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„Applying the COBIT Process Assessment Model to BI process readiness assessment“

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Andreas Hornich

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Zusammenfassung

Mit einer weltweit täglich ansteigenden Datenmenge, wird die Verfügbarkeit der richtigen Information zum richtigen Zeitpunkt zum Schlüsselfaktor um hochwertige Entscheidungen zu treffen. Business Intelligence Systeme versprechen durch zeitgerechte und qualitative Datenbereitstellung diesen Informationsbedarf zu decken. Trotz der Einführung von Business Intelligence Systemen in einem Großteil der mittleren- und größeren Organisationen, wurden die Erwartungen an Informationen bezüglich Aktualität, Konsistenz und Verfügbarkeit oft nicht hinreichend erfüllt. Der Grund dafür ist meist in inkonsistenten Informationen zu finden, bei denen der Informationsgehalt der verfügbaren Daten nicht zu den definierten organisatorischen Zielen passt. Ein möglicher Lösungsansatz bezüglich dieser Problematik ist die Einführung einer BI-Strategie und unternehmensweiten Standards. Um solch umfangreiche Initiativen umzusetzen, bedarf es zuallererst einer Ist-Analyse, um vorhandene Lücken aufzuzeigen Die vorliegende Masterarbeit schlägt ein Rahmenwerk vor, welchen es Entscheidungsträgern ermöglicht, ihre BI Reife zu beurteilen und dadurch aufzeigt wo etwaige Schwachstellen zu suchen sind. Basierend auf den dadurch identifizierten Schwachstellen, können erforderlich Maßnahmen abgeleitet geplant und schließlich umzusetzen.

Diese Masterarbeit adaptiert Teile des COBIT Prozess Assessment Models (PAM) an die wichtigsten BI-Prozesse, um auf dieser Grundlage eine Prozessbewertung durchführen zu können. COBIT bietet hierzu ein robustes Reifegrad- und Prozessmodell welches sich basierend auf internationalen Standard zu einem weitverbreiteten und etablierten Framework entwickelt hat. Durch die Anwendung einer simplifizierten Version des COBIT PAM können Evaluationen relativ schnell und einfach durchgeführt werden. Die daraus resultierenden Ergebnisse können dann verwendet werden, um die nächsten Schritte in Richtung einer effizienten, wertschöpfenden und informationsorientierten Organisation zu definieren.

Abstract

With a growing amount of data in the world being produced every day, the availability of correct information at the right time in order to make quality decisions becomes a key factor in day to day business. Business Intelligence systems promise to provide such service through delivering information in-time and in-quality. With the introduction of Business Intelligence systems in most of the medium to larger organizations, the expectations of timely, consistent and easy to access information were often not fulfilled. Consequently this produced non consistent information where the output is not aligned with the organizational goals. The answer to this topic could be the establishment of organization-wide BI strategy and standards. Starting such initiatives always demands an as-is analysis in order to plan and implement necessary measures. This thesis is proposing a framework which allows decision makers to assess their BI maturity upfront and revealing where the most serious weaknesses occur. Based on that gaps between target capabilities an current state can be identified and improvement plans can be commenced.

This thesis adapts parts of the COBIT Process Assessment Model (PAM) for maturity assessment based on the main BI processes. A well established framework such as COBIT provides a robust maturity and process model compliant with international standards. By applying a simplified Version of the assessment process BI capability evaluation can be performed relatively fast and easy. The results can then be used to define the next steps in order to transform the status-quo into a more efficient and value adding information-driven organization.

Chapter 1

Introduction

The BI landscape in organisations has been evolved in recent decades along with rapidly changing business and IT requirements. Such historically grown landscapes often result in a heterogeneous BI system with a variety of applications and tools in use. BI systems vary from Management Support Systems, producing paper based reports, to complex analytical in-memory systems. Additionally, most departments and employees using spreadsheet tools to analyse relevant data for their daily business. [Gan13, cf. p.14]

"More than half of all BI (Business Intelligence) programmes and projects are either never completed or fail to deliver features and benefits that are optimistically agreed on at their outset."[Atr03, cf.] Reasons vary from insufficient data quality to inadequate executive support.

The scope of this master thesis is to identify the necessary processes of successful information-driven organisation and then, based on that, implement a framework that allows decision makers to assess the maturity of the existing Business Intelligence processes.

This process assessment is based on the well-established governance framework COBIT, developed by ISACA (Information Systems Audit and Control Association). The final result will provide a self-assessment framework revealing the strength and weaknesses of the organisation, showing where improvements regarding their BI related processes are necessary. Developing a process assessment framework, which meets the requirements of modern organisations, also needs to be simple to execute, and should be easy to interpret. At the bottom line, the output enables identification of how well the organizations' analytical processes are developed for providing information in the expected manner and in which areas improvement is necessary.

1.1 Motivation and Problem Description

Today, organizations face a highly competitive and constantly changing market. In the last decades the globalization of the markets led to a situation where gaining competitive advan-

tages became more and more difficult. One of the major driver of competitive advantage can be the information provided by Business Intelligence systems. It allows organisations to improve revenues, manage costs and improve customer satisfaction. According to [GG88] organisations with a "structured Business Intelligence programme are better able to track current and potential competitors, analyse markets, develop profitable new products, determine likely candidates for acquisition or merger, monitor technological developments, keep abreast of a broad range of political, economic, social and legislative trends with significant impact on a company's future."[GG88] Therefore BI is being perceived as a top technology priority for some years now and has recently been perceived as a top businesspriority too. [LBZ09, Moo14].

IT and Business understand that Business Intelligence represents on of the best opportunity to gain insight in business processes and develop decision making capabilities. This will help organizations to identify new opportunities and increase efficiencies to better reach strategic goals.

"Yet, many organizations are struggling to implement strategic BI initiatives that can help improve enterprise-level access to the information needed to support business improvement. After decades of building the information infra-structure and amazing oceans of data, it seems many organizations have found themselves with silos of knowledge that are difficult to reconcile, complex to comprehend, and limited in their ability to provide the needed insight"[BFG+10, cf. p.1].

1.1.1 Problem Description

Although the concept for information management and business intelligence are relative mature, efficient implementations still seem to be a big challenge for organizations. "Only 14 percent of organizations are connecting strategy to execution with these technologies. At the same time, 67 percent of these organizations claim that there is a lack of time, resources, and budget applied to these efforts."[BFG+10]

Obviously there is a gap between the information requirements of business and the actual information delivered by business intelligence programmes. The reasons why so many BI initiatives fail are myriad. [Atr03] points out that BI projects are not similar to common IT programmes "BI is neither a product nor a system. It is rather, a constantly evolving strategy, vision and architecture that continuously seeks alignment with the organization's operations and directions with its strategic business goals."[Atr03]

Therefore, not only the introduction of a new system but also the enhancement and maintenance of an existing BI solution requires detailed knowledge and experience in many areas. Furthermore, successful BI projects need to meet various requirements on technical and organizational levels.
Initiatives are often treated solely as a technology implementations. Thus many issues are organizational in origin and may not be reflected when the program is rolled out.

[BFG+10] identified the following major issues within business intelligence programmes:

- no strategy in place
- no metrics to define or measure success
- no business case for the endeavour
- no demonstrated justification of the value
- lack of executive buy-in
- no organizational structure for BI

The lack of a suitable organisational framework often lead to the following symptoms [Gan13, cf. p.16]:

Bad data quality

The quality of data is crucial to the success for the measures that are introduced based on the analytical outcome. Nevertheless, the actual quality of the data is either not enough or possibly even unknown. The data basis of the decision is doubtful, so the business decision may be incorrect or based on a high degree of uncertainty.

Unclear data origin

Depending on the organisational structure and size of the company, it is sometimes not clear which external or internal data sources and systems provides the data, which is then used to answer the analytical questions. The origin of data is unclear or even undefined.

Undefined analytical processes

The way how analytical questions can be answered off-division or across organizations is not defined clean. Often data provisioning is associated with manual effort or spontaneous ingenuity. Using different data exchange processes, interfaces and tools, data is collected and analysed rather uncontrolled. This is inefficient and causes data inconsistencies. A typical symptom of undefined analytical processes are the so-called spread-marts, where semi-automated or manual sourced data by question or application will be individually compiled and processed.

[SSY+09] summarizes the problem as following: "Systems supporting the BI concept require business process-IT alignment in the sense that they should provide functionality useful for achieving the business goals and therefore demands:

> "We need a business process-IT alignment method for BI covering all variations. In addition, it is essential for people engaged in BI to convince enterprise management that their proposed hypotheses and the actions necessary to implement them are comprehensive and rational. This means that a kind of framework used

to clarify and organize the hypotheses and the actions is required." [SSY+09, cf. p.47]

1.1.2 Envisaged Solution

The ultimate goal for an organisation should be to reach out for BI excellence. [BFG+10] defines BI excellence as "enabling of execution of a more effective business strategy with the right technology, people, and processes in place". In order to achieve BI excellence [Gan13] is proposing a method of continual improvement analogous to the strategic development plan of organisations. It consists of the following steps.

As-Is Analysis
Describes the as-is situation of the organisation as well as the rough requirements.

BI Maturity
Assessment and evaluation of the status-quo against the requirements as well as against other organisations.

BI Concept
Definition of Vision, Goals, Information availability, future architecture and tool portfolio.

BI Roadmap
Development of a gradual measurement plan and project portfolio for a successively implementation of the BI concept.

"Continual improvement requires the company's positioning with regard to its BI capabilities and the quality of its goods and services. This positioning involves a comparison with the company's goals, external requirements or benchmarks."[BKP09] To come to an objective and comparable assessment of an organisations position is requiring a great amount of effort and is a difficult exercise. "For each aspect of the company's IT under investigation, the questions arise what needs to be measured and how, and what to compare it with, in order to assess the as-is situation of a company and to assign it a specific quality or degree of maturity. IT management therefore needs supportive tools to assess the as-is situation of a company, derive and prioritize improvement measures and subsequently control the progress of their implementation."[BKP09] The common way to master this challenges is to make use maturity models comparing the existing processes to industry standards.

"A maturity model consists of a sequence of maturity levels for a class of objects. It represents an anticipated, desired, or typical evolution path of these objects shaped as discrete stages. Typically, these objects are organizations or processes. The bottom stage stands for an initial state that can be, for instance, characterized by an organization having little capabilities in the domain under consideration. In contrast, the highest stage represents a conception of total maturity. Advancing on the evolution path between the two extremes involves a continuous progression regarding the organization's capabilities or process performance. The maturity model serves as the scale for the appraisal of the position on the

evolution path. It provides criteria and characteristics that need to be fulfilled to reach a particular maturity level. During a maturity appraisal, a snap-shot of the organization regarding the given criteria is made. The characteristics found are evaluated to identify the appropriate organization-individual maturity level. The application of maturity models can be supported by predetermined procedures, e. g. by questionnaires. Based on the results of the as-is analysis, recommendations for improvement measures can be derived and prioritized in order to reach higher maturity levels" [BKP09].

"Studies have shown that more than a hundred different maturity models have been proposed"[DBFKR05]. The "constant publication of new maturity models for often fairly similar applications, however suggests a certain arbitrariness. The authors of the maturity models only rarely reveal their motivation and the development of the model, or their procedural method and the results of their evaluation." [BKP09].

[SSR06] is proposing a Capability Maturity Model (CMM) which is derived from classical software engineering as a framework for BI auditing. Additionally, Mummert Consulting introduced BIMM (Business Intelligence Maturity Model) in 2004. However, CMM has a strong focus on the application development process and often leaves the holistic point of view to be desired. The problems on the organizational and process level are often left behind technical aspects. Also, the question of business process alignment is often not covered in a satisfactory manner. As mentioned above BI must not be treated as classical IT programmes as they demand a strong focus on business alignment and business knowledge. Looking at the alternatives soon leads to more holistic IT Governance frameworks. In this area one of the most relevant existing method is COBIT.

This thesis therefore proposes a BI Maturity Model based on the COBIT process assessment model. The aim is the development of a framework which allows to assess BI maturity considering the multi dimensionality of problems and their special needs. Such "assessment is essential for good monitoring, enhancement and management of existing BI governance processes and structures. In particular, by using a method for measuring BI maturity, it is possible to compare and rationally select between potential future scenarios."[SJW07, cf. p.3] In addition the results can be used to compare organisations against others and identify existing potential and gaps.

"COBIT, issued by the IT Governance Institute (ITGI), is a set of guidelines IT organizations can use to employ management best practices, measure IT processes and align IT with business processes. It has become a recommended tool for IT departments to measure their value to the business." [Hol06] The framework "provides the effective measures, indicators and activities for enterprise. It has also been applied to the other governance needs, e.g., software process, security governance, IT service management."[Mor09, p.1] Developed by the IT Governance Institute (ITGI) and Information Systems Audit and Control Association (ISACA) in 1998, it has been under constant development ever since. COBIT describes the IT organization through 37 processes, divided among five domains:

- Evaluate, Direct and Monitor (EDM)
- Align, Plan and Organise (APO)

- Build, Acquire and Implement (BAI)
- Deliver, Service and Support (DSS)
- Monitor, Evaluate and Assess (MEA)

"Each domain is divided into several processes and a set of detailed descriptions and statements of the desired results to be achieved by implementing control procedures for the processes. Lists of inputs and outputs for each process are provided. Each process has a corresponding process assessment model (PAM). COBIT is a frequently used, best practice based framework, and its adoption in various areas is described in several case studies. COBIT models are intended to be tailored and developed to suit specific needs of the enterprise." [SJW07, cf. p.5] COBIT meets adoption needs because it does not prescribe the assessment approach. "Ranging from a high-level workshop discussion to an in-depth analysis, it is driven by business needs. COBIT based models provide management with a self-assessment tool for positioning IT capability in comparison to business requirements."[SJ06, SJ08, Ins07]

This thesis will present, how a tailored COBIT process assessment model can serve as a tool for an easy to implement BI maturity assessment. It should cover not only technical processes but also addresses questions of expertise, organization and business strategy alignment in BI projects. Through the utilisation of an already established framework a proven and stable underlying model enables profound analysis results. The utilization of COBITs Self-Assessment approach will keep executions costs, both monetary and time, at a minimum level. The results can be used for the continual improvement of the organisations' BI capabilities and lead the way to BI excellence.

Based on that the following research questions can be formulated.

RQ1: Is it possible to adapt COBIT Process Assessment to the specific area of Business Intelligence?

RQ2: How applicable is COBIT Process Assessment model for Business Intelligence process assessment?

1.2 Structure of the thesis

The structure of this thesis is divided into two main parts: a theoretical part, which defines the field of Business Intelligence as well as COBIT in the context of IT Governance. Subsequently the practical part follows, in which the application of the COBIT framework for the area of Business Intelligence will be described. In the practical section the detailed development process of the model is outlined.

Chapter 2 will briefly describe the historical development to modern business intelligence systems and give an overview of current typical BI system landscapes. Based on that, technical and organisational aspects of Business Intelligence will be explained and major processes of successful BI will be identified.

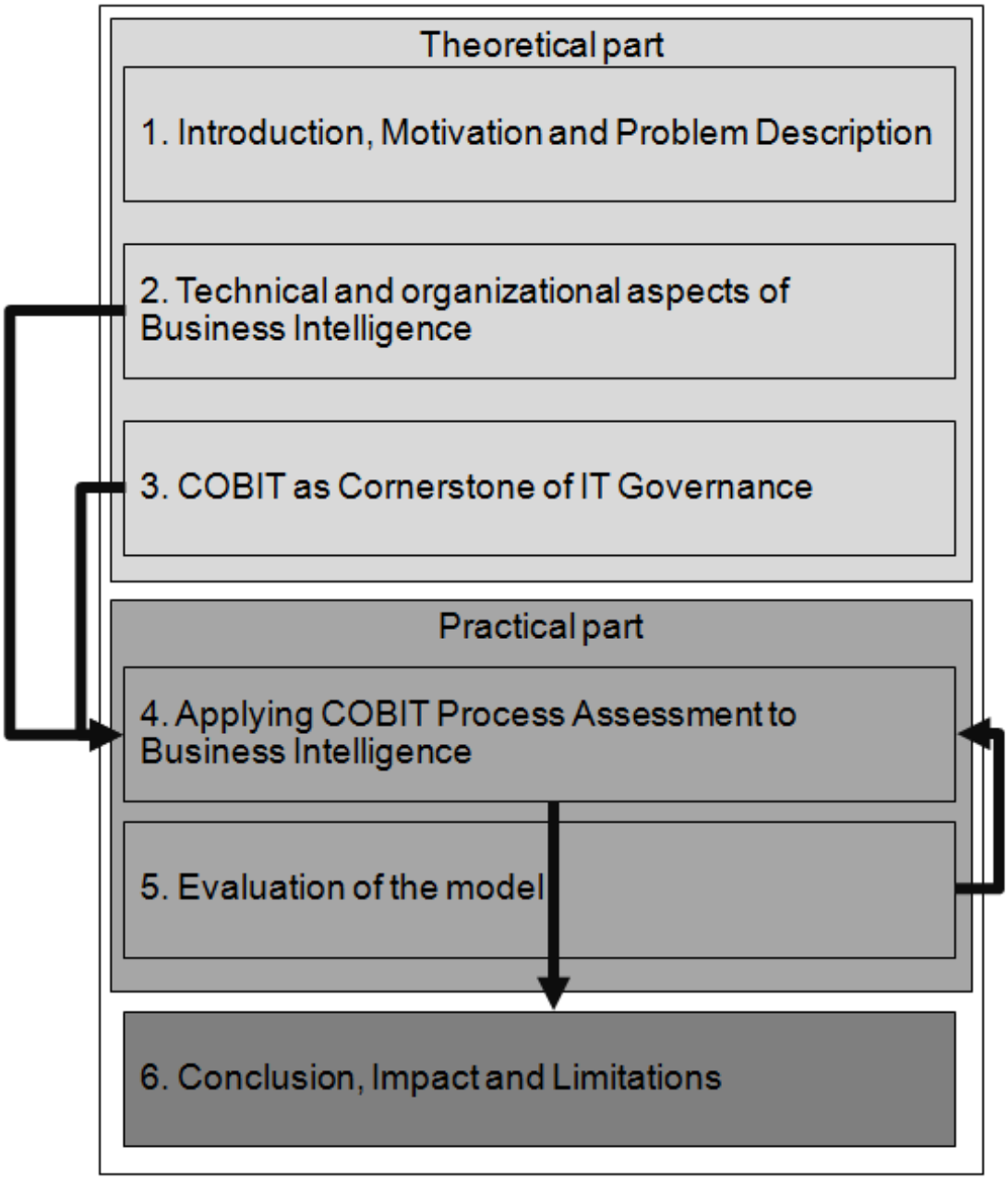

Figure 1.1: Structure of the thesis

Chapter 3 gives an outline to the area of COBIT and its application. First, the development history of IT and BI Governance and the context within Corporate Governance will be explained. After that the presentation of the current version of the COBIT framework, focusing on the parts used in the BI Process Assessment, will follow.

