

# The Business Intelligence Use In Healthcare And Its Enhancement By Predictive Analytics

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## ABSTRACT

*In the last few years the business intelligence systems (BI) had seen a wide spread among organisations in different sectors such as healthcare and it was studied by many researchers. This study aims to describe what are the business intelligence systems, their benefits and challenges especially when its used in healthcare sector. Moreover, this research suggests that the integration of predictive analytics with BI models could give a better understanding especially regarding the effect of information quality and decision-making quality on the organizational growth and performance. The outcomes of this research show that the main benefits of using BI in healthcare is to improve the decision-making b making it better and faster, enhancing hospitals performance, reducing costs, enhance the quality of healthcare provided to patients, and save time. Moreover, the main challenges in healthcare is the problem of data quality, and the integration of BI with other hospital systems. Therefore, the analysis of previous BI models shows that there is a consensus that BI system maturity and management quality influence the data and information quality which in turn affect positively the users' satisfaction, BI usage, and the decision-making quality and lead to improve it. While there is some a contradictory opinion which claim that data quality is no more a challenge and does not affect the success of BI systems. Moreover, BI systems have direct and indirect effect on the decision-making quality but there still no research proving its influence on the organizational growth.*

**Key words:** business intelligence, predictive analytics, healthcare

## INTRODUCTION

In last few years the business intelligence systems (BI) had seen a wide spread among organisations in different sectors and it was studied by many researchers. The first definition of BI systems was by an IBM researcher Hans Peter Luhn as “the ability to apprehend the

interrelationships of presented facts in such a way as to guide action towards a desired goal.” in 1958 (Meimei, 2013). Then in the late 1970s business intelligence started to be known as technologies for decision support and then it was expanded in 1989 by Gartner who defined “Business intelligence (BI) - as an umbrella term that includes the applications, infrastructure and tools, and best practices that enable access to and analysis of information to improve and optimize decisions and performance”. BI are used for performance management and making reports, analysis, predictive analytics, and decision making (Vikas , Amol, 2015).

The next sections of the paper will include a deep overview of BI systems and their use in healthcare, and what are the predictive analytic systems and their relationship with BI and how the addition of predictive analytics systems to BI models can enhance their results.

## I. OVERVIEW OF BUSINESS INTELLIGENCE SYSTEMS

BI systems were defined with various definitions, (O'yku", Mary and Anna, 2013) consider BI as a system including organizational and technical elements which provides its users with historical information for analysis to be able to take better decisions and to support management to get an improvement and increase of the organizational performance. Moreover, BI can be considered as a term for decision support systems by the integration and analysis of organizational data resources to enhance the business decision making that will be based on wider knowledge. (Lior , Nir, and Adir, 2017) and (Cheng-Che, Ray-E, Ching, and I-Chiu, 2017) agreed in the definition of BI, (Lior , Nir, and Adir, 2017) see the aim of BI is to improve the quality of information utilized in the decision-making process by simplifying the storage, identification and analysis of information. Moreover, BI enables to analyze business activities from different

perspectives and improve the agility of the organization. Thus, the BI lead to enhancement not only for the technical side but also it has a significant organizational impact in improving the decision-making process and executing business activities. Thus, BI systems application permits the change to a culture of fact based decision making and this will lead to many benefits such as improvement in the information and business processes, saving cost and time, better decisions, and greater strategic performance (Lior. F., 2017). And (Cheng-Che.S..., 2017) consider BI as a modern information technology that allow the extraction, integration, and analyses of the timely and useful information of the organization to be able to assemble knowledge for accurate and better decisions. In fact, BI provide a strategic intelligence and business logic that support the decision-making process. One of the BI characteristics that its applicable and works well with the structured and unstructured data. "BI transforms information into knowledge and has the capability of putting the right information into the hands of the right user at the right time to support the decision-making process" (Wilfred,2013). Moreover, (Bernhard and Maria, 2015) define BI "is not just about software and systems, but about the whole process of managing data to eventually support managerial decision making"

An additional definition of BI is that its "*a set of methodologies, processes, architectures and technologies that transform raw data into meaningful and useful information used to enable more effective strategic tactical, and operational insights and decision-making*". (Pablo, Viktor, Marat and Jorge, 2014). (Celina and Kornelia, 2012) assume that BI goal is to help in improving the decision making by applying the applications, technologies and practices that allow to collect, access, integrate, analyze, and present business information to get deeper business insight and allow decision makers to take better and effective decisions. Thus, the BI systems are used by organizations to achieve their strategic goals, to augment their profits, and satisfy more their customers (Celina and Kornelia, 2012). The implementation of BI suffers from some limitations and flaws such as there is no concentration on the individual need of decision makers and the rely is only on reporting and analytical methods and technical skills, the lack of business context for the analytical data which will increase costs and efforts, the alignment between IT department and business department is poor, the time of BI implementation is long which lead in an increase in its cost and limit BI deployment. Moreover, BI focus on internal and structured data with limited capabilities to integrate external and unstructured data in real-time and

effective way which may lead to inaccurate business decisions (Pablo, Viktor, Marat and Jorge, 2014).

