Department of Information Science and Technology

Developing a Business Intelligence Initiative in Higher Education

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In God we trust. All others must bring data.

W. Edwards Deming
1900-1993

Summary

In nowadays, Business Intelligence (BI) is one of the most important areas for managers and their organizations, whose investments on this type of projects are increasing. The decision-making process has become crucial to be more competitive, and higher education institutions (HEIs) are not an exception. For the last years, HEIs from all over the world have started to apply BI to their educational and decision-making challenges. In 2013, the BI Task Force from EUNIS (European University Information Systems) surveyed several HEIs to understand the maturity of their BI systems. The results revealed inconsistencies, raising the doubt about the comprehension of BI concepts. Considering this survey and its basis on maturity models, this dissertation analyses the existing models regarding higher education. Understanding the difficulties in answering the EUNIS survey from a perspective of two Portuguese universities is also a goal. It was created a feedback survey, whose results revealed it was a positive experience, although the lack of clarification of BI concepts was underlined.

Thinking about other universities starting their BI journey, it was developed a kit proposal that clarifies concepts and best practices for this sector. It was validated by the two universities mentioned above, which will be starting their initiative in January 2015. This validation was made through an interview, and the feedback was encouraging. Having a guidance to be methodical in this phase was highlighted, as well as the presentation of real success cases that allow to understand what other institutions do on their daily basis.

Keywords: Business Intelligence, Data Warehouse, Maturity Model, Higher Education, EUNIS

ACM Classification: H.4.2 Types of Systems – Decision Support

Abstract

Atualmente, *Business Intelligence* (BI) é uma das mais importantes áreas para gestores e empresas, cujo investimento tem vindo a aumentar substancialmente. A tomada de decisão tem-se tornado fundamental para o aumento da competitividade e as instituições do ensino superior não são exceção. Nos últimos anos, instituições de todo o mundo têm começado a aplicar BI nos seus desafios. Em 2013, a *BI Task Force* da EUNIS (*European University Information Systems*) decidiu realizar um inquérito a instituições de ensino superior para conhecer a maturidade dos seus sistemas de BI. Os resultados revelaram incoerências, criando a dúvida sobre a correta compreensão dos conceitos. Tendo em conta este inquérito e a sua base em modelos de maturidade de BI, é realizada uma revisão bibliográfica dos modelos existentes direcionados para o ensino superior. Compreender as dificuldades em responder ao inquérito da EUNIS, na perspetiva de duas universidades, também é um objetivo deste estudo. Foi criado um questionário de *feedback*, cujos resultados revelaram ter sido uma experiência positiva, embora a falta de clarificação dos conceitos fosse sublinhada.

Considerando instituições a iniciar a sua aventura em BI, foi criado um guião que clarifica conceitos e boas práticas para o sector. Foi validado pelas universidades mencionadas, que vão começar as suas iniciativas no próximo ano. Essa validação, feita com entrevistas, revelou que um guião que ajude as universidades a serem metódicas nesta fase é essencial, bem como a apresentação de casos reais de sucesso que permitem dar a conhecer o que é feito no dia-a-dia do sector.

Palavras-Chave: Business Intelligence, Data Warehouse, Modelos de Maturidade, Ensino Superior, EUNIS

Classificação ACM: H.4.2 Types of Systems – Decision Support

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This journey of two years was intense, a mix of good and not so good feelings. I was supported by the most important people in my life, through all the moments and changes that I lived. At the end of this journey, I have so much to be thankful for, that words might not be enough. And because music was my constant partner during the days (and evenings) dedicated to this dissertation, and because Hans Christian Andersen once said that "When words fail, music speaks", I decided to choose important lyrics from songs that have been on my MP3 player since the beginning of this adventure, to help me express my deepest gratitude.

You can be the greatest, you can be the best
You can be the king kong banging on your chest
You can beat the world, you can beat the war
You could talk to God, go banging on His door

The Script – "Hall of Fame"

To my supervisor Elsa Cardoso, who made possible for me to find an exciting subject to this dissertation, keeping me inside the beauty of Business Intelligence. Someone who constantly challenged me along the way, and who always believed I could go further. I will always be thankful for this opportunity to team up with such a special person.

Still sometimes the rain can turn into a waterfall
And the prettiest things can come out of the coldest night
And even with broken wings, sometimes you find your way to fly

Taio Cruz – "I Can Be"

To Eng. Joaquim Godinho, Professor Luís Rato, Professor Sá da Costa, and Dr. João Paulo Cavaco, my sincere thank you for sharing your precious time with the crucial interviews for this study. All the exchanged information truly enriched my work. Without your collaboration, none of this would be possible.

I'll spread my wings and I'll learn how to fly
I'll do anything until I touch the sky
I make a wish, take a chance, make a change and breakaway!

Kelly Clarkson – "Breakaway"

To all of my work colleagues and supervisors who supported me with their knowledge and professional experience, and who made possible to me to have the needed moments to write

this dissertation. And also to all of my friends who always knew how to deal with my several "No" to a great part of our cinemas, evenings out and so many other things we could have done together…

Vivir, amar, sentir y saber que hoy puede que no salga el sol…
Aunque llueva, tu y yo sabremos bailar
Nadie nos puede parar…

Ruth Lorenzo – "Dancing in the Rain"

To my parents, for the support, love and patience during these years, for taking up with the hours away from home, for the bad sleeping nights and all the bad moments of this journey. I am here today because you made it possible and you believed I could do it. And also my sisters and the rest of the family, for being there and always apologizing me for skipping so many important moments: thank you from my heart!

All I want from you is to see you tomorrow, and every tomorrow
Maybe you'll let me borrow your heart
And is it too much to ask for every Sunday?
And while we're at it throw in every other day to start…

Justin Timberlake – "Not a Bad Thing"

To my fiancé, my best friend and biggest support, for guiding me through this journey with his unique way of upsetting me to go further and be better. Now that we have conquered this "mountain", we can start the rest of our lives together.

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Acronyms

Acronym	Description
BI	Business Intelligence
CIF	Corporate Information Factory
DB	Database
EDW	Enterprise Data Warehouse
ER	Entity-Relationship
ETL	Extraction, Transformation and Loading
EUNIS	European University Information Systems
HE	Higher Education
HEI	Higher Education Institution
IS	Information Systems
ISCTE-IUL	ISCTE-University Institute of Lisbon
IT	Information Technology
ITSM	Information Technology Service Management
JISC	Joint Information Systems Committee
PDF	Portable Document Format

CHAPTER 1

Introduction

The current chapter provides an overview of the context and motivation behind this research, as Introductionwell as the adopted research method and approach. Furthermore, it outlines the structure of this dissertation.

1.1. Research Context

Business Intelligence (BI) can play an important role in transforming data from heterogeneous sources into an integrated view for supporting organisational, decision-making, management and strategic planning. Devised by the Gartner Group in 1990s, the term BI is about "a variety of information technology (IT)-based tools and approaches for helping organisations to make better use of the increasingly vast amounts of data accumulated from both internal and external sources" (Isik et al., 2011). It can encompass applications such as data warehouses, data mining, data marts and Online Analytical Processing (OLAP).

The main purpose of BI is to allow interactive and easy access to data, enable manipulation and transformation of it, and provide business managers and analysts the ability to conduct appropriate analysis and perform actions (Turban et al., 2008).

The education sector, like all other types of organizations, need to have accurate, understandable and accessible information, in order to develop its strategy and planning BI is the answer to this kind of issues, and has the capability of allowing colleges or universities to be competitive, more adaptable to changes, and capable of planning the future and optimizing resources (JISC, n.d.). Higher Education institutions (HEIs) collect a large volume of data, however there are not individuals who know what to do to manage and consume that information (Kelly 2005). According to JISC (n.d.), they collect data on how their students interact with their standard business systems like library, finance, among others, and improving their BI capabilities will help position them to take the best out of their services. In addition, the pressure from social and economic changes – like public accountability required, funding constraints and reductions, compliance requirements for accreditation systems and intense international competition for students - prioritize student acquisition, engagement and retention more critical than ever. Kuh (2001) and Trowler (2010) believe that the success and development of university students has less to do with what they contribute or where they study, but more with what they do during their years as students. Consequently, student engagement is viewed as an important antecedent to student learning and achievement, as well as to institutional success. According to Coates (2010), student engagement is valuable for managers

because by monitoring student commitment, institutions can identify areas of good practice and areas that need improvement.

For the past years, HEIs have been under pressure to provide management information, not only for their own boards, but also to share with regulatory entities, accreditation bodies, and government agencies. All institutions want to measure and evaluate their own effectiveness, especially the public institutions which are dependent from the state aid and must show results. Gaining insights about academic performance, student success, persistence, and retention are increasing the demand for information (Goldstein, 2005). HEIs have become extremely competitive and their main goal is to attract students and funding for their governance and research. According to James (2013), HEIs should be able to answer critical questions like which programmes are popular, from which locations and demographics are students coming or are the marketing strategies aligned with feedback from students. Because of this need, the concept of BI is progressively rising up the priority list within various HEIs (JISC, 2013). Foster (2011) emphasizes that an objective study of data on students can produce highly relevant results to educational policy.

Universities are already using BI to analyse class failure patterns, to identify at-risk students and direct them to appropriate support services (Durso, 2009); and to predict student's dropout (Dekker et al., 2009). An increasing number of institutions have understood the benefits of using BI, in particular to optimize their decision-making process and to strengthen the management of their areas and departments. Analysing the Gartner survey from 2013 – *Top 10 CIO Technology Priorities* – there were 75 Higher Education CIOs who responded to it and reported that their one technology-related priority was to "attract and retain new customers".

A BI solution in this sector can also be referred as an Institutional Intelligence (II) initiative. This concept is about the academic analytics that appear on standard transactional reports, metrics, charts, and projections (Figure 1).

Figure 1 - Institutional Intelligence (adapted from Kuster and Rouse, 2009)

Institutional Research is "a set of activities that support institutional planning, policy development, and decision making" (Royal University of Phnom Penh, 2011). It refers to the collected data about an institution, its analysis and transformation intro information, and the interpretation made to that information. It is based on three categories: (1) Technical/Analytic Intelligence, (2) Issues Intelligence, and (3) Contextual Intelligence. The first tier encompasses the factual information and methods that provide the basis to define, count and measure data.

The second one is about the generated knowledge about crucial issues like budgeting or evaluations, which is based on the information from the first category. The third tier represents the knowledge of higher education in general and of the particular institution in question (Penn State University, n.d.). Combining these activities with BI capabilities creates the capacity to carry out analysis on questions of strategic importance under continuously changing conditions (TDWI, 2007). In order to develop an effective II initiative, it is necessary to have institutional research analysts, financial analysts, and IT report writers paired up as a team. Ideally, they manage the processes of data storage and update, to provide a unified view from multiple source systems – "one source of the truth" (Kuster and Rouse, 2009).

Nevertheless, currently it is not known the state of art of the utilization of these systems in Higher Education. According to TDWI (2007), a large number of universities do not embrace BI concepts, due to scope barriers and the complexity of the initiative to make possible to manage so many different needs. There was a great need to conduct a study to comprehend at what level of maturity they are. In order to answer this question, a survey was led in the context of an international project done by the Business Intelligence Task Force (BI Task Force) of EUNIS – the European University Information Systems organization. This organization aims to improve the cooperation and exchange of good practices between BI practitioners in Higher Education all over Europe. The BI Task Force wanted to collect a *big picture* of BI systems in institutions, so it decided to start a project in order to make an initial assessment of the maturity of BI systems in European HEIs, including Portugal. A survey was created and it was active during 2013. The initial results were presented at the Terena Networking Conference 2014, in Dublin (Ireland). Across the different countries (including Portugal), there seems to be a lack of understanding about the used concepts, and consequently the conditions required to develop a successful BI solution might be insufficient. A BI program is a challenging effort that requires a strong level of commitment from the executive management, continuous funding, and other critical success factors that need to be in place in the organization. Clarifying the subjacent concepts is crucial to start a successful BI journey.

The present dissertation focuses on the design of a kit to help institutions in the beginning of its BI journey. This kit proposal is divided into eight key dimensions, having in consideration the TDWI Maturity Model (TDWI, 2012): Scope, Sponsorship, Funding, Value, Architecture, Data, Development and Delivery. For each dimension, several authors were analysed, in order to gain different perspectives from the same subject. It is important to refer that this kit is merely a suggestion for the higher education sector, specifically adapted to the reality of these institutions. In order to validate this kit proposal, there were made two interviews to two public Portuguese universities, where it was collected important feedback to enrich the kit and make it more suitable for the needs of the sector. Taking the advantage of those interviews, it was also made a feedback survey about the 2013 EUNIS BI Maturity survey, in order to understand which problems these Portuguese HEIs struggled with.

1.1.1. Research Aim

This dissertation intends to study the best practices available that can be used by higher education institutions to trigger a more effective and informative starting of a BI initiative. This strategy encompasses several key aspects regarding BI systems: BI Maturity Models, higher education roadmaps, success cases and higher education specialized opinions like JISC from United Kingdom. This broad purpose can be divided into more specific goals:

- The analysis of the 2013 EUNIS survey results;
- The proposal of a kit to higher education institutions, in order to start their BI initiatives.

Two public Portuguese universities, which are just starting their BI initiative, will be considered to evaluate the experience of answering to the EUNIS survey, and the usefulness of the kit proposal.

1.1.2. Research Motivation

This research was motivated by a problem that was evidenced by the 2013 EUNIS BI Maturity Survey: the answers from the higher education stakeholders revealed a misunderstanding of concepts, which led to unfaithful results. This dissertation wanted to understand the major problems with this kind of institutions, because it is wrong to compare the HEI systems with the ones used in commercial organizations - their maturities are at different levels. Taking in consideration the existing maturity models, it is crucial to understand how each one works and if they produce comparable results, due to the characteristics of HE sector.

Other motivation of this research was the development of a guiding tool to institutions that are in the beginning of their BI journey, creating a clean path for them to follow considering their characteristics. One important factor that this dissertation wanted to keep in consideration throughout this development was the budget limitations, and consequently the restrictions to consultants and to the development of major IT projects that HEIs experience. Developing a kit proposal (what this study called to the roadmap) that was realistic and adapted to the reality of HEIs worked as a top motivation.

1.1.3. Research Contribution

One contribution of this research is a kit proposal made for higher education institutions, regarding their BI systems. For those institutions that are starting their first BI initiative, this kit acts as guidance to the success of the implementation, highlighting important aspects that need to be in place for the success of their journey. It also clarifies key BI concepts and gathers success cases that will help HEI stakeholders to perform a correct evaluation of their BI systems, using the TDWI Maturity Model and The White Book Maturity Model questions.

Another important contribution is about the suggestions to improve the next edition of the EUNIS BI Maturity Survey, to be launched in the beginning of next year. It was identified the

need of having the used BI concepts clearly defined in the survey; nevertheless, there might be other important improvements that will lead to more accurate results.

1.1.4. Problem Statement

In order to help the Higher Education institutions in the beginning of their BI initiative, this study is focused on finding the best approach to start a BI initiative in a Higher Education institution. Consequently, the problem statement for this dissertation is:

- To institutions that have not started their BI initiative yet, what are the best practices to succeed?

Since the 2013 EUNIS BI Maturity Survey is the basis of this dissertation, there is another problem statement that will be answered in the end of this study, with the collaboration of the interviewed Portuguese universities, which is:

- How can EUNIS improve the next edition of its BI Maturity Survey, in order to return more accurate results?

1.2. Research Methodology

This dissertation is considered to be a case study. This methodology was used to gather results with the practical application of the feedback survey about 2013 EUNIS BI Maturity Survey, and also of the kit proposal developed in this dissertation, in order to understand the studied theory when applied to the HEIs. A quantitative investigation was embraced regarding the feedback survey, while it was adopted a qualitative investigation to describe the dimensions used in the developed kit. The starting point to reach the research aim is the state of the art, and its critical analysis. The case study encompasses information collection with interviews and surveys, observation, documentation, feedback, and the elaboration of a final narrative (Patton, 2001). To conclude this study, it is created a critical analysis about the results gathered from the interviewed universities.

1.3. Research Structure

This dissertation is divided in five chapters. In the first chapter, there is an overview of the chosen subject and the motivation to study it deeply. It is also described the contributions and the identified problem statement.

Chapter two presents the state of the art, describing the key concepts regarding the subject. Three maturity models related to the HE sector are explained, being also comparatively analysed, in order to understand the main differences and similarities. This chapter also describes the BI Task Force from EUNIS and its developed work.

In chapter three, there is the kit proposal developed for the HEIs that are in the beginning of their BI initiatives, being clarified all the used dimensions with definitions and success cases.

Chapter four describe the interviews performed to the Portuguese universities (University of Évora, and ISCTE-University Institute of Lisbon).

The last chapter presents the conclusions, limitations and future work resulting from the state of the art, the developed kit, and the interviews.

CHAPTER 2

State of the Art

2.1 Business Intelligence

Ponelis and Blitz (2001) found that BI has become a great interest for Information Systems, implying systems composed of people, information and processes that improve the effectiveness and efficiency of organizations. However, what is the real definition of Business Intelligence? There are several academic and practitioner proposals. For example, Ralph Kimball says BI is about the initiative from business users, rather than the technology (Kimball et al., 2008). Another example comes from Gartner, an important IT research and advisory company that defends it is a broad term that includes applications, infrastructure, tools and best practices which allow information access and analysis, in order to improve the decision making process and productivity (Gartner, 2010). Table 1 presents some BI definitions, displayed chronologically, with contributions from renowned authors and BI vendors.

Table 1. BI Definitions

		Definition
Authors	Eckerson, 2003	"Historical information presented to users for analysis to enable effective decision making and for management support"
	Moss and Atre, 2003; Alter, 2004	"Holistic and sophisticated approach to cross-organizational decision support"
	Watson et al., 2006	"Term comprised of both technical and organizational elements"
	Rud, 2009	"Term that encompasses all needed capabilities to transform data in information, and that encourages organizations to achieve the goal of making available the right information to the right people, in the right moment and through the right way"
	Raber et al., 2012	"Strategical capacity of organizations to create, collect, analyse and use information and knowledge"
BI Vendors	Microsoft, 2007	"BI simplifies information discovery and analysis, making it possible for decision-makers at all levels of an organization to more easily access, understand, analyse, collaborate and act on information, anytime and anywhere"
	Microstrategy, n.d.	"Set of software systems and practices that enable organizations to analyse data, and make better decisions based on the insight from that information"
	SAS, n.d.	"The right information supplier, when and where is needed, in order to improve productivity and decision-making process"

Authors tend to emphasize the importance of BI in the organizations strategy; BI vendors highlight technical aspects of this kind of systems. The term can mean different things to different people, but everyone understands its goals equally. The goals are: (1) allow improved access to data; (2) allow data manipulation; and (3) give to managers and business analysts the ability of performing important analysis. This dissertation will always have in consideration both perspectives, however, there will be a more restricted scope whenever is necessary, in order to better fit the subject.

2.2 BI Systems

A BI system can be defined as "an integrated set of tools, technologies and programmed products that are used to collect, integrate, analyze and make data available" (Reinschmidt and Francoise, 2000). Another definition is presented by Negash and Gray (2003) as a system that "combines data gathering, data storage and knowledge management with analytical tools to present complex and competitive information to planners and decision makers".

Regarding its structure, Fisher et al. (2011) define three complementary data management technologies: data warehousing, online analytical processing (OLAP) and knowledge discovery – predominantly aided by data mining techniques. Olszak and Ziemba (2007) complete this information with the components presented in Figure 2.

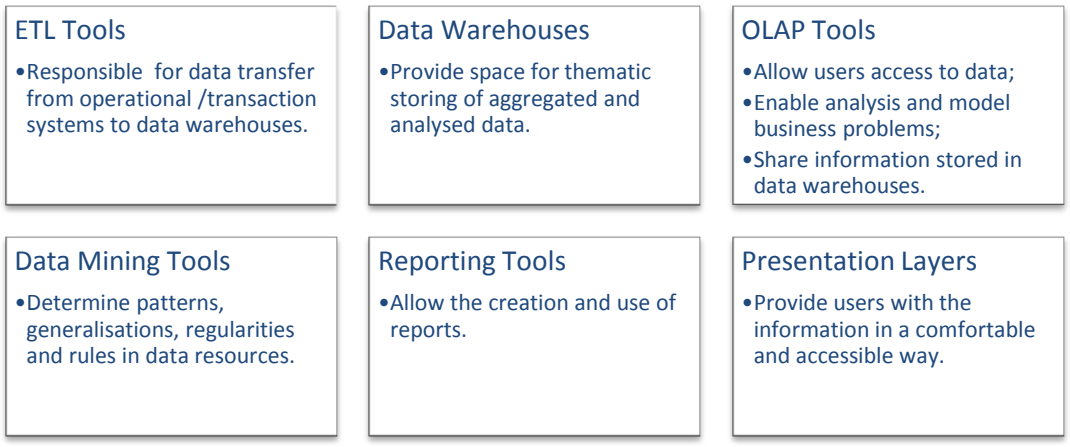

Figure 2 - BI System Key Components (adapted from Olszak and Ziemba, 2007)

2.3 Maturity Models

Understanding a BI system is easier with the help of Maturity Models. These models are used to describe, explain and evaluate the lifecycle of the growth of the system. One of their great benefits is the capability of explaining the right path to the organization, in order to help improving its technology alignment with business processes.

The main idea inherent to all maturity models is that they enable organizations to assess their BI systems, in order to identify and explore their BI strengthens and weaknesses (Lahrmann et

al., 2011). Besides, they also allow establishing an evolutive path and helping them with recommendations, so they can be more aligned with their own business and technology (HP, 2009).

Maturity models have their own evaluation method: through a specialist or a self-assessment exercise. They also offer their own procedures and processes according to best practices (Gartner, 2010).

There are maturity models focused on software development, knowledge management, performance management and data management. They are broad enough to be used for BI, but there are a few developed models for this domain – as we will be able to see further.

This kind of models aid organizations to understand where they are at the moment and how they can improve. Besides, there are a number of questions which can be better understood, as "where in the organization is most of the reporting and business analysis done today?" or "what business value does BI bring?". Table 2 shows some of the existing BI Maturity Models.

Table 2. BI Maturity Models

BI Maturity Model	Reference
AMR	Hagerty, 2006
Claraview BI Maturity Assessment	Teradata, 2009
Gartner	Gartner, 2010
HP	HP, 2009
Microsoft's BI Maturity Model	Microsoft, 2008
Capability Maturity Model for BI	Raber et al., 2012
SAS Information Evolution Model	SAS, 2007
Data Warehousing Process Maturity Model	Sen et al., 2006
The Data Warehouse Institute (TDWI)	TDWI, 2012
Data Warehousing Stages of Growth	Watson et al., 2001
Business Information Maturity Model	Williams and Williams, 2007

There are other developed BI Maturity Models, but their credibility needs to be improved. Some sources are unavailable and/or incomplete, others were only developed in academic studies. Those maturity models are:

- BIDM – Business Intelligence Development Model (Sacu and Spruit, 2010);
- EBIMM – Enterprise Business Intelligence Maturity Model (Chuah, 2010);
- Enterprise Data Management Maturity Model (Fisher, 2007);

- SOBIMM – Service-Oriented Business Intelligence Maturity Model (Shaaban et al., 2011);
- LOBI – Ladder of Business Intelligence (Cates et al., 2005);
- SMC – Steria Mummert Consulting (Lahrmann et al., 2010).

Regarding this dissertation, and because the higher education sector is the main focus, it is important to refer another BI maturity model created especially for the sector: (1) The White Book Maturity Model, developed by Oficina de Cooperación Universitaria (OCU).

Until today, these are the BI maturity models concerning higher education, so that is why these models will be further explained. Still, this does not mean that general BI maturity models cannot be applied to the sector; from Table 2, we will be working with the TDWI model.

With a different perspective, there is the BI Strategy and Roadmap from IBM. This document is specific to the higher education sector and the presented strategy is based on the IBM Maturity Model. Thus, it will also be explored furthermore.

2.3.1 TDWI Maturity Model

The maturity model proposed by The Data Warehousing Institute (TDWI) was initially developed by Wayne Eckerson. TDWI is an institute whose mission is to promote the education and research in Business Intelligence area, and data warehousing. Initially built in 2004, it was improved in 2007. This maturity model was developed to respond to several professionals and executives that wanted to know how to evaluate their BI systems in comparison to their competitors. It presents, nowadays, five levels of maturity, as we can see on the figure below, equivalent to the phases of the growth of man.

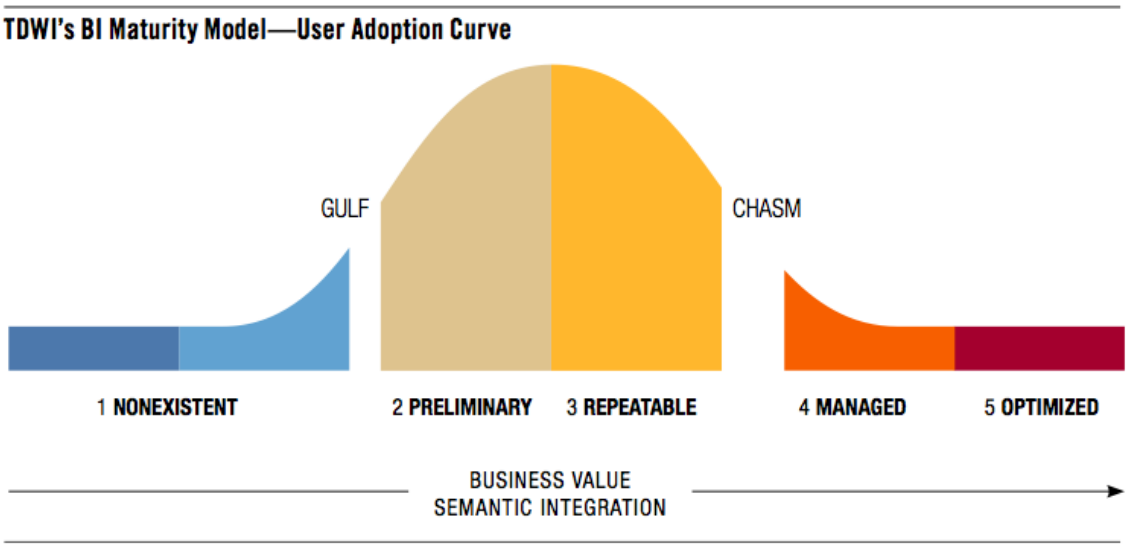

Figure 3 - TDWI Maturity Model (TDWI, 2012)

This maturity model is focused, mainly, on the technical aspect for the maturity assessment (Rajteric, 2010). Maturity is evaluated through eight key areas: Scope, Sponsorship, Funding,

Value, Architecture, Data, Development and Delivery. The evaluation method is a questionnaire that presents, in the final, an indicator of the maturity level. Each of these areas is graded as we can see in the Figure 3. There are five maturity levels:

- The first grading level, the *Nonexistent* stage, comprises two phases. The first phase persists until the creation of a data warehouse; the second phase is where the organization faces several partial data sources – also known as *Spreadmarts*. The first half of this stage represents an organization that relies entirely on operational reports for information. These reports are, generally, static and inflexible, showing a limited range of data (TDWI, 2012). In the second half of this phase, due to the lack of reports flexibility, users create their own reporting tools, typically one for each data source. To those reports TDWI calls *spreadmarts* and they comprises a particular set of data, metrics and rules with no correlation (or small) among them, between operational reports or between analytical systems (Rajteric, 2010).
- After the first grading level, there is the *Gulf Phase*, where is faced the first obstacle. As a result of lowly planning, insufficient data quality, cultural resistance, poor scope definition and over usage of *spreadmarts*, the organization struggles for reaching the next level (TDWI, 2012). Eckerson (2007) defends that the organization has to launch a few challenges to overcome it: contest the perception their executives have of BI as a strategic resource, adequate the financial support to the BI initiatives, improve data quality and perform a cultural change on how data is accessed, how it is analysed and how decisions are made. It represents a phase that all organizations can cross without major problems.
- At the second grading level, the *Preliminary* stage, there are departmental initiatives along with a few alignment attempts with other initiatives at the organization level. It also represents the phase in which new BI tools are implemented, allowing the use of new capabilities. This improvement will make the process of decision making and business understanding more accurate (Eckerson, 2007).
- The third grading level, the *Repeatable* stage, represents the continuation of the work begun at the previous level, in a more comprehensive and integrated way. The organization recognizes the value of consolidating regional data warehouses into a centralized one. The major change at this level is the increased utilization of BI systems, because there are a wider number of users. The organization recognizes the value of fast data availability and creates a number of reports/dashboards for different groups of users (Eckerson, 2007).

  The second obstacle happens at the *Chasm Phase*. This obstacle is deeper than the first one, and some organizations that struggle in this point do not get out of it. The challenges at this point might be related to business volatility, when the organization acquires or merges with another company, hire a new CEO/CIO, change its strategy, or restructures itself (and some things must go back to the start); or to semantics

standardization, when integrating different terms, definitions, and rules from several data marts/data warehouses is not a peaceful process; or even to a high report number, when the organization enables its users to creating their reports and there is not a defined limit for it. In order to overcome this battle, it is usually built an Enterprise Data Warehouse and it is an initiative that frequently comes from management. The aim is to unite independent regional data warehouses to accomplish a more reliable view on dispersed business information on all aspects of the organization (Rajteric, 2010).

- At the fourth grading level, the *Managed* stage, Eckerson (2009) reveals that the BI/DW teams overcome the *Chasm Phase* and obtain a tool that enables the organization to achieve its goals. The main characteristics of this level are the centralized management of BI data sources, a common architecture for the data warehouse, predictive and rapid data analysis, and centralized performance management (Rajteric, 2010).
- The last grading level, the *Optimized* stage, is the moment where BI is seen as a completely intrinsic service in processes, applications and strategies at the organization. This phase is about using BI to deliver interactive reports, dashboards and other information services. The use of enterprise portals is a generalized procedure and the organization works with complex applications that incorporate data through techniques such as rules, notifications, alerts, predictive models, in order to monitor processes in real-time (Eckerson, 2007).

Eckerson says that this maturity model should not be seen as a final evaluation of the BI systems, because it cannot evaluate the program with the necessary depth. For the best results, it should be complemented with an independent consultant study, in order to identify and evaluate, sporadically, the strengths and weaknesses of the BI systems.

Concerning the assessment, there is an online survey available, with forty questions. Each of them has five possible answers and all the questions are grouped in eight categories. This structure is explained on Figure 4.

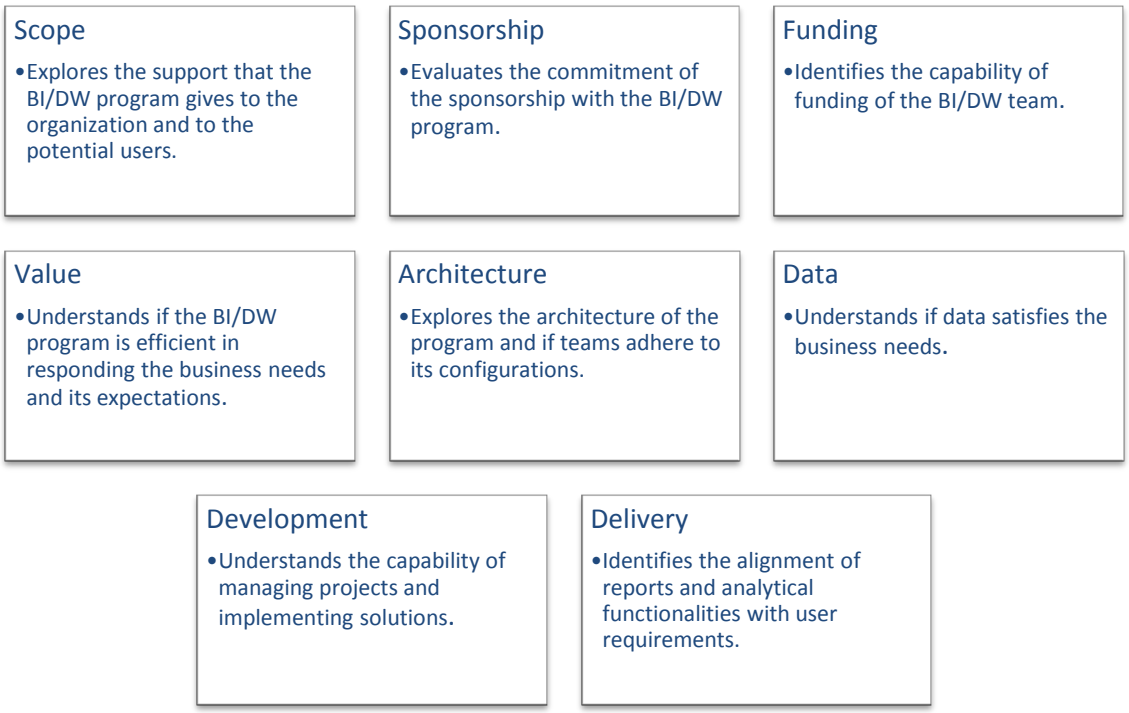

Figure 4 - Structure of Assessment Survey (adapted from TDWI, 2012)

It is given a weight to each answer, from 1 to 5, whose value corresponds to the maturity level. The value 1 matches to the level "Preliminary" and the value 5 matches to "Optimized" level. The sum of the values from the various answers originates a global result and a result by category. Table 3 presents the overall score and demonstrates the possible results and the equivalent maturity levels.