Through defining the technical and organisational aspects of BI as well as the application of COBIT in the context of IT Governance in the previous chapters a comprehensive starting point for the following chapter has been established.

Chapter 4 briefly describes the initial situation in the area of BI maturity assessment based on the information provided in the previous chapters. After that, the development of the COBIT based BI Process Assessment Model will be outlined. Based on an expert questionnaire, the initial model will be further refined. In conclusion, the practical use of the models will be described.

In order to test the applicability of the model proposed initially, chapter 5 describes the evaluation process. The model will be evaluated by an empirical evaluation technique, a survey by means of expert interviews. The method was used to check how sound and complete the proposed processes and capability dimensions are.

In conclusion the final chapter describes the major findings, including impact limitation and possible future steps of the presented modell.

Chapter 2

Technical and organisational aspects of Business Intelligence

This chapter will briefly describe the historical development of modern business intelligence systems and give an overview of a typical state-of-the-art BI system architecture. Based on that, technical and organisational aspects of Business Intelligence will be explained and major processes, necessary for an information driven organisation will be introduced.

2.1 Development History of Business Intelligence

BI was initially a collective term for analysis front-end tools. Nowadays the understanding broadened and the meaning of BI covers all components of an integrated decision support infrastructure [BK08]. In modern BI systems, data from operational systems is gathered and structured in a way analytical front-ends can present the data in various ways in order to create valuable information. This means that the term BI nowadays also covers various areas like Management Support Systems and Decision Support Systems which were the foundation of the development in this area.

2.1.1 Management Support Systems

Management Information Systems

With the increased use of dialogue and transaction systems and the growing storage volume, the requirement to derive information from databases in order to use it for planning and control purposes became an increasingly pressing issue. [GGD08, cf. p.55] Since the 1960s data is gathered with the help of various types of database systems. Looking at a vast amount of data, organizations always tried to use the information in the best possible way [Fer99].

This led to the emergence of the so-called Management Information System (MIS). Management Information Systems allow management on all levels to extract detailed and aggregated data from operational systems. The extraction itself is commonly not enriched by complex data models or algorithms. Therefore, Management Information Systems does not offer tools like result structuring or problem solving support to the end user. Due to the lack of dynamic user interaction Management Information Systems are mainly applied in the area of standard reporting where user interaction is not necessary. Based on the base systems, even nowadays Management Information Systems can be found in a majority of organisations. The basic operation consists of sending predefined parametrised algorithms to the database where a result set is being calculated. The results are then presented in standard reports. The reports are then usually distributed in a printed version. The focus of MIS lies on the day-to-day business reporting and aims to support the lower- and middle management in short- and middle-term decision making. [GGD08, cf. p.55] The original Management Information Systems had neither functions for mapping large models nor approaches to algorithmic problem solving processes. Thus, the user had to manually perform appropriate processing steps himself. This original approach of MIS failed in particular, because instead of removing the information deficit, it resulted in a flood of information without adequate preparation, cleaning and aggregation. In the 1990s, the Management Information Systems experienced a revival, in which the MIS was separated into manageable parts. Management Information Systems nowadays offer an aggregated view through standard reports. They provide a set of operative control instruments with a short-and medium-term decision horizon for the lower and middle management. [GGD08, cf. p.58]

Decision Support Systems

In contrast to management informations systems (MIS), Decision Support Systems (DSS) provide a comprehensive method stock ranging from descriptive models to optimisation methods. DSS are oriented towards the decision behaviour of professionals and managers. [GGD08, cf. p.62]

DSS can be defined as computer systems which assist decision-makers with decision process models, methods and problem-adequate data supply. The main focus of Decision Support Systems lies in supporting the operational management in solution finding of structured and semi-structured problems. The main focus in operating a DSS is the problem structuring, and the alternative solution generation.

With the increasing number of personal computers, in the 1980s, spreadsheet programs became more and more popular. Since then, DSS were implemented by various users, on the basis of numerous electronic calculation worksheets. The application was, however, often ad-hoc and for a single use only. From this point, the first serious problems began to appear. Decision support systems were not able to provide managed and enterprise-wide process models for information provision. Instead systems for special sub-problems were developed. Nowadays classic DSS hardly play a role.[Gan13, cf. p.26]

Executive Information Systems (EIS)

Due to the growing network of computer systems and increasingly powerful personal computers in the 1980's, EIS were developed. Through this technology completely new forms of presentation and access to information was possible. This promised a new quality of information processing and timeliness. EIS are dialogue- and data-oriented information systems for management with strong communication elements. They offer current, decision-relevant as well as internal and external information to specialists and executives through an intuitively usable and customizable user interface. Through building multidimensional data models, an individual and tailored information delivery could be established. [Gan13, cf. p.27]

In general, MIS, DSS and EIS are often referred to as management support systems (MSS). In the context of modern IT architecture, management support systems are usually not standalone any more, but can be seen as specialized applications within the overall context of an Information system architecture.

2.1.2 Data Warehouse

Based on the progressive development of management support systems, a further step towards information maturity has been achieved through integration of data applying the data warehouse concept. A Data Warehouse (DWH) is an enterprise-wide system which integrates relevant data for decision-making and serves as a so-called Single Point of Truth.[CG06, cf. p.12]

The term Data Warehouse was published the first time by [DM88] in 1988. However, it received increased attention when [Inm92] defined 4 key feature a DWH is determined by. These are:

Topics orientation The purpose of the system is not the fulfilment of an isolated task, but the modelling of cross-applications

Standardization Data from different sources (internal and external) are harmonized and merged

Durability Data is maintained in the long term in its original form

Time orientation Data history is available, so that changes can be analysed in the structure and content over a long period of time

In contrast to its origianl purpose, the range of DWH users of today is no longer limited to the management of a company. But rather all people that require data in the above form are nowadays seen as information customers.

Additional technological advances changed the DWH concept. In the past, only applications with long time latency were considered necessary. Today, even real-time enabled data warehouse architecture is not uncommon any more.

Recently and in contrast to the original DWH concept a broader approach has been established. The increasing operationalization of the DWH concept is reflected in the literature in terms of information logistics which follows a more holistic approach, including strategy, organisation and information systems. The DWH is not any more an special application but rather an important subsystem of the complete information infrastructure and organisation.[MW03, cf. p.2]

2.1.3 Business Intelligence

To take into account the variety of options for management support and due to the ongoing development of the information systems, the term "Business intelligence" was created. This phrase was first used in a 1996 Gartner Group report.

> "Data analysis, reporting, and query tools can help business users wade through a sea of data to synthetic size valuable information from it. Today synthesis tools collectively fall into a category called Business Intelligence."

"The concept of business intelligence (BI) provides information for achieving business goals such as improving profits or solving business process issues is becoming important. The BI systems supporting the concept require business process-IT alignment in the sense that they should provide functionality useful for achieving the business goals. However, BI systems in reality vary from system to system depending on the maturity of the target enterprises and the quality of data available. For example, in some cases, users require such functionality as visualization of key performance indicators (KPIs) and related data using online analytical processing (OLAP) tools, while in other cases they require validation of hypotheses for achieving business goals using data mining methods, or support of actions implementing the hypotheses."[SSY+09, p.47]

"In summary, business intelligence can be understood as an analytical process which transforms the organisational data as well as the competitive data into actionable knowledge in order to support decision making"[Gan13, cf. p.29]. As every IT system, BI consists of technical as well as organisational parts. These two factors will be examined in the following two chapters.

2.2 Business Intelligence technical architecture

To get a better understanding of the manifoldness and the variety of the corresponding organisational impact this chapter gives an overview of the major BI components. [OSW11] researched several existing BI architectures in literature and defined the common components of BI architectures.

He defines BI systems based on a five-tier referencee architecture considering value, quality of data as well as information flows.

- Data Source

- ETL (Extract-Transform-Load)
- Data Warehouse
- End User
- Meta data

These layers and its interactions towards each other are represented in figure 2.1 and will be described in the following sections.

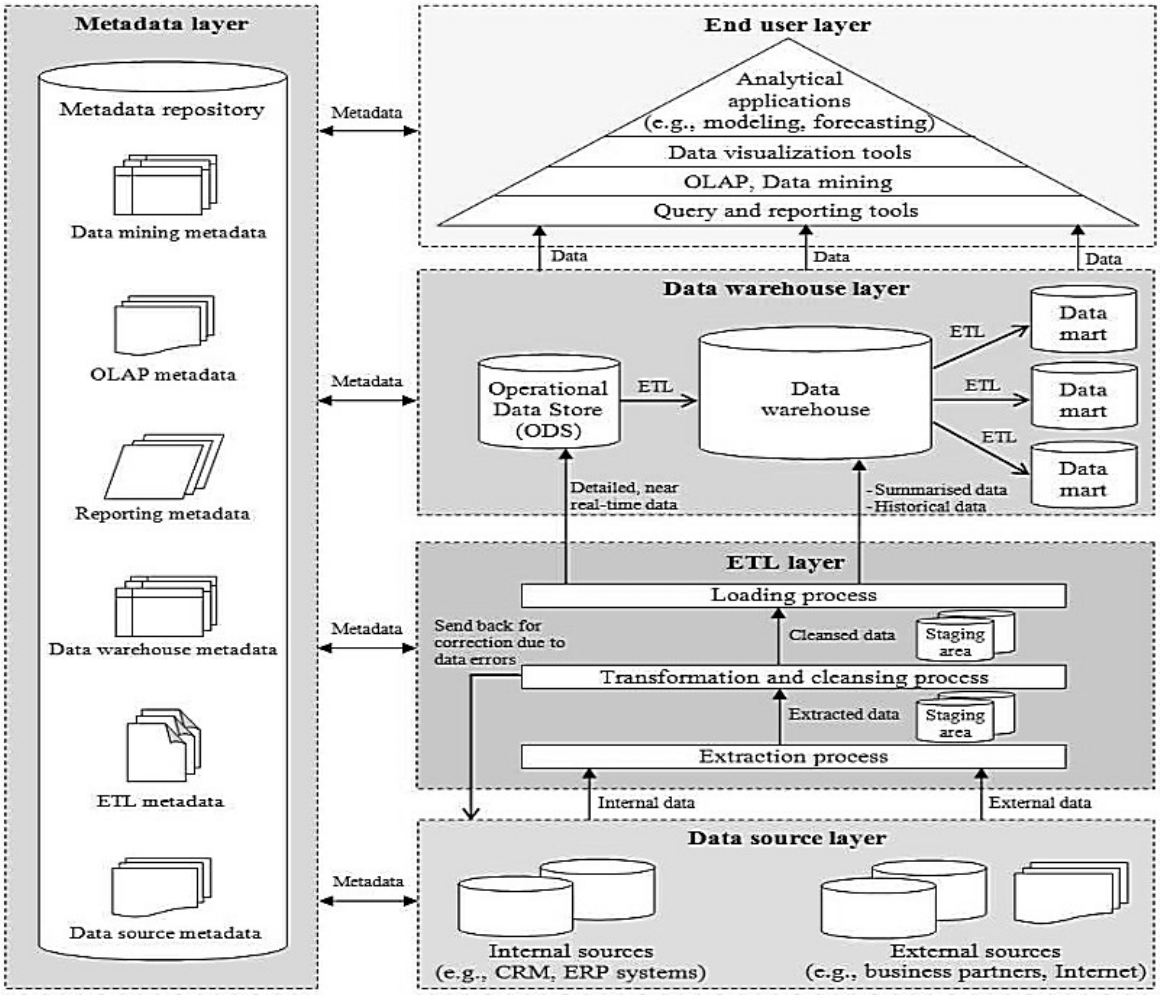

Figure 2.1: Five-Layered Business Intelligence Architecture [OSW11]

2.2.1 Data Source

“Relevant data can be derived from internal and external systems. Internal data source refers to data that is captured and maintained by operational systems inside an organization such as Customer Relationship Management and Enterprise Resource Planning systems. These

operational systems are also known as on-line transaction processing (OLTP) systems because they process large amount of transactions in real time and update data whenever it is needed."[OSW11, cf. p.4]

External data is often provided by market research companies, associations or partner companies. Through an extraction layer within the data warehouse, source data interfaces are available. It is of great importance to clearly identify relevant data sources. Defining the required data which is actual used, can be crucial in addressing specific business questions and requirements.

2.2.2 ETL (Extract-Transform-Load)

This layer is also called integration layer and consists of "three main processes: extraction, transformation and loading. Extraction is the first step in the process of getting data into the data warehouse environment. Extracting means reading and understanding the source data and copying the data needed into the ETL system for further manipulation."[KR13, p.8]

After the data is extracted, the syntactic and semantic transformation of data from different sources takes place. Syntactical defects, such as format adaptations and format incompatibilities are automatically detected and adjusted, as far as possible. Typical syntactical differences e.g. different coding of similar attributes, attribute names with different meanings will be cleansed by standardized and professionally defined clean-up rules. Semantic defects, such as missing data values, unknown value expressions or semantic errors in operational source data are detected with professionally defined validation rules and logs. Nevertheless, they often require manual clean-up in the operational source systems. Furthermore, the semantic unification of the merged data regarding business, subject-specific and temporal meanings takes place in this layer.[Kem09, cf. p.24] "Once data has been transformed and cleansed, they are stored in the staging area. This can prevent the need of transforming data again if the loading processes fail or terminate. Loading is the final phase of the ETL process. The transformations are all precursors to loading the data into the target Data Warehouse."[KR13]

2.2.3 Data Warehouse

This central data core stores the data in an integrated, coherent structure over longer historical periods and makes them available for evaluation and further processing steps. It is essential that the data is stored permanently (non-volatile), structured (subject-oriented), integrated and historically accurate (time-variant). The data structure consists of application-neutral models, which are independent of individual reporting requirements and is based on relevant business objects and their relationships. In addition, it allows historicization and versioning of business object relationships.[Kem09, cf. p.53]

The objective of the data warehouse is to manage the information necessary for the analysis of the user data and to provide the analysis processes in a suitable form. Therefore, the

structuring of the data is oriented exclusively to the analysis needs of the user. To implement the data warehouse usually one or more database management systems (DBMS) are used, which must be appropriately configured for the specific data warehouse project.[BG13, cf. p.59]

In order to analyse data quickly and flexibly, the central relational storage of data has often proved to bad performance in a data warehouse. Therefore data extracts for further processing are often formed, which can be understood as persons-, application-, functional-oriented areas or problem-specific segments of the central data warehouse. These are called data marts.[GGD08, cf. p.117]

2.2.4 Meta data

This layer maintains information about the existing data, their availability, performed transformations and the provision of this data. Meta data is information about the data from data sources, the base database and the data warehouse. The use of meta data fulfils three main tasks: analysis, information and planning.

The term Meta data in the context of business intelligence describes all data that supports the construction, maintenance and administration of the information system. It is of high relevance to store meta data in machine-readable form in order to take advantage of the semantics contained in them. The storage of meta data is often described as a meta data repository.

A general classification of meta data within BI systems refers to its principal use, which business versus IT. The technical meta data primarily serves the goal of further development. It covers conceptual and logical database schemas and their documentation, physical storage information, access rights as well as information about the different data warehouse processes which extract, clean up, transform the data. The business meta data allows the end-user to use the BI applications more effectively, understand data in the data warehouse, find relevant data and interpret the results of the evaluations. Meta data thus include descriptive information about content, structure, context, and meaning of data, but also process-related information on the processing of this data. In this way, transformations of the data can be understood more easily. In addition, the accuracy and quality of evaluations can easily be verified and guaranteed. Also, changes in the source systems and their impact on the analysis applications can be based on the information in the repository to estimate and interpret.[BG13, cf. p.72]

2.2.5 End User

This layer contains applications which supports a great variety of information requirements and can be usually accessed via the organisations' infrastructure. Depending on the type of application, different technologies and methods are utilised in the BI applications. Ranging

from simple report generators on components for the so called online analytical processing (OLAP) to multidimensional data analysis as well as data mining.

Data Mining

Data mining not only allows the analysis of data from the past, but the generation of new hypotheses and the derivation of future trends and behaviour patterns. This requires matching mining process and appropriate model types such as classification models, clustering, sequence models or association models are used. It "involves an integration of techniques from multiple disciplines such as database and data warehouse technology, statistics, machine learning, high-performance computing, pattern recognition, neural networks, data visualization, information retrieval, image and signal processing, and spatial or temporal data analysis. By performing data mining, interesting knowledge, regularities, or high-level information can be extracted from databases and viewed or browsed from different angles. The discovered knowledge can be applied to decision making, process control, information management, and query processing." [Han06] Especially through the advent of Big Data, which developed from the area of data mining this topic gained a lot of attention recently. "Therefore, data mining is considered one of the most important frontiers in database and information systems and one of the most promising interdisciplinary developments in the area of information technology."[Han06]

Query and Reporting Tools

"Query and reporting tools are very useful tools which allow end users to access and query data quickly, and to produce reports for decision making and management purposes. There are many different types of reports including standard reports, ad-hoc reports, budgeting and planning reports as well as metadata reports. Users can manage reports and other information easier and faster through BI portals. BI portal is a popular end user tool to deliver information. It is a single, secure interface that integrates data and information from various sources so that users can have a one-stop access to different types of information."[OSW11, cf. p.7]

OLAP (Online Analytical Processing)

Information systems should provide operational professionals and managers in their decision making responsibilities valuable support. For this, they must be based on the understanding of the business and the vision of the organization.

