesses to stay competitive and Business Intelligence tools vendors such SAP, IBM, Oracle, and Microsoft saw a boost in their productivity. BI tools proved their usefulness even more with the emergence of big data and starting in 2005, companies found it convenient to have real-time access to their data for ad hoc reporting.

Using data visualization[14] techniques played a critical role in understanding data and making decisions. The use of images such as graphs and maps to understand data started in the seventeenth (17th) century and led to the creation of pie charts in the early 19th century. Data visualization techniques and tools have been used by scientists to discover and uncover value from data. Visualizing data influenced the impact of data on the business through the definition of how to work with data, how to extract insights as well as how to develop strategies over time. Mapping Napoleon's invasion of Russia, Charles Minard used statistical graphics that depicted

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[13] ERP system: System used in an organization in the management and integration of all important aspects of the business.
[14] Data visualization: Technic used to represent information graphically using charts, histograms, and other graphics in order to reveal trends and enable understanding.

the size of the army and Napoleon's retreat path from Moscow and tied that information to time and temperature scales to understand the event more in-depth.

In addition to the problem that businesses faced to make effective data-driven decisions were cybersecurity issues. Cybersecurity[15] has long affected fast and reliable decision-making due to the increase of data security risks and the high cost associated with data breaches. Data breach[16] started when companies and individuals began to maintain records and it increased in the 1980s. From the 1990s to the 2000s, the public became more aware of the potential of data breaches and the loss of personal and business information (De Groot, 2020). The year 2005 marks the official starting point of data breaches with the beginning of a chronological record of data breaches by the Privacy Rights Clearinghouse. This is due not only to the proliferation of Business Intelligence tools, but also and more importantly due to the storage of business data in digital forms, the emergence of workforce mobility, and cloud computing. To mitigate the problem associated with data breaches, laws and regulations such as the Payment Card Industry Data Security Standard[17] and HIPAA[18] are created to provide a framework for the storage, safeguard, and practices to handle sensitive information (V. Liu et al., 2015). Even though these regulations do not apply to all industries, their goal is to provide

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[15] Cybersecurity: The protection of computer and network systems from disruption, damage, or theft of data.
[16] Data breach: Data leak, data spill, unintentional disclosure of information to an untrusted environment.
[17] PCI data Security: An information security standard that targets organizations that issue or handle credit cards transactions.
[18] Health Insurance Portability and Accountability Act (HIPAA): Federal law that govern the protection of sensitive health information of a patient from being disclosed without the consent or knowledge of the patient.

guidelines and directions for organizations and companies that handle customer-sensitive information such as Personally Identifiable

Information[19] PII or medical records.

Methodology

The main method used in this paper to answer the research questions is a literature review. There are many resources related to

business decision making and by comparing and evaluating Business Intelligence tools that companies are already using; researchers

and decision-makers can see what it takes to make an effective data-driven decision. By literature review, the goal is to synthesize

unique information not only on the importance of Business Intelligence but also, and more importantly gather unique information and

explore the effective use of Business Intelligence tools in modern decision making. Business Intelligence goes hand in hand with

Business Analytics or Machine Learning[20] and Artificial Intelligence, therefore these areas will be explored as well in our objective of

using Business Intelligence tools to make sound decisions.

The literature review used in this paper focuses on an integrative review of different Business Intelligence tools to provide an

interpretative analysis and a critical evaluation of the literature on existing tools while reviewing their strengths and weaknesses as

well as controversies and contradictions. To give the reader a better understanding of Business Intelligence as well as its evolution, the

timeframe includes 1865 which marks the early beginning of Business Intelligence. However, this research is mainly focused on

emerging Business Intelligence tools and the literature review is heavily focused on the last ten (10) years to review how modern

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[19] PII: Data or information that could be used to identify a specific person.
[20] Machine Learning: Using statistical algorithm to find trends and patterns in vast amount of data.

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Business Intelligence technologies could be used differently and lead to a better understanding of the selection of the right tools in the business decision-making process. Although there are thousands of tools and articles available on the topic, the goal here is to choose articles that are few enough to answer the research question but also rich enough to help emphasize and analyze the use and importance of Business Intelligence tools in decision making.

Before going into the details of how to use the information and existing data to support decision making, it is important to first analyze and understand how organizations store the data used in decision making because Business Intelligence and decision making are not possible without a data warehouse (Inmon, 1996).

Data Storage in the Organization

The importance of Business Intelligence and the critical role of data storage is that it plays a central role in how modern companies achieve business objectives, make business decisions, engage with stakeholders and customers, and align the technology with the needs of the business (Padgavankar & Gupta, 2014). Successful use of data in decision-making relies on the means used to collect and store the information. There are two fundamental topics related to data storage: types of data storage and data storage devices.

Where do organizations store data?

How and where an organization stores its information is of prime importance in decision making. To answer complex business questions about the data and use the answers to make important decisions, businesses need a data warehouse[21] not only to safely store and centralize data but also and more importantly to answer business questions more effectively and quickly when needed. The importance of data warehouses in Business Intelligence and decision-making is that they serve as the backbone of data storage since Business Intelligence deals with complex queries, a vast amount of information or data in various forms, and compares multiple data sources to inform about the state of the business (Gangadharan & Swami, 2004). Organizations use three (3) primary means to store business information: data can be stored locally on the premises of the business, collocated with another company, or be stored in the cloud.

The on-premises storage[22] type is the ability of the organization to have the appropriate technologies in place to store and manage the data locally. An important factor of on-premises storage is that the company takes the responsibility for building an IT infrastructure to store the information and oversees the data. With on-premises storage, the data stored and other information are shared between computers in the local network, and the server hosting the data is maintained, administered, and controlled by the internal IT department of the company (Maturana & Asenjo, 2017).

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[21] Data Warehouse: System to pull and consolidate data together from many sources of the organization for reporting, analysis, and business decision making.
[22] On-premises data storage: ability of the organization to have the appropriate technologies in place to store and manage the data locally.

The second type of storage is datacenter colocation[23] which is a service provided by companies offering a shared and secured space for other businesses to store data storage hardware devices. In data center colocation, many businesses house their data storage servers in one shared facility (Ren & Islam, 2014). By collocating the datacenter, they gain the advantage of a versatile data center and services with complete control over the data. A unique feature of the colocation data storage type is data centers' connectivity options which allow data centers the incorporation of new features into their existing network infrastructure with more robust compliance and security protocols. Datacenter colocation is a good option for companies that do not want or cannot afford to build their own data centers as it is cheaper and allow data owners to maintain their equipment and exercise full control of the data as if in on-premises storage. By using a data center colocation, organizations can augment or reduce their space in the colocation facility as they deem necessary and have higher levels of data bandwidth[24]. With more reliability, datacenter colocation protects greater from power outages due to the multiple backups in place, offers low latency options of networking, and provides higher levels of security with more stringent protection measures that include fire detection, firewalls, mantraps, suppression systems, as well as closed-circuit television [25](CCTV) monitoring.

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[23] Data Center Colocation: The ability of large datacenter facilities to rent out rack spaces for third parties network equipment or server because they do not have the needed resources to host their own data center.
[24] Data bandwidth: The maximum space allocated to host business data.
[25] Closed-circuit television: video surveillance; it uses video cameras to transmits signals to a specific place or monitors and allows the business to keep an eye on its premises.

The third data storage type is the use of cloud storage[26] for data versatility, adaptability, flexibility, and efficiency(H. Li et al., 2021). There are a variety of cloud storage options that include private[27], hybrid[28], and public clouds[29]. The public cloud is cost-effective, highly reliable, scalable, highly monitored, and does not require maintenance while the private cloud provides better security, is highly efficient, and is more customizable. As for the hybrid cloud, it is a mixture of the private and public clouds and offers greater control, higher customization, and is more cost-effective.