Table 3. Overall Score from TDWI Assessment

OVERALL SCORE	
SCORE	**STAGE**
5 to 7	Nonexistent
6 to 9	The Gulf
8 to 12	Preliminary
13 to 17	Repeatable
15 to 19	The Chasm
18 to 22	Managed
23 to 25	Optimized

It is important to refer that this scale may or may not include the stages “The Gulf” and “The Chasm”.

Figure 5 presents a synthesis of the characteristics of each maturity level related to each category.

Category/Stage	Infant	Child	Teenager	Adult	Sage
Scope	Individual	Department	Division	Enterprise	Inter-enterprise
Sponsorship	Non-existent or uncommitted	↔	Somewhat committed & accountable	↔	Very committed & accountable
Funding	None	Departmental budget	Divisional budget	Corporate IT budget	Self-funding
Value	Cost Center	Tactical	Mission critical	Strategic	Competitive differentiator
Architecture	Spreadmarts	Non-integrated data marts	Non-integrated data warehouses	Central DW with or without data marts	BI or data service via service-oriented architecture
Data	Not trustworthy, not timely, not comprehensive	↔	Somewhat trustworthy, timely, and comprehensive	↔	Fully trustworthy, timely, and comprehensive
Development	Non-standardized processes	↔	Somewhat standardized processes	↔	Fully standardized processes
Delivery	View static reports	Analyze trends and issues	Monitor processes	Predict outcomes	Automate processes

Figure 5 - Synthesis of the Characteristics of the TDWI BI Maturity Model (TDWI, 2012)

The BI Task Force @ EUNIS (see section 2.4) created an assessment survey based on this maturity model. All the questions were adapted to the higher education sector, especially in terms of vocabulary. The calculations for the overall score and the maturity levels were maintained as the original.

2.3.2 The White Book BI Maturity Model

The Spanish Oficina de Cooperación Universitaria (OCU) developed a BI maturity model for Higher Education institutions with the help from JISC InfoNet. – this collaboration resulted in the White Book Maturity Model. This maturity model is based on the experience of the contributors and was conceived as a specific tool for the Higher Education sector (OCU, 2013).

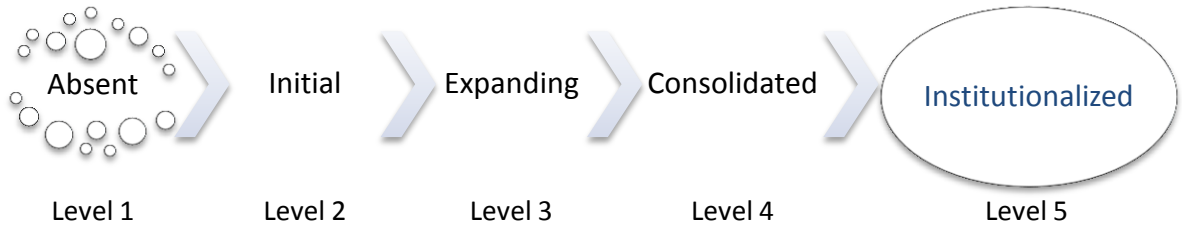

Figure 6 - The White Book Maturity Model Levels (adapted from OCU, 2013)

As displayed in Figure 6, there are five maturity levels:

- The first level, *Absent*, represents institutions with no dedicated initiatives, or they are in such an early state that it cannot be perceived. Data usage is, in general, limited to operational contexts;
- At the second level, *Initial*, the institution starts to realize data and its importance. In a small scale, there might be a few local success stories regarding data analysis;
- In the third level, *Expanding*, the potential of data to empower the institution is clearly perceived. There is a strong wish to translate the success of the local success stories to a wider scale. There is the first global effort to put in place and gradually incorporate and/or substitute the previous local initiatives;
- At the fourth level, *Consolidated*, the institution has its intelligence clearly established as a permanent and wide program, originating an effective internal service. Also, there are data products targeted to different user groups and covering different functional areas;
- The last level, *Institutionalized*, covers an institution where institutional intelligence forms an integral part of its culture. Everyone uses effectively the data tools and they cover all key functional areas.

Regarding the assessment, there is not enough information about the used tools or criteria.

2.3.3 Business Intelligence Strategy and Roadmap - IBM

In 2007, IBM was chosen to help define a BI strategy for An Chéim[1] and the Institutes of Technology (IoT)[2] in Ireland. There was a crescent need in meeting the external needs of Higher Education concerning accountability and in supporting the growing internal requirement for more targeted information and analytics. In order to better define this BI strategy, the IBM Information Maturity Model was used, which is a maturity model that can be used in several industries – higher education is not an exception (IBM, 2007).

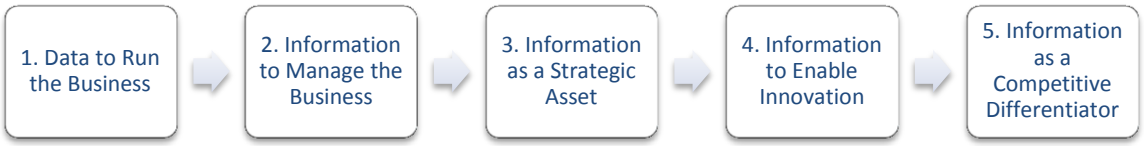

Figure 7 - IBM Information Maturity Model (adapted from IBM, 2007)

According to the Figure 7, there are five maturity levels on this maturity model used to develop the Business Intelligence Strategy and Roadmap by IBM.

[1] An Chéim Computer Services is a specialist shared services organization, which operates in the public and higher education sectors in Ireland. This organization implements, maintain and support business-critical and regulatory systems.

[2] Institutes of Technology represent 13 Irish university-level institutes that operate a unique system where they allow students to progress from Degree programs to Masters and PhD. These institutes are focused on teaching/learning, purpose-driven research, and public service.

- The first level, *Data to Run the Business*, have basic reporting and the utilization of spreadsheets is global. It is hard to get the "single version of the truth", because solutions are non-integrated and the applications are stand-alone modules.
- The second level, *Information to Manage the Business*, have basic search and querying. Working environments are disparate and there is a limited enterprise visibility, originating multiple versions of the truth.
- The third level, *Information as a Strategic Asset*, see a single version of truth. There is an integrated business performance management and an effort to present real-time information.
- The fourth level, *Information to Enable Innovation*, have their capabilities within workflow, processes and systems fully embedded. They already use predictive analysis and there are improved business processes and operations management. Data is seamless and shared.
- The fifth level, *Information as a Competitive Differentiator*, are optimizing the strategic business innovation. Business performance and operations are enhanced and all relevant information is unified and public.

Regarding the assessment, there is not enough information about the used tools or criteria.

2.3.4 Comparative Analysis

This section presents a comparative analysis of the previous BI maturity models. Using Lahrmann et al. (2011) as a reference, the compared properties are: maturity concept, dimensions, maturity levels, and assessment. Maturity Concept represents the understanding of maturity, and it can be seen from three different angles: people, processes and technology. Dimensions express specific areas of capability, process or objects structuring the field of interest. Maturity Levels define the maturity state of a certain dimension, with a designation and a detailed description. Assessment is the evaluation made that can be qualitative or quantitative. The authors also indicate a characteristic called Maturity Principle. The Maturity Principle can have two values: continuous or staged. Continuous maturity models allow a scoring of different activities in different levels. Staged maturity models demand the accomplishment of all requisites of each level. This characteristic was not relevant to include in this comparison, because all of analyzed maturity models are staged models: all of them represent maturity in levels, and each level has its own goals that are applied to all evaluated organizations.

Table 4. Comparative Analysis of BI Maturity Models

Maturity Model	Maturity Concept	Dimensions		Maturity Levels	Assessment
TDWI	Processes Technology	• Scope • Sponsorship • Funding • Value	• Architecture • Data • Development • Delivery	(1) Nonexistent (2) Preliminary (3) Repeatable (4) Managed (5) Optimized	Online Self-Evaluation Quantitative
OCU	People Processes Technology	• Team • Scope • SBU Role • Data Products • User Coverage • Users Engagement	• Data Management • Business Value • Strategic Support	(1) Absent (2) Initial (3) Expanded (4) Consolidated (5) Institutionalized	Self-Evaluation Quantitative
IBM	Processes Technology	• Data • Integration • Applications • Infrastructure		(1) Data to Run Business (2) Information to Run Business (3) Information as Strategic Asset (4) Information to Enable Innovation (5) Information as a Competitive Differentiator	Unknown

Table 4 presents a comparative analysis of the maturity models according to their characteristics. There are several ways to differentiate the presented models, but one of the most obvious is its origin: academic or practical. Academic models generally have a context, whether are based on a bibliographic review, a subjacent theory or well-known concepts. Practical models are usually developed by consultants and are the result of their professional experience. It is important to state that there might be models whose origin can be both academic and practical – although their sources are not academic, it is not possible to say that they have influence of commercial aspects. The maturity models from Table 4 can be characterized according to its origin.

- Practical Origin: **IBM**;
- Academic/Practical Origin: **TDWI** and **OCU**.

Regarding the number of maturity levels, there is an equal situation: the TDWI Maturity Model, the White Book Maturity Model (OCU) and the IBM Information Maturity Model have five maturity levels.

Another important characteristic is the assessment (see Table 5). TDWI maturity model enables the online assessment, where the user can answer to a survey and see the results instantly. Both OCU and IBM do not specify how the assessment is done.

Table 5. Assessment of the BI Maturity Models

Maturity Model	Online Assessment?	Link	Results
TDWI	Yes	http://tdwiorg0000.web711.discountasp.net/	Indicated after the completion of assessment
OCU	Unknown	-	-
IBM	Unknown	-	-

2.4 BI Task Force @ EUNIS

The BI Task Force @ EUNIS is a group of members of the European University Information Systems (EUNIS) organization. The goal of this task force is to promote the creation of a European online platform to share knowledge and practices on BI in the higher education sector. This platform is a way to achieve an ideal goal: a cooperation environment for the development of innovate applications across all higher education subject categories. The exchanged experiences can be classified in four groups: (1) BI Adoption and Management; (2) Success Factors; (3) Technical Infrastructures; and (4) Software.

The core team of this task force is made by participants of eight European countries: France, Germany, Ireland, Italy, Norway, Portugal, Spain and United Kingdom. As displayed in Figure 8, the BI Task Force @ EUNIS members are managers, professors, IT directors, BI professionals and workers from several departments in universities.

Figure 8 - Levels of Professional Career of BI Task Force @ EUNIS members (adapted from EUNIS, n.d.)

In 2013, the core team decided to create a BI Maturity Survey and use it as a starting point for the BI Task Force goals. This survey was developed to assess the "occurrence and maturity of BI applications across European HEIs", and aims for a "continuously updated collection of maturity information, enabling participants to perform a self-assessment and benchmark of its BI maturity level against other HEIs, both actually and over time" (EUNIS, n.d.). It was available

online until the end of 2013, and through the AlmaLaurea platform[3]. Figure 9 represents the participants in this survey regarding their geographical localization.

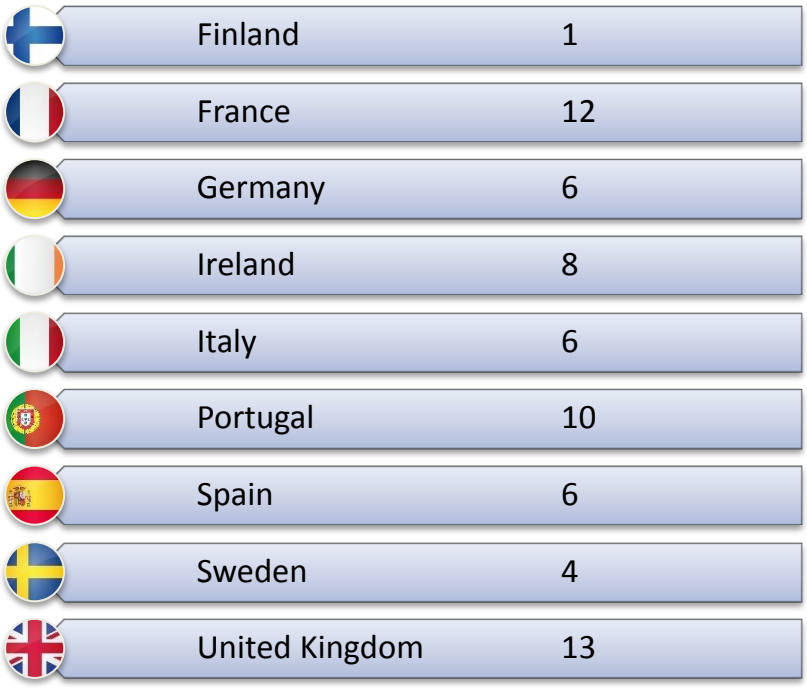

Figure 9 - Participant Countries in the BI Maturity Survey, and corresponding Number of Answers

The BI Maturity Survey was addressed mostly to IT Directors/CIOs, BI Managers or Rectory level. In total, there were 66 collected answers, mostly from public HEIs (about 92%). In Portugal and Italy, only universities were included.

The countries with more answers were France, Portugal and United Kingdom, each of them with more than 10 answers. The sum of the answers from these three countries represents more than half of the collected responses.

All of the collected answers were treated as anonymous, protecting the real identity of the respondents. Table 6 presents the profile of these respondents.

[3] AlmaLaurea is a public Italian inter-university Consortium, composed by 65 universities, representing an innovative service providing online curricula to graduates. It has been a model for the analysis of academic performance of students, and of their entry into the labor market.

Table 6. Profile of BI Maturity Survey Participants

Profile Questions	Percentage
How long ago did the BI/DW initiative start?	
Not started yet	18%
Less than 1 year ago	11%
1 to 5 years ago	16%
5 to 10 years ago	33%
More than 10 years ago	11%
Don't know	2%
What is the number of full-time equivalent BI/DW staff members (including contractors)?	
None	26%
1	18%
2 to 10	51%
More than 10	2%
Don't know	3%

Regarding the number of years that universities had implemented a BI/DW initiative, the respondents represent different realities. Most of them use BI for 5 to 10 years, however, does not characterize half of the universities (33%). The second most popular answer was chosen for 18% of respondents and denote universities that have not started a BI/DW initiative. About 16% say that it is a recent reality in their institutions.

Concerning the full-time BI/DW staff members, about half of the universities have 2 to 10 employees. Still, an important percentage of them (26%) have no one working on BI. Regarding the survey analysis, Figure 10 shows the aggregated survey analysis, and Figures 11 to 19 presents the survey analysis for each country involved.

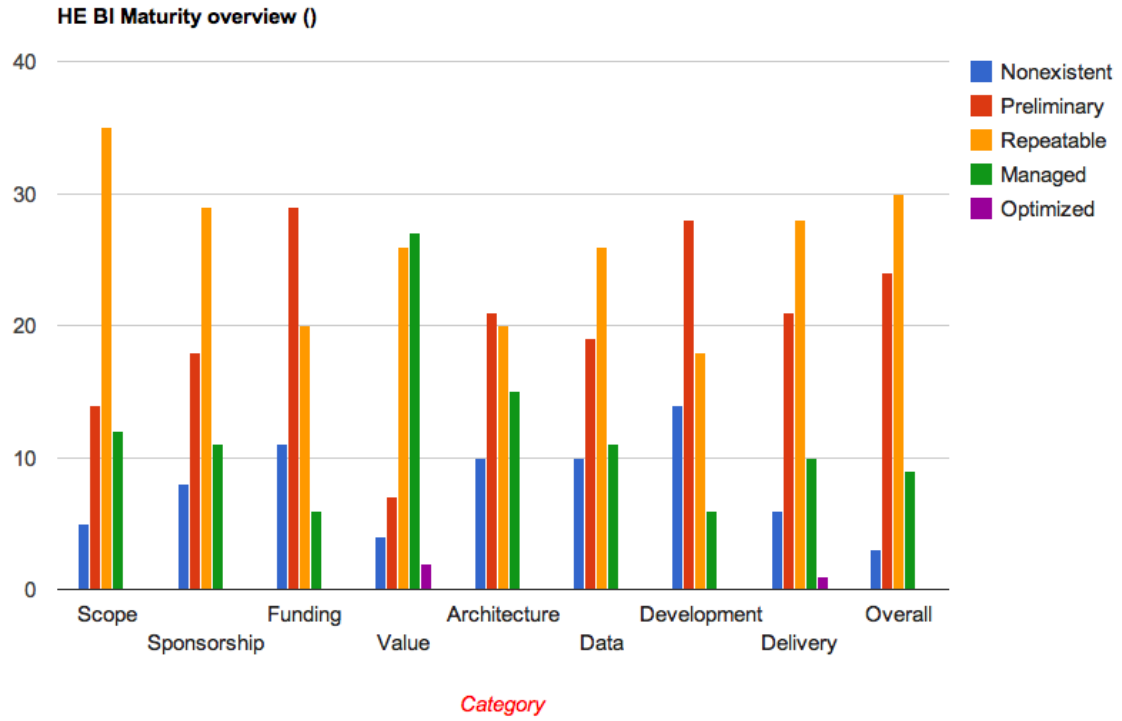

Figure 10 - Survey Analysis with Aggregated View

Figure 10 displays the survey results regarding the eight dimensions from TDWI Maturity Model and the Overall dimension – which demonstrates the overview perspective. Each dimension represents the total of respondents evaluated for each maturity level: Nonexistent, Preliminary, Repeatable, Managed and Optimized. Regarding the dimensions Scope, Sponsorship, Data and Delivery, most institutions assess themselves as in the Repeatable maturity level. Funding, Architecture and Development are the two dimensions where most institutions think they are at a starting level (Preliminary maturity level). Value is the only dimension with an assessment at the Managed level. Very few institutions find themselves at the Nonexistent maturity level, and practically none is at the Optimized level.

Concerning the Overall dimension, most institutions are at the Repeatable maturity level.

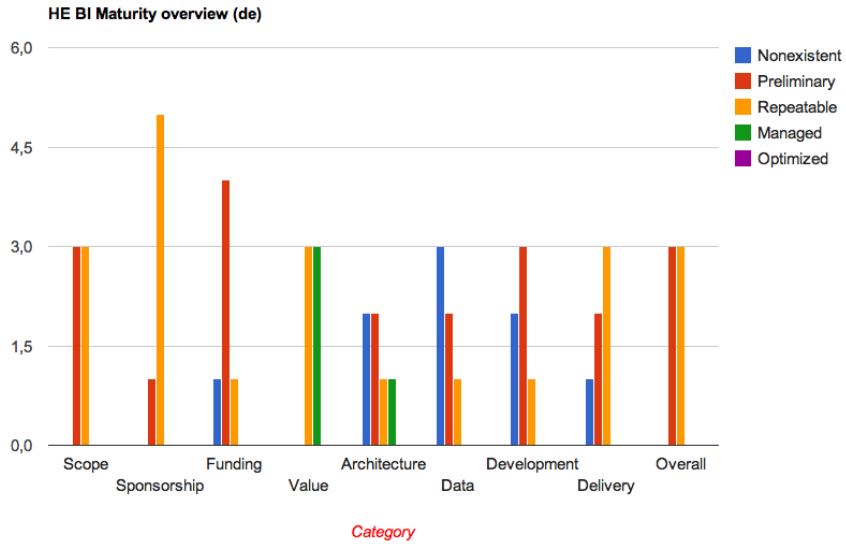

Figure 11 - Survey Analysis of German Participants

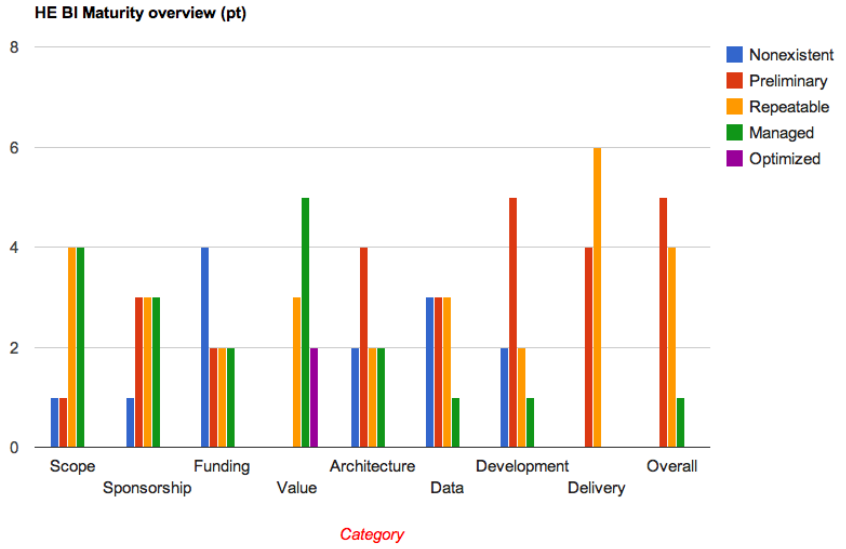

Figure 12 - Survey Analysis of Portuguese Participants

Figure 11 and Figure 12 show the survey results of Germany and Portugal, respectively.

Regarding Germany, Architecture and Data dimensions were considered the least developed areas. At a preliminary level, Scope, Funding and Development are the dimensions in an initial state. Considering Sponsorship and Delivery, institutions assess themselves more strongly at the Repeatable level, while the Value dimension has half of the German institutions at the Managed level. The main conclusion from the Overall dimension is the equal division in the number of institutions at the Preliminary and Repeatable maturity levels.

Considering Portugal, Funding and Data dimensions were the two dimensions with the majority of institutions at the Nonexistent level. At the Preliminary maturity level, there are the Architecture and Development dimensions with the strongest results. Delivery is the dimension

that most of Portuguese institutions assess themselves at the Repeatable maturity level. From the Overall dimension, we can conclude that most institutions are at the Preliminary maturity level, although there are a few which assess themselves at the Managed level.

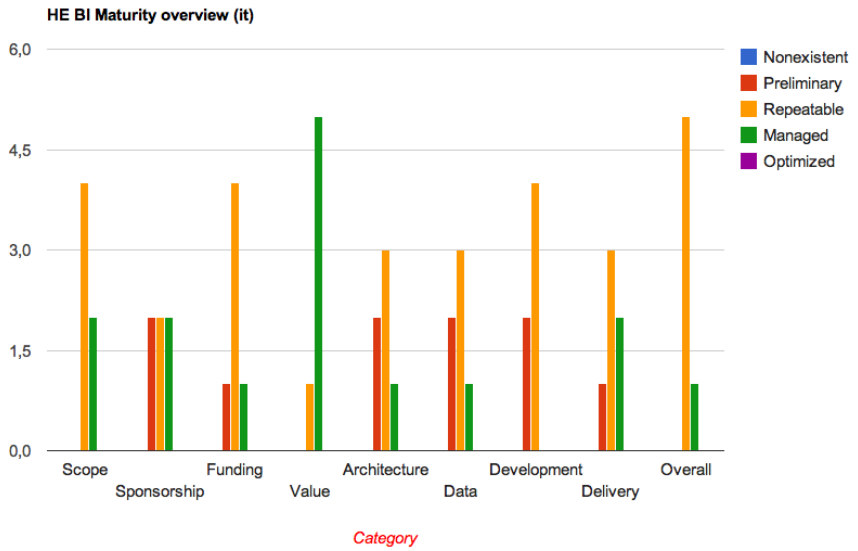

Figure 13 - Survey Analysis of Italian Participants

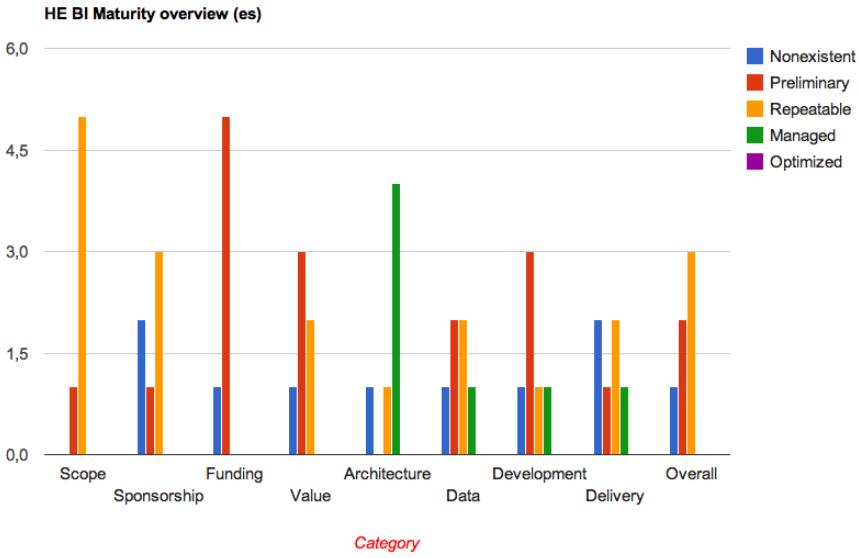

Figure 14 - Survey Analysis of Spanish Participants

Figure 13 and Figure 14 show the survey results of Italy and Spain, correspondingly. Analyzing the Italian results, it is consensual that the Managed and Repeatable maturity levels have a significant presence in this assessment. Scope, Funding, Architecture, Data, Development and Delivery have the biggest number of institutions at the Repeatable level. The Value dimension is mainly at the Managed level, yet it has a meaningful position in all other dimensions. At the

Overall dimension, it is clear that most Italian institutions assess themselves at the Repeatable maturity level.

Regarding the Spanish results, Funding, Value and Development are at a starting level – mostly Preliminary level. Scope and Sponsorship are at the Repeatable level for most institutions, while Architecture is the dimension where results show more for the Managed level. The Overall dimension shows that most Spanish institutions are at the Repeatable level, although the Nonexistent level is a reality for many of them (regarding all dimensions).

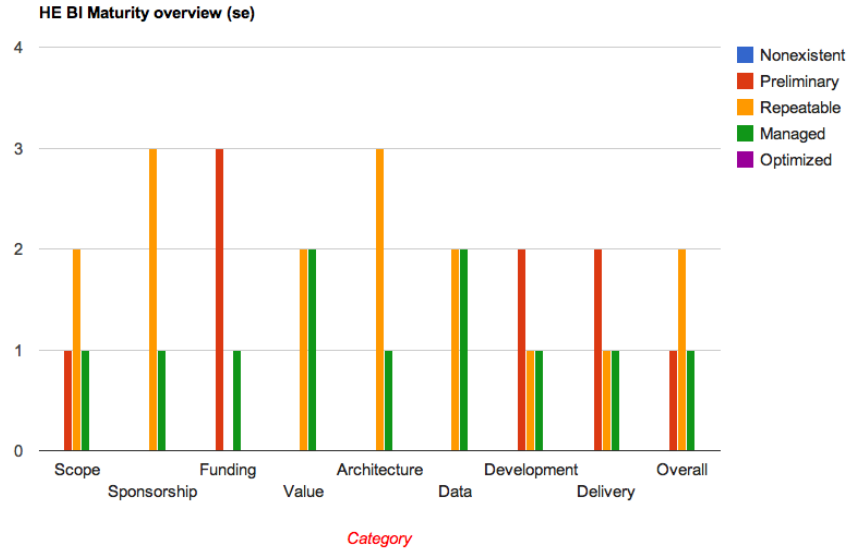

Figure 15 - Survey Analysis of Swedish Participants

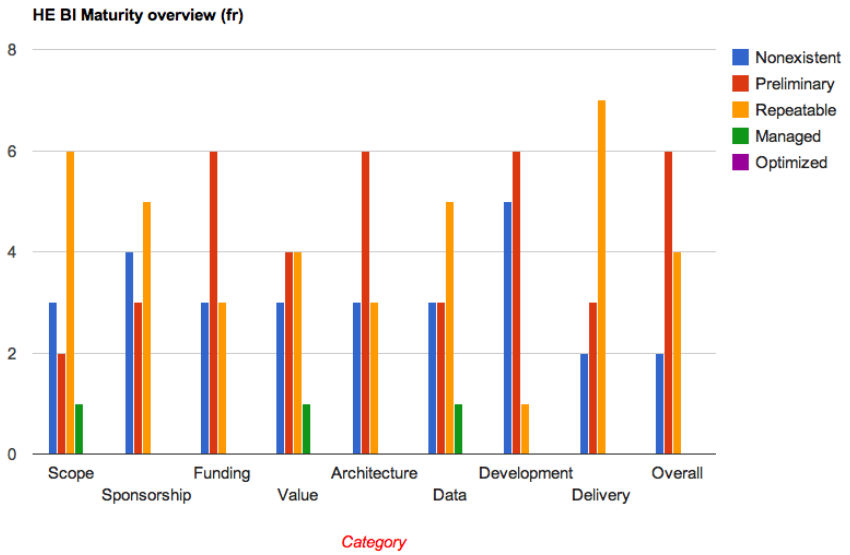

Figure 16 - Survey Analysis of French Participants

Figure 15 and Figure 16 show the survey results of Sweden and France, respectively. The first conclusion we take from the Swedish results is that, from all respondents, there is not any

institution at the Nonexistent level regarding any dimension. Funding, Development and Delivery are the dimensions where the majority of institutions find themselves at the Preliminary level. Scope, Sponsorship and Architecture are at a Repeatable level, while Value and Data have the institutions equally distributed between Repeatable and Managed levels. Regarding the Overall dimension, the predominant maturity level is Repeatable.

Regarding France, Funding, Architecture and Development have the majority of institutions at the Preliminary level, while Scope, Sponsorship, Data and Delivery are at the Repeatable level. At the Overall dimension, French institutions find themselves at the Preliminary maturity level, although the Nonexistent level is a reality for many of the respondents.

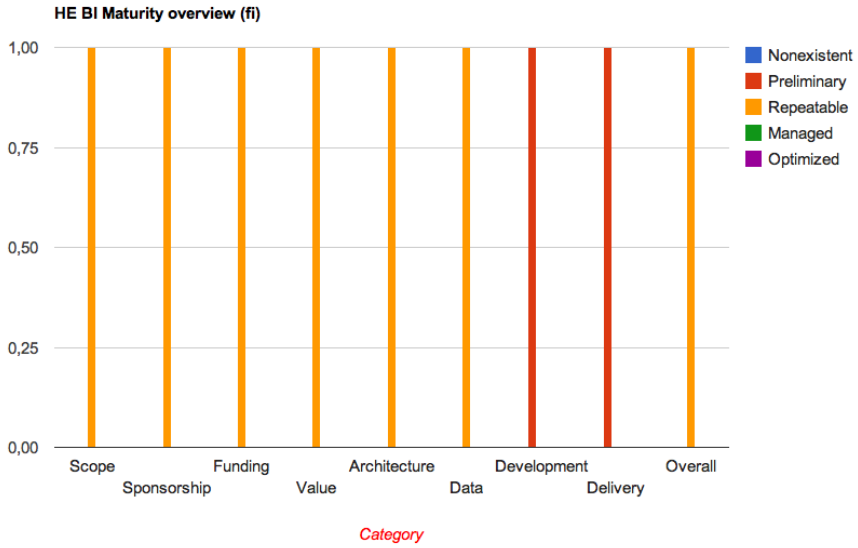

Figure 17 - Survey Analysis of Finnish Participants

As there was only one Finnish answer, we can conclude that the institution is at the Repeatable maturity level. Regarding all dimensions, only Development and Delivery are at the Preliminary level – see Figure 17.