BI systems solutions are mainly based on various automated analytical and processing tools such as ETL, OLAP, reporting, and data mining. For effective use of BI solutions and efficient investment, organizations must be aware of its actual needs and how those systems can be effectively used, and there should be a continuous update, investment and development of the ICT structure and solutions. Thus, the BI systems architecture is composed of interdependent components as follows (Osama, Ali and Luiz, 2013):

- The multidimensional data warehouse: Data ware house is the essence of a BI solution, it's a database that contain the needed data for decision making, prediction, and performance management. The multidimensional modeling techniques are used to design organization data warehouse and departmental databases. In the healthcare context, the clinical data warehouse is considered more complex to build in comparison to other businesses and can be defined as "Place where healthcare providers gain access to clinical data gathered in the patient care process"
- The source system: the BI should include all information in databases, and external data such as through excel sheet, XML, flat data files and others.
- ETL (extract, transform, and load): it's a process starting by extracting data from various data sources and transfer it after cleaning and harmonizing to data warehouse to make the data match and fit the multidimensional model, then the stage area where the intermediate results for transformation will be stored in a separate database in the data warehouse, after that, once the transformation is done the data can be loaded into the multidimensional model. Thus, the aim of ETL is to extract, load and transfer historical and current data into a common data warehouse.
- Operational data store (ODS): it's an off-line copy of production source systems that help in the operational reporting and not for assisting the strategic decision making.
- OLAP (online analytical processing): it's an analysis technique that have different functions such as the accumulation, summarization, integration, and viewing the information from various angles.
- Semantic layer for reporting: it's a layer between the database and reporting that facilitate the access to data for the end users and make the creation of reports easier by translated the database fields to objects that each has a business

definition which make their dragged and drop onto a report easier.

- Business intelligence portal: it's the creation of a single point of access in the form of portal that include reports with obvious description of each report scope and business owner for monitoring business results.
- Data mining: it's an automated process to discover and find the unknown useful patterns in structured data. (Osama, Ali and Luiz, 2013)

Over the last few years BI has become in the top of IT preference between organizations business leaders (Leszek Ziora, 2015) due to its numerous benefits and advantages which are mainly to be able to take faster and better decisions, increase of revenues and decrease in costs, improve the internal communication in the organization, makes customers more satisfied by improving the quality of services provided to them (Nebojša, Zoran , Miroslav and Jasmina, 2014), the

prediction of future trends, and faster respond to internal and external issues (Meimei, 2013), increasing the efficiency of management, agility to respond to market changes, help also in the creation and improvement of the organization strategy and the enhancement of business processes (Leszek Ziora, 2015).

In this research the business intelligence systems will be defined as set of technologies, architecture, tools, processes and best practices to extract insight and useful information from structured and unstructured data about the current business performance of the organization and to report about historical trends to take better decisions and improve the organization performance.

The table below show the main business intelligence benefits and challenges in different sectors

<b>BI BENEFITS</b>	<b>REFERENCES</b>	<b>BI CHALLENGES AND ISSUES</b>	<b>REFERENCES</b>
-to take better decisions - to support management - to get an improvement and increase of the organizational performance -to enhance the business decision making	(O'yku", Mary and Anna, 2013)	- rely is only on reporting and analytical methods and technical skills - the lack of business context for the analytical data -, the alignment between IT department and business department is poor - the time of BI implementation is long -Dispute between researchers about the BI capability toward unstructured data	(Pablo, Viktor, Marat and Jorge, 2014).
- to improve the quality of information utilized in the decision-making process - improve the agility of the organization - improving the decision-making process - fact based decision making - improving business processes - saving cost and time - greater strategic performance	(Lior, Nir, and Adir, 2017)  (Lior. F., 2017)	-continuous update	(Osama, Ali and Luiz, 2013)

-To achieve strategic goal - to augment profits, - to satisfy customers	(Celina and Kornelia, 2012)		
-improve the internal communication in the organization - improving the quality of services	(Nebojša, Zoran , Miroslav and Jasmina, 2014)		
- prediction of future trends - faster respond to internal and external issues	(Meimei, 2013)		
-help in the creation and improvement of the organization strategy - enhancement of business processes	(Leszek Ziora, 2015)		

**Table 1: BI benefits and challenges in general**

**II. BUSINESS INTELLIGENCE SYSTEMS USE IN HEALTHCARE**

In the healthcare organizations information constitute a significant component to be able to take administrative and clinical decision making to deploy resources efficiently and providing high quality of patient care. In this context, business intelligence can help by using analytical tools that allow informed decision making in different organizational contexts by integrating data from various internal and external sources and provide an effective platform of information for the decision makers in healthcare organizations. BI has various benefits in healthcare comprising reducing costs, improving process, improve the quality of healthcare provided to patients, and better use of human resources (Neil and Craig, 2014).

BI can be used as a term that cover and refer to analysis tools and includes applications, methodologies, and technologies for the collection, manipulation, analyze, store, and provide access to data to help decision makers in organizations to take better and faster decisions. BI are spreading among healthcare organizations due to their ability to assist managers to take better decisions in the agile and complex environment to be able to compete and manage organization efficiently. Thus, BI help in managing effectively data to enhance the operational performance, financial performance, and quality of healthcare provided to patients. And it helps by its use with EHR to get the required clinical information easily and efficiently. The integration of BI with EHR in healthcare organizations have many benefits such as operational efficiency, simple and rapid analyses, saving time, enhanced decision support, ease of use,

flexibility, and faster response to customers. EHR and EMR contain a big amount of unused clinical and strategic information with significant value in the clinical decision-making process, thus the application and use of BI to EHR will allow the healthcare organization to extract meaningful information with high quality that will simplify the real-time decision making, evidence based practices, and enhance patient results.

