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Business Intelligence systems development in hospitals using an Agile Project Management approach

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Manuel Monteiro
Supervisor: Professor Bruno S. Gonçalves

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To my family for their unconditional support, which has allowed me to complete this demanding challenge in my 50s.

To the exceptional dedication of Professor Bruno S. Gonçalves.

Abstract

"Measure to manage" is a widely used expression to demonstrate that good governance must necessarily go through obtaining good data and information. These will allow managers to know the past and the momentum of the business and also to predict, estimate and take the best-informed decisions. The greater the complexity of the business, the greater this need. Healthcare units, specifically hospitals, are organizations that, due to their function and diversity of areas, are considered one of the most complex. In this context, projects for the development of business intelligence solutions, with huge impact and scope, undergo the need for continuous improvement and incremental evolution. Agile methods, by their nature and principles, are suitable to fulfil this need. The purpose of this dissertation is to support future research towards better models with agile tools to develop business intelligence system in hospitals and, manly, to understand how can Agile methodology improve a Business Intelligence System Implementation. This will be done mainly through bibliographical research on the covered topics, namely, Hospitals, Business Intelligence, Agile and Project Management. The expect results will be some clear practical guidelines, that any IT Project Manager could use for an efficient Business Intelligence System implementation using an Agile methodology. This will be done with the presentation of two use cases, from implementations in two hospitals in Portugal, where the Agile proposed model could be used to improve the outcomes of the projects. For that a deep analysis of the various phases of Business Intelligence development was carried out on the basis of information obtained in the literature and on the basis of information obtained in the practical development of Business Intelligence implementation projects. In the end it can be seen that the application of Agile can bring enormous benefits to the development of this kind of project, as, in addition to the advantages listed and widely known about Agile, it can help intensively to bring together and involve all the stakeholders of a project in a common goal of success and effectiveness.

Keywords: agile; project management; hospital; healthcare; business intelligence

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Abbreviations List

AMAM	Adoption Model for Analytics Maturity
APAH	Portuguese Association of Hospital Administrators
EHR	Electronic Health Record
HIS	Hospital Information System
LIS	Laboratory Information System
PACS	Picture Archiving and Communication System
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
VBHC	Value-Based Healthcare

1 Introduction

In the organizational complexity in which hospitals operate, developing a project to create or improve a business intelligence system implies an effective project management model, which meets the need for continuous and incremental improvement of the solution, in a scenario marked by high number of stakeholders with different needs. Due to its characteristics, an Agile project management may be the solution that suits best this context.

1.1 Contextualization

Healthcare organizations, namely hospitals, are considered to be one of the most complex. These generate and collect data in large quantities, what is currently called Big Data in Healthcare.

Big Data in Healthcare is crucial to the value delivery in hospitals. As referred by Bohmer (2009, p. 8), recent evidence suggests that how care is managed matters a great deal, namely, "improved performance measurement has revealed the extend to with organizational performance – in particular, how care processes are approached, supported, and managed – is an important determinant of individual patient outcomes".

For the last 3 decades, the production of articles with "Big Data" and "Healthcare" in the title have been growing (search on Google Scholar). From 573 articles in the 90s, to 2750 from 2000 to 2009, and to 75000 on the second decade of the century. In 2020 here produced 29300 articles.

Laney (2001) observed that (big) data was growing in three different dimensions namely, volume, velocity and variety (known as the 3 Vs). From those, the "variety" dimension remarks on the different types of organized and unorganized data that any firm or system can collect. Furthermore, a lot of data is totally unused, and, in many cases, the extracted information is disseminated in an inefficient way. In fact, these data and information, if well used, are of great value both for the management and administration of the healthcare organizations, as well as for the treatment and experience journey of the patients, scientific research, among others.

Therefore, continuous improvement strategies are urgently needed to gradually and effectively take advantage of the data generated, and to transform and distribute them in an equitable way. For this reason, business intelligence systems developed in a sustained and evolutionary way are fundamental to make the best use of the full potential of big data in healthcare.

Developing and maintaining a business intelligence system in a scenario of complexity, variety of data, multiple stakeholders and constantly changing demand requires project management methods that are adequate to this situation and that allow for evolution and continuous adaptation to needs. The traditional project management method, commonly known as waterfall, is not fully fitted to the dynamic and incremental characteristics of this type of project. A project is defined in the PMBOK© guide as a temporary effort undertaken to create a unique product, service or result (PMI, 2021). In fact, a temporary effort is not fully adequate to define an entire development of a business intelligence system in a hospital in constant evolution. This does not mean that some stages of a business intelligence implementation could not be temporary. Some early stages of the implementation could benefit from the PMI guidelines, like the business intelligence platform procurement, the deployment of the platform, the "construction" of the data warehouse (if it is the case), among others.

On the other hand, the final products of business intelligence projects are often useless because the needs of the organizations change during the solutions developments (Eckerson, 2007). In fact, the initial user requirements can be rapidly obsolete in a long-term project. Users improve the maturity level about the business intelligence, metrics and indicators, unpredicted questions arise, the demand of the market changes, among other changes.

It is also mentioned by several authors that the project management component has a strong impact on the implementation of a business intelligence system (El-Adaileh, 2019, p.6).

The combination of these factors (hospitals complexity and evolution, variety of data, multiple stakeholders, demand change rapidly, long developments, incremental changes) suggest that an agile project management methodology may be more adequate in some stages of the development and implementation of a business intelligence system, mainly due to its evolutionary and incremental nature and greater adaptability to change.

1.2 General Goals

Implementing an agile project management methodology in a hospital context has significant challenges. The Agile methodology is different from traditional methodologies because Agile is focused on delivering small functional parts of the features as early as possible, constantly improving them and adding new functionality throughout the project lifecycle (Flora, 2014). Exploring the success and failure factors of an implementation of the Agile methodology is relevant to the success of a model.

The main objective is to investigate if an agile project management methodology, due to its characteristics, is best suited to the development of some components of a business intelligence system in a hospital context.

1.3 Specific Objectives

The theme Agile in the context of healthcare services, as happened with Lean in combating waste and optimizing processes, has appeared in recent years in the literature with examples of application, such as in Rust (2013) and Tolf (2015), where it exemplifies how to adapt the Agile methodology in the (re)definition and improvement of health service delivery processes. Kanban boards are also a familiar theme in healthcare, which is an important tool in the application of Agile methodologies. Also, Kisielnicki (2017) presents the study on the effectiveness of agile methods compared to waterfall projects in the implementation of IT projects, specifically in business intelligence projects. Besides that, Olszak & Ziemba (2007) refers that "little attention has been paid so far to questions of creating and implementing business intelligence in organizations".

This study aims to emphasize and demonstrate the advantages of the Agile methodology in the development and implementation of business intelligence projects in a hospital context. It should answer the following questions:

Q1: Can business intelligence benefit and evolve with the use of Agile methodologies?

Q2: What are the differences between the Agile and Waterfall methodology?

Q3: What Agile frameworks, methodologies and tools can be applied in the development of business intelligence solutions?

Q4: What are Agile's success factors in developing business intelligence solutions?

Q5. Does the proposed model make sense in this type of project?

1.4 Work organization

To create an Agile Project Management model to develop and implement a business intelligence system in hospitals, deepen investigation must be developed to understand all the core knowledge associated to hospitals complexity, Business Intelligence development and implementations, and Agile methodology and tools. For that a literature review will be carried out mainly through research on scientific knowledge databases such as the Web of Science, Research Gate, Google Scholar, Scopus, Sciencedirect, IEEE Xplore, SAGE Journals and PMI, and also some books. This in-depth analysis will allow exploring the topic of agile methodology in the development of business intelligence projects, the use of Agile in other types of hospital projects, as well as case studies of hospital business intelligence. Will be searched articles using the combination of words like "agile", "project management", "healthcare", "hospitals", "BI", "Business Intelligence", "implementation", among others.

The literature revision will be used as a research methodology. In this organized way it is intended to identify, evaluate, and interpret the results of the research related to the mentioned topics. This will facilitate the identification of strengths and weaknesses in the investigation of some themes and will help to summarize the existing research on Agile used in the development of Business Intelligence systems.

The literature review will reveal insights and patterns, which will allow to detail and exemplify agile techniques best suited to the development of a business intelligence system in a hospital, such as user-stories, Kanban and Scrum boards, among others. Given the refinement of techniques and methodologies, it will be possible to prototype an Agile Project Management model for the development of a hospital business intelligence system, which best suits the profile

of this type of organizations. This will be done through the creation of a guide where will be explained the Agile tools to be used, with examples, the multiple functions involved and the development cycle.

The present literature review will be structured (1) in a first part dedicated to understanding hospitals as complex organizations. (2) A second part explores the theme "Business Intelligence" in general and their application in hospitals, exploring different views on how to implement a business intelligence system; (3) A third part dedicated to the "Agile Project Management", where will be explored the Agile foundations and principles, the differences between Agile and Waterfall methodologies, and deepen study about the Agile development cycle and tools. (4) A last part will be dedicated to "Agile business intelligence in hospitals", where the first three initial parts of the study will be consolidated. In this final part will try to collect several experiences in implementing business intelligence systems using Agile, compared to Waterfall approach.

In the last chapters of this dissertation will be presented a current state of the tendencies in the business intelligence world, namely on the need to follow some maturity models that will guide organizations to a culture of continuous improvement of their Business Intelligence & Analytics systems. That will allow to classify the two use cases presented, and, after the presentation of a model with four stages to a business intelligence system implementation, apply the model to the presented use cases.

2 Literature review

This literature review aims to build a guiding thread that contextualizes the Agile theme in the development of business intelligence solutions in hospitals. For this purpose, the literature review intents to focus on research areas related to hospital, such as complex and evolutionary organizations, business intelligence in hospitals and the adoption of Agile project management methodologies. With this investigation, it is expected that connection points will emerge, creating the desired guiding thread to further deepen the theme on the application of the Agile project management model in the development of business intelligence systems in hospitals.

2.1 Hospitals as complex organizations

Various aspects (organizational, technological and orientation) of hospitals have evolved over the centuries, from the first hospitals where patients were isolated from society to the present times, where patients are the centre of attention (Patient-Centric).

Increasingly, and the COVID19 pandemic confirms this idea, hospitals must adapt to scenarios of constant (and eventually sudden) changes in demand, scientific and technological developments, competition, regulatory and financial constraints, among others. For that "data" and "information" are vital in any modern hospital, and it is critical for those who follow the premises of Value-Based Healthcare (VBHC). As Gonçalves (2020, p. 14-15) points out, "to be implemented ", the VBHC," stakeholders, each in their own role, will have to be able to make well-informed decisions that optimize balance in a sustainable manner. This analysis and decision lacks information, so a fundamental assumption of the Value-Based Healthcare is access to valid, reliable and relevant information". To achieve these assumptions in complex systems such as hospitals, it requires the adoption of strategies for integrated and holistic data management that adopt agile methodologies, proven to be effective in involving all stakeholders and capable of responding quickly to the evolution and rapid changes of demand.

In fact, hospitals are complex organizations, due to their top skills, high technology, need of continuous training, dimension, organization, and variety of stakeholders (Smet, 2002) (Armony et al, 2015) (McKee & Healy, 2002) (Braithwaite et al, 2017).

Effectively, as mentioned by WHO (2012), healthcare is complex due to several aspects, namely (1) the diversity of tasks involved in the delivery of patient care; the dependency of health-care providers on one another; (2) the diversity of patients, clinicians and other staff; (3) the huge number of relationships between patients, careers, health-care providers, support staff, administrators, family and community members; the vulnerability of patients; (4) variations in the physical layout of clinical environments; variability or lack of regulations; implementation of new technology; (5) the diversity of care pathways and organizations involved; (6) increased specialization of health-care professionals—while specialization allows a wider range of patient treatments and services, it also provides more opportunity for things to go wrong and errors to occur.

Understanding the complexity and the evolution, namely perceiving the evolution of the data generated, as well as the information needs for the different stakeholders, is essential to understand the dynamics of continuous improvement of business intelligence systems.

2.2 Business Intelligence in Hospitals

Nowadays, multiple information systems in hospitals (EHR, HIS, PACS, LIS, etc.) accumulate huge amounts of data. As well, medical devices and the various biomedical and healthcare tools such as genomics, mobile biometric sensors and smartphone apps generate and store a big amount of data (Dash, 2019). As referred by Dash, "the analysis of such data can provide further insights in terms of procedural, technical, medical and other types of improvements in healthcare". Healthcare professionals, including hospital managers, should ask themselves how they can deliver better care, ensuring the performance and sustainability of the hospital and managing costs effectively.