Contrary to the other two types of data storage, cloud storage makes it easy for organizations to have more storage space or resources as they need and allows employees to have access to the data almost anywhere. Colocation and cloud storage share the same principles of cost savings because of shared facilities even though cloud storage offers virtual storage while colocation offers physical ones. Contrary to the colocation and on-premises storage, the cloud service provider is fully responsible for the data and manages the networks, servers, and data storage. The importance of choosing the right data storage type in decision making is that storage operations are performed based on storage preferences such as user preference or the storage policy of the business (Prahlad et al., 2010).

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[26] Cloud Storage: The storage of data on the Internet facilitated by a cloud storage provider who has the responsibility of managing and operating data storage.
[27] Private Cloud Storage: The storage of data on remote servers dedicated to a single customer.
[28] Hybrid Cloud Storage: The use of local and off-site resources to supplement internal storage with public storage.
[29] Public Cloud: Storage in which resources are made available to the public through the Internet.

Issues in data storage and effects on effective decision-making

Today, many organizations use cloud storage to store their data, but what to keep in mind is the security, privacy, and availability of the information stored. How to make quick business decisions when you do not have the means and technologies required to store the data? How to access the data and maintain its privacy when your data is collocated? How do you make decisions and maintain a competitive advantage when the data is stored on the cloud where you do not have full control and other people can assess it? Whether an organization chooses to use on-premises storage, colocation, or cloud storage, it is important to mention that each type of storage has its advantages and disadvantages. For example, even though the on-premises storage may be hard to implement due to the high cost of the appropriate Information Technology infrastructure, it has the advantage to ensure that only the organization has access to the data.

In colocation, different companies share the data storage facility along with the costs associated with maintaining the data facility. While choosing the storage type to use, organizations must weigh between what they want most, whether it is to maintain the security and privacy of their data or to access it from anywhere. The use of on-premises storage provides peace of mind, although it requires the company to manage the integration capabilities, to house the server hardware and software licenses, and to have the IT staff on hand to manage and support issues that may arise (Tadapaneni, 2017). The storage type chosen can enable or prevent a real security threat in information management and decision making and should not be taken lightly. By exploring the different storage options, organizations should consider their business needs before deciding the type of storage to use because each business has its

own specific needs and requirements, and the different kinds of cloud storage solutions have unique benefits (Abdel-Basset et al., 2018).

Regardless of the Business Intelligence and data analytics tools used to make decisions, the storage of the data is a security concern because in a cloud storage environment where the data is often breached, making decisions on data that has been accessed and modified by a third party could lead the business in the wrong direction. We can refer to Banks that recognize the importance of using the right storage type and this is the reason even though they have systems in place to store data safely and retrieve information quickly, they still go through a lengthy process of identifying the specific business case on which they are making decisions, the validation of the case, the acceptance of the case from the information technology department, the processing of the data by running the business case, the validation of the results in case they justify the business case, as well as the traceability of the results to make sure that the decisions made support the business needs. Even though this is time-consuming, can take months, and banks still need to invest in technology tools that make their data available across all areas and systems of the bank, it is important to note that banks value the security and accuracy of their data over fast accessibility (Mathur et al., 2020)

How do organizations store data?

Nonetheless where the data is stored or where it is located, the device used to store it can present some advantage or disadvantage in business decision making. Several considerations should be made based on the data use cases, whether it is databases,

mobile applications, files, websites, or backup purposes. Even though there are different types of storage options, this section will be dedicated to options that are suitable for Business Intelligence and can affect decision making (J. Liu et al., 2018).

➢ Direct Attached Storage (DAS): These are storage devices such as internal or external hard drives or USB directly connected to a device. The main advantage of DAS devices is that their prices are always going down. As a disadvantage, these types of devices are not very sharable and cannot be used in a cloud environment.

➢ Network Attached Storage (NAS): NAS devices have two (2) main properties: They require internet and local area network connectivity and require multiple hard drives attached to the NAS configured in a RAID configuration. NAS has the advantage of providing centralized control of files as well as the replication of the data for backup purposes. Another advantage is that NAS is more suitable for collaboration and businesses that require simultaneous access to files. However, NAS performance depends on the performance of the network and the more users are using the storage system, the less it performs.

➢ Storage Area Network (SAN): SAN is most used in cloud computing and for mission-critical applications and databases, ERP and Customer Relationship Management[30] (CRM) systems, virtualized environments, and virtual desktop infrastructures. Storage Area Network is used in many cases because it offers universal connectivity of all the storage and computing devices and allows computers in a heterogeneous network to read and write data in its native format (O'Connor, 2003). Businesses can effectively use SAN with its self-healing and data restoration in case of device failure features and storage sharing capability to

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[30] CRM: A system to manage all the relationships and interactions of the company with customers to improve business relationships.

make important decisions. Advantages associated with SAN include the enhancement of application performance and the improvement of application availability with many data paths. However, the implementation of SAN for on-premises storage is expensive, complex, and difficult to set up.

Business Intelligence and data warehousing

The ability of organizations to make good decisions depends on high-quality data. As such, a competitive business is a business that has agile access to its data storage warehouse which is carefully organized to improve business performance and to deliver relevant, fast, and accurate data insights. To meet the requirements of making decisions faster, Business Intelligence architecture[31] which involves the standards and requirements to organize data with the help of techniques based on computers and technologies used in visualizing, reporting, and analyzing data, has emerged. Decision-making relies on data warehouses because the data warehouse makes it easier and efficient to store and process information used to support decision-making (Gupta & Mumick, 2005). Data warehousing and Business Intelligence entail the process used to store the company's data in external or internal database systems from various sources to generate insights using online Business Intelligence tools. Even though companies may use sophisticated Business Intelligence tools to analyze data, the data they analyze as well as the decision they make highly relies on the data warehousing system implemented.

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[31] BI Architecture: Standards and policies that organizations implement to collect, store, and organize data with the help of technologies and computer-based techniques.

Business Intelligence Architecture

The implementation of a Business Intelligence architecture is crucial for any business because the Business Intelligence architecture defines how to collect data, how to administer the information as well as available technologies that support Business Intelligence. A good Business Intelligence architecture depends on understanding the various components involved in developing successful and sophisticated Business Intelligence tools (Shariat & Hightower, 2007). Components of Business Intelligence architecture include:

➢ Data Collection: The data collection policy refers to methods and channels that are used in the organization to collect data from activities carried out by the organization. Effective data collection depends on the resources and requirements of the business and involves gathering data from various sources such as Customer Relationship Management (CRM) system, Enterprise resource planning (ERP) system, files, databases, Application programming interface (API) system. An effective data collection policy requires an understanding of the type of data that different users or departments need to satisfy their requirements, and the type, quality, and currency of the data. If implemented correctly, a good data collection mechanism leads to capturing relevant data and adds value to the organization because the best Business Intelligence insights rely on the right data. A good data collection method enables disparate systems and departments to communicate and is the beginning of a successful data-driven culture by eliminating errors, increasing productivity, and streamlining operations.

➢ Data Integration: A method used to manipulate the collected data and involves data extraction, data transformation, and data loading into the data warehouse for quick access and fast decision making. Through data integration, businesses extract the

data from external sources where they are stored, transform the data to confirm it to business requirements and decision needs, and load the data by converting it into a destination data warehouse. While integrating the data into the data warehouse, businesses should ensure that the data sources are not negatively impacted, and that necessary data cleaning takes place.

➢ Data storage: Even though they are often used interchangeably, Business Intelligence concepts and data warehousing concepts are significantly different based on their goals and their end-use. Data warehousing requires storing data from various sources without cleaning, while data stored for Business Intelligence and decision-making purposes needs cleaning and preprocessing for better results. Another consideration worth mentioning is that the data stored for Business Intelligence is for accessing, exploring, and analyzing measurable aspects of the business while the goal of the data warehouse is just the storage of the company's data in a single place. In other words, BI systems and tools rely on data warehouses while data warehouses are the foundation for Business Intelligence systems and tools (Dayal et al., 2009).