In the other hand, the integration of BI with HER can be affected by some challenges such as data governance and roles which represent an important contributor for the successful adoption of BI, and problems with data architecture such as data security, data integrity, and data semantics it affects BI implementation with EHR (Wilfred,2013). Moreover, in general BI can face some challenges when applied in the healthcare context due its complexity, those challenges are the requirement of the integration of financial and clinical data, the variance types of data formats which can give information for higher level analytics, and the requests and assumptions of external data for financial and clinical decisions. The lack of standard terminology makes of external data a challenge and lead to problems with interoperability and integration of the health data. In the organizational level, operational and clinical data is required for assessing, measuring, controlling, and improving the quality of operations and output (Patti, Omar and Surendra, 2013).

In healthcare organizations BI are used to improve the decision making at the highest level, achieving strategic goals such as the return on investment for the strategic investments, the quality of care indicators, and operating margin. BI is not only about data analysis but also about the knowledge of linking the outcomes of

data analysis to decision support. Management practices in healthcare sector is different than other sectors due to having operational and clinical reporting, and it include a diversity of stakeholders comprising government, clinicians, payers, service providers, and users. Moreover, all sectors are working to reduce their costs, improving their quality, reducing time, but healthcare organizations are patient-oriented. Thus, the application of BI systems in healthcare sector face some challenges such as the data quality and standards, the selection of information and determination of key areas demanding support, and staff specifically the medical staff to deal with the information systems. In the other hands the application of BI in healthcare sector might bring many benefits such as integration and protection of data by having a single point of access to data stored, efficiency improvement by making the process of decision making for patient treatment shorter and based on information in addition to the efficient staff scheduling, minimizing the costs and increasing revenues, patients will be more satisfied and care and treatment provided to them will be better. In addition, the medical errors will be reduced which will increase the patient's safety, the decision making will be improved, BI can help in discovering the overall picture of the hospital, improve its control and monitoring, and detecting violations and fraud (Celina and Kornelia, 2012).

BI application is for both administration of hospitals and for medical affairs. For instance, BI can be used to process big amounts of data analyze it, and show results in hospital dashboards for managers who need to take decisions. Moreover, BI can help physicians' by having less affairs and concentrating and giving more time in the diagnose of diseases and patient treatment which will improve the quality of healthcare services. For the successful application of BI in healthcare its necessary to take some points into consideration such as the quality of data used, the determination of any repeated data, data integration for all available sources, and reporting must be on-time. Also, the readiness of information to access administrative, clinical, and financial data faster assist managers in decision making (Marjan , Mohammad and Alireza, 2014).

(Marjan, Mohammad and Alireza, 2014) studied the critical success factors of business intelligence implementation, and tried to find what are the organizational, process, and technological factors for the implementation of BI in hospitals. The organizational factors include committed management support and sponsorship, well-determined business case, and a clear vision. While, the process factors comprise balanced-team structure, business-centric championship, user oriented change management, business driven and interactive development approach.

And technological factors including sustainable data quality and integrity, business-driven, scalable and flexible technical framework. The results, show the equal effect of technological, process, and organizational factors in the implementation of BI systems but the variables included in each factor was with different level of influence. These results will help hospitals in making better decisions for the select, design, evaluation, and adoption of BI systems, by utilizing criteria that assist them in the creation of better decision support environment.

(Osama, Ali and Luiz, 2013) highlight that BI applications in healthcare takes two forms technology solutions and business solutions. Firstly, technology solutions constitute the tools, data, information and services including decision support systems (DSS) to support operational decision making , Executive information systems (EIS) to assist senior managers in decision making, Online analytical processing (OLAP) allow multidimensional view of data in relational databases , query and reporting services help access faster and easier to data with defined report design capabilities, data mining(predictive model) to discover hidden pattern in data by using various techniques, operational data services , and integration services design and implementation of process flow of data ETL to the data warehouse. The other set of solutions provided by BI are business solutions including patient analysis concentrating on analyzing the satisfaction process and demographic of patient, EHR (electronic health records) analysis aiming on analyzing the quality of clinical data, performance analysis guide and improve the use of resources such as human, budget and equipment, fund channel analysis focus on implementing and evaluating the fund strategies and utilize metrics to control and improve the fund process, productivity analysis concentrate on creating business metrics for activities such as asset management and quality improvement etc., Behavioral analysis to predict patterns and trends which give a business advantage, supply chain analysis to control and optimize the supply chain activities, and wait time analysis (Osama, Ali and Luiz, 2013).

Indeed, from what was explained by (Osama, Ali and Luiz, 2013) we can see that the two forms of solutions provided by BI systems are complementary the technology form complete and assist in the achievement of business form, the technology solutions help in achieving the necessary analysis for instance for the patient satisfaction, budget, behavioral analysis, supply chain, human resources and other business solutions especially using data mining and predictive analytics systems.



In another point of view regarding BI in healthcare (Noushin, Lori and Jean-Pierre, 2014) consider having two perspectives of BI systems which are data centric and process centric. The data centric view that BI systems are used to recognize the organization capabilities by the collection, transformation and integration of data to display information to decision makers to enhance the quality and reduce time of decision making. While in the other hand the process centric view the organization as a group of integrated processes where BI is used to integrate information into processes.

In effect, BI process centric perspective is considered in this research as a part of data centric perspective not as a separated view and perspective.

The BI has four main capabilities which are:

- Organizational memory capability: it's based on the capture and store of historical data enabled by data warehouse to help organization in the creation of new insights and knowledge based on information about the past.
- Information integration capability: In healthcare there is a need of sharing data in and across entities. Thus, information integration capability helps in linking and integrating historical data from different sources which include organizational memory with the new real-time content. It helps in linking unstructured and structured data from various sources. Indeed, this BI capability help in reducing time, cost and improve quality of healthcare.