2.2.1 Business intelligence

The term "intelligence" refers to the field of military science (Mettler, 2009). In fact, military intelligence is a discipline that applies data analysis methodologies to the data and information collected to provide guidance and direction in commanders' decisions (Austin, 1995). As in war, the "commanders" of organizations, units, departments or services, need this "intelligence" to make the best decisions and deliver the best possible value to stakeholders. Thus, business intelligence is generally understood as the tool to transform organizations' existing data into knowledge to help them make informed decisions (Cao, 2013). Evelson (2008) defines business intelligence as "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". In fact, business intelligence can be described as "an umbrella term that combines architectures, tools, methodologies, databases and data warehouses, analytical tools, and applications." (El Morr, 2019a, p. 5-6).

El Morr (2019b) distinguishes business intelligence from Advanced Analytics, defining business intelligence as "set of metrics to measure past performance and report a set of indicators that can guide decision-making", and Advanced Analytics as "analyse trends, recognize patterns and possibly prescribe actions for better outcomes".

In a business intelligence architecture, the data warehouse and data marts are the fundamental elements, which include several layers, of which the data sources, the data warehouse, the ETL and the visualization layer.

As explained by Olszak & Ziemba (2007), the most important components of the business intelligence technological infrastructure consist of (1) key information technologies that are related with data acquisition and storing (ETL tools and data warehouses) and (2) information technologies potential, related to analyses and presentation of data (OLAP techniques and data mining).

Other processes and areas of knowledge are associated with business intelligence, namely the "delivery" component of this data, through reports or dashboards, or in other words, the layer of data visualization. In fact, this is an extremely important component, because the way the data is

shown, with graphical representations that help to interpret and better understand trends, volumes, among others, is vital for the adoption of these systems. In fact, the data visualization component and the capability of end-users to make their own analyses has an increasing importance, and will help business intelligence users and decision makers, at different levels and needs, to use the business intelligence system from different perspectives (Zheng, 2017).

Kisielnicki (2017, p.5) highlights several problems that appears during business intelligence implementation: (1) a long development lifecycle and less visibility to user; (2) users are not involved in the development cycles; (3) after the design phase, there is no possibility to modify analytical requirements; (4) testing is performed at the end of the development cycle, again without a possibility for change requests; (5) a different language: the developers think in terms of code, the business thinks in terms of business value, and solution designers think in terms of customer experience.

In this last point, the communication gap is in fact one of the major problems in this or any other type of system development process. The communication between the "clients" and the "developers" of the business intelligence system is extremely important. The "client" will request metrics and indicators in business language, and the developer will need to translate the business language into queries to multiple sources of data (databases, data warehouses, etc). The metrics are quantitative measurements to measure an aspect of quality or performance. The indicators are metrics that are tied to a certain target (Morr, 2019a).

In healthcare, the interaction between the "clients" and the "developers", during the process of definition of the metrics, indicators and dashboards will be a major part of this future study, where Agile methods can have a major contribute.

2.2.2 Develop and implement a Business Intelligence system

As any software development project, a business intelligence project following a waterfall approach, will go from a "requirement" collect and "detailed documentation of functional business need" collect stages in the beginning, until the "release" in the end. The end-users are present in

this two moments. Between them the development process as also an "analysis", "design", "developing" and "testing" phases, where the end-users normally do not participate (Bajaj, 2018).

However, as referred by Shelman (2015), a business intelligence project "is a journey that is not going to be completed with a single business intelligence project; if you are successful, business intelligence will continually expand with new data, technologies, analytics, and business uses". This is an important remark about the process of developing and implementing a business intelligence system. Even though a formal project can be started to the technical aspects of the implementation, like choosing the infrastructure model and technology, the core of the business intelligence system, the data management, involving the data sources, metrics, indicators and dashboards will be continuously growing, changing, improved and adapted. Shelman (2015) reinforces this idea saying that "BI should be built incrementally and iteratively".

Despite other activities or many other possible paths to create a business intelligence system, some models arise in literature. Olszak & Ziemba (2007) suggests the following stages to be followed: (1) definition of the business intelligence undertaking, i.e. determination of the business intelligence system development strategies; (2) identification and preparation of source data; (3) selection of business intelligence tools; (4) designing and implementing of business intelligence; and (5) discovering and exploring new informational needs and other business applications and practices.

Two of them are good candidates to Agile adoption, due to their need of interaction with multiple stakeholders in the "definition of sources of data" and "discovering and exploring new informational needs".

Serheichuk (2020) suggests "10 steps for BI strategy implementation": (1) Create a business intelligence strategy; (2) Set the Key Performance Indicators; (3) Appoint stakeholders and educate the staff; (4) Build a strong business intelligence team or outsource; (5) Find the best software for your needs; (6) Choose your data storage, environment, and platform; (7) Finetune your data preparation process; (8) Consider more advanced solutions; (9) Implement the PoC or a pilot project; (10) Implement the changes to meet the KPIs.

In these steps, some are typical project management processes, associated to procurement processes, others, like the "Set Key Performance Indicators", "Finetune your data preparation process" and "Implement the changes to meet the KPIs", are candidates to an Agile approach.

As mentioned by Mettler (2009), there are some differences and similarities between the business intelligence systems of industrial organizations and healthcare organizations. From the differences, it can be assumed that implementing a business intelligence system in a hospital adds some challenges. First of all, the clinical component is highly complex and heterogeneous. Second, the diversity of stakeholders, ranging from patients, insurance companies, authorities, health professionals, among others. Finally, the human component of health, where the opinions and outcomes of multiple stakeholders are a relevant asset.

In addition to the differences between business intelligence systems in health and non-health highlighted by Mettler (2009), research shows that doctors express concerns related to issues such as security and data protection, interpretation, analysis and dissemination, flexibility to adjust what to track and how records and summaries are presented and workflow integration (Jacob, 2019). These concerns are just a small example, but they reveal a central point in the implementation of a business intelligence system in a hospital and the adoption of the system by health professionals. In addition to the technical complexity that the sector represents, there are non-technical components that can dictate the success of these systems.

Furthermore, business intelligence projects are long and painful (Barone, 2012), requiring in some way a project management methodology that allows correct monitoring of the development life cycle and continuous improvement.

El-Adaileh & Foster (2019) refers the top success factors in literature about a business intelligence implementation as (1) Management support; (2) Data source system; (3) Organisational resources; (4) IT infrastructure; (5) Vision; (6) Champion; (7) Team skills; (8) Project manager; (9) User participation; and (10) Change management.

Also, Jamaludin & Mansor (2011) refers three determinants of success. The "organizational determinants" as the management support and dedicated functional and system support resources; the "project determinants" as the user participation, resources and highly skilled

project team members; and the "technical determinants" as the un-documented and un-standardized source systems and development tools increase the technical issues that project teams need to overcome. The author also defines the "critical implementation factors" into two categories, the technical and organizational factors. The (1) technical factors are related to data and data management, development methodology, the technology being adapted, appropriate resources with the technical skill, training and expertise to develop and manage data warehouse systems, the (2) organizational factors as the executive sponsorship, operating sponsorship, factors related to business needs, clear link to business objectives, user related factors such as user involvement, support and expectations, organizational resistance and organizational politics and planning for system evolution and sustaining growth.

2.2.3 The diversity of data and information in hospitals

The pressure to deliver more health services, with higher quality and at a lower cost, leads to the need to improve processes and diagnostics, among others. This is possible with the use of the information that the generated data can give us. Electronic healthcare applications can maximize service quality by producing insights from data while minimizing cost, or optimize operational health decision-making outcomes, and such systematic solutions have already been extensively adopted (Miah, 2019). In fact, introducing and improving business intelligence systems in hospitals, should be part of the strategy of all the departments and holistically to the hospital management (Escher, 2019).

From a management perspective, by creating business intelligence systems in hospitals, health professionals and managers will be able to access a wide range of information of extreme relevance for the fulfilment of the objectives, which will also allow them to react quickly to change, adapt strategies and especially, optimize processes.

As referred by Bohmer (2009, p. 8), recent evidence suggests that how care is managed matters a great deal, namely, "improved performance measurement has revealed the extend to with organizational performance – in particular, how care processes are approached, supported, and managed – is an important determinant of individual patient outcomes".

Bittar (2011) refers that the indicators can be divided into External and Internal Environment. According to Bittar (2011), the information from the external environment are the demography, geography, economics, politics, culture, education, psychosocial, technology, whether or not other health institutions exist and epidemiological. In the Internal Environment refers those characterized by the resource structures (Human Resources, Financial Resources, Information Resources, External Services Resources, Material Resources (Permanent and Consumption), Commodities Resources), divided into areas and sub-areas, infrastructure, ambulatory / emergency, complementary to diagnosis and therapy and clinical and surgical hospitalization.

The emphasis and usefulness of indicators may differ between different types of hospital managers (Souza, 2014). In fact, as Souza (2014) exemplifies, "managers of the public hospital use indicators as a source of management of scarce resources and philanthropic hospital managers use indicators as a source of information for economic sustainability and caregiving". These different approaches and needs indicate that these systems must be agile, evolutionary, and open enough to allow for change, and be adaptable to different management needs and profiles.

2.2.4 The evolution of the Business Intelligence Systems

The AMAM (Adoption Model for Analytics Maturity) model, designed by HIMSS (Healthcare Information and Management Systems Society), measures the level of maturity in the adoption of analytical tools (HIMSS, 2021). The AMAM model measures the analytical resources that healthcare organisations have gained by having a strong analytical strategy and competence, and suggests an organisation for healthcare delivery analytics, regardless of the technologies installed.

This maturity model is composed of 8 levels, as shown in Table 1.

Table 1. Adoption Model for Analytics Maturity Levels (HIMSS, 2021)

Level 7	Stage 7 represents the pinnacle of applying analytics to support patient specific prescriptive care. Healthcare organizations can leverage advanced data sets, such as genomic and biometrics data to support the uniquely tailored and specific prescriptive healthcare treatments of personalized medicine. Organizations can deliver mass customization of care combined with prescriptive analytics.
Level 6	Stage 6 pushes the organization to mature in the use of predictive analytics and expands the focus on advanced data content and clinical support.
Level 5	Organizations show expanded point of care-oriented analytics and support of population health. Data governance is aligned to support quality-based performance reporting and bring further understanding around the economics of care.
Level 4	The organization directs analytical data assets, skills, and infrastructure squarely towards improving clinical, financial, and operational program areas. This includes a concerted effort to understand and optimize by honing analytics resources that support evidence-based care, track and report care and operational variability, and identify and minimize clinical and operational waste.
Level 3	Mastery of descriptive reporting broadly across the enterprise. Varying and different parts of the organization are able to effectively corral data, work with it, and produce historical and current period reporting with minimal effort. Data quality is stable and predictable, tools are standardized and broadly available, and data warehouse access is managed and reliable.
Level 2	Data is presented in a formal data warehouse as an enterprise resource (as opposed to a silo oriented and narrowly used resource) with master data management (MDM) that supports ad-hoc queries and descriptive reporting. The enterprise begins maturing data governance while leveraging this environment in support of basic clinical and operational tasks, such as patient registries. All

	activities should be aligned with the organizations' overall strategic goals. Analytic skills, standards, and education are managed through an analytics competency center.
Level 1	Organizations are just beginning to accumulate and manage data into a centralized location, like an operational data store or data warehouse supporting historical reference and consolidated access. The main focus of Stage 1 is to document and begin execution of an analytics strategy that brings basic data together from appropriate systems of record and learn to manage (data governance) and define data so that it can be used and referenced by a broad cross section of analysts.
Level 0	All organizations start their analytics journey at Stage 0, with a desire to learn about developing analytics capabilities in response to business demands, market pressures, and a need to develop further insights into the important decisions they make every day

Currently (October 2021), there are only 42 hospitals with a level 6 or 7 in the world, and none in Europe (HIMSS, 2021).

In fact, the challenges to achieve high levels of maturity are still difficult to overcome for many hospitals around the world, which are still struggling, in many cases, to reach high levels of maturity in their electronic clinical processes, for which the EMRAM (Electronic Medical Records Adoption Model), also developed and promoted by HIMSS, is the reference at a global level.

Another guideline is the Analytics Maturity Model of a business intelligence system presented by Gartner (Figure 1), which presents an expected life cycle of a business intelligence system, from an initial level of "Descriptive Analytics", which essentially answers the questions "What happened? " in the organization, through "Diagnostic Analytics", which identifies the "Why did it happen?", followed by "Predictive Analytics" which answers the "What will happen?" and finally, the "Prescriptive Analytics", which answers the "How can we make it happen?" question.