Especially multidimensional perspectives on available quantitative data sets have proven to be suitable to open a flexible and intuitive access to the required information for decision makers.

"Multidimensionality is useful to understand a particular form of logical analysis of quantitative and managerial sizes. Here, the economically relevant figures will be broken down

simultaneously along different classes of logically related information objects. This allows multi-dimensional problem analysis. Typical dimensions are, for example, customers, products and regions. A very common feature is also to provide the user with hierarchical relationships based on the relevant dimension. Thereby, the user can navigate his analysis along provided hierarchies or aggregations. In particular, the early executive information systems were already using such multidimensional perspectives. However, only the decision support systems defined OLAP as a central design paradigm for information systems" [GGD08, cf. p.144].

Data Visualisation Tools

Unlike classical reporting, data visualization tools do not provide information in printable form, but rather tend to focus on the direct use of the screen. The individual related information units are arranged to optimize displaying information on a screen or report. Usually information is displayed as part of an information portal or via a dashboard. The portal approach is determined by the integration of different content under a common user interface, the Dashboard concept provides aggregated and relevant facts on few screens in the foreground. In addition to the widespread tabular and graphical formats of business data material here especially all kinds of speedometer displays or artificial analogue gauges and maps representations are utilized. Data visualization tools provide information through intuitively understandable designs, based on the visual perception of humans in receiving information. The explicit goal of these approaches is compact and essential information, presented noticeable at a glance.[GGD08, cf. p.215] Decision makers can hereby monitor their business key indicators and progress more effectively.

Analytical Applications

"Analytical applications provide functionalities such as modelling, forecasting, sales analysis, and what-if scenarios. These applications can be used to support both internal and external business processes. Applications that are equipped with analytical capabilities allow users to gain insights into improving the performance of business operations. By employing analytical applications, decision makers can also identify and understand what factors drive their business value, and thus able to leverage opportunities faster than their competitors."[OSW11, cf. p.8]

In addition to technical architecture, the establishment of appropriate organizational measures is a key success factor for business intelligence. The following chapter will examine the organisational aspects of Business Intelligence systems.

2.3 Organisation of Business Intelligence

Business intelligence (BI) is often seen as a combined business and IT function. As such, the operational structure of BI is not always clearly defined. It often depends on a variety of factors like the organizational structure, the size as well as the culture of a company. Nevertheless, in order to define a valid maturity model, it is necessary to define general core processes which should be available at every information driven organisation.

"Currently, there is no common understanding which processes a BI organization should cover."[LRW10] This thesis proposes 9 core BI processes based on the findings of [LRW10] and [Gan13]. These processes create a holistic BI reference process map which will then be utilised for adapting the COBIT PAM to BI process assessment in chapter 4.

2.3.1 BI Strategy

The organizational design of the BI landscape arises primarily from the BI strategy and the requirements of end users. The BI strategy defines professional, organizational, architectural and technological objectives. Based on these objectives relevant measures can be derived. A useful and promising BI strategy needs to be based on the overall strategic requirements. Corporate, business and IT strategic principles should be incorporated and span the scope of the BI strategy.[Krc09, cf.] The first step in the development of a BI strategy is a top-down approach where Mission and Vision will be defined. Based on that, the strategic BI goals can be derived.

Overall, the BI Strategy is considered as an organising framework for enterprise-wide management and coordination of all BI activities and acts as an intermediary authority between the corporate strategy and BI project management.[Glu09]

2.3.2 BI Management

The BI Management takes over the design of the BI programme. Additionally, it manages the derived projects, measures and initiatives. Consequently, this is a management process comparable to processes in the IT department. Nevertheless, a key of this process is also the involvement of other departments and functions within the organization. As not all challenges can be solved solely out of own resources the scope of this process is also to steer external partners such as software vendors, service providers or communities of interest. Also, the organisation and integration of partners and the use of communities of interest should be managed as part of the BI Strategy and carried out by the BI Management. "The objective of BI Management is the optimal planning and control of BI programs and the consistent implementation of the BI strategy."[Gan13]

2.3.3 BI Standardisation

Another key process is the standardization of BI activities. Typically, this includes the standardization of procedures, methods and development processes, and integration into key processes and systems. The objective is to support BI operations optimally through creating a framework for projects, initiatives and measures for BI. This framework should offer ideal conditions which allows project teams to focus on the objectives of the project through providing policies or guidelines, prerequisites and best practice documentation as well as templates.

Due to numerous connections to the central IT policies, standardisation is not primarily a management task. Nevertheless, this process is dependent on the support of management.

2.3.4 Manage Information Architecture

The management of the Information Architecture should provide a business oriented model of the organisation including data and data flows. Typically, these models contain the following artefacts.

- A basic data architecture of operational data
- A basic model of business objects
- A basic data model including data acquisition, -integration and supply

These models should represent a department-independent architecture in order to cover the complete organisation.[Gan13, cf. p.121]

2.3.5 Manage Technical Architecture

The process of managing the technical architecture contains the acquisition and management of hardware and software components connected to Business Intelligence. The range of Hardware includes the management of physical and virtual computer systems and the corresponding networks. From the software point of view, database systems, ETL and data integration systems, BI-core systems as well as front-end systems are relevant. Nevertheless, the technical architecture is not only a catalogue of software and hardware components but rather a concept of the interaction between those components on all tiers. Main topics in this process is scalability and extensibility in order to fulfil constantly changing requirements.[Gan13, cf. p.122]

2.3.6 BI Human Resources

The business intelligence HR process deals with all the challenges which result from having a BI system. This covers adequate ressource planning and development which concentrates on

necessary BI skills within the available staff. In practice, this means identifying personnel which can support business intelligence activities, matching the skills requirements to the existing and then take appropriate measure. Measures range from hiring new personal, add external partners or provide training activities.

2.3.7 BI Support

This process supports the business user as well as the project teams in their activities related to business intelligence. This includes solving and answering upcoming questions as well as providing solutions for occurring problems. Dependent on the organisation of an already existing central IT Support BI Support must be provided accordingly. A central task of the BI Support is also the documentation of the occurring problems and the corresponding solutions. well-documented support activities serves as a useful source of input for measures within other processes. This includes use behaviour and frequency, necessary modifications and staff development needs.

2.3.8 BI Development

The BI development implements BI projects. These require not only IT Development Skills but also BI knowledge (e.g. methods and modelling) as well as business expertise. This skill mix can rarely be provided solely by the business department or IT departments alone. It is therefore usually necessary to use mixed project teams consisting of IT and business departments. The main goal is a professional implementation of BI projects considering the guidelines. In particular, it is to ensure that standards and architectural guidelines, set by the BI Strategy and BI Management, are adhered to. The concrete tasks are depending on the project phase or iteration but usually it consists of Analysis, design, implementation, testing or roll-out using the necessary tools and procedures.

2.3.9 BI Operations

The BI-operation ensures that deployed BI solutions are available to end users and can be used to their satisfaction. This means that the system provides the desired performance and functions so that analysis, reports and data are available as expected and agreed on. This process is facing a number of IT-related tasks, including ensuring the availability of infrastructure as well as the administration of database systems and BI systems. In cooperation with the BI support it also needs to monitor the systems landscape and be able to remedy in case of failure. In addition, the operation is also responsible for the execution of optimization and system evolutions.

Chapter 3

COBIT as Cornerstone of IT Governance

Information Technology (IT) became the foundation of almost every business process of organisations. Without IT most of the processes could not be executed. Additionally, the efficient application of IT often plays a major part in gaining competitive advantage. Therefore, concepts, methods and frameworks have been developed to support organizations to manage their IT domain.

COBIT is an "IT governance framework delivering a supporting tool set that allows managers to bridge the gap between control requirements, technical issues and business risks."[IGI07, p.36] As part of such a holistic approach, COBIT also provides a flexible and adaptable Process Assessment Model. "This kind of assessment is essential for good monitoring, enhancement and management of existing processes and structures. In particular, by using a method for assessing process capabilities, it is possible to compare and rationally select between potential future scenarios."[SJW07]

This chapter aims to give an outline to the area of COBIT and its application. First, the development history of IT and BI Governance and the context within Corporate Governance will be explained. After that the presentation of the current version of the COBIT framework, focusing on the parts used in the BI Process Assessment, will follow.

3.1 Overview IT Governance

"The use of rules to ensure focus and standard-compliant actions has a long history in our society. Since centuries the coexistence of individuals in collectives is controlled by applying rules."[Sch05] Triggered by several economic crises and their aftermath in the past, the question of the quality of corporate governance was brought to the focus of public attention. Influenced by increasingly complex corporate structures, globalization and the resulting competitive pressure, management today faces the challenge of making complex and important decisions. Based on that, there has been renewed focus in up-to-date corporate governance practices. The OECD defines Corporate Governance as following:

> ”Corporate governance involves a set of relationships between a company’s management, its board, its shareholders and other stakeholders. Corporate governance also provides the structure through which the objectives of the company are set, and the means of attaining those objectives and monitoring performance are determined.”[CoD04]

Based on the increasing importance of Information Technology within organisations the topic of governance for IT entered the discussion.

3.1.1 IT Governance

IT is nowadays used to support almost all business processes in a company. IT not only supports business processes, but also makes many processes possible in the first place. At the same time, the efficient use of IT is the major part of competitive advantage and cannot be neglected. This leads to a particular importance that IT is strongly aligned with the overall strategy and objectives of the organisation, which are precisely the main function and scope of IT governance.

Through all the challenges and changes within the last decades, “IT Governance has become not only a fundamental business imperative but is also a top management priority. It became the single most important determinant of IT value realization. IT Governance is the system by which an organization’s IT portfolio is directed and controlled. IT Governance describes the distribution of IT decision-making and the according responsibilities among different stakeholders within the organization.” [Gre04, cf. p.37]

The purpose of IT governance can be summarised as following:

> “The overall objective of IT governance [...] is to understand the issues and the strategic importance of IT, so that the enterprise can sustain its operations and implement the strategies required to extend its activities into the future. IT governance aims at ensuring that expectations for IT are met and IT risks are mitigated.” [Ins03, p.7]

3.1.2 BI Governance

BI Governance can be seen as a specialised area of IT Governance. Due to the increased complexity of BI systems in terms of scope, resources, and its dependencies to other systems, organisations face a variety of challenges.

Individual micro-management of isolated BI systems is no longer sufficient. The pursuit of a consistent and strategic approach to the success of BI solutions is of central importance. Companies are facing the challenge to solve conflicts of interest of different business sectors and need to ensure an optimal approach for the overall company. The implementation of suitable organisational framework based on the experiences in IT Governance is ongoing at the moment.

Nevertheless, the existing rules and frameworks for IT governance are much more ambiguous. They focus on the content of general IT processes and are often not sufficient due to the general objectives and the high specificity of the area BI. In addition, BI and IT differ in their value proposition for the company, its applications and the risks. As a result, the unadjusted transfer from IT Governance to the area of BI is not sufficient. Rather, it is necessary to extend and adjust IT and corporate governance in order to satisfy the specific requirements of BI.

"BI Governance is thus understood as a fully formulated, company-specific framework that ensures the alignment of the strategic direction of BI to the business goals with the help of guidelines and tools." [BAK10, cf. p.1067]

3.1.3 Process Assessment and Capability/Maturity Models

An important component of a successful IT Governance is the as-is analysis. For this purpose, using Process Assessment or Maturity Models, the existing processes of the organisation are measured against best practice processes.

"Process assessment, in general, is essential for good monitoring, enhancement and management of existing processes and structures. The possibility to perform trade-off analysis between potential scenarios is one of the most important benefits of having an efficient IT governance assessment method in place. Another benefit is the possibility to compare the results against other organizations. Also, a good IT governance assessment method can provide useful prescriptive results about what can be done to improve the governance of IT within the organization under evaluation."[SJW07, cf.]

"Maturity models are established means to identify strengths and weaknesses of certain domains and processes of an organisation. They consist of multiple, fundamental levels of maturity of a certain domain and can be used for organisational assessment. To reach a desired state of maturity, an evolutionary transformation path from an initial to a target stage needs to be progressed." [FMG02, p.245] Maturity models help to understand the as-is situation and can be helpful by guiding through the different stages.

Since the concept of maturity models has been proposed in 1974 by [GN74], "more than a hundred maturity models have been published in the field of IS up to date. As these high numbers led to a certain arbitrariness of the design process, methods for the design of maturity models were developed. The key characteristics of maturity models are the maturity concept, the dimensions, the levels, the maturity principle, and the assessment approach."[LMWW10, p.93]

Maturity concept

"Three different maturity concepts (or understandings of maturity) can be distinguished. People (or workforce) capability defines the level of knowledge, skills, and process abilities available for performing business activities. Process maturity defines the extent to

which a specific process is explicitly defined, managed, measured, controlled, and effective. Object (or technology) maturity defines the respective level of development of a design object."[LMWW10, p.93]

Dimension

"Dimensions are specific capability areas, process areas, or design objects structuring the field of interest. They should be exhaustive and distinct. Each dimension is further specified by measures (practices, objects, or activities) at each level."[LMWW10, p.93]

Level

"Levels are archetypal states of maturity of a certain dimension or domain. Each level has a distinguishing descriptor providing the level's intent and a detailed description."[LMWW10, p.93]

Maturity principle

"Maturity models can be continuous or staged. Continuous maturity models allow a scoring of activities at different levels. Therefore, the level can be either the (weighted) sum of the individual scores or the individual levels in different dimensions. Staged models require the compliance with all elements of one level. They specify a number of goals and key practices to reach a predefined level. Staged maturity models reduce the levels to the defined stages, whereas continuous maturity models open up the possibility of specifying situational levels."[LMWW10, p.93]

Assessment approach

"The assessment approach can be qualitative using descriptions or quantitative"[LMWW10, p.93]

3.1.4 Advent of industry models

Along with different tools in the area of IT governance, industry standardised concepts appeared more recently under the term industrialization of IT. In the course of sorting out the processes of the IT landscape and to establish an overarching governance model, the Information Systems Audit and Control Association introduced COBIT. COBIT as a term stands for Control Objectives of Information and related Technology and has its roots in a variety of predecessors. In the area of IT governance or in addition to IT Service management, there are a number of existing models and initiatives. The models can be divided into two

categories, in public and commercial. COSO, ITIL and COBIT are public domain and accessible. Commercial offerings available are MOF (Microsoft Operational Framework) and SOF (Siemens Operational Framework) among others. Nevertheless, this thesis is focusing on the COBIT framework and will discuss this in more detail in the following section.

3.2 COBIT - Control Objectives of Information and related Technologies

One of the most established IT governance framework is COBIT, which provides a comprehensive "framework that assists enterprises in achieving their objectives for the governance and management of enterprise IT. Simply stated, it helps enterprises create optimal value from IT by maintaining a balance between realising benefits and optimising risk levels and resource use. COBIT enables IT to be governed and managed in a holistic manner for the entire enterprise, taking in the full end-to-end business and IT functional areas of responsibility, considering the IT-related interests of internal and external stakeholders. COBIT is generic and useful for enterprises of all sizes, whether commercial, not-for-profit or in the public sector."[ISA12]

The COBIT Framework, developed by the IT Governance Institute (ITGI), became a standard in the area of IT-Governance. The institute was founded by the Information Systems Audit and Control Association (ISACA) as the growing importance of IT Governance became evident.

"Today ISACA counts more than 65.000 members from 140 different countries. ITGI is a research think tank that exists to be the leading reference on IT governance for the global business community. ITGI aims to benefit enterprises by assisting enterprise leaders in their responsibility to make IT successful in supporting the enterprise's mission and goals. By conducting original research on IT governance and related topics, ITGI helps enterprise leaders understand and have the tools to ensure effective governance over IT within their enterprise. The COBIT framework is the most important publication of ITGI. Since its foundation in 1998 COBIT was revised several times and has been published in various versions."[Ins03] COBIT incorporates various standards from different sources to integrate the best of all worlds. COBIT supports IT-Governance with a holistic description of IT processes, based on statements that formulate the objectives, inputs and outputs which are going to be reached with the implementation of certain processes. In principle COBIT utilises the control model of Deming but also uses standards and objectives as input for improvement. The latest release version is COBIT 5.

"COBIT 5 provides a holistic and systemic view on governance and management of enterprise IT, based on a number of enablers. Those enablers are enterprise-wide and end-to-end, i.e., inclusive of everything and everyone, internal and external, that are relevant to governance and management of enterprise information and related IT, including the activities and responsibilities of both the IT functions and non-IT business functions."[ISA12, p.24]

"The COBIT 5 framework describes seven categories of enablers like Principles, Processes,

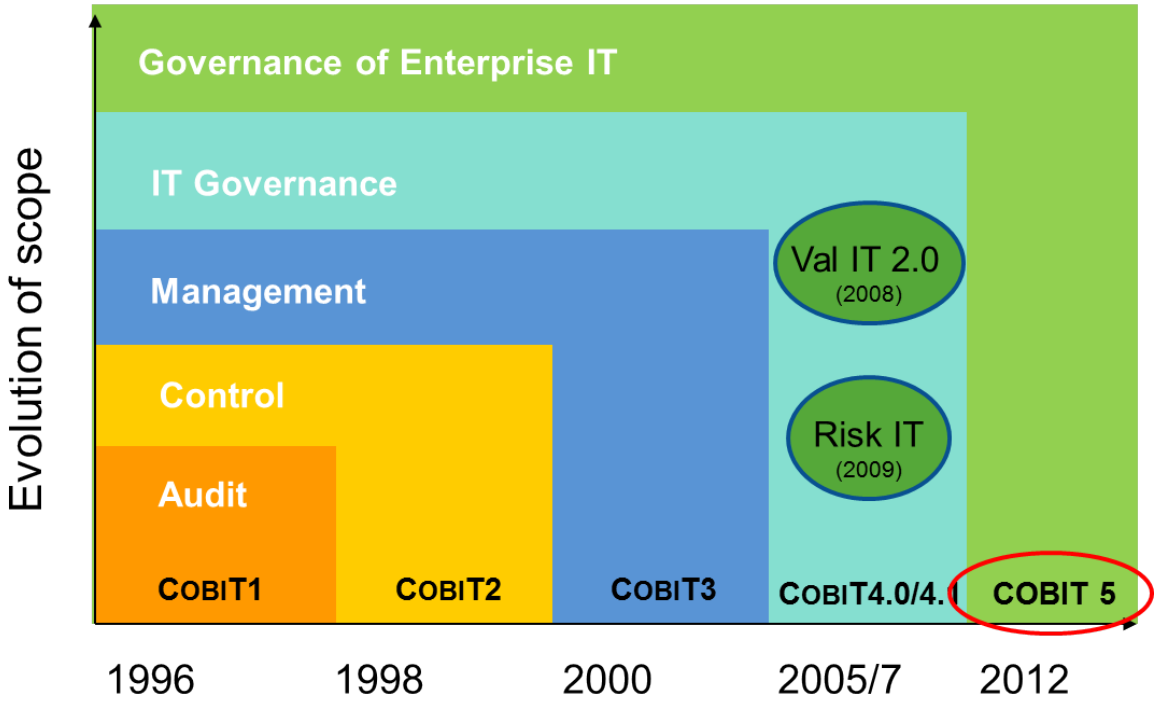

Figure 3.1: COBIT Development History

Organisational structures, Culture and Ethics, Information Services as well as People, Skills and Competencies. Nevertheless this thesis is focusing on the area of Processes which describes an organised set of practices and activities to achieve certain objectives and produce a set of outputs in support of achieving overall IT-related goals."[ISA12, p.27]

COBITs "Processes" chapter provides an process assessment model (PAM) based on the ISO/IEC 15504 Process Assessment standard. This model provides a framework to measure the performance of defined processes and points to areas where improvement is necessary.