- Insight creation capability: the insight and knowledge created is based on organizational memory and information integration capabilities. It allows the organizations to predict the future based on the understanding of past events by using data mining and decision support systems. Data mining tools help in providing in-depth analysis of data aiming to build predictive models and answering questions
- Presentation or communication capabilities: it promotes the communication between medical teams by making it more effective and faster.

BI was utilized before only by IT professionals who were qualified and trained to query and format data. But today BI allow workers to easily access to the information when they need it. BI can be utilized in the organizational level to attain strategic goals such as ROI (return on investment), operating margin, quality of care, and strategic investments. And BI can be used in departmental level to assist employees to work more efficiently as a team (Noushin, Lori and Jean-Pierre, 2014).

We can infer from the review of previous researches of BI use in administration and medical affairs in healthcare that there is a consensus about the important and main role of BI systems especially when its integrated with other hospital systems which is helping decision makers to take better decision which impact positively the organization performance. The table below show the main business intelligence benefits and challenges in healthcare.

<b>BI HEALTHCARE BENEFITS</b>	<b>REFERENCES</b>	<b>BI HEALTHCARE CHALLENGES</b>	<b>REFERENCES</b>
-using analytical tools that allow informed decision making in different organizational contexts -reduce costs, - improving process, - improve the quality of healthcare provided to patients, - better use of human resources	(Neil and Craig, 2014)	-problems with data architecture such as data security, data integrity, and data semantics it affects BI implementation with EHR	(Wilfred,2013)
-to help decision makers in organizations to take better and faster decisions - to assist managers to take better decisions - to compete and manage organization efficiently - to enhance the operational	(Wilfred,2013)	-data quality and standards - staff specifically the medical staff to deal with the information systems	Celina and Kornelia, 2012

<p>performance,                      - financial performance,                      - quality of healthcare provided to patients.                      - The integration of BI with EHR in healthcare                      - operational efficiency                      - saving time,                      -enhanced decision support,                      - ease of use,                      - flexibility,                      - faster response to customers</p>			
<p>- achieving strategic goals such as the return on investment                      - the quality of care indicators</p>	Celina and Kornelia, 2012	-the quality of data used	(Marjan , Mohammad and Alireza, 2014)
<p>- improve the quality of healthcare services                      - assist managers in decision making</p>	(Marjan , Mohammad and Alireza, 2014)	<p>-the requirement of the integration of financial and clinical data                      - the variance types of data formats                      - requests and assumptions of external data for financial and clinical decisions                      - The lack of standard terminology makes of external data a challenge and lead to problems with interoperability and integration of the health data.</p>	(Patti, Omar and Surendra, 2013)
<p>- improve the use of resources such as human, budget and equipment, fund channel analysis                      - utilize metrics to control and improve the fund process                      - to predict patterns and trends which give a business advantage                      - supply chain analysis to control and optimize the supply chain activities,</p>	(Osama, Ali and Luiz, 2013)		
<p>-to display information to decision makers to enhance the quality and reduce time of decision making                      -BI can be utilized in the organizational level to attain strategic goals such as ROI</p>	(Noushin, Lori and Jean-Pierre, 2014)		

- BI can be used in departmental level to assist employees to work more efficiently as a team			
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Table 2: BI benefits and challenges in healthcare

### III. PREDICTIVE ANALYTICS SYSTEMS

To introduce what is predictive analytics we need to know where it comes from. Thus, firstly the umbrella that covers those systems is called business intelligence (BI). In this research the business intelligence systems are defined as set of technologies, architecture, tools, processes and best practices to extract insight and useful information from structured and unstructured data about the current business performance of the organization and to report about historical trends to take better decisions and improve the organization performance. Thus, Data mining is part of Business intelligence functionalities as defined by Gartner who described BI as a software platform delivering 14 capabilities divided into three groups of functionalities including integration, information delivery and analysis functionality which contain the data mining and predictive modeling. While data mining is considered

as the automated process to detect the unknown patterns in the structured data of the organization (Martin, Miranda, V. Prasanna, 2014) (Osama, Ali and Luiz Fernando, 2013). Another research (Mohammad Ahmad Alkhatib, 2015) describes data mining as the process to collect, filter, prepare, analyze and store data that will be used to create useful knowledge and supporting the data analytics and predictive modelling. In fact, data analytics is divided into four types as follow:

- The descriptive analytics: which describe the current situation and answer the question what is happening now?
- The diagnostic analytics: which answer the question Why this is happening?
- The predictive analytics: which answer the question what will happen in the future?
- The prescriptive analytics: which answer the question what is the right choice or solution?