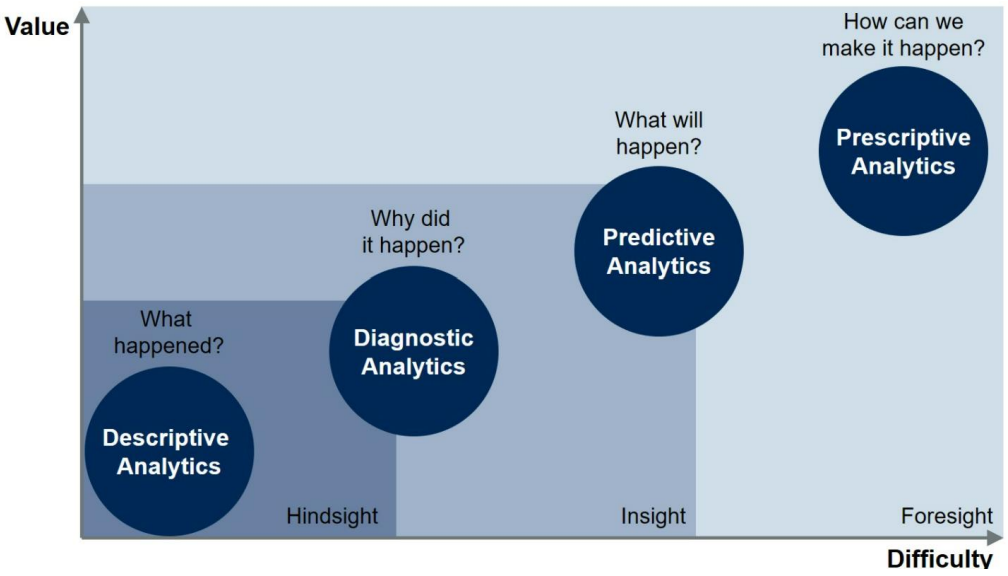

Figure 1. The Analytics Maturity Model (Gartner, 2019)

2.3 Agile Project Management

2.3.1 The principles of AGILE

The principles that guide the Agile methodology are presented in the Agile Manifesto (Manifesto for Agile Software Development, 2001), a document in which are described four core values supported by 12 principles. The 4 core values are the heart of the Agile methodology: (1) Individuals and interactions over processes and tools; (2) Working software over comprehensive documentation; (3) Customer collaboration over contract negotiation; (4) Responding to change over following a plan.

Karlesky & Voord (2008) synthesize key Agile concepts on "Customer", "Feature" and "Done".

In this perspective the authors refer the "customer" as the single point of contact responsible for taking decisions about direction, prioritization and answering to domain questions. They are close to the development team to collaborate, prioritize features, to test and to give feedback on

usability, among other contributes. If many persons are involved as end-users (or clients) a single person can bridge the relation between them and the development team, the Product Owner.

The authors define "feature" as the unit of functionality described by the customer on their own words, verifiable in its completion to the satisfaction of the customer. In Agile Project Management, the efforts are centered on delivering features, which are short, high-level narratives capturing the customer's expectations, defined as "user stories".

Finally, the authors define "Done" as a measurable state of completion. A feature is done completed after going through a series of tests, all unit, system, and acceptance tests. This acceptance tests are performed by the customer.

Agile project management is an iterative approach to project management, on the other hand, traditional project management (known as Waterfall), relies on a sequential approach.

Agile methods have gained ground over traditional software development methods, as they are permeable to requirements that change frequently, with very tight execution times. Agile methods include frameworks like Extreme Programming, (XP), Scrum, Feature Driven Development (FDD), Crystal methodology, Dynamic System Driven Development (DSDM), Adaptive Software Development (ASD), Open Source (OS), Agile Modeling (AM), Pragmatic Programming (PP) and Kaban. All those frameworks are based on the Agile Manifesto and have their own software development life cycle (Bhalerao, 2009) (Ullah, 2019).

While each Agile method is suitable for different problems and contexts, the challenge remains in determining which agile method is best suited for certain activities in a project (Ullah, 2019).

The most popular today, Kanban, Extreme Programming and Scrum, are considered standard development methodologies (Hsieh & Chen, 2015)(Ullah, 2019).

2.3.2 Agile Vs Waterfall

Analyzing the Agile principles, some perspectives between the development of projects using an Agile or Waterfall methodology (Kisielnicki, 2017) cab be highlighted.

First, Agile is focused on people, Waterfall is focused on processes, on other words, one is "Customer Centric", the other is "Process Centric". This brings other relevant difference related to the requirements. On waterfall they are defined in the beginning of the project, on Agile they are based on business value with regular updates, which brings a performance measurement based on the value added to the business in Agile, against the conformity to the plan on Waterfall.

Second, the initial planning is low in Agile and high in Waterfall, which brings a more adaptive, flexible, and responsive goal achieve in Agile, compared to a goal optimization focus on Waterfall.

At last, in the problem-solving perspective, Waterfall is focused in selecting the best means to accomplish a given end through well-planned activities, and Agile is focused on learning through experimentation and introspection, constantly reframing the problems and the solutions. This implies an early return of the investment and efforts, throughout the project's life cycle in Agile, against a return of the investment in the end of the project on Waterfall.

Other perspectives are presented by Karlesky & Voord (2008). The authors mention that traditional project management (waterfall) view change and rework as an expense and for that reason tries to limit change through extensive upfront planning, design, and documentation. On the other hand, Agile project management views failure on delivering as the most expensive aspect on the software development.

On the perspective of managing risk and scope, is considered quite simple using Agile Project Management (Karlesky & Voord, 2008). The most important parts of the project are prioritized to be completed first. The burndown chart is updated on each completed iteration, with the most important features done first. This point it is a huge difference between Agile versus Waterfall. In a situation of termination of the project ahead of time, in Agile the most important parts of the project may be already developed and functional, while in waterfall the delivery is made only at the end, with the the risk of the client being left with nothing functional.

Rehani (2011) presents a deep analysis about the differences between Agile and Waterfall. In the perspective of the "Flexibility", in Agile the requirements can keep changing within an iteration based on user inputs. In the perspective of "Visibility", users and developers are part of the same

team, and users are involved in the interactions. In the "Risk" perspective, the author states that users are engaged in early stage which brings less risk of failure.

It is possible to perceive through the analysis of the differences that an Agile Project Management is better suited to projects and environments in constant change and evolution.

2.3.3 Agile Life Cycle

In the systems development cycle, Agile methodologies resolve several problems from the Waterfall methodology, but one specifically is very relevant, the time it takes to deliver something to the costumer (MOSS, 2013). For that the requests from the customers must be divided in multiple "releases". Some of the advantages of doing this are: (1) Converting a big scope into smaller scopes, bringing less complexity and easier management; (2) The lessons learned from one release can be used in the following ones cumulatively; (3) The customers can improve their maturity during the releases, improving the pendant requests with more insightful and sharper contributes.

Those releases feel like prototyping, but with the ongoing of the project, continuous improvements, and the sum of all the parts, the business intelligence system starts gaining a consistent body.

As explained by Sliger (2011), an Agile project begins with a vision and a set of features of the solution ranked in order of importance. These features are included and prioritized in the product backlog, which is maintained by the customer or customer representative (called the Product Owner). On the top, the most important features.

A time box, commonly called as iteration or sprint, is the amount of time the team has to complete the selected features. Sprints generally last from one to four weeks, and this duration is maintained throughout the life of the project to establish a cadence.

The development team selects the items from the product backlog that they believe can be completed in the next sprint and creates a sprint backlog that consists of the features and tasks as part of the sprint planning meeting.

The task work begins once the team has committed to a sprint backlog. During this time the team is totally focused on its development and fulfillment of the sprint goal, without interruptions and without any changes in the sprint backlog. However, the product backlog can be changed in preparation for the next sprint.

During the sprint, the team meets every day in a 15-minute meeting known as a scrum meeting. At that meeting, each member explains what he did the day before, what he will do on the current day and what difficulties is experiencing.

At the end of the sprint, the team demonstrates the work it has completed to the stakeholders and gathers feedback that will affect the work in the next sprint. They also hold a retrospective meeting to learn how to improve. Its focus is on the three pillars of Scrum: transparency, inspection, and adaptation.

2.3.4 Agile Tools

From the Agile, despite many others, four tools must be highlighted: (1) User Stories; (2) Epics and Initiatives; (3) Product Backlog; (4) Kanban Boards.

The "User Stories" are a method for representing requirements, using a template. As defined by Rehkopf (2020), the user stories serve several key benefits: (1) Stories keep the focus on the user. A To-Do list keeps the team focused on tasks that need checked off, but a collection of stories keeps the team focused on solving problems for real users. (2) Stories enable collaboration. With the end goal defined, the team can work together to decide how best to serve the user and meet that goal. (3) Stories drive creative solutions. Stories encourage the team to think critically and creatively about how to best solve for an end goal. (4) Stories create momentum. With each passing story the development team enjoys a small challenge and a small win, driving momentum.

User stories are also the building blocks of larger agile frameworks like epics and initiatives. In short, epics are large work items divided into a set of stories, and several epics can be aggregated in an initiative (Rehkopf, 2020).

On the other hand, the product backlog will be the list that will prioritize the user stories. The most relevant/urgent in the top, the less important in the bottom. This prioritization can have a defined rule that must be transparent for all. The product backlog will allow all the stakeholders to be aware of the list of "requests" waiting for development and their prioritization. This product backlog can be the first column of a Kanban Board (Inflectra, 2020). The Kanban Boards are also one agile tool that must be considered, where a Scrum Board can also be an option. There are some differences between Scrum and Kanban boards, but they are superficial different, not relevant to the subject of this study. Despite the differences, the principles are largely the same. The essential idea is that with any of this boards the stakeholders will have transparency and a holistic visibility about the work to be done, the work that is ongoing, and the work already done.

2.3.5 Agile Scope Management

In a traditional project management approach, it is assumed, by definition, that a clear project scope prevents common problems such as:

- Constantly changing requirements
- Changes of direction
- Unfulfilled stakeholder expectations
- Unforeseen costs
- Implementation delays

Clearly defining the scope of the project allows for correct estimation of time, quantification of labour and project cost. It also allows to distinguish between what is necessary and what is not necessary for the realisation of the project.

One of the most relevant points in the management of a project is to manage the scope, which in a traditional approach, may see the change of the scope as an indicator of poor initial planning, in project management jargon referred to as "scope creep".

In fact, there are differences in managing the "scope" when applying an Agile methodology compared to a traditional approach.

In agile scoping, the scope is considered variable, in the perspective that incrementally it can incorporate lessons learned and feedback from stakeholders.

This principle is evident in the Agile Manifesto, which states "Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage."

The differences between Agile and traditional scope management are resumed in table 2.

Table 2. Differences between Agile and traditional scope management (Layton, 2020)

Traditional approach	Agile Approach
Project teams attempt to identify and document complete scope at the beginning of the project, when the teams are the least informed about the product.	The product owner gathers high-level requirements at the beginning of the project, breaking down and further detailing requirements that are going to be implemented in the immediate future. Requirements are gathered and refined throughout the project as the team's knowledge of customer needs and project realities grows.
Organizations view scope change after the requirements phase is complete as negative.	Organizations view change as a positive way to improve a product as the project progresses. Changes late in the project, when everyone know the most about the product, are often the most valuable changes.

Project managers rigidly control and discourage changes after stakeholders sign off on requirements.	Change management is an inherent part of agile processes. You assess scope and have an opportunity to include new requirements with every sprint. The product owner determines the value and priority of new requirements and adds those requirements to the product backlog.
The cost of change increases over time, while the ability to make changes decreases.	Fix resources and schedule initially. New features with high priority don't necessarily cause budget or schedule slip; they simply push out the lowest-priority features. Iterative development allows for changes with each new sprint.
Projects often include scope bloat, unnecessary product features included out of fear of mid-project change.	The scrum team determines scope by considering which features directly support the product vision, the release goal, and the sprint goal. The development team creates the most valuable features first to guarantee their inclusion and to ship those features as soon as possible. Less valuable features might never be created, which may be acceptable to the business and the customer after they have the highest-value features.

2.3.6 Agile Procurement

While in the traditional procurement model the emphasis is on cost reduction and detailed requirements gathering, in agile procurement the focus is on orienting the procurement function towards generating value, supporting and meeting dynamic business needs.

The key differences between traditional procurement and agile procurement are resumed in table 3.