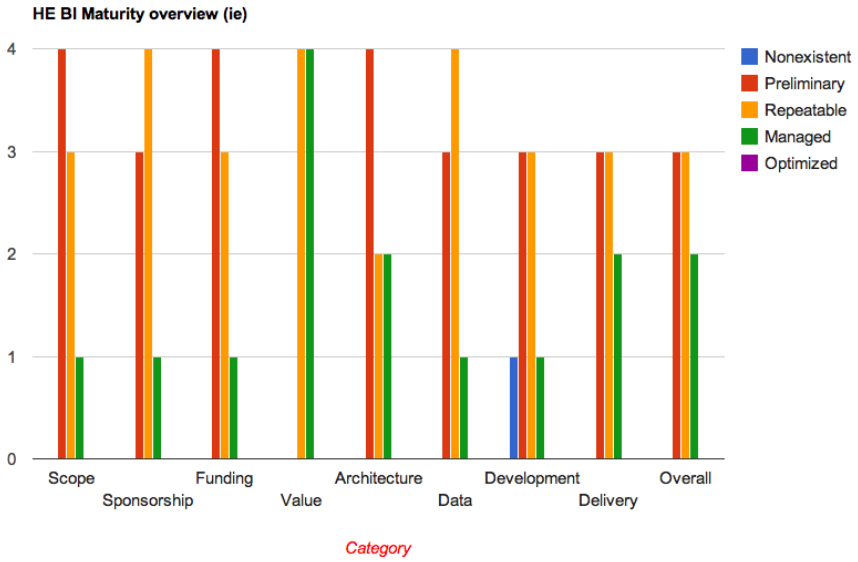

Figure 18 - Survey Analysis of Irish Participants

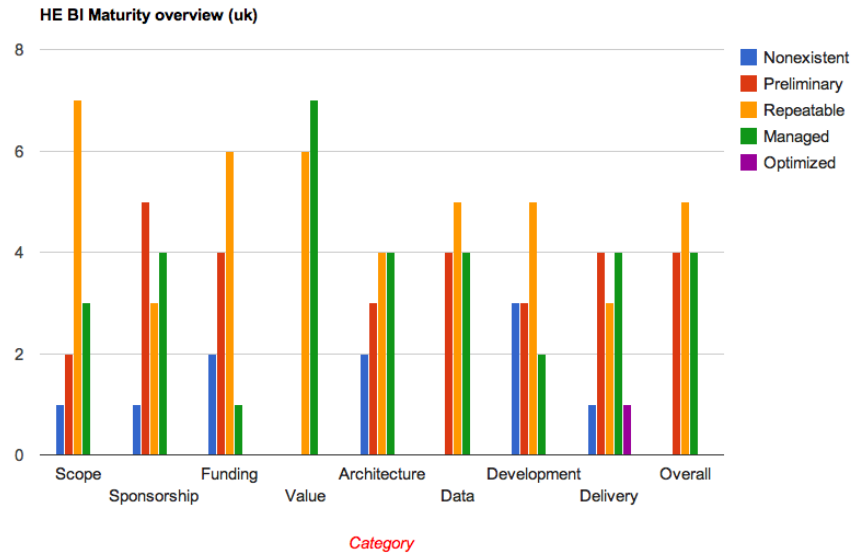

Figure 19 - Survey Analysis of English Participants

Figure 18 and Figure 19 show the survey results of Ireland and United Kingdom, correspondingly. Considering Ireland, Scope, Funding, Architecture have the most Irish institutions at the Preliminary level. Sponsorship and Data have the most of them at the Repeatable level. Value dimension have institutions equally distributed between Repeatable and Managed level, at the same that we verify a similar situation in Development and Delivery dimensions – although between Preliminary and Repeatable maturity levels. Considering the Overall dimension, institutions are similarly balanced between Preliminary and Repeatable maturity levels, though it can be concluded that some of them are at the Managed level.

Considering the results from United Kingdom, it is possible to verify that Scope, Funding, Data and Development have the most part of respondents at the Repeatable level. Sponsorship is

mainly at the starting level, while Value is at the Managed level. The difference between the institutions and their corresponding maturity levels is significant, meaning different realities for several institutions. Regarding the Overall dimension, the majority of them are at the Repeatable maturity level, although a significant part is also at a Preliminary and at a Managed state.

The concluding remarks that BI Task Force @ EUNIS collected from this survey are presented in Figure 20.

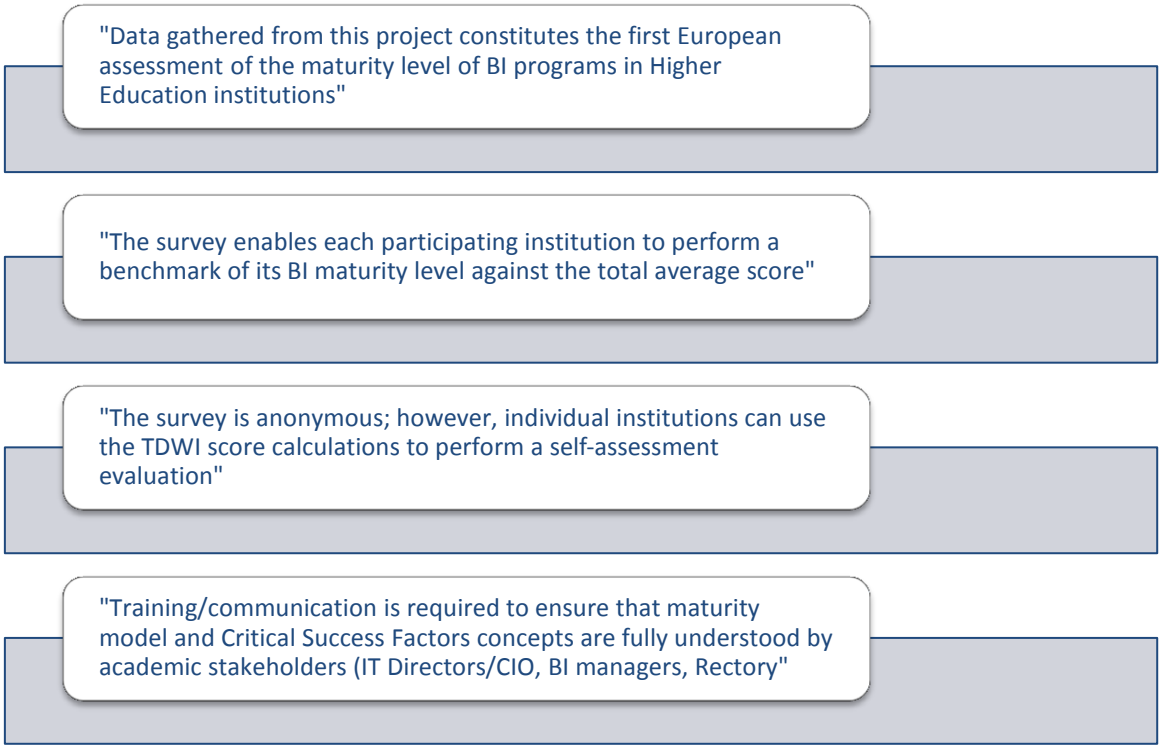

Figure 20 - Concluding Remarks about BI Task Force @ EUNIS survey (adapted from Cardoso, 2014)

2.4.1 Critical Analysis to the Results of the 2013 EUNIS BI Maturity Survey

The results of the 2013 EUNIS Maturity Survey reveal a lack of consistency. Considering the overall view, this might not be perceptible, because there are several countries involved, and each one of them with their own reality. However, analyzing the results of each nationality makes it easier to understand.

In Germany and Portugal' case, respondents evaluated their funding, architecture and data dimensions as in an initial state, but their value dimension is in an advanced stage. In other words, this situation says that their budget is limited, their architecture is not fully developed, and there is a lot of work to do to accomplish fully integrated data sources with a "single version of the truth", revealing that their BI initiatives are not completely stable; on the other hand, their universities are taking full advantages of their analytics. If data is not universal, it is difficult to produce effective BI products that will help improving higher education services.

Finland also reveals a similar situation, due to its evaluation of development and delivery dimensions, which are also in the beginning. Value is the dimension that takes longer to be more mature, because it is dependent of the success of all other dimensions. If the development team is not fully established, with a defined methodology, the produced BI products take longer to be developed, and consequently, the HEIs must wait longer to use the information in their decision-making tasks.

It would be interesting to verify the results regarding the White Book maturity model; however, it was not possible to gather that information in time for this dissertation.

These results might be saying that either the 2013 EUNIS BI Maturity Survey was not correctly structured, or the institutions had difficulties in understanding what was being asked, or they had problems with the dimensions' definition.

CHAPTER 3

Kit Proposal

This chapter describes a kit proposal to assist HEI stakeholders in assessing the maturity of their BI initiative. The goal is to provide the definition for the key concepts used in the questions from the TDWI and OCU maturity models presented in the 2013 EUNIS BI Maturity Survey (see appendix A). It also aims to gather success cases to support the definitions and described guidelines. This kit proposal intends to act as guidance to HEIs that want to start their first BI initiative.

3.1 Assumptions

This kit proposal is to be applied to institutions that are starting their BI journey. It is a support for HEIs that do not have any solid BI tasks running on their environments, and are willing to develop a structure regarding their data and analytic capabilities.

3.2 Key Dimensions

The kit proposal analyzes a set of key dimensions, which were created using the dimensions from the TDWI Maturity Model and the White Book Maturity Model. Table 7 reflects how these key dimensions were created. The kit proposal dimensions are an intersection of the idea of the dimensions from both models.

Table 7. Development of Kit Proposal Dimensions

TDWI Dimensions		White Book Dimensions		Kit Proposal Dimensions
Scope		Scope		Scope
Sponsorship		Strategic Support		Sponsorship
Funding		-		Funding
Value		Business Value		Value
Architecture	∩	-	▶	Architecture
Data		Source Business Units Role + Data Management		Data
Development		Institutional Intelligence Team		Development
Delivery		User Coverage + Users Engagement + Data Products		Delivery

Using TDWI as basis, the White Book dimensions were involved according to their corresponding questions created for BI maturity assessment. This decision was made, because TDWI dimensions were considered to be more explicit. For example, the question about Users

Engagement is more related to how BI products are delivered, rather than to users. Figure 21 presents graphically the resulted dimensions.

Figure 21 - Kit Proposal Dimensions

3.3 Architecture

The BI/DW Architecture specifies the technical framework for the achievement of the BI/DW project success. It provides technical guidelines and allows individual projects to deliver components that support the whole BI environment. This architecture plays an important role because it affects development and implementation decisions. The architecture needs to (IBM, 2007):

- Deliver functionality to combine data across all source systems and deliver reports to the different users;
- Support reporting from each operational system, mainly the student system;
- Be sufficiently flexible to meet institutional needs and lifecycle changes to source systems.

There are several BI/DW architecture proposals. According to Adamson (2010), some of them place a heavy emphasis on the star schema, while others use it in a limited capacity. However, the principles of dimensional design are the same for both cases. This author identifies three architecture categories: (1) Dimensional Data Warehouse, (2) Corporate Information Factory, and (3) Stand-alone Data Marts. Dimensional Data Warehouse is an approach devised by Ralph Kimball, and the Corporate Information Factory was formulated by Bill Inmon. The third category has no known advocate.

Kimball defends a dimensional design approach – the bottom-up design. This approach is about creating a set of data marts that facilitate analysis and reports. This set origins a conceptual enterprise data warehouse. According to Adamson (2010), it allows for an integrated repository of data and relies on dimensional design to support analytics. Also known as Data Warehouse Bus Architecture or the Dimensional Data Warehouse, the following figure represents this idea:

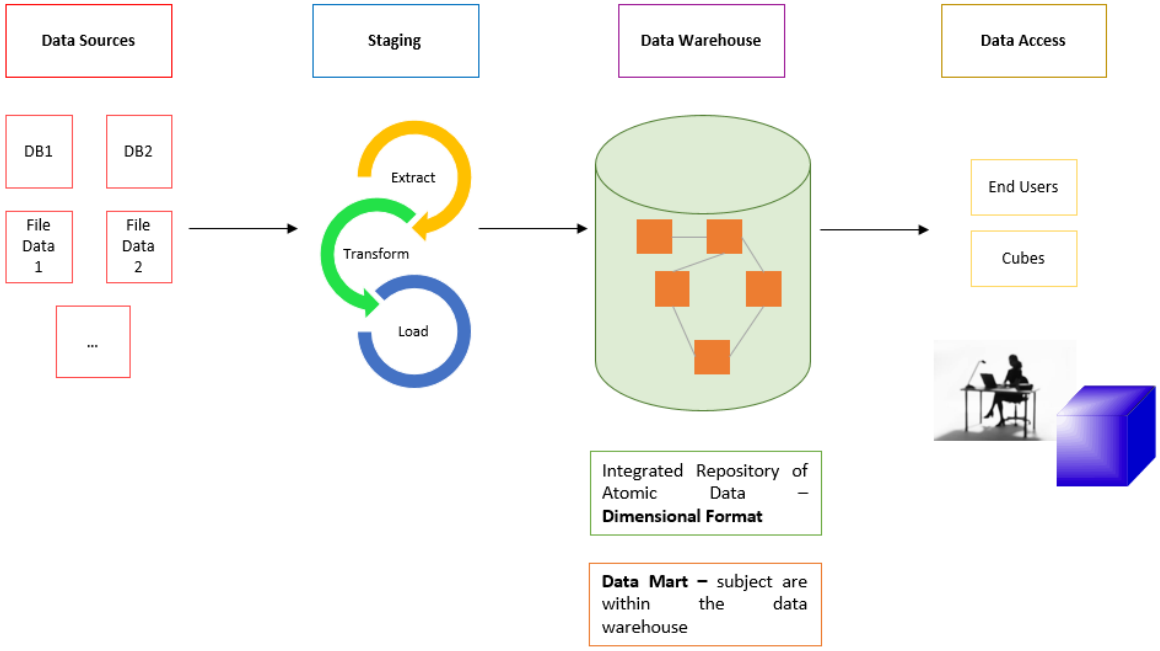

Figure 22 - Data Warehouse Architecture (Kimball) – adapted from Adamson (2010)

Kimball defends that data should be extracted from the data sources and moved to a Staging area, where it is scrubbed and made consistent. From the Staging area the data marts are created. The Staging Area – also called the Extraction, Transformation and Loading (ETL) System – represents a set of processes that store temporarily the extracted data, in order to be cleansed. This process might incorporate correction of grammar errors, conflict resolution, treatment of empty fields, elimination of duplications and data standardization. After this transformation, it is necessary to load the data into the DW. The Data Warehouse section covers several data marts, as we can see in Figure 22 – a set of data marts creates a conceptual Enterprise Data Warehouse. At last, the Data Access section encompasses the applications used to create queries to the DW, to analyse and show their results. It can be accessed directly by analytic systems.

As mentioned before, another proposal belongs to Inmon – the Corporate Information Factory architecture. Using the top-down design, this architecture (also called the Hub-and-Spoke) represents a centralized data warehouse with dependant data marts. It indicates that the data warehouse should be designed from the top-down to include all corporate data, where the data marts are created only after the complete data warehouse has been created. Figure 23 characterizes Inmon's architecture.

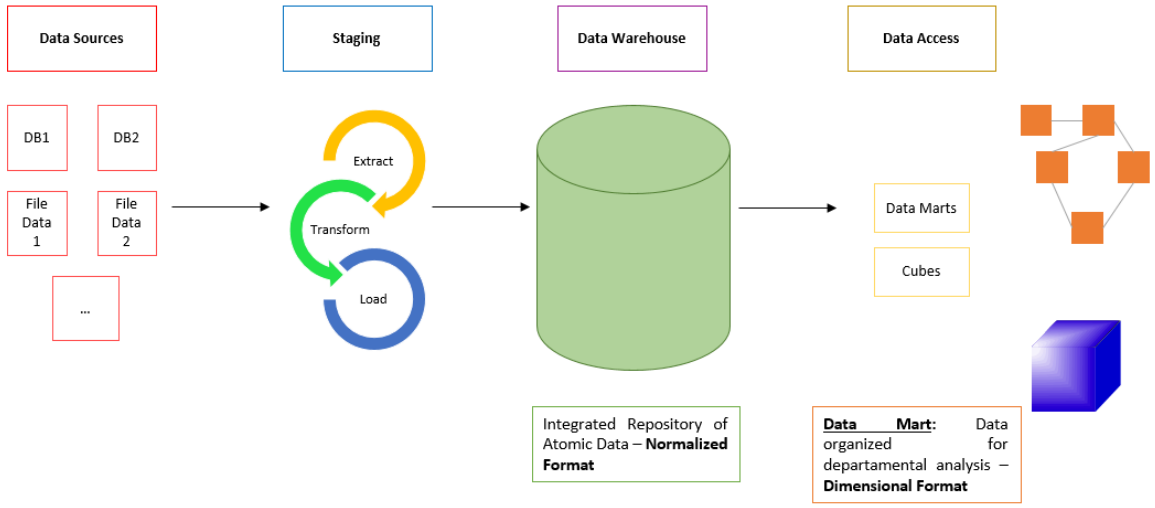

Figure 23 - Data Warehouse Architecture (Inmon) – adapted from Adamson (2010)

The data sources feed the ETL process, where information is consolidated, integrated and loaded into a single repository – also called Enterprise Data Warehouse (EDW). The EDW it is integrated from the several operational systems and contains a definitive and consistent representation of business activities in one place; it is atomic, because it captures data at the lowest level of detail. In Inmon's approach, the EDW is not designed to be queried directly by analytic applications or BI tools – its purpose is to feed data marts.

Throughout the 1990s, data warehouse experts kept debating which approach was the best: Inmon's approach focused on operational data or Kimball's approach dedicated to dimensional models expressed in integrated data marts. Comparing both on Table 8, it is possible to identify a few differences.

Table 8. Comparing Kimball and Inmon Architectures (adapted from Breslin, 2004, and Adamson, 2010)

	Kimball	Inmon
Design	Bottom-up *It is designed according to the principles of dimensional modelling: a series of star schemas or cubes wich capture information at the lowest level of detail.*	Top-down *It is designed according to the principles of ER modelling.*
Architectural Structure	Data marts model business process; success is achieved with conformed dimensions	Enterprise-wide DW feeds departmental DBs
Complexity	Fairly simple	Quite complex
End User Accessibility	High	Low
Primary Audience	End Users	IT
Objective	Deliver solution that makes it easy for end users to directly query data and still have reasonable response rate	Deliver a rigorous technical solution based on proven methods

According to Russom (2014), the discussion has cooled down in the recent years because most DW architects employ multiple approaches, selecting the one that fits better to the organization and the project – this means that most of them incorporate both Kimball and Inmon.

The Stand-alone Data Marts architecture (see Figure 24) does not have any well-known advocate, unlike the previous two approaches. This situation is due to its characteristics: although it allows rapid and inexpensive results in a short term, on the other hand it raises long-term costs and problems. This architecture represents an analytic data store that has not been designed in an enterprise context and is focused exclusively on a subject area (Adamson, 2010).

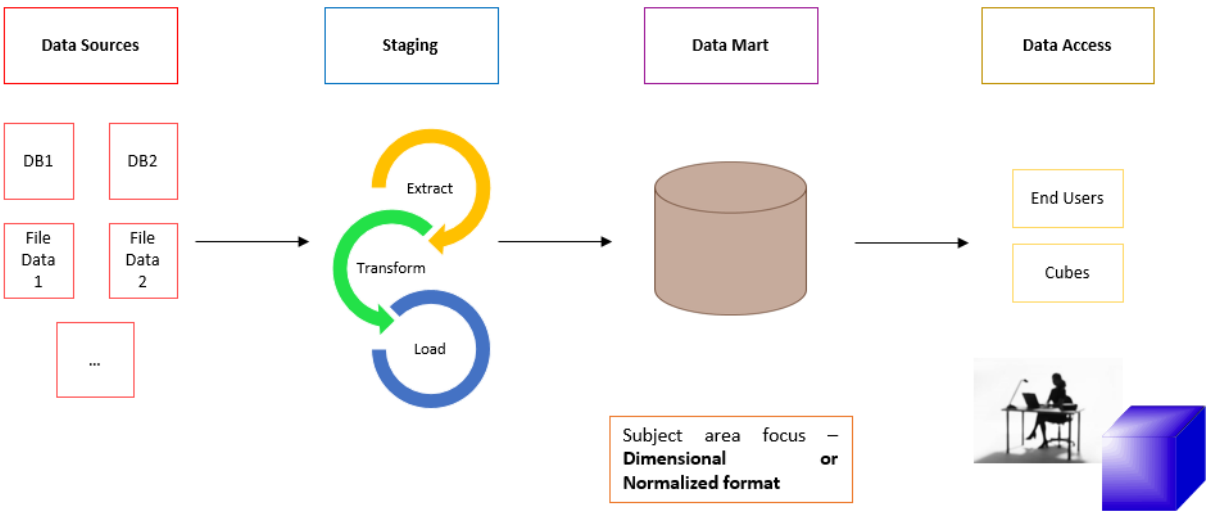

Figure 24 - Stand-Alone Data Mart - adapted from Adamson (2010)

Developing a stand-alone data mart is the most practical path to visible results, because it does not require cross-functional analysis and the data mart can be put into production quickly. However, it can be a problem, especially if more than one subject area is supported via stand-alone data marts. There is not a single view of data, because it is fragmented and it can be inconsistent if each data mart is developed independently. According to Adamson (2010), these data marts may be based on different technologies, and users may be relying on separate query and reporting infrastructures, connoting a lack of compatibility between them, leading to high maintenance costs. Besides this negative characteristic, without a data repository, a data mart can fail to answer a future question that requires more detail than originally anticipated.

Table 9 presents a comparison of the mentioned BI architectures.

Table 9. Comparison of BI Architectures

	Author/Advocate	Description
Corporate Information Factory	Bill Inmon	- **Data Warehouse**: integrated repository of atomic data; - Not directly accessed; - Data marts reorganize data for departmental analysis.
Dimensional Data Warehouse	Kimball	- **Data Warehouse**: integrated repository of atomic data; - May be directly accessed; - Subject areas within the DW are the data marts.
Stand-Alone Data Marts	*Not known*	- Subject area implementation without an enterprise context.

According to TDWI maturity model, BI/DW architecture is crucial for the success of the initiative. TDWI presents important guidelines throughout the maturity model regarding this dimension. One of the key characteristics is a flexible architecture, capable of responding to changing requests for information, and of supporting agile development processes to create new applications quickly. Failing this makes BI not able to keep up with business and will be seen as more of a burden rather than a benefit. It is also critical to have a unified architecture that defines a common set of semantics and rules for terms and metrics shared across the organisation. This cohesive architecture depends on the business. For some cases, it might involve a consolidated set of information contained in a single multi-layered repository, comprising a staging area, a data warehouse area, and multiple logical data marts – representing Inmon's approach. For other organisations, it can be a distributed architecture logically unified like Kimball approach (multiple, physically distinct data marts linked by conformed dimensions). There are cases that a federated approach is the best architecture, representing federated query tools that integrate different data marts on the fly using a global, virtualized semantic model.

Regarding the higher education sector, typical institutions encompass a lot of subsystems that are crucial for its internal processes and operations – student registration systems, payroll systems, accounting systems, and human resources systems, among others. All these systems are connected to several underlying databases that are employed for daily transactions and processes. In order to respond effectively to data analysis, forecasting, prediction and decision-making, it is necessary to transform the existing operational databases into an information database or data warehouse. According to Bassil (2012), there are four required steps in order to create an effective data warehouse for universities: (1) Capture and extract, (2) Scrub and data cleansing, (3) Transform, and (4) Load and index.

At the first step, data is extracted from source data systems and stored temporarily in a buffer area. Then, at the second step, it is pre-processed where it is included cleansing, scrubbing,

reconciling and fixing data entry errors. At the end, data is transformed into a normalized standard – step three. Once cleaned, the transformed data is loaded and indexed in the data warehouse, representing the fourth step. Figures 25 to 27 represent these steps integrated in the data warehouse architecture, under the perspective of different authors.

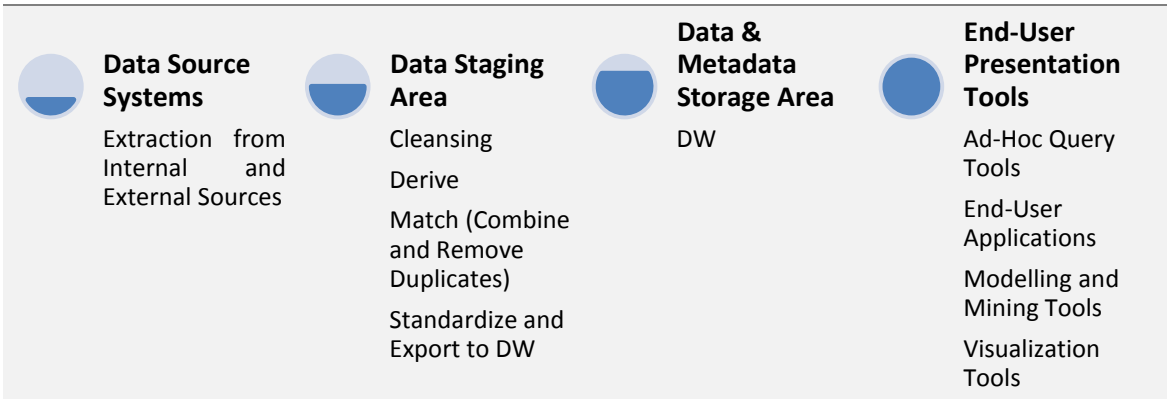

Figure 25 - Architecture for University Data Warehouse (adapted from Bassil, 2012)

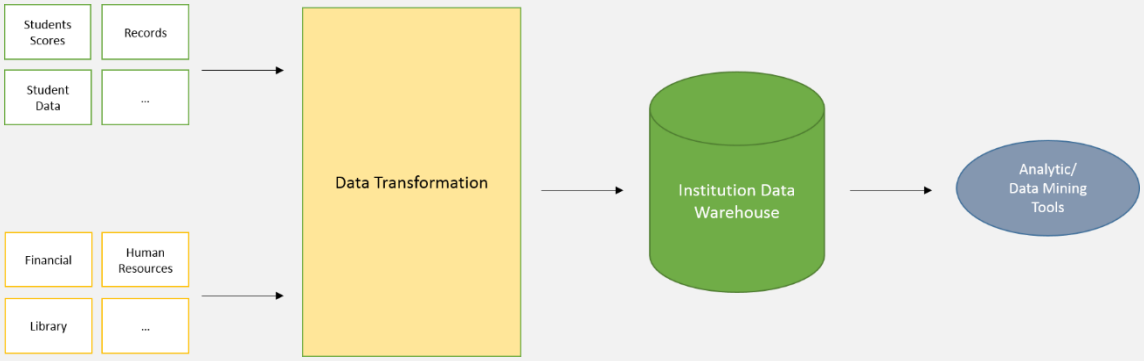

Figure 26 - Adapted from Recommended High-Level Architecture for BI Strategy in Higher Education (adapted from IBM, 2007)

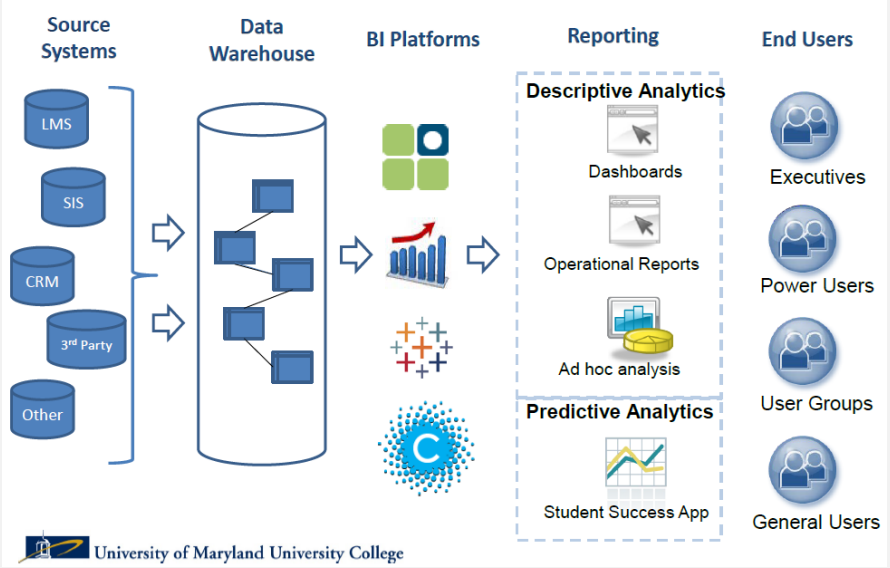

Figure 27 - University of Maryland BI Architecture (Catalano, 2014)

Figure 25 and Figure 26 have four stages representing the same components. Data sources systems encompass data capture and extraction, representing all data collected from the internal and external sources used in the university. In the Data Staging area (also known as data transformation), there is all cleansed and normalized data, prepared to be loaded to the data warehouse. The data storage area (or the DW area) is where data is loaded into the data warehouse. It is important to refer that Kimball's approach is considered to be one of the primary options for HEIs, where data is stored in a logically centralized environment (IBM, 2007). The end-user presentation tools are also highlighted, which denote how users visualize the results from queries made to the data warehouse, and how they explore it. They can also be called as analytic tools. There might be a fifth section, regarding the integration with other systems, where BI applications can influence other data, including financial and demanding planning. The reason why this section was not considered is that it can be seen as a future step, not necessarily important to the beginning of the DW creation. Proving this architecture proposal can be applied to higher education, there is the success case of University of Maryland (see Figure 27). This university created its institution data warehouse as a centrally hosted data repository that contains all university data (Catalano, 2014). Although the ETL phase is not represented, it is possible to understand that those processes happen between Source Systems area and Data Warehouse. The set of data marts create the data warehouse, which are then explored by BI applications (also known as platforms).

The answer to what is the best data warehouse architecture is not simple and plain, because "each real-world implementation is different" (Adamson, 2010). Yet, after analysing the three architecture proposals and considering the higher education examples from IBM and University of Maryland, the kit proposal advocates for the Kimball's approach to begin the BI journey. This approach takes less time to develop a data warehouse, when comparing to Inmon. The subject areas work as data marts inside the DW, and end-users can access the information directly, which is the best way to demonstrate quicker the real BI value.

3.4 Development

BI/DW Development is about how effective the approach, made by the team, to the project management and the solution development is (TDWI, 2012).

It is important to clarify that this concept is different from architecture. BI/DW Development is about the chosen methodology that identifies the activities that must be performed and in which order. A BI/DW architecture identifies component parts, their characteristics, and the relationships among the parts. These two concepts are intimately related and it is the reason why it creates confusion (Ariyachandra and Watson, 2006).