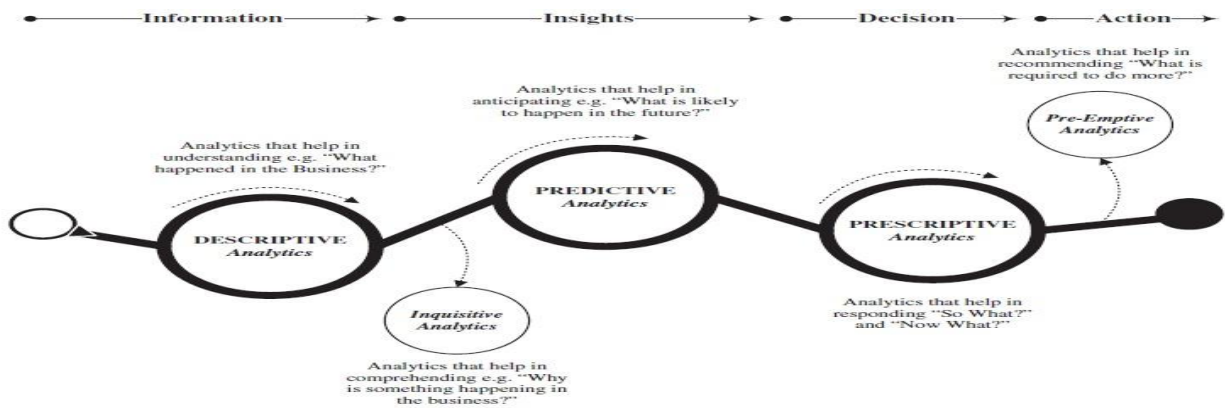


Figure 1: classification of analytical methods (Uthayasankar, Muhammad, Zahir, Vishanth, 2017)

Thus, Predictive analytics in general are used to detect the relationships and patterns in data to look forward and to predict the future by analyzing the past and taking better preventive decisions (Hoda, Stephen, Steven, Nilmini, 2016). While, as shown in the figure (1) above the classification of analytical methods start by the descriptive analytics which look backward and deliver information that help in understanding what happened in the organization. Thus, business intelligence (BI) is considered as descriptive analytics and it had proven its efficiency in enhancing the quality and process of decision making (Lior, Nir, and Adir, 2017). Whereas, predictive analytics is a higher level

than descriptive analytics due to its capability to create insight to know what can happen in the future which help decision makers to make fact based decisions. Based on that, we can consider that predictive analytics have been developed to optimize the level of analytics and results of BI which are the precedent and preparatory stage for predictive analytics that can analyses the information delivered by BI to create insight and make future predictions and better decisions.

Indeed, predictive analytics is defined in this research as the analysis of past performance, structured and



unstructured data by using predictive models, to discover new patterns and information to learn, to predict the future and make better and preventive decisions.

#### IV. FRAMEWORKS AND PREVIOUS MODELS OF THE USE OF BUSINESS INTELLIGENCE

(Vikas, Amol, 2015) clarify that today the agility and rapid changes in business environment had push decision makers toward the responsibility to increase the quality of decisions that comprise activities assumed when defining the cause of a problem, when creating alternatives to solve problems, and when final decision must be taken and integrated, this participate crucially to the overall performance of business and organization. The quality of decisions refers to make decisions that are effective, fast, on time and participate in constructing efficient organization, focusing on improving the performance of the organization, and help in the growth and sustainability of the organization. Moreover, to be able to take decisions with high quality this requires a decision-making

process that needs complete and accurate information provided by using BI tools. Thus, the quality of information affects significantly the quality of decisions. The steps of decision making process are firstly defining the problem, developing standard, creating alternatives, evaluating the alternatives based on chosen standard, and then making decision (Vikas, Amol, 2015).

(Vikas , Amol, 2015) propose that organizational growth is improved by using business intelligence tools which help in improving the decision making process and quality. The findings of this study have shown that the new trends in business intelligence tools are to make analytics based on mobile, social, and cloud. Moreover, the results show that the business intelligence tools play a role in decision making but further research is needed to prove that business intelligence tools are linked to organizational growth and lead to improved decision making (Vikas , Amol, 2015).

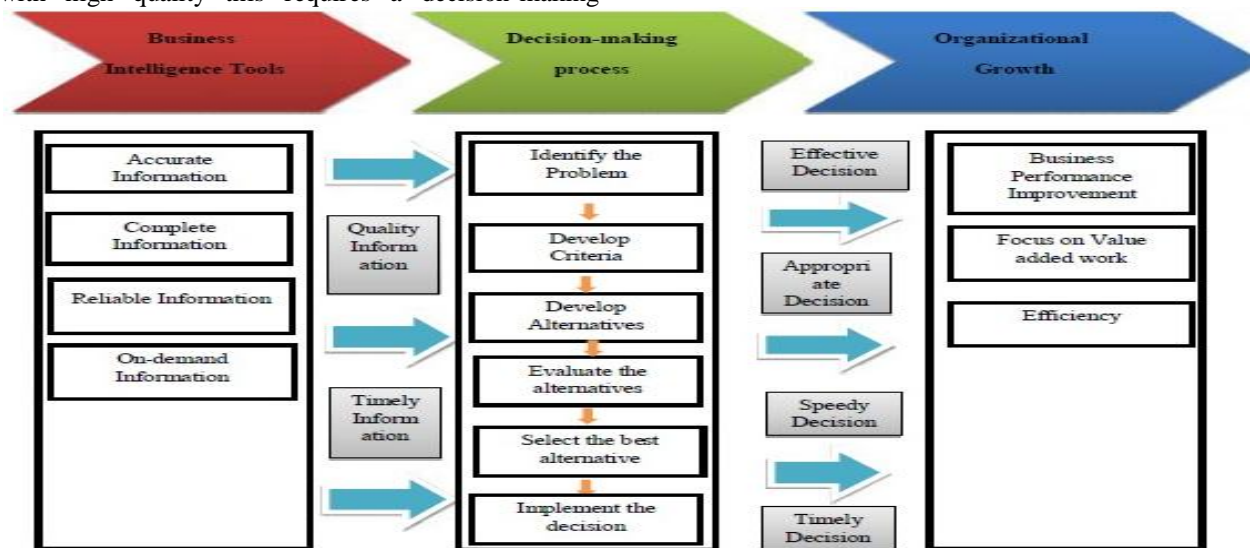


Figure 2: conceptual model for organizational growth with business intelligence tools (Vikas , Amol, 2015)