Table 3. Differences between Agile and traditional Procurement (GEP, 2019) (DelVecchio, 2020)

Traditional approach	Agile Approach
Procurement involves fixed deliverables, extensive documentation and a comprehensive project plan	Procurement is based on an analysis of the working functionality at the end of each sprint, rather than on fixed deliverables
Traditional negotiations are confrontational and competitive and can sometimes get challenging and stressful, damaging relationships between buyers and sellers.	This is avoided by agile project teams that believe in maintaining a positive and cooperative relationship between both parties right from the start of the procurement process. It's more collaborative and communicative. Focused on strong supplier relationships and shared success.
Traditional procurement makes it difficult to switch vendors after the start of a project, as the new vendor has to first understand the previous vendor's work-in-progress status before starting his work.	Agile projects are divided into sprints that make it possible to cost-effectively change the vendor at the end of a sprint.
Traditional projects emphasize on compliance and their parameter for defining success	Agile firms, on the other hand, define success in terms of working functionality

includes checking off documents and deliverables.	
Regarding the deliverables, they are fixed with extensive planning and documentation.	In Agile, deliverables are Sprint-based, reactive, and iterative, with a focus on meeting expectations rather than fixed benchmarks or deliverables.

2.3.7 Agile Stakeholders Analysis

By definition, "stakeholder analysis" typically refers to the range of techniques or tools to identify and understand the needs and expectations of major interests inside and outside the project environment (Smith, 2020).

The process involves identifying, for each stakeholder, the level of influence and importance and grouping them as such. The measures of influence and importance are distinct, but combining these provides insight not only into how stakeholders interact, but also helps to identify additional assumptions and risks.

It may be important to develop a diagram (Figure 2) of these relationships to understand potential risks and highlight stakeholder groups whose needs can be addressed in the same way.

This classification can be translated, in a simple and agile way, into a "Stakeholder List" where the most important and influential are at the top, and the least important and influential at the bottom. This is not to say that the stakeholders at the bottom of the list should not be considered, but they will certainly be less revisited in interactions and engagement during the course of the project.

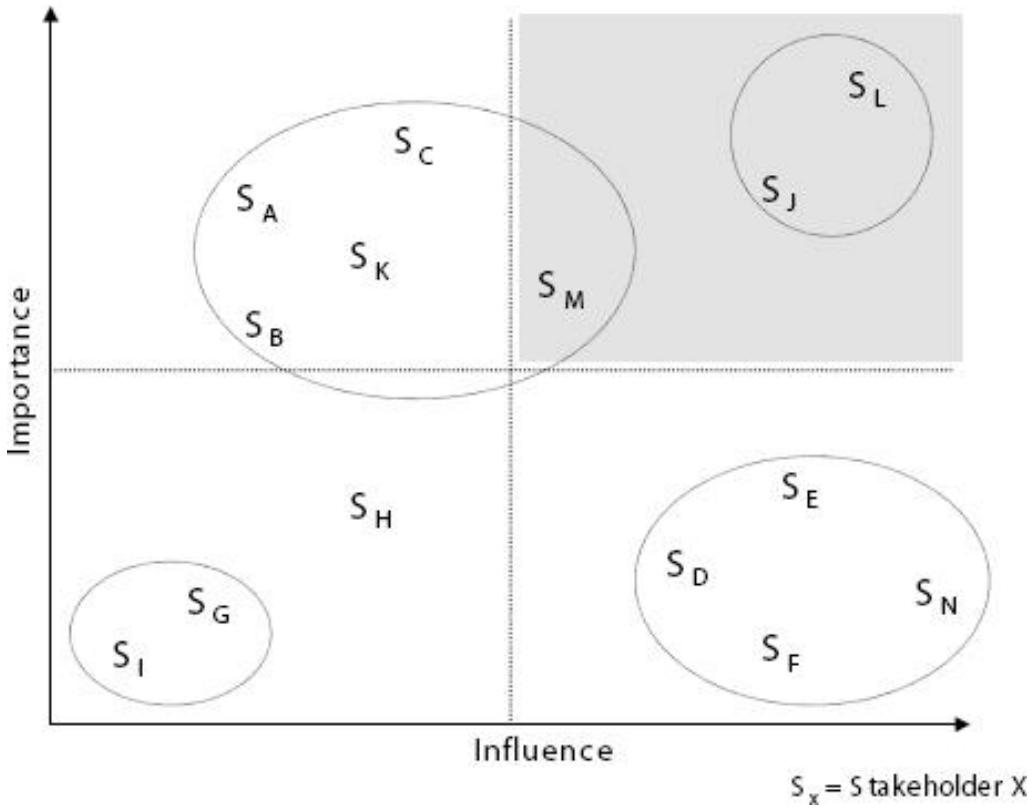

Figure 2. Interest-Influence Classification (Smith, 2020)

Regardless, whatever a stakeholder's position in the "Stackholder List", the agile project manager should try to engage them all continuously and communicate important information about the project quickly and effectively.

This is where the application of agile tools, such as Kanban boards, gain relevance over traditional methods such as meetings or more formal communications.

2.3.8 Agile business intelligence team

Building a business intelligence system must be a work done with the collaboration of multiple stakeholders from the multiple business units and business intelligence specialists.

Agile promotes face-to-face communication and discourages spending time on written communication and documentation (Rehani, 2011). Normally, the size of a team should consist of a group of 6 to 8 people, as this way it enhances better communication and teamwork.

If the number of user-stories to be closed during a sprint is high and if a larger team is needed, it is suggested to divide the team into several groups, each assigned to a different functional area.

In a small Agile business intelligence team, there must be a mix of technical skills and business skills and must have owners for each of the following areas: (1) User requirements; (2) Source of data and applications; (3) Data warehouse data model; (4) Data transformations and ETL routines; and (5) Reporting applications.

In order to meet these needs, the team will be composed by end users, business analyst, ETL specialist, report designer / developer, database administrator and business intelligence architect.

A "Project Champion" is defended by El-Adaileh & Foster (2019). This project champion must have strong leadership skills and management skills. The project champion is defined here as an individual who can recognize ideas that are useful to your organization and leads with adequate authority and resources during all phases of development and implementation. The champion must be an enthusiastic person with deep knowledge of the organization's business processes, in addition to a good knowledge of technological innovations. The research that exists in the area shows that the project champions, when present, are able to significantly impact the successful adoption of the business intelligence system.

El-Adaileh & Foster (2019) also argues that teams in business intelligence projects should have participants from different areas of the business to enhance the sharing of ideas and thereby potentiate increased standardization.

2.4 Business Intelligence System development in Hospitals using Agile

2.4.1 Implement a Business Intelligence in hospitals

As mentioned by Mettler (2009), table 4 explains some of the differences and similarities between the business intelligence systems of industrial organizations and healthcare organizations.

Table 4. Differences and Similarities between business intelligence systems in industrial organizations and healthcare organizations

Differences	Similarities
• *Management* is unified in most sectors, but health care has clinical and administrative reporting.	• All sectors seek improvements in cost, quality and delay through integrated *processes*.
• Most sectors have a clear group of *customers* with typically a few product variants; health care involves a multiplicity of *actors* with distinct needs (e.g. patients, insurance companies, governmental authorities, doctors).	• Following the customer-centred success in other sectors, the *centre of attention* in health care should be primarily the patient but also the mentioned variety of other customer segments.
• Most industrial systems have hard *metrics*, in health care people's feelings and choices matter too.	• As in other sectors, health care will benefit from *system integration*.

From the differences, it is clear that implementing a business intelligence system in a hospital adds some challenges. First of all, the clinical component is highly complex and heterogeneous. Second, the diversity of stakeholders, ranging from patients, insurance companies, authorities, health professionals, among others. Finally, the human component of health, where the opinions and outcomes of multiple stakeholders are a relevant asset.

In addition to the differences between business intelligence systems in health and non-health highlighted by Mettler (2009), research shows that doctors express concerns related to issues such as security and data protection, interpretation, analysis and dissemination, flexibility to adjust what to track and how records and summaries are presented and workflow integration (Jacob, 2019). These concerns are just a small example, but they reveal a central point in the

implementation of a business intelligence system in a hospital, the adoption of the system by health professionals. In addition to the technical complexity that the sector represents, there are non-technical components that can dictate the success or otherwise of these systems. Furthermore, business intelligence projects are long and painful (Barone, 2012), requiring in some way a project management methodology that allows correct monitoring of the development life cycle and continuous improvement.

2.4.2 Using Agile Project Management in business intelligence projects in hospitals

Any long journey starts with the first step, and this first step in a business intelligence project can be the "skeleton" of the business intelligence. A first release cab be such as: (1) A table populated with current-month data; (2) A sample report prototype with extracts of this data; and a (3) Graphical representations of this data in a dashboard.

As mentioned by Bajaj (2018), the "BI road map is a living vision that will evolve, reacting to changes in business, organization, economy, and technology". In fact, with the maturity evolution in the use of the business intelligence, new ideas, needs and uses will emerge, justifying continuous revisions of the business intelligence road map to reflect the momentum business intelligence needs and analytical demands.

Developing a business intelligence system is 80% data management (Moss, 2013). This means that the development of business intelligence solutions involves less creation of functional software and more dealing with data in business context. The software used in a business intelligence system includes database management, cleaning, and data transformation.

From the several inputs in this study, several reasons arise to use Agile in a business intelligence project. An Agile approach will (1) allow to deliver functional parts of the overall solution faster; (2) be more flexible to changes to the initial requirements; (3) allow to react quicker to change requirements; (3) bring more visibility, transparency and collaboration to the end-users on the development stage;

In fact, as stated by Larson & Chang, 2016), IT departments "are faced with maintaining a competitive edge, which, in turn, increases pressure to deliver high quality technology solutions

faster. Under these circumstances, the value of technology efforts is determined based on how soon payback and return on investment occur". In the same note, Bajaj (2018) says that Agile methodology for business intelligence implementation "enable strategic, tactical and operational decision-makers to be more flexible and more responsive to the fast pace of changes to business and regulatory requirements".

With traditional methodologies, the requirements for the business intelligence systems seems to be a "moving target" (Moss, 2013). With an Agile Project Management approach (1) the deliveries are fasters, (2) the end-users are involved continuously, (3) changes are accepted during the development, (4) the tests and acceptances are done on each delivery.

Also Ullah (2019) state some disadvantages of the waterfall model approach reinforcing that there are (1) Very long development cycles; (2) Less user involvement; (3) Very inflexible to adopt changing analytics requirements; and (4) Testing is performed just at the end.

Rehani, B. (2011) states that Agile works well in business intelligence projects due to the following reasons: (1) Many business intelligence projects are about integrating new data, combinations of these or new reports into an existing data warehouse. These require some improvements or changes to existing data stores and create reports that derive from that data warehouse, Agile being suitable for this type of interaction and change. (2) A typical business intelligence implementation consists of several modules, such as Data Integration, Data Modeling, Data Quality, Data extraction and reports. The agile methodology can be used to develop each module separately and then integrate each module to create a complete business intelligence solution. (3) business intelligence reporting and data extraction tuning require a lot of interaction between the client and the development team. Agile helps bring the language of the business closer to the development team, which helps to speed up development processes and reduce risks. The communication gap is reduced, errors in interpretation are less. With multiple client / developer iterations during a sprint, it allows that at the end of the sprint, the reports delivered, or any other item are what the client really expects. (4) Agile is a test-driven approach, with the customer actively involved in the design and implementation process, for this reason, many reports and data bugs are found in the early stages and are easier to fix, as opposed to the more traditional

approach, where the tests are carried out at the end of the project. Agile also has the advantage that lessons learned over multiple tests can be applied in the following iterations.

Shah (2019, p.5) quotes Jackson et al.27 who refers to "'Agile software development' practices that became an industry standard for analytics application design in healthcare". It also states that "This methodology supports with efficient methods of collaboration and effective ways of conducting analytics solution design."

Kisielnicki (2017, p.8) also presents the results of a study, in table 5, the result of a questionnaire to end users of a business intelligence system on the success factors of Agile, where all the agile principles are highlighted.