3.3 COBITs Process Assessment Model

The process assessment consists of a two-dimensional model of process capability. As shown in figure 3.2 it consists of two dimensions

- The processes dimension consists of well-defined processes classified into process categories.
- The capability dimension consists of a set of process attributes which are grouped into capability levels.

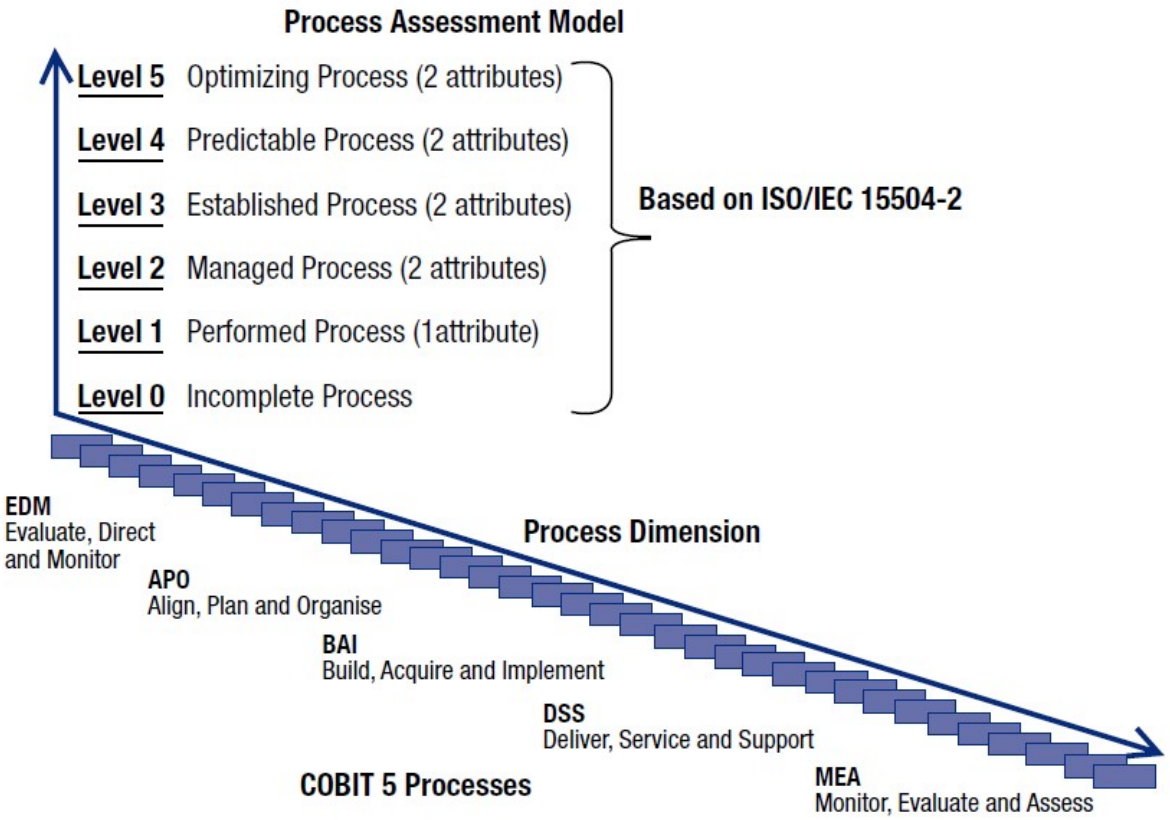

Figure 3.2: COBIT 5 Process Assessment Model [IGI13, p. 11]

3.3.1 The Process Dimension

COBITs process assessment model defines processes as "a collection of practices influenced by the enterprise's policies and procedures that takes inputs from a number of sources and other processes, manipulates the inputs and produces outputs like services, products or artefacts."[ISA12]

The process dimension utilizes the process reference model of COBIT 5 which provides definitions of processes in a lifecycle together with a description of the relationships amongst the processes. "The COBIT 5 process reference model (PRM) is composed of 37 processes describing a life cycle for governance and management of enterprise IT."[IGI13, p. 11]

The COBIT 5 process reference model subdivides the processes of an organizations IT into the following domains.

Evaluate, Direct and Monitor (EDM)

"These governance processes deal with the stakeholder governance objectives and value delivery, risk optimisation and resource optimisation and include practices and activities aimed at evaluating strategic options, providing direction to IT and monitoring the

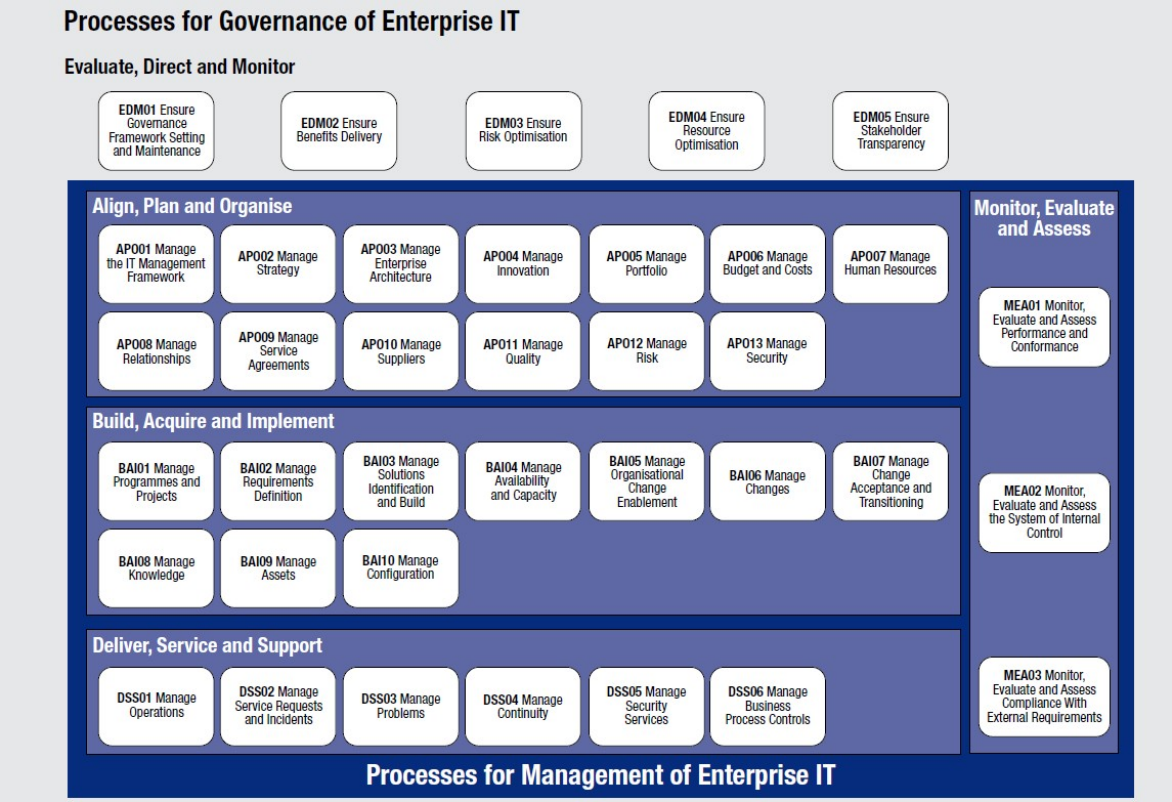

Figure 3.3: COBIT 5 Process Reference Model [IGI13, p. 11]

outcome."[IGI13, p. 12]

Align, Plan and Organise (APO)

"Provides direction to solution delivery (BAI) and service delivery and support (DSS). This domain covers strategy and tactics, and concerns identifying the best way IT can contribute to the achievement of the business objectives. The realisation of the strategic vision needs to be planned, communicated and managed for different perspectives. A proper organisation, as well as technological infrastructure, should be put in place."[IGI13, p. 12]

Build, Acquire and Implement (BAI)

"Provides the solutions and passes them on to be turned into services. To realise the IT strategy, IT solutions need to be identified, developed or acquired, as well as implemented and integrated into the business process. Changes in and maintenance of existing systems are also covered by this domain, to ensure that the solutions continue to meet business objectives."[IGI13, p. 12]:

Deliver, Service and Support (DSS)

"Receives the solutions and makes them usable for end users. This domain is concerned with the actual delivery and support of required services, which include service delivery, management of security and continuity, service support for users, and management of data and operational facilities."[IGI13, p. 12]

Monitor, Evaluate and Assess (MEA)

"Monitors all processes to ensure that the direction provided is followed. All IT processes need to be regularly assessed over time for their quality and compliance with control requirements. This domain addresses performance management, monitoring of internal control, regulatory compliance and governance."[IGI13, p. 12]

3.3.2 Process Reference Model

Across the five domains there are 37 defined IT processes. The COBIT 5 processes dimensions are listed in table 3.1

No.	IT Process	IT Process description
1	EDM01	Ensure governance framework setting and maintenance.
2	EDM02	Ensure benefits delivery.
3	EDM03	Ensure risk optimisation.
4	EDM04	Ensure resource optimisation.
5	EDM05	Ensure stakeholder transparency.
6	APO01	Manage the IT management framework.
7	APO02	Manage strategy.
8	APO03	Manage enterprise architecture.
9	APO04	Manage innovation.
10	APO05	Manage portfolio.
11	APO06	Manage budget and costs.
12	APO07	Manage human resources.
13	APO08	Manage relationships.
14	APO09	Manage service agreements.
15	APO10	Manage suppliers.
16	APO11	Manage quality.
17	APO12	Manage risk.
18	APO13	Manage security.
19	BAI01	Manage programmes and projects.
20	BAI02	Manage requirements definition.
21	BAI03	Manage solutions identification and build.
22	BAI04	Manage availability and capacity.
23	BAI05	Manage organisational change enablement.
24	BAI06	Manage changes.
25	BAI07	Manage change acceptance and transitioning.
26	BAI08	Manage knowledge.
27	BAI09	Manage assets.
28	BAI10	Manage configuration.
29	DSS01	Manage operations.
30	DSS02	Manage service requests and incidents.
31	DSS03	Manage problems.
32	DSS04	Manage continuity.
33	DSS05	Manage security services.
34	DSS06	Manage business process controls.
35	MEA01	Monitor, evaluate and assess performance and conformance.
36	MEA02	Monitor, evaluate and assess the system of internal control.
37	MEA03	Monitor, evaluate and assess compliance with external requirements.

Table 3.1: COBIT 5 Defined IT processes [IGI13, p. 12]

Process Definition

The COBIT process reference modell provides a detailed description for each of the processes listed in table 3.1. Each process is defined through the following attributes

Name Name and unique ID of the process

Purpose Purpose of the process

Outcomes (O) Artefact, a significant change of state or the meeting of specified constraints

Base practices (BP) Tasks and activities which needs to accomplish the process purpose

Input and output work products (WP) Artefact associated with the execution of a process

3.3.3 The Capability Dimension

"The capability dimension provides a measure of a process's capability to meet an enterprise's current or projected business goals for the process. The process capability is expressed in terms of process attributes grouped into capability levels. The capability level of a process is determined on the basis of the achievement of specific process attributes according to ISO/IEC 15504-2:2003 and can be used as the basis for conducting an assessment of the capability of each COBIT 5 process."[IGI13, p.11] "ISO/IEC 15504 is an emerging international standard on software process assessment. It defines a number of software engineering processes and a scale for measuring their capability. It is the reference model for the maturity models (consisting of capability levels which in turn consist of the process attributes and further consist of generic practices) against which the assessors can place the evidence that they collect during their assessment, so that the assessors can give an overall determination of the organization's capabilities for delivering products (software, systems, and IT services)."[EEB00, p.1]

The rating scale involves six capability levels.

Level 0 Incomplete process

"The process is not implemented or fails to achieve its process purpose. At this level, there is little or no evidence of any systematic achievement of the process purpose."[IGI13, p.13]

Level 1 Performed process

"The implemented process achieves its process purpose."

Level 2 Managed process

"The previously described performed process is now implemented in a managed fashion (planned, monitored and adjusted) and its work products are appropriately established, controlled and maintained."[IGI13, p.13]

Level 3 Established process

"The previously described managed process is now implemented using a defined process that is capable of achieving its process outcomes."[IGI13, p.13]

Level 4 Predictable process

"The previously described established process now operates within defined limits to achieve its process outcomes."[IGI13, p.13]

Level 5 Optimizing process

"The previously described predictable process is continuously improved to meet relevant current and projected business goals."[IGI13, p.13]

Assessment Indicators

Another fundamental part of the concept of capability dimension COBIT are the so called assessment indicators which are used to assess whether is level 1 or higher. There are two types of assessment indicators:

Process capability attribute Process capability attribute indicators(Lvl 1-5)

Process performance indicators Process performance indicators (Lvl 1)

"Process performance indicators are specific for each process and are used to determine whether a process is at capability level 1. These performance indicators consist of base practices and work products and are exclusive to level 1.

The process capability attribute indicators are generic for each process attribute for capability levels 1 to 5. Level 1, however, has only a single generic practice indicator for capability that aligns directly to the achievement of the specific performance indicators."[IGI13, p. 14]

Rating Scale

In order to be able to define which capability dimension has been reached a rating scale has been defined by COBIT PAM. Based on ISO/IEC 15504 standard, each assessment indicator

will be rated according to the following scale.

(N) Not achieved

(P) Partially achieved

(L) Largely achieved

(F) Fully achieved

> "The assessor uses these scales to determine the level of capability achieved. Applied consistently, these criteria allow each assessment to be based on a structured degree of formality and enable the comparison of assessments across an organisation or even across different enterprises." [IGI13, p. 14]

Chapter 4

Applying COBIT Process Assessment to Business Intelligence

Previous chapters established a comprehensive starting point for the following definition of the model. Through defining the technical and organisational aspects of BI as well as the application of COBIT in the context of IT Governance, this chapter briefly describes the initial situation in the area of BI maturity assessment. After that, the development of the COBIT based BI Process Assessment Model will be outlined. Based on an expert questionnaire, the initial model will be further refined. In conclusion, the practical use of the models will be described.

4.1 Initial situation

BI is a topic of high relevance with increasing managerial and scientific attention. "BI has become an essential component of the information supply infrastructure and a contributor and prerequisite to overall organizational success. The original role of BI and its impact have changed in recent years from a single analytical-application-view to an organizational capability of strategic importance." [BH08]

Due to the relatively long history of BI and MSS, technical implementations reached a high level of maturity. Nevertheless, an increasing number of implementations lead to separate silos of information based on individual solutions which do not align with the strategic direction of organisations. These silos often produce information for individual purposes not following an overall information strategy.

In the course of the emergence of IT Governance technical discussions, especially in the context of BI, were therefore replaced by questions of business value regarding the overall effort, including strategy and business alignment, efficiency, operations and information architecture. The development of a successful BI system should therefore be defined by BI strategy, supported by leadership. This strategy must be aligned with the overall corporate strategy. The first step of the strategy definition must always be a holistic as-is analysis of

the existing processes followed by an assessment and evaluation of the status-quo against the requirements as well as against other organisations. Maturity models provide a method for process assessment through classification and measurement of BI processes. This provides a reference for audits as well as industry benchmarks [Krc09, cf. p.241].

However, existing maturity models in the area of BI often have a number of flaws or weak spots. [LMWW10] assesses existing maturity model approaches critical. "Whereas classic IT topics, e.g. applications, data, and infrastructure, are highly present, other topics like efficiency, organizational structures, staff, and strategy are rarely addressed. Overall, the links between BI technology, BI usage, and organizational performance often stays unclear. Furthermore, they contained methodical gaps in the design process of the models regarding the reliability, including the theoretical foundation of the model and the explication of the underlying maturity concept."[LMWW10, cf. p.99]

4.2 Proposed solution

In order to overcome the downsides of existing approaches, this thesis proposes a maturity model designed for process assessment in the area of business intelligence. It uses parts of the COBIT framework proposed by the Information Systems Audit and Control Association (ISACA) and the IT Governance Institute (ITGI).

"COBIT is a framework which provides measures, indicators, processes and best practices to maximize the benefits derived through IT utilization for an organization"[ISA12]

COBIT by design, "can be widely applied to various purposes, ISACA and ITGI have clearly defined the mapping of COBIT against the other related standards, e.g., ISO/IEC 27002, ITIL (Information Technology Infrastructure Library), PMBOK (Project Management Body of Knowledge), CMM (Capability Maturity Model)." [Mor09, p.1] The original purpose of COBIT is the organisational-wide management of the processes of IT. Due to the broad scope of COBIT, the application of its framework for special fields becomes a complex task. A purely BI-oriented model must therefore narrow COBITs Process Assessment Model to BI-related processes in order to allow a relatively simple and targeted process assessment.