(O'yku", Mary and Anna, 2013) studied the effect of BI capabilities on BI success in the presence of various decision environments. The model below shows the technological BI capability including attributes such as data quality, integration with other systems, and user access; and organizational BI capability comprising attributes such as flexibility and risk management support. The model examines the effect of those capabilities and their attributes to the BI success and the role of decision environment including two elements

which are decision types and information processing needs. The study findings of (O'yku", Mary and Anna, 2013) show that the technological capabilities have direct impact on the success of BI regardless of the decision environment. While the organizational capabilities should be moderated considering the decision environment in which the BI is used. (O'yku", Mary and Anna, 2013) claim that data quality have attain an acceptable level and more enhancement of this capability will not lead to considerable BI success.

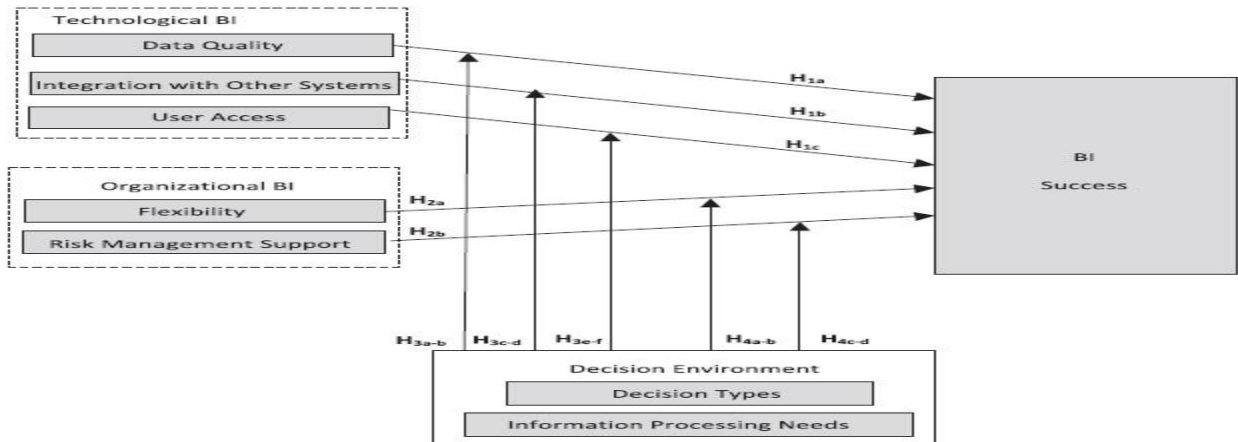


Figure 3: Research model (O'yku, Mary and Anna, 2013)

(Lior, Nir, and Adir, 2017), created a model about the value creation process of BI, the analysis depends on the resource based view and on perceptions of organizational learning to hypothesize about the process of business value creation by BI capabilities and BI assets. Thus, to get a full understanding of the value creation this research have combined both knowledge on the IT value creation in general and BI value creation in specific. The findings in IT in general comprising the relationship between IT capabilities, IT assets, organizational resources and business value. While for BI it includes the difference between the strategic and operational BI capabilities and the important role of organizational learning in recognizing how BI creates business value. Thus, the framework of exploitation and exploration in organizational learning is used by (Lior, Nir, and Adir, 2017) due to the conceptual fit among the strategic and operational BI capabilities and the exploration and exploitation organizational mechanisms; and in coordination with the resource based view of the organization. Based on this a research model was created to understand how BI resources creates business value (figure 4) (Lior, Nir,

and Adir, 2017). The findings of this research confirm that firstly BI creates value from assets out of capabilities to value at both the strategic and operational levels and this process is managed by organizational resources. Moreover, the findings show that there must be a distinction among strategic and operational BI capabilities to well understand BI value creation. This distinction will permit to observe the variance in how BI capabilities are affected by BI assets of team and infrastructure. And how business value is affected by BI capabilities, and how the impact of BI assets on BI capabilities is managed by the organizational learning. Moreover, the exploitation and exploration framework play a role in understanding how the organizational context help in the conversion of BI assets to BI capabilities. Moreover, the practical implications of (Lior, Nir, and Adir, 2017) findings is that firstly for successful use of BI in organization managers must form BI team with high skills and knowledge in data analysis, data integration, technical skills, understand well the business issues, and ensuring effective communication among team members.

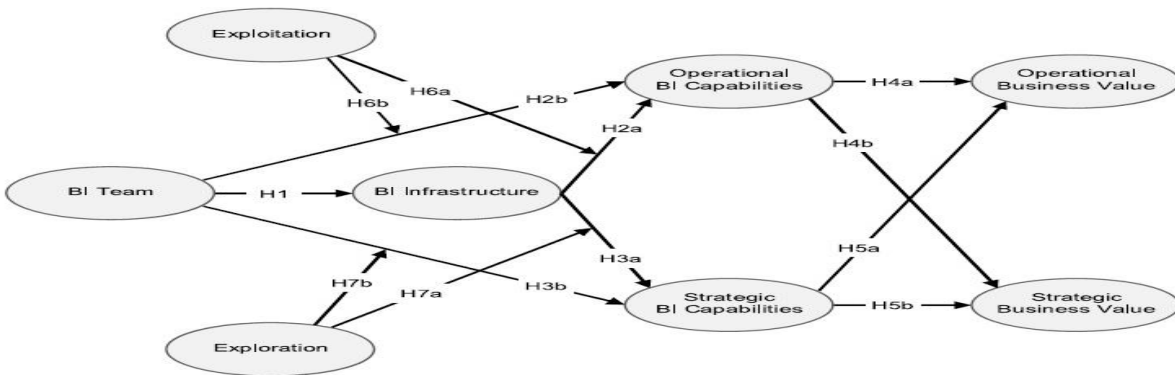


Figure 4: research model (Lior, Nir, and Adir, 2017)