There are several project managers that make the wrong assumption that a BI project is like any other software development initiative, and the traditional steps are also applied: assemble a team of developers, collect specific project requirements from business users, build a DW or data mart for specific projects/departments, buy a reporting or multidimensional tool and create

reports, train the users on the new capability, disassemble the team after the conclusion of the project and repeat this whole process when a next BI project is requested. However, this traditional approach might generate a few problems, due to its (1) lack of business involvement, (2) lack of audit controls, (3) lack of program mentality, (4) lack of a technological roadmap, and (5) lack of data quality processes. Without an involvement of the actual end-users, they will not contribute to its requirements, nor believe in the success of the initiative. If there is not a guarantee that information represents the same data from the original sources, BI applications will not be used. It is also necessary to establish the idea that starting a BI initiative is creating a new environment, and not only a project; it is a process that must be continued, and the organizations' mentality must set to this idea. Without a technological roadmap, it will not be possible to keep improving the overall BI strategy, and the same happens with data quality processes: without metrics to measure quality, business will not be able to trust in BI results. It is plain to see that the traditional approach promotes inconsistency in data, lack of data reuse and sharing, and other negative characteristics that BI tries to eliminate from organizations (Imhoff, 2005).

Regarding TDWI maturity model, the BI/DW development should identify a working methodology with defined standards and prioritization. Other two important characteristics about BI/DW development according to TDWI are the number of BI applications developed concurrently and the development time of a new subject area.

Kimball, the author of the Data Warehouse Bus Architecture previously analysed, conceived a methodology regarding BI projects: the Kimball Lifecycle – also referred as the Business Dimensional Lifecycle approach (see Figure 28). The main characteristic of this approach is to "iteratively develop the BI/DW environment in manageable *lifecycle* increments, rather than attempting a galactic Big Bang approach" (Kimball et al., 2008). Figure 28 illustrates the overall roadmap representing the sequence of high level task required for successful BI projects.

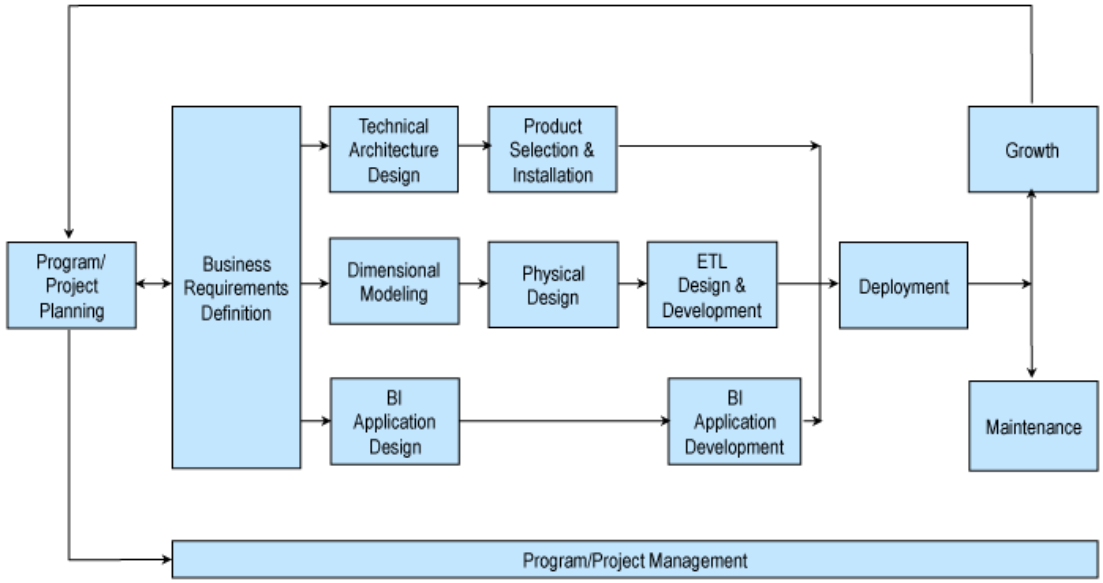

Figure 28 - The Kimball Lifecycle (Kimball et al., 2008)

This methodology believes in business acceptance of the BI deliverables to support decision-making. As displayed in Figure 28, the first step – at the left side – is about the Program/Project Planning, closely related to the Program/Project Management box at the bottom. Program/Project Planning focuses on getting the program/project started and emphasizes scope definition, program/project goals and staffing. Throughout the lifecycle, there are ongoing management tasks to track activities.

Business Requirements Definition is the following activity, in order to understand what business users want to do in the future.

Technology track is important to enable the integration of existing technologies, data stores and associated metadata. This track starts with Technical Architecture Design and is followed by Product Selection and Installation that satisfy the architectural needs.

After it, it is necessary to consider data track. This activity begins with Dimensional Modelling, in order to address business requirements. Then, the dimensional model is converted into a Physical Design where performance tuning strategies are considered. ETL Design and Development is the following step.

While technology and data is being worked on, other project members concentrate on identifying and creating BI applications: reports, parameterized queries, dashboards, scorecards, analytic models, among others – BI Application Design and BI Application Development.

Deployment, Maintenance and Growth encompass technology, data and applications. The deployed iteration goes into a maintenance phase, while growth is addressed by the arrow back to project planning for the next BI/DW project.

Several authors say that an agile approach is another way to develop BI projects. The principles, the practices and the philosophy of Agile Modeling can be applied to this kind of

projects. According to Hughes and Powell (2010), "Agile data warehousing uses Scrum as an alternative to waterfall project planning, providing a streamlined framework for building DW and BI applications that regularly delivers modules faster with one fourth the developer hours, cuts project costs in half, and drives project defect rates toward zero".

The agile approach has several enthusiasts and Ralph Hughes is one of them. According to this author, requirements – or the understanding people have of them – change throughout the lifecycle of the BI/DW project for several reasons. In order to develop a solution which meets the needs of business users and all stakeholders, it is necessary to take an iterative and incremental approach to the development. The agile methodology has the capability to answer to this need. Figure 29 presents some best practices regarding this methodology according to Hughes (2008).

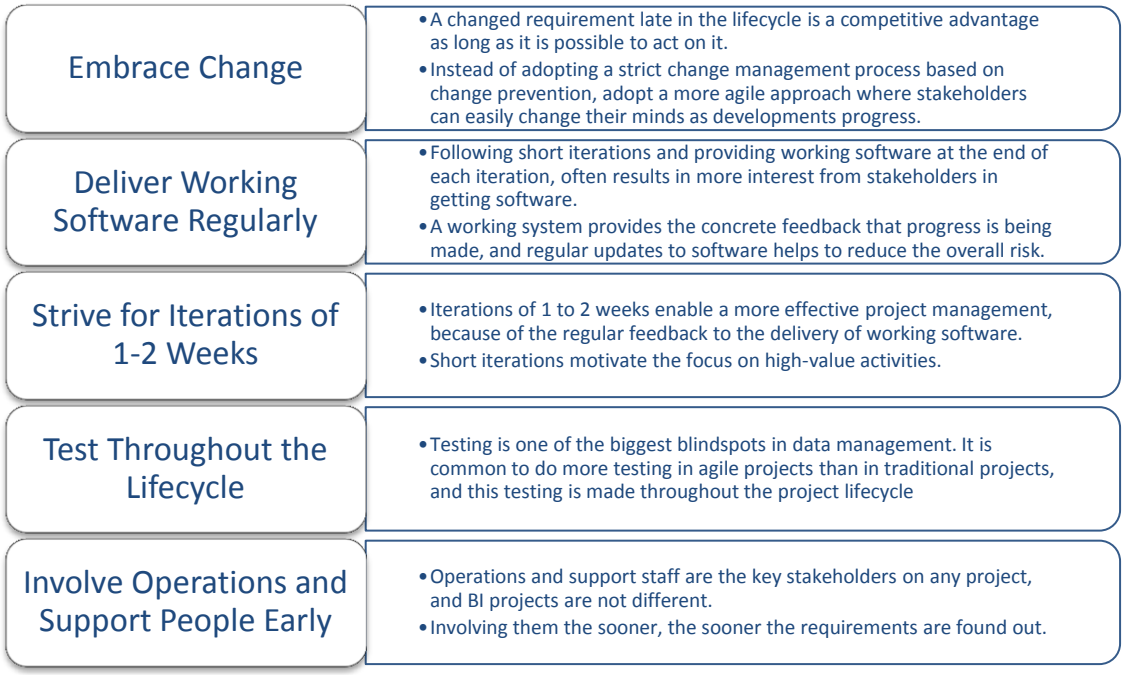

Figure 29 - BI Agile Methodology Best Practices (adapted from Hughes, 2008)

Sandler (2010) also defends that a BI/DW initiative should use an agile methodology in its development process, rather than a waterfall approach. An agile methodology improves quality, reduces risks and, compared to the waterfall approaches, the delivery timeframe is similar. Figure 30 shows the success keys to the agile approach to BI according to Sandler (2010).

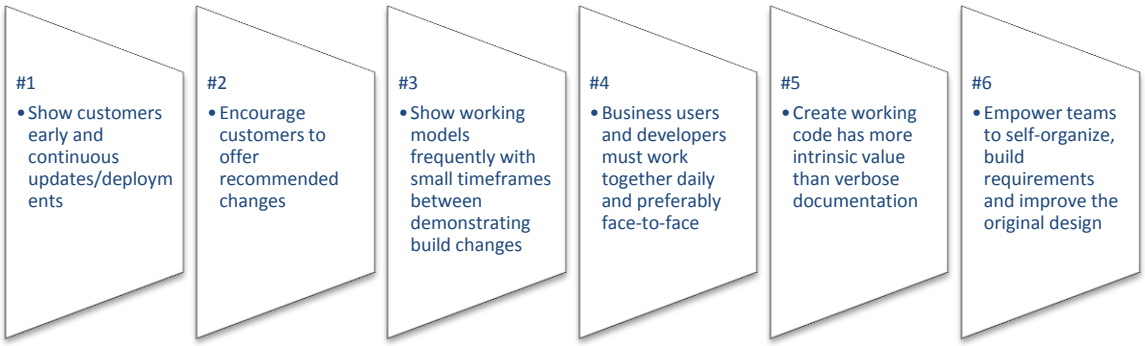

Figure 30 - Success Keys to Agile BI Approach (adapted from Sandler, 2010)

Considering Kimball and agile methodologies, it is possible to see a relationship between the two approaches: the principle of iterative developments defended by Kimball is at the base of agile methodologies.

One of the known success cases regarding the Higher Education sector is the George Washington University, in Washington DC, USA (n.d.). In order to speed up delivery of BI capabilities to the university stakeholders, this institution used an agile development methodology. This approach was iterative and incremental, based on Scrum Methodology. Its strategy included (The George Washington University, n.d.):

- Iterative, incremental and evolutionary approach;
- Emphasis on value-driven development;
- Delivery production-quality applications;
- Collaboration with end-users;
- Encourage of self-organizing and self-managing teams.

Figure 31 represents this BI agile methodology used on the George Washington University:

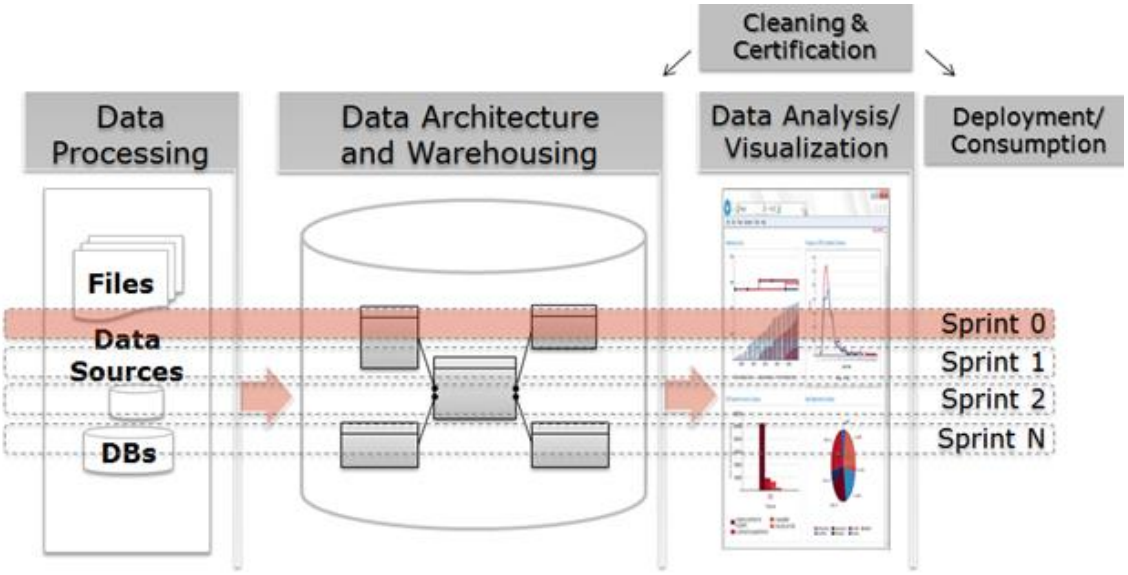

Figure 31 - BI Agile Methodology used on the George Washington University (The George Washington University, n.d.)

This university develops a new subject area in twelve weeks, according to their official site, and it has a special committee that prioritizes BI needs – the Business Intelligence Advisory Committee.

The George Washington University adopted an agile methodology due to its ability to deliver faster deliverables, to have the process more transparent, and to respond to changing priorities (Roljevic and Roldan, 2014). Figure 32 represents the Scrum cycle that characterizes its development sprints.

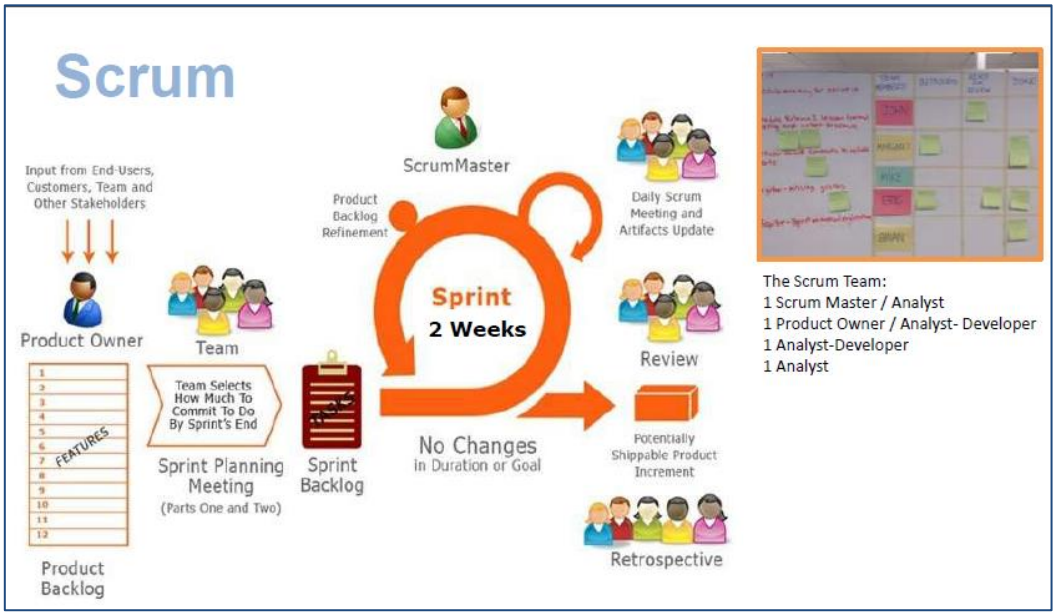

Figure 32 - Agile Methodology in The George Washington University (Roljevic and Roldan, 2014)

The product backlog, which is the document where is defined all needed features, is the base for the planning meetings. Then, BI team develops one feature every two weeks, with daily update meetings and reviews, until the deliverable is ready.

University of Toronto also uses an agile methodology for BI developments (Beckermann and Agostino, 2014). With its experience, it was created a list of pros and cons about this approach – Table 10.

Table 10. Agile Methodology - Pros & Cons (adapted from Beckermann and Agostino, 2014)

Agile Methodology – Pros & Cons	
Pros	Faster time to deliverables and better feedback loop.
	Team discussions and decision-making result in better and faster solutions.
	Deeper understanding of what is involved in the work of each other and how data is used.
	Closer connection to the end product.
	Methodology that reflects change.
	Team members feel ownership of their tasks and accountable to deliver as estimated and production ready.
Cons	Challenging environment, because things are constantly evolving.
	Because of time boxing, it can lead to shortcuts in architecture that may be paid for later.
	Individual skill enhancement is a challenge.

Adopting an agile methodology means being able to work in a challenging environment, because changing requirements is a strong reality. Related to it, it is also the need to have a team that is constantly learning and improving its skills. Other con is related to the architecture shortcuts that sometimes are made to deliver components in time. Still, fast iterations to deliver components, daily meetings, frequent and detailed testing, good communication between all members are important aspects of this approach and contribute to a successful development. An agile methodology reduces the needed time to deliver value from BI projects, and engages sooner and better with users, allowing them to explore data more rapidly (Westlake et al., n.d.). In HEIs, this approach can create an effective working environment.

3.5 Funding

This dimension represents the funding gathered to meet the requirements from both BI project and business (TDWI, 2012).

The cost of a BI project is a strong limitation to its implementation. BI applications not only require investments in infrastructure, technology and human resources, but also in maintenance and operational costs, particularly if an organization seeks to fully exploit BI capabilities.

The TDWI Maturity Model highlights that funding problems might appear in the beginning of BI projects. A significant part of these projects are funded by a department head and are susceptible to the budget axe, especially if the sponsor changes jobs or roles. Often there is not

enough time to demonstrate the real value of the BI initiative before the organization needs to prioritize its funding, and BI gets eliminated most of the times. That is why it is important to show quick gains to create funding pressure.

This maturity model make organizations reflect about how easy it is to get funding, and compare themselves to similar companies in their country and evaluate their level of investment.

Considering the higher education sector, where public institutions are dependent from public administration of their country, having budget for BI initiatives can be very hard to obtain. Therefore, the BI initiative can be at risk without funding.

Considering the previous sections, Kimball approach might be a good solution for higher education institutions, because it is not necessary a very high budget to start the initiative, due to the nature of the methodology. Not building an EDW in the first phase of the initiative and developing data marts iteratively is a less expensive approach.

Even if reduced, BI budget must be a concern for HEIs. The White Book Maturity Model stresses that any institutional intelligence initiative involves numerous high impact decisions and funding is one of them. Thus, it is important to have a specified and permanent budget with ownership delegated to a member – or more than one – of the senior management of the institution.

Regarding success cases, the Berkeley Campus of the University of California (2006) defends that the successful management of this crucial factor involves the creation of a Steering Committee. This committee created for this campus had the aim to provide funding and overall objectives for the DW Competency Center, a virtual organization consisting of both business and IT resources that are responsible for defining, building and maintaining a centralized DW environment. Figure 33 presents the structure of the DW Competency Center of the Berkeley Campus.

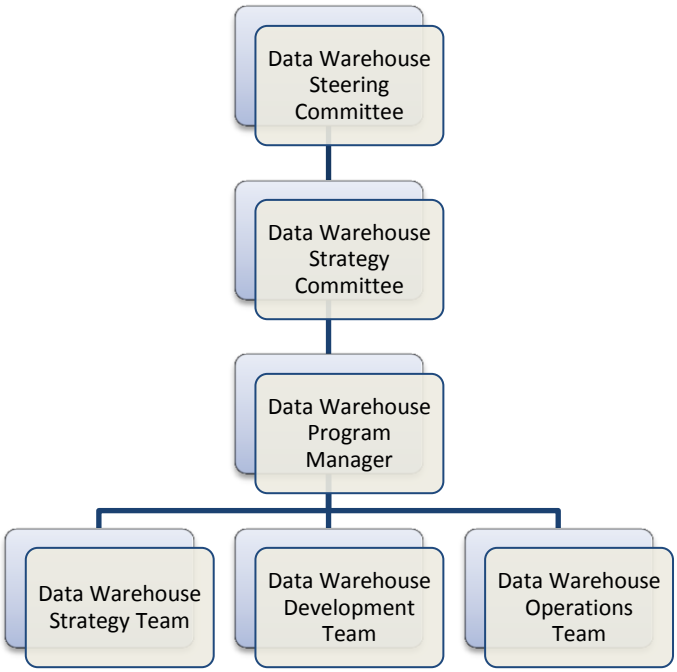

Figure 33 - The DW Competency Center of UC-Berkeley (adapted from UC-Berkeley, 2006)

The DW Steering Committee is comprised of Cabinet level officers representing all divisions of the UC-Berkeley organization. The responsibilities of this committee are:

- Provide the overall objectives for the DW based on campus strategic goals;
- Provide funding for DW initiatives;
- Review periodically the performance of DW activities;
- Provide guidance on regulatory requirements that impact the DW.

Another success case of a similar structure is the Penn State University (2010), which created the Data Access Subcomittee to help improve community access and usage of institutional data. One of its responsibilities is funding the improvement of its BI functionality regarding software purchase.

In conclusion, funding is a very sensitive issue to all organizations, especially HEIs that daily struggle to get budget for improving their IT systems. Having a dedicated structure to manage the financial issue might be essential to keep the initiative focused on the stakeholders' expectations. Besides, it will keep BI team working without worrying about this issue. In the beginning of the BI journey, the structure might have only one individual.

3.6 Scope

BI scope is considered to be the first step to the initiative success, along with the establishment of a clear understanding of how business performance can be improved with BI (Williams and Williams, 2007). Scope can be defined as:

- Enterprise-wide
- Limited to a Single Line of Business

- Limited to a Single Function
- Limited to a Group of Users

Any way is correct – the important thing is to define it. Williams and Williams (2007) say that "until you know what you're *not* going to do, it's very hard to speak with confidence about what you *are* going to do". That is why the scope of a BI initiative is a prerequisite for defining the value proposition.

Moss and Atre (2003) also emphasize the need of the BI scope to create estimations for the project. Traditionally, scope has been measured by the number of functions that a system will perform. However, in BI projects the reality is different – "scope must be measured by the number of data elements that have to be extracted from the source systems, transformed and cleansed, and loaded into the BI target databases".

The scope of a BI strategy must include making the best use of information for strategic, tactical and operational requirements, because the initiative is all about helping business with long-term planning, helping middle management with tactical reporting, and helping operations with daily decision making, in order to run it efficiently. Defining the BI scope should be made by the business drivers and goals, and it should always account for changing business requirements to keep the BI strategy aligned.

In order to correctly scope the BI initiative, Kimball et al. (2008) advise organizations to focus on a single business process, because it ensures a more manageably sized design and development iteration. Other guidelines for defining BI/DW scope are in Figure 34.

Figure 34 - Guidelines for BI/DW Project Scope (adapted from Kimball et al., 2008)

Whatever level of scope is being worked on, it is crucial to document it. Writing it down is part of setting expectations. All the organization knows at what point the initiative is, because everyone can read by themselves. Including what is not in scope is part of the best scope documents (Deloitte, 2009). The project scope statement must be regularly reviewed, revised whenever needed and republished.

University of Utah (n.d) developed a BI initiative with the main purpose of delivering high-quality, meaningful data and analytics to the university community. Figure 35 presents its scope definition, as a title of example.

Justification	Enable fact-based decision-making by providing campus-wide access to a concise, trusted repository of institutional information
	Provide access to easy-to-use reporting and analysis tools that can help users gain better insights, discover issues, and spot trends quickly
Deliverables	High level enterprise data warehouse bus matrix
	Business-process oriented dimensional data models
	Detailed dimension and fact table design
	ETL of source system data into dimensional enterprise data warehouse/data marts
	Web-based reporting tools to develop reports, dashboards, and scorecards.
Milestones	Conduct interviews and gather project requirements
	Create enterprise data warehouse bus matrix
	Design dimensional models for key high-priority business processes
	Populate data warehouse dimension and fact tables
	Create business representation of DW to facilitate user interaction with institutional data
	Create web-based reports, dashboards, and scorecards

Figure 35 - Scope Definition of University of Utah BI Project (University of Utah, n.d.)

University of Arizona (2009) also wanted to provide a new approach to data management, presentation and analytics, in order to enable access and retrieval of financial, student, research and personnel data from one single source, spending minimal time on this retrieval and making reports, analysis and models available to a broad user base. This implementation was divided three phases and each of them had its own scope definition – see Figure 36.

Data Conversion and Data Quality	Data Warehouse	Data Consumption
• Objective: Migrate high value information from legacy systems into proper transaction systems. • Scope: All valid operational data collected in legacy systems. • Out of Scope: Conversion of departmental databases; Development of intricate querying methods to legacy systems data.	• Objective: Create a BI environment and data models that provide the ability to access information in different ways without errors. • Scope: Creation of a DW environment. • Out of Scope: Departmental and low use databases will not be included in the new DW; No integration to external databases.	• Objective: Provide easy and fast access to data, through dashboards and reports, as well as by training users to create their own queries and reports. • Scope: Data access through reporting tool. If necessary - but discouraged, download of data into excel spreadsheets. • Out of Scope: Creation of non-critical BI queries/dashboards; Querying unstructured data; Accommodation for interfaces to applications that use the new DW.

Figure 36 - Scope Definition of University of Arizona BI Project (adapted from University of Arizona, 2009)

Both examples present two universities that documented their scopes, enabling other individuals to understand what is going to be done, including the readers of this dissertation.

3.7 Sponsorship

BI Sponsorship is about the engagement and commitment by sponsors to the BI program (TDWI, 2012). According to IBM (2007), maintaining a clear and focused business sponsorship is one of the critical success factors of the BI solution.

The business sponsor guarantees that the appropriate objectives for the BI applications are established and that those objectives support the strategic business goals of the organization. This sponsor also helps set and negotiate the BI project scope to meet the specified BI application purposes. Losing BI sponsorship is considered to be a project risk (Moss and Atre, 2003).

Kimball et al. (2008) also have a word about the BI sponsorship. Intimately related to BI scope and BI funding, the authors advise that "before beginning a data warehouse or data mart project, make sure you understand whether there is demand and where that demand is coming from. If you have no strong business sponsor and no eager users, postpone the project". A strong sponsor has several crucial characteristics: (1) be an influential leader, (2) be realistic, and (3) be personally convicted. A good BI sponsor must be an influential leader throughout the organization. This person must be politically wise and well-connected, and before being chosen for this task, there must have been strong records of success.

Being realistic is also very important, because it is crucial to be able to avoid unrealistic expectations regarding the data warehousing concepts and BI development. A realistic sponsor accepts short-term problems and delays because the focus is on the long-term success of the project.

A strong sponsor has a firm personal conviction, especially regarding his/her vision, which is generally demonstrated by their willingness to be accountable for it – see Figure 37.

Why strong BI Sponsors are critically important?	They are able to formulate and articulate the needed vision for data warehousing and its impact on the organization.
	They play an important role regarding BI funding, because data warehouses can be expensive, and strong sponsorship coupled with a solid financial return is crucial to sustain the project.
	They are able to manage resources even when competing with other mission-critical projects.
	They embrace and facilitate cultural changes on organizations, due to data warehousing.

Figure 37 - Why strong BI Sponsors are critically important? (adapted from Kimball et al., 2008)

The role of project owner is critical for these kind of projects. However, BI sponsors have also another responsibility: “cheerleading”, like Kimball et al. define (2008). Their enthusiasm must encourage others to share the vision for the impact of improved access to information.

Given the multi-organizational nature of the HE sector, it is mostly important to have a clear vision of the desired results, pro-active participation of senior management and other key stakeholders, and a complete definition of overall governance and sponsorship. In order to achieve this level of engagement and sponsorship, the IBM roadmap recommends a strong program management function. “One of the roles of this function will be to manage coordination with senior management (…) and to promote and monitor engagement of all stakeholders” (2007). Other responsibilities include taking major decisions as required throughout the program and acting as the arbiter of any conflicting issues, acting as an overall design authority and defining project charters.

In the beginning of the BI initiative development, which can encompass highly complex actions, IBM recommends the creation of a detailed mobilization phase, in order to include the key activities described in Figure 38.

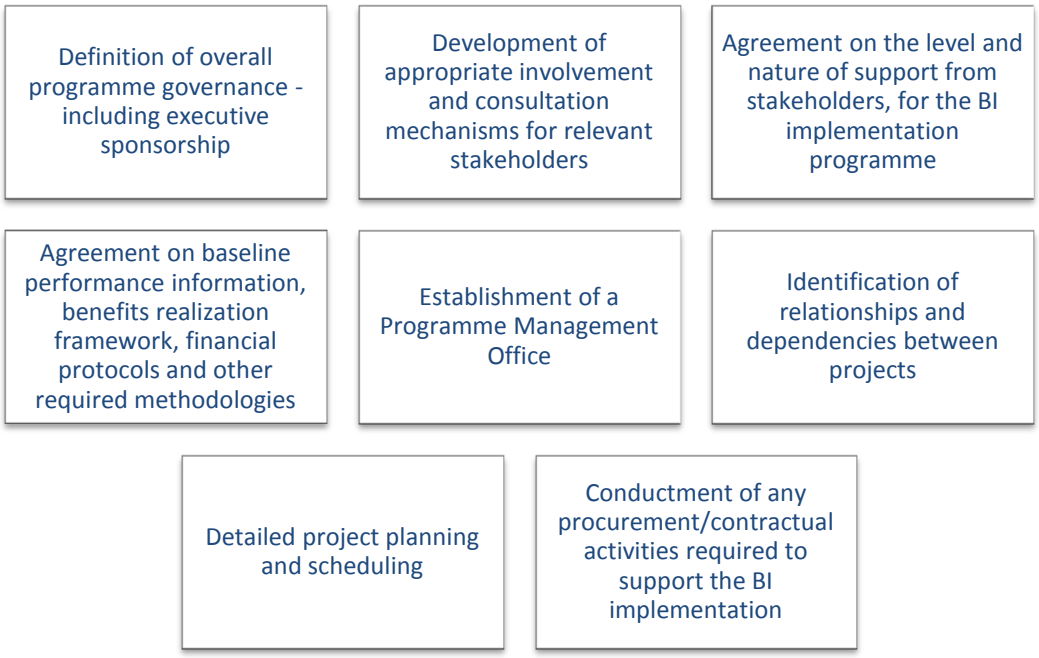

Figure 38 - Key Activities in the Mobilisation Phase (adapted from IBM, 2007)

Regarding success cases, Berkeley Campus of the University of Carolina created a Strategy Committee to handle the sponsorship question (2006). This committee is responsible for approving the DW roadmap, prioritizing activities, managing the DW program and the sponsorship of DW projects. It is formed by senior-officers one level below the Rector and by the DW program manager. Those members represent all divisions of the UC-Berkeley organization with an interest and need for BI.

University of Texas at Austin also implemented a BI governance structure with three levels, based on a typical governance model as we can see in Figure 39.

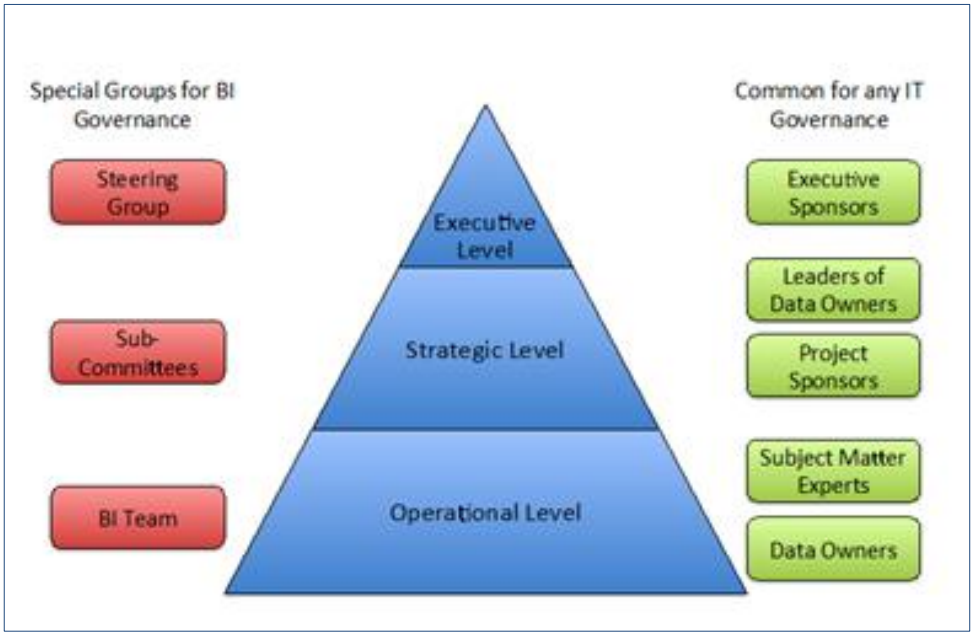

Figure 39 - BI Governance Structure in University of Texas at Austin (Friedrich, 2013)

At the Executive Level, the university had two governance groups: the executive sponsors and the steering committee. Executive sponsors were focused on resolving strategic budget and resource issues, while the steering committee focused on data quality and user requirements. As a practical example of the need of the executive sponsors group, in 2004 the University of Texas was experiencing growing demands in BI beyond the capability of its team, at the same time that the institution was facing serious financial challenges. The executive sponsors advocated BI to the University Budget Council and gained priority to their issues, resulting in an increase in ongoing budgeted funds for BI.