Table 5. Agile principles in context of business intelligence users (Kisielnicki, 2017)

Agile Principle	Business Intelligence Response
Customer satisfaction because of early and continuous delivery of valuable software	Owing to the fact that business intelligence users have a chance to see a product already after few weeks, it is easier to make sure that the project is meeting the requirements
Welcome changing requirements, even in late development	During the project, end-users' requirements changes and it is not possible to avoid it, especially in the environment such as reports and data. Data is increasing in incredible fast way, which impact new required sources and new analytics. By agreeing to these changes, a project meets customer expectations
Working software is delivered frequently (weeks rather than months)	End-user has a chance to verify and challenge requirements on regular basis

Close, daily cooperation between business people and developers	Constant, daily end-user involvement helps the project to follow actual business needs and changes, which may impact the solution
Projects are built around motivated individuals, who should be trusted	Best involvement of committed people always helps to obtain success
Face-to-face conversation is the best form of communication (colocation)	End-users are committed and cooperative when the communication process is performed properly
Working software is the principal measure of progress	Working software means that users can actually work on it and test it. That helps end-users follow the project by seeing actual development and estimate its progress.
Sustainable development, able to maintain a constant pace	This way there is no rush and possible mistakes in the product delivery
Continuous attention to technical excellence and good design	These are factors always required by end-users
Simplicity the art of maximizing the amount of work not done is essential	Simple solutions especially in business intelligence projects help users to understand and use the new functions better. At the same time, it might be easier to provide a change, if required
Self-organizing teams	The customer as a part of a team takes responsibility for working, valuable data, and reports. May impact the daily work and feed info on regular basis. At the same

	time, cooperation is more efficient by eliminating any walls between customer and vendor
Regular adaptation to changing circumstance	This point is one of the most important for business intelligence users. Need for reports, information, and data sources might change often. Thus, thanks to all of the above principles; users can deliver actual requirements and possible changes

These analyses allow us to sustain and highlight, in the case of business intelligence projects in hospitals, some virtues of agile methodologies:

- As long projects, due to the complexity of health care organizations, the high number of stakeholders and the diversity of areas and types of data, the interactive component and permeability regarding change, are fundamental to the success of the projects;
- Also, the incremental component (small steps), experimental, collaborative, centred on the needs of customers, allows the adoption of solutions to be much greater by all stakeholders, this being done from the first deliveries.

In the process of developing a business intelligence system from scratch, there will be several stages, as referred earlier by Olszak & Ziemba (2007). In some of these stages agile tools can be emphasized, as it is in these phases that the interaction between developers and end users will be most valued.

Kisielnicki (2017, p.8) presents the results of a study the result of a questionnaire to end users of a business intelligence system on the success factors of Agile, where all the agile principles are highlighted. The results to those 12 Agile principles here: (1) Owing to the fact that business intelligence users have a chance to see a product already after few weeks, it is easier to make sure that the project is meeting the requirements; (2) During the project, end-users' requirements

changes and it is not possible to avoid it, especially in the environment such as reports and data. Data is increasing in incredible fast way, which impact new required sources and new analytics. By agreeing to these changes, a project meets customer expectations; (3) End-user has a chance to verify and challenge requirements on regular basis; (4) Constant, daily end-user involvement helps the project to follow actual business needs and changes, which may impact the solution; (5) Best involvement of committed people always helps to obtain success; (6) End-users are committed and cooperative when the communication process is performed properly; (7) Working software means that users can actually work on it and test it. That helps end-users follow the project by seeing actual development and estimate its progress; (8) This way there is no rush and possible mistakes in the product delivery; (9) These are factors always required by end-users; (10) Simple solutions especially in business intelligence projects help users to understand and use the new functions better. At the same time, it might be easier to provide a change, if required; (11) The customer as a part of a team takes responsibility for working, valuable data, and reports. May impact the daily work and feed info on regular basis. At the same time, cooperation is more efficient by eliminating any walls between customer and vendor; (12) Need for reports, information, and data sources might change often. Thus, thanks to all the above principles; users can deliver actual requirements and possible changes.

Agile software development practices became an industry standard for analytics application design in healthcare, which brings efficient methods of collaboration and effective ways of conducting analytics solution design (Jackson et al, 2019).

In the case of business intelligence projects in hospitals, some virtues of agile methodologies can be highlighted:

- As long projects, due to the complexity of health care organizations, the high number of stakeholders and the diversity of areas and types of data, the interactive component and permeability regarding change, are fundamental to the success of the projects;

- Also, the incremental component (small steps), experimental, collaborative, centred on the needs of end-users, allows the better adoption of solutions by all stakeholders, from the first deliveries;

– The Agile tools (User Stories, Epics and Initiatives, Product Backlog and Kanban Boards) are relevant are concepts easy to understand by non-IT stakeholders, which contributes for an overall collaboration improvement.

The "User Stories" are a method for representing requirements, using a template. As defined by Rehkopf (2020), the user stories serve several key benefits: (1) Stories keep the focus on the user. A To-Do list keeps the team focused on tasks that need checked off, but a collection of stories keeps the team focused on solving problems for real users. (2) Stories enable collaboration. With the end goal defined, the team can work together to decide how best to serve the user and meet that goal. (3) Stories drive creative solutions. Stories encourage the team to think critically and creatively about how to best solve for an end goal. (4) Stories create momentum. With each passing story the development team enjoys a small challenge and a small win, driving momentum.

User stories are also the building blocks of larger agile frameworks like epics and initiatives. In short, epics are large work items divided into a set of stories, and several epics can be aggregated in an initiative (Rehkopf, 2020).

On the other hand, the product backlog will be the list that will prioritize the user stories. The most relevant/urgent in the top, the less important in the bottom. This prioritization can have a defined rule that must be transparent for all. The product backlog will allow all the stakeholders to be aware of the list of "requests" waiting for development and their prioritization. This product backlog can be the first column of a Kanban Board (Inflectra, 2020). The Kanban Boards are also one agile tool that must be considered, where a Scrum Board can also be an option. There are some differences between Scrum and Kanban boards, but they are superficial different, not relevant to the subject of this study. Despite the differences, the principles are largely the same. The essential idea is that with any of this boards the stakeholders will have transparency and a holistic visibility about the work to be done, the work that is ongoing, and the work already done.

2.4.2 Why Agile Project Management is more suitable to Business Intelligence Projects?

Kannan (2011) refers to a matrix developed by Todd Little to effectively select which projects are suitable for an agile methodology. The matrix (figure 3) has two dimensions, Uncertainty and Complexity.

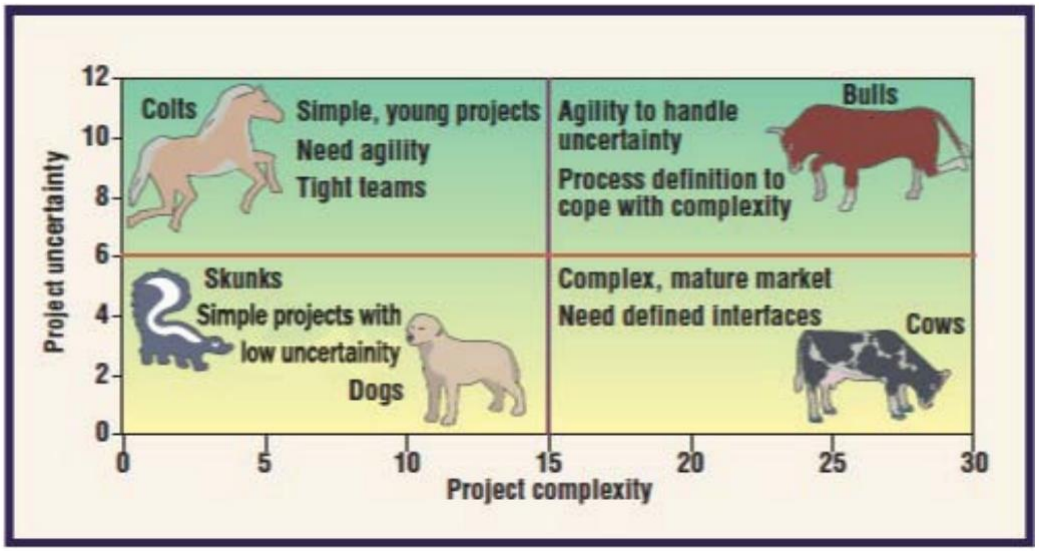

Figure 3. Todd Little proposed Matrix

Kannan (2011) mentions that agile methods are more suitable to deal with the uncertainty of the results, also mentioning that regarding complexity, agile methods can help in adaptive software development projects.

Based on this assumption it identifies a number of reasons for classifying a project to create a data warehouse as having high uncertainty, namely:

- New needs arise as end users deepen their understanding of the organisation's data and improve their maturity in the concepts of data warehouses or data integration;

- The results of data analysis lead to new requirements and ideas, which often represent anything from minor changes (change in reporting) to major changes (change in technology);

– End users expect rapid delivery when they are still refining their needs;

– Development teams strive to meet data delivery expectations to end users, which leads to skipping some steps such as standardising data and taking shortcuts to testing, as well as developing incomplete documentation with compromised quality;

– The data model changes frequently due to changes in reporting and other organisational requirements;

– End users are unclear about the data until they see the data in the target system;

– Organisation logic has frequent changes;

– Most data warehouse projects run for long periods of time and are subject to continuous change;

– The resources required may be added as the project grows.

3 Characterisation of the current state

Analysing the current state of hospital organisations in Portugal, a study intitled "Business Intelligence in the SNS: Main Challenges", developed by the Portuguese Association of Hospital Administrators (APAH, 2019), are highlighted some of the main problems that (healthcare) organisations in Portugal often face.

The following problems stand out:

1. The quality and cross-checking of data
2. Difficulty of access to data
3. Experience of users
4. Sharing Experiences

Within the scope of this study, some of these skewers are highlighted. Regarding problem 1, the dependence on the Technology and Information Systems Offices or Information and Management Control Offices for the extraction of specific data is mentioned. This dependency does exist, but it diminishes when a business intelligence system is implemented, since data access is democratised (with the appropriate access controls), but downstream, the extraction of these same data is fully automated, totally reducing the dependency on these offices.

Regarding the "difficulty of access to data", the study states that "at local or hospital level there is a deficit in the ability to obtain the desired data in time, either by inability to extract them, or by inability to cross-reference them". Once again, if the correct data access tools are made available, if all users are trained to use them and if all key-users and stakeholders are involved from the beginning, a self-service data access model is achieved that cancels out the difficulty in accessing data.

In the case of "user experience", there is a relevant fact. Most of the time, when one thinks about the development of a business intelligence system, one thinks inside the organisation, rarely considering the user as a potential consumer of data from these systems. There is still a long way to go, because in addition to the challenges of developing a business intelligence that meets the

information needs of the organisation itself, in order for this information to reach users and for it to be comparable between organisations, there must be an effort to standardise data between organisations.

Finally, with regard to "sharing experiences", little communication and sharing of experiences between hospitals is mentioned. Effectively, sharing experiences between hospital organisations is relevant to the success of a business intelligence project.

Also mentioned in the same APAH study (2019), according to the consultancy firm Gartner, 70% to 80% of business intelligence projects fail mainly due to some factors (Raghavan, 2015):

- **Reliance on old technology:** Purchase of solutions that are already technologically outdated
- **Lack of understanding of the meaning:** Lack of knowledge of the meaning of the project
- **Poor user experience:** Users at the point of use do not have their expectations met
- **No support from hierarchy:** There is not full commitment of the top hierarchy in the organisation

Some success factors in the implementation of a business intelligence system in a hospital will be to ensure that the above factors are met.

They also mention "vital factors to reduce the risk of implementation failure", of which:

1. **Return on Investment (ROI):** Demonstrate that the implementation of the solution represents a return on investment.
2. **Budget:** Ensure the financial capacity to see the project through to completion.
3. **Data quality and integration**: Ensure data reliability and ensure that changes to production systems are reflected in the business intelligence system.
4. **User expectations and training:** Need to engage and train key users so that there is confidence in the data and full use of it.
5. **Timing of implementation:** Clearly define a detailed implementation schedule.

6. **Business rules:** The system should be flexible and configurable enough to reflect the business rules. It should be the system to adapt to the way the Hospital operates and not the Hospital to the pre-defined rules of the solution.
7. **Sponsorship:** Already mentioned above, possibly one of the most relevant aspects. It is of vital importance that the Board of Directors of the Hospital, as well as the middle management are aligned with the objectives, expectations and security of the results.
8. **Change Management:** The way data is accessed, sometimes the democratisation of this access and ensuring the participation of all stakeholders so that they feel part of the project, is a key factor for the success of the project.

Not mentioned in the APAH study, but considered to be relevant:

9. **Skills:** All skills, internal or external, should be guaranteed so that the project is developed professionally, in the right time and with quality. These include Business Skills, Technology Skills and Analytics Skills.

4 Use Cases

In this chapter will be presented two real business intelligence systems implementations where the author of this dissertation actively participated and managed.

4.1 Case 1: Information is Power

In this use case is presented a situation where the stakeholders were not involved in the development of the business intelligence system.

Characterisation of the hospital

A small, private, university hospital with 300 beds, 3 operating theatres, in operation for less than 3 years, covering a population of 500,000.