The proposed model claims to utilise the advantages of the existing models and frameworks COBIT is build on. At the same time it should avoid weaknesses, like pure IT orientation, identified within other maturity models by [LMWW10, cf. p.99]. Therefore, this work uses the widely established Process Assessment Model (PAM)[IGI13, cf.] of the COBIT 5 framework and combines this with a sound process map based on the results of [Gan13, cf.] described in Chapter 2. Additionally, this BI process map has been evaluated by experts and, based on that, extended where necessary.

4.3 Development Process

The proposed process assessment model has been developed on the following underlying concepts.

4.3.1 Profound Development Procedure

[BKP09] states that "New models may also just be an improvement of an already existing one. The process description of design, science requires an iterative procedure for the development of a problem solution. [...] By using the available means, solutions must be iteratively proposed, refined, evaluated, and, if necessary, enhanced. For the design of a Maturity model this means that they must be developed iteratively."[CV12]

Therefore this thesis follows the development procedure from [LM10] who propose a Maturity Model development process consisting of the following phases:

1. Scope Defines the scope and what processes are to be assessed

2. Design Outline of the principle concept of maturity, the structure of levels and dimensions

3. Populate Defines the maturity assessment, which includes the specification of instruments

4. Test Tests model on content completeness and the intended model scope and accuracy

5. Deploy Deploy model to the initial stakeholders and to an independent community

6. Maintain Model is maintained to ensure its evolution.

Due to natural limitations in scope and time, this thesis will focus on the steps Scope, Design, Populate and Test. The test of the proposed model will be performed in chapter 5 performing an expert interview. The model will then be redesigned based on the outcomes of expert interviews. The steps Deploy and Maintain are not in the scope of this thesis.

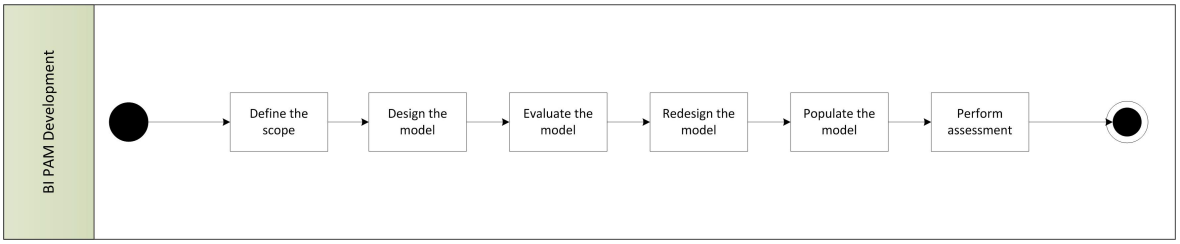

Figure 4.1: The development process of BI Process Assessment Model

4.3.2 A solid foundation

Utilising the COBIT PAM guarantees a solid foundation of the entire model. The "COBIT 5 product set includes a process capability model, based on the ISO/IEC 15504 Software En-

gineering Process Assessment standard."[IGI13] The underlying ISO/IEC 15504 Software Engineering Process Assessment standard is an internationally recognised model which "is publicly available and has been used in more than 4000 assessments." Additionally COBIT as "a result of years of research and cooperation among global IT and business experts provides an authoritative, international set of generally accepted IT practices"[Pat05]

4.3.3 Process model covering business and IT

Since existing maturity models are often restricted on the areas of technology and development, it was important to use a comprehensive process reference map (PRM) as a basis for the selection of maturity dimensions. This should take into account the previously neglected areas such as organizational structures, staff, and strategy. The reference process map of [Gan13] is the result of literature research and serves in its origin as a basis for the introduction of a BI Competence Center (BICC).

"A BICC is a cross-functional organizational team that has defined tasks, roles, responsibilities and processes for supporting and promoting the effective use of Business Intelligence across an organization."[Wik13] It can therefore be assumed that in this case the most relevant processes of BI within an organization have been considered.

4.3.4 Simple execution approach

The proposed model should be simple enough to be executed without having the knowledge of the overall COBIT Framework or the necessity of including external auditors. The execution approach is based on the self-assessment guide, which is designed to perform "a less rigorous assessment of IT processes. This can be a precursor of undertaking a more rigorous, evidenced-based assessment. The approach is based on the COBIT PAM used in the COBIT assessment programme, but does not require evidentiary requirements in support of the self-assessment, nor does it require use of the official COBIT PAM documents."[Pro13] The utilization of COBITs Self-Assessment approach will keep executions costs, both monetary and time, at a minimum level. An additional benefit is the possibility to integrate those outcomes into relevant parts of the original COBIT model. The result can be used for the continual improvement of the organisations BI capabilities and lead the way to BI excellence.

4.4 Defining the scope

"The scope phase defines the focus and identifies the relevant stakeholders and targeted audiences of the model. It determines the balance between complex reality and model simplicity."[LM10] The central step in the adoption of COBIT Process Assessment Models is to decide what processes are to be assessed. COBIT allows explicitly to use "all the COBIT processes or focus on a number of processes of concern to enterprise management or

on those relating to specific business goals."[Pro13]. As the focus of this thesis is to provide a process assessment model for Business Intelligence an adoption of the model is necessary.

As outlined in section 3.3.1 the COBIT 5 process reference model (PRM) is composed of 37 processes describing a life cycle for governance and management of enterprise IT, as shown in figure 3.3.

To narrow down the 37 existing COBIT processes to only the BI relevant, the reference processes described in Chapter 2 will be utilized. It consists of the following processes

- BI Strategy
- BI Management
- BI Standardisation
- Manage Information Architecture
- Manage Technical Architecture
- BI Human Resources
- BI Support
- BI Development
- BI Operations

4.4.1 Mapping BI processes to COBIT process dimensions

The nine key processes of a BI organisation, already introduced in chapter 2, served as a basis for the scope definition of the new process assessment model. Based on the content description and the purpose of the processes the COBIT PAM was assessed. Through content based analysis, the processes proposed by [Gan13] where then mapped to relating Process Dimensions of COBITs reference process model (RPM). Finally, the mapped processes where renamed. This allows an integration of the BI Process Dimension into an unchanged Process Assessment Model and avoids confusion. The result is the following mapping of BI processes to relevant COBIT processes. The first column represents the processes of the RPM described in chapter 2. The second column is the mapping of those processes to the relevant COBIT processes. Finally, the third column shows the resulted process within the first draft of the BI adapted RPM.

No.	**BI Reference Process**	**COBIT Process Dimension**	**BI Process Dimension**
1	BI Strategy	APO02 Manage Strategy	BIM01 Manage BI Strategy
2	BI Standardisation	APO03 Manage Enterprise Architecture	BIM02 Manage Information Architecture and Standardisation
3	Manage Information Architecture	APO03 Manage Enterprise Architecture	BIM02 Manage Information Architecture and Standardisation
4	BI Human Resources	APO07 Manage Human Resources	BIM03 Manage BI Human Resources
5	BI Management	BAI01 Manage Programmes and Projects	BIM04 Manage BI Programme
6	BI Development	BAI03 Manage Solutions Identification and Build	BIM05 Manage BI Development
7	Manage Technical Architecture	BAI10 Manage Configuration	BIM06 Manage Technical BI Architecture
8	BI Operations	DSS01 Manage Operations	BIM07 Manage BI Operations
9	BI Support	DSS02 Manage service requests and incidents.	BIM08 Manage BI Support

Table 4.1: Mapping of COBIT PAM with BI reference processes

Especially to be emphasised is the mapping of the process “BI Standardisation” and “Manage Information Architecture”. The contents of both of these processes could be mapped to only one process dimension in the COBIT PAM. This dimension is APO03 Manage Enterprise Architecture and includes the general information architecture as well as the definition of guidelines and standards.

The result of the mapping is an adapted version of the COBIT reference process map tailored for BI consisting of the following processes

- BIM01 Manage BI Strategy
- BIM02 Manage Information Architecture
- BIM02 Manage Information Architecture
- BIM03 Manage BI Human Resources
- BIM04 Manage BI Programme
- BIM05 Manage BI Development
- BIM06 Manage Technical BI Architectur
- BIM07 Manage BI Operations
- BIM08 Manage BI Support

4.5 Design of the model

“In the design phase, the principle concept of maturity, the structure of levels, dimensions, and sub-dimensions (i.e. the meta-model) are outlined. Based on this, the descriptors of levels and their definitions are derived. Thereby, the design process can follow a top-down or a bottom-up approach. A top-down approach first specifies levels and their descriptions. A bottom-up approach first defines dimensions and characteristics representing maturity and then derives descriptions from it.”[LM10]

4.5.1 First Iteration

The foundation of the development is the COBIT PAM model. The “process assessment model is a two-dimensional model of process capability, as shown in figure 3.2. Within the process dimension, processes are defined and classified into process categories. The other dimension defines a set of process attributes grouped into capability levels. The process attributes provide the measurable characteristics of process capability.”[Pro13]

Following the bottom-up approach, in this phase, the descriptions of the Process Definition, Process Purpose Statements and Process Outcomes (Os) will be adjusted to the area of BI. Due to the already very sophisticated process definitions provided by the COBIT PAM,

changes were marginal in many areas and limited to IT Governance specific formulations. The content of the process definition can be found at the ISACA official website[1].

This first design iteration of the BI PAM has been the foundation for the expert evaluation. There, 5 experts have been interviewed and asked for their opinion towards the completeness and applicability of the derived COBIT processes. The evaluation process and its outcome is described in chapter 5 in more detail. The critics and the proposed improvement potential of the expert can be summarized as follows.

- Not optimal fitting of process descriptions and output definitions
- Missing demand and requirements management
- Missing data quality process
- Missing information security process
- The process BIM06 Manage Technical BI Architecture misses the topic "Reference Architecture"
- The to-be assessed outcomes of process BIM03 Manage BI Human Resources are to generic

4.5.2 Redesign of the model

Based on the expert inputs the following steps have been executed in order to further refine the model.

General redefinition of process dimensions

Based on the inputs an the COBIT process dimensions have been redefined according to the requirements of Business Intelligence. Only still relevant parts of the original have been kept in the process definitions.

Integration of demand and requirement management

The areas of demand and requirement definition have been incorporated into the processes "BIM01 Manage BI Strategy" and "BIM02 Manage Information Architecture".

Add a new process BIM09 Manage BI Security

Based on inputs regarding the topics of missing information and data security, a new process "BIM09 Manage BI Security" has been added to the BI RPM.

[1] http://www.isaca.org/COBIT/Pages/COBIT-5-PAM.aspx

Add a new process BIM10 Manage BI Quality

Based on the inputs regarding the topics missing data quality process the new process "BIM10 Manage BI Quality" has been introduced to the model.

Add Reference Architecture to "BIM06 Manage Technical BI Architecture"

Based on the critics towards the missing Reference Architecture, a new Outcome has been introduced to the process "BIM06 Manage Technical BI Architecture".

Added outcomes to the process BIM03 Manage BI Human Resources

Based on the critic, that the defined outcomes of the process"BIM03 Manage BI Human Resources" are too generic, the outcome definition has been redefined.

The result of the redesign is an adapted version of the COBIT process model of the first iteration consisting of the following processes

- BIM01 Manage BI Strategy
- BIM02 Manage Information Architecture
- BIM03 Manage BI Human Resources
- BIM04 Manage BI Programme
- BIM05 Manage BI Development
- BIM06 Manage Technical BI Architecture
- BIM07 Manage BI Operations
- BIM08 Manage BI Support
- BIM09 Manage BI Security
- BIM10 Manage BI Quality

Based on this list the according process descriptions, purpose statements and outcomes have been defined.

4.5.3 BIM01 Manage BI Strategy

BIM01 Manage BI Strategy[2]

[2]Based on the Process Dimension APO02 [IGI13, p.34]

Process Description

Provide a future-oriented master plan of BI initiatives and projects, derived from IT strategy and corporate strategy. Describe plans regarding the future BI architecture and organizational structure. Define concrete priorities, target milestones and necessary resources and capacities.

Process Purpose Statement

Define the general direction of the BI Landscape from a long-term perspective aligned with IT and business objectives. Clearly state a vision, including strategic goals and communicate it to all relevant stakeholders.

Outcomes (Os)

BIM01-O1 The BI strategy is aligned with IT and enterprise strategy.

BIM01-O2 The BI strategy is realistic, cost-efficient, achievable, enterprise focused and balanced.

BIM01-O3 Relevant strategic business requirements is defined and translated into information requirements.

BIM01-O4 Business Blueprint covering short-term and long-term business requirements at a vision level.

BIM01-O5 Gaps between the current and future state are defined and documented.

BIM01-O6 Accountability for the delivery of the BI strategy has been clearly defined.

BIM01-O7 The BI strategy has been communicated and is publicly available within the organization.

BIM01-O8 The conceptual BI architecture has been defined.

4.5.4 BIM02 Manage Information Architecture

BIM02 Manage Information Architecture[3]

Process Description

"Establish a common conceptual architecture consisting of business process, information and information entities application and technology architecture layers."[IGI13, p.39] Define a conceptual information model of the organizations' data and dataflow. Establish architectural standards for the BI architecture by creating a framework and rule set for BI architecture. "Identify solutions and analyse requirements before acquisition or creation to ensure that they are in line with enterprise strategic requirements covering business processes, applications, information/data, infrastructure and services."[IGI13, p.39]

Process Purpose Statement

Design a blueprint defining the data needs of the enterprise in order to understand the information flow within the organization. This enables identification and definition of data requirements. Design conceptual architecture to be able to translate business requirements to data requirements. Provide organization wide standards to provide consistency for future information development and delivery.

Outcomes (Os)

BIM02-O1 Information architecture is well defined and is a single point of knowledge of the organizations information model.

BIM02-O2 The conceptual data model is up-to-date and provides an overview of the organizations' entities.

BIM02-O3 The conceptual data flow model represents the organizations data sourcing, integration and provisioning for structured and unstructured data.

BIM02-O4 "Business functional and technical requirements reflect enterprise needs and expectations."[IGI13, p.39]

BIM02-O5 "The proposed BI solution satisfies business functional, technical and compliance requirements."[IGI13, p.39]

[3]Based on the Process Dimension APO03 [IGI13, p.39]

BIM02-O6 "Risk associated with the requirements has been addressed in the proposed solution."[IGI13, p.39]

BIM02-O6 "Requirements and proposed solutions meet business case objectives including expected value expected and estimated costs."[IGI13, p.39]

4.5.5 BIM03 Manage BI Human Resources

BIM03 Manage BI Human Resources[4]

Process Description

Provide a structured approach of human resources based on the BI strategy and the operational requirements. Manage the HR portfolio and communicate the defined roles and responsibilities within the organization. Define jobs based on the existing role descriptions. Provide development plans and assure a general level of motivation.

Process Purpose Statement

Provide the right people the right jobs. Continuously map the HR portfolio with the requirements of the BI processes. React on knowledge and resource gaps by training or hiring relevant ressources. Provide an up-date training program aligned with the latest technology standards.

Outcomes (OS)

BIM03-O1 "The BI organizational structure and relationships are flexible and responsive."[IGI13, p.49]

BIM03-O2 "Human resources are effectively and efficiently managed."[IGI13, p.49]

BIM03-O3 "Provide the right level of people, at the right moment in time."[IGI13, p.49]

BIM03-O4 "Provide a Risk mapping in place that puts all stakeholder interest into a risk and organisation's specific context."[IGI13, p.49]

[4]Based on the Process Dimension APO07 [IGI13, p.49]

BIM03-O5 "Map stakeholders to their HR requirements and mirror it with the organizations interests"[IGI13, p.49]

BIM03-O6 A training program is offered to all human resources aligned with the organizations needs and based on latest technology standards.

4.5.6 BIM04 Manage BI Programme

BIM04 Manage BI Programme[5]

Process Description

Coordinate all BI initiatives and projects according to the BI strategy. "Identifying and managing internal and external stakeholder (e.g. Software vendors, Consulting, Development support). Provide a central interface for all departments of the organization. Execute the strategic direction set for investments in line with the BI strategy. Evaluate, prioritise and balance projects and services, managing demand within resource and funding constraints. Monitor the performance of the overall programme, proposing adjustments as necessary in response to programme and service performance or changing enterprise priorities"[IGI13, p.67]

Process Purpose Statement

"Transforming the BI strategy into specific measures. Planning and controlling of all BI relevant internal and external processes including the consequent implementation of the BI program according to the BI strategy. Supervise all projects in alignment with BI guidelines and in a coordinated way. Ensuring the value and quality of project deliverables, and maximising their contribution to business objectives."[IGI13, p.67]

Outcomes (Os)

BIM04-O1 "Relevant stakeholders are engaged in the BI programme and associated projects."[IGI13, p.67]

BIM04-O2 "The scope and outcomes of the BI programme and associated projects are viable and aligned with business objectives."[IGI13, p.67]

[5]Based on the Process Dimension BAI01 [IGI13, p.67]

BIM04-O3 "The programme and project plans are likely to achieve the expected outcomes."[IGI13, p.67]

BIM04-O4 "The programme and project activities are executed according to the plans."[IGI13, p.67]

BIM04-O5 "There are sufficient programme and project resources to perform activities according to the plans."[IGI13, p.67]

BIM04-O6 "The programme and project expected benefits are achieved and accepted."[IGI13, p.67]

4.5.7 BIM05 Manage BI Development

BIM05 Manage BI Development[6]

Process Description

Provide design, implementation and maintenance of solutions based on the requirements of the organization. Design data structure based on the identified information requirements. Implement and maintain the solution components compliant to information architecture and standards. "Manage configuration and testing of applications, information/data, infrastructure and services."[IGI13, p.73]

Process Purpose Statement

Establish timely and cost-effective solutions by analysis, design, implementation, deployment, and maintenance to maximize the value of information and support the organization information strategy. BI development is part of the overall project activities and covers the defining, designing and developing of BI components including DBMS, ETL and BI Applications.

Outcomes (OS)

BIM05-O1 "The BI design, including relevant components, meets organization needs, aligns with standards and addresses all identified risk."[IGI13, p.73]

[6]Based on the Process Dimension BAI03 [IGI13, p.73]

BIM05-O2 Business Rules have been transformed accordingly into concrete Data Requirements.

BIM05-O3 Data Requirements are represented by a logical and physical Datamodel including derived Metadata.