Having a strong sponsorship, someone who believes that BI can make a positive impact in the institution, motivates others, and overcomes political and other obstacles is a critical success factor.

3.8 Value

TDWI (2012) states that BI value is about how effectively a BI solution meets business needs and expectations. It can be understood through the final product of a BI initiative and how it helps organizations to improve their products/services.

According to IBM (2007), simply having BI does not lead to business value. Organizations need to implement solutions and integrate them within business processes so that they can be acted upon. From the users perspective, this means meeting end user expectations and delivering solutions that are easy to access, easy to interact with, and reliable.

Rita Sallam, a Gartner analyst, said that “these systems cost a company millions, yet sometimes they provide little or no value because there is a mismatch between what is purchased and the needs of the users” (Gartner, 2014). Failing to align the product with end users capabilities can be tremendously unfavourable to the value of a BI tool. If users lack the needed skills to work with the software then it is likely to be serious problems.

According to Williams and Williams (2003), BI projects should be subjected to a rigorous assessment of how the investment will result in increased revenues, reduced costs or both. With BI usage, it is common to highlight business benefits such as agility, awareness, closer customer relationship, and information sharing. However, achieving these characteristics might destroy business value unless those attributes can be defined in operational terms and recognized by business processes that affect revenues or costs. BI value lies in its use within administration processes that influence operational processes that drive revenue or reduce costs, and/or in its use within those operational processes themselves.

TDWI and its maturity model defend that an organization must have a BI initiative that becomes a “mission-critical resource to support operational processing”. Besides, the BI environment should play a protuberant role in providing value-added commercial services that generate revenue and provide a competitive advantage – BI becomes a significant revenue generator. Business and IT work harmoniously to gain new customers and increase sales (TDWI, 2012).

On the other hand, OCU (2013) states that in order to capture the real BI value, the output of data products should be used in decision-making, planning and management processes in such a way that they must be considered crucial to complete them. In an ideal scenario, the delivered data products should be successfully embedded in critical processes for the right functioning of the institution, either due to its weighty impact on core decisions or administrative activities, or because analytic culture is so established and institutionalized that information drives the activities at all levels.

Specifically in the higher education section, according to White Book Maturity Model (OCU 2013), this dimension assesses the business impact of the delivered data products as perceived by its users. They might reduce costs and/or improve the institutions’ services. This business impact depends on the quality and relevance of the delivered data products, and on the “analytic culture” of the user base.

Considering the success case of University of Manchester (JISC, 2012), there were important outcomes with the implementation of IN-GRiD project, a project which was developed to support decision-making activities of senior management of the university in the area of sustainability. This BI system was thought to allow senior managers and decision makers to have access to updated information about performance and progress of the institution. Table 11 shows the obtained results.

Table 11. Obtained Outcomes from BI in University of Manchester (adapted from JISC, 2012)

Outcome	Description
Maturity	Before starting the initiative, the institution was at a very initial phase. During the project and through the implementation of the solution, the maturity of this BI project moved to early stages of level 4, in a scale from 1 to 4 levels.
Process Redesign and Improvement	Before the initiative, data collection process was mainly manually driven, and used to take around five persons per month to do it, twelve data owners from different business units, five different IT systems and data integration made in silos. Besides, there was no documentation about these procedures. With the implementation of the BI system, it is only needed one person to complete the task.
Data Management	Data from three different systems started being integrated in a comprehensive data warehouse, with established procedures for data validation.

In conclusion, the value that comes with BI does not only mean cost reduction. In HEIs, this value can be translated into more informed decision-making, improved programmes, and better classroom management, among others. If the initiative can answer to the defined goals, it is expected to generate value to the institution.

3.9 Delivery

BI Delivery covers the reporting and analytics capabilities, and their usage inside the organization (TDWI, 2012). Depending on the functionality, there are several types of data products aimed to different types of business users (OCU, 2013). For this kit proposal, this dimension identifies business users and their data products: who uses BI, how they use it, and are they using BI with the right understanding of it.

In higher education institutions, major stakeholders are (Sujitparapitaya et al., 2012):

- Students;
- Departmental, College and University level administrative units;
- Accreditation agencies;
- State and Federal Governments, and Oversight agencies.

Considering an example regarding HEI stakeholders, University of Maryland (Catalano 2014) serves its end-users by constituency: (1) Academic Affairs, (2) Strategic Enrollment Management, (3) Finance and Operations, and (4) Executive Committee.

Table 12. Categorization of Data Products (adapted from OCU, 2013)

Categorization	Definition	Properties	Main Usage
Parameterized Reports	Online reports offering limited, fixed options to personalize its data output.	- User visualizes one report at a time; - Created for specific domains where there is a recurrent, well known data need.	- Operational Support; - Recurrent Data Distribution.
Ad Hoc Data Navigation	Data exploration without	This navigation offer a	- Analysis;

Categorization	Definition	Properties	Main Usage
	a preconceived notion of the resulting output.	catalog of all available data elements, and give users the functionality to interactively build data outputs.	- Discovery.
Dashboards/Scorecards	Access to a combination of complementary, simultaneous data outputs that conform a rich, cross functional, integrated data output.	- Highly aggregated data, displayed in a compact interface, graphical views; - KPIs with color-coded representations of their values.	- Monitoring
Advanced Analytics	Wide range of applications of Data Mining, Machine Learning and advanced statistical techniques.	Predictive models provided, as well as what-if analysis, and automatic knowledge discovery systems	- Operational Support; - Analysis.

To OCU (2013), the classification of data products is represented in Table 12.

The Berkeley Campus of University of California (UC-Berkeley 2006) believes that "for the information in the data warehouse to be valuable, it needs to be delivered in a way that makes it useful to campus personnel in doing their jobs. This is the job of BI applications". Because users have different needs and skills, and because all campus personnel use information to work, BI applications must be appropriate to all kinds of constituencies. Figure 40 represents the three kinds of applications used in Berkeley.

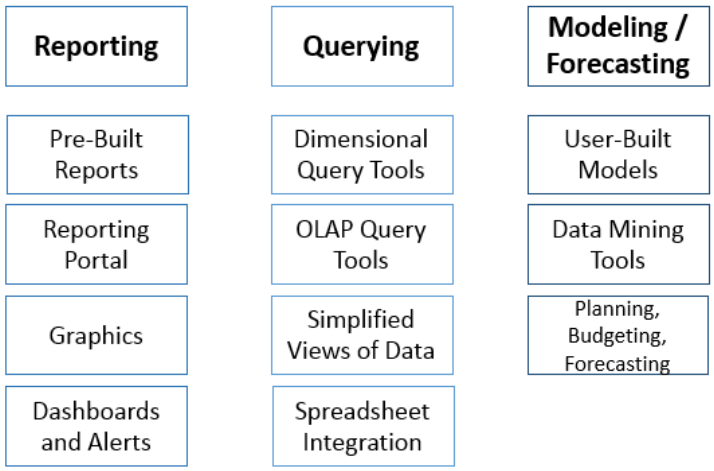

Figure 40 - UC Berkeley BI Applications (adapted from UC-Berkeley, 2006)

Reporting applications deliver information in a form. It implies a partnership between users who need information and specialists who design reports, displays and graphics. In the case of this university, there will be designed reports and they will be available in a secure portal, where it

will be also possible to schedule routine reports, print them and share as electronic documents in formats like PDF.

Querying applications include explorer query tools (for selecting data, drilling down or summarizing it, and combining across subject areas), and special-purpose information views (for organizing information into simpler structures, easily understood and enabled to particular kinds of users).

Modeling and Forecasting applications enable users to use historical data to build models of alternative scenarios.

Figure 41 - Example of BI Delivery in University of Maryland (Catalano 2014)

Figure 41 shows a few examples of how BI is delivered in University of Maryland. Using the categories of UC-Berkeley (2006), metrics dashboards, operational reporting, variance analysis and *ad hoc* reporting are reporting applications. Predictive applications and forecast modeling represent modeling/forecasting tools.

Usually, modeling and forecasting applications are seen as complex BI products that are delivered in a more advanced maturity level of the initiative.

3.10 Data

According to TDWI (2012), data provided by the BI environment must meet business requirements. In order to accomplish it, it is important to have a part in the BI strategy that ensures data is universally visible throughout the organization, and that users can trust in data accuracy – to this part of the BI strategy we can also call BI Governance. Data Governance provides policies, sets of processes, standards, controls, and an execution plan for managing data (Deloitte, 2009). “It promotes data quality, data integrity, data consistency, data timeliness,

data security, information privacy, and thus increases the information usability and reliability", according to the same previous source.

OCU (2013) alerts for a set of important aspects regarding data governance and they described in the Table 13.

Table 13. Important Data Management Aspects (adapted from OCU, 2013)

Data Aspect	Important Notions
Data Quality	Data must be fit for analysis, and the reality encoded in the source systems must be represented through all data products. It is crucial to have a responsible to report to, for data deficiencies.
Data Access	Data must have an owner. The access to data must be controlled – it must be someone responsible for data access requests.
Metadata	Origin, meaning, business rules, and calculation criteria must be documented and maintained updated, as well as how each type of metadata should effectively reach the intended users.
Data Integration	Data from different source systems must be combined to create new facts. Having duplicated entities in different systems might have impact in the institutional intelligence platform; thus, it is important to have mechanisms to detect and normalize it.
Data Retention and Archival	It is important to preserve history in the DW and define for how long the historic data is kept.

University of Notre Dame (Freda 2014) is a success case regarding data governance. Their governance model delivers a common language, consistency, basis to assess quality and integrity of information, and foundation for analytics and reporting. Figure 42 shows the structure of the governance model implemented in the university.

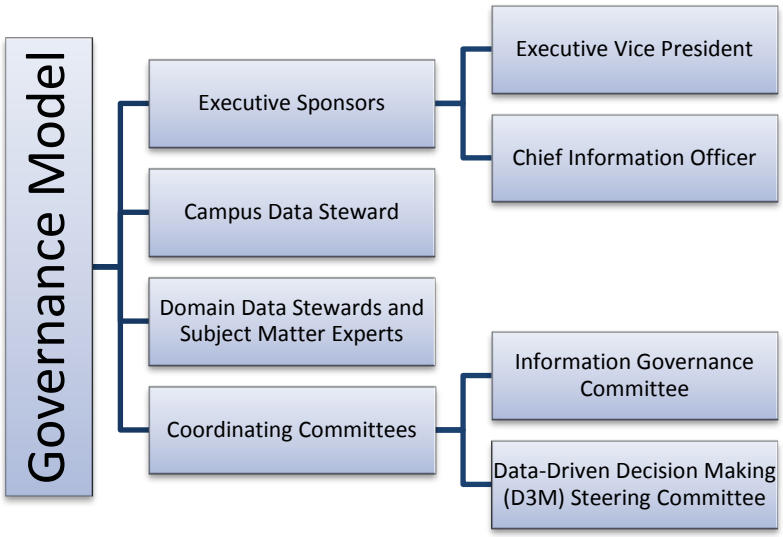

Figure 42 - University of Notre Dame Governance Model (adapted from Freda 2014)

This university adopted a dedicated data governance framework. There were five supporting columns, each one representing a subject that allows users to control technology tools and increase access to business information - .

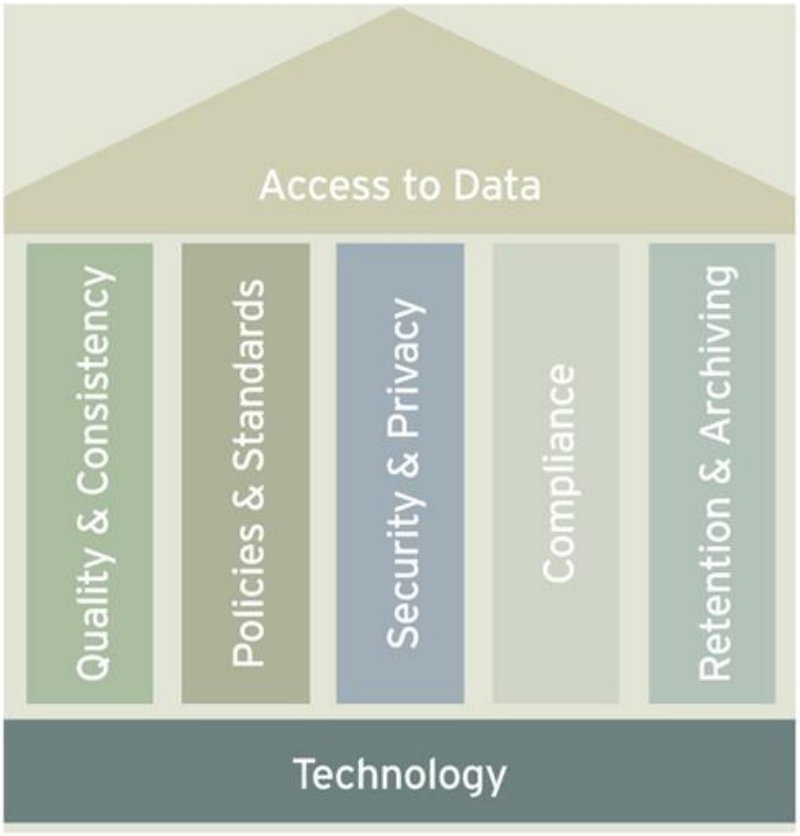

Figure 43 - University of Notre Dame's Data Governance Framework (Chapple, 2013)

According to Chapple (2013), Quality and Consistency guarantees that the used data comes from a reliable source and that all offices and departments interpret it in the same way. Policies and Standards is about providing documentation about the data governance policy and the supporting standards that describe the practices used to successfully implement the all framework. Security and Privacy represents institutional data protection. Compliance is about assuring that everyone adheres to the laws and regulations that govern the storing, processing, and transmitting information. Retention and Archiving guarantees the establishment of practices related to effective and efficient data preservation, to be used in the future.

It is clear that data must have someone responsible. In this example, the university emphasizes the stewards to campus data and domain data. According to Hansen and Merth (2014), “data stewards maintain the quality and integrity of data but encourage its use by anyone in the campus community who needs this information for their work”.

With the governance model, University of Notre Dame created a new institutional language, where the terms from the several data sources were turned into one with a universal meaning.

Table 14. University of Notre Dame Institutional Language

Terms in Data Source	With New Institutional Language
Course Course Section	Class
Course Section Instructor Responsibility Course Section Primary Instructor	Course Section Affiliate
Active Student Enrolled Student	Externally Reportable Enrolled Student

Table 14 represents an example of the institutional language. University of Notre Dame states that “Governance is as much about how you use terms as it is about the terms themselves!”. It is crucial to have in consideration the context, the clarity and the question (Freda 2014).

As a conclusion, considering the HE sector, a BI initiative must fulfill the requirements of the end-users (i.e., the business requirements). Consequently, it is important to establish a BI strategy for data management, ensuring that data is conformed (using the Kimball’s terminology). This encompasses data quality, data access, calculation criteria, data integration, and data retention and archival. It requires a strong commitment of institutional resources, and, therefore, can only be successful with the support of senior leadership and sponsorship at the Rectory level. There is not a general approach for data governance (the part of the BI strategy dedicated to data) to all HEIs, because it is necessary to adapt to their particular culture and business requirements. However, whatever governance model an institution adopts, institutions must have in consideration that they must (1) start with leadership support, because developing data definitions can be time-consuming and demands several efforts to accomplish it regarding human resources; (2) demonstrate business value; (3) draft the first conversations about a data term, in order to avoid lost information or misunderstandings (considering it is a very sensitive issue); (4) identify and involve stakeholders that will define data terms; and (5) eliminate unnecessary terms, following the use of language simple enough that any administrator from any area can understand the definition, without any technical or functional knowledge (Chapple, 2013).

CHAPTER 4

Evaluation

As mentioned in chapter 1, the goals of this dissertation are centered on the 2013 EUNIS BI Maturity Survey and the kit proposal developed to help HEIs in the beginning of their BI journey. In order to get feedback about both of these ideas, two Portuguese universities were identified to be interviewed: University of Évora and ISCTE – University Institute of Lisbon (ISCTE-IUL). These institutions were selected for three reasons: (1) they are currently on the beginning of their BI initiatives; (2) they answered the 2013 EUNIS BI Maturity Survey; and (3) they also actively collaborate with the EUNIS BI Task Force.

At University of Évora, the interview was conducted with Prof. Luís Rato – the Pro-Rector for IT, and Eng. Joaquim Godinho, the IT Director. At ISCTE-IUL, the interviewees were Prof. Carlos Sá da Costa, the Vice-Rector of Information Systems for Human Resources, and Teaching and Learning and Dr. João Paulo Cavaco, the IT Director.

4.1 Interview Protocol

Each interview had a planned duration of one hour. To cope with this time restriction, a small survey was developed to speed the process of gathering information from the HEI. This survey (see Appendix B) was sent by email to the interviewees prior to the date of the interview and focused mainly on the feedback from the 2013 EUNIS BI Maturity Survey. This survey was sent to the IT directors and vice-rector of the universities, who have a deep knowledge regarding the BI initiative in their institution and its participation in the EUNIS survey.

This feedback survey is a qualitative method, because it was the best way to get answers from an identified group and analyze them statistically. Originally, this survey was supposed to be sent to several HEIs in other countries to get a richer feedback from respondents of the EUNIS survey. However, it was not possible to contact again the HEIs, due to the delicate network of sponsors to disseminate the survey in each country. The BI Task Force is planning a second edition of the survey starting in January 2015. Despite the decision of not sending the survey to a wider audience, which renders impossible a statistic analysis of the results, the feedback survey was still a very useful instrument for several reasons. Firstly, it was used as a starting point of the interview to explain the context of the Kit proposal. Secondly, it enabled to uncover the main difficulties in filling out the EUNIS survey. Finally, it was used to gather suggestions to improve the 2015 edition of the EUNIS BI Maturity Survey.

The interviews followed a predefined protocol, as described below, and was complemented with a presentation (see Appendix C).

Before starting the interviews, there was an introductory moment where, besides the interviewer presentation, all the practical information was given:

- **Introductory Protocol**

  Thank you for your agreeing to participate!

  We have planned this interview to last no longer than one hour. During this time, we have several questions we would like to cover. If time begins to run short, it may be necessary to interrupt in order to push ahead and complete this line of questioning.

- **Introduction**

  We asked you to speak with us today, because you have been identified as a respondent of the 2013 EUNIS BI Maturity Survey. Our research project focuses on the beginning of BI initiatives in HEIs, with particular interest in understanding the roadmap that has been followed, and what have been the major challenges of this path. Our study does not aim to evaluate your techniques or experiences. Rather, we are trying to get feedback about the 2013 EUNIS BI Maturity Survey, as well as the validation of a kit proposal developed on this dissertation in order to help HEI in the beginning of their BI journey.

After introduction, there was an overview of the study goals: why the interviews were happening and which information was going to be collected.

The first questions were regarding the interviewees' background and their BI experience, questioning about:

Q1: How long they have been in your present position? And at the institution?

Q2: What are their fields of study?

Q3: What primary functions do their jobs involve?

Then, after confirming the reception of the feedback survey, the responses were asked. Question seven was the starting point of the conversation, in order to understand which BI definition was being considered in both universities.

Understanding when and how their BI journey started was the next step, with the following questions:

Q4: Can you describe the BI initiative in your institution (when it started, how did it started …)?

Q5: What were the original goals of the initiative?

Q6: Is there a roadmap that guides the development of the BI program?

After understanding the status of their BI initiatives, the kit proposal was introduced. It was handed, to all interviewees, a physical kit, in order to provide a support for the rest of the interview. It was made a ten-minute overview presentation about the kit and its structure. With the help of the handed physical kit, each dimension was analyzed, according to the following questions:

Q7: Which architecture is predominant in their BI initiative (or will be)?

Q8: Are there any defined standards for the used tools/technologies (or will be)?

Q9: Regarding the development, is there a followed methodology (or will be)?

Q10: Is there a defined team? Is it physically in the universities? Is it full-time allocated? (or will be)

Q11: Is there any process that manages the priority of the BI projects (or will be)?

Q12: Is it easy to get funding?

Q13: Which areas are being used as source systems (or will be)?

Q14: Who is the sponsor? Is an individual or a group? What is the sponsorship level of commitment?

Q15: Do you believe that BI helps in cost reduction regarding business processes? Do you believe it increases the value of the offered services?

Q16: What is the type of data products that the BI application delivers (or will be)?

Q17: Regarding the table presented in the kit proposal, are the universities having in consideration any of those aspects?

To conclude, the interviewees were asked to share their opinion about the kit proposal, and how it could be improved.

4.1 Background of the Interviewees

University of Évora agreed to be interviewed for this dissertation with the collaboration of Eng. Joaquim Godinho and Prof. Luís Rato. Table 15 presents their background information.

Table 15. Interviewees' Background: University of Évora

	**Name:** Eng. Joaquim Godinho **Field of Study:** Computer Engineering Eng. Joaquim Godinho has been working in University of Évora for 16 years and he is responsible for the IT services, which is an area that has been improving along the years. This area was born from the need of supporting university users.
	**Name:** Prof. Luís Rato **Field of Study:** Electric and Computer Engineering Prof. Luís Rato has been working in University of Évora for 14 years and he is the pro-rector for IT.

ISCTE-IUL was interviewed with the collaboration of Dr. João Cavaco and Prof. Sá da Costa. Table 16 presents their background information.

Table 16. Interviewees' Background: ISCTE – University Institute of Lisbon

	**Name:** Dr. João Paulo Cavaco **Field of Study:** Computer Science Dr. João Paulo Cavaco has been the IT Director in ISCTE-IUL for three years and has a strong BI background for over 20 years. Previously, he had been working in Foresight and Planning for the Environment National Department.
	**Name:** Prof. Sá da Costa **Field of Study:** Electric and Computer Engineering Prof. Sá da Costa is the Vice-Rector of Information Systems for Human Resources, and Teaching and Learning.

The interviewees from University of Évora have been working in the university for several years. Both have been present since the beginning of their IT systems, which represents a deep knowledge about data needs in the university.
Regarding ISCTE-IUL, Dr. João Paulo Cavaco has joined the IT team for less than five years.

4.2 Summary of the Interviews

The first interview was with University of Évora, to Eng. Joaquim Godinho and Prof. Luís Rato. This university has an academic management system since 2000, which has revealed a great need to be improved throughout the years, in order to present integrated data. This situation shows that the university has clearly identified the benefits of a BI solution and has been preparing the data infrastructure to enable the implementation of such solution.
Presenting effective data to the Rector has always been a priority, and in 2012, it was decided to perform a consolidation of the different areas of the academic management system. According to the interviewees, this was considered to be an initial step of University of Évora towards the future implementation of a BI solution. This system started to generate Excel and PDF lists with aggregated and normalized information. However, they were not developed with analytical systems. A formal beginning of the BI initiative is expected only in January 2015.

The second interview was with ISCTE-IUL, to Prof. Sá da Costa, Vice-Rector of Information Systems for Human Resources, and Teaching and Learning, and Dr. João Paulo Cavaco, IT Director.

Like University of Évora, ISCTE-IUL has been developing in-house their academic information system (Fénix) over the past years. Currently, Fénix is ISCTE-IUL's main source of information and also the entry-point for both internal and external stakeholders (ISCTE-IUL, 2013, pp.25).

Since 2008, ISCTE-IUL has been developing an Information Technology Service Management (ITSM) strategy, based on the best practices proposed by ITIL®v3 combined with a business intelligence approach. This initiative aimed at improving the efficiency and maturity of the university's IT services, as a result of a close collaboration between IT services, master students and a BI professor. An IT helpdesk service (using the EasyVista tool) has been implemented focusing on service operation processes. This was the first BI project in the university. Despite the success of the initiative (i.e., other university services, such as facility management, are now interested in using a similar approach) there is still a long way to build a sustainable BI project, fully integrated in a BI environment.

ISCTE-IUL has also made a remarkable effort in terms of training. Three senior developers have successfully taken the Data Warehouse course (lectured at the Information and Management programme) in the academic year of 2012-2013. Moreover, in April 2013, these developers also participated in the Lisbon BI course on Agile Data Warehousing and ETL[4], a four days training that took place at ISCTE-IUL.

4.3 Feedback Survey

The feedback survey (see section B) is divided in ten questions. The first three questions confirm if the respondent answered to the 2013 EUNIS BI Maturity Survey and if he had known EUNIS before that moment. After these questions, there are two figures that remind the structure of the EUNIS survey, and the fourth, fifth and sixth questions intend to analyze the experience of answering to it and its utility to the university. The questions seven, eight, and nine enable the respondent to share some information about the BI initiative in its university, while the tenth question is where suggestions to improve the next edition of the EUNIS BI Maturity Survey can be made.

In University of Évora, the feedback survey was sent to the IT director, the person who answered the 2013 EUNIS BI Maturity Survey. With ISCTE-IUL, both interviewees received it. Professor Luís Rato did not receive the survey previously, because his attendance to the interview was not confirmed. However, a copy was delivered during the interview.

Taking University of Évora as the first example, Eng. Joaquim Godinho had previously heard about EUNIS before answering its survey, and Figure 44 represents its experience.

[4] http://home.iscte-iul.pt/~earc/LisbonBICourse.htm

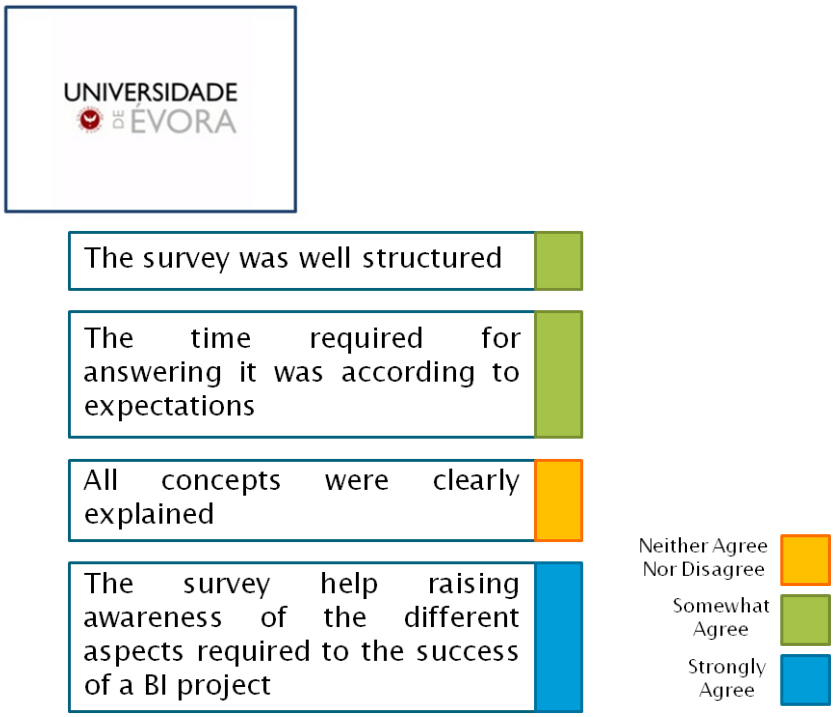

Figure 44 - University of Évora Experience Results

Analyzing the structure and time required to answer it, the EUNIS survey answered to the expectations. However, regarding the explanation of used concepts, the respondent answered "Neither agree nor disagree", representing the weakest feature of the survey. There was a strong agreement in considering it as a tool that helped raising awareness of the needed aspects to be successful with the BI project. With this survey, University of Évora realized that its BI strategy is not effectively defined. Although concepts were not cleared, the EUNIS survey was a positive experience.

At ISCTE-IUL, Prof. Sá da Costa and Dr. João Cavaco also had previous knowledge about EUNIS. However, the task of answering to the EUNIS survey was delegated to the IT director, Dr. João Cavaco. Figure 45 presents the survey experience.

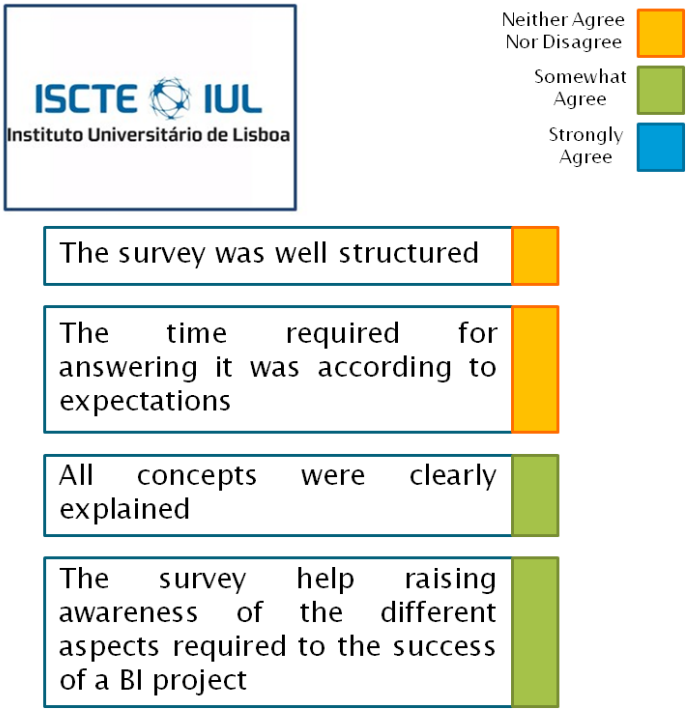

Figure 45 - ISCTE - University Institute of Lisbon Experience Results

About the survey structure and the time required to answer the EUNIS survey, the respondent did not have a formed opinion, representing, in this case, the weakest features. The explanation of used concepts was according to the expectations; however, further in the feedback survey, the respondent left a remark saying that several survey questions might lead to different interpretations. This situation comes to support the idea that concepts could be better described. There was an agreement in considering it as a tool that helped raising awareness of the needed aspects to be successful with the BI project. This survey also helped ISCTE – University Institute of Lisbon in identifying that the expected BI value is not correctly defined yet. If answering this survey was a positive experience, this university replied, “Neither agree or disagree”, meaning that it was as fruitful as it could be.

The seventh question aims to understand the perception of BI implementation in the universities. The respondent could only choose one option from the six available answers. Those possible answers were taken from TDWI Maturity Model’ maturity levels, so that we could confirm if universities had the real perception that they were in the beginning of their BI journey. The three respondents gave similar answers: the current understanding of this type of initiative is “a reporting system over the academic information system with manual consolidation of data”, which translates the TDWI’s first maturity level. However, all of them had the perception that it should be “a DW that lets distributed groups build their own applications within framework of standards, and which provides users the ability of creating composite applications”, the definition for an organization in the TDWI’s *Optimized* level. Both universities know where they are (first level) and where they want to be (fifth level).

About their own BI initiatives, each university presented its own drivers of the BI system implementation – see Figure 46.