➢ Data Analysis: A process required after handling, processing, and cleaning the data stored. Due to advances in technology and applications, analyzing data is not done with pencil and paper as used by Frederick Taylor at the beginning, but requires the use of Business Intelligence tools that will be discussed later. The use of specific tools is required for ad hoc analysis that enables flexibility, usability, and freedom in analysis performance as well as answering critical business questions accurately and efficiently.

➢ Data Distribution: Involves providing information and insights to stakeholders for sustainable business development. The three (3) ways to distribute data are automated email distribution, dashboarding, and embedding. Automated email reporting is the

sharing of information on a predefined schedule with selected recipients. Automated email reporting does not only eliminate manual work but also enables selected recipients to have up-to-date information. On the other hand, dashboarding is a technique used in a secure environment to share data without the ability of users to edit or modify the information in any way, even though they can use filters to gain access to the data and interact with the dashboard. An example of dashboard sharing is sharing an excel file with a public URL link while preventing users to modify the original file. Lastly, embedding distribution is enabled through embedded Business Intelligence systems.

➢ Insights: Fundamentally rely on data warehousing and Business Intelligence and are the decisions made from data. By using the power of data, business managers, CEOs, and anyone interested in making data-driven decisions can generate accurate, valid, and important decisions that will help them to move forward. Insights are often generated through dashboards and the use of key performance indicators which bring the best data management practice and positive results in decision making. Insights are important and drive business decisions, the reason why business executives are more relying on data-driven decisions and want to understand the best plan for the business based on scenarios and simulations (Lavalle et al., 2011).

Preparing data for decision making

As we have seen in the above sections, businesses use different types of means, devices, and systems to store and gather business data. The first step to make the data useful for decision making is not only to access the data stored but also and more importantly to preprocess it by cleaning it. Data cleaning is the step required to ensure that the data is consistent, usable, and supports

business needs. Just as businesses choose the storage device that fits the needs of the business, businesses also choose the data cleaning tool based on the type of data and the business decision to be made. Data preprocessing can be referred to as data wrangling[32], a step used to simplify and clean messy, complex, and incomplete data and make it ready and usable for analysis (Furche et al., n.d.). Data wrangling involves fixing the data by dropping missing and null values in the dataset, filtering the data using some criteria based on the business problem to be solved, and grouping the data into logical categories. There are six (6) major benefits associated with cleaning the data before using it in decision making:

- Monitoring errors and making it easier to fix corrupt or incorrect data.

- Standardizing processes by reducing the risk of duplication.

- Verifying and testing the accuracy of the data.

- Identifying duplicate data helps save time during data analysis.

- Compiling the data to provide complete information for Business Analytics and intelligence

- Determining the scope of the data and having a basic idea in determining if the data can answer the business question or more data is needed.

Preliminary data cleaning is important in every decision-making process and once the data cleaning process is complete, decision-makers can move forward and use reliable, credible, and accurate data for deep operational insights (Kandel et al., 2011).

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[32] Data wrangling: data gathering, selection, cleaning, and transforming process to answer an analytical question.

Data Processing Tools

After collecting data, organizations use different tools to prepare the data, analyze it, to derive business decisions. Data processing and decision-making tools fall into three (3) categories: Business Analytics tools, Business Intelligence tools, and Artificial Intelligence tools. Even though these tools are closely related and are often used interchangeably, it is worth mentioning the difference between them before exploring how each of them could be used in decision making. Contrary to Business Intelligence with a focus on the past and present business data to drive current business needs, Business Analytics only analyses past data to drive current business. On the other hand, Artificial Intelligence is the ability of a system to learn, process, analyze, and solve business problems (Miller, 2019). In terms of usage, Business Intelligence is used to run current business operations while Business Analytics focuses on changing business operations and improving productivity. Also, Business Intelligence deals with the current business operation and decision making while Business Analytics deals with future business operations and uses predictive analytics. While Business Intelligence deals with what happened, the time it happened, who is responsible, and how many things happened, Business Analytics studies why it happened, if it will happen again, what will happen if something is changed, and the current lesson learned.

Business Analytics tools

Business Analytics tools are mostly used by decision-makers such as business analysts and managers. They include statistical and quantitative analysis, predictive modeling, data mining, text, and big data analytics as well as multivariate analysis. The importance of these tools in decision making is that they retrieve data from different business systems and combine it in a repository

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for easy review and analysis to detect new opportunities and patterns (Acito & Khatri, 2014). Business Analytics tools include spreadsheets with statistical functions, sophisticated data mining tools, statistical software packages, and predictive modeling tools.

The goal of this paper is not to recommend companies the Business Analytics tools that they should use or are best for them. Rather, it is to emphasize the importance of having the right Business Analytic tools and how these tools can have an impact on decision-making. Business Analytic tools give a complete overview of decision-makers and provide an understanding of the data to make smarter decisions to support business operations.

Following are some of the benefits of using Business Analytics tools:

- ❖ The improvement of business decision making: Gartner, a global research and advisory company, predicted that by 2021, up to seventy percent of global and middle-size organizations will deploy advanced and strong analytics as part of their data analytics applications or platform (Keller, 2020).

- ❖ The development of popular analytics and state-of-the-art tools to provide powerful analytics to business processes.

- ❖ The development of Business Analytics tools to analyze and find relationships in all forms of data whether structured or unstructured.

- ❖ The use of Business Analytics tools to analyze the data flow and to support data exploration through an intuitive interface.

- ❖ The ability of Business Analytics to upgrade to advanced analytics models without the need for a data scientist.

- ❖ Finding new correlations or patterns in real-time data sources to build new models. Business Analytics tools enable efficient data collection and presentation of semi-structured data.

Automated approaches to data analysis include the use of Natural Language Interface[33] NLI or Natural Language Processing NLP, such as IBM's Watson Natural Language Interface. However, the use of automated tools in deep learning requires the correct data because data that is not easy to interpret and integrate requires a data scientist and professional data integrator to use the new tools effectively (Panetta, 2017). Another important consideration of business analytics tools is having a simple-to-use interface that business analysts and decision-makers can customize. In their choice of tools, businesses should study the flexibility of any tools they want to use and consider if even non-technical users can use the tools to create and analyze processes.

The capabilities of the tools should be considered in decision making and the ability of the tool to find patterns in data and recommend visualizations should be emphasized. Advanced analytics algorithms are very useful in decision-making because they prompt users to see how they want to represent data. The importance of using advanced analytics tools is that they generate previously unknown knowledge and save time.

The data to work with comes from various sources and is often unorganized and unstructured. Businesses should consider tools that can combine and analyze complex data. These tools should be flexible with the ability to process structured, semi-structured, or unstructured data. The flexibility of the Business Analytics tool also involves the ability of decision-makers to define the parameters of the test for analytics models for quick analysis and decision making.

Advanced Business Analytics tools are expensive and often require a highly qualified data scientist and the analytics industry has seen a radical shift in how and which Business Analytic tools are used (Janardhanan & Umamaheswari, 2020). To save money,

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[33] Natural Language Interface: Interface that enables users to interact with computers in human language instead of computer language.

companies can use powerful open-source analytics tools such as Python and R which allow not only for advanced statistical modeling but also for sorting large amounts of data and creating algorithms.

The selection of the best or right Business Analytics tools is required to bridge the gap between business-led, predictive, and descriptive analytics as well as contextual analytics (Evans & Lindner, 2012). Based on the capabilities of the business and their decision-making goals, they can choose to use open-source analytics or commercial tools. The most used open-source tools include R which is a versatile tool with the ability to handle large data sets; Python with comprehensive coverage of mathematical and statistical functions; and Apache Spark built with a focus on analyzing unstructured and large data sets.

From SAS Business Analytics used to examine large datasets in real-time while forecasting future trends based on the information gathered from the datasets and to analyze unstructured data and convert it to meaningful information ready to use for analysis and decision making to MicroStrategy analytics that leverage native and advanced analytical capabilities, there is a variety of commercial Business Analytic tools that companies can use to stay competitive. The most used commercial Business Analytics tools include Tableau, SAP Business Objects, QlikView, Oracle BI, and Splunk.