BIM05-O4 Functional and Non-functional requirements towards the information delivery have been defined and translated into technical specification.

BIM05-O5 The solution is of acceptable quality and has been successfully tested."[IGI13, p.73]

BIM05-O6 A version controlled data model where changes are traceable and old versions are restoreable.

BIM05-O7 Business Rules have been transformed into Data Mapping and ETL modules.

BIM05-O8 "The solution is of acceptable quality and has been successfully tested."[IGI13, p.73]

BIM05-O9 "Maintenance activities successfully address business and technological needs."[IGI13, p.73]

4.5.8 BIM06 Manage Technical BI Architecture

BIM06 Manage Technical BI Architecture[7]

Process Description

Provide the planning, implementation, and control of the technical architecture representing hardware and software necessary to provide information and decision support to all relevant stakeholders.

[7] Based on the Process Dimension BAI10 [IGI13, p.89]

Process Purpose Statement

Provide a holistic picture of the overall technical architecture. Build an efficient landscape of hardware and software aligned with strategic information goals. Manage the technical infrastructure and prepare the environment for future requirements and changes.

Outcomes (OS)

BIM06-O1 "Technical BI architecture is accurate, complete and up to date."[IGI13, p.89]

BIM06-O2 "Impact on Architecture is managed and aligned with business requirements."[IGI13, p.89]

BIM06-O3 A multilayer architecture design defines the data warehouse and specifies the data management and operation activities on each layer.

BIM06-O4 Interfaces to sources, analytical databases as well as BI Frontends have been defined on a conceptual and a technical level.

BIM06-O5 Scalability strategies and capabilities are available and have been tested.

4.5.9 BIM07 Manage BI Operations

BIM07 Manage BI Operations[8]

Process Description

"Co-ordinate and execute the activities and operational procedures required to deliver internal and outsourced IT services, including the execution of pre-defined standard operating procedures and the required monitoring activities."[IGI13, p.93] Ensure that deployed BI solutions are available to end users and can be used to their satisfaction. Plan, control, and support the infrastructure availability along the information lifecycle, from source to BI application.

[8]Based on the Process Dimension DSS01 [IGI13, p.93]

Process Purpose Statement

Protect and ensure the integrity of BI infrastructure and provide desired performance and functions of the systems as expected and agreed on. Monitor the systems landscape and implement infrastructure optimization and system evolutions aligned with the technical BI Architecture.

Outcomes (OS)

BIM07-O1 The BI infrastructure is available and works as expected and according to service-level agreements.

BIM07-O2 "Operational activities are performed as required and scheduled."[IGI13, p.93]

BIM07-O3 "Operations are monitored, measured, reported and remediated."[IGI13, p.93]

BIM07-O4 Operational incidents are resolved in a timely manner.

BIM07-O5 Infrastructure monitoring is available and is periodically examined.

BIM07-O6 Information recovery and Business continuity plans are available and have been tested.

4.5.10 BIM08 Manage BI Support

BIM08 Manage BI Support[9]

Process Description

Support business and development teams timely and effective in all issues related to business intelligence. Solve and answer upcoming questions and provide solutions for occurring problems. Document the occurring problems and the corresponding solutions.

[9]Based on the Process Dimension DSS02 [IGI13, p.95]

Process Purpose Statement

"Achieve increased productivity and minimize disruptions through quick resolution of user queries and incidents."[IGI13, p.95] Document issues and provide useful input for BI Operations, BI Architecture and BI Human Resources.

Outcomes (OS)

BIM08-O1 BI-related support services are available and reachable.

BIM08-O2 "Service requests are dealt with according to agreed-on service levels and to the satisfaction of users."[IGI13, p.95]

BIM08-O3 Incidents and Service requests are managed and transparent to the issuers.

BIM08-O4 Incidents and resolutions are well documented and made available to related processes.

4.5.11 BIM09 Manage BI Security

BIM09 Manage BI Security[10]

Process Description

Plan, develop and execute the security policies and procedures to maintain the level of information security risk at an acceptable level. Provide proper authentication and authorization. Ensure compliance of application by logging information access and executing regular auditing of data and information.security policy. "Establish and maintain information security roles and access privileges and perform security monitoring."[IGI13, p.101]

Process Purpose Statement

"Minimize the business impact of operational information security vulnerabilities and incidents."[IGI13, p.101] Prevent inappropriate access to data and information. Ensure that read/write access to data is provided only to the necessary minimum. Comply with regulatory requirements for privacy and confidentiality. Implement the necessary security measures in a way that business day-to-day routine is impacted as little as possible.

[10]Based on the Process Dimension DSS05 [IGI13, p.101]

Outcomes (OS)

BIM09-O1 Data Security guidelines are defined, publicly available and applied.

BIM09-O2 User Profiles, passwords and roles are defined and stored in compliance with data privacy and confidentiality standards.

BIM09-O3 "All users are uniquely identifiable and have access rights in accordance with their business role."[IGI13, p.101]

BIM09-O4 Security classifications are in place and are applied for Data and Documents.

BIM09-O5 "Information is properly secured when stored, transmitted or destroyed."[IGI13, p.101]

BIM09-O6 Authorization and authentication systems are available and applied to all systems.

BIM09-O7 Data Masking mechanism are available and applied to all data classified accordingly.

4.5.12 BIM10 Manage BI Quality

BIM10 Manage BI Quality[11]

Process Description

"Define and communicate data quality requirements in all processes, procedures and the related enterprise outcomes, including controls, ongoing monitoring, and the use of proven practices and standards in continuous improvement and efficiency efforts."[IGI13, p.59] Provide data quality assessment and continuous improvement of enterprise data quality. "Plan, implement and control activities that apply information quality techniques to measure, assess, improve, and ensure the quality of information."[IGI13, p.59]

[11] Based on the Process Dimension APO11 [IGI13, p.59]

Process Purpose Statement

"Measurably improve the quality of data in relation to defined business expectations. Define requirements arid specifications for integrating data quality control into the system development lifecycle Provide defined processes for measuring. Monitoring, and reporting conformance to acceptable levels of data quality. Ensure the consistent delivery of BI solutions and services to meet the data quality requirements of the enterprise and satisfy stakeholder needs."[IGI13, p.59]

Outcomes (OS)

BIM10-O1 "Stakeholders are satisfied with the quality of solutions and services."[IGI13, p.59]

BIM10-O2 "Quality requirements are implemented in all processes."[IGI13, p.59]

BIM10-O3 A data management plan is in place, ensuring continuously improvement of Data Quality.

BIM10-O4 Key performance indicators for data quality are defined and reported back to information consumers.

BIM10-O5 Masterdata and Reference Data management processes are in place and implemented in all BI applications.

4.6 Populate the model

"In the populate phase, the corresponding characteristics are determined. It also defines the maturity assessment, which includes the specification of instruments."[LM10]

The BI tailored process dimension defined in the section above can be used as the starting point for this step in the model development. According to the main aspects of process assessment model described in 3.1.3 the major characteristics can now be defined. This includes the maturity concept, dimensions, levels, the maturity principle, and the assessment approach.

4.6.1 Maturity concept

The concept of the proposed model is a tailored COBIT process assessment model focusing on relevant BI processes of organisations. It is a process based model where the defined process outputs will be the basis for the assessment according to the COBIT PAM approach.

4.6.2 Dimension

The dimensions are based on a process reference model consisting of the following processes:

- BIM01 Manage BI Strategy
- BIM02 Manage Information Architecture
- BIM03 Manage BI Human Resources
- BIM04 Manage BI Programme
- BIM05 Manage BI Development
- BIM06 Manage Technical BI Architecture
- BIM07 Manage BI Operations
- BIM08 Manage BI Support
- BIM09 Manage BI Security
- BIM10 Manage BI Quality

4.6.3 Level

The capability levels of the assessment model are utilizing the capability dimension of the COBIT process assessment model described in section 3.3.3.

Process Level	Capability
0 (Incomplete)	The process is not implemented or fails to achieve its process purpose. At this level, there is little or no evidence of any systematic achievement of the process purpose.
1 (Performed)	The implemented process achieves its process purpose.
2 (Managed)	The performed process is now implemented in a managed fashion (planned, monitored and adjusted) and its work products are appropriately established, controlled and maintained.
3 (Established)	The managed process is now implemented using a defined process that is capable of achieving its process outcomes.
4 (Predictable)	The established process now operates within defined limits to achieve its process outcomes.
5 (Optimizing)	The predictable process is continuously improved to meet relevant current and projected business goals.

Figure 4.2: COBIT 5 Process Capability Levels [IGI13, p. 11]

4.6.4 Maturity principle

The maturity principle of the model uses the concept of assessment indicators, process attributes and the rating scale described in section 3.3.3.

Assessment Indicators

"Assessment indicators in the COBIT PAM provide the basis for determining whether process attributes have been achieved: Capability."[Pro13]

Determine level 1 capability "The first step in the assessment of each process is to determine whether a process is actually being performed and is achieving its outcomes. The indicators at capability level 1 are specific for each process and assess whether implemented process achieves its purpose."[Pro13]

Determine capability for levels 2 to 5 "Above level 2, the assessment criteria are generic and need to be rated on every process attribute (PA) according to the level. The PAs are taken from the capability indicators above."[Pro13]

Scale	Process Attributes	Rating
Level 1	Process Performance	Largely or fully
Level 2	Process Performance Performance Management Work Product Management	Fully Largely or fully Largely or fully
Level 3	Process Performance Performance Management Work Product Management Process Definition Process Deployment	Fully Fully Fully Largely or fully Largely or fully
Level 4	Process Performance Performance Management Work Product Management Process Definition Process Deployment Process Measurement Process Control	Fully Fully Fully Fully Fully Largely or fully Largely or fully
Level 5	Process Performance Performance Management Work Product Management Process Definition Process Deployment Process Measurement Process Control Process Innovation Process Optimization	Fully Fully Fully Fully Fully Fully Fully Largely or fully Largely or fully

Figure 4.3: COBIT 5 PAM Levels and Necessary Ratings [IGI13, p. 11]

4.6.5 Process Attributes

"Within the COBIT PAM, the measure of capability is based on the nine process attributes (prefixed by PA) defined in ISO/IEC 15504-2, as shown in 4.4. Each attribute applies to a specific process capability. Process attributes are used to determine whether a process has reached a given capability."[Pro13]

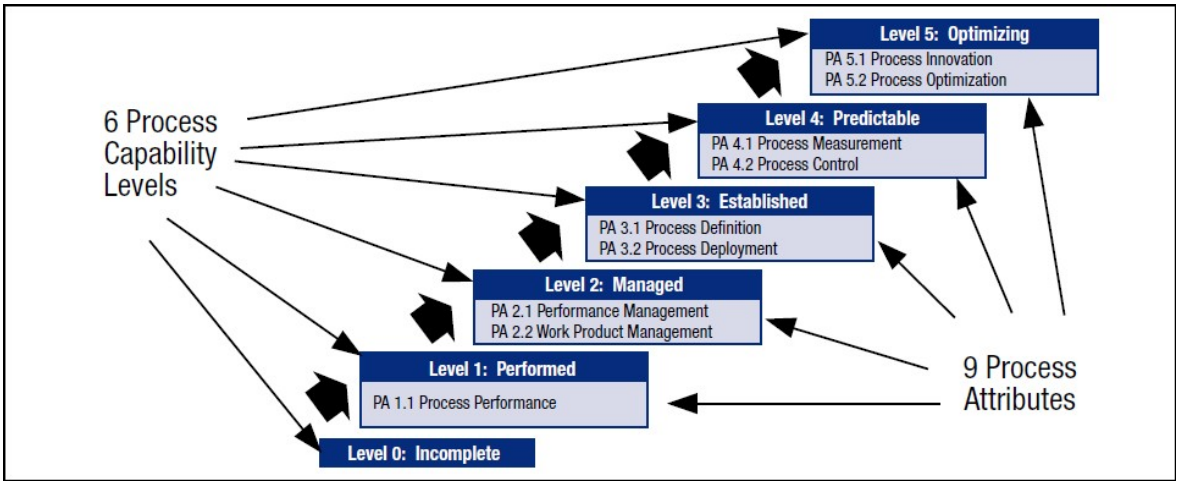

Figure 4.4: COBIT 5 Process Attributes [IGI13, p. 11]

Rating Scale

Each attribute is rated using a standard rating scale defined in the ISO/IEC 15504 standard. These ratings consist of:

(N) Not achieved "There is little or no evidence of achievement of the defined attribute in the assessed process."[IGI13, p. 14]

(P) Partially achieved "There is some evidence of an approach to, and some achievement of, the defined attribute in the assessed process. Some aspects of achievement of the attribute may be unpredictable."[IGI13, p. 14]

(L) Largely achieved "There is evidence of a systematic approach to, and significant achievement of, the defined attribute"[IGI13, p. 14] in the assessed process. Some weakness related to this attribute may exist in the assessed process.

(F) Fully achieved "There is evidence of a complete and systematic approach to, and full achievement of, the defined attribute in the assessed process. No significant weaknesses related to this attribute exist in the assessed process."[IGI13, p. 14]

Abbreviation	Description	% Achieved
N	Not achieved	0 to 15% achievement
P	Partially achieved	>15% to 50% achievement
L	Largely achieved	>50% to 85% achievement
F	Fully achieved	>85% to 100% achievement

Figure 4.5: Rating Levels [IGI13, p. 11]

4.6.6 Assessment approach

Finally, this section describes how the process assessment model is applied. In order to meet the basic concept of simplicity stated in the initial section of this chapter, the following assessment approach has been chosen.

The COBIT Framework provides a simplified version of the process assessment which does not require an independent or certified assessor and can be done by enterprise management or knowledge.

The proposed assessment approach is based on the self-assessment guide and is designed to perform "a less rigorous assessment of IT processes. This can be a precursor of undertaking a more rigorous, evidenced-based assessment. The approach is based on the COBIT PAM used in the COBIT assessment programme, but does not require evidentiary requirements in support of the self-assessment, nor does it require use of the official COBIT PAM documents."[Pro13] The utilization of COBITs Self-Assessment approach will keep executions costs, both monetary and time, at a minimum level. This approach allows to perform the assessment quick and relatively easy by following 5 steps.

1. Decide on Processes to Assess
2. Determine Whether the Selected Process Is a Level 1 Capability
3. Determine Whether Capability Levels 2 to 5 for the Selected Processes Are Being Achieved
4. Record and Summarise the Capability Levels
5. Develop an Improvement Plan of Action

[Pro13]

Decide on Processes to Assess

"At this point, the target capability level needs to be defined. This will define the level of capability required of the process. In setting the target capability, the impact on the business objectives should be considered especially if a specified level of capability is not achieved. The first consideration is the impact on the enterprise if the process is non-existent or not working effectively or efficiently. The second consideration concerns the additional con-

sequences of the effective and efficient operation of the processes at the various capability levels."[Pro13]

Determine Level 1 Capability

This step of the assessment the process makes the significant difference from a full-blown COBIT process assessment. Instead of assessing all Base Practices, Work Products and Outputs of processes only the Outputs will be assessed. To do that, the first step is to "determine whether a process is actually being performed and is achieving its outcomes. The indicators at capability level 1 are specific for each process are based on the define process outputs (Os)."[Pro13] Exemplary for the process "BIM01 Manage BI Strategy" the Level 1 Capability has been achieved if the following process outputs can be rated largely or fully existing (greater 50%)

BIM01-O1 All aspects of the BI strategy are aligned with the enterprise long-term strategic goals.

BIM01-O2 The BI strategy is cost-effective, appropriate, realistic, achievable, enterprise-focussed and balanced.

BIM01-O3 The strategic business requirements have been define clearly and have been mapped to the according information requirements.

BIM01-O4 A vision statement is available covering the strategic requirements as well as short-term goals.

BIM01-O5 Possible gaps on functional or non-functional requirements have been identified and management is aware of them.

BIM01-O6 Ownership and of data and delivery of information is clearly defined.

BIM01-O7 The major point of the aligned strategy (BIM01-O2) have been communicated within the organisation.

BIM01-O8 A abstract business data model is defined and aligned, representing the single point of truth of the the high-level information architecture.

Determine Capability Levels 2 to 5

The determination of process capability level 2 to 5 only needs to be done, in case the assessed processed has successfully passed level 1 as described in the section above. Above level 1, the assessment criteria are generic and are the same for each and every process. The criteria can be found in Appendix B within the exemplary assessment template in the column "criteria""[Pro13] Exemplary for Level 2.1 (Performance Management) the following criteria will be tested.

1. "Objectives for the performance of the process are identified." [Pro13]
2. "Performance of the process is planned and monitored." [Pro13]
3. "Performance of the process is adjusted to meet plans." [Pro13]
4. "Responsibilities and authorities for performing the process are defined, assigned and communicated." [Pro13]
5. "Resources and information necessary for performing the process are identified, made available, allocated and used." [Pro13]

Record and Summarise the Capability Levels and Develop an Improvement Plan of Action

Finally, the results need to be recorded. Gaps between the target and the results are presented. ISACA provides templates for process assessment. An already customised template for the process BIM01 can be found in the Appendix C

"Based on the results consideration should be given to the development of a plan of action for process improvement. One option could be to commence an initial improvement plan based on the self-assessment. This could address the areas of highest importance to the enterprise's business goals and focus on areas with gaps between the 'current' and 'target' process capability levels."[Pro13]

Additionally, the result can be used to compare and then select between potential future scenarios. Another benefit is the possibility to benchmark against other organizations.

4.7 The resulting model

Based on the characteristic defined in the previous sections, the elements can now be integrated into a complete picture of the model. The figure shows the previously defined processes at the x-axis and the according capability levels on the y-axis. Further it points out that the process of capability assessment is performed on the basis of the outputs (Os) of the according processes using the rating scale and the assessment indicators. Figure 4.6 shows the adapted model with the new dimensions integrated in the existing COBIT PAM components.