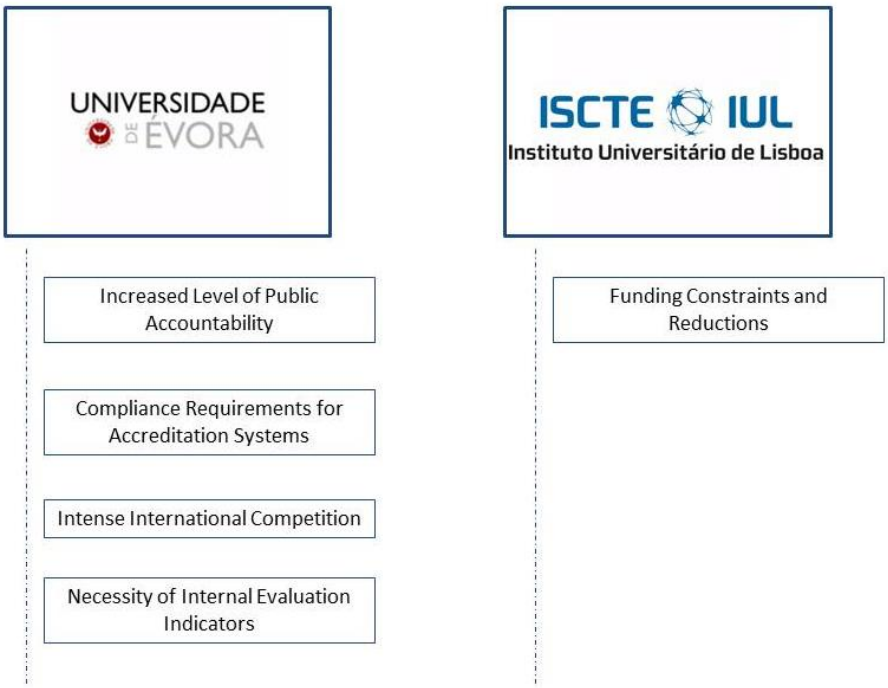

Figure 46 - Drivers of the Implementation of the BI/DW System

University of Évora identified several drivers like the increased level of public accountability required from universities, and the intense international competition for students. ISCTE-IUL stated that the main driver is funding restrictions.

Regarding previous attempts to build a BI system that were not successful, University of Évora does not have any knowledge about it. On the other hand, ISCTE-IUL identified one BI effort; however the lack of success was due to inadequate user involvement and organizational politics.

4.4 Kit Application

The interview in person involved a ten-minute presentation (see Appendix C) with an overview of the kit proposal. After that moment, each of the eight dimensions was analyzed regarding the university experience. This presentation also included the offer of a physical support of the kit to the interviewees.

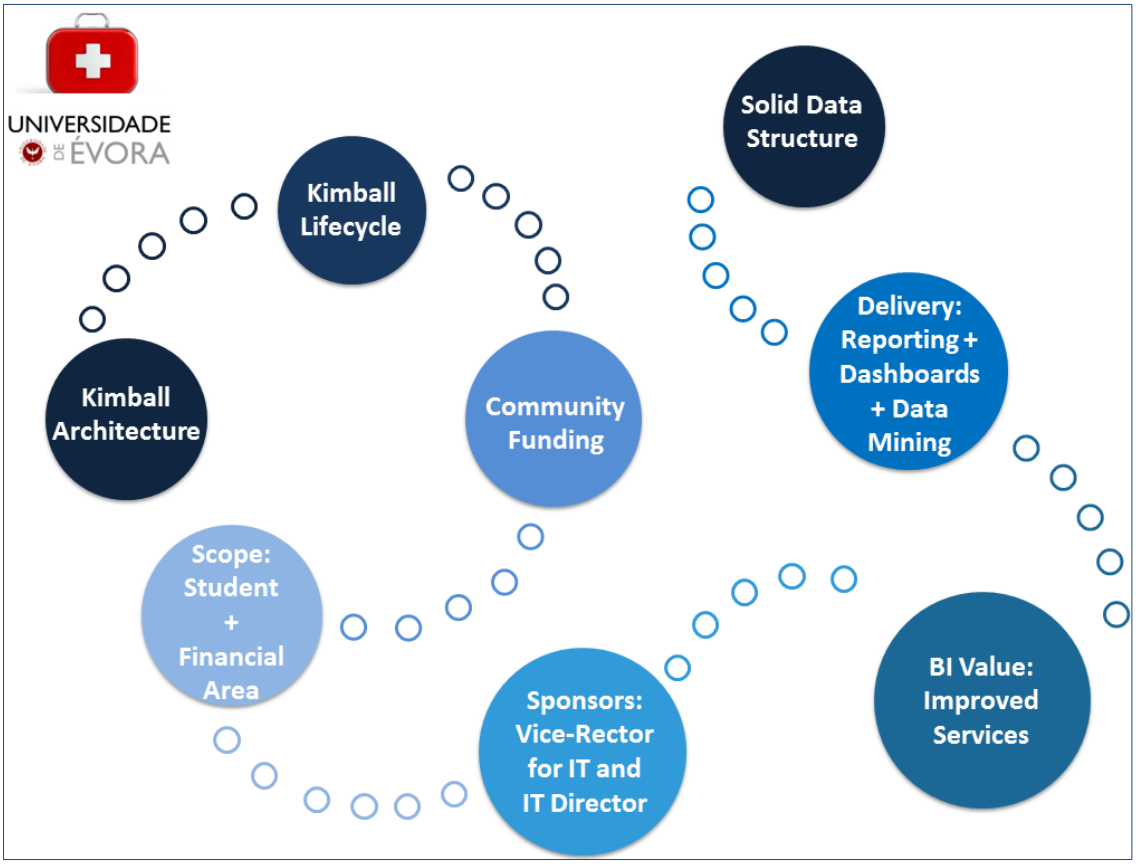

Figure 47 - Kit Application to University of Évora

Figure 47 presents the kit application to University of Évora. Regarding architecture, University of Évora intends to adopt Kimball's approach to their BI initiative, because it enables faster results, and it is possible to show earlier the real value of analytics. Regarding tools and standards, open-source will be chosen, in order to develop new modules without major licencing costs. It was mentioned the possible use of the Pentaho tool.

The development methodology will also follow Kimball's approach. Currently, they use a software development framework for the in-house development of the operational system. For the BI initiative, they intend to adopt the Kimball's Lifecycle methodology.

The team composition is still undefined, but will most certainly include members from the current software development team. It was mentioned that it is important for the BI initiative to have a clear identity within the HEI, and not be diluted inside the IT Direction. Therefore, it is expected that a specific team will be dedicated to the BI initiative.

Funding to their BI initiative might be coming from European funds, whose entry is being considered. However, they have some funds that can be allocated to this initiative for the beginning of the project

The scope of the initial BI project is clearly identified: students and financial data. In a second iteration research data might be addressed.

Sponsorship is well defined for this institution. There is a team of two persons: the Pro-Rector for IT and the IT Director. This team also has the support of the Vice-Rector for Teaching and Learning who has been demonstrating a great need to have data to work with.

In terms of value, the interviewees mentioned that the BI initiative would hardly reduce cost in the short run, maybe in a longer period of time. However, it was considered very important for the decision making process in terms of the attractiveness analysis of programs. With the help of BI, the university will be able to adjust its programs to what students are looking for their future. Therefore, the BI initiative can be useful to enhance the value of the university products (e.g., programs, research) and services, as well as support the selection of the best applicants.

Regarding delivery, University of Évora intends to start by developing reports. In a second phase, dashboards and data mining solutions will also be considered. For instance, data mining can be applied to uncover the normal “academic path” of students and identify critical cases. Users’ training is critical for the most complex products. In fact, the interviewees noted “it is as dangerous not to have information as using it in a wrong way”.

Finally, concerning the data dimension, University of Évora has data sources with well-defined owners, and have consolidated and integrated data for the past three years. Data concerning programs executed before the Bologna process reforms does not possess the required quality for the BI initiative.

Overall, University of Évora has a stable and integrated dataset (for a period of three years) and a clear view of the analytic priorities for the institution. Next step ahead is the development of the activity plan for the next year. It should be noted that this institution has a recently elected Rector.

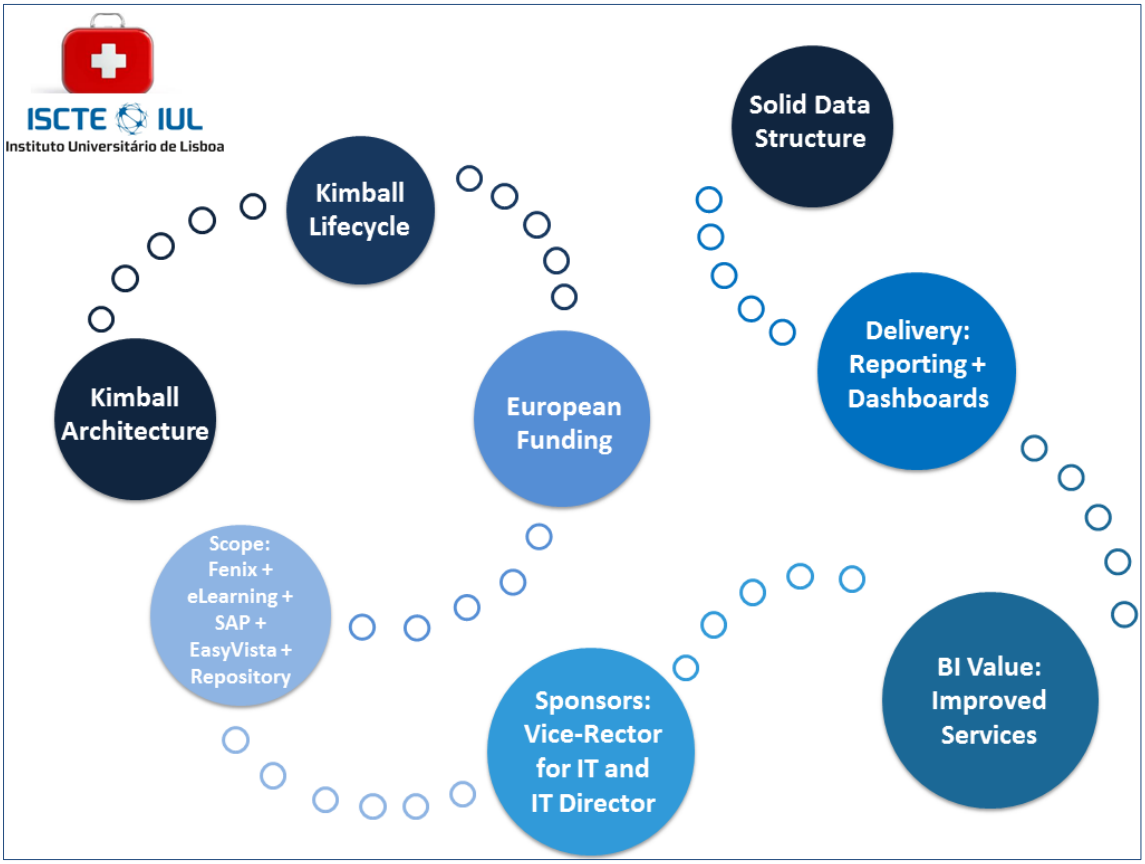

Figure 48 - Kit Application to ISCTE - University Institute of Lisbon

Figure 48 presents the kit application to ISCTE-IUL. Considering the architecture dimension, the IT Director mentioned the need to follow an iterative approach, referring to the BI initiative as a process rather than a project. Therefore, most likely the Kimball architecture will be adopted.

Regarding tools and standards, although there is not yet a formal decision, Microsoft is the framework that might be chosen, because it presents the best cost/benefit relationship for the university. Moreover, this framework is already being used in other areas, so that will be a natural choice.

The preferred development methodology is the Kimball's approach. The team structure is already thought out: the selected people are currently allocated to the development of the Fénix academic system, but as soon as the BI initiative starts, they will be dedicating more time to it. ISCTE-IUL has the resources in the IT services with the adequate skills to integrate the BI development team (namely the three resources who have received training, as mentioned earlier). Starting in January 2015, the IT Director foresees an involvement of one and a half person full time (FTE) from ISCTE-IUL plus the help of consultant for a short period of time.

In terms of the funding dimension, the interviewees mentioned that "is always very difficult to get funding for the IT budget". There is a strong need to demonstrate the value of the investment. However, this is not easy to quantify. It may involve human resources, external consultancy or new equipment. Currently, ISCTE-IUL has an approved QREN (European programme) funding

with the project Balcão Único do ISCTE-IUL, aimed at developing a common institutional access point of excellence (ISCTE-IUL, 2013). One of the activities of this project (Activity 6) is specifically the beginning of the implementation of the BI initiative – "implementation of technical infrastructure to gather, produce and report quality and management indicators, using Data Warehouse and Business Intelligence systems" (ISCTE-IUL, 2013, pp. 25-26).

The scope of the initial BI project is already defined and documented in the activity plan. ISCTE-IUL has several data sources: the academic system Fénix, the e-learning platform Blackboard, SAP for human resources and financial data, EasyVista for ITSM data and Repository of the library services. All of these data sources are expected to be integrated in the BI initiative, however, in the initial phase the scope will be limited to the academic system Fénix.

Regarding sponsorship ISCTE-IUL has a business sponsor – the Vice-Rector of Information Systems for Human Resources, and Teaching and Learning – and a technical sponsor – the IT Director. The Vice-Rector mentioned that expectations upon this team are high. The BI initiative must deliver meaningful results within a year time, in order to secure funding.

In terms of the value dimension, the Vice-Rector mentioned that value might be indirectly translated into cost reduction in processes. Specifically, by monitoring the students' success rate, and acting in a timely manner, it will be possible to fine tune the material and human resources required. This is however a slow process; a better student success rate leads to fewer classes and consequently, lower operational costs (in terms of faculty and facilities required). In addition, with higher success rates there will be more graduated students and, therefore, more new students can enter every year.

Regarding delivery, the expected analytical capabilities are reporting and querying, considering the classification used by UC Berkeley BI Applications (see Figure 40). Forecasting will be considered in a later future.

The IT Director mentioned that the entire data aspects presented in the kit are being taken into consideration in the design of the activity plan. It was also noted that the table presented in the kit (see Table 13) was a good checklist to focus on data challenges and will be studied more carefully.

4.5 Kit Feedback

In the end of both interviews, there was a discussion about how useful can the developed kit be for HEIs that are starting their BI initiative. In general terms, the feedback was positive. University of Évora emphasized the importance of being systematic and methodical in this situation, and the kit of this dissertation works as an essential guidance. The covered dimensions were clearly defined and present the idea of what is a priority at this initial phase of the BI initiative. ISCTE-IUL also highlighted the importance of having real success case studies, in order to help decision-makers (typically, individuals without a technical background) to understand how other universities benefit from the best practices of each dimension in the kit.

CHAPTER 5

Conclusions

BI is one of the most important areas to be invested on, due to the abilities that it brings to all types of organizations. The higher education sector is not an exception and this dissertation was developed from the necessity of clarifying what needs to be done, so that institutions can start their BI initiative and be successful. In 2013, the BI Task Force of EUNIS conducted a survey to several European HEIs, in order to understand the maturity level of their BI systems. Those answers revealed controversial results, reflecting a lack of understanding about the necessary conditions to develop a successful BI solution. To help those institutions beginning their journey, this dissertation developed a *kit*, clarifying key concepts and best practices regarding BI in the Higher Education sector. This kit analyzes eight aspects: Architecture, Development, Funding, Sponsorship, Scope, Value, Delivery and Data. For each dimension, as it was called, there were several analyzed authors, different methodologies and a set of success cases from other HEIs.

To confirm the lack of comprehension of the BI aspects mentioned in the 2013 EUNIS survey, and to validate the developed kit, two Portuguese universities were interviewed: University of Évora and ISCTE – University Institute of Lisbon. The given feedback confirmed the need of having the covered aspects better explained, in order to give a more accurate answer. Because of that, the developed kit was considered a crucial element to the institutions that are in the same phase. With this aid, HEIs are able to understand what is expected to be successful and are also able to verify several success stories that used the good practices presented in the kit.

5.1 Contributions

The answers to the initially proposed problem statements can be considered as an important contribution to the BI communities, as well as to University of Évora, ISCTE-IUL and all HEIs that are in the beginning of their BI initiatives. EUNIS can also benefit with this dissertation.

To institutions that have not started their BI initiative yet, what are the best practices to succeed?

The developed kit proposal can be seen as a possible answer to the best practices to succeed with BI in HE. The eight dimensions represented in the kit are the areas that require attention from the BI stakeholders.

Choosing the best data warehouse architecture is not simple and plain, because like Adamson (2011) said, “each real-world implementation is different”. Yet, after analysing the architecture proposals and considering the higher education examples from IBM and University of Maryland, the kit proposal advocates for the Kimball’s approach. This approach takes less time to develop

a data warehouse, when comparing to Inmon's. The subject areas work as data marts inside the DW, and end-users can access the information directly, which is the best way to demonstrate quicker the real BI value.

Adopting an agile development methodology means working in a challenging environment, because changing requirements is a strong reality. Related to it, it is also the need to have a team that is constantly learning and improving its skills. An agile methodology reduces the needed time to deliver value from BI projects, and engages sooner and better with the end-users, allowing them to explore data more rapidly (Westlake et al., n.d.). In HEIs, this approach can create an effective working environment.

Funding is a sensitive issue to all organizations, especially HEIs that daily struggle to get budget for improving their IT systems. Having a dedicated structure to manage the financial issue might be essential to keep the initiative focused on the stakeholders' expectations. Besides, it will keep BI team working without worrying about budget. In the beginning of the BI journey, the structure might have only one individual.

The scope of a BI initiative in HEIs has to be seen as the first step to be done: decide what is going to be done (and what is not going to be done) is crucial and has to be documented. It must enable other individuals to understand what is expected to be achieved.

Having a strong sponsorship, someone who believes that BI can make a positive impact in the institution, motivates others, and overcomes political and other obstacles is a critical success factor. Kimball et al. (2008) advise that "before beginning a data warehouse or a data mart project, make sure you understand whether there is demand and where that demand is coming from. If you have no strong business sponsor and no eager users, postpone the project".

The value that comes with BI does not only mean cost reduction. In HEIs, this value can also be translated into more informed decision-making, improved programmes, and better classroom management, among others. If the initiative can answer to the defined goals, it is expected to generate value to the institution.

BI delivery is about how information is presented to end-users. Considering an example from UC-Berkeley (2006), this delivery can be divided in three categories: reporting, querying and modeling/forecasting. Pre-built reports, a reporting portal, charts, dashboards and alerts are examples of reporting tools. Dimensional query tools, OLAP query tools, simplified views of data, spreadsheet integration can be seen as querying tools. User-built models, data mining tools, planning/budgeting/forecasting tools represent modeling/forecasting tools. In an initial phase, HEIs should focus on the first two categories. Usually, modeling and forecasting applications are seen as complex BI products that are delivered in a more advanced maturity level of the initiative.

A BI initiative must fulfill the requirements of the end-users (i.e., the business requirements). Consequently, it is important to establish a BI strategy for data management, ensuring that data is conformed (using the Kimball's terminology). This encompasses data quality, data access, calculation criteria, data integration, and data retention and archival. It requires a strong

commitment of institutional resources, and, therefore, can only be successful with the support of senior leadership and sponsorship at the Rectory level. There is not a general approach for data governance (the part of the BI strategy dedicated to data) to all HEIs, because it is necessary to adapt to their particular culture and business requirements.

How can EUNIS improve the next edition of its BI Maturity Survey, in order to return more accurate results?

Another important contribution is about the suggestions to improve the next edition of the EUNIS BI Maturity Survey, to be launched in the beginning of next year. One of the interviewed universities mentioned that "some questions in the survey left room for different interpretations". Therefore, it is important to have clearer questions, in order to get more objective results. For instance, in the feedback survey used in this dissertation (see Appendix B), question seven regarding the current definition of BI of the HEI was perceived by the majority of the interviewees as the stage of their BI initiative. However, one interviewee perceived it has the optimal and encompassing definition of BI (as a centrally managed BI center of excellence). The same biased view may be applied to all dimensions of the survey. Considering the value dimension for instance, instead of mentioning the current valued gained from the BI initiative some might answer according to the potential and ideal value that BI can bring.

5.2 Limitations

This study struggled with a major time limitation, considering it was developed as a part-time dissertation, due to professional restrictions as a full-time BI consultant. Because of this situation, it was decided to schedule interviews with only two Portuguese universities, in order to gather a more complete feedback about fewer institutions, rather than performing shorter interviews to more of them and taking the chance of losing the important details of their initiatives.

There was also the lack of access to important information for the State of the Art chapter that could improve the developed work. There were insufficient resources for a set of BI definitions, as well as for the background of several maturity models.

During the development of the kit proposal, there were limitations regarding the available information about BI initiatives in HEIs, considering success cases.

5.3 Future Work

As future work, the results from this dissertation must become public, in order to contribute to the improvement of the next edition of the EUNIS survey. It is necessary to guarantee that respondents know the definitions of the used concepts, and also understand the meaning of maturity in BI. Therefore, there will be a report written for the EUNIS website, and the due date is December 2014.

Another important future task is interviewing other HEIs, in Portugal and in other European countries. It is important to gather more feedback about the kit proposal, as well as more success cases, so the developed kit can be enriched to institutions that are starting their BI journey.

The developed kit can improve to a roadmap guide, considering the HEIs that have already started their BI initiative and are looking for guidance to progress for a higher maturity level. The EUNIS collaboration is crucial for this possible roadmap, considering a roadmap to European institutions.

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Appendices

A. EUNIS BI Task Force – HE Maturity Model Survey 2013

BI TASK FORCE @ EUNIS - Higher Education Business Intelligence Maturity Model Survey 2013

This survey is proposed by the BI Task Force @EUNIS. The goal is to perform an evaluation of the maturity level of Business Intelligence (BI) initiatives in European Higher Education Institutions. This survey is completely anonymous (neither you or your institution will be identifiable).
The survey includes questions that will enable the assessment using two maturity models. Sections 1-8 are related to the TDWI Maturity Model. Section 9 includes the questions required by the "White Book of Institutional Intelligence" maturity model, a Higher Education specific BI maturity model.
The BI Task Force @EUNIS specifically acknowledges the copyright of TDWI regarding the TDWI Maturity Model.

INSTITUTION'S BACKGROUND

YOUR INFORMATION

In regards to the BI/DW environment, which best describes your POSITION?
- ○ IT Professional
- ○ Business Sponsor, Driver or User
- ○ Academic Staff
- ○ Other

Which best describes WHICH SIDE of the business you're on?
- ○ Business
- ○ Information Technology
- ○ I straddle both sides

Which best describes your ROLE?
- ○ BI/DW Sponsor
- ○ Business Analyst or Subject Expert
- ○ BI/DW Director or Manager
- ○ BI/DW Architect or Developer
- ○ BI/DW Administrator or Systems Analyst
- ○ Other

YOUR HIGHER EDUCATION INSTITUTION'S BACKGROUND

What is the total number of students enrolled in the 2012/2013 academic year
- ○ Less than 999
- ○ 1,000 to 4,999
- ○ 5,000 to 9,999
- ○ 10,000 to 19,999
- ○ More than 20,000
- ○ Don't know

Which best describes your institution's Higher Education SECTOR?
- ○ Public
- ○ Private

In which country is your institution LOCATED?
- ○ France
- ○ Germany
- ○ Italy
- ○ Portugal
- ○ Spain

YOUR GROUP

Which best describes the SCOPE of the group in which you work?
- ○ Rectory
- ○ School
- ○ Department or functional area (e.g. finance, IT, academic services)
- ○ Other

Which best describes the ORIENTATION of the group in which you work?
- ○ Executive management
- ○ Administrative
- ○ IT
- ○ Other

How LONG AGO was your institution's BI/DW initiative started?
- Not started yet
- Less than one year
- 1 to 2,5 years
- 2,5 to 5 years
- 5 to 10 years
- 10 to 20 years
- 20+ years
- Don't know

How many full-time equivalent BI/DW STAFF MEMBERS does your institution maintain (including contractors)?
- None
- 1
- 2 to 5
- 6 to 10
- 11 or more
- Don't know

1. SCOPE

The goals for BI/DW systems are defined before building a system
- Entirely Unfulfilled
- Unfulfilled
- Undecided or Uncertain
- Fullfilled
- Entirely Fullfilled

BI/DW strategy is aligned with the strategic plan of the organization
- Entirely Unfulfilled
- Unfulfilled
- Undecided or Uncertain
- Fullfilled
- Entirely Fullfilled

BI/DW objectives adapt to the changing objectives of the organization
- Entirely Unfulfilled
- Unfulfilled
- Undecided or Uncertain
- Fullfilled
- Entirely Fullfilled

How many APPLICATIONS does your BI/DW environment support?
A BI/DW application consists of a distinct set of related reports, dashboards, briefing books, or scorecards designed to support a specific set of tasks within a business domain or process, such as tuition management, student performance analysis, etc.
- 0
- 1 to 2
- 3 to 5
- 6 to 10
- 11 to 20
- 20+

Users are assigned full-time tasks/roles to BI/DW projects
- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

2. SPONSORSHIP

Which best describes how EXECUTIVES perceive the PURPOSE of your group's BI/DW environment?
- Operational Cost Center – an IT system needed to run the university
- Tactical Resource – tools to assist decision-making
- Mission-Critical Resource – a system that is critical to running university operations
- Strategic Resource – key to achieve performance objectives and goals
- Competitive Differentiator – key to gain or keep students and other stakeholders

Which best describes the SPONSOR of your BI/DW group?

- None to speak of right now
- CIO or an IT director
- Single sponsor from a school or department (academic or non-academic)
- Multiple individual sponsors from multiple schools or departments (academic and/or non-academic)
- Multiple levels of business-driven (academic and/or non-academic), cross-departmental steering committees

To what degree is your sponsor COMMITTED to the BI/DW program?

- Very Low
- Low
- Moderate
- High
- Very High

To what degree is the BI sponsor held ACCOUNTABLE for the outcome of the BI/DW solution?

- Very Low – Only project or program managers are held accountable
- Low – Between very low and moderate
- Moderate – Sponsor assumes accountability but is not incented for performance
- High – Between moderate and very high
- Very High – Sponsor assumes accountability and is incented for performance

Senior management is involved in the BI/DW through steering committee/governance

- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

3. FUNDING

How easy is it to get FUNDING for your annual BI/DW budget?

- Very Hard - Our budget gets cut before other IT projects
- Hard - Between very hard and moderate
- Moderate - We are usually funded at a rate comparable to the rest of IT
- Easy - Between moderate and very easy
- Very Easy - With our demonstrated track record, we usually get what we ask for

Compared to other universities in your country your level of investment in BI/DW is...

- Much Lower
- Lower
- Undecided or Uncertain
- Higher
- Much Higher

The annual BI/DW BUDGET for your BI/DW group represents approximately what percent of the annual IT budget for your group? Consider the costs associated with BI platform and team (internal and/or external).

- 0%
- 1%
- 2% to 3%
- 4% to 5%
- 6% to 10%
- 11% or more

Which best describes the current degree of capital investment in your BI/DW system?

- We're bootstrapping our system
- We've received initial capital funding to purchase software and systems
- We've received additional capital funding to build on our initial success
- We've received significant and sustained capital investments to pursue full deployment of our vision
- We're now fully deployed with less need for additional capital

Which best describes the current MAINTENANCE BUDGET for your group's BI/DW system?
- Very Low – Limited or no funds to deliver and support requested BI projects
- Low – Between very low and moderate
- Moderate – We have sufficient funds to deliver and support some but not all requested BI projects
- High – Between moderate and very high
- Very High – We're fully funded to deliver and support most or all requested BI projects

4. VALUE

BI/DW reduces the cost for many business processes
- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

BI/DW enhances the value of our products (e.g., programmes, research) and/or services
- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

BI/DW assists in identifying the most appropriate clients (e.g., students) for our institution
- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

BI/DW assists in identifying the most important research areas for our institution
- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

BI/DW projects always contain an assessment of risk
- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

5. ARCHITECTURE

What is the PREDOMINANT ARCHITECTURE of your DW environment?
- Desktop or user-generated reports (i.e., spreadmarts)
- Multiple, non-integrated data marts or packaged solutions
- Multiple, non-integrated data warehouses
- A single, central DW with multiple dependent marts (Inmon), conformed data marts (Kimball), or no data marts
- A BI/DW service that federates a central DW and other data sources via a standard interface

To what degree can users directly ACCESS the data they need to make decisions from a single user interface?
- Very Low – Users can access virtually none of the data they need
- Low – Between very low and moderate
- Moderate – Users can access a moderate amount of the data they need
- High – Between moderate and very high
- Very high – Users can access all the data they need

To what degree have you established standards for TECHNOLOGY and TOOLS in your BI/DW environment?
- Very Low – We have not defined standards
- Low – We have defined some standards
- Moderate – We have defined about half the standards
- High – We have defined most of the standards
- Very High – We have defined all standards

To what degree do individuals and groups ADHERE to the technology and tool standards established for your BI/DW environment?
- Very Low – No one adheres (or standards don't yet exist)
- Low – Few people and groups adhere
- Moderate – Some people and groups adhere
- High – Most people and groups adhere
- Very High – All people and groups adhere

To what degree has your institution defined, documented and implemented DEFINITIONS and RULES for key terms and metrics?
- Very Low – None defined
- Low – Some defined
- Moderate – About half defined
- High – Most defined
- Very High – All defined

6. DATA

To what degree do end users TRUST THE DATA in your BI/DW environment?
- Very low - Users don't trust the data. They find too many errors, exceptions, or omissions. They rely on other sources of data to make critical decisions
- Low - Between very low and moderate
- Moderate - Users somewhat trust the data. They reconcile it with more trusted sources before using
- High - Between moderate and very high
- Very high - Users trust the data. They view it as the system of record for the company and rely on it for critical decisions

How many unique DATA SOURCES does your BI/DW environment draw from?

- 0
- 1 to 2
- 3 to 6
- 7 to 10
- 11 to 20
- 21 or more

On average, how often are the MAJORITY of data elements in your BI/DW environment REFRESHED?

- Either annually or quarterly
- Either quarterly or monthly
- Either monthly or weekly
- Either weekly or daily
- Either daily or intra-day

Which best describes the degree of synchronization among the DATA MODELS below that your group maintains?

- **ETL Source and Target Models**
- **Data Warehouse and Data Marts Models**
- **BI Semantic or Query Object Models**

- Very low - We do not synchronize models
- Low - We manually synchronize some of the models
- Moderate - We manually synchronize some models, others automatically
- High - We automatically synchronize most models, but not all
- Very high - We automatically synchronize all models

To what degree has your institution integrated UNSTRUCTURED DATA (i.e., text or documents) in the BI/DW environment?

- Very Low – No plans or approach
- Low – Between very low and moderate
- Moderate – Users can search text and documents via a separate (non-BI) application
- High – Between moderate and very high
- Very High – We return related structured and unstructured data via a single BI query

7. DEVELOPMENT

Which best describes your BI/DW group's approach to DEVELOPING BI/DW solutions?

- Independent - User groups develop their own BI/DW solutions without our assistance or guidance
- Ad hoc - We develop one-off BI/DW solutions as user groups fund them using whatever tools and techniques make sense
- Aligned - We develop one-off BI/DW solutions, but use a common set of tools and techniques to ensure long-term alignment
- Standardized - We develop a portfolio of integrated BI applications using a common set of tools and techniques, working within a common architecture and process framework
- Federated - We let schools/departments (business units) develop their own BI/DW solutions as long as they adhere to our architecture and process framework

To what degree has your institution defined, documented, and implemented standards for DEVELOPING, TESTING, and DEPLOYING BI/DW functionality (i.e., ETL code and BI reports)?

- Very low - Our institution has not established BI/DW standards
- Low - Our institution has established some BI/DW standards
- Moderate - Our institution has established about half of the BI/DW standards needed
- High - Our institution has established most BI/DW standards
- Very high - Our institution has established a comprehensive set of BI/DW standards

A standardized process for prioritizing BI/DW projects has been established

- Entirely Unfulfilled
- Unfulfilled
- Undecided or Uncertain
- Fullfilled
- Entirely Fullfilled

On average, how many BI/DW PROJECTS that last three or more months does your institution run concurrently?