Artificial Intelligence and decision-making

The concept of Artificial Intelligence originated in the first half of the 20th century with the involvement of mathematicians, scientists, and philosophers in the 1950s. One of such scientists at the beginning of Artificial Intelligence was the British polymath Alan Turing who studied the mathematical possibilities of Artificial Intelligence. In his paper Computing Machinery and Intelligence

published in 1950, Alan discussed not only how to build intelligent machines, but also how to test their capabilities and intelligence: This marked the beginning of the implementation of Artificial Intelligence (TURING, 1950).

After the publication of Alan's Computing Machinery and Intelligence, Allen Newell, Herbert Simon, and Cliff Shaw initialized the proof of concept through Logic Theorist, a program funded by the Research and Development Corporation, designed to mimic human's problem-solving skills. The Logic Theorist, interpreted by many people as the AI program, was presented in 1956 at the Dartmouth Summer Research Project on Artificial Intelligence, a project hosted by John McCarthy and Marvin Minsky.

Efforts in the implementation of Artificial Intelligence flourished from 1957 to 1974 with the ability of computers to store more data, acting faster, being cheaper, and more accessible. With the improvement of machine learning algorithms, decision-makers had a better understanding of which algorithm to use in their decision-making. One of the significant successes in the implementation of Artificial Intelligence that assured people and the government is Simon and Newell's General Problem Solver with the use of Artificial Intelligence to solve business problems. The second promising factor of Artificial Intelligence was the ELIZA of Joseph Weizenbaum demonstrating the ability of AI to interpret spoken language.

A problem in the development of Artificial Intelligence tools was the inability of computers to store information or the lack of sophisticated computational power. However, in the 1980s, the expansion of AI algorithm toolkits and the boost of funds reignited AI. In addition to David Rumelhart and John Hopfield's deep learning techniques which allowed computers to learn based on experience, Edward Feigenbaum also introduced *Expert systems* which mimicked how humans make decisions, by asking experts how to respond in each situation which is learned by the computer to allow non-experts to receive advice from the program. Besides the long

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implementation of Artificial Intelligence, the increase in the computer storage capacity with Moore's Law estimating that computer memory and speed double every year is the true enabler of Artificial Intelligence.

Artificial Intelligence is proven even more useful in the age of big data and the ability to collect huge sums of data that is too cumbersome to process without a sophisticated tool or system. Even more important is the fact that even if algorithms are unable to improve much, massive computing and big data enable Artificial Intelligence to learn by brute force by learning from data while interpreting it (Haenlein & Kaplan, 2019). Artificial Intelligence is very useful in the processing of large amounts of data and improves decision making in a variety of ways:

- Unlike passive machines, Artificial Intelligence algorithms often use real-time data to make decisions. By digital data, remote inputs, or sensors, AI algorithms combine information from different sources and analyze the material instantly before acting on the insights derived from the data (Duan et al., 2019).

- AI enables intelligent decision-making by taking data and looking for patterns. To make decisions faster and efficiently, Artificial Intelligence uses intelligent algorithms that use different considerations before compiling decisions.

- AI systems can learn new information and adapt quickly while compiling information and making decisions. The adaptability of AI systems also makes it possible to adjust inputs as conditions or circumstances change.

The growth of Artificial Intelligence and machine learning has led to an increase in the number of tools and frameworks. Some of the most important AI tools and frameworks used in decision making include:

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- Scikit Learn which expands on the NumPy and SciPy Python libraries,

- Tensor flow which enables google to understand verbal words in its voice acknowledgment application,

- Theano which exploits the GPU of the computer and enables the computer to process information faster,

- Caffe, a profound learning structure with a focus on speed, articulation, and measured quality,

- And Auto ML, one of the strongest AI tools used by Machine learning engineers in their models' optimization.

Business Intelligence tools

There are specific Business Intelligence tools that can be used to help in strategic and tactical business decision-making by focusing on understanding the trends in data and deriving insights. Again, our goal here is not to recommend a specific Business Intelligence tool but rather, define the importance of having these tools and how they impact decision-making. Business Intelligence tools are used to make better business decisions, to build reports faster and accurately, to improve operational efficiency, to find existing problems and new revenue streams. The use of Business Intelligence tools is crucial to discover data and give actionable insights to achieve business growth, resolve problems, and forecast future business opportunities. They include key performance indicator metrics, automated monitoring, and alerting tools, dashboards, ad hoc reports, scorecards, and operational and real-time Business Intelligence. Contrary to Business Analytics which deals with data warehousing and data storage, Business Intelligence tools use the data already stored in the data warehouse, data mart, or in the cloud and analyze them and tune them into actionable and insightful reports. The use of Business Intelligence tools enables organizations to:

- Bring together relevant data from different sources such as CRMs, ERPs, databases, flat files, and APIs. By using modern data connectors to obtain a high level of intelligence, to manage all data sources, and to develop a better understanding of the information collected, decision-makers can centralize disparate sources of data and have a single view of all business processes.

- Unlock data through self-service analytics: The ability of business users to explore the data on their own using modern Business Intelligence software considerably reduces the need of having to report from the IT department. The importance of Business Intelligence self-service is that it gives decision-makers a competitive advantage by equipping each employee with the minimum knowledge of analytical skills that will save the company time and resources and unburden the IT department and therefore enables them to focus on other important tasks (Alpar & Schulz, 2016).

- Predict future trends: By using Business Intelligence tools with forecast engines, users can generate information for future scenarios to adjust current strategies and deliver the best possible results. Predictions also enable decision-makers to discover new trends and patterns for immediate reaction in case business conditions change.

- Eliminate manual tasks: Business Intelligence tools can be used to eliminate manual processes by automating tasks.

- Reduce business cost: By using Business Intelligence tools, decision-makers can better monitor and optimize processes in real-time and plan, analyze, and report processes faster. BI tools can reduce cost because they enable businesses to work faster, accurately, and achieve better business results while making profitable adjustments.

- Optimize internal business processes and increase company revenue.

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- Increase business efficiency and boost business performance.

- Determine the trends and insights of the market and accelerate and improve decision making.

There are hundreds of Business Intelligence tools and we cannot list them all, but these tools can be divided into three (3) categories:

● Business Intelligence reporting tools: using Business Intelligence reporting tools can present some advantages for the business user as well as for the business analyst. To the user, the use of these tools enables scheduling a report of a dashboard that can be emailed at the scheduled time from the reporting software, determining how to report embedded within an email or how to receive a PDF attachment, receiving only needed information using customization and filters, unsubscribing, or turning off scheduled reports by email as well as personalizing the look and feel of the attached PDF file attached in the email. To the business analyst, the benefit of using Business Intelligence reporting tools could be pushing critical business reports at a specific time based on the needs of the company and decision making, preventing a user or group of users from viewing the report, and having control of the dashboard and disabling sensitive data subscriptions. Using reporting tools is necessary to have a report that is meant to the right audience and is targeted with the correct information, making decision-making what it should be in a good data-driven company (Tvrdikova, 2007).

● Business Intelligence querying tools: Querying tools are used by decision-makers to query a database system and generate reports. Not only do querying tools give business users a simple answer but they also are customizable to filter, sort, and format data.

● Advanced Business Intelligence tools: these are tools used to dive deeper into data analysis with the use of predictive analytics.