The existing process before business intelligence

The hospital had a Management Board, which met every month and where each of the directors showed the data from their area, without any predefined template, using slides and spreadsheets. One week before each meeting, the IT department was "bombarded" by those directors with requests for the needed data. The Information Systems Department had a seat on that board.

The Director of Information Systems, concerned about the time and resources consumed every month by his team to provide the data, decided with his team to develop a business intelligence system from scratch. The needs were already known, as for many months it was this team that provided the data to the different areas. However, some research was carried out to find out the state of the art in terms of hospital indicators and a survey of reports/indicators from other hospitals was carried out.

This project was not official, as it was the aim of the Director of Information Systems to present this project when it was completed, and the multiple stakeholders were not involved.

The budget was zero, so a procurement of Open Source business intelligence solutions was carried out. A current, powerful system was found, being one of the references at the time by comparative quadrant analysis of this type of solutions. The team chose Pentaho Community. The learning curve was low and the tools provided were very visual and intuitive. The team had a deep knowledge of the existing databases and had internal resources with high expertise in databases and development, namely in SQL. The team also had a deep knowledge of the hospital processes, infrastructure and data sources.

During weeks the IT team implemented the solution, developed the ETL (Extract, Transform and Load) process and built a data warehouse.

All the reports that were normally required were developed, but now consistently, with the same formatting.

The high interoperability in the hospital systems facilitated the creation of the business intelligence system.

After the development of processes (ETL) to Extract and Transform, where the team built a data warehouse to receive all data, settled two phases of deployment, the first with the basic

management indicators and more urgent, and a second phase with more advanced indicators and "intelligence".

Most of the predefined reports with the various indicators are automatically generated to pdf and sent to authorized groups, daily or monthly. At the same time, was developed a search tool that authorized employees could drill down and infer their own reports.

The predefined reports were structured in the following categories:

Production:

- Monthly production report for each specialty;
- Monthly production reports for Imaging, ED and Outpatients;

Finance:

- Monthly report with evolution of the main financial indicators with evolution of the last 13 months of core indicators. These reports include indicators such as invoicing, receipt, monthly and annual quantitative and relative comparison;
- Daily report with the financial indicators of the previous day and monthly accumulated, as well homologous values.

Productivity:

- Monthly reports with indicators by professional, with indication of personal production (associated episodes) and financial production. These reports are the basis of payment to the professionals.

Audit & Quality:

- Monthly audit report with quantitative comparison between imaging studies in each equipment and the respective amount invoiced.
- Multiple daily reports with detection of abnormal situations in administrative proceedings:
  - Episodes without invoicing;

- Outstanding Invoices;

- Episodes not closed;

- Data failure detection;

- Report for the detection of abnormal situations of completing the clinical process;

- Report with customers waiting and permanence times;

"Intelligence":

Multiple reports with results obtained by the application of advanced techniques and datamining, with multiple sources cross-reference. Some examples:

- Relationship between first and subsequent episodes;

- Relationship between number of consultations held and the number of surgeries performed by specialty;

- Search estimation based on the scheduling history (time series);

- Billing forecast based on history (time series);

- Determination of the probability of occurrence of a second visit within x days;

- Application of "Market Basket Analysis" technique for detection of frequent relations of consumption of services by clients;

Gains after business intelligence implementation

The system led to a transition from a situation where multiple decision-makers and professionals generate their own reports for days, all different and difficult to compare, to a situation of centralization, standardization and automation. With little or no human interference, the key indicators necessary for hospital managers are generated in seconds, regularly and based on reliable data. The distribution of reports is also carried out in an automated way via multiple distribution lists. The system allowed extraordinary savings of working hours and earnings in the quality of the information.

Some of the lessons learned from the project:

Lesson 1: In this project the key-users and stakeholders were not involved from the beginning and were faced with a ready-made solution. Adoption was problematic for several reasons:

- Mid-level decision-makers, namely those who made up the Management Board, felt they lost their grip on the data and thus the power it gave them.
- Their first reaction was to reject the data, questioning its reliability.

The big lesson of this project is precisely the involvement of all stakeholders from the beginning.

Lesson 2: The project was not sponsored (and known) by the Board of Directors, as it was developed internally by the information systems department. When the system was launched, there were financial reports which the Board of Directors considered to be of a confidential nature, and they were concerned and questioned the legitimacy of the information systems in generating these reports.

Once again, the non-involvement of all stakeholders had an impact on the project's results. In addition to the involvement of all stakeholders, the project manager should have defined a scope and requirements of the solution, sponsored by the Board of Directors, where eventually it would have been defined who could access certain data.

Lesson 3: Some of the reports generated by the system, being highly visual and easy to read, exposed situations (trends and values) that were not perceptible by traditional accounting chart readings (Balance sheets, diaries, etc.). This exposure of fragile situations, created antagonisms between the information systems department and the accounting department, which found it difficult to justify the results highlighted by the business intelligence system. Once again, the involvement of all stakeholders could have avoided undesirable reactions.

4.2 Case 2: Excessive resources to extract and transform data

In this use case is presented an organization with high maturity in the use of data, with a deep analytic culture, but that use excessive human resources in the process of data extract, transform, load and distribution.

Characterisation of the hospital

Portuguese public hospital, over 100 years old, with 700 beds, 13 operating theatres and more than 3000 employees. It covers a population of over one million people.

The existing process before business intelligence

The Hospital has a planning department that centralises in itself all the data collection necessary for the management of the hospital. The sources of the data come from various systems, some in an automated way, others in a manual way provided at the beginning of each month by the information systems department. The planning department manually collects and processes these data, which it distributes in various ways, namely through slide shows.

The maturity in handling this data is high, but involves (consumes) dozens of skilled FTE's (Full Time Equivalent) in its entire life cycle.

The hospital decided to start a business intelligence solution implementation process, so it carried out a market discovery process, identifying potential technological solutions and potential implementation suppliers. It organised several demonstrations to have a better perception of the market offer and started an acquisition process, following the legal procedures of the Portuguese public administration.

After awarding the winning supplier of the business intelligence solution procurement procedure, it began implementing the solution, according to the scope and schedule clearly defined in its offer.

The system envisaged a considerable initial supply of reports, which would meet the hospital's immediate data needs.

All stakeholders were involved and training sessions were developed for all interested parties so that they could get the best out of the system and gain independence in the development of new reports and data extraction.

To create an analytical, data-driven management culture, the hospital decided to create a "data room", with a video-hall for viewing dashboards in real time, becoming a meeting point for data analysis, accessible to all stakeholders.

Gains after business intelligence implementation

The dozens of qualified human resources that until then were dedicated to data collection and processing could be assigned to other deficit areas, performing tasks of greater added value in line with their qualified training.

Data processing times went from weeks to seconds, making it possible to monitor this data in real time on a self-service basis.

With the maturity of the key-users in the use of the system, other needs emerged, allowing the organisation to establish a growth path for the solution, aligned with HIMSS' AMAM maturity model and Gartner's Analytics Maturity Model.

One of the lessons learned from the project, was in this case, the key-users where involved since the beginning, namely in the demonstration sessions, but most of the needed indicators and reports were already developed by the supplier. Throughout the implementation of the project, it was not necessary to interact with the key-users and stakeholders to identify their needs, as these had already been met. New needs would only arise when the solution was installed and there was more interaction with the system, where key-users and stakeholders would certainly identify gaps in the initial delivery, as well as new needs. This all-inclusive delivery model could lead to non-adoption risks if the product delivered does not correspond exactly to initial presentations by the supplier. The initial demonstration phase should be more detailed, with verification sessions, by the different areas and key-users together with the supplier.

5. The proposed Model

From a project management perspective, the model proposed for the implementation and development of a Business Intelligence solution in a hospital is presented next.

The application of this model is assumed in a hospital unit that is in the most basic forms of maturity of the AMAM model, level 0 or 1, table 3.

The suggested model is composed of four phases (figure 4).

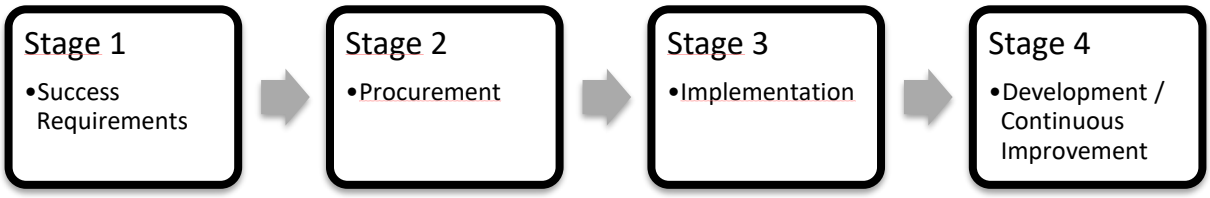

Figure 4. Implementation phases of a Business Intelligence system

5.1 Stage 1 – Creating the conditions for success

As mentioned in chapter 3.1, there are factors that potentiate the implementation failure of a business intelligence system and are also identified "vital factors to decrease the risk of implementation failure".

Thus, considering this previous analysis, it should be considered the compliance with the following list as four key factors for the success of an implementation:

1. **Technology choice**

   The decision on the best technology to adopt should be supported with data that allow the potentiality of the system to be assessed, but, above all, the prospects for evolution of the solution and security of the supplier.

Figure 5. Gartner Magic Quadrant for Analytics & business intelligence Platforms (2021)

You may, for example, resort to the analysis of Gartner's magic quadrants, which annually identify Leaders, Challengers, Visionaries and Niche Players. In the scope of this study, it is interesting to analyse the magic quadrant referring to the Business Intelligence & Analytics platforms, represented in Figure 5.

Obviously, a bet on a leader will be safer than a bet on a niche player.

2. **Defining the Scope with Agile Scope Management**

Questions that can be asked at this stage:

- Is this a business intelligence system for just one area of the hospital, more than one or for the whole hospital?
- If it is for the entire hospital, will it be a phased implementation?

- Which reports and indicators should be included initially?
- Which reports and indicators should be included in the next phases of the project?
- Which indicators and reports will are not expected to be included, but can be developed internally?

For example, if new indicators and reports are to be developed internally, which are not planned to be delivered by the supplier of the business intelligence system, at this stage the Agile methodology could start to be used to do this survey. In this way, by the time the system is installed and in use, much work would have been done and the move to development and delivery could begin immediately.

An Agile scope management can be adopted, as referred in chapter 2.3.5. One example using one of the initial questions of this chapter. Imagine that in the initial scope the decision was to start implementing BI only in the emergency department of the hospital, but during the implementation, the hospital administration decided to extend the implementation to the inpatient area. In a traditional scope management, it would be seen as a "scope creep", but in an Agile approach it would represent just an addition of activities to add to the product backlog. Obviously with an impact on project time and cost, but aligned with two of the fundamental values of Agile:

- "Customer collaboration over contract negotiation"
- "Responding to change over following a plan"

3. Stakeholder Analysis

Once the scope has been defined, it is extremely important to identify the stakeholders and key users so that everyone is involved from the beginning. As mentioned in Use Case 1, if all stakeholders are not involved in the development project, there is a huge risk that the solutions will not be adopted.

As referred in chapter 2.3.7 (Agile Stakeholders Analysis) a "Stakeholder List" can be adopted to prioritize the most important and influence stakeholders.

Agile tools like Kanban Boards, can be used to continuously transmit to all the stakeholder the status of the project. Simple online collaboration tools, like Microsoft Teams and Microsoft Sharepoint, for example, can also bring a sense of participation to all the stakeholders, allowing interaction in any time and any place.

4. **Full alignment/sponsorship with decision makers/sponsors**

   Similarly, it is necessary that the decision makers, namely the Board of Directors of the Hospital and the middle level decision makers, namely directors, are fully aligned and informed about the project.

   Failure to meet this success requirement will condemn the project to non-realisation, oblivion or non-adoption. These risks can be minimized with a good stakeholder analysis.

In order to reduce risks, beyond all the steps for good project management, the project manager should:

1. **Return on Investment (ROI):** Agile methodology typically represents better performance in scope management, final product quality, deadlines and costs. If cost is reduced, margin increases, reducing the time to return on investment (Scrum Alliance, 2021).

   Demonstrate through an economic/financial analysis that the project translates into savings for the hospital. For example, measure how many FTE resources are needed to collect data manually before the project and demonstrate that these, due to the automation of data collection, transformation and delivery, can be freed up for other types of higher added value tasks.

2. **Budget:** Budgeting in an agile project requires a different approach to traditional project management as it needs to consider the incremental nature and relationship with change of agile projects.