- 0
- 1
- 2
- 3
- 4
- 5+

How long does it take your team to add a new SUBJECT AREA to the BI/DW environment?
Creating a subject area usually involves the following: 1) Define user requirements 2) Analyze source systems 3) Model/revise target model 4) Develop extract, transform, load, and validation routines 5) Create/revise reports 6) Test 7) Deploy and train users

- 12+ months
- 9 to 12 months
- 6 to 9 months
- 3 to 6 months
- 3 months or less

8. DELIVERY

Of the people who use BI on a regular basis, most have a strong understanding of university products and services

- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

There is a well-organized availability of technical training for BI projects

- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

There exists a well-organized availability of business training (i.e., university-related functions) for BI projects

- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

Which best describes how users access BUSINESS METADATA?

- Level 1 – There is no business metadata to access
- Level 2 – Users consult metadata reports that we periodically distribute
- Level 3 – Users query various repositories to access business metadata
- Level 4 – Users query a central repository to access up-to-date business metadata
- Level 5 - Users click once to view integrated, contextual, up-to-date business metadata

Formal measurement of training is done to improve BI training courses

- Strongly Disagree
- Disagree
- Undecided or Uncertain
- Agree
- Strongly Agree

9. WHITE BOOK Maturity Model

TEAM

Which better describes the organization of your BI team?

- ABSENT - The concept of a BI Team is not yet applicable anywhere
- LOCAL - BI teams are local to functional units and disconnected
- GLOBAL, VIRTUAL - There is a virtual team composed by BI part-time personnel from different units
- GLOBAL, FORMAL - There is a central BI team, formally positioned in the organizational chart, with full time employees
- BICC - There is a full-featured "Business Intelligence Competency Center" proactively supporting and promoting the effective use of BI across the institution

SPONSORSHIP

Which better describes the strategic positioning of the BI initiative in your institution?

- FREE-FLOATING - No strategy for BI. Any activity that does occur is improvised, sporadic, uncoordinated and neither centrally or locally sanctioned
- LOCALLY EMBEDDED - Efforts have the support of local management and both inform and form part of local strategic planning processes
- PROJECT FOOTING. BI is viewed as a global trial project. Separate budget and reporting lines are established but for a finite time period with no clear consideration of what will follow
- SUSTAINABLE SERVICE - Permanent budget and reporting lines established with ownership delegated to member of the senior management team. BI may not specifically appear in the global institutional strategy and its future direction and goals may not be fully defined but the means have been put in place to sustain an active and developing service into the future, transcending the previous time-limited approach
- INTERDEPENDENT WITH INSTITUTIONAL STRATEGY - BI and Institutional strategy are mutually dependent; BI supports Institutional strategy by providing a highly efficient information analysis context to support institutional goals, and Institutional strategy supports Institutional Intelligence by explicitly considering it as a key capability to acquire and evolve. A clear, global development path exists and it is inconceivable that the institution can meet its agreed goals without the support of the BI service

VALUE

Which better describes the general user perception and effective use of the data products being delivered?

- SCARCE - Either the delivered data products that reach business users are judged as superfluous or irrelevant, or business users lack the training and/or analytic culture to appreciate its value. Effective use is almost absent, and if exists, is limited to a few very specific individuals with almost no global impact
- OPTIONAL - Delivered data products' perceived value is often not enough to overcome the resistance to change or to learn the new required tools. Effective use is low, limited to small niches and its business impact is low
- INTERESTING - Either the potential obtainable value is relevant enough to create generalized interest in the targeted user group, or the analytic culture is such that most individuals tend to use every source of information available to make decisions based on analysis. Effective use is generalized, and its business impact is relevant
- NECESSARY - The output of the data products is used in decisional, administrative or planning processes in such a way that they are considered necessary to successfully complete them. This may be due to a real restriction (it's not possible to continue the process without the information they provide) or because analytic culture is high enough to make every one reluctant of completing the processes without the insights revealed by the involved data products. Effective use and business impact is high
- CRITICAL - The delivered data products are effectively embedded in processes that are considered critical for the proper functioning of the institution, either due to its profound impact on decision making or administrative activities, or because analytic culture is so established and institutionalized that information effectively drives the activity at all levels, and is considered vital. Effective use and business impact are very high

SCOPE

How many of the following general functional areas are being actively used as data sources in your BI implementation?

- **Economic/Financial**
- **Academic**
- **Human Resources**
- **Research**

to consider that a functional area is covered, there has to exist at least one deployment of a data product offering information extracted from any of its modules/subsystems in production and under active support.

- NONE - Zero
- SPECIALIZED - One
- MULTIPLE - Two
- GENERALIZED - Three
- COMPLETE - All of them (four)

DATA MANAGEMENT

Which better describes the general situation of the following data management areas?

- **Data quality**
- **Data access**
- **Data integration**
- **Metadata**
- **Data retention/archival**

(Note: if the situation is uneven among these five aspects, this question must be answered based on an average)

- UNAWARE - Data management aspects of the BI initiative are neglected (not even identified), and issues arisen in these areas are treated reactively and left to be solved via improvisation and voluntarism by those involved
- AWARE - Data management aspects are identified and anticipated as possible areas of conflict, and managed (more or less formally) as potential risk for the BI initiative. As a result some mitigating measures may be put in place, but in general, issues are still managed in a reactive way
- MANAGED - Explicit principles and policies are defined in advance to manage the data management aspects of BI. These identify all relevant stakeholders and distribute clear responsibilities
- SUPPORTED - Specific processes and tools are put in place to facilitate and support the effective application of the defined data management policies and principles
- ENFORCED - Accountability for data management aspects is exercised, based on the existence of clear policies and principles, and the corresponding supporting processes and tools. Unexpected conflicts are addressed by new, specific, specialized committees or by existing governing entities officially tasked with this responsibility

SOURCE FUNCTIONAL UNITS ROLE

Which better describes the role of source functional units regarding analytical information requests from other areas?

- UNAWARE - They perceive them as a burden that competes with their 'real' duty. Results are based on voluntarism
- AWARE - They do their best to directly attend them through local, partial, reactive efforts
- PARTICIPANTS - They delegate on an external BI unit, offering clear but limited participation in terms of man-hours when explicitly demanded
- SUPPORTING - They get involved as a whole unit in partnership with the BI unit to deal with specifically demanded tasks
- DATA STEWARDS - They have clear and internalized responsibilities as data stewards and experts in their functional domain and offer systematic, proactive support to the BI unit

USER ENGAGEMENT

Which better describes the role users play regarding data requests in your current BI scenario?

- UNAWARE - They are unaware of the possibility of requesting data from other units
- AWARE - They informally contact other functional units when they need data and expect something in return
- CUSTOMERS - They define fixed requirements through a formal data request to the BI team, and wait until sometime later a result arrives
- DRIVERS - They define initial requirements through a formal data request to the BI team, but continue involved through the development process, guiding it and refining what was initially defined
- CO-OWNERS - They define initial requirements through a formal data request to the BI team, guide actively the development process, and actively promote the effective use and evolution of the resulting data product

DATA PRODUCTS

How many of the following types of data products are being actively offered and maintained in your institution?

- **Parameterized reports**
- **Ad hoc data navigation (i.e., user oriented query tools, OLAP cubes)**
- **Dashboards/scorecards**
- **Advanced analytics (i.e., predictive models, what-if simulations)**

to consider that a data product type is being offered, there has to exist at least one deployment of that data product type in production and under active support.

- NONE - Zero
- LIMITED - One
- EXPANDED - Two
- MAJORITY - Three
- COMPLETE - All of them (four)

USER COVERAGE

How many of these groups are being actively addressed as users by the BI initiative?

- **Management (top level management, local school management, global/local services management)**
- **Administrative staff (global or local services)**
- **Faculties (teachers, researchers)**
- **Students (aspiring, current, alumni)**

to consider that a key user group is being addressed, there has to exist at least one deployment of a data product intended for them in production and under active support.

- ○ NONE - Zero
- ○ LIMITED - One
- ○ EXPANDED - Two
- ○ MAJORITY - Three
- ○ UNIVERSAL - All of them (four)

SUBMIT

B. Feedback Survey

Feedback Survey of
2013 EUNIS BI Maturity Survey

Thank you for giving us the opportunity to understand how the 2013 EUNIS BI Maturity Survey for Higher Education worked as a benefit for your BI journey. This small feedback survey will take less than 15 minutes to complete.

1. Did your institution participate in the 2013 EUNIS BI Maturity Survey?

☐Yes
☐No
If No, go to question 7.

2. If yes, who answered the survey?

☐You personally
☐Someone you delegated in your team
☐ Don't know

3. Before answering the 2013 EUNIS BI Maturity Survey, have you previously heard about EUNIS?

☐Yes
☐No

4. The following figures summarize the structure of the 2013 EUNIS BI Maturity Survey.

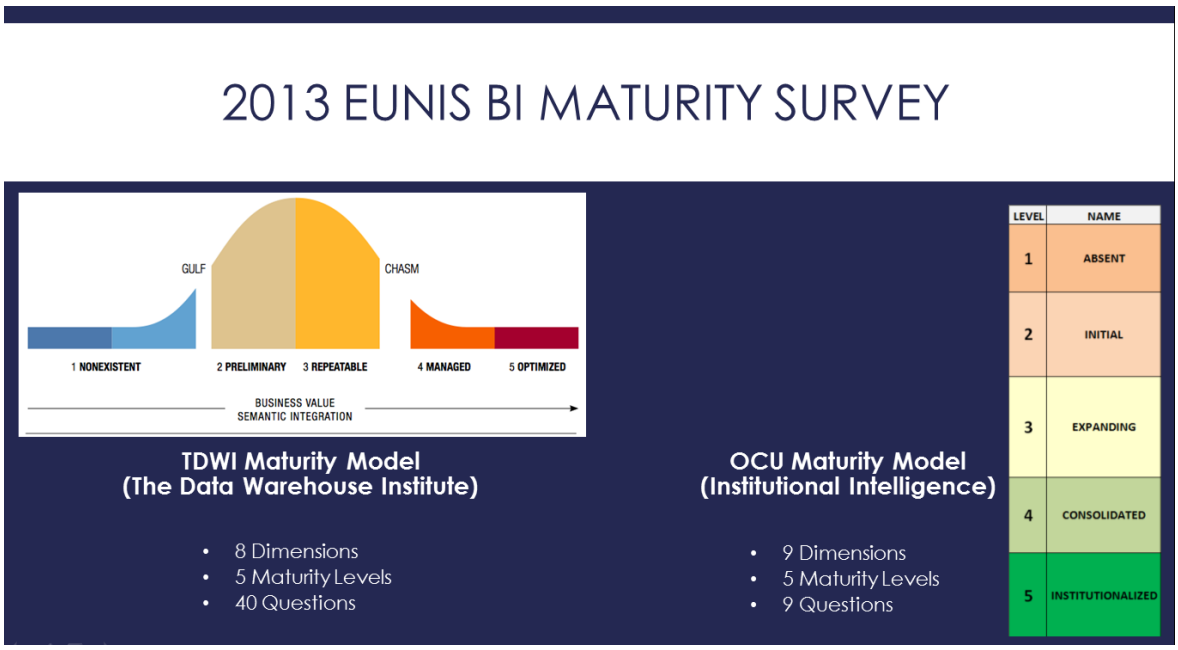


Figure 1 - 2013 EUNIS BI Maturity Survey

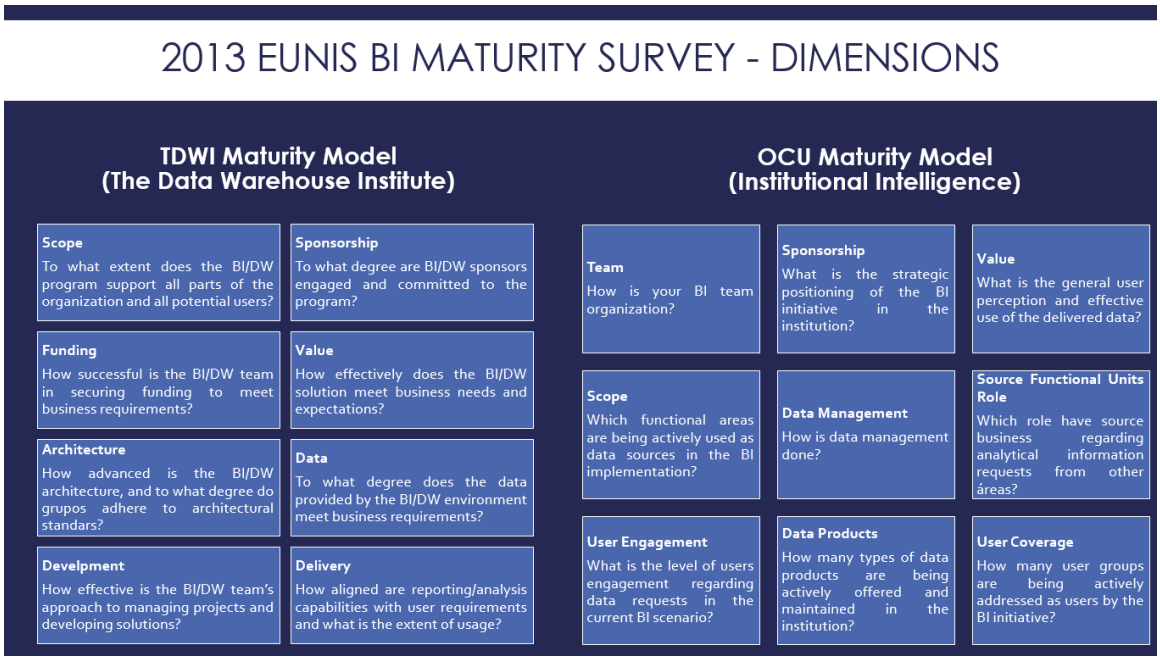


Figure 2 - 2013 EUNIS BI Maturity Survey's Dimensions

4a. Give us your opinion regarding the operationalization of the 2013 EUNIS BI Maturity Survey:

	Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
The survey was well structured.	☐	☐	☐	☐	☐
The time required for answering the survey was according to your expectations.	☐	☐	☐	☐	☐
All concepts were clearly explained.	☐	☐	☐	☐	☐

5. Regardless of the number of years of the BI initiative in your institution, did the 2013 EUNIS BI Maturity Survey help raising the awareness in your team of the different aspects required to successfully implement a BI project?

☐ Strongly Disagree
☐ Somewhat Disagree
☐ Neither Agree Nor Disagree
☐ Somewhat Agree
☐ Strongly Agree

5a. Additionally, did you identify some aspects that your institution has not yet started tackling?

☐No

☐Yes. Please give an example: _____

6. Overall, answering the survey was a positive experience.

☐ Strongly Disagree

☐ Somewhat Disagree

☐ Neither Agree Nor Disagree

☐ Somewhat Agree

☐ Strongly Agree

7. Consider the following definition of Business Intelligence (BI) as an approach that encompasses a broad category of applications and technologies for gathering, storing, analyzing, sharing and providing access to data to help users make better business decisions and reach organizational goals. Which of the following best describes your institution's current understanding of a BI implementation? Please select only one answer.

BI is mainly implemented as a reporting system over the academic information system with manual consolidation of data. Report dissemination to information requests from individual managers.	
Collection, cleansing, transformation, aggregation and format of data for individual/group consumption that originates *spreadmarts* (spreadsheets/desktop databases acting as data marts/DW), run against a single operational system.	
Departmental initiative to implement data marts and the usage of online analytical processing (OLAP) tools, in order to increase awareness and understanding of how the activity of institution has run in the past.	
Consolidation of departmental data marts into a single Data Warehouse, along with sets of parameterized reports or dashboards tailored to different users, daily refreshed and containing Key Performance Indicators (KPIs) that visually depict the performance of the institution.	
Centrally managed data warehouse, built upon a common set of semantic and rules for terms and metrics shared across the institution, populated with all data that all users might need to do their jobs and integrated with real-time data feeds. Reports and dashboards are built using sophisticated analytical tools.	
Centrally managed by a center of excellence, BI is about a data warehouse that lets distributed groups build their own applications within a framework of standards, and which provides users the ability of creating composite applications (tailored, interactive reports and dashboards with incorporate data-driven data capture techniques with rules engines, predictive models, alert notification and workflow processing to monitor and execute the institutional processes in real-time.	

8. Which of the following best describe the drivers of the implementation of the DW/BI system in your institution? Please select all that apply.

Increased level of public accountability required from universities	
Funding constraints and reductions	
Compliance requirements for accreditation systems	

Intense international competition for students	
Other: please specify: _____	

9. Are you aware of a previous unsuccessful attempt to build a Data Warehouse (DW) system in your Higher Education Institution?

☐Yes

☐No

9a. If yes, which of the following reasons were responsible for the lack of success of the DW/BI initiative? Choose all answers that apply.

Weak sponsorship and management support	
Insufficient funding	
Inadequate user involvement	
Organizational politics	
Other, please specify: _____	

10. Do you have any additional comments you would like to share to help us improve the next edition of the EUNIS BI Maturity survey?

_____

_____

_____

_____

All the information provided in this survey will be kept completely confidential and used only for statistical purposes. The results will be analyzed in a dissertation (ISCTE – University Institute of Lisbon, Portugal) and published in the EUNIS BI Taskforce website.

EUNIS BI Task Force

Master in Computer Science and Management
"Developing a Business Intelligence Initiative in Higher Education"
Marta Pinheiro, 2014
Supervisor: Prof. Dr. Elsa Cardoso

C. Interview Presentation

Developing a BI Initiative in Higher Education: Interview

Marta Pinheiro
October 2014

ISCTE IUL
Instituto Universitário de Lisboa

Figure 49 - Interview Presentation: Slide 1

Agenda

- Why are we here today?
- The interview starts and follows the ideias about…
  - … background and BI experience
  - … the feedback about the 2013 EUNIS BI Maturity Survey
  - … the BI journey started in your institution
  - … the overview of the kit proposal
  - … the feedback about BI initiative in your HEI
- Kit Proposal: can it be useful?