Importance of data visualization tools

In simple terms, data visualization is a visual representation of information. Visualization tools are used with information systems such as Business Intelligence systems, knowledge management systems, and big data analytics to tackle complex decision making and as such, decision-makers can use external sources of information to help them acquire useful insight into the problem and collaborate effectively in solving the problem (Burnay et al., 2019). Data visualization tools are used quickly in transferring data and explaining it in human terms by communicating relationships of the data in graphs. While making important business decisions with big data, visualization makes it easy to convey the message with clarity and see the relationship and connection in the data. For example, even though using raw data in excel or a database management system is useful, representing the same data using pies, charts, or histogram is more powerful than the raw data because it allows even non-technical users to see how every data impacts the overall data and helps the presenter to communicate data in a way that is easy for the viewer to interpret and draw conclusions (Cardno et al., 2014). To illustrate the importance of data visualization, let us consider this dataset:

| Age	Has Job	Own House	Credit Rating	Class
young	false	false	fair	No
young	false	false	good	No
young	true	false	good	Yes
young	true	true	fair	Yes
young	false	false	fair	No
middle	false	false	fair	No
middle	false	false	good	No
middle	true	true	good	Yes
middle	false	true	excellent	Yes
middle	false	true	excellent	Yes
old	false	true	excellent	Yes
old	false	true	good	Yes
old	true	false	good	Yes
old	true	false	excellent	Yes
old	false	false	fair	No

This dataset represents loan applications, and a decision is made to identify people who are approved for a loan application and those who are denied. In the class column, rows with "yes" value represent loan approval while rows with "no" value represent its denial. The bank could be interested in finding the percent of any age group approved for the loan. Even though this is a very simple dataset, the question is not just simple to answer. Below is an efficient way to answer the question and enable even non-technical users to understand the decision-making process. While the chart represents the percent of each age group based on the total application, the histogram represents the percent approval rate based on the total number of applicants in each age group.

Figure 1: Data visualization with a pie chart
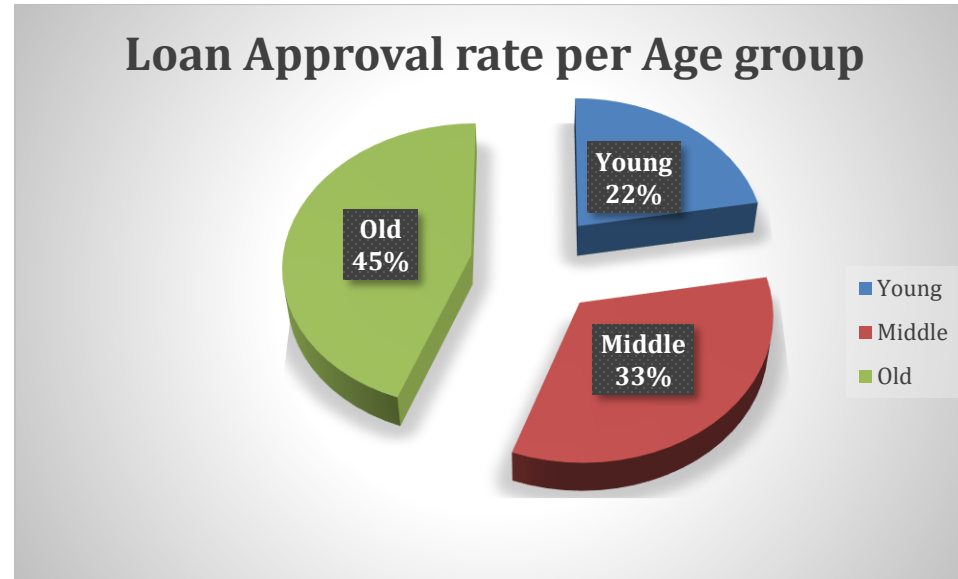
In the histogram below, the visualization enables people without technical knowledge to understand that forty percent (40%) of young applicants, sixty percent (60%) of middle applicants, and eighty percent (80%) of old applicants are approved.
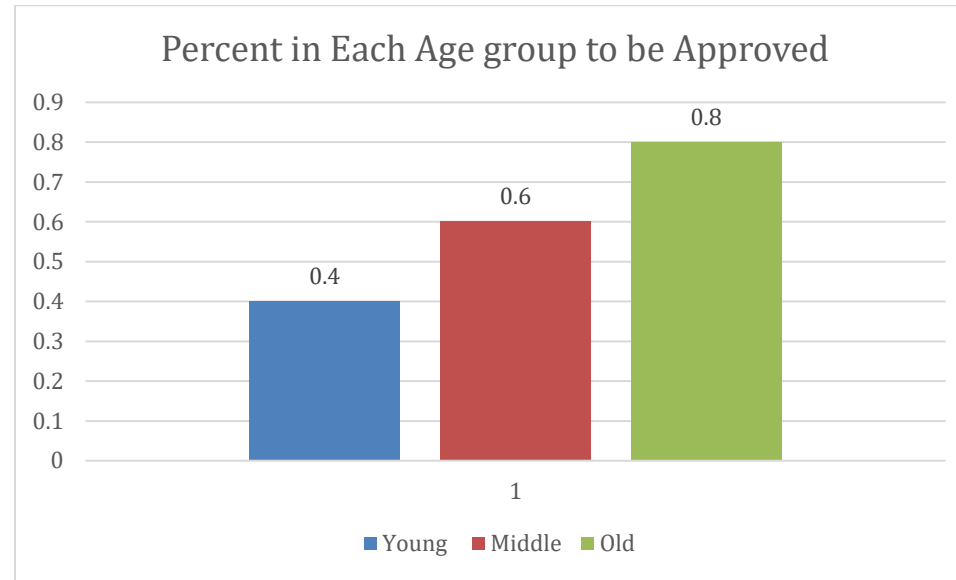
Better yet, a decision tree can be used to answer important questions about the loan application approval. The following are some questions that can be answered by the decision tree that follows:

- How many people have applied for a loan

- How many applicants own or do not own a house

- How many applicants have or do not a job

- How many applicants are denied even though they have a job

- How many applicants without a house are approved

- How many applicants with jobs are approved or denied, …..

Figure 3: Loan Application Decision Tree
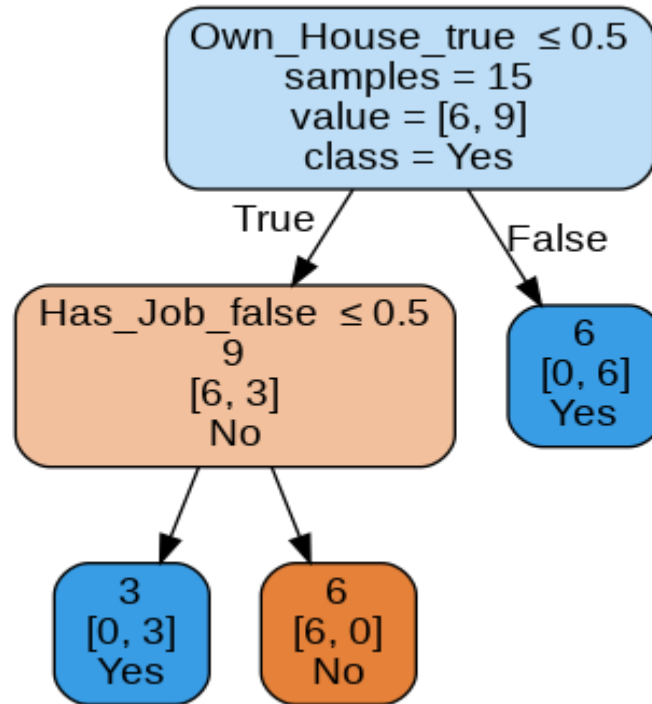
How to use data visualization in decision making

The English adage "A picture is worth a thousand words" has its true meaning in data visualization and decision making. Data

visualization allows patterns and trends to be seen more easily and is important to use because a visual representation of information

makes it easier to identify trends and patterns. Data visualization has also thrived on helping application and end-users transfer data in

computer terms or space to knowledge and information in the cognitive and perceptual space to further human understanding (Chen et al., 2009). The importance of effective data visualization include:

- Data visualization tools can be used to see the change in trends over time. If we take data stored about road car accidents, for example, the use of data visualization tools can enable decision-makers to see the change in trends such as the month and season that most accidents occurred, the severity of the accident as well as the make and model of vehicles involved. If most accidents take place between fall and spring, then maybe the weather may be the primary contributor and decision-makers can make their decision based on the most contributing factors.