(Cheng-Che, Ray-E, Ching, and I-Chiu, 2017) targeting in their research to assess the maturity of BI systems and their effect on decision quality to detect the impact of BI systems on hospital agility. Thus, this study suppose that more the BI systems maturity level is high this will lead to greater quality of medical information produced by the system. And when the information quality provided by BI systems in hospitals is high this will lead to make BI systems users more satisfied and with high level of usage. The findings of the study show that the level of BI usage and users' satisfaction is

highly affected by the quality of the information. The BI system maturity significantly affects the quality of information this was proved by revealing that the level of data analytics and integration provided by the BI systems positively linked to the completeness, and accuracy of medical information quality. Moreover, (Cheng-Che, Ray-E, Ching, and I-Chiu, 2017) found that the high quality of medical information delivered by BI systems will lead to an improvement in the efficiency of decision quality.

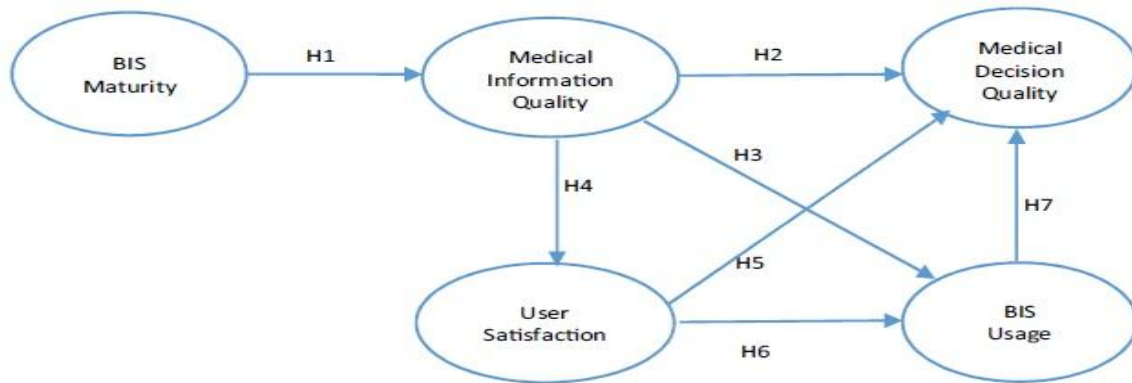


Figure 5: research model (Cheng-Che, Ray-E, Ching, and I-Chiu, 2017)

(Bernhard and Maria, 2015), claim that there is no sufficient focus on what is beyond the implementation phase for a successful management of BI systems. For that, in their study they searched on how the BI management quality can directly and indirectly affect the quality of managerial decision making. The results of the research show that the data and information quality, and BI solutions scope are affected positively

directly and indirectly by the BI management quality. Moreover, there is an indirect positive effect of BI management quality on the decision-making quality that pass through the data and information quality. The figure below shows the research model developed by (Bernhard and Maria, 2015)

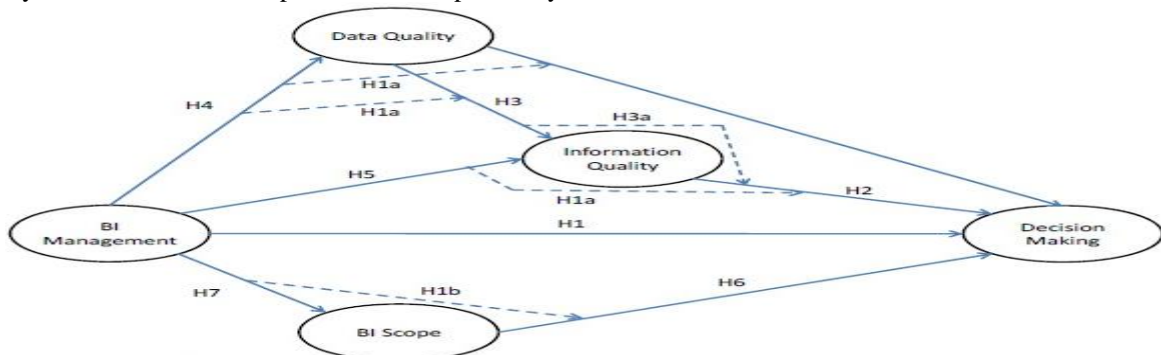


Figure 6: research model (Bernhard and Maria, 2015)

(Rikke, Tom, and Niels, 2017) studied how to successfully apply the business intelligence systems to health information system. To attain this (Rikke, Tom,

and Niels, 2017) have used the DeLone and McLeans IS success model to discover which are the factors that assist in the BI success and to measure the individual

impact while excluding the organizational impact from the research model. Thus, after an empirical test the results have shown that the user satisfaction is significantly influenced by high system and information quality, which in turn affect the individual impact in contrast of use which is not related to individual impact.

Although, the use factor was not sufficiently explained and tested. Moreover, additional variables can be added such as experience with BI, training, and job function. Additionally, this model can be studied to measure the BI effects when applied to health information systems on the organizational level.