Figure 50 - Interview Presentation: Slide 2

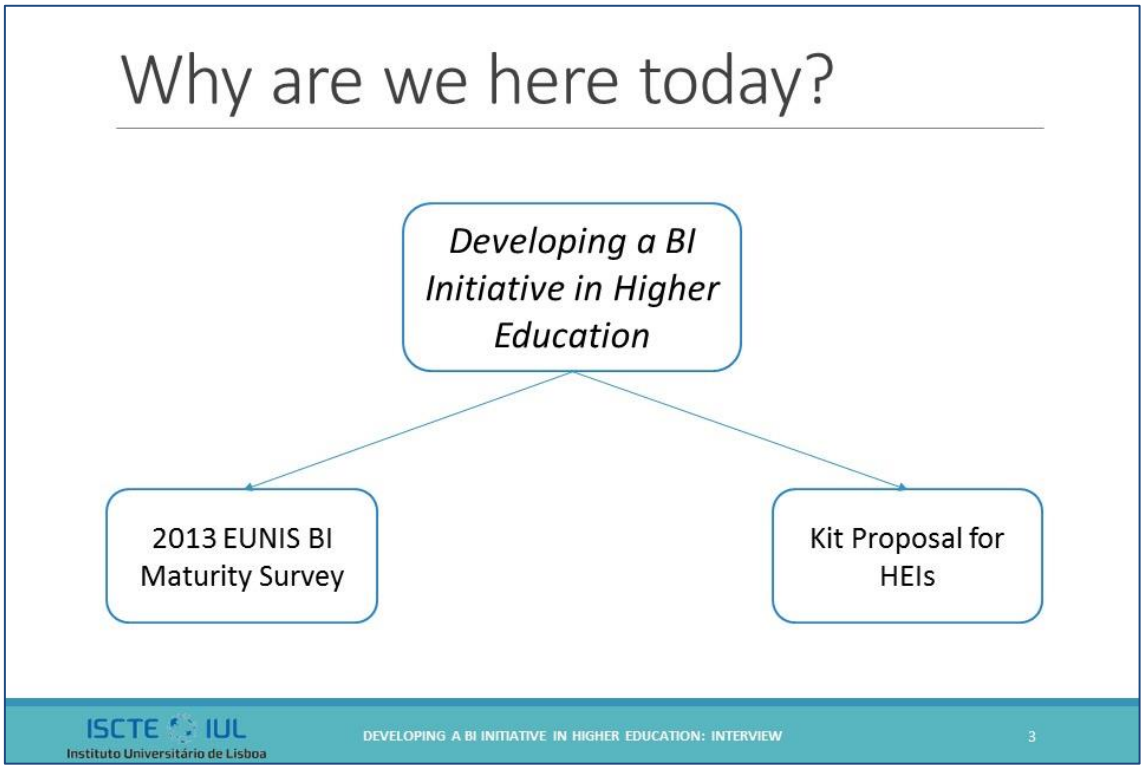


Figure 51 - Interview Presentation: Slide 3

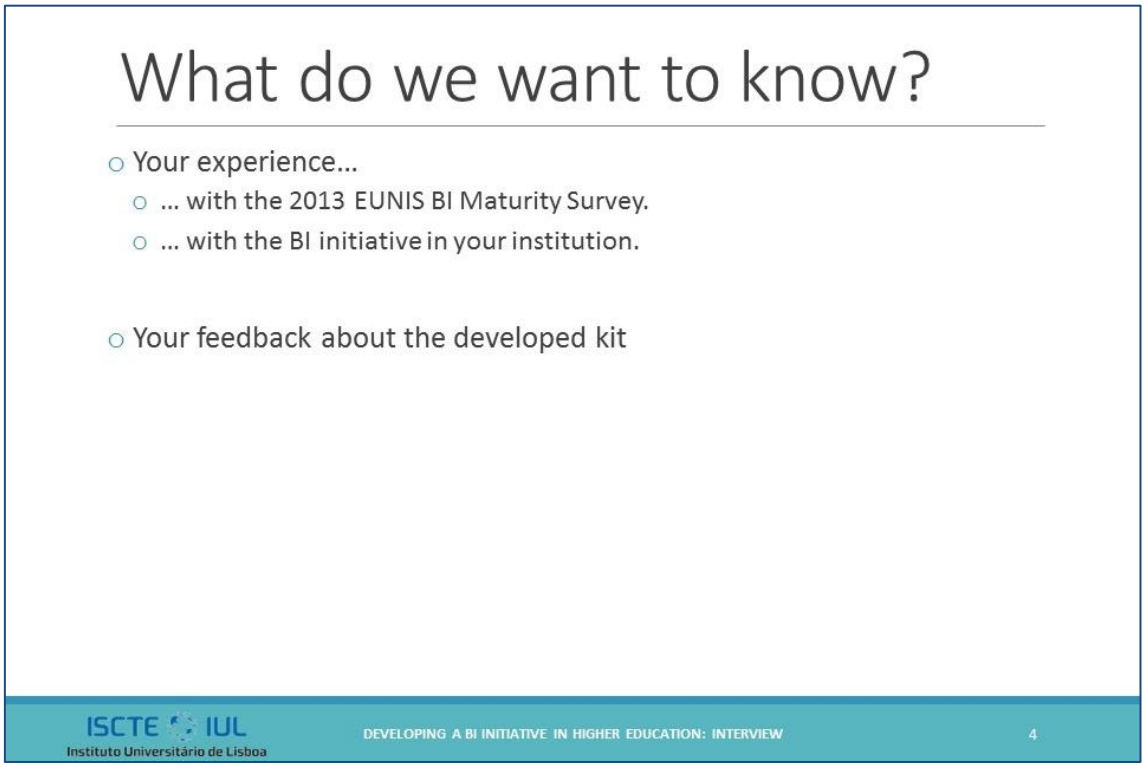


Figure 52 - Interview Presentation: Slide 4

Figure 53 - Interview Presentation: Slide 5

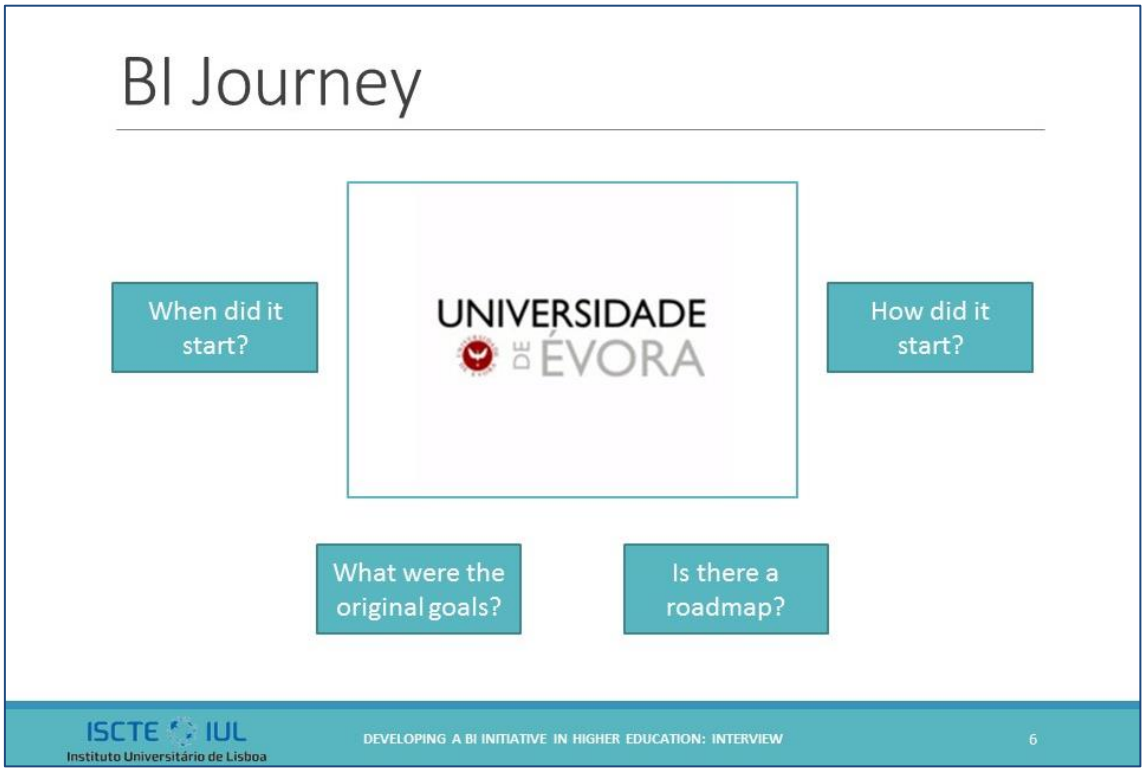


Figure 54 - Interview Presentation: Slide 6

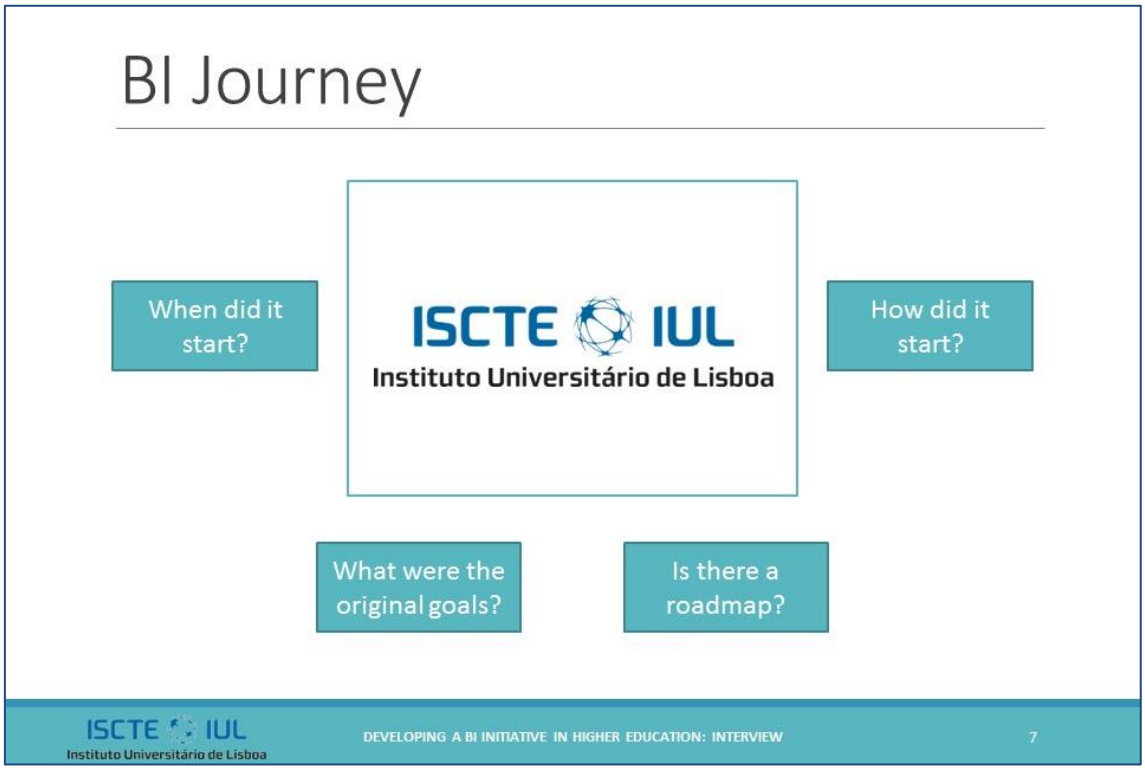


Figure 55 - Interview Presentation: Slide 7

Figure 56 - Interview Presentation: Slide 8

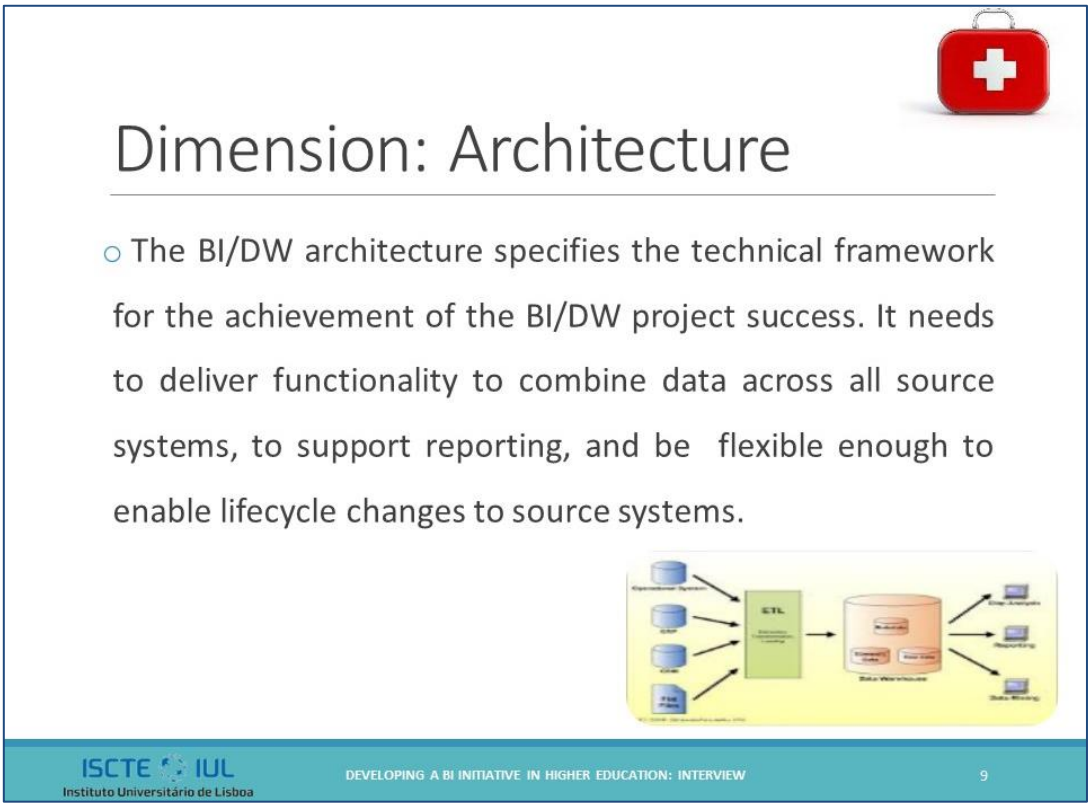


Figure 57 - Interview Presentation: Slide 9

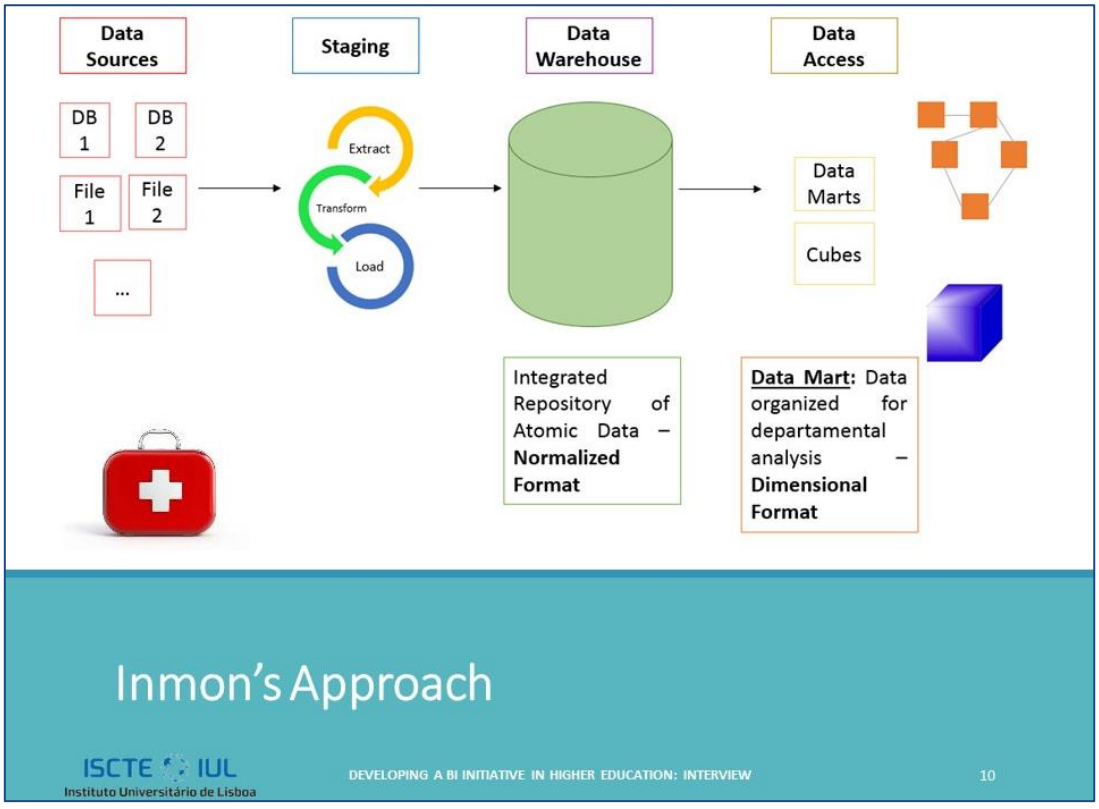


Figure 58 - Interview Presentation: Slide 10

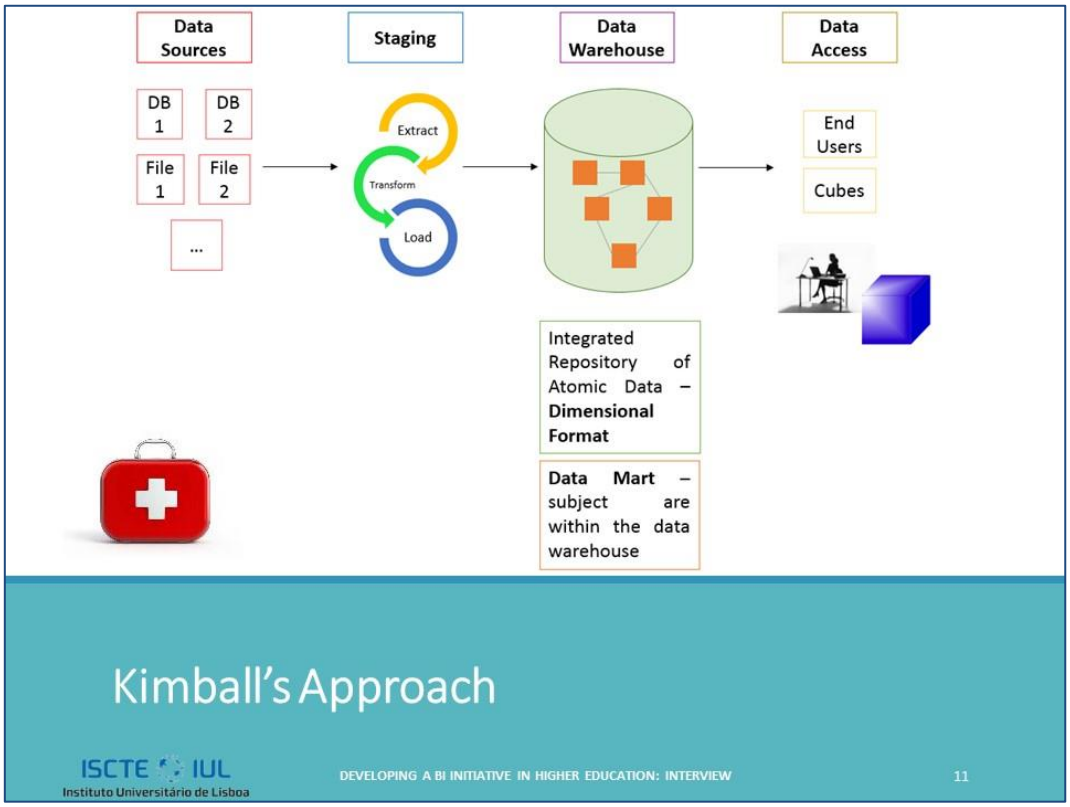
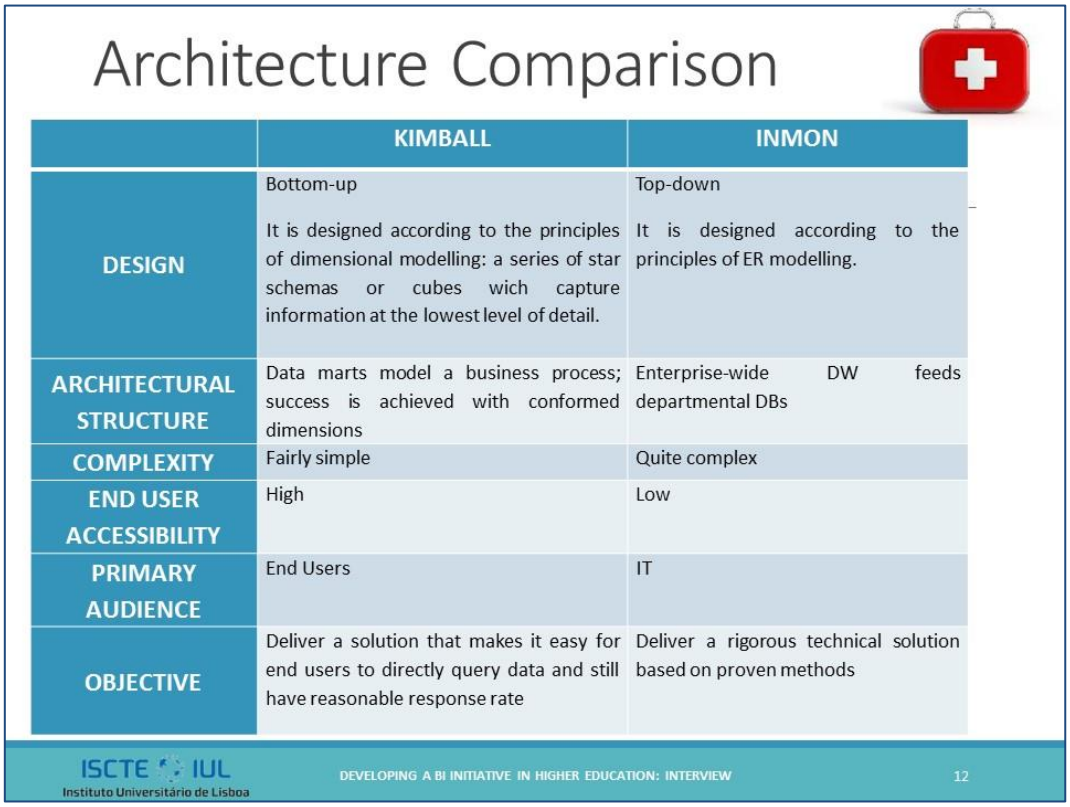


Figure 59 - Interview Presentation: Slide 11



	KIMBALL	INMON
DESIGN	Bottom-up It is designed according to the principles of dimensional modelling: a series of star schemas or cubes wich capture information at the lowest level of detail.	Top-down It is designed according to the principles of ER modelling.
ARCHITECTURAL STRUCTURE	Data marts model a business process; success is achieved with conformed dimensions	Enterprise-wide DW feeds departmental DBs
COMPLEXITY	Fairly simple	Quite complex
END USER ACCESSIBILITY	High	Low
PRIMARY AUDIENCE	End Users	IT
OBJECTIVE	Deliver a solution that makes it easy for end users to directly query data and still have reasonable response rate	Deliver a rigorous technical solution based on proven methods

Figure 60 - Interview Presentation: Slide 12

Figure 61 - Interview Presentation: Slide 13

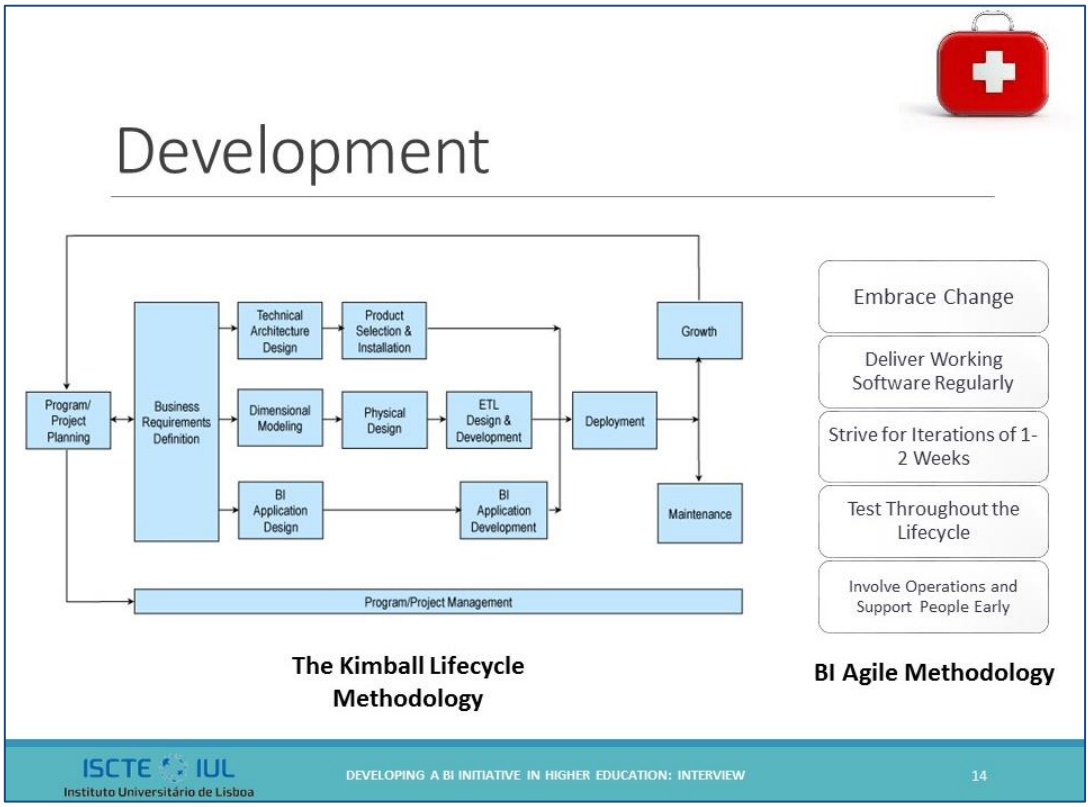


Figure 62 - Interview Presentation: Slide 14

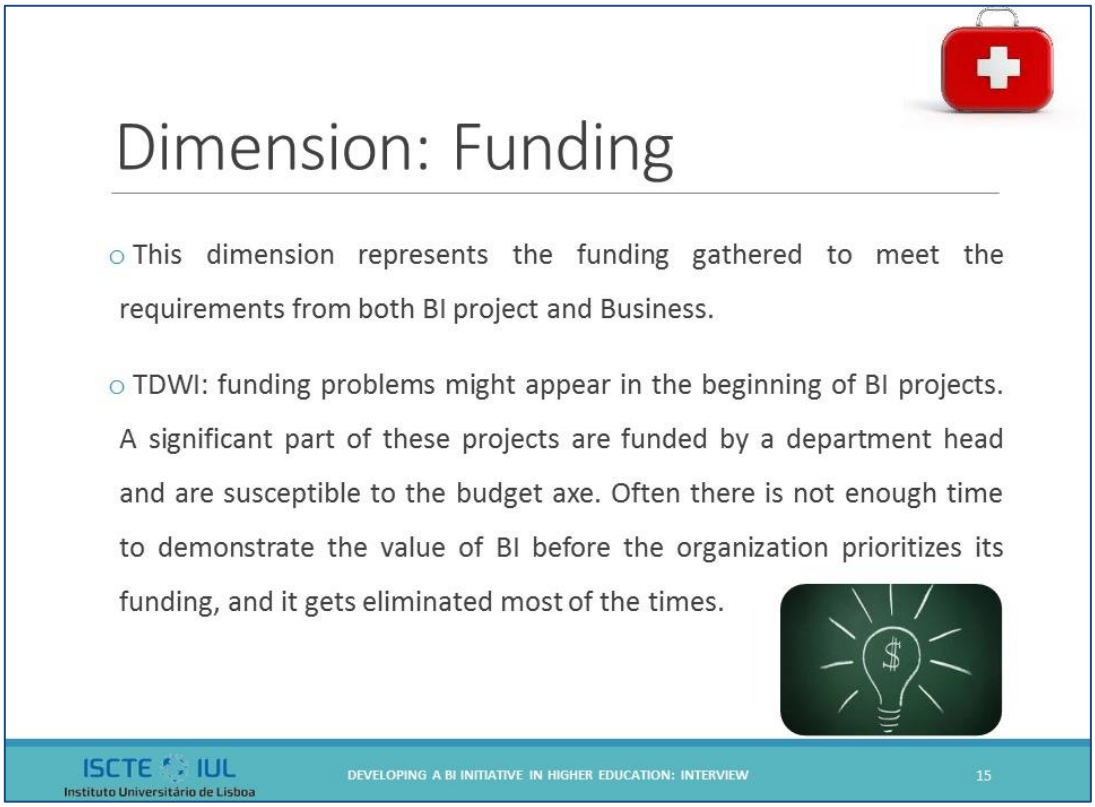


Figure 63 - Interview Presentation: Slide 15

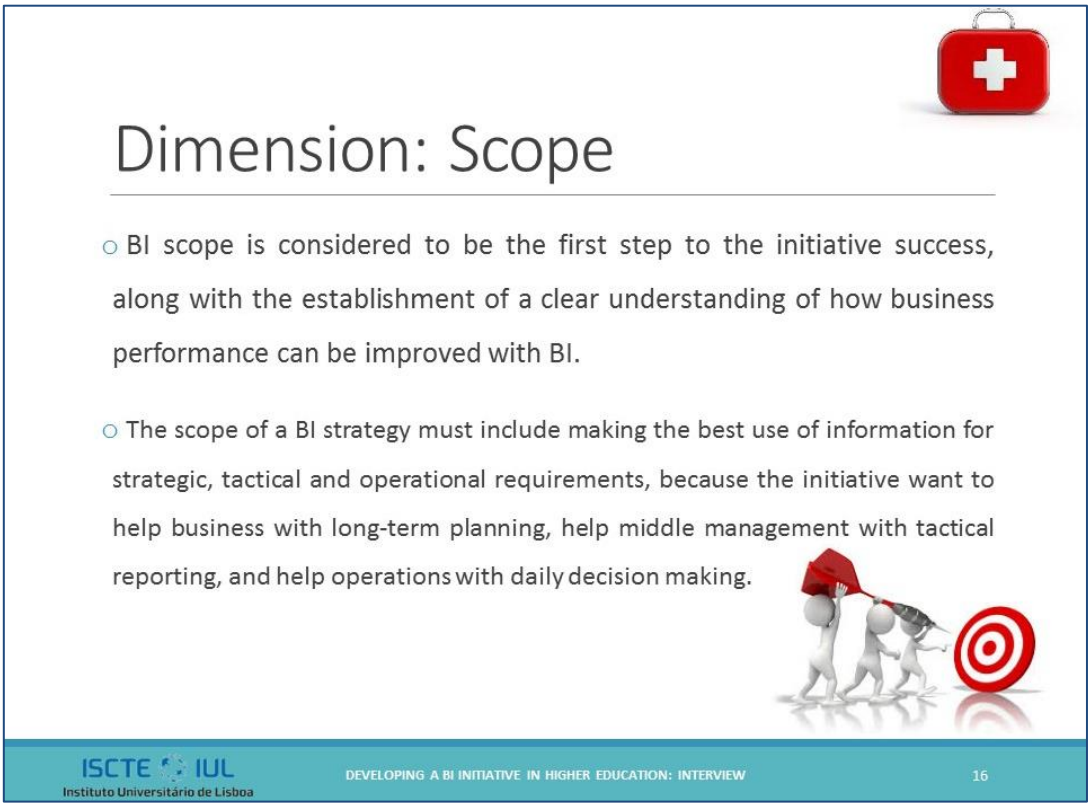


Figure 64 - Interview Presentation: Slide 16

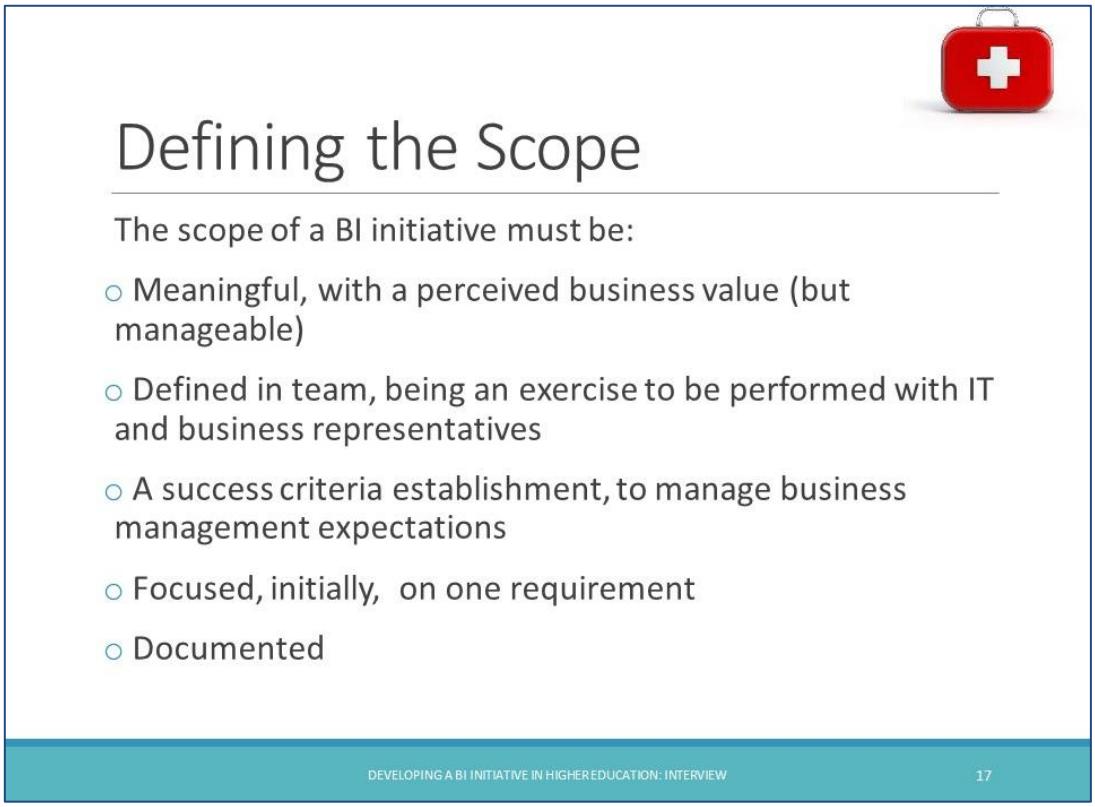


Figure 65 - Interview Presentation: Slide 17

Figure 66 - Interview Presentation: Slide 18

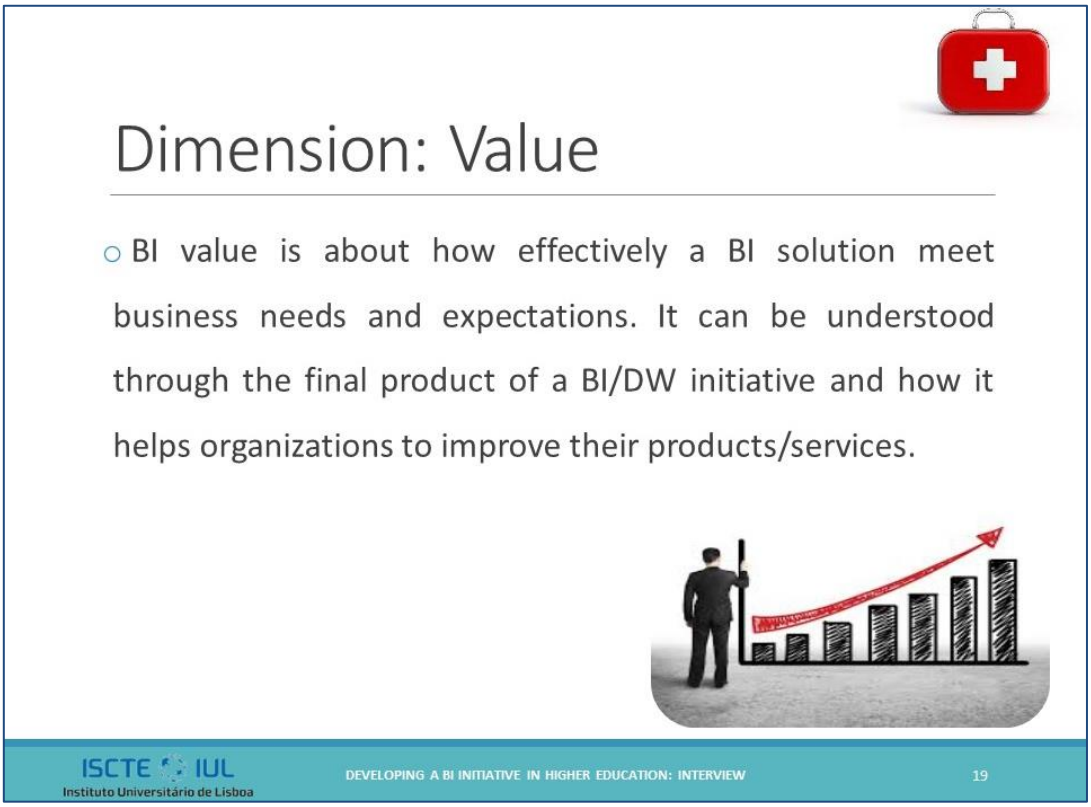


Figure 67 - Interview Presentation: Slide 19

Figure 68 - Interview Presentation: Slide 20

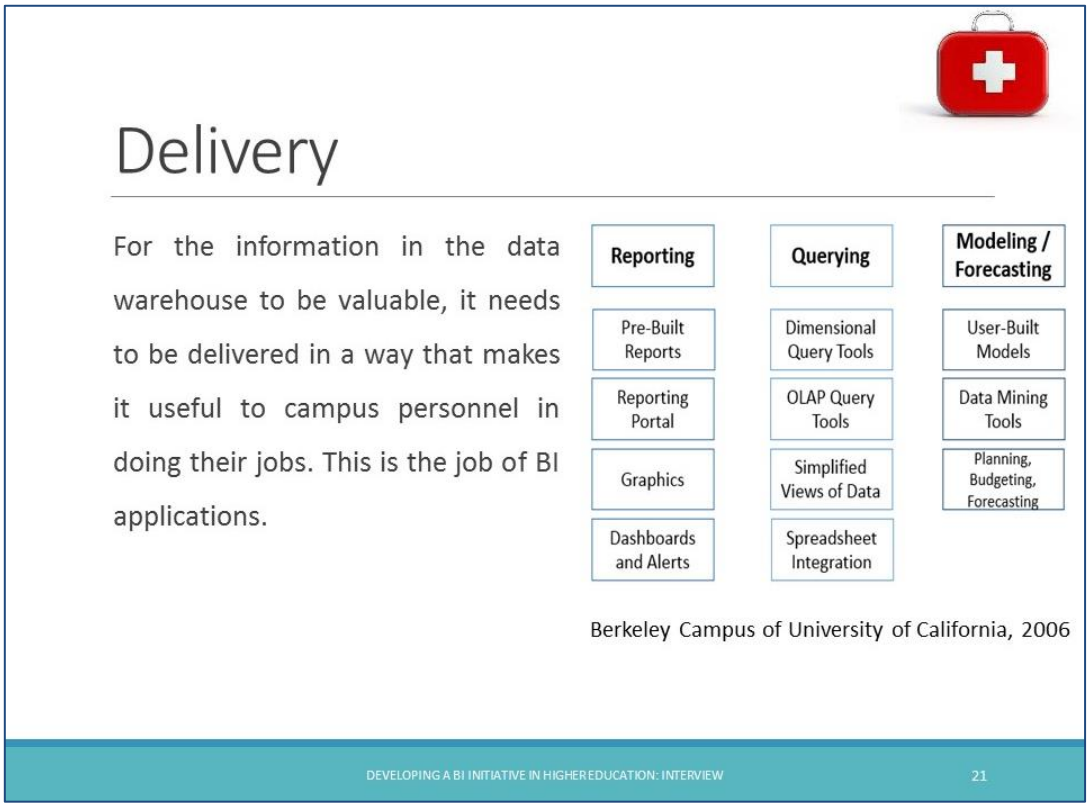


Figure 69 - Interview Presentation: Slide 21

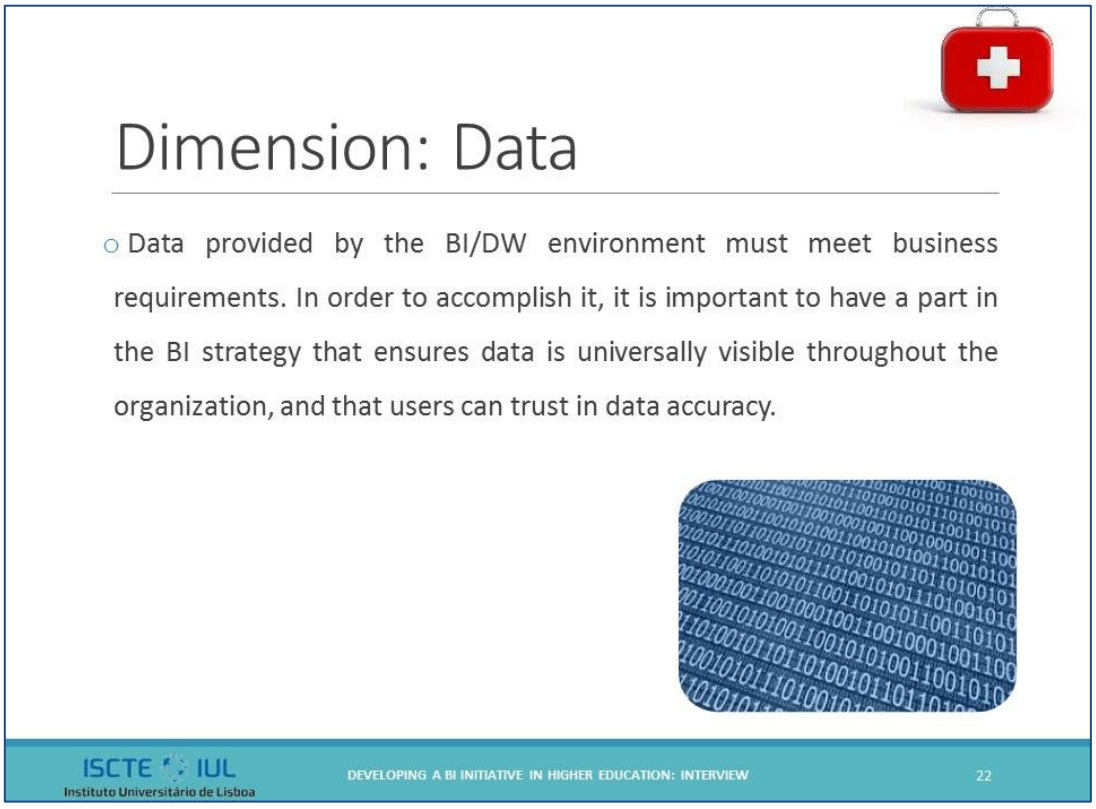


Figure 70 - Interview Presentation: Slide 22

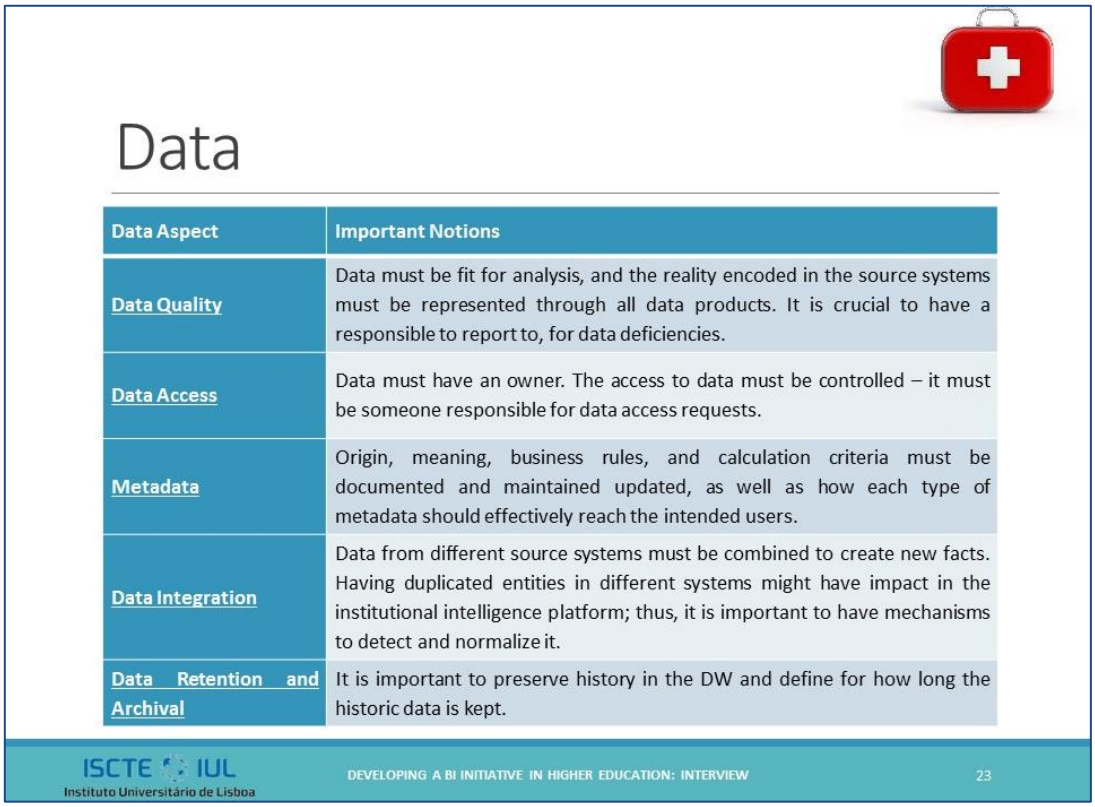


Figure 71 - Interview Presentation: Slide 23

Figure 72 - Interview Presentation: Slide 24

Figure 73 - Interview Presentation: Slide 25