- Data visualization tools can also be used to see the frequency of data in the business environment. When making decisions, it is important to see the frequency of events. For example, even though a single factor may affect a business environment significantly, it is important to see if that factor happens over time or occurred only one time. If the factor just happens for the first time, then it is necessary to closely monitor it without using too much of the company's resources on that factor or making decisions based only on that factor.

- Just like determining the frequency of events, determining relationships or correlations between the data is important as well. Using a pie chart visualization, for example, decision-makers can easily define the percent rate of all variables. Identifying relationships in data is important to make the decision based on the right factors and using the resources of the company in the right place.

- Some data visualization tools offer scheduling capabilities. For example, project management could get confusing, complex, and tricky without thorough planning. By using a visualization tool like Gantt chart and work breakdown structure, for example, project managers and decision-makers can simply go into detail with the tasks required to complete the project and keep track of the timeline and important decisions to make.

- The use of data visualization tools facilitates decision-making by comparing value and risk. Before making any decisions, businesses should consider the opportunities, values, and risks associated with the decision. To evaluate the risks and values, data visualization tools can be used to factor variables that are involved in decisions by looking at the false positives, false negatives, true positives, and true negatives.

There are different methods to visualize the data and decision-makers should consider what they want to visualize and what is the best way to visualize it. Very often, decision-makers can use different visualizations for the same data to view the data from different angles. Data visualization techniques are summarized in the table below:

Table 2. Decision-Making Data visualization techniques

Visualization technique	Use Case
Pie Chart	Used to illustrate change over time. Ideal to illustrate part to whole comparison or proportion. Suitable for an audience who is not familiar with the information by displaying key takeaways.
Bar Chart	Uses two axes to show the values being compared and the measurement of the values compared.
Histogram	Used to illustrate the distribution of data over a defined or continuous interval. Great to identify concentration areas as well as unusual values, show the frequency of an occurrence, and determine the maximum and minimum values.
Gantt Chart	Used to illustrate the timeline of each task in a project, present project plans, report progress, and keep the project on track. Helps decision-makers to stay organized by displaying timelines and enabling teams to keep track of every aspect of the project.
Heat Map	Used to show differences in data by variations in color. By using color to communicate values, users can easily identify trends.

A box and whisker plot	Provides a visual summary of the data through quartiles. Most useful in the provision of a visual summary of the data and to identify if a data is symmetrical or skewed.
Waterfall chart	Used to illustrate how value changes. Primarily used to show how a value has declined or grown over some time.
Scatter plot	Used to illustrate the relationship between variables and the correlation or trends in data.
Area Chart	Most useful to show changes in one or more values over time and the combination of each value to make up the whole.
Decision Map	Used to make better decisions by making the thinking more rigorous, clear, and complete. Requires making explicit all the decision points and producing a map to represent the decision points in a visual form.
Pert Chart	Used after planning and breaking the project into tasks, outline the time needed to complete each task, and help project managers do determine the succession of tasks, and to illustrate the least and most important tasks
Pareto chart	Used to visualize the most important items in a set. Mostly used in the visualization of quality control

	issues in the prioritization of problem areas.
Work Breakdown Structure	Used to illustrate components and subcomponents of a project, to arrange a work into manageable pieces,
Decision trees	Used to outline all decision alternatives and outcomes in a diagram, used to identify the highest or best predictive value in decision making

As we can learn from the table above, there are many techniques to visualize data and to achieve the best visualization and make the right decisions, it is important to know and understand how to use data visualization effectively to support analytic reasoning (Viégas & Wattenberg, 2007). Data visualization can be used in every industry and decision making and, in the sales industry, for example, it can be used to identify areas that need improvement or attention, to understand which factors influence customer behavior, predict sales volumes as well as identify where to place each product to maximize sales.

Data visualization should be used in decision-making whenever possible because many people are visually oriented, meaning they understand a visual representation of information better than raw data or information in technical terms. Making sound strategic decisions requires companies to establish coherent management and decision-making system enabled by data visualization (Kokina et al., 2017). The effective use of data visualization requires answering five (5) important questions: who the audience is, the questions

the audience has, the best suitable answers, the best way to present the information, and other questions that may arise from the visualization. Below are some of the best practices in data visualization to make effective decisions.

Table 3 Data visualization best practices

The suggestion of data methodology	What it entails	Goal
Agreeing on the data visualization methodology	strict adherence to data acquisition process standardization, design parameters., and visual schema	Consistency in data visualizations and the customization and familiarization of the target audience to the visualizations
Understanding the audience	Knowing the target audience, their occupations, and interest.	Designing a meaningful and understandable visualization, keeping users engaged
Determining the desired outcome	Calling to action, knowing the end goal of the visualization	Meeting the expectations of business users and making the right decisions
Using classification	Knowing the industry and the problem you are trying to solve	Meeting the purpose of the visualization

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Profiling the data	Make common sense to everyone, categorizing and ordering data,	Differentiating and grouping data in logical sets to make the best possible decision
Using visual elements as intended	The use of less creativity in a way to distract users and convey non-essential data	Making the audience focusing on the visualization without distraction, choosing the right visual for the right purpose
Doing a deep study of the data	Differentiating between quantitative, ordinal, and categorical data.	Having an interactive design, understanding a high-level overview of the data

Considerations before choosing a Business Intelligence tool

To harness the power of analytics, big data, and make smarter and data-driven decisions, companies use Business Intelligence tools and software. Popular Business Intelligence tools include Microsoft Power BI with its dataset, dashboard, and report functions, SAP Business Intelligence, IBM Cognos, and Tableau to name a few. Features that are common to most Business Intelligence tools include:

- their ability to connect to source data in real-time from external and internal sources (ERP, CRM, HRM, and more);
- their ability to get the data ready for analysis through the ETL process.

- The use of visualization tools to present the data in a visual format.

- The use of a data warehouse with information from all business systems and applications.

- The use of Online Analytical Processing tools to pull out data from the data warehouse.

- The use of dashboards to present the most important reports.

- the use of data mining tools to find patterns and new information within complex and large data sets.

- the use of ad hoc reporting tools as well as predictive analytic tools.

Even though there are hundreds of Business Intelligence tools, they often target some specific industries or are more often used to support decision-making in some businesses and are not very suitable for other businesses. Although Business Intelligence technologies are more accessible and there are many technologies to choose from, choosing a suitable solution remains a challenge for many businesses. To choose the best Business Intelligence tool and make informed decisions, organizations must do several things including:

- The knowledge of the needs of the company: it requires talking to every department in the organization that will use the Business Intelligence tool or will be affected by the decisions made. Knowing the needs of the company presents many benefits such as finding issues that need to be addressed, ensuring top executives are informed and onboard during the implementation of the tool, and prioritizing the objectives of using the tool. This is important as it allows us to align the business solutions with the objectives of the company.

- The creation of a shortlist: After defining the objectives of using the BI tool, decision-makers should make a shortlist of vendors that best fit the needs of the company. Creating a shortlist involves listing the features that the tool must have as well as the optional features and the deployment options that meet the requirements of the company.

- Reaching out to BI tools vendors: Before spending money on any Business Intelligence tools, businesses should reach out to the vendors of the BI tools that they have shortlisted. This is an opportunity to explain the objectives of the company, the business problems the BI tool will solve, as well as the features that are required in a solution. Businesses should request a demo to see what the tool does in real-time and request a free trial of the tool to ensure that it will solve the business problem in real-time and support decision making.

- Comparing tools and vendors: the last step in choosing the right BI tool is the comparison of different vendors. Even though the first vendor's tool may be suitable to solve the business problem, businesses should contact additional vendors to compare not only the tools and features, but also and more importantly the price of the tools which often varies based on the size of the company, implementation, customization, and deployment. While comparing vendors, companies can request references from these vendors not only to know if the tool is efficient and effective but also and more importantly any issues that the client has experienced while using the tool.