   Sometimes there are costs not foreseen in an external supplier's budget for the implementation of a business intelligence platform, namely software and database system licences, user licences, maintenance in the following years, costs associated to the increase in the necessary computing capacity, equipment, integration with 3rd players, training and monitoring time allowances. All these details should be taken care of, so that the project reaches its end smoothly.

3. **Data quality and integration:** As shown in Use Case 1, the non-involvement of all stakeholders in the development of the solution, led to their rejection of the data as unreliable. In fact, the problem was not in the data, but in the fact that the loss of power through the democratisation of data generated resistance to change and attitudes of non-adoption. To ensure that this does not happen, stakeholders and key-users should be involved from the beginning, so that they may participate in the development and testing processes, ensuring co-responsibility in the results obtained. It is also relevant that the data integration architecture in the business intelligence solution is schematised and documented so that a change in a system that is the source of the data does not impact the quality and reliability of the data.

   In fact, there should be total alignment between those responsible for the business intelligence system and the product owners of the multiple solutions that exist in a hospital's application ecosystem so that a change (for example, an upgrade, a patch or a hot fix) in an application that is a business intelligence data source does not cause its operation to be inhibited.

4. **Users' expectations and training:** The communication management component should be defined at the beginning of the project so that all stakeholders are regularly informed and involved throughout the solution development process. User training should also be

foreseen so that adoption is optimised. An important training at this stage would be on user stories, scrum and agile methodology. If internal teams are not trained in Agile, it would be interesting to have resources with Scrum Master and Product Owner training and certification.

5. **Implementation time:** Clearly defining and communicating a schedule will bring a more secure management of expectations for the project. Typically, a business intelligence system development project takes months depending on the scope, so a clear and detailed schedule is important to better manage expectations and effective control of the implementation.

   This should include all project management activities, an analysis phase where a detailed scope document is approved, a data integration and platform delivery phase, and delivery phases for all modules, with consistency testing and training (figure 6).

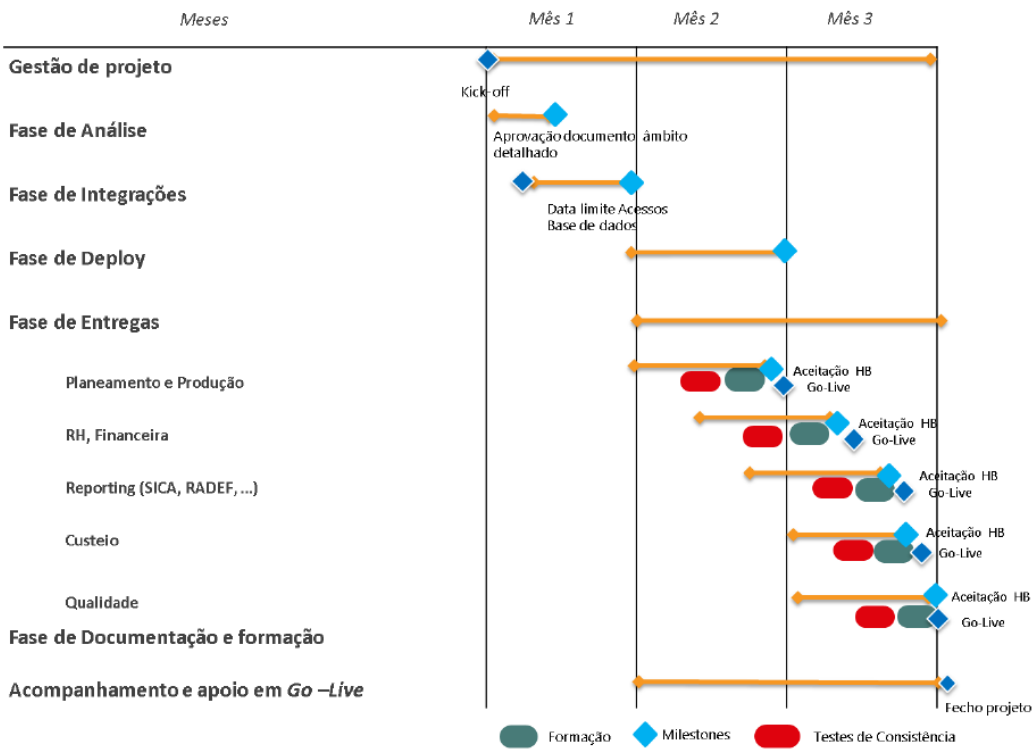

Figure 6. Business Intelligence implementation Plan (Example in Portuguese)

6. **Business rules:** If a hospital is mature in data extraction and transformation, even if manually, the system to be implemented should reflect this maturity in its outputs. A hospital without any reporting process should start a series of initiatives to collect needs from all stakeholders, which safely represent the rules and effective needs of the business.

   Also, in this phase the business rules survey can be done using Agile methodology, being the business rules pointed out in user stories as system requirements.

7. **Sponsorship:** The start of the project should be formalised with a kick-off for presentation and formal acceptance of the Project Charter by all stakeholders and Sponsors of the project.

8. **Change Management:** As a basic rule for this type of project, involve all stakeholders from the very first moment. If it is a project for everyone, it will be a successful project.

   This is a key point of the benefits of Agile. Traditional requirements gathering is usually highly technical, overly documented and not very interactive. Agile can introduce interaction between all stakeholders, involving everyone in a common goal.

9. **Skills:** All training of key-users of the system shall be ensured during its implementation. The hospital shall also ensure that it has all necessary skills for the implementation and future development of the system, namely those represented in Figure 7.

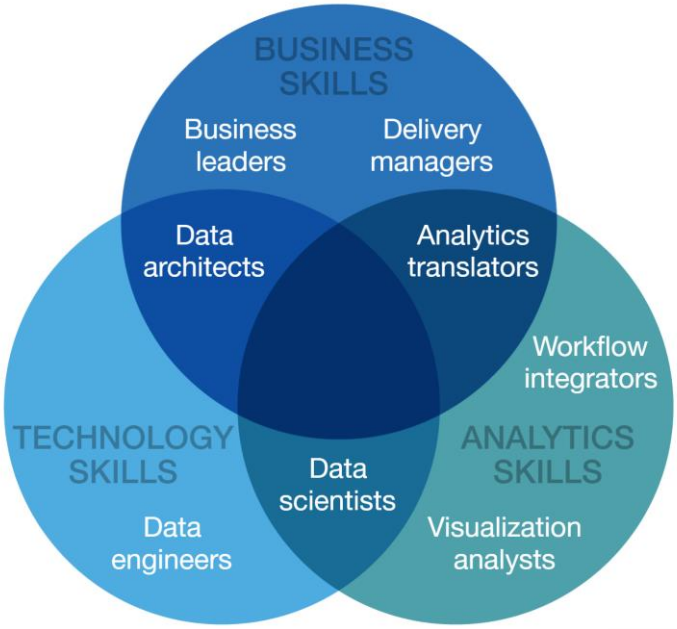

Figure 7. Skills needed in a business intelligence project (Mckinsey, 2018)

And, obviously, not represented in this figure, transversal Project Management and Agile Skills.

5.2 Stage 2 – Agile Procurement of the technological solution

The implementation of a technological infrastructure that supports the Business Intelligence system must follow a discovery process, which, in an initial phase, involves searching the market for current solutions, consulting potential suppliers and exchanging experiences with other hospitals and having as a reference the magic quadrants referred to in phase 1.

Considering an agile procurement, a business intelligence project can decrease risks if it considers the possibility of changing supplier mid-project. This can happen due to a change of scope, perfectly admissible in an agile project, or simply if a supplier contracted to install the entire infrastructure, for whatever reason, begins to delay the delivery of scheduled deliverables and does not fulfill the contract.

Moreover, the solution can be strongly enhanced by the involvement of several supplying companies. Once the infrastructure is in place, in certain areas of information extraction and transformation, some companies can add additional value in highly specialised areas. For example, one company may be a specialist in algorithms for optimising schedules and resources in an operating theatre, while another may have a solution for optimising stocks and managing hospital logistics.

However, it is not always easy to move from theory to practice, and in the case of the contracting procedures existing in public companies in Portugal, this agility may be impossible due to various legal constraints.

Once the requirements of the system to be implemented have been identified, in the case of a public hospital in Portugal, a set of specifications with all the requirements is defined and a procurement procedure is launched, enabling multiple potential suppliers to compete for the supply of the solution. A similar process will be followed by a private unit, certainly more agile and without the bureaucratic constraints typical of the state services.

Certainly, some of these potential suppliers already have experience of implementation in hospitals, so the solutions presented, regardless of the technologies that support them, already include a set of indicators and requirements from scratch, which can be considered mandatory given the needs of a Portuguese public hospital.

If not, those requirements can all be raised using the Agile methodology, with the use of user stories and creation of a backlog of requirements to be developed.

These include:

Management Modules

A. Assistential Activity

1. Assistential Activity:
    a. Inpatient
    b. Operating theatre
    c. Consultations

d. Sessions
e. Complementary diagnostic and therapeutic means
f. Delivery Block
g. Emergency Room

2. Data Quality Audit
    a. Inpatient
    b. Operating theatre
    c. Consultations
    d. Sessions
    e. Complementary diagnostic and therapeutic means
    f. Delivery Block
    g. Emergency Room
3. DRG
    a. Inpatient DRG
    b. Ambulatory DRG
4. Waiting List
    a. Consultations Waiting List
    b. Surgical Waiting List
    c. Complementary diagnostic and therapeutic means Waiting List
5. Pharmacy
6. Logistics
7. Diagnostics and Procedurese

B. Clinical Management

1. Patient journey
2. Nursing

C. Finance

D. Human Resources

E. Quality

a. SINAS

b. PCCIRA|PAPA

SNS Model Module

A. Indicators
B. Operational Reports
    a. SICA
    b. RADEF
    c. Quarterly Report on Financial Implementation (ACSS)
    d. Other reports ACSS and DGS
    e. New indicators and other ad-hoc reports
C. Dashboards
    a. Programme Contract
    b. Penalties

Cost Model Module
Benchmarking Model Module

5.3 Stage 3 – Technological implementation

In summary, the architecture of a business intelligence solution is composed of 4 distinct areas (figure 8)

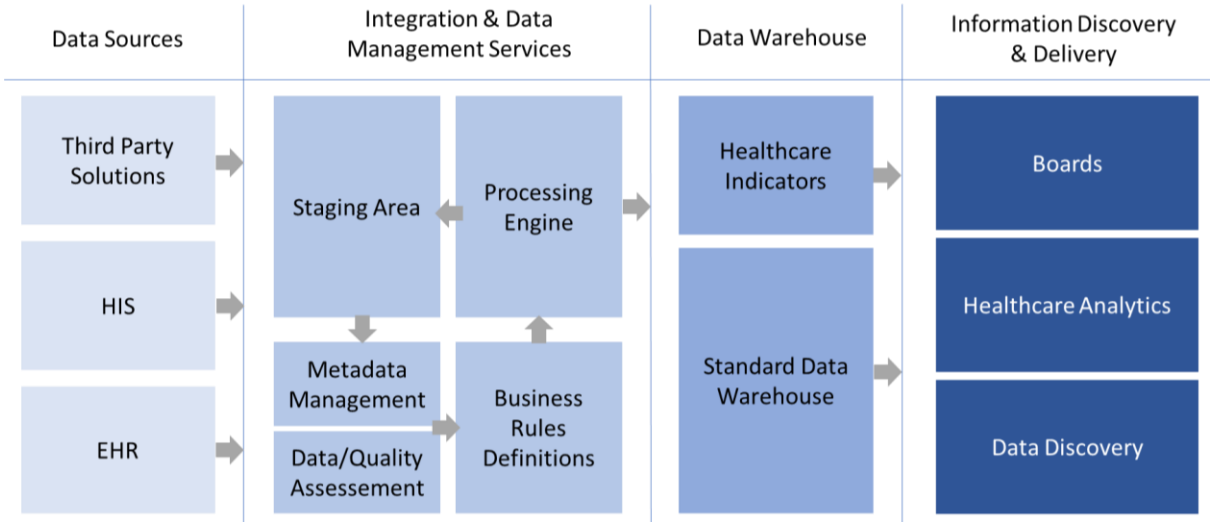

Figure 8. Architecture of a business intelligence solution

In detail:

A. **Data Sources**: The identification of all data sources is a fundamental point in the process. From this identification situations may be highlighted where participations in the data extraction process by the suppliers of these systems, namely the solutions that compose the HIS/EHR and third-party solutions, are necessary.

B. **Integration & Data Management Services**: The ETL (Extract, Transform and Load) process is the engine of the whole process of data extraction and transformation. Being a central point of the project's success, the experimentation of these tools during the procurement process is relevant. The tools provided must be intuitive.