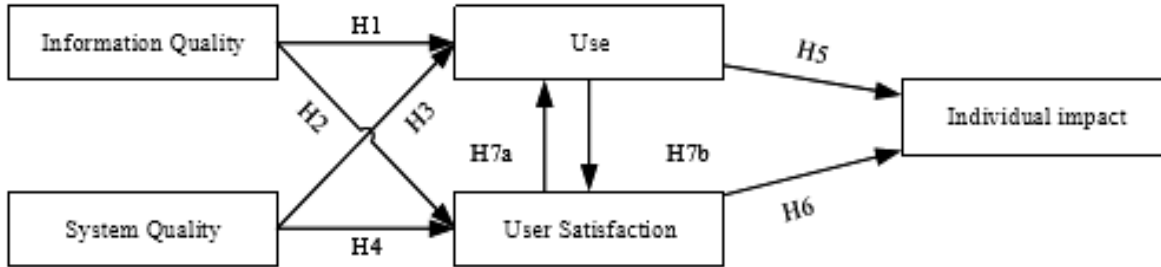


Figure 7: research model (Rikke, Tom, and Niels, 2017)

**V. BUSINESS INTELLIGENCE MODELS' IMPROVEMENT BY ADDING PREDICTIVE ANALYTICS**

addition to the possibility to add predictive analytics to the model and its role in the success and improvement of BI success.

The table below describe the strength and weaknesses of the previous research models and frameworks in

AIM OF RESEARCH	STRENGTH AND WEAKNESSES	HOW CAN BE IMPROVED BY ADDING PREDICTIVE ANALYTICS
Investigate the relation between business intelligence tools, decision making quality and process, and the organizational growth (Vikas, Amol, 2015)	-Business intelligence play a role in decision making -The relation between business intelligence and organizational growth is not proved * There is no clear definition of what are the business intelligence tools that will lead to have high information quality and on time	The use of predictive analytics systems in the stage after business intelligence tools and before decision making process will lead to get the information from BI and transform it to knowledge and insights to discover the future trends in the organization which will fill the gap in this model by proving the relation between BI and organizational growth which pass through predictive analytics and their ability to improve decisions and discover opportunities.
Studied the effect of BI capabilities (technological and organizational) on BI success in the presence of various decision environments (O'yku", Mary and Anna, 2013)	-The technological capabilities have direct impact on the success of BI regardless of the decision environment -The organizational capabilities should be moderated considering the decision environment in which the BI is used * study did not work sufficiently on the importance of having high quality of data, cause the issue of	Considering predictive analytics and modeling as a BI capability will increase its benefits and success

	<p>data integrity and quality still a challenge in the use of BI systems and their success</p> <p>* the BI infrastructure was not taken into consideration and its effect on BI success</p>	
<p>Creation of a research model to understand how BI resources creates business value (Lior , Nir, and Adir, 2017)</p>	<p>- BI creates value from assets out of capabilities to value at both the strategic and operational levels and this process is managed by organizational resources</p> <p>-for successful use of BI in organization managers must form BI team with high skills and knowledge, and ensuring effective communication among team members</p>	<p>Predictive analytics can be added to study the effect of team and BI infrastructure on it and to investigate the influence of predictive analytics in both operational and strategic business value</p>
<p>To assess the maturity of BI systems and their effect on decision quality to detect the impact of BI systems on hospital agility (Cheng-Che, Ray-E, Ching, and I-Chiu, 2017)</p>	<p>- The level of BI usage and users' satisfaction is highly affected by the quality of the information</p> <p>- the high quality of medical information delivered by BI systems will lead to an improvement in the efficiency of decision quality</p>	<p>The effect of the quality of the information provided by BI systems on predictive analytics efficiency and accuracy, and the predictive analytics effect on the quality of decision making</p>
<p>How the BI management quality can directly and indirectly affect the quality of managerial decision making. (Bernhard and Maria, 2015)</p>	<p>-The data and information quality, and BI solutions scope are affected positively directly and indirectly by the BI management quality.</p> <p>-there is an indirect positive effect of BI management quality on the decision-making quality that pass through the data and information quality</p>	<p>In this model the managerial decision making can be improved in the tactical level only because BI study the past and current situation of the organization, but to make this model more efficient the predictive analytics can be added to investigate the effect of information quality on PA and the influence of PA on decision making to make strategic improvements in the organization</p>
<p>How to successfully apply the business intelligence systems to health information system. (Rikke, Tom, and Niels, 2017)</p>	<p>- The user satisfaction is significantly influenced by high system and information quality, which in turn affect the individual impact in contrast of use which is not related to individual impact</p> <p>* this model can be studied to measure the BI effects when applied to health information systems on the organizational level</p> <p>* additional variables can be added such as experience with BI, training, and job function</p>	<p>The same model can be studied to measure the predictive analytics effects when applied to health information systems on the organizational level</p>

**Table 3: Previous models and frameworks and the addition of predictive analytics**



## CONCLUSION

We can conclude that there is a consensus that BI system maturity and management quality influence the data and information quality which in turn affect positively the users' satisfaction, BI usage, and the decision-making quality and lead to improve it. While (O'yku", Mary and Anna, 2013) had a contradictory opinion by claiming that data quality is no more a challenge and does not affect the success of BI systems. Moreover, BI systems have direct and indirect effect on the decision-making quality but there still no research proving its influence on the organizational growth. Moreover, this research suggests that the integration of predictive analytics with BI in the models above could give a better understanding especially regarding the effect of information quality and decision-making quality on the organizational growth and performance.

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