Table 4. BI Tools Comparison

Tools	Advantages	Disadvantages
Microsoft Power BI	Powerful platform with many data source connectors, Exceptional data visualization capability, user friendly	Web and desktop versions dividing data preparation tools, Limiting refresh cycle on the free version
Tableau Desktop	Enormous data visualization and connectors collection User friendly Maturity of the tool with a large users' community	Full mastery requiring substantial training
Google analytics	An exceptional platform for mobile app and website analytics	Automation of customer support Too much marketing and advertising Reliance on third parties for training
Zoho Analytics	Decent price ($25 / mon]th for the basic plan) Simple and quick automatic report generation	Steep learning curve Reporting features frustrating

	The interface that is easy to use/follow	
Chartio	Web-based Handles complex queries well Query optimization on SQL Impressive processing engine	Steep learning curve User interface poorly designed
Sisense	Strong natural language query in third-party apps Appealing comprehensive features Fewer bottlenecks	Too complex for self-service BI tool Weak analytical process Limitations of natural language features
Domo	Impressive sharing features Wide range of connectors Unlimited data storage Solid data visualization capabilities	Steep learning curve Not intuitive user interface Hard to use by new analysts
SAP Analytics	Consolidated analytics and centralized view Very responsive	Lacking data prep features Confusing toolbar design

	Impressive storytelling paradigm	Unfriendly for beginners

Business Intelligence and Cybersecurity

There is a big responsibility associated with big data. Even though Business Intelligence has helped businesses to solve important issues and make important decisions, it also enables organizations to expose their data more often, raising the question to understand if Business Intelligence is a threat or an opportunity because big data has enabled cybercriminals to use advanced technologies to gain access to business-sensitive information and personal information of employees (Moore, 2015). The implementation of Business Intelligence tools can raise security concerns for any organization as cybersecurity Business Intelligence presents the challenge of information security in a factual way which will give decision-makers a clear picture of what needs to be done for a secured company. Data security is one of the major concerns with effective decision-making and companies must establish self-configurable security policies to maintain (Balachandran & Prasad, 2017). Whether it is during the storage of the business data or its use during decision making, organizations should always take a step back and consider all possible security implications that can arise. For example, the data of a company can be exposed through network attacks, unauthorized access to the data center or storage device, software vulnerability, and even a threat from an insider.

The security of a company's data does not only depend on the software or tools used, but also on people and the organization's cybersecurity team needs to recognize risky behavior models and vulnerabilities. With the rise of big data, companies face new

challenges to protect personal sensitive information, defining data rights and ownership, as well as analyzing and making good use of the data. Most companies are prone to exposing their Business Intelligence systems to attacks because they have almost no cyber-Business Intelligence to track key performance indicators (KPI) that can keep them safe and free from financial ruin. As such, the ultimate goal of cybersecurity or the importance of cybersecurity implications is making data-driven decisions from trustworthy, secure, and reliable data (Sarker et al., 2020).

As the value of information is increasing, data breaches and attacks to break information systems are also increasing. Social engineering attacks are also on the rise and companies have the responsibility in encouraging employees to accept the idea of being the gatekeepers of corporate information and of playing a tremendous role in keeping the company's data safe because once employees know and understand the impact they are making, they will do everything to ensure the security of the data and the company. The importance of employees' training and awareness of cybersecurity best practices is that they provide to employees guidance to identify threats and fight cyberattacks (L. Li et al., 2019). To emphasize the importance of attacks to information systems, the top data breaches in 2020 are listed in the table below:

Table 5. Attacks against information systems

Company	Number of records affected	Information accessed
Microsoft	250 million	Email addresses, IP addresses, support case details
Wattpad	268 million	Personal information such as usernames and passwords, full names, IP and email addresses, genders, location, birthdates
Broadvoice	350 million	Caller name, business, and phone number, identifier or name for voicemail, internal identifiers
Estée Lauder	440 million	Email addresses in full text, internal documents, IP addresses, pathways, and storage information
Sina Weibo	538 million	Personal Identification Information such as names, gender, site, usernames, location, phone number
Whisper	900 million	No real name exposed, but user age, gender, ethnicity, nickname, hometown, and group membership

BlueKai	billions	Names, home address, email addresses, and web browsing activity
Keepnet Labs	5 billion	No exposition of customer information or company data
Advanced Info Service (AIS)	8.3 billion	NetFlow logs and DNS query logs for AWN customers
CAM4	10.88 billion (more than 7 terabytes of data)	Full names, user chats, IP addresses, credit card information, password hashes, inter-user chats, etc

As we can argue from the table above, data breaches are on the rise and companies should take all necessary precautions to protect their data. One of the most important measures that every company should take to protect their data is the use of tokens[34] such as security devices to protect sensitive information like employees' information from being accessible to fraudsters (Maharaj, 2020). These are suggestions to deal with cybersecurity implications in decision-making:

1. Data breaches: Using Business Intelligence tools to analyze sensitive data is risky because there is often a vulnerability in the tool that leads to data leaks. By exposing sensitive information, the tool can harm the business, employees, or customers. As

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[34] Token: Special physical device used to protect sensitive information and can enable authorized access to computer and network systems.

such, an important consideration when choosing Business Intelligence tools is the review of the security options available as well as the security credentials of the developer to prevent the loss of valuable data, resources, and customer trust.

2. Businesses should implement access control in the data warehouse, at presentation and reporting levels and grant access to users as needed.

3. To reduce data leaks, businesses should adopt data de-identification[35] procedures and strip all personal data details. Data de-identification is the removal of personal and critical business information from data before sharing it or using it in business decision making.

4. User training and education: Even if a company has implemented all possible security measures, training, and educating users is the best way to avoid cyber-attacks. Users should be training not only on the use of the data but also and more importantly on how to safely use the software and tools in decision making as well as ways to recognize security issues to raise awareness. It is important to invest in Business Intelligence security systems to solve the biggest and most challenging cybersecurity threats as they relate to decision-making (Tadapaneni, 2020).

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[35] Data de-identification: Removing personal information and critical business information from data before sharing it or using it in business decision making.

Conclusion

The importance of understanding how to use Business Intelligence tools to answer critical business questions is that they can give businesses an edge over the competition and as business information and processes are taking a digital format, Business Intelligence tools have become increasingly valuable (Borissova et al., 2020). To make the best possible decisions, businesses need to evaluate all factors that may be involved in decision making and change the outcome of the decision. Decision-making starts with the storage of information and the security implications of the information system because even though most businesses are very competitive in using the latest technologies, technologies do not make decisions: people do. As such, instead of focusing on using the latest technologies, businesses should focus instead on evaluating different tools and technologies to decide which tool best suits their needs and can improve their decision-making.

Data-driven decision-making framework.

There are eleven (11) steps that businesses can take when making a data-driven decision. These steps constitute the data-driven decision-making framework and following these steps will lead to making a better and smarter business decision:

1. Identify the business problem: This is the primary and most important step in decision making because before trying to decide, businesses should have a business question to answer, a change to make, a goal to achieve, or an objective to meet. This step is the first step in decision making because all the following steps including the decisions to be made are based on the business problem identified.

2. Define how to solve the problem: By defining how to solve the problem, decision-makers can look at all the factors involved in the decision-making. The importance of this step is that it allows decision-makers to choose the right Business Intelligence tools to answer the question or solve the business question. Also, the definition of how to answer the business question gives a better understanding to decision-makers and enables them to identify all the necessary prerequisites.

3. Gather relevant data: Because businesses collect a variety of data, this step allows them to access their data storage systems and gather only the data that is most suitable to answer the business question. To improve sales, for example, businesses would look at their previous sales and marketing data as well as customer reviews since all these can affect sales or customer relationships.

4. Assess the data quality: This is a required step to make sure that the quality of the data is acceptable and that there is nothing obvious that may lead the business in a different direction or lead it to make the wrong decision. By accessing the data quality, for example, a business can discover that the data is irrelevant or has been accessed and modified and this will require gathering another data.