Several authors (Xavier & Moreira, 2013) refer to Agile ETL, as being a tool for technicians working in the business intelligence area that facilitates the consolidation of information in a data warehouse, but because it is a technical method not related to project management, it was not developed in this study.

C. **Data Warehouse (DW):** A good definition of the structure of the Data Warehouse, in all its aspects and dimensions, will allow the best use to be made of the data in the future. Prakash and Prakash (2017) refer that projects for implementation of data warehouses are long and expensive and propose an agile model for writing user stories in a systematic way. The model will not be developed in this study, being left as a reference for its high interest for the theme under study.

D. **Information Discovery & Delivery**: As with ETL tools, the discovery and reporting tools will have to be easy to use for the adoption of the solution by key-users to be a success.

5.4 Stage 4 – Development / Continuous Improvement

At any stage of the project, either at the beginning when it is necessary to define requirements, or after the platform is installed, where new functionalities or improvements to existing functionalities or new KPIs and Dashboards are required, an AGILE methodology can be used.

The essence of the AGILE development cycle is represented in figure 9. It assumes a continuous, incremental development of functionalities.

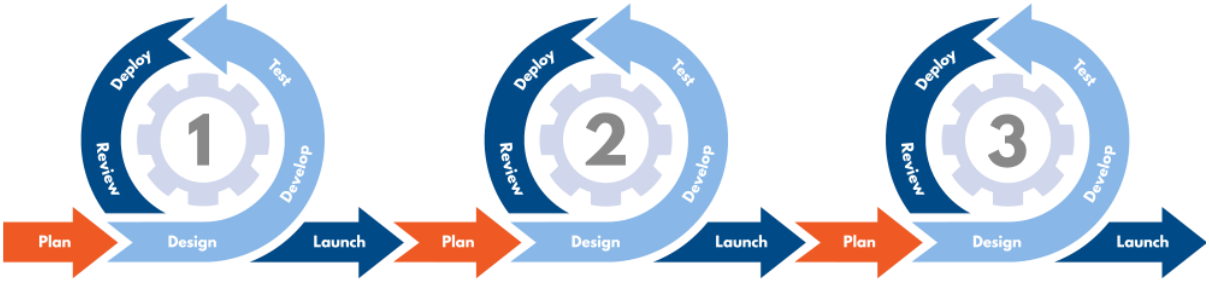

Figure 9. The AGILE Development Cycle

These cycles are processes that may adopt, for example, the SCRUM methodology, represented in figure 10.

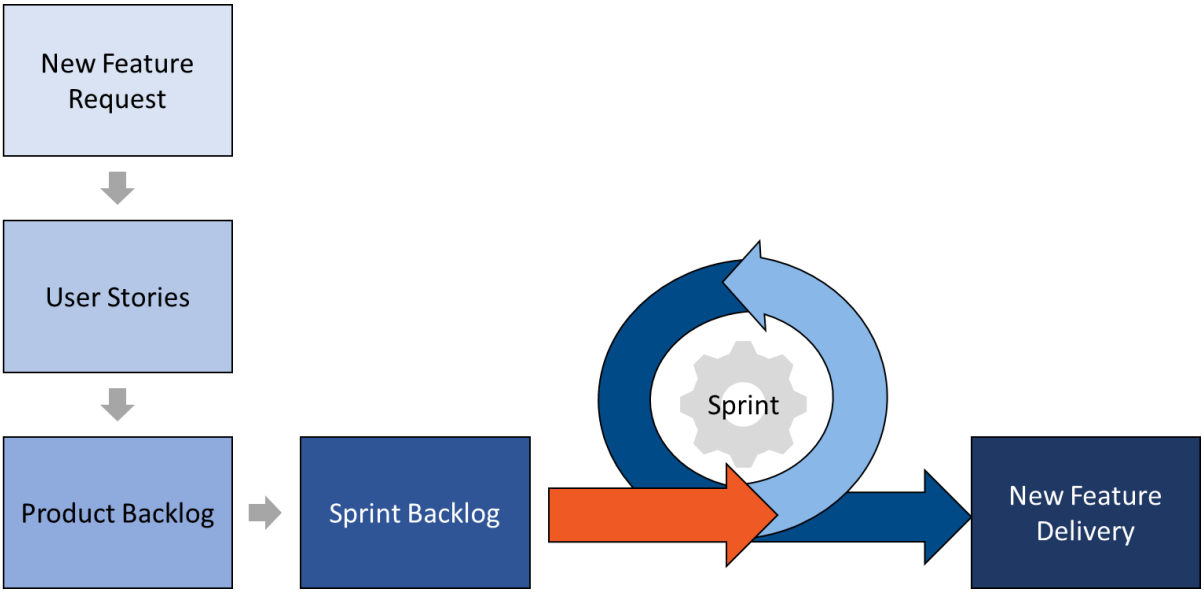

Figure 10. The Scrum Process

A. **The Beginning**: The SCRUM process starts with an idea, with the identification of a need, of improvement or new functionality or the need to solve a problem, which for simplification we will call a feature.

Example:

To improve the performance of the unit, an emergency department nurse needs to have a daily KPI that indicates, for a given day, the maximum waiting time of a patient for observation, after triage.

B. **User Stories**: User stories are short, simple descriptions of a feature told from the perspective of the person who wants the new feature, usually a business intelligence system user.
User stories are based on the simple principle of completing the following sentence:

As a < type of user >, I want < some goal > so that < some reason >

User stories are usually written on cards (figure 11) or post-its, stored in a box or arranged on walls or tables to facilitate planning, prioritization and discussion.

As such, they strongly shift the focus from writing about requirements to discussing them. In fact, these discussions are more important than any written text.

To add more detail to a user story for a more complex feature, you can:

- Split the user story into smaller user stories; or
- Complete the user storie with "Conditions of acceptance".

Conditions of acceptance are a high-level acceptance test that will be true after delivery of the user storie. A user storie can have several acceptance criteria.

It is relevant for the success of the methodology that during the development of the user stories the users interact with the Product Owner of the solution. The solution's Product Owner has the mission of serving as an interface between customers (users) and the solution's development team.

A user story should be subject to discussion among the multiple stakeholders until there is consensus on the usefulness of the feature and on the acceptance criteria.

Title:	**Priority:**	**Estimate:**
As a *<type of user>* **I want to** *<perform some task>* **so that I can** *<achieve some goal>*		
Acceptance criteria **Given** *<some context>* **When** *<some action is carried out>* **Then** *<a set of observable outcomes should occur>*		

Figure 11. User Storie Card template example

Sample:

User Story

AS A chief emergency nurse **I WANT** a daily KPI that tells me, for a given day, the maximum waiting time of a patient for observation, after triage. **SO THAT** can improve the performance of the uni

Acceptance Criteria

WHEN every day at 12 p.m. **THEN** Send the KPI by email to me **AND** Includes the result in the Emergency Nursing dashboard in a linear graph, with visibility of the evolution of the last 30 days.

C. Product Backlog

The Product Backlog is a list where all user stories are placed and prioritised.

D. Sprint Backlog

For each development cycle, some user stories are selected from the Product Backlog and passed to the Sprint Backlog. The total time allotted to the set of User Stories selected should not exceed the time allotted for the development Sprint, typically 2 to 4 weeks.

E. Sprint & New Feature Delivery

During the development Sprint the new features are developed and delivered.

6 Applying the model to use cases

Returning to the use cases described in chapter 4, how could these cases benefit from the model presented?

In Use Case 1 several problems were identified, namely the non-involvement of all stakeholders (lesson 1) in the development project, the undefined scope and the non-sponsorship of the Board of Directors (lessons 2 and 3).

Applying the model, it suggests in phase 1 "Identification and involvement of Stakeholders and Key Users", the "Full alignment/sponsorship with decision makers/sponsors" and the "Clear definition of the scope". Following these recommendations, the project would already have a different direction and adoption. However, how could this use case take advantage of the AGILE component proposed in Phase 4?

Although the whole project was mostly based on reports that were manually extracted every month, before the business intelligence system existed, being something already known, it would be redundant to apply the AGILE methodology. However, the project had an innovative component, with new indicators and new reports that could have taken advantage of the methodology, involving all stakeholders in its development. The adoption would be totally different because it assumes that each user story developed involves discussion and involvement of stakeholders. In this specific case, it would no longer be a project of the information systems department but a project of the entire hospital.

In Use Case 2, being a successful case of implementation of the system's base infrastructure, already with a considerable set of data and reports, the hospital intends to continue evolving the business intelligence platform to reach new maturity levels, according to the maturity models referred (AMAM of HIMSS and Gartner). In this evolution, the AGILE methodology makes perfect sense.

It makes perfect sense that in this hospital, due to its enormous size, there is intensive training on Agile methodologies and that this becomes a cultural issue in the development of this or any other system.

With development resources typically being scarce or expensive, in a large hospital, it makes perfect sense for requirements gathering to be done using Agile and for these to be prioritised in a Product Backlog. It also makes a lot of sense to have a Product Owner in the organisation, as it is clearly necessary to have a person who has a holistic view of the solution and can bridge the gap between the key-user requirements and the development team.

7 Conclusions

For centuries, the improvement in the supply of health units was based mainly on the evolution of knowledge (medicine, nursing and other specialties) and technology. Today, in the face of growing global demand, an aging population and rising costs, there is constant pressure (social, political and economic) for the provision of services to be of higher quality, more effective and efficient, at a lower cost, which represents a challenge for the multiple stakeholders of healthcare organizations.

Change and uncertainty have always been part of healthcare institutions. More than ever, effective change management and risk management, as well as the optimization of outcomes, are fundamental to the success and improvement of the sustainability of these organizations.

Typically, business intelligence projects are long and involve multiple components, such as choosing a platform, create a data warehouse, defining metrics, indicators, reports and dashboards, among others. This implies that many of the requirements defined in the beginning naturally change during the development and after the implementation, due to multiple factors, such as changes of needs, quick changes on market demands or maturity and understanding of the business intelligence system by the customers, among others.

Stakeholders demand more empowerment and involvement. For that the Agile methodology seems to bring tools that will allow to fulfil those needs with better collaboration between the developer teams and the customers.

Agile also brings more transparency and allowance to change. With the Kanban boards all the stakeholders can have the vision of the status of the project, perceive the product backlog priorities, and have better understanding of the impacts of changes in the overall project.

The incremental and interactive processes also bring a feeling of belonging to all the involved stakeholders. It is not just a product that is presented in the final of the project, possibly with amounts of changes to be done. With the continuous involvement of all the stakeholders during the development process, small improvements and changes can be done and the results can be used immediately.

By analysing the themes that support this work, it seems that the adoption of Agile Project Management approach will meet the needs, as it allows hospitals to create ideas, develop them, test them, make the necessary adjustments and continue its evolution in an interactive way until reaching the desired outcome or improvements, as an alternative to waterfall approach where the initial requirements are more closed to change during the development process, and that can compromise the overall result and outcomes.

Multiple authors support the use of Agile Project Management in the development of business intelligence projects. Many benefits are presented compared to the use of Waterfall methods, from the improvement of performance, permeability to changes, the ability to detect problems early, faster functional deliveries, iteration between customers and developers and the final quality of the solution. In particular, in business intelligence projects, the advantages of iterations related to the treatment of data sources and reports are sustained, which, being interactive, incremental and collaborative, allow to detect and correct initial requirements and design problems earlier, reducing costs and execution time.

The experience in the application of agile methods, namely with the use of user stories is very interesting, because it is extremely simple to understand and use and is quickly adopted. It is also curious to verify that it becomes a cultural issue of the organisation, which adapts to many other system implementation projects where the detail and the involvement of multiple stakeholders becomes easier to manage.

The model presented results from the author's experience in developing business intelligence solutions and applying the Agile methodology in the development of various information system projects. It is intended to be a reference of steps to take, not only with regard to the application of Agile, but in a set of essential points that it is important to verify in order to reduce the risks of failure, and to enhance a good experience for all stakeholders. Applying these methodologies reduces the communication gap between the development teams and the business, which subsequently translates into a higher adoption of the solutions.

Applying this methodology in Use Case 2, allowed us to quickly involve all stakeholders in the collection of KPIs and reports required by dozens of business areas, which would be impractical to achieve in such a short period of time using a traditional requirements survey.

Ideas and strategies are important, but the real challenge is their execution. Asking for the right things (requirements gathering) and building the things right (development) remains a challenge in developing new solutions. Building the wrong thing, with incorrect requirements, can be costly because developing all the subsequent features can result in a waste of resources and time. Agile methods consistently outperform a traditional waterfall approach in these cases.

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