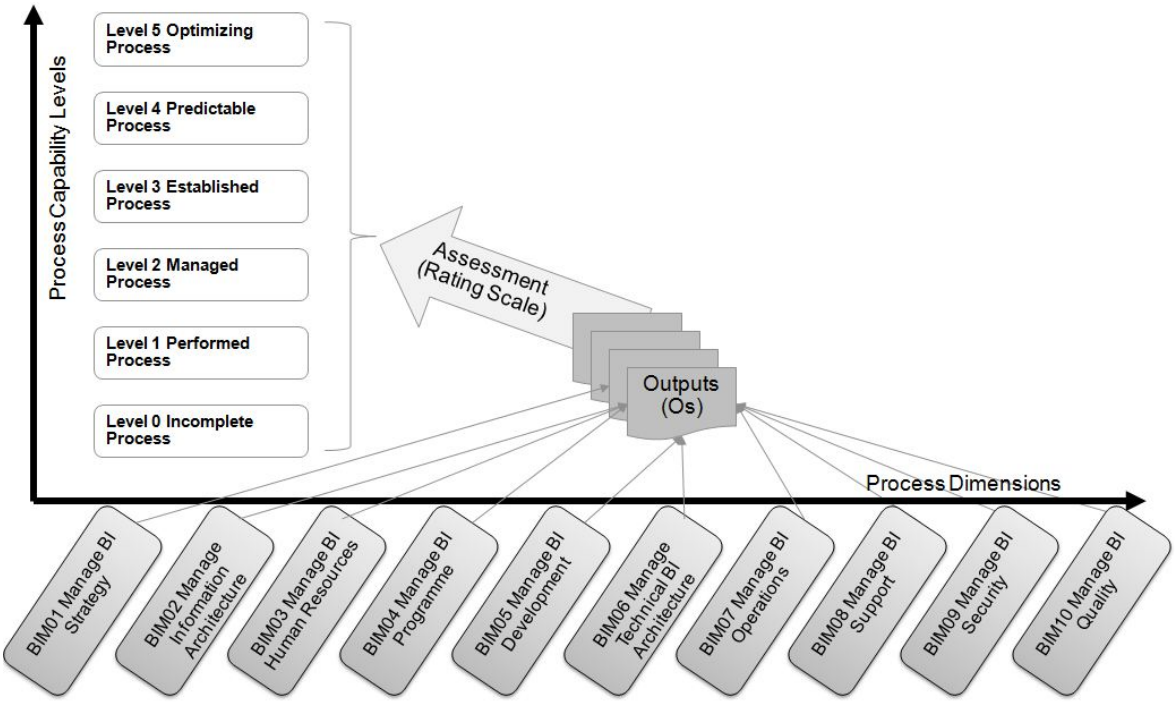

Figure 4.6: BI Process Assessment Model

4.7.1 BI Process Reference Model

As shown in figure 4.7 the reference process model, defined in this chapter, provides a holistic view on all BI related process within the IT-Management of an organization. The BI strategy aligns the information requirements based on the strategic goals and defines high-level information architecture of the organization.

Based on this vision, the Information Architecture process maps business processes to information assets and the architectural components.

The BI Programme process manages the implementation including all projects and initiatives within the budget and time constraints.

Within those projects the technical BI architecture designs the necessary components according to the business requirements.

The designed artefacts will then be developed within the BI Development process and put in production using the BI Operations process. The BI support process represents the single point of contact to receive issues and change request which will be handed over again either to Operations or Development.

BI Quality processes covers the overall quality management of the delivered modules focusing on the data quality along the information chain including sources and front-end BI applications.

The overarching process Manage BI Human Resources provides the necessary resources and

training, enabling the programme to deliver solutions.

The BI Security process monitors and ensures information security and the compliance within all processes.

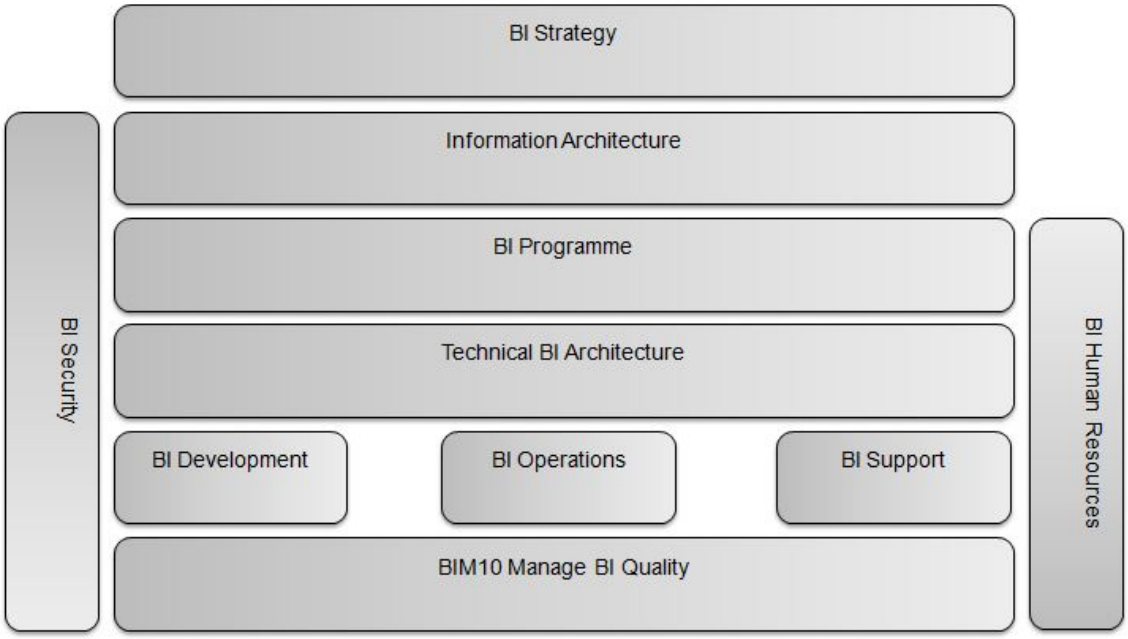

Figure 4.7: BI Process Reference Model

4.7.2 Assessment characteristics

For each process expected outputs have been defined (Os) in section 4.5.2. Those outputs build the basis for the COBIT assessment approach, shown in the center of figure 4.7.

The expected outputs will be matched against the existing outputs of the processes within an organization. Depending on the maturity and completeness of the existing processes the COBIT rating scale will define the achievement level for each Output will be defined.

The complete picture of the assessed output will then define the level of maturity for each process resulting in a holistic picture of the BI maturity of the respective organization.

Based on all those components BI relevant processes can be assed using the well-established COBIT assessment approach, providing an clear picture of BI maturity of organizations.

Chapter 5

Evaluation of the model

In order to test the applicability of the initial iteration of the model discussed in section 4.5.1, this chapter describes the conducted evaluation process. The model was evaluated by an empirical evaluation technique, a survey by means of expert interviews. This method was used to check how sound and complete the proposed processes and capability dimensions are. This empirical technique should "help to assess if a design artefact meets the criteria of utility, quality, and efficacy."[vAMPR04, cf. p.75]

The goal was to test the process dimension against completeness and applicability in the context of Business Intelligence process assessment.

5.1 Assessment approach

[GL10] point out that in expert surveys, the term interview has been established. One of the most important classifications for interviews is, according to the authors, the distinction of the degree of standardization:

- (full) standardized interviews: solid formulated questions in a fixed order with possible answers
- semi-structured interviews: solid formulated questions in a fixed order, but the interviewee can choose the answers free
- non-standardized interviews: no standardization of answers and questions

In this thesis, a mixture of standardized and semi-standardized interview is used. The reasons for this are the following restrictions on the survey.

The topic of business intelligence, especially in connection with COBIT, is quite unique. The number of potential participants for an expert interview is therefore highly restricted. Due to the relatively small time budget of the participants, the questionnaire had to offer the opportunity to deliver results as quickly as possible and easily. In principle, therefore, a highly structured design was chosen as the foundation which is based on a 5-point Likert-like scale

(one being the lowest value). Nevertheless, the questionnaire should produce qualitative results where possible. For this purpose, in addition to the scale, a text field has been offered to explain the selected answer in detail if needed.

The interviews lasted about 15-30 minutes and were conducted with the help of a structured questionnaire that was provided to the participants in advance. The participants were also allowed to review the interview again, add complementary notes and send the result via email.

5.1.1 Questionnaire design

All interviews were structured into an introductory phase in which the general settings and purpose of the interview has been explained. In this phase the personal details as well as the knowledge background was documented. Then a short introduction of the model, where the processes and dimensions were explained to the interviewee, followed. The main part consisted of the assessment of the processes and dimensions. The focus was on the applicability and completeness of the processes and dimensions used in the model. First, the integrity of the underlying processes was queried. Thereafter, based on the process descriptions, the completeness of the process definitions was evaluated. In addition, the artefacts of the processes were checked for applicability. If there were additional comments by the interviewee, they have been written down correspondingly. The detailed questionnaire including the anonymised answers can be found in the Appendix B.

At the end of the interview, two questions have been asked regarding the holistic usability and the potential users of the model.

5.1.2 Evaluation approach

For the semi-structured part the so-called formulated Interpretation is used. The formulation interprets the meaning. Finding the truth or reality of the results is not part of this procedure. Not the interviewees themselves, but the issues raised are the subject of a conceptual-theoretical explanation. The interpreter provides only an overview of the results[Boh07, cf. p.134]

Due to the small number of participants the quantitative part of the questionnaire can not be utilized for a statistical analysis of the results. Nevertheless, the quantitative evaluation will show the ranges based on the answers to give a high-level picture of the results. Additionally, the notes and remarks of the participants were grouped and summarized which is shown in the section of qualitative results.

5.1.3 Participants

"Someone can be referred to as an expert who bears responsibility in any way for the design, Implementation or control of a problem solution or who has privileged access to information on people groups or decision-making processes."[MN91, cf. p.443] The experts themselves can be categorized into the following types[FL03, cf. p.228]

- Internal expertise of action refers to the implicit experiential knowledge of actors that has arisen from the direct employment with the interesting facts.
- Internal expertise of reflection relates to reflected experience and knowledge of experts which is more abstract than pure procedural knowledge.
- External expertise refers to "sound theoretical knowledge of the subject area

In this survey mainly experts with internal expertise were covered. Overall, this thesis conducts 5 interviews with BI experts from the authors' network. A total of five people were interviewed. The experts come mainly from the field of consulting, only one participant was out of the industry. As the majority of people have their background in consulting the interpretation of the results needs to take this into account.

Furthermore, participants differed in origin and gender. The participants come from Austria (2), Germany (2) and United Kingdom (1). A vast majority is represented by male experts (4). Only one participant was female. The number of years of experience of the participants ranges from 7-30 with an average of 17. The names of the experts are given in the 5.1 to prove the quality of the sample and also to ensure traceability of the records. In the content analysis, for reasons of anonymity the names of experts were omitted, as in the interviews sensitive information has been collected. The following table shows the details of the interviewees of the survey.

Name	Company	Job title	Industry	Years of experience working in the BI area
Josef Mayer	Capgemini Österreich	Managing Consulting BI	IT Consulting	25
Matthias Loidolt	Capgemini Österreich	Managing Consultant	IT Consulting	8
Simon Turnbull	Capgemini UK	Managing Architect	Consulting	30
Marie-Fleur Revel	BMW	IT Project Manager	Automotive	7
Andreas Bauer	Capgemini Deutschland	Principal Consultant	IT Consulting	15

Table 5.1: List of participants

5.2 Outcome

Due to the strong IT consultant background of the majority of the participants, the results should be treated with care. The general outcome does therefore not represent any industry perspective, but focus on the applicability of the model within IT Consulting.

5.2.1 Quantitative results

Based on the introductory question block, the experiences of the participants could be derived. Interestingly, only one of the participants had previous experience with COBIT and COBIT Process Assessment Model. Despite the vast working experience of the participants, the COBIT Framework apparently was in the focus of their work. Nevertheless, three persons had already performed maturity assessments with other frameworks. As alternatives to COBIT the frameworks MIKE 2.0, DAMA, Zachman and TOGAF were highlighted.

As for the main part of the survey, the objective was to survey the accuracy and completeness of the model. The results show the average number of all handed in survey ranging from 1 (very bad) to 5 (very good). In general the results are tending to the positive and can be found in the following table.

Question ID	Question description	Range
	Processmodel and descriptions	
2.1	Processmodel in general	3
2.2	Description of Manage BI Strategy	3
2.3	Description of Manage BI Development	3-4
2.4	Description of Manage Technical BI Architecture	3
2.5	Description of Manage Information Architecture and Standardisation	3-4
	Capability indicators	
3.1	Manage BI Strategy (Os)	3-4
3.2	Manage Information Architecture and Standardisation (Os)	3-4
3.3	Manage BI Human Resources (Os)	3
3.4	Manage BI Programme (Os)	3-4
3.5	Manage BI Development (Os)	3-4
3.6	Manage Information Architecture and Standardisation (Os)	3-4
3.7	Manage BI Operations (Os)	3
3.8	Manage BI Support (Os)	3-4

Table 5.2: Results of expert interview

The large part of the results range 3-4. The best results achieved the maturity levels dimensions of processes “Manage Information Architecture and Standardization” and “Manage BI Programme”. The worst value for the applicability got the definition of maturity dimension of “Manage BI Human Resources”.

5.2.2 Qualitative Results

The following results are derived from comments, suggestions and criticisms which were added by the participants in the form of free text to the corresponding questions.

Process model in general

Remarks were made that this process model supports mainly more or less stable organizational environments. It is less applicable for organizations in the state of growing or consolidation because of change, modernization and restructuring demands, which are not covered. It was also recommend adding the the areas of Demand Management and Requirements, Data Quality, Information Security and Data Governance.

Process description of Manage BI Strategy

It was recommended to focus more on the business requirements. "BI should provide the means to make the company able to respond to the market requirements, logistic problems, etc. as fast as possible." The BI system should also be capable to support the long term company strategy.

Process description of Manage BI Development

In this section improvements through decoupling of Demand Management and Requirement Management as well as the decoupling to Process Management have been proposed.

Process description of Manage Technical BI Architecture

Adding aspects of reference Architecture as well as the BI Operational Model in context of Enterprise Architecture framework had been recommendations for improvement.

Process description of Information Architecture and Standardisation

For this question, no remarks were made.

Description of the Outputs (Os)

In general, the description of the outputs and the associated quantification was perceived as difficult. The suitability of this method was perceived as hard to implement.

> "Sentences like BI is a value driver for the enterprise is difficult to measure."

Also goals with concrete KPIs like number of tickets, number of concurrent users were missing by the participant.

Concluding questions

Despite the rather average general assessment results of the individual components of the model, the final assessment was tending to the positive. The answers to the question "Do you feel the COBIT model provides a better understanding about BI maturity? Please explain?" were mostly heading into the same positive direction. In summary, most of the participants were of the opinion that the proposed model is a good support for a high-level review of the BI landscape. Only one participant refused the COBIT-based approach completely. He criticized the orientation towards a Supply and Demand model which is no longer appropriate in times of service-oriented BI architecture.

As the most appropriate users for the model the following were named

- IT Organizations (external/internal) within process and service aware mature organizations
- IT-Departments entrusted with BI solution
- BI project sponsors and owners
- IT strategy departments together
- BI business/key users

5.2.3 Results summary

In summary, the following picture emerges. The proposed model provides a good overview of relevant BI processes of an organization at a relatively high level. The COBIT-based processes and process descriptions are consistent with the view of the experts for the most part.

The quantitative results of the questionnaire, ranging between 3 and 4, draws a picture, which is difficult to interpret. In general it can be assumed that the interviewees have been able to associate the defined process with the BI relevant process they see in their daily routine.

The main areas of criticism were the high-level definitions of process purposes. The definitions of outputs are considered critical by the experts. These are often very vague and difficult to quantify. Additional, according to the interviewees, some areas were missing completely or are not fully covered by the original COBIT processes definition. Due to quite generic nature of the original COBIT PAM this seems to be logical.

According to the conclusionary questions, an application of the current model is not expected to provide detailed answers regarding potential for improvement. However, it was stated that it will help to understand the overarching organization of the BI landscape and will help to identify existing gaps.

The findings of the questionnaire have been reflected in a further iteration of the model design in chapter 4, which defines a narrow definition of the expected outcomes and process definitions and reflects the area of BI in a suitable way.

Chapter 6

Conclusion

This paper proposes a Business Intelligence Capability Model based on the COBIT Framework. It utilizes the COBIT Process Assessment Model as a basis and adapts it to the area of Business Intelligence. The model provides a basis for assessing an organization's BI processes against a well established framework which is also compliant to international standards. Furthermore, it provides an overview of mandatory processes and its capabilities for successful BI within organizations.

6.1 Impact

The proposed model comprises 8 core processes retrieved from literature which were then mapped to the COBIT Process model. The resulting BI process model supports organizations to understand BI as a constantly evolving strategy, vision and architecture that continuously seeks alignment with the organization's operations and directions. Furthermore it shows that successful BI need to meet various requirements not only on technical but also organizational levels.

COBITs holistic and systemic view on governance and management of enterprise provides a good entry point in order to govern and manage IT. Its flexibility allows the implementation for a wide range of organisation sizes and types, whether commercial, not-for-profit or in the public sector.

Another big advantage is, that COBIT provides integration with other common frameworks ISO/IEC 27002, ITIL (Information Technology Infrastructure Library), PMBOK (Project Management Body of Knowledge), CMM (Capability Maturity Model). Existing implementations of other frameworks can thus be easily continued to be used but also used as input for implementation of the COBIT framework.

The COBIT PAM allows a very flexible and modular definition of the processes to be assessed. Additionally, the existing range of processes, offer a comprehensive and widely accepted library of process definitions. These can be relatively easily adapted to the organ-

isational needs. These processes are already embedded in a solid framework which already provides predefined dependencies, the most important parameters and constraints. This allows for a very quick definition of the underlying target processes dimension model.

The process capability levels of the processes are determined on the basis of the achievement of specific process attributes based on the ISO/IEC 15504-2:2003 standard. It is a generic model and provides a solid foundation for applying process assessment. Through the application of such standards the assessment can an be carried out without interfering with the underlying model. This allows applications in almost every area of IT and speeds up the execution.

6.2 Limitations

Nevertheless there are various downfalls using the ISO/IEC 15504 standard. The main point of criticism is probably the procedure for the evaluation of the capability levels. As mentioned above, processes can only reach the level 1 if they are appropriate implemented. This approach makes it difficult to apply, especially for semi-structured organizations. Smaller companies or organizations where there is no structured approach might always remain at level 0 even though initial or ad hoc processes are already in place. Other process assessment models, like the CMMI cover these issues better by setting the first level of maturity to “Initial”. Applying the COBIT PAM could therefore be rather frustrating for smaller and medium enterprises and will not provide added value for an as-is analysis.

Additionally, although ISO/IEC 15504 is a widespread model it has not yet been as successful, as the full version of ISO/IEC 15504 is not available as free download but must be purchased from the International Standards Organization (ISO) website. CMM and CMMI, however, are available as free downloads from the Software Engineering Institute (SEI) website. The higher popularity can also be attributed to the fact that it was created first, and reached critical ‘market’ share before ISO 15504 became available. In addition, CMMI has already incorporated many of the ideas of ISO/IEC 15504.

Unfortunately the COBIT model turns out to be very generic. While the evaluation of Level 1 is performed based on the processes and descriptions individually defined, at the higher levels generic statements must be measured. However, these generic statements remain the same for each process. Although this increases flexibility on the one hand, it comes at the expense of specific process problems evaluation. To measure rather vague statements like “Suitable methods for monitoring the effectiveness and suitability of the process are determined.” (3.1 Process Definition) require a great deal of sensitivity, experience and organisational knowledge. This leads to great need for discussion during the assessments and create a high potential for conflict.

This problem was also confirmed in the expert interviews. While the participants were satisfied with the proposed processes in general, the description of the imported objects was often perceived as too abstract.

6.3 Overcoming the identified limitations

In order to further improve the assessment model it would be necessary to incorporate the points of criticism into the existing model. Especially emerging topics like Master Data Management are not covered at the moment. The existing process descriptions would need to be refined in even more detail and additional processes might need to be added in order to allow more specific analysis of capabilities. After an additional evaluation phase based on a broader number of participants the model could be further analysed and detailed. Finally the re-conceptualized model needs to be implemented in a real-world example in order to prove its applicability and stability.

Appendix A

Glossary

BI → Business Intelligence

COBIT → The Control Objectives for Information and related Technology

DSS → Decision Support Systems

EIS → Executive Information System

ISACA → Information Systems Audit and Control Association

IT → Information Technology

ITGI → Information Technology Governance Institute

MIS → Management Information Systems

MSS → Management Support Systems

OECD → Organisation for Economic Co-operation and Development

OLAP → On Line Analytical Processing

PAM → Process Assessment Model

RPM → Reference Process Model

Appendix B

Appendix: Questionnaire

Questionnaire:
COBIT PAM for BI maturity assessment

Name (optional)	
Company (optional)	
Job title (optional)	
Industry	
Years of experience working in the area of Business Information Management	

The COBIT BI maturity assessment has been created in order to inform stakeholders of the capability of its BI processes as well as targets for improvement. Therefore the COBIT Process Assessment Model has been adapted and distilled for BI maturity assessment.

Please answer the following questions and send it to andreas.hornich@capgemini.com

General Questions

QUESTIONS	YOUR ANSWERS
Do you know the COBIT framework?	
Do you know the COBIT Process Assessment Model / Maturity Model?	
Did you ever use/apply COBIT framework in your work?	
Have you ever been part of a maturity assessment? If yes, which frameworks did you utilize?	
Which other frameworks/maturity models do you know for Maturity Assessment?	
Do you know any frameworks for Maturity Assessment tailored for the area of Business Information Management?	

In order to adapt COBIT for BI Process Assessment 8 core processes have been defined. Please indicate how well you think the listed process definition fit to the area of Business Intelligence

Process Map

QUESTIONS	YOUR ANSWERS
The proposed model defines BI in enterprises through 8 core processes. These are • Manage BI Strategy • Manage Information Architecture and Standardisation • Manage BI Human Resources • Manage BI Programme • Manage BI Development • Manage Technical BI Architecture • Manage BI Operations • Manage BI Support *How sufficient do you think these core processes are to describe Business Information Management within organizations?*	1 | 2 | 3 | 4 | 5 Please highlight the suitable field (1=not sufficient, 5=very sufficient) Which processes would you add?
Manage BI Strategy Provide a holistic view of the current BI environment, the future direction, and the initiatives required to migrate to the desired future environment. Leverage the BI architecture building blocks and components, including externally provided services and related capabilities to enable nimble, reliable and efficient response to strategic business objectives. *How sufficient do you think this process is described? What are you missing?*	1 | 2 | 3 | 4 | 5 Please highlight the suitable field (1=not sufficient, 5=very sufficient) Which processes would you add?
Manage BI Development Establish and maintain identified solutions in line with enterprise requirements covering design, development, procurement/sourcing and partnering with suppliers/vendors. Manage configuration, test preparation, testing, requirements management and maintenance of business processes, applications, information/data, infrastructure and services. *How sufficient do you think this process is described? What are you missing?*	1 | 2 | 3 | 4 | 5 Please highlight the suitable field (1=not sufficient, 5=very sufficient) Which processes would you add?

QUESTIONS	YOUR ANSWERS
Manage Technical BI Architecture Define and maintain descriptions and relationships between key resources and capabilities required to BI services, including collecting configuration information, establishing baselines, verifying and auditing information, and updating the technical BI architecture. Provide and continuously improve a framework that supports the future technical architecture maintenance. *How sufficient do you think this process is described? What are you missing?*	1 | 2 | 3 | 4 | 5 Please highlight the suitable field (1=not sufficient, 5=very sufficient) Which processes would you add?
Manage Information Architecture and Standardisation Establish a common architecture consisting of business process, information, information entities, application and technology architecture layers for effectively and efficiently realizing enterprise and IT strategies by creating key models and practices that describe the baseline and target architectures. Define requirements for taxonomy, standards, guidelines, procedures, templates and tools, and provide a linkage for these components. Improve alignment, increase agility, improve quality of information and generate potential cost savings through initiatives such as re-use of building block components. *How sufficient do you think this process is described? What are you missing?*	1 | 2 | 3 | 4 | 5 Please highlight the suitable field (1=not sufficient, 5=very sufficient) Which processes would you add?

The processes in the COBIT MM are defined through their defined outputs (O1, O2,…).
In order to conduct the maturity level for the individual processes, the completeness of the expected outcomes is reviewed first.
Please indicate how well you think the listed outcomes define each process.

Process Definitions

QUESTIONS	YOUR ANSWERS
Manage BI Strategy	
BIM01-O1 All aspects of the BI strategy are aligned with the enterprise strategy.	1 | 2 | 3 | 4 | 5 Please highlight the suitable field (1=not defined, 5=very well defined)
BIM01-O2 The BI strategy is cost-effective, appropriate, realistic, achievable, enterprise focused and balanced.	
BIM01-O3 Clear and concrete short-term goals can be derived from, and traced back to, specific long-term initiatives, and can then be translated into operational plans.	
BIM01-O4 BI is a value driver for the enterprise.	
BIM01-O5 There is awareness of the BI strategy and a clear assignment of accountability for delivery	If possible, please elaborate your decision roughly

Manage Information Architecture and Standardisation

	1	2	3	4	5
BIM02-O1 The business BI architecture and standards are an effective documentation supporting the BI programme					
BIM02-O2 A portfolio of business BI architecture services supports agile enterprise change.					
BIM02-O3 Appropriate and up-to-date domain and/or federated architectures exist that provide reliable business BI architecture information.					
BIM02-O4 A common business BI architecture including a data supply plan, a reference data model and an information usage map. A set of templates covering all relevant BI deliverables to support on-going documentation.					

Please highlight the suitable field (1=not defined, 5=very well defined)

If possible, please elaborate your decision roughly

Manage BI Human Resources

	1	2	3	4	5
BIM03-O1 The IT organisational structure and relationships are flexible and responsive.					
BIM03-O2 Human resources are effectively and efficiently managed.					

Please highlight the suitable field (1=not defined, 5=very well defined)

If possible, please elaborate your decision roughly

Manage BI Programme

	1	2	3	4	5
BIM04-O1 Relevant stakeholders are engaged in the BI programme and associated projects.					
BIM04-O2 The scope and outcomes of the BI programme and associated projects are viableand aligned with business objectives.					
BIM04-O3 The programme and project plans are likely to achieve the expected outcomes.					
BIM04-O4 The programme and project activities are executed according to the plans.					
BIM04-O5 There are sufficient programme and project resources to perform activities according to the plans.					
BIM04-O6 The programme and project expected benefits are achieved and accepted.					

Please highlight the suitable field (1=not defined, 5=very well defined)

If possible, please elaborate your decision roughly

BIM05 Manage BI Development

	1	2	3	4	5
BIM05-O1 The solution design, including relevant					

components, meets enterprise needs, aligns with standards and addresses all identified risk.	Please highlight the suitable field (1=not defined, 5=very well defined)
BIM05-O2 The solution conforms to the design, is in accordance with organisational standards, and has appropriate control, security and auditability.	
BIM05-O3 The solution is of acceptable quality and has been successfully tested.	
BIM05-O4 Approved changes to requirements are correctly incorporated into the solution.	If possible, please elaborate your decision roughly
BIM05-O5 Maintenance activities successfully address business and technological needs.	
Manage Technical BI Architecture	1 | 2 | 3 | 4 | 5
BIM06-BP1 Establish and maintain a technical BI architecture Establish and maintain a logical model of the data, services, assets, infrastructure and the relationships amongst them. Include the resources considered necessary to manage services effectively and to provide a single reliable description of the assets in a service.	Please highlight the suitable field (1=not defined, 5=very well defined)
BIM06-BP2 Establish and maintain a configuration repository and baseline Establish and maintain a technical architecture management repository.	
BIM06-BP3 Maintain and control BI assets Maintain an up-to-date repository of BI assets by populating with changes.	If possible, please elaborate your decision roughly
BIM06-BP4 Produce status and configuration reports Define and produce configuration reports on status changes of BI assets.	
Manage BI Operations	1 | 2 | 3 | 4 | 5
BIM07-O1 Operational activities are performed as required and scheduled.	Please highlight the suitable field (1=not defined, 5=very well defined)
BIM07-O2 Operations are monitored, measured, reported and remediated.	
	If possible, please elaborate your decision roughly
Manage BI Support	1 | 2 | 3 | 4 | 5
BIM08-O1 BI-related services are available for use.	Please highlight the suitable field (1=not defined, 5=very well defined)
BIM08-O2	

Incidents are resolved according to agreed-on service levels. **BIM08-O3** Service requests are dealt with according to agreed-on service levels and to the satisfaction of users.	If possible, please elaborate your decision roughly

Comprehensive Questions

QUESTIONS	YOUR ANSWERS
Do you feel the COBIT model provides a better understanding about BI maturity? Please explain.	
Who do you think is the most appropriate user of the COBIT model, if any? Please explain.	

Appendix C

Appendix: COBIT Assessment Template

BIM01	BIM01 - Manage BI Strategy							
	Purpose	Define the general direction of the BI Landscape from a long-term perspective aligned with IT and business objectives. Clearly state a vision, including strategic goals and communicate it to all relevant stakeholders.						
	Assess whether the following outcomes are achieved.	**Criteria**	**Criteria Are Met Y/N**	**Comment**	Not achieved (0-15%)	Partially Achieved (15% 50%)	Largely Achieved (50% 85%)	Fully Achieved (85-100%)
Level 0 Incomplete	**The process is not implemented, or fails to achieve its process purpose.**	At this level, there is little or no evidence of any achievement of the process purpose.						
Level 1 Performed	**PA 1.1 The implemented process achieves its process purpose.**	The following process outcomes are being achieved:	**Overall rating for the process**					
		BIM01-O1 The BI strategy is aligned with IT and enterprise strategy.						
		BIM01-O2 The BI strategy is realistic, cost-efficient, achievable, enterprise focused and balanced.						
		BIM01-O3 Relevant strategic business requirements is defined and translated into information requirements.						
		BIM01-O4 Business Blueprint covering short-term and long-term business requirements at a vision level.						
		BIM01-O5 There is awareness of the BI strategy and a clear assignment of accountability for delivery						
		BIM01-O6 Accountability for the delivery of the BI strategy has been clearly defined.						
		BIM01-O7 The BI strategy has been communicated and is publicly available within the organization.						
		BIM01-O8 The conceptual BI architecture has been defined.						
Level 2 Managed	**PA 2.1 Performance Management - A measure of the extent to which the performance of the process is managed.**	As a result of full achievement of this attribute: a) Objectives for the performance of the process are identified. b) Performance of the process is planned and monitored. c) Performance of the process is adjusted to meet plans. d) Responsibilities and authorities for performing the process are defined, assigned and communicated. e) Resources and information necessary for performing the process are identified, made available, allocated and used. f) Interfaces between the involved parties are managed to ensure both effective communication and also clear assignment of responsibility.						
	PA 2.2 Work Product Management - A measure of the extent to which the work products produced by the process are appropriately managed. The work products (or outputs from the process) are defined and controlled.	As a result of full achievement of this attribute: a) Requirements for the work products of the process are defined. b) Requirements for documentation and control of the work products are defined. c) Work products are appropriately identified, documented, and controlled. d) Work products are reviewed in accordance with planned arrangements and adjusted as necessary to meet requirements.						
Level 3 Established	**PA 3.1 Process Definition - A measure of the extent to which a standard process is maintained to support the deployment of the defined process.**	As a result of full achievement of this attribute: a) A standard process, including appropriate tailoring guidelines, is defined that describes the fundamental elements that must be incorporated into a defined process. b) The sequence and interaction of the standard process with other processes is determined. c) Required competencies and roles for performing a process are identified as part of the standard process. d) Required infrastructure and work environment for performing a process are identified as part of the standard process. e) Suitable methods for monitoring the effectiveness and suitability of the process are determined.						
	PA 3.2 Process Deployment - A measure of the extent to which the standard process is effectively deployed as a defined process to achieve its process outcomes.	As a result of full achievement of this attribute: a) A defined process is deployed based upon an appropriately selected and/or tailored standard process. b) Required roles, responsibilities and authorities for performing the defined process are assigned and communicated. c) Personnel performing the defined process are competent on the basis of appropriate education, training, and experience. d) Required resources and information necessary for performing the defined process are made available, allocated and used. e) Required infrastructure and work environment for performing the defined process are made available, managed and maintained. f) Appropriate data are collected and analysed as a basis for understanding the behaviour of, and to demonstrate the suitability and effectiveness of the process, and to evaluate where continuous improvement of the process can be made.						

Level 4 Predictable	**PA 4.1 Process Measurement - A measure of the extent to which measurement results are used to ensure that performance of the process supports the achievement of relevant process performance objectives in support of defined business goals.**	As a result of full achievement of this attribute: a) Process information needs in support of relevant defined business goals are established. b) Process measurement objectives are derived from process information needs. c) Quantitative objectives for process performance in support of relevant business goals are established. d) Measures and frequency of measurement are identified and defined in line with process measurement objectives and quantitative objectives for process performance. e) Results of measurement are collected, analysed and reported in order to monitor the extent to which the quantitative objectives for process performance are met. f) Measurement results are used to characterise process performance.						
	PA 4.2 Process Control - A measure of the extent to which the process is quantitatively managed to produce a process that is stable, capable and predictable within defined limits.	As a result of full achievement of this attribute: a) Analysis and control techniques are determined and applied where applicable. b) Control limits of variation are established for normal process performance. c) Measurement data are analysed for special causes of variation. d) Corrective actions are taken to address special causes of variation. e) Control limits are re-established (as necessary) following corrective action.						
Level 5 Optimizing.	**PA 5.1 Process innovation - A measure of the extent to which changes to the process are identified from analysis of common causes of variation in performance, and from investigations of innovative approaches to the definition and deployment of the process.**	As a result of full achievement of this attribute: a) Pprocess improvement objectives for the process are defined that support the relevant business goals. b) Appropriate data are analysed to identify common causes of variations in process performance. c) Appropriate data are analysed to identify opportunities for best practice and innovation. d) Improvement opportunities derived from new technologies and process concepts are identified. e) An implementation strategy is established to achieve the process improvement objectives.						
	PA 5.2 Process optimisation - A measure of the extent to which changes to the definition, management and performance of the process result in effective impact that achieves the relevant process improvement objectives.	As a result of full achievement of this attribute: a) Impact of all proposed changes is assessed against the objectives of the defined process and standard process. b) Implementation of all agreed changes is managed to ensure that any disruption to the process performance is understood and acted upon. c) Based on actual performance, effectiveness of process change is evaluated against the defined product requirements and process objectives to determine whether results are due to common or special causes.						

Appendix D

Appendix: Curriculum Vitae

Curriculum Vitae

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Ausbildung

2009 **B.Sc. Wirtschaftsinformatik,** Universität Wien, Technische Universität Wien
Schwerpunkte: IT Migration, Webentwicklung,

2006 **ERASMUS,** ERASMUS Semester an der Dublin City University

1994 - 2002 **Gymnasium,** BRG Petersgasse, Graz
Schwerpunkte: Mathematik, Informatik, Darstellende Geometrie

Berufserfahrung

2011 - today **Capgemini Consulting Österreich AG** | Wien, München
Managing BI Consultant
Beratung, Projektleitung und Implementierung im Bereich Business Information Management

2008 - 2010 **Harrer & Partner Unternehmensberatung** | Wien
BI Consultant/Developer
QlikView Beratung und Implementierung von BI Projekten mit Schwerpunkt QlikView

2007 - 2008 **SENACTIVE IT-Dienstleistungs GmbH** | Wien
Web Developer
Design, Implementierung und Rollout des Firmenportals basierend auf dem Content Management System Typo3

2006 **SAPPHIR IT & Management Consulting GmbH** | Wien
Java Developer
Ferialpraktikum, Weiterentwicklung des SAPPHIR Produktes SITmobile insbesondere Ändern, Erweitern und Testen der Benutzeroberfläche

2005 **HighQ IT for the manufacturing industry** | München
Java Developer
Ferialpraktikum, Implementierung von umfangreichen Erweiterungen an einer bestehenden mobilen Web-Lösung im Bereich „Instandhaltung SAP"

2004 - 2006 **Internationales Studentenheim Döbling** | Wien
Netzwerk Administrator

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