5. Prepare the data for analysis: After gathering the relevant data and accessing its quality, the next critical step is to prepare it for analysis. Preparing the data for analysis is required to ensure that enough data cleaning and data is preprocessing.

6. Analyze the data to derive insights: Data analysis is at the center of business decision-making. The data analysis relies on the definition of how to answer the business question in step two and the Business Intelligence tools chosen to answer the

question. The importance of data analysis is that it allows deriving insights from the data and can be used to identify the major sources of the business problem which requires decision making.

7. Identify the primary and alternative solutions: After analyzing the data, there should be a recommendation about how to improve business performance and maintain a competitive advantage. Even though data analysis may lead decision-makers to identify one primary trend that will shift the business drastically, it is important to consider alternative trends and evaluate all possible solutions.

8. Interpret the solutions: Interpreting the solution is required to explain to decision-makers and business executives the findings in the data analytics and the recommendations to improve business performance.

9. Conduct a SWOT[36] analysis: To determine the best course of action, decision-makers, the management, and senior executives must conduct a SWOT analysis. The importance of conducting a SWOT analysis is that it allows the business to question not only the decision to be made but also and more importantly the capability of the business to take that direction. For example, while data analysis may indicate that buying a new technology can improve business performance, the reality of the business could be different requiring to keep using the old technologies and implementing alternate solutions to boost performance and to stay competitive. There is often no need to use the same tools as a competitor to maintain a competitive advantage.

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[36] SWOT Analysis: A detailed analysis that reveals the strengths and weaknesses of a decision as well as opportunities and threat in making that decision.

10. Make the final decision: After weighing the strengths, weaknesses, opportunities, and threats of all possible solutions, decision-makers should select the best possible solution. What is important to consider here is that the final solution may not be the primary solution identified in the data analysis, the reason why conducting a SWOT analysis is very important. The best decision is chosen as it relates to the business environment because decision-making is very complex and involves several internal steps that the tools do not take into consideration or cannot predict (Clemen & Reilly, 2013).

11. Solve the business problem: To solve the business problem, the best solution is selected. After selecting the best decision for the business, decision-makers have the responsibility of implementing this new decision to solve the business problem or to beat competitors. The implementation of the new decision may require purchasing new technology, changing some aspect of the business, or stop doing certain things which do not benefit the business.

Figure 4. Data-Driven Decision-Making Framework
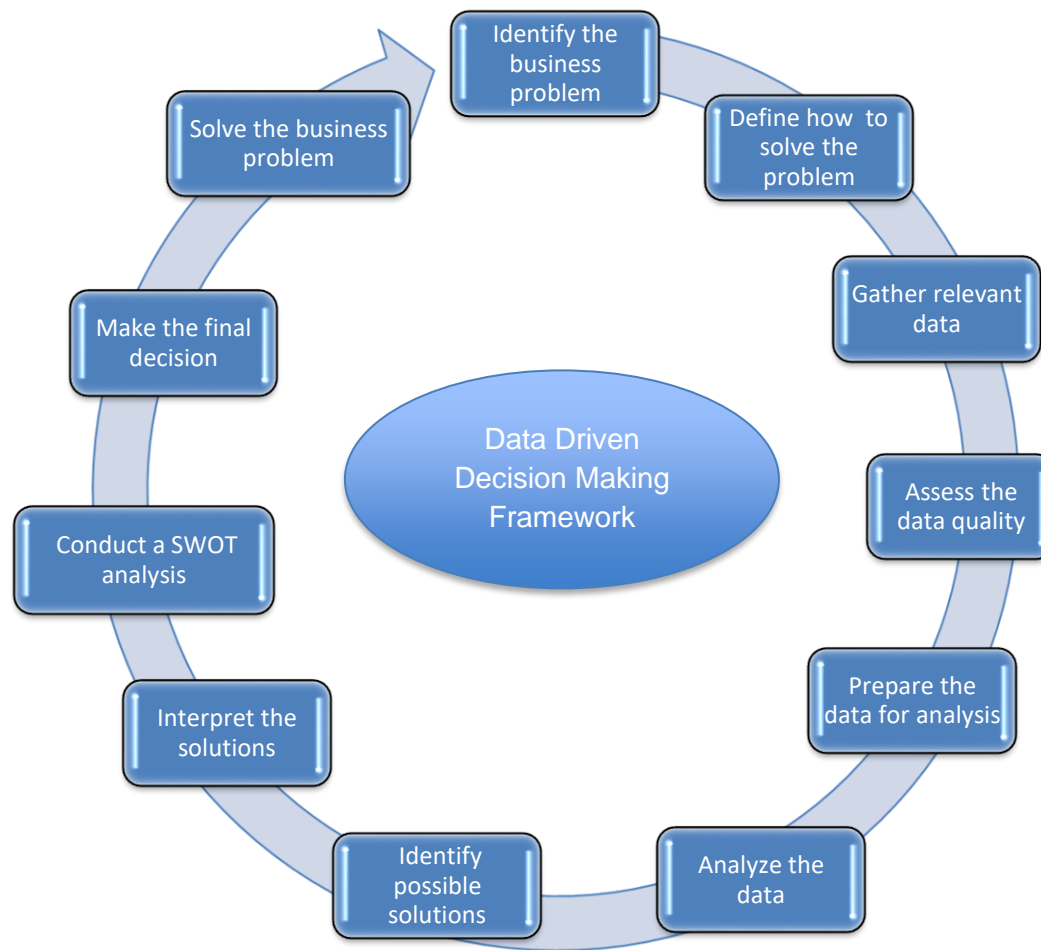
No matter how good or accurate the tools may be and how good the decision may sound, a SWOT analysis will help the business to do a deep evaluation of the decision before implementing it. By a SWOT analysis, the company can analyze its strengths such as qualities that make it competitive as well as resources and assets that are in the disposition of the company and how these

strengths can support the company's new direction. By analyzing weaknesses, the goal is not to analyze the overall weakness of the company, but weaknesses that can arise in the adoption of the chosen decision. For example, the analysis says using this tool or this technology will make the company competitive, but does the company has the resources to implement the technology? Does it have or understand the required knowledge and limitations of the technology? Asking these questions would help the company to deeply evaluate the technology to be implemented before making the final decision. By opportunities, the company studies how their decision will move the company forward from the current state to the state where the company wants to be in the future. Opportunities reveal all the success that making the new decision will bring and can help the company to find if making the decision will help it to maintain a competitive advantage. Evaluating the threats goes beyond knowing the security risks involved in decision making. By evaluating the threats, the company can evaluate its customers and competitors and decide how stakeholders may react to the new decision. For example, a new decision can change a customer's attitude towards the company, henceforth it is important to evaluate all the alternatives before making a business decision.

Even with the proliferation of Business Intelligence tools, big data still makes it a challenge for companies to make decisions. These challenges will only grow up with an increase in the information collected. An extra step that decision-makers can take before the implementation of any changes in the business is using decision support systems which are useful in processing semi-structured and unstructured data. With decision support systems, companies can see the impact of their decisions by developing a scenario for a solution or by seeking a goal by analyzing what happens if another decision is made or what to do to meet a specific goal and solve a

business problem. By using Executive Information Systems, for example, managers and decision-makers can easily track critical success factors to make the best possible decision.

Future implications

Due to the change of data mining tools over the years, many things are possible for the future. How will Business Intelligence change the decision-making process in the future of businesses? Will Business Intelligence be able to solve all business problems and assist decision-makers in reducing errors when making decisions? Microsoft has acquired [Lobe Artificial Intelligence](#) to facilitate machine learning and decision-making for people without any knowledge in data mining. How will applications such as Lobe and other Artificial Intelligence models improve machine learning and decision-making in the future? Just like robots and machines have taken humans' place and do almost one hundred percent (100%) in major manufacturing companies, will Artificial Intelligence eliminate humans' work in decision-making? Machine Learning and business decision making are still new, are emerging, and there are many possibilities and opportunities for the future, and these are some of the questions that are important to consider for the future of data-driven decision making.

Table of Figures

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