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Optimizing Business Intelligence Through A Process-Centric Approach

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Master Thesis

Optimizing Business Intelligence Through a Process-Centric Approach

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Executive Summary

Business Intelligence (BI) is essential for decision makers in many organizations today. However, while dominating the priority lists of many CIO's, organizations are often lacking a vision and strategy for the development of their BI capabilities. This thesis describes and evaluates a process centric approach for the optimization of BI capabilities. Based on thirteen BI process improvement projects, levels of maturity and types of waste within BI processes are identified and the applicability of lean within BI is evaluated.

The empirical data suggests that organizations are often lacking a strategy and direction for the development of their BI capabilities. Furthermore the principles of lean are directly beneficial for BI processes. The focus on value, flow, consistency and the focus on the bigger picture were all identified as useful in regard to BI. A focus on reducing waste helps organizations continuously make improvements. The evaluation of the case studies led to the conclusion that in every case researched there was a lack of alignment between different departments within BI processes. Despite the fact that BI requires collaboration, communication and clear agreements between the actors in the process. Often the improvements which were necessary were invisible from the process actors' points of view, but obvious when analysed from a process-perspective.

The conclusion of this study is that a process centric approach to BI can help organizations to align their BI activities, which leads to direct and long term improvements over the whole BI process. These improvements close the information gap, which result in more value for decision makers.

TABLE OF CONTENTS

LIST OF FIGURES ..... **III**

LIST OF TABLES ..... **IV**

ABBREVIATIONS ..... **V**

1 INTRODUCTION **1**

1.1 BACKGROUND 1
1.2 RESEARCH OBJECTIVE 2
1.3 RESEARCH RELEVANCE 2
1.4 RESEARCH QUESTIONS 2
1.5 RESEARCH SCOPE 3
1.6 THESIS OVERVIEW 3

2 THEORETICAL FRAMEWORK **4**

2.1 LEAN 4
2.2 LEAN METHODOLOGIES 8
2.3 BUSINESS INTELLIGENCE & INFORMATION MANAGEMENT 9
2.4 LEAN IN BI RELATED FIELDS 16
2.5 TOWARDS LEAN BUSINESS INTELLIGENCE 23

3 RESEARCH METHODOLOGY **25**

3.1 RESEARCH APPROACH 25
3.2 LITERATURE REVIEW 25
3.3 SEMI-STRUCTURED INTERVIEWS 26
3.4 CODING 26
3.5 CREATING PROCESS MODELS 27

4 RESULTS **28**

4.1 COLLECTED CASES 28
4.2 REPORTING PROCESSES 29
4.3 CHANGE PROCESSES 35
4.4 TYPES OF WASTE IDENTIFIED 42
4.5 PERCEIVED CHALLENGES IN PRACTICE 45
4.6 PERCEIVED BENEFITS IN PRACTICE 46

5 ANALYSIS AND DISCUSSION **48**

5.1 WHICH LEVELS OF BI PROCESS MATURITY CAN BE DEFINED? 48
5.2 TO WHAT EXTENT ARE THE WASTE CATEGORIES IDENTIFIED BY HICKS APPROPRIATE FOR BI PROCESSES? 52
5.3 TO WHAT EXTENT ARE LEAN PRINCIPLES APPLICABLE TO BI PROCESSES? 53
5.4 TO WHAT EXTENT CAN BUSINESS INTELLIGENCE CAPABILITIES BENEFIT FROM A PROCESS-ORIENTED VIEW? 54

6 CONCLUSION AND RECOMMENDATIONS **55**

6.1 VALIDITY CONCERNS 55
6.2 RECOMMENDATIONS FOR PRACTICE 56
6.3 RECOMMENDATIONS FOR FUTURE RESEARCH 56

7 REFERENCES **57**

8 APPENDIX 62

8.1 APPENDIX I – BI FRAMEWORK 62
8.2 APPENDIX II – INTERVIEW QUESTIONS 65
8.3 APPENDIX III – PROCESS MODELS 66
8.4 APPENDIX IV – CODEBOOK 80
8.5 APPENDIX V – RAW INTERVIEW TRANSCRIPTIONS 86

LIST OF FIGURES

Figure 1 Lean in Three Levels (Arlbjørn & Freytag, 2013, p. 177) 5

Figure 2 Structure of a Fishbone Diagram (Lang, 2015) 9

Figure 3 Dimensions of BI 10

Figure 4 Critical Success Factors of BI (Derived from Yeoh & Koronios, 2010) 11

Figure 5 The Integrative BI Framework (Derived from Dekkers et al., 2007, p. 629) 13

Figure 6 The Capability Maturity Model (Bell & Orzen, 2010, p. 83) 14

Figure 7 The Value-Flow Model as Applied to Information Management (Hicks, 2007, p. 238) 20

Figure 8 General Research Approach 25

Figure 9 Old Reporting Processes 33

Figure 10 New Reporting Processes 34

Figure 11 Old BI Change Processes 40

Figure 12 New BI Change Processes 41

Figure 13 Wastes Identified (Classic, as defined in section 2.1.4) 42

Figure 14 Wastes identified (Information Management, as defined in section 2.4.4) 44

Figure 15 Challenges reported in case organizations 46

Figure 16 Benefits reported in case organizations 47

Figure 17 BI Execution Process Maturity Model 49

Figure 18 BI Development Process Maturity model 51

LIST OF TABLES

Table 1 Lean Six Sigma Metrics by Category (Bhasin, 2015, p. 128-130) 15

Table 2 The Seven Wastes of Software Development (Poppendieck, 2011, p. 3) 17

Table 3 Identified Waste in IT organizations (Al-Baik & Miller, 2014, p. 2056) 19

Table 4 The Key Principles of a Strategy for Lean Information Management (Hicks, 2007, p. 245) 22

Table 5 BI Related Forms of Waste Compared 24

Table 6 Characteristics of Interviewees and Discussed Case 28

ABBREVIATIONS

BI	Business Intelligence
BICC	Business Intelligence Competency Centre
CAB	Change Advisory Board
CIO	Chief Information Officer
CMM	Capability Maturity Model
FIFO	First In, First Out
IM	Information Management
JIT	Just In Time
KPI	Key Performance Indicators
OLAP	OnLine Analytical Processing
PPI	Process Performance Indicators
SD	Service Desk
SG	Steering Group
TOQ	Theory Of Constraints
TPS	Toyota Production System
TQM	Total Quality Management

1 INTRODUCTION

1.1 BACKGROUND

Business Intelligence (BI) is essential for decision makers in many organizations today. However, while dominating the priority lists of many CIO's (Gartner Research, 2014; Yeoh & Koronios, 2010), organizations lack frameworks to improve BI processes. BI is commonly understood to encompass all components of an integrated management support infrastructure. The increased importance of these management support infrastructures reflects three interacting trends (Baars & Kemper, 2008):

1 More turbulent, global business environments.
2 Additional pressures to unveil valid risk and performance indicators to stakeholders.
3 Aggravated challenges of effectively managing the more and more densely interwoven processes.

The task of BI is to integrate the massive data from many different sources of a large enterprise into a coherent body to provide a '360 degrees' view of the business. Hence, meaningful information can be delivered at the right time, at the right location, and in the right form to assist individuals, departments, divisions or even larger units to facilitate improved decision making (Yeoh & Koronios, 2010).

While BI system implementations are successful from a technological perspective, in practice problems occur when organisations are using BI systems (Dekkers, Versendaal, & Batenburg, 2007). According to industry experts, between 60 and 65 percent of BI projects and programs fail to deliver on the requirements of their customers. In many BI projects the information generated is inaccurate, irrelevant to the user's needs or is delivered too late to be useful (Hawking & Sellitto, 2010). While the exact reasons for failure are often debated, most agree that a lack of business involvement, long delivery cycles and poor data quality lead the list. Next to these problems, most organization struggle to define the value of BI to the customer and how that value will be delivered, given the resource constraints and political complexities in most organizations (Dine, 2013a). The impact of failing BI projects reaches far beyond the project investment, from unrealized revenue to increased operating costs (Dine, 2013a).

Organizations require a better approach to BI, which provides a greater focus on defining and delivering value, as well as principles and practices that help them deliver more with their existing resources (Dine, 2013a). In contrast to the lack of supportive methods for improving the overall information management system or infrastructure, there are a number of well-established techniques that support continuous process improvement of manufacturing and production systems (Hicks, 2007). One of the most well-known methods is lean. A potential solution for improving these BI projects is to introduce this lean thinking to BI.

Lean thinking has proven its value within in production and services. While the nature of producing information is different from producing tangible goods, some authors claim that the principles of lean are universal (*e.g.,* Al-Baik & Miller, 2014; Hicks, 2007; Karmarkar & Apte, 2007; Poppendieck, 2011). They can potentially help organizations deliver greater value across all levels of decision-making, by reducing waste, improving customer focus and stimulating continuous improvement. By applying lean thinking to BI, inherently BI has to be approached from a process-centric view.

1.2 RESEARCH OBJECTIVE

The aim of this research is to contribute to the understanding of the optimization of business intelligence processes. This understanding should provide organizations a comprehensive view on where they are and where they want to be. To support this understanding this research aims to create a process maturity framework, research the types of waste within BI processes and review the applicability of lean principles on BI. The overall research objective is to determine whether BI capabilities can benefit from a process-oriented view.

1.3 RESEARCH RELEVANCE

1.3.1 Theoretical relevance

Although BI is widely applied in practice, scientific research in the field is limited. Most literature available focuses on BI technology such as data-warehousing, OLAP and data-mining. Unfortunately, considerably less attention is given to the organizational side of BI, investigating BI processes and BI organization (Tijsen, Spruit, van Raaij, & van de Ridder, 2009). This paper aims at developing methods for analysing and improving BI processes. In addition, limited research has been written about applying lean to information processes and none specifically on applying lean to BI. According to (Näslund, 2008) scientific research is missing systematic approaches for organizational improvement, in which process orientation is a common theme. Because this research emphasises a process based view of BI and its organization, it fits to this gap in scientific research as well.

1.3.2 Practical Relevance

This research aims at helping organizations analyse, asses and improve their BI processes. First of all by assessing their level of BI process maturity, secondly by identifying the main sources of waste within BI processes and thirdly by evaluating the applicability of lean principles to BI. A process-oriented view can potentially help organizations to speed up their BI processes while reducing operating cost. Which should lead to delivering more value for the users of the BI capabilities using existing recourses.

1.4 RESEARCH QUESTIONS

The main research question of this thesis is:

To what extent can business intelligence capabilities benefit from a process-oriented view?

In answering the main research question the sub-questions are:

1. *Which levels of BI process maturity can be defined?*
2. *To what extent are the waste categories identified by Hicks (2007) appropriate for BI processes?*
3. *To what extent are lean principles applicable to BI processes?*

1.5 Research Scope

The dimensions of BI can be spread based on complexity. The less complex tasks are often recurrent and cyclical, for example monthly reports. Predictive tasks are often more on an ad hoc basis. This research will focus on the, relatively, less complex activities within BI: reporting, analysis and monitoring. The reason for this focus is because these tasks are more structured recurrent processes, therefore more suitable for process improvement. Next to the focus on these dimensions, the research will focus on medium-sized (1.000-9.999 employees) to large-sized companies (10.000+ employees). These organizations are more suitable for the research because of the complexity of their IT Systems, their organization and their processes.

1.6 Thesis Overview

Below in Table 1 a brief overview of this master thesis' outline is presented. The first chapter introduces the research and provides the objective, research questions and scope. After this a literature study will describe the core constructs of the study providing the scientific state-of-the-art context. After this the methodology section will state how the research process was executed scientifically leading into the result chapter discussing the empirical findings. In the next chapter these findings will be discussed and compared with the findings in literature. Finally in the last chapter the conclusions and recommendations are presented.

Table 1 Thesis Chapter Outline

Chapter	Outline
1	The first chapter will provide an **overview** presenting the essential basics of the study by placing it into context of current top level scientific research. After this the overall objective, research relevance, research questions and scoping will be defined.
2	An elaborate scientific **literature review** of the core constructs of the study will be presented in this chapter describing the essence of lean, information management and BI.
3	After the literature review the **methodology and design** will be presented. This chapter will elaborate on the scientific methods used to gather and analyze the data.
4	This chapter will present the **results** regarding the collected cases, created process models and coding of the interviews.
5	The fifth chapter, **Analysis and Discussion**, will answer the research questions by combining and analysing the findings from literature with the empirical data gathered.
6	Finally the last chapter will be designed to give **conclusions and recommendations** on how to further approach the virtual work environment and presents possible areas for further scientific study.

2 THEORETICAL FRAMEWORK

Although the specific research regarding lean BI is lacking, the topics of lean and BI themselves have been studied extensively. In section 2.1 the origins, definitions and main concepts of lean will be discussed, secondly in section 2.2 some essential lean methodologies will be discussed, thirdly in section 2.3 the concepts of BI and IM will be defined and discussed in detail, furthermore in section 2.4 the advances in research regarding lean in fields related to BI will be discussed, finally in section 2.5 the concept and principles of lean BI will be defined.

2.1 LEAN

In recent years, lean has become widely used across industries and sectors (Arlbjørn & Freytag, 2013). While the origins of lean are clear, different definitions of lean are used in literature. The existence of these different definitions is caused by the different interpretations of lean which are being used. In the following section the origins of lean will be described, the most common definitions of lean will be given and the core concepts of lean are described.

2.1.1 Origins

The concept of lean originates in the Japanese car industry, specifically at Toyota. After World War II, Toyota could not afford the enormous investments in single purpose machines which American car manufacturers made. Nor could Toyota afford the inventory, or large amount of indirect labour, that seemed necessary for mass production. This led to Toyota developing a production system, using very low inventory and moving decision-making to production workers (Poppendieck, 2011). This system is commonly called the Toyota Production System (TPS) (Arlbjørn & Freytag, 2013; Staats, Brunner, & Upton, 2011). The TPS developed gradually over many years through the accumulation of small innovations. After a journey of over 50 years, Toyota became the most profitable mass production auto company in the world (McIntyre, 2014).

In the early 1980's, Toyota and other Japanese manufacturers started conquering the global markets. This led to western researchers starting to study these companies in depth (e.g., Abernathy, Clark, & Kantrow, 1981; Hayes, 1981). In an attempt to generalize the methods of the TPS, Krafcik (1988) introduced the concept of lean. Krafcik used the term "lean" to emphasize the principles of limiting inventory and excessive work (Staats et al., 2011). The concept of lean eventually gained popularity due to the bestseller *The Machine That Changed the World: The story of Lean Production* (J. P. Womack, Jones, & Roos, 1990).

2.1.2 Definitions

Despite significant study, academics struggle to agree upon a definition of what lean is (Arlbjørn & Freytag, 2013; Staats et al., 2011). But most definitions emphasize on being more effective with less resources. Womack et al. (1990, p. 13) defined lean in comparison with its predecessor, mass production. They gave the following definition:

"Lean production is lean because it uses less of everything compared with mass production – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time."

George (2002), provides a more general definition, according to him lean is a process philosophy with three purposes:

- ✓ Eliminate waste
- ✓ Provide customers with make-to-order products
- ✓ Reduce cost while improving quality

Atkinson (2004, p. 20) emphasizes that lean really does mean what it says: “thinking about doing things better, quicker, at economical cost, generating minimal waste in terms of materials, time and rework”. Hicks (2007) focuses mostly on which lean principles causes lean to be successful: “fundamental to the successful application of lean is the characterization of waste, identification of value and the understanding of flow”. Näslund (2008) says lean is mostly based on the mapping and analysing of activities in processes, or in lean terminology: *value stream mapping*. The main objective of lean production is to eliminate muda, the Japanese word for waste. Staats et al. (2011, p. 3) define four essential aspects of lean systems: specified tasks, streamlined communication, simple process architecture and hypothesis-driven problem solving.

To gain a deeper and better understanding of what lean is and to be able to define it more precisely, Arlbjørn, Nørby, Norlyk, Wiborg, & Holm (2008) make a distinction between lean philosophy, lean principles and lean tools & techniques, which is shown in Figure 1.

The top level, philosophy, emphasizes the focus of lean on reducing waste and developing customer value by ensuring value streams. While the philosophy is easy to understand, it’s often hard to implement. The middle level, five principles deducted from the TPS, are more concrete. The final level consists of a number of well-known tools, primarily taken from methods like just in time (JIT), total quality management (TQM) and the theory of constraints (TOQ) (Arlbjørn & Freytag, 2013).

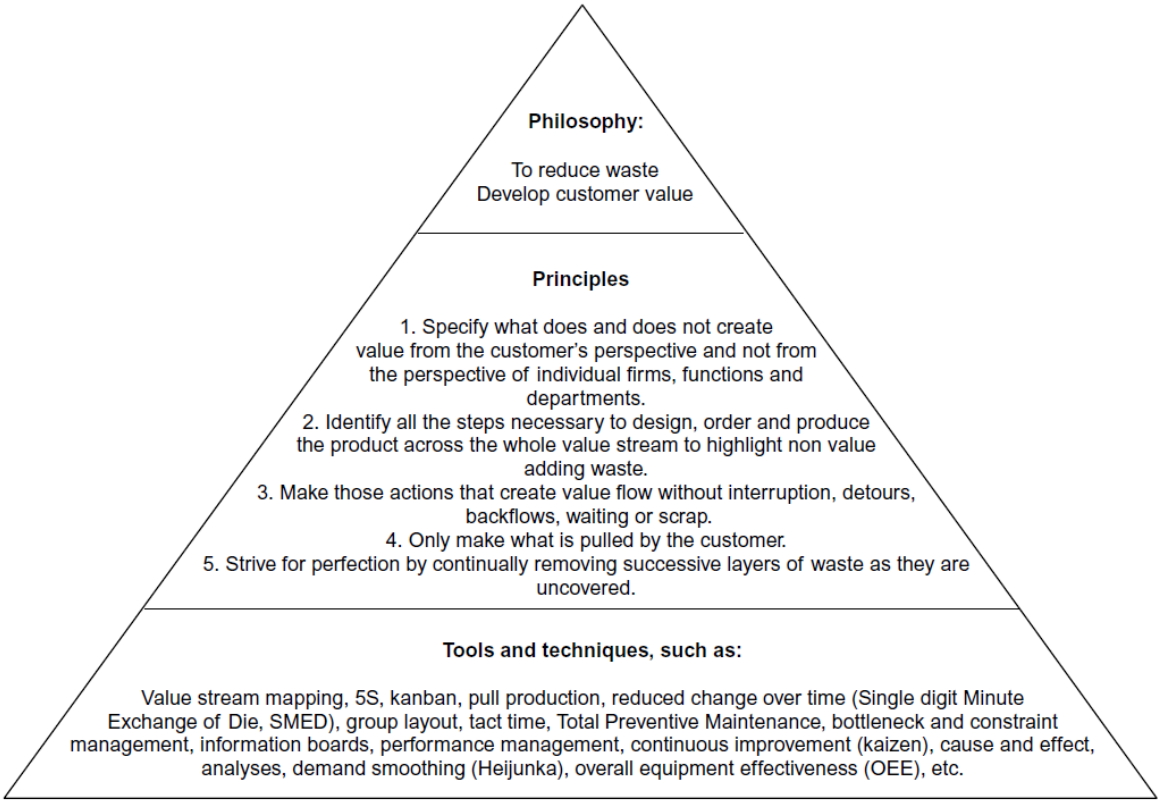

Figure 1 Lean in Three Levels (Arlbjørn & Freytag, 2013, p. 177)

2.1.3 Main concepts & principles

Lean thinking consists of five core principles, which were identified in the TPS by Womack & Jones (2003). These principles are (1) identify value to the customer, (2) understand/map the value stream, (3) create flow, (4) create pull and (5) seek perfection (continuous improvement). In the following section, these principles are briefly explained.

(1) *Identifying value* is the first principle in Lean Thinking. Slack (1999, p. 3) defines value as "a measurement of the worth of a specific product or service by a customer, and is a function of (1) the product's usefulness in satisfying a customer need, (2) the relative importance of the need being satisfied, and (3) the exchange cost to the customer". Value works backwards to build the production process (Poppendieck, 2011).

(2) In order to determine which steps in processes create value, *value streams* are mapped and analysed. A value stream is the set of activities that convert customer needs into delivered products and services (George, 2002). A traditional supply or value chain includes all the activities involved in a process. A value stream only focuses on specific parts of the process that actually add value to the product or service under consideration. The value stream is a focused and contingent view of the value-adding process (Hines & Rich, 1997)

(3) The next fundamental idea to lean production is *flow*. If you only add value, you want to add the value in the most rapid flow as possible (Poppendieck, 2011). Also by increasing the velocity of the flow, the cost of stockrooms, material movers and equipment, expeditors, scrap, rework, obsolescence, excess capital expenditures – the hidden factory – will be removed (George, 2002, p. 36). According to Staats et al. (2011), flow is about reorganising processes so products move smoothly through the value adding process.

(4) The fourth concept of lean is *pull*, which means that nothing is done unless and until a downstream process requires it. So each "customer" in a process calls out from the previous step, on demand. The effect of 'pull' is that production is not based on forecast; commitment is delayed until demand is present to indicate what the customer really wants (Poppendieck, 2011; Staats et al., 2011). Pull leads to shorter feedback loops, which gives more control over a process than longer feedback loops. Additionally, problems are more visible and traceable, so they can be corrected immediately (Poppendieck, 2011).

(5) The final core concept of lean is *continuous improvement*, it calls for a permanent effort for improvement involving everyone in the organization (Singh & Singh, 2009). In lean this is about perfection, constantly striving to meet customer needs and improve one's process – with zero defects (Staats et al., 2011).

2.1.4 Waste

Every activity in the value stream which doesn't provide any added value for customers is considered waste. Taiichi Ohno, founder of the TPS, identified seven types of waste in manufacturing (Al-Baik & Miller, 2014; Näslund, 2008). These seven types are:

1. *Overproduction.* Overproduction occurs when producing an item that is not intended for immediate use or sale (Tapping, Luyster, & Shuker, 2002). As a result defects may not be detected early, products may deteriorate and artificial pressures on work rate may be generated (Hines & Rich, 1997).

2. *Waiting.* Waiting occurs when a worker has to wait for the work to be released from another worker, another manufacturing process, or for material to be delivered (Al-Baik & Miller, 2014). This means time is being used ineffectively, the ideal state should have no waiting time, with a consequent faster flow of goods or services (Hines & Rich, 1997).

3. *Transportation.* A transportation waste results when material is moved more than is necessary; this type of waste is usually caused by an inefficient and poor workplace layout. Although transportation is a non-value adding activity, it is a necessary process, however, organizations should strive to minimize material movement (Al-Baik & Miller, 2014).

4. *Over-processing.* Over-processing relates to spending more time, efforts, and resources to produce higher quality product than is required by the customer. Over-processing is considered the most difficult type of waste to identify and eliminate (Al-Baik & Miller, 2014).

5. *Inventory.* The build-up of excessive or unnecessary raw materials, work-in-progress (WIP), and finished products (Woehrle & Abou-Shady, 2010). Overproduction and waiting creates inventory. Unnecessary inventory tends to hide organization's performance problems. Unnecessary inventory increases lead times, consumes otherwise productive floor space, delays the identification of problems, and inhibits communication (Dennis, 2007; Hines & Rich, 1997).

6. *Motion*. Unnecessary movements of workers or machines before, after, or during processing (Woehrle & Abou-Shady, 2010). Jobs that need excessive human movement should be analysed and redesigned to reduce the required amount of motion (Al-Baik & Miller, 2014; Dennis, 2007).

7. *Defect or Rework*. Making mistakes in the production process that results in generating reworked or scrapped products (Woehrle & Abou-Shady, 2010). Defects are considered the bottom-line waste because these are direct costs (Hines & Rich, 1997).

2.2 LEAN METHODOLOGIES

The lean toolbox consist of a broad range of tools, which are used to analyse processes and apply lean principles on these processes. In the following section four lean tools are described which are potentially useful to analyse and improve BI processes.

2.2.1 Process activity mapping

Process activity mapping is a technique that can be used to eliminate waste, inconsistencies and irrationalities in processes. The technique is known by a number of names, but process analysis is the most common.

Hines & Rich (1997, p. 51) describe five general stages to this process analysis approach:

1. The study of the flow of processes;
2. The identification of waste;
3. A consideration of whether the process can be rearranged in a more efficient sequence;
4. A consideration of a better flow pattern, involving different flow layout or transport routing
5. A consideration of whether everything that is being done at each stage is really necessary and what would happen if superfluous tasks were removed.

2.2.2 5 whys

In order to eliminate wastage problems, one must first recognise the root cause of the problem and attempt to solve the problem in a systematic way (Murugaiah, Jebaraj Benjamin, Srikamaladevi Marathamuthu, & Muthaiyah, 2010). The 5 *Whys* is a technique developed by Toyota, which is used to identify the root-cause of a problem. Al-Baik & Miller (2014, pp. 2032-2033) give an example from their research which illustrates the use of the 5 whys technique, and its effectiveness:

1. *Why* do the employees implement workarounds?
   Because they try to find quick fixes for problems.
2. *Why* do the employees try to find quick fixes for problems?
   Because they try to avoid waiting for customer's feedback.
3. *Why* do the employees try to avoid waiting for customer's feedback?
   Because getting the customer's feedback is time consuming.
4. *Why* is getting customer's feedback time consuming?
   Because contacting the customer requires the relationship manager's approval.
5. *Why* does contacting the customer require the relationship manager's approval?
   Because it is a company policy!

2.2.3 Bottleneck and constraint management

The Theory of Constraints is based on five steps, Rand (2000, p. 174) describes these steps as follows:

1. Identify the system's constraints(s)
2. Decide how to exploit the system's constraint(s)
3. Subordinate everything else to the above decision
4. Elevate the system's constraint(s)
5. If, in the previous steps, a constraint has been broken, go back to step 1, and do not allow inertia to cause a system's constraint.

2.2.4 Cause and effect diagram (Fishbone)

A cause and effect or fishbone diagram is used to show the relationship between causes and effects. Often a fishbone diagram is used to reduce a problem to a few basic problems and focus on these basic problems. The fishbone diagram identifies many possible causes for an effect or problem. It can be used to structure a brainstorming session. It immediately sorts ideas into useful categories.

The structure of a fishbone diagram can be found in Figure 2.

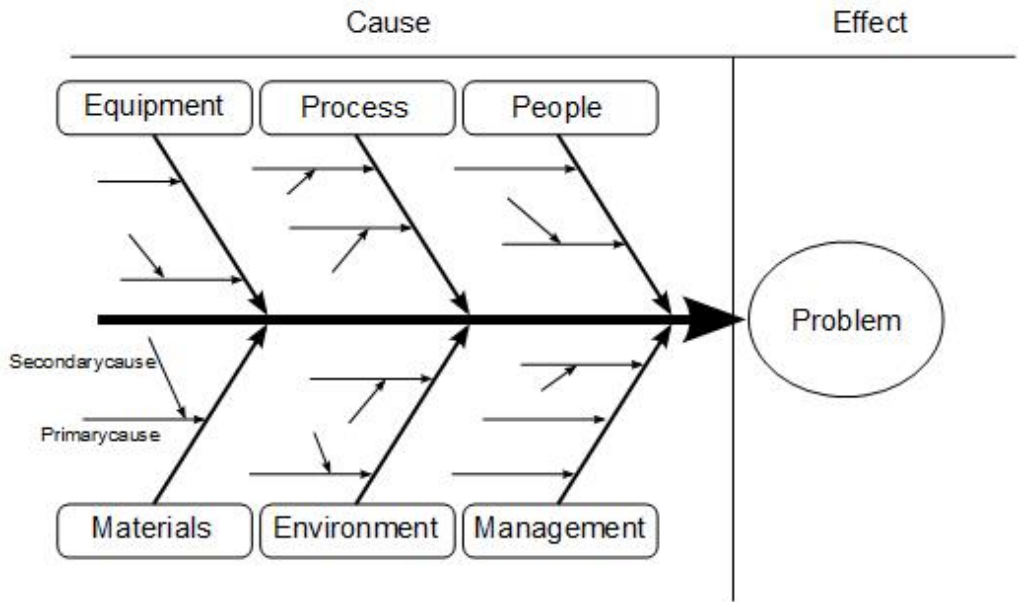

Figure 2 Structure of a Fishbone Diagram (Lang, 2015)

2.3 Business Intelligence & Information Management

The fields of BI and IM are closely related. Although the terms are widely used in the business and academic environment, definitions differ. In the coming sections both terms will be defined for the use in this thesis. Furthermore the measurement and levels of maturity of information process will be described and finally four dimensions of BI will be discussed.

2.3.1 Definitions

IM is a broad conceptual term that has various meanings and interpretations among different constituencies (Detlor, 2010). Although IM can be viewed from multiple perspectives, this paper focuses on the organizational perspective. According to Detlor (2010) this organizational perspective "deals with the management of all information processes involved in the information lifecycle with the goal of helping an organization reach its competitive and strategic objectives" (p. 103). Wilson (2002) defines IM as "the application of management principles to the acquisition, organization, control, dissemination and use of information relevant to the effective operation of organizations of all kinds".

BI is commonly understood to encompass all components of an integrated management support infrastructure. According to Vuori (2006), "BI aims to provide accurate and timely business information for both operative and strategic decision-making" (p. 1). In other words, the goal of BI is to satisfy the

managers' information needs, enhancing the organizational decision making capabilities, creating a competitive advantage (Vuori, 2006).

The increased importance of these management support infrastructures reflects three interacting trends (Baars & Kemper, 2008):

1 More turbulent, global business environments.
2 Additional pressures to unveil valid risk and performance indicators to stakeholders.
3 Aggravated challenges of effectively managing the more and more densely interwoven processes.

The need for fast decision making on the one hand, and the longer time needed to acquire the right information on the other hand causes a so-called *information gap*. BI is implemented in order to narrow down this information gap (Tijsen et al., 2009).

2.3.2 Dimensions

The information environment is driven by the nature of business activities. This nature is the one hand recurrent and cyclical, supported mostly by the function of a management information system (MIS). On the other hand this nature is turbulent and unpredictable, for example competitive analysis and operational intelligence (Skyrius, Kazakevičienė, & Bujauskas, 2013).

The dimensions of BI can be spread based on complexity and potential business value. The less complex tasks are often recurrent and cyclical, for example monthly reports. Predictive tasks are often more on an ad hoc basis. These dimensions are represented in Figure 3. This research will mostly focus on the first three dimensions: reporting, analysis and monitoring. The reason for this focus is because these tasks are more structured recurrent processes, therefore more suitable for process improvement.

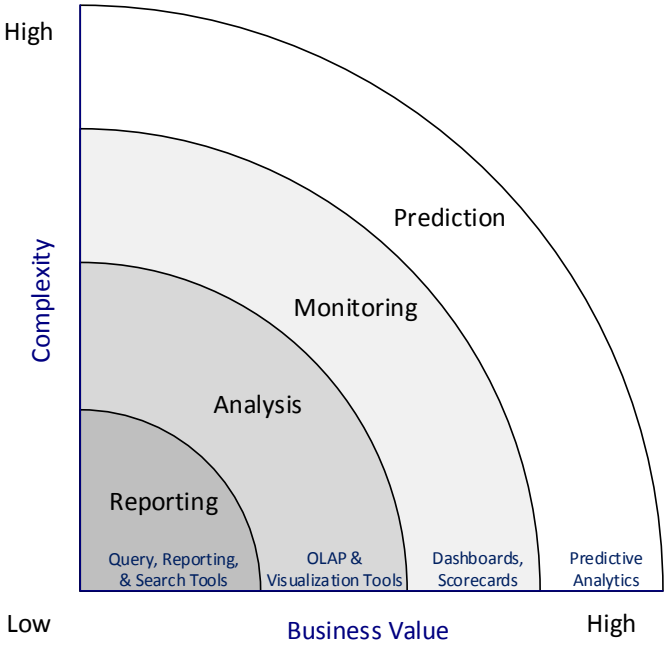

Figure 3 Dimensions of BI

2.3.3 Critical success factors

The implementation of BI systems differs from conventional application-based IT projects. It is not simply an activity of merely purchasing a combination of software and hardware. It is a rather complex undertaking requiring appropriate infrastructure and resources over a lengthy period. Although BI has the potential to improve the performance of a company, a review of literature indicated that a significant number of companies often fail to realise expected benefits of BI and sometimes consider the project a failure in itself (e.g., Dekkers, Versendaal, & Batenburg, 2007; Dine, 2013a; Sangar & Iahad, 2013; Yeoh & Koronios, 2010). BI projects mostly failed due to poor planning, poor project management, undelivered business requirements, and poor quality of delivered products/requirements (Hawking & Sellitto, 2010).

Critical success factors (CSF) are the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. If the efforts in these areas are not adequate, the organization's results for the period will be less then desired. Therefore the critical success factors are areas of activity that should receive constant and careful attention from management (Rockart, 1979).

The critical success factors for BI are defined by Yeoh & Koronios (2010). In Figure 4 these CSF for BI are summarized and sorted based on the type of the CSF. To gain a deeper understanding of BI implementations in the following section the CSF of BI implementations are explained.

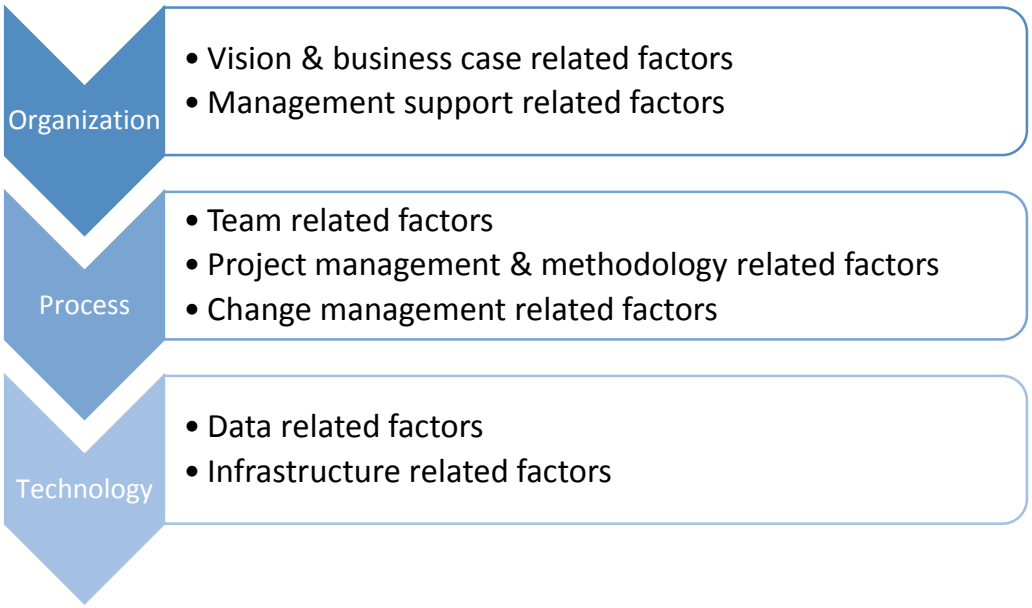

Figure 4 Critical Success Factors of BI (Derived from Yeoh & Koronios, 2010)

2.3.4 Organization

Committed management support and sponsorship has been widely acknowledged as the most important factor for BI system implementation. Consistent funding and resource allocation from senior management is necessary to overcome continual organizational issues (Yeoh & Koronios, 2010). Also research has shown that the ideal BI sponsor should come from a business function. Such a sponsor often has a strong stake in the success of a BI initiative (Webster & Watson, 2002).

Next to management commitment, a clear vision and well established business case is essential for the success of a BI project. Because BI initiatives are driven by business, a strategic business vision is needed to steer the implementation. The failing of BI projects is often not due to technical challenges, because many of the technological issues have proven answers. Rather the most common cause for failure is that BI initiatives lack alignment with the business vision and so fail to meet the core objectives of the business. BI systems which do not satisfy the business needs will neither satisfy the customers (Yeoh & Koronios, 2010).

2.3.5 Process

A BI initiative often spans multiple functional units and demands extensive data and resources from these business units. To carefully manage the organizational challenges that arise during a project, a champion from the business side of the organization is critical for project success. This champion needs to ensure collaboration between business units and between the business and the BI project team.

Another requirement is that BI teams should be cross-functional and composed of both technical and business personnel, so called "*best of both worlds"*. This cross functional team should include business domain experts. This is necessary to have a business driven system design and ensures that the BI needs derived from the business are a driver of the logical data architecture. To enable business users to navigate and manipulate data in an intuitive way, the structure and model of the data warehouse must be closely related to their perception of the business objectives and processes (Yeoh & Koronios, 2010).

The next factor to be considered is the business-driven and iterative development approach. According to the research of Yeoh & Koronios (2010) it is advisable to start with small changes and developments, by adopting incremental delivery, a so-called 'iterative' approach. Large-scale change efforts are always fraught with greater risks given the substantial variables to be managed simultaneously. An incremental delivery approach allows an organisation to concentrate on crucial issues, enabling teams to prove that the system implementation is feasible and productive for the enterprise.

The final critical success factor which is linked to the process of BI is user oriented change management.

2.3.6 Technology

A key factor for BI is that the technical framework of a BI system must be able to accommodate scalability and flexibility requirements in line with dynamic business needs. This allows for easy expansion of the system to align with future information needs. Although establishing an initial technical infrastructure for a BI system is/will be a time consuming activity, it pays off in the sense that the system will be able to adapt to the emerging and ever-changing business requirements.

Besides a flexible infrastructure, sustainable data quality and integrity is of vital importance. Data quality at the sources will affect the quality of management reports, which in turn influence the decision outcomes. Corporate data can only be fully integrated and exploited for greater business value once their quality and integrity are assured; garbage in means garbage out. Common measures and definitions across business units helps increasing consistency, interpretability and ease of understanding of the data (Yeoh & Koronios, 2010).

2.3.7 Information Processes

Because of the process centric approach to BI, which this study takes, it is important to precisely define what is meant by an information process and a BI process. Also it is important to determine how to measure these processes. The following section will define these concepts.

According to Detlor, leading information management scholars purport a process-driven view of IM. Detlor defines the following predominant information processes within IM:

1. *Information creation*, the process where individuals and organizations generate and produce new information artefacts and items.
2. *Information acquisition*, the process where information items are obtained from external sources.

3 *Organization of information*, the process of indexing or classifying information in ways that support easy retrieval at later points in time.
4 *Information storage*, the process of physically housing information content in structures such as databases or file systems.
5 *Distribution of information*¸ the process of disseminating, transporting or sharing information.
6 *Use of information,* the process where individuals or organizations utilize and apply information made available to them.

Effectively managing these processes helps getting the right information to the right people in the right forms at the right times and at reasonable costs (Detlor, 2010, p. 104).

2.3.8 Generic Business Intelligence process framework

Generally speaking, BI processes can be split into two key BI process cycles, the *use* and the *development* of information. Although there are multiple BI process models in literature (e.g., Dresner et al., 2002; Zeng, Xu, Shi, Wang, & Wu, 2006), these models do not take the organisational aspects into account. Dekkers, Versendaal, & Batenburg (2007) have developed and successfully validated a framework that takes these aspects into account.

The framework provides insights in the activities, roles and decision points for satisfying information needs. It is also method to assess and monitor all key BI activities by determining the degree to which BI related information gathering and processing activities are present in an organization. Finally it provides a method to make BI activities, processes and roles more explicit. A simple representation of the model is given in Figure 5. In Appendix I a more detailed view and description can be found.

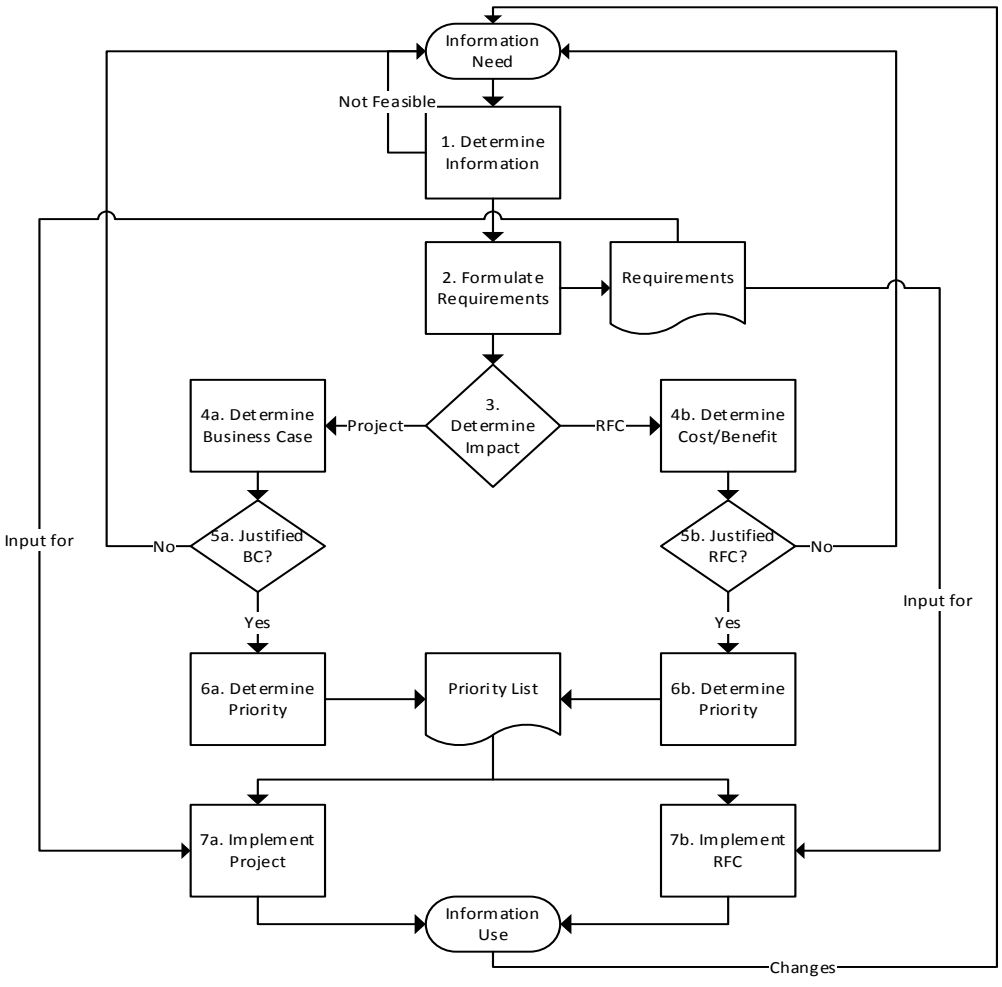

Figure 5 The Integrative BI Framework (Derived from Dekkers et al., 2007, p. 629)

2.3.9 Capability Maturity Model

The more explicitly defined a process is, the more efficiently it can often be executed. But because the majority of knowledge is typically stored in the workers' mind and is not explicitly documented, everyone performs the same task differently. This inconsequent behaviour is almost impossible to improve, because there is no established baseline to start from. When process and practical knowledge belongs only to certain people, outcomes remain inconsistent, and knowledge is lost when they leave. But once tribal knowledge becomes stabilized, standardized, documented, and shared with others, processes can be continuously improved and meaningfully measured (Bell & Orzen, 2010).

Process standardization create efficiencies, and information systems should be designed to reinforce explicitly defined procedures. This level of standardization combined with the level of continuous improvement can be defined as level of process maturity. This maturity level of a process can be assessed, using the Capability Maturity Model (CMM) shown in Figure 6.

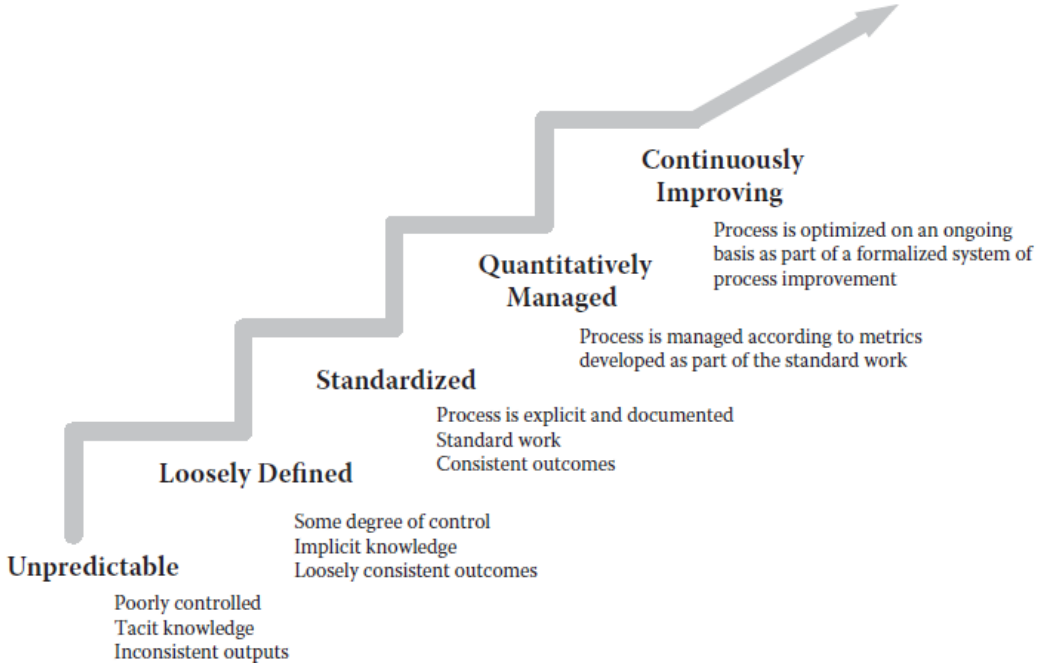

Figure 6 The Capability Maturity Model (Bell & Orzen, 2010, p. 83)

2.3.10 Measurements/metrics

In the process of identifying areas for improvement in (information) processes and after having implemented improvements, essential to measure whether the efforts make a difference or not. Table 2 contains a list of metrics frequently used in Lean (Six Sigma) projects to measure the outcomes of a process, identify opportunities for improvement and monitor changes over time. These metrics will help to pinpoint sources of waste, variability or customer dissatisfaction, and that can lead to the discovery of the root causes of problems and thus high-leverage areas for improvement.

Which metrics are most important for a specific lean project depends on the organization and the goals of the project. These metrics may require multiple iterations as more is discovered about the process which is being improve. Often it is helpful to focus on a metric that is meaningful to the customer and the organization's strategic goals.

Table 2 Lean Six Sigma Metrics by Category (Bhasin, 2015, p. 128-130)

Time metrics	**Lead time**, the total time from start to finish to develop a service/product and deliver it to the customer, including waiting time. **Processing time**, "touch time", or the number of working hours spent on process steps, not including waiting time. **Response (wait) time**, the number of working hours it takes to react to a customer request for a service or product. **Activity ratio**, processing time divided by lead time. **Best and worst completion time**, the range of variation in lead time or processing time, may also include standard deviation if data are available (a smaller range is better). **Percent on time delivery**, how often your lead time meets your target.
Quality metrics	**Customer satisfaction**, qualitative or quantitative data derived from surveys, number of complaints, thank-you notes or other feedback mechanisms (goal varies by measurement technique). **Defect rate**, percent of services/products that are "defective", where a defect is defined as "something the customer does not like". **Rework steps / time,** amount of a process spent correcting mistakes or going back for missing information. **Percent complete and accurate,** percent of occurrences where a process step is completed without needing corrections or requesting missing information. **Rolling first pass yield,** percent of occurrences where the entire process is completed without rework, or the product of all steps' percent complete and accurate rating.
Output metrics	**Production**, total number of services or products completed or produced in a given amount of time (goal varies by service or product; the optimal level should align with customer demand to minimize backlogs and excess inventory). **Work in process**, number of services or products currently being processed (goal varies by service or product). **Backlog**, number of services or products that are waiting to start the process (a lower number is better). **Inventory**, a supply of raw materials, finished products or unfinished products in excess of customer demand (a lower number is better).
Process complexity	**Process steps,** total number of steps to complete the process (aim for reduction). **Value added process steps,** number of process steps which add value to service/product (aim to increase proportion of value added steps, or eliminate non-value added steps). **Decisions,** Number of decision points where process changes for different situations and staff must decide the appropriate path to follow (goal varies by service or product, typically aim for reduction)**.** **Signatures required,** number of approvals needed, usually involve delays and handoffs (aim for reduction). **Handoffs,** number of times the service/product changes hands, can be a source of errors, miscommunication, or delays (aim for reduction). **Loop backs,** when steps of a process must be repeated, usually to correct errors or find missing information (aim for reduction).
Organizational metrics	**Lean events,** number of Lean events, such as Kaizen or value stream mapping events. **Lean participation,** number of employees participating in Lean events or projects. **Lean training,** number of employees receiving Lean training. **Employee satisfaction,** qualitative or quantitative data derived from surveys, number of complaints or other feedback mechanisms (goal varies by measurement technique).

2.4 LEAN IN BI RELATED FIELDS

In the following section, efforts on converting the traditional ideas of lean towards BI related fields are described. First lean in non-manufacturing processes will be specified, then lean software development will be explained, followed by lean IT organizations and lean information management.

2.4.1 Lean in non-manufacturing processes

The application of lean theory focuses mostly on environments, which includes the following preconditions (Arlbjørn & Freytag, 2013):

- Production of standard goods/services
- Large volume
- Relatively long product cycle

Academics do not seem to agree as to whether lean can be applied to high variety/low volume environments, just like there is no agreement on what the critical implantation elements of leanness are (Arlbjørn & Freytag, 2013). Hicks (2007) says that because lean is a generic philosophy, it has the potential to be applied to any system or process, in order to identify and improve critical areas in these systems or processes. George (2002) tends to agree that lean can be used to improve not only manufacturing processes, but also non-manufacturing processes:

"When people here 'Lean," they think "manufacturing," but the principle of speeding up processes applies to non-manufacturing (transactional processes as well as manufacturing. In fact, even if you wished to improve only manufacturing cost, quality, and lead time, you would have to improve the velocity, responsiveness, and quality of the associated transactional processes as well." (George, p. 40)

Staats & Upton (2011) explain that while in manufacturing there is a common understanding of how to make an operation lean, and many of the same techniques can be easily employed in different organizations, this is not the case for knowledge work. Nevertheless they have found that lean principles can be applied in some form to almost all kinds of knowledge work and can generate significant benefits.

Because lean is an evolving concept, many researchers have studied the principles and practices of lean from their own perspective. Lean has already been applied in many other sectors than manufacturing, for example in hospitals, administrations and service organizations (Kundu & Manohar, 2012). The main challenge for using the ideas of lean in a knowledge-based industry is the lack of repetition (Staats et al., 2011).

Arlbjørn & Freytag (2013) question the positive effect of lean, outside of the TPS. They conclude from their literature review that there is a low level of operationalisation of the concept of lean, making the concept seem unclear and vague. They emphasize that it is important to have the original idea of lean "It is all about removing waste!" in mind, in situations where lean tools are applied.

2.4.2 Lean software development

Agile software development has been adopted industry wide. When appropriate applied, lean thinking can be a well-developed platform upon which to build agile software development practices, according to Poppendieck (2011).

Poppendieck emphasizes that the underlying principles of eliminating waste, empowering front line workers, responding immediately to customer requests, and optimizing across the value chain are

fundamental to lean thinking. In her paper *Principles of Lean Thinking*, she describes how these principles can be translated towards software development.

If something does not directly add value, it is waste. To develop breakthroughs with lean thinking, the first step is learning to identify waste and eliminate it. To structure the different kinds of waste, Poppendieck took the seven types of waste of the TPS and converted them towards software development, next Poppendieck pointed out that extreme programming tackles these problems directly. These wastes in software development and how extreme programming addresses these wastes is represented in Table 3.

Table 3 the Seven Wastes of Software Development (Poppendieck, 2011, p. 3)

TPS type of waste	Waste in software development	How Extreme Programming Addresses Waste
Overproduction	Extra Features	Develop only for today's stories
Inventory	Requirements	Story cards are detailed only for the current iteration
Extra Processing Steps	Extra Steps	Code directly from stories; get verbal clarification directly from customers
Motion	Finding Information	Have everyone in the same room; customer included
Defects	Defects Not Caught by Tests	Test first; both developer tests and customer tests
Waiting	Waiting, Including Customers	Deliver in small increments
Transportation	Handoffs	Developers work directly with customers

The next step is to empower the employees who actually deliver value. It is often common that low skilled programmers produce code while a few high skilled architects and designers do the critical thinking. With this in mind, a project is often divided into requirements gathering, analysis, design, coding, testing, and so on, with decreasing skill presumably required at each step. A 'standard process' is developed for each step, so that low-skilled programmers for example, can translate design into code simply by following the process. This kind of thinking comes from mass-production, where skilled industrial engineers are expected to design production work for unskilled labourers. In contrast to lean philosophy, this devalues the skills of the developers who actually write the code. Focussing on the people who add value means upgrading the skills of developers through training and apprenticeships. It means forming teams that design their own processes and address complete problems. It means that staff groups and managers exist to support developers, not to tell them what to do (Poppendieck, 2011, p.5).

Flow value from demand is the next fundamental idea to lean according to Poppendieck, which is based on the principle of 'pull'. The goal of pull is that production is not based on forecast; commitment is delayed until demand is present to indicate what the customer really wants. In lean software development this idea of flow is translated to maximizing the flow of information and delivered value. This maximization of flow means limiting what has to be transferred, and transferring that as few times as possible over the shortest distance with the widest communication bandwidth as late as possible. Next to maximizing the flow, the other objective is to rapidly deliver this flow, in software development the key is here to divide the problem in small batches (increments) pulled by a customer story and customer test. So overall goal is to eliminate as many documents and handoffs as possible while delivering increments of real business value in in short-time boxes, driven by customer priority and feedback (Poppendieck, 2011).

The final idea Poppendieck discusses is optimizing across organizations. This idea is closely related to the *Theory of constraints* (TOC), developed by Eliyahu Goldratt (Goldratt & Cox, 1992). Different departments in organizations measure performance in different ways. This difference in measurement leads to local or

sub-optimization, which goes at the expense of the overall performance of the company. Sub-optimizing measurements are very common, and overall optimization is virtually impossible when they are in place. To tackle these problems of sub-optimizations, lean organizations are usually structured around teams that maintain responsibility for overall business value, rather than intermediate. Another approach is to create awareness that the downstream department is a customer, and satisfying this internal customer is the ultimate performance measurement.

These principles, eliminating waste, empowering front line workers, optimizing value flow, and optimizing across the value chain are often complementary to agile software development. Using the production metaphor can lead to a better understanding why these principles should be applied to software development. Poppendieck concludes that these principles provide a broad framework for improving software development.

2.4.3 Lean IT organizations

In their effort to make IT organizations leaner, Al-Baik and Miller (2014) focussed on the lean principle of eliminating waste. In their article they propose a new model for categorizing wasteful processes and activities in IT organizations. Al-Baik and Miller stress that previous waste identification models, for instance the model of (Poppendieck, 2011), are mapped from the waste categorization that was established purely for manufacturing, specifically, the automobile industry. The authors state that in order to understand what the wastes are, where they exist, and how to attack them, they have to develop a more stable and suitable model for IT organizations that evolves based upon IT core work, instead of a forced mapping from the auto industry.

To identify wasteful processes, the authors used a straightforward approach by asking the following three questions:

I. Does the activity, or the process increase customer satisfaction?
II. Does the activity, or the process reduces cost, time, or effort?
III. Is the activity, or the process mandated by a legal authority? Is it a rule that we need to follow?

If all questions were answered with “No”, the activity or process would be further analysed. During this analysis the 5 *Whys* technique was employed to identify the root-cause of wastes. Table 4 provides a summary of the identified waste in IT organizations, including related examples identified during their case study. The authors note that the model developed during the project could be used as a starting point for organizations that would like to tackle a lean initiative, however they should still analyse their own processes to discover wastefulness within their core IT operations.

Table 4 Identified Waste in IT organizations (Al-Baik & Miller, 2014, p. 2056)

Classification	Examples
Gold plating	- Unnecessary tools, technologies or methodologies - Unnecessary cosmetic functionality designed and developed into software - Striving to design perfect systems, rather than designing systems that are adequate - Producing and distributing reports that are not required, and providing more information than necessary
Over-specifications	- Excessive analysis that does not support decision-making - Searching for information that is difficult to find - Overdesign of software or application
Lack of customer involvement & inappropriate assumptions	- Misunderstanding of user requirements - Inflexible and lengthy approval process that encourages workarounds - Work performed earlier than needed because of the absence of prioritization and dependencies (result of assumptions)
Double handling/ duplicate processes	- Providing the same service by more than one team - Having redundant data in the same or different systems - Repetitive, unnecessary and ineffective meetings - Troubleshooting to solve single problem instead of root cause - Focussing on team optimization not overall departmental performance
Centralized decision making	- Unnecessary approval processes and unclear responsibility and authority - Complex reporting systems that add extra effort without adding value - Making decisions that lock in resources too early and produce inflexibility - Lengthy approval processes that discourage innovation and creativity - Lack of delegation to empower the employees resulting in technical decisions made by non-technical people
Waiting	- Waiting for review and approval on items - Waiting for information that is needed to complete a task - Using shared resources; waiting to assign specialists to accomplished tasks - Developer waits for testing to finish before starting work on the next piece of code - Waiting for a physical signature - Waiting to identify the team for providing problem resolution
Deferred verification & validation	- Lack of system integration between legacy systems - Excessive standards to follow that encourage avoiding testing - Not enough training on, or awareness of, the importance of testing - Limited time to release
Defects	- Excessive quantitative productivity standards for evaluation - Unclear customer requirements, resulting in defective software - Inaccurate and obsolete specifications and conflict between supervisor directions and client's requirements
Outdated information/ obsolete working version	- Developers do not integrate frequently enough - Missing, inaccurate or incomplete documentation for complex systems - Distributing reports to early, with information that is quickly obsolete

2.4.4 Lean information management

Information management can be considered to involve adding value to information by virtue of how it is organized, visualized and represented and enabling information (value) to flow to the end-user (customer) through the processes of exchange, sharing and collaboration (Cottyn, Stockman, & Van Landeghem, 2008). Womack's (2004) idea about information management is as follows: "Piling up information in a large inventory is as bad – maybe worse - than piling up large inventories of products." Information must be sent in small batches at a high frequency instead of large batches infrequently. System failures must be made immediately visible, so that they can be treated directly (Cottyn et al., 2008).

An important bridge between the application of lean thinking and BI is the work of Hicks (2007). He discusses the application of lean thinking to information management, which is closely related to BI. Hicks starts with defining the product flow of lean manufacturing in terms of IM. This can be defined as the information flow, in which information is pulled by the consumer. The consumer can be a customer, user or another system. When a manager requests Key Performance Indicators (KPI's), then he is the consumer. The information must flow to the consumer as fast as possible, to deliver maximum value. This information flow is displayed in

Figure 7. Hicks calls this information flow: the analogous value-flow model for information management.

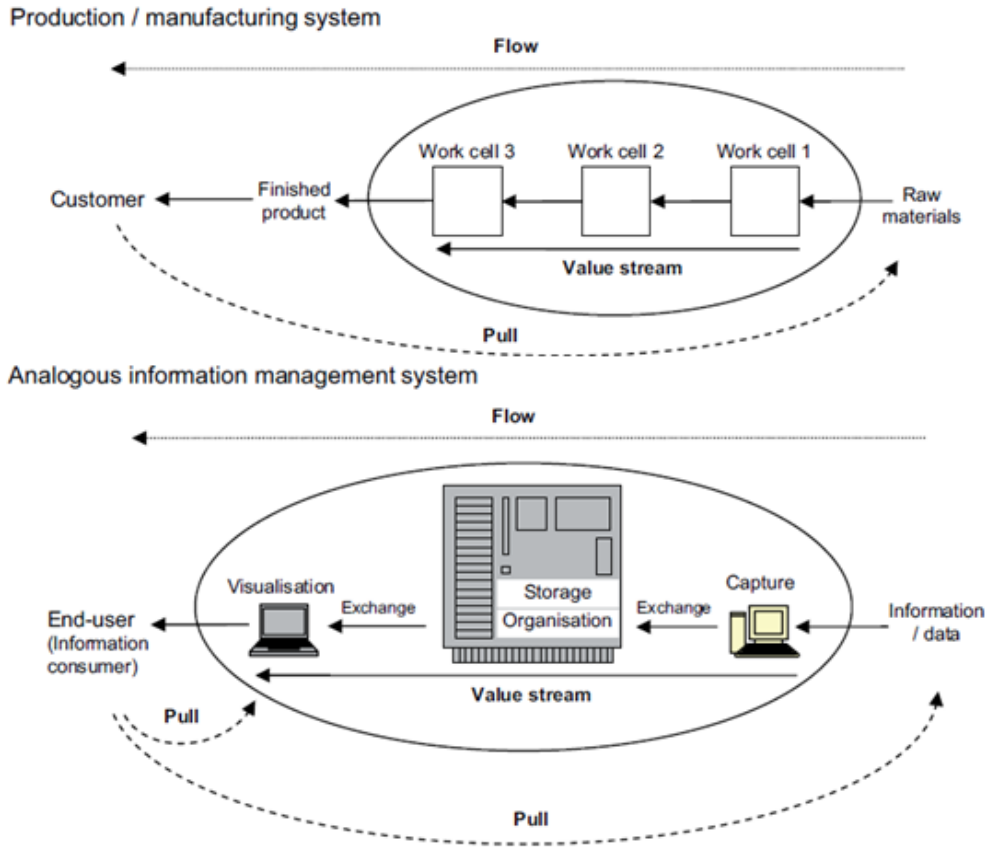

Figure 7 The Value-Flow Model as Applied to Information Management (Hicks, 2007, p. 238)

Hicks (2007) states that the value-flow model can be applied to any information processing activity in which value in the information (data) itself and further value is generated by the virtue of the mechanisms by which it is organized, represented, exchanged and visualized.

Hicks (2007, p. 238) gives the following general definition of what waste within IM is:

"All additional actions and any inactivity that arise as a consequence of not providing the information customer immediate access to an adequate amount of appropriate, accurate and up-to-date information."

In contrast to Al-Baik and Miller (2014), Hicks attempts to directly map the seven wastes of production with information management. He defines four types of waste in IM which correspond directly with the original types of waste:

1. *Flow Excess:* relates to the time and the resources that are necessary to overcome excessive information.
2. *Flow demand:* concerns the time and resources spent trying to identify the information elements that need to flow.
3. *Failure demand:* the resources and activities that are necessary to overcome a lack of information. This may include generating new information and/or acquiring additional information.
4. *Flawed Flow:* includes the resources and activities that are necessary to correct or verify information. It also includes the unnecessary or inappropriate activities that result from its use.

The concepts of flow excess, flow demand, failure demand and flawed flow, can be mapped directly to the traditional model and in particular to the wastes of overproduction, waiting, extra processing and defects, respectively. In contrast, according to the author, for the purpose of IM there are no analogous dimensions of waste for transport, inventory or motion. The primary reason for this is because of the electronic or digital nature of information systems. In general, events (data exchange) within the system appear to occur almost instantly and capacity (data transfer) can be increased at relatively minimal cost in order to meet demand. The impact compared with a manufacturing environment is commonly considered negligible.

Besides the transformation of the forms of waste in production towards information management, Hicks translates the five key principles of lean manufacturing, which are explained in section 2.1.3, towards information management. These key principles of a strategy for lean information management can be found in Table 5. Hicks (2007) states that these principles should enable practitioners to identify and perform focused improvements on the various aspects of information management, in order to eliminate waste while improving the flow of value. The goal of these improvements is to create more efficiency, productivity and quality of the overall process (information management) and product (information). All of these advantages helps organization undertaking their core activities and sustaining its long-term competitiveness.

Principle	Description	
Value	1	Only manage valuable information – information that has to be managed and information that supports the core business activities
	2	Remember users benefit from the systems and only use it if it offers direct value or they understand the indirect value i.e. for another department
Value Stream	1	Ensure that the series of processes and activities that deliver information are mapped. This includes processes that support the capture, representation, exchange, organization, retrieval and visualisation of information
	2	Ensure that the sequence of processes that support IM are integrated
Flow	1	Information should be available real time (as soon as it is generated/acquired.
	2	Ensure that all information processes and support processes occur in the shortest possible time
	3	Procedures and processes should be invoked and performed in the simplest way possible
	4	Minimise duplication of information within the organization, across departments, and customers and suppliers
	5	Minimise amount of out-of-date or unnecessary information within the organization, across departments, and customers and suppliers
	6	Minimise duplication of effort within the organization, across departments and customers and suppliers
Pull	1	Information and additional functionality should only be delivered as it is demanded by the customer (end-user)
	2	To facilitate pull, the interfaces, methodology and procedures need to be consistent across the organization
	3	Minimize the dependency on IT staff and programmers for implementation. Support users to undertake local customisation and promote ownership – end user developed systems
Continuous Improvement	1	Regularly review infrastructure and processes – remember information systems, business processes and processes that support products and services change and as such opportunities for improvement will also change
	2	Support rapid implementation and training. This is the time form system acquisition to full implementation and integration with the business processes.

Table 5 The Key Principles of a Strategy for Lean Information Management (Hicks, 2007, p. 245)

2.5 TOWARDS LEAN BUSINESS INTELLIGENCE

Although scientific articles have been published on BI related fields, there are currently no published scientific articles on lean BI itself. However, there are a few non-scientific articles published on lean BI. The following section will define what is meant by lean BI, followed by a conceptual framework of lean BI.

Lean Bi can be defined as the application of Lean manufacturing principles to the BI/Data Integration/Data Warehouse space. These principles focus on generating additional value by accomplishing more with existing resources and eliminating waste (Datasource Consulting, 2012).

Dine (2013a) describes Lean BI as a set of principles and practices that have been influenced by 3 main concepts:

1 Lean Manufacturing
2 Systems Theory
3 Agile Project Management

The goal is to become more efficient and effective while still focusing on delivering value within a BI organization. This additional value is generated by accomplishing more with existing resources by eliminating waste and applying the five lean BI principles (Dine, 2013b). Dine continues by describing lean BI through these five principles, which are closely related to the original five principles of lean.

The first principle is focus on customer *value*, which is defined as meeting or exceeding customer needs at a specific cost and time, which can only be defined by the customer. Everything which consumes resources and does not deliver value is considered waste. To enhance this focus on customer value, Dine proposes to instil a BI program governance model, a collective asset of procedures, policies, roles and responsibilities, and organizational structures required to support an effective decision making process.

The second principle is *"See the whole picture"*: organizations should learn to see beyond individual decisions and consider them in a wider context. This means that they should try to find the root cause of an issue instead of focusing on local problems, This principle relates closely with system theory, which focusses on the hypothesis, methods and philosophy needed to analyse the behaviour of management systems and other complex systems (Forrester, 1993).

The next principle is *"Iterate quickly"*: by iterating quickly the scope of each iteration can be reduced while the flow is increased. The reason to increase flow and reduce the scope size is that, often, by the time a project is implemented the requirements have changed and a part of what is implemented is not required anymore. The part that is not required, and thus not utilized, can be considered waste.

A lack of standardization in processes, design, procedures development and practices, causes variations in BI. *"Reducing variation"* is the fourth principle, which is achieved by communicating standards, processes and practices at the beginning of projects and ensure compliance during projects.

The fifth and final principle is *"pursue perfection",* which is closely related to continuous improvement. Although it is impossible to reach perfection, BI teams should free up enough time to work on lean initiatives to improve their processes.

These five principles are closely related to the original five principles of lean. Dine converts these principles in a way that they are more suitable for BI.

2.5.1 Waste in Business Intelligence

No scientific literature has been written specifically on the topic of waste within BI. However, there has been done research towards applying lean in related fields, and specifically on defining and identifying waste in these related fields.

Generally, these related fields can be split into two points of view. The first point of view is from an IT perspective. This perspective is closely related towards the findings of Poppendieck (2011) on eliminating waste in software development and Al-Baik & Miller (2014) which is focused on eliminating waste in IT organizations. The second perspective is from the point of view of the business, in this case the focus is on eliminating waste in the use of information, which is closely related to the work of Hicks (2007) on eliminating waste in information management. In Table 6 these forms of waste are compared with each other and with the seven original forms of waste.

Table 6 BI Related Forms of Waste Compared

The seven wastes of manufacturing	**The seven wastes of software development**	**Identified waste in IT organizations**	**Wastes in Information Management**
Ohno (1988)	*Poppendieck (2011)*	*Al-Baik & Miller (2014)*	*Hicks (2007)*
Inventory	Requirements	Gold plating	
Extra processing steps	Extra steps	Over-specifications	Failure demand
Overproduction	Extra features	Lack of customer involvement & inappropriate assumptions	Flow Excess
Transportation	Handoffs	Double handling / duplicate processes	
Waiting	Waiting, including customers	Waiting	Flow demand
Motion	Finding Information	Centralized decision making	
Defects	Defects, not caught by tests	Defects	Flawed Flow
		Deferred verification and validation	
		Outdated information/ obsolete working version	

3 RESEARCH METHODOLOGY

The following chapter describes the overall research methodology and design used in this research. The following sections explain the overall research approach taken, the structure of the literature review, the research protocol for the gathering and analysis of the data and the creation of the process models.

3.1 RESEARCH APPROACH

In general, the goal of Information Systems research is to produce knowledge that enables the application of information technology for managerial and organizational purposes (Hevner, March, Park, & Ram, 2004). To produce this knowledge, a qualitative research approach, grounded theory, is taken for answering the research questions. In Figure 8, a representation of the general research approach is shown.

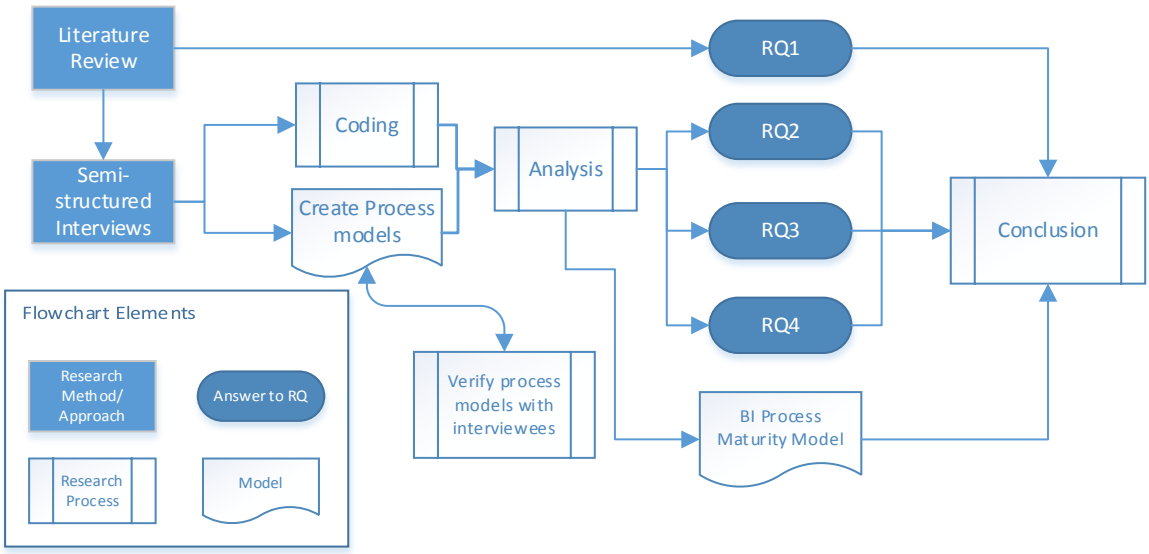

Figure 8 General Research Approach

3.2 LITERATURE REVIEW

The literature review has followed the steps proposed by Webster & Watson (2002). The literature review began with a set of keywords that were used to search for relevant literature. The following keywords were used: “lean”, “waste”, “process improvement”, “business intelligence”, “management decision support”, “management reporting”, “information management” and “critical success factors”. In addition to the keyword search, a backward and a forward search has been performed, to expose a larger window source of literature allowing more theories and sights to be identified. The literature review is concept centric, meaning that the concepts determine the structure of the review, as proposed by Webster & Watson (2002).

3.3 SEMI-STRUCTURED INTERVIEWS

Interviews were held with experts in the field of BI, process optimization and lean. The research aimed at interviewing BI consultants, in this way, multiple cases are accounted for. Consultants gained their experience from multiple organizations and projects in combination with deep knowledge about improvement projects.

The questions of Appendix II formed the basic structure of the interviews. The interviewees were asked upfront whether they gave permission for recording of the interview. Recordings made it possible to accurately and precisely transcribe the interviews. Through semi-structured interview a consistent line of inquiry is pursued while avoiding being too rigid.

3.4 CODING

To apply grounded theory, the method of Corbin and Strauss is used. Grounded theory seeks not only to uncover relevant conditions but also to determine how the actors under investigation actively respond to those conditions, and to the consequences of their actions (Corbin & Strauss, 1990).

In grounded theory, data collection and analysis are interrelated processes. The analysis should begin directly after the first data has been collected, because it directs the next interviews. Although there is standardization created with the basic interview in Appendix II, in order to not miss anything that maybe salient to area under study, the first data must be directly analysed for cues, and incorporate all seemingly relevant issues into the net set of interviews. This approach is highly effective because it allows it to ground the theory in reality.

The data found in the interviews are analysed to find potential indicators of phenomena, which are then given potential conceptual labels. Different phenomena with the same conceptual term accumulate as the basic units for theory. These concepts tin the grounded theory approach become more numerous and more abstract as the analysis continues (Corbin & Strauss, 1990). Important for grounded theory is to group concepts that are found to pertain the same phenomenon into categories. Corbin and Strauss call these categories the “cornerstones” of a developing theory because they provide the means by which a theory is integrated.

To go into more detail about the coding, Corbin and Strauss divide the coding process into three stages

1. **Open coding:** here events/actions/interactions etcetera are compared against others for similarities and differences. These phenomena are conceptually labelled. The next step in this stage is to categorise these concepts into categories and subcategories.

2. **Axial coding:** In the next phase these categories are interconnected. These relationships are tested against the data. Also the categories are further developed. Subcategories are related to categories base on conditions, context, strategies and consequences, this is done to make the conceptual linkage more specific.

3. **Selective coding:** is the process by which all categories are unified around a central core category, which represents the central phenomenon of the study. Also categories which needs further explanation are filled-in with descriptive detail.

The data analysis followed the following steps

1. Recordings are transcribed as literally as possible, where necessary
2. Transcriptions are imported into Nvivo 10 (Professional tool, used for open-coding).
3. Each transcript is coded based on Corbin and Strauss method. This means the first step is to begin with open coding. The text is conceptually labelled and first efforts are made to identify categories.
4. The codes are categorized based on frequency of coding in combination with concepts found in the literature review and concepts discovered during the analysis phase.
5. Each coded transcription is analysed once more and first attempts are made to relate codes to each other on paper.
6. Categories which need further explanation are filled-in with descriptive detail.

3.5 CREATING PROCESS MODELS

In each interview one specific case regarding a BI process improvement project is discussed in detail. The interviewee had to describe the old process before the improvement project started, the new process and the improvement project itself. Based on the transcription and coding of these interviews process models are set up. The process models contain the workflow of the old process, the workflow of the new process and a summary of the most important issues, solutions for these issues and benefits which were gained by applying these solutions.

After the initial version of the process model is set up, each interviewee is contacted to verify the correctness of the workflows. They are asked whether the model is the correct representation of their case. Afterwards their feedback is processed into the workflows.

4 RESULTS

In this chapter the results of the data collection are described. The performed interviews collected led to a total of twenty-six process models. The processes are described both textual and visual.

First of all Section 4.1 describes a general overview of the interviewees and their specific cases. Secondly section 4.2 contains the five old and new reporting processes which were extracted from the interviews. Consequently section 4.3 contains the eight old and new BI change processes which were extracted from the interviews. Furthermore section 4.4 describes the results regarding the identified forms of waste within BI processes. Finally section 4.5 and 4.6 will respectively describe the perceived challenges and benefits of the discussed cases.

4.1 COLLECTED CASES

Table 7 presents an overview of the characteristics of the consultants interviewed and the specific case discussed with the interviewee. Due to privacy reasons and confidentiality agreements the data is anonymized, the cases described by interviewees can be identified with the letters A-M. A total of 14 interviews have been conducted of which a total of 13 have been transcribed and analysed. One interview has been left out due to lack of knowledge of the interviewee on the specific topic of this research. The consultants that have been interviewed have experience ranging between four and twenty-five years, with an average of 9.15 years. All the consultants have done a comprehensive amount of projects within the field of BI. As mentioned before, during the interview the consultant had to describe a specific improvement project in which he improved a dysfunctional BI process. Their descriptions were visualized in process maps, these process maps have been reviewed by the interviewees. The result of this research process can be found in Appendix III – Process Models.

The organizations discussed were functioning in the (semi) public (3) and public (10) sector. The size of the organizations varied, five organizations were classified as medium (1.000 – 9.999 employees), while the other eight organizations were classified as large (10.000 employees or more). The industries in which the organizations operated varied, Consumer Products (3), Process Industries (2), Utilities (2), Government (2) were the most common.

The discussed processes were classified as either BI change processes (8) or reporting processes (5). Change processes are about the development of BI capabilities. Reporting processes are about the cyclic process of generating specific reports or dashboards.

Table 7 Characteristics of Interviewees and Discussed Case

Interview	Years of experience	Sector of case	Industry of case	Size	Process type
A	4	Private	Process manufacturing	Large	Change Process
B	10	Private	Financial	Large	Reporting Process
C	15	(Semi) Public	Government	Medium	Reporting Process
D	14	Private	Process manufacturing	Large	Change Process
E	10	(Semi) Public	Utilities	Medium	Change Process
F	9	Private	Consumer Products	Large	Reporting Process

Interview	Years of experience	Sector of case	Industry of case	Size	Process type
G	4	Private	Financial	Large	Change Process
H	4	Private	Professional services	Large	Reporting Process
I	4	Private	Utilities	Medium	Change Process
J	6	Private	Consumer Products	Large	Reporting Process
K	25	Private	Consumer Products	Large	Change Process
L	8	(Semi) Public	Government	Medium	Change Process
M	6	Private	IT	Medium	Change Process

4.2 REPORTING PROCESSES

Figure 9 and Figure 10 compares the five old and new reporting processes which were described in the semi-structured interviews (B, C, F, H, J). In each reporting process four main phases were identified: In the first phase data from different sources is requested and collected, subsequently in the second phase the data is processed and analysed, followed by the third phase in which the data is represented in a report of dashboard, finally in the fourth phase the created report or dashboard is distributed towards the end users. In the following section the five cases and the four phases of reporting will be discussed in detail.

4.2.1 Cases (old situation)

Organization B is a large insurance company: the core problem was that it took them too long to create two types of reports for the finance department. Also too many people had to work on these reports and there were quality issues. The interviewee identified that the process of how they produced these reports contained design flaws. It was not clear who the (internal) customers were and what information that customer needed on which moment. They only delivered information to the next internal customer when it was complete, while certain elements which the client needed were available earlier, meaning they worked in batches. This led to the problem that too much information was delivered too late. Next to these problems the steps within the process were not properly connected. It was not clear in which form information should be delivered, which led to a lot of rework. For example the interviewee stated: *This report was printed and put in a bookbinder. Afterwards the first thing the internal customer would do, so someone who was part of the process, was to take the documents out of the bookbinder, put it into the feeder, scan the documents and then e-mail these files digitally.*

Organization C is a governance instance with an unstructured BI process. They relied mostly on a legacy version of excel, which causes their process to be reliant on manual operations. This manual process caused data quality issues especially in combination with the lack of common data definitions. Also the data itself was not up to date. They were lacking a properly defined BI department, like a Business Intelligence Competency Centre (BICC). Because they had no structure in their processes which led to a constantly growing number of reports while they never shut one down. Because they weren't tracking the usage of reports they also weren't able to identify unused reports. Reporting in this organization is a mostly decentralized operation. Also the information they reported on was lacking, the interviewee stated that: "*they were blind, they couldn't see some of the numbers while you do need to know them".*

For a specific quality reporting process *Organization F* was reliant on the reports provided by all their local operating companies. The problem was that all these local organizations had their own operating systems, their own data definitions and they all had differently designed reports. Furthermore they had different ideas about quality. Because the reports had to come from these local companies, the lead time for a new report was too long and caused a lot of redundant work during the phases of analyses and the creation of reports.

The BI system of *Organization H* was underperforming. Users were complaining about its speed, stability and that it did not deliver the required information. This caused a lack of trust in the system. The interviewee stated that the users had lack of knowledge on the possibilities of the system: they didn't knew how to generate certain reports. The lack of trust in combination with the lack of knowledge made the situation only worse. Employees were massively creating whole dumps of the database and made a report in excel themselves. The need for different kinds of reports than those available in the tooling also caused users to create dumps and create their own unstandardized reports in excel. All these data dumps put a strain on the resources of the system, which only caused more problems regarding speed and stability.

Organization J was facing the problem that only one person in their organization was able to execute the reporting process, these reports were destined for the top level of management in the organization. The process of generating the reports was extremely complex and consisted of multiple manual procedures, developed by one person over the years. The cycle time of the process was relatively long, it was unclear which business rules were applied in which part of the process and at the same time the process relied heavily on legacy applications. Also there was no documentation about the process.

Besides this dependency issue, the data quality was also lacking. *"The way they were accessing the data - through all these different layers, in an unstandardized way of manipulation- caused a lot of data redundancy*", explained the interviewee. Next to this data redundancy issue, the numbers were also incorrect: *"What he got from the mainframe and what was on his report were completely different numbers. There was a very big data quality issue but he was not aware of it."* For the CIO this reporting process was also an issue because it was not in line with the overall information strategy of the company.

4.2.2 Phases (old situation)

In the first phase, *Gathering Data,* data is mostly gathered by creating dumps from ERP systems (C, F, H) or mainframes (J). Also this data is gathered in batches (B, C, F, H, J), so everything is collected all together before it is put through to the next phase. The result of the batching of data is that information in reports is not as up to date as it could potentially be (C, F), or that the next internal customer has unnecessary waiting time (B, J). The gathering of data is not automated in any of the cases researched.

Differences in data definitions (C, F) create inefficiencies during the *analyses phase* and a lack of (trust in) data quality in general causes rework (B, H). Multiple processes contain mostly manual consolidation and analyses proceedings (B, C, F, H, J). These manual proceedings are more prone to error than pre-defined, automated proceedings. In some cases the analyses phase took too long due to technical design (H, J).

In multiple cases a lack of tooling (H) or the use of legacy tooling (C, J) caused problems during the *create report* phase. Also a lack of an (agreed upon) standard template which can directly be filled with data caused difficulties (B, H, J), again because without these templates this step in the process is more prone

to errors. Also the activity designing/creating these reports ad hoc every week is inefficient and a form of rework.

In one case (B) the distribution of the reports was a very inefficient process because the requirements were never clearly communicated between the internal producer and customer. The form in which the reports were delivered differed, but dashboards were not used by the organizations. Interviewee C mentioned that because the reports were published through e-mail, instead of on a server, it was very difficult to keep track of the usage of the report, which led to a proliferation of reports.

4.2.3 Cases (new situation)

To improve the process in *organization B* the interviewed consultant did a voice of the customer analyses. The goal was to analyse which information was required for which (internal) customer, on which moment and in which form. They removed a lot of unnecessary data which was in reports but never used. This brought down the processing time of the gathering and analysing phases dramatically. Also they brought the process back to one physical location, which removed a lot of waiting and transporting waste. In the end, the steps in the process were more aligned, the actors were more aware of the needs of their colleagues and the process was more visible for the employees. These improvements led to a decrease in cycle time of 40%.

Because of the immature nature of the reporting process of *organization C*, the consultant decided to create a solution which was placed next to or upon their current architecture. She explained: *"We analysed what they should report on, so we did workshops to see how you should do it, how should you make sure that you can. Then we looked at the things they wanted, […] so how can you get that information out of their system."* The solution automated the extraction and consolidation of the data. While data definitions were standardized, master sources were defined and reusable reporting templates were created. By distributing the reports via a server report usage was tracked. Also the reports were now displayed in a dashboard, instead of in a static report, this provided deeper insights for the customer of the process. Eventually processing time was reduced because of the automation of steps, the amount of unused reports was reduced and there was an improvement in data quality.

The key for improving the reporting process of *organization F* was to create common data definitions. According to the interviewee this was a very difficult process, it took the consultants months to get the actors involved to agree on all the different definitions. When these data definitions were established they were able to gather data directly from the source systems of the local operating companies, this greatly reduced the processing time during the data gathering phase. Also because of the standardized definitions the time to consolidate the data was reduced. They created reusable templates which could be automatically filled with source data. The information was displayed into dashboards. Overall the data in these dashboards was more accurate. Most of the manual processing steps were eliminated, which led to a decrease in processing and cycle time.

To improve the performance *of organization H's* reporting process the organization decided to decentralize data analyses for the different regions. All the regions wanted more capabilities, but they all had different requirements. The solution was to let the different countries built their own capabilities on top of the current reporting system. Besides these new capabilities, effort was also spent on education, which was considered an important factor. The program was paid for per head of FTE in their country. So they paid per user, but if half of the users don't use the system they are wasting opportunities. They could

make better decisions, steer more on that data or use the information for projects. In the end stability and speed of the system was increased, mainly because a decrease in the amount of dumps made from the system. Furthermore because of the regional solutions, flexibility was increased.

For organization J their main goal was to decrease the reliance on a single person for their reporting process. This was done by automating most of the gathering data, analyses and generating reports phases. It was now clearly documented where business rules were applied, the proper application of business rules increased data quality. They created reusable templates for the reporting phase. Only the extraction of the data from the mainframes was still an issue: they still had to use the old scripts for this. Variation was reduced, because of the automation the process became more predictable. Overall the processing time was decreased and entire process was simplified.

4.2.4 Phases (new situation)

In three of the five *data gathering* phases the process was improved by streamlining the data requirements (B, C, F). These data requirements can be split into two categories, requirements regarding which data is required (B) and requirements regarding the form in which the data is delivered (C, F). Because the form in which the data was delivered was streamlined, for example by agreeing on data definitions, two processes could completely automate this part of the process. These processes could directly extract data from the source systems (C, F). Within one organization a shadow process was removed, which improved performance (H). Finally, one organization changed the way gathered data was saved, from a local hard drive to a SQL server which simplified the process and more future proof (J).

Four out of five *data analyses* phases were standardized and (semi-) automated; this was achieved by creating standardized queries (C, F, H, J). An additional advantage was that business rules applied within the analyses phase became more visible (C, J). Although process B was not automated, it was improved: The organization decided to let the analyses part of the process be performed on one physical location, this removed unnecessary transport. Rework and overproduction was reduced by a voice of the customer analyses, which helped the organization focus on the information which delivered value. Finally because the data gathered in the first phase was transferred earlier, the workload could be spread evenly.

Next to the automation of the analyses phase, also the *generation of reports* was automated in three of the five organizations. This was done by creating reusable reporting templates (C, F, J). This way of reporting reduces variations and is less prone to error. Organization H decided to partly automate the reporting phase by providing locally optimized reporting templates, also they made local BI tools available for specific management information. In two organizations legacy tools were eliminated (C, J). Two organizations switched from reports to dashboards (C, F) and one organization shifted from printed to only digital documents (B).

In three of the five organizations the distribute phase process was adjusted. Organization B removed unnecessary steps in their report distribution by delivering directly in the required form. Organizations C and F publish their reports on a server instead of emailing them, so they can track the usage of reports. Organizations H and J did not change their distribution process.

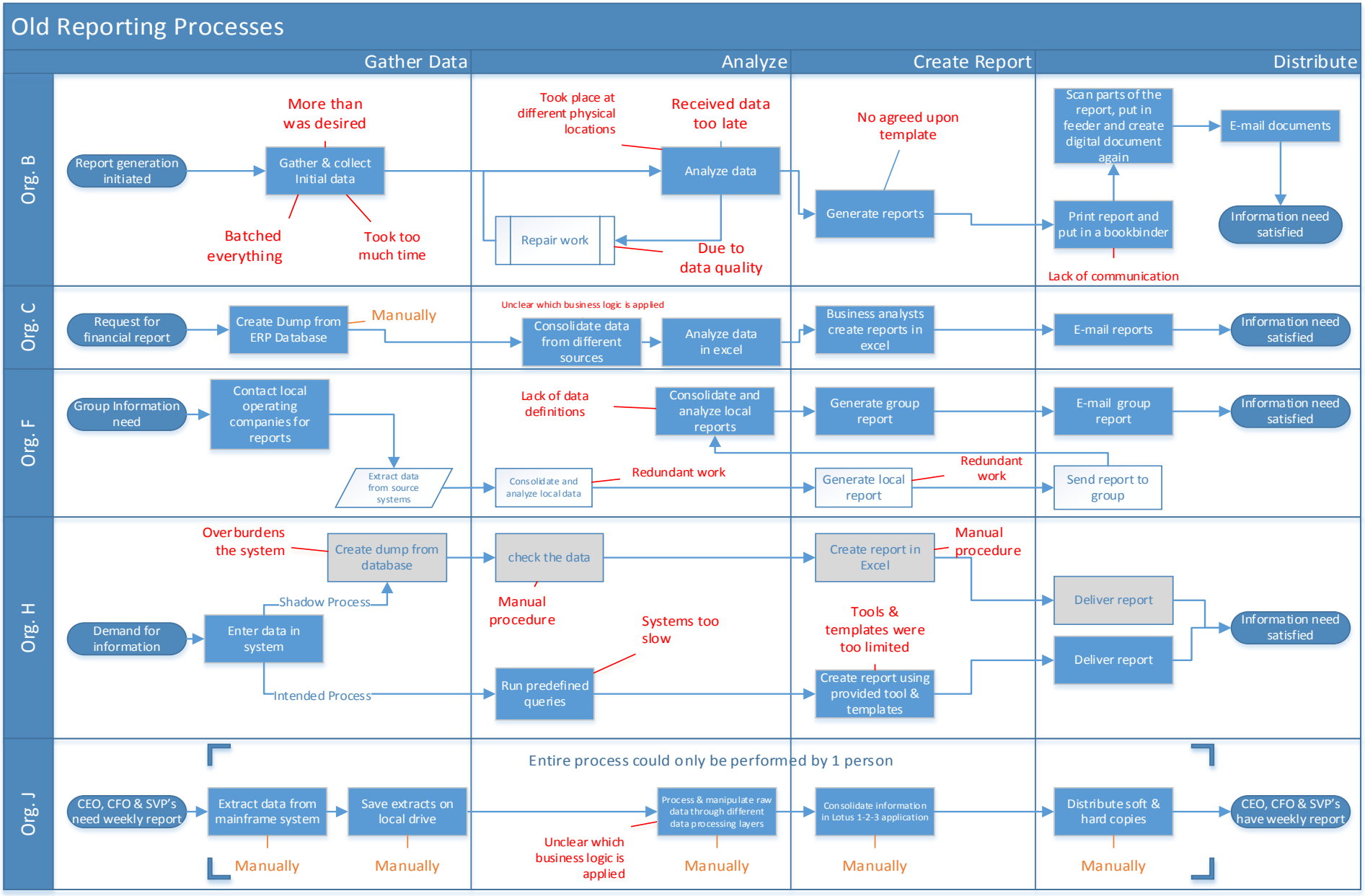

Figure 9 Old Reporting Processes

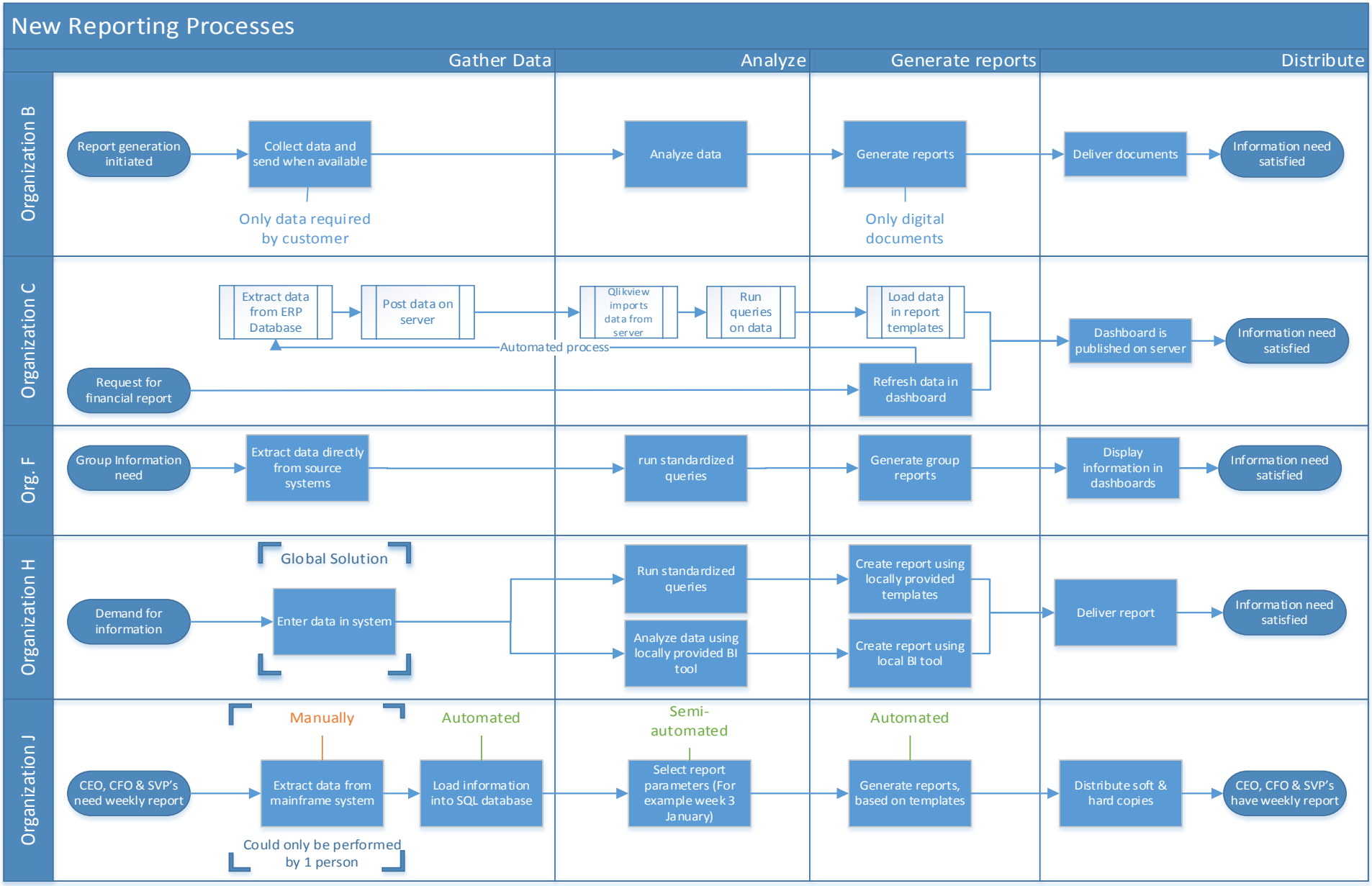

Figure 10 New Reporting Processes

4.3 CHANGE PROCESSES

Figure 11 and Figure 12 represent the eight old and new change processes which were described in the semi-structured interviews (A, D, E, G, I, K, L, M). In each change process four main phases were identified: In the first phase the change is initiated by the customer, subsequently in the second phase the change is analysed and planned, followed by the third phase in which the change is implemented, finally in the fourth phase the implemented change is delivered to and checked by the customer. In the following section the eight cases and the four phases of change will be discussed in detail.

4.3.1 Cases (old situation)

Organization A is a large company within the oil and gas industry. The core problem they were facing was that their reporting department had a lack of innovative projects: they had no clear vision. Also the implementation of the latest technologies took the BI organization too long. Finally there was a lack of alignment with the overall information strategy of the company. The interviewee described it as follows: *"Many organizations work in a way which resembles a support department, often they have yearly budgets or they fund projects. […] But these projects don't get created from an actual structured substantive vision. It is more like the BI in our procurement function is moderate so let's do something there. So it's more like who has money and wants to do something instead of following a vision".* Their main problem coming up with new opportunities. It used to go in a very ad hoc manner, like when you meet someone in the hallway or someone gives you a call; there was no structure for this process.

Organization D, a large producer of chemicals, had eight different BI departments. "*Every unit had their own BI processes, their own BI organization and their own BI teams, where some consisted of 2 people some of 15 persons depending on the budget they were willing to put into BI",* the interviewee explained*.* There was no standardization, agreed upon data definitions or control over the BI portfolio. This led to an excessive amount of reports and tools, while they were not able to utilize the potential of their economy of scale benefits. The implementation of reports was too expensive, especially for the smaller subsidiaries.

Organization E was lacking a structured reporting house. This infrastructure company aimed for setting up a BICC. Their current process was all ad hoc, the interviewee stated: "*every week finance would come to reporting and would say: ""Ok, we need this different, that different"", etcetera".* Overall they had data quality issues, lacked data definitions, lacked alignment with IT strategy and lacked clear responsibilities. The customer of the BI process, finance and business, had little trust in the current reports.

Organization G, a large bank, had a BICC in place but it was too IT minded. They were not visible for the business and overall they were not social enough. It took the BICC too long to create new reports and because of their way of working - for instance developing through a waterfall method- they were too static for the quickly changing business requirements. The business often hired expensive consultants to skip the BICC altogether.

Organization I, a large energy and utilities company, had a reporting department with no maturity at all. According to the interviewee only IT had some processes in place to make reports and financial statements. The organization had a lot of data and information but it was not connected. The department was young and they were not in control of their information. They had some BI tools in place, but there were no clear choices made. They weren't sure what to pick or what to do, so they just tried three different things simultaneously. But because this department was new, they did not feel responsible for the immaturity. According to the interviewee for that reason they were open for change.

Organization K, a large Japanese automotive company, aimed to optimize their BI capabilities. According to the interviewee they had about twelve BI tools: "*Cognos, Business Objects, SPSS, a couple of industry specific BI tools, SAS analytics, if you named it they more or less had it".* Their problem was that instead of IT developing the BI reports, IT provided the tool directly to the business. This led to multiple issues, an excessive amount of tools, reports & licenses, dependency on individuals for reports, a lack of traceability, a lack of maintenance, badly designed reports ("*Queries of mass destruction"*) and overall a lack of control over the BI portfolio.

The development of new BI capabilities for semi-governmental *organization L* took the business way too long. They constantly had a large pool of unfinished projects. They lacked a proper structure for measuring prioritization: in the old situation it was done based on FIFO (First In, First Out). Projects were planned too late in the process, analyses were made deliberately too high, testing was a bottleneck and they switched too often between resources. Also there was a lack of communication between IT and business, while IT had trouble understanding the business at the same time the business didn't see the impact of their requests on IT. Overall the business had very little trust in IT. The interviewee stated: "*They were already frustrated by the process, so they didn't have the energy or motivation to help the process. They were cynically about the outcome*."

Organization M, a software company, had a centralized IT department but a decentralized BICC. Consequently the responsibility and accountability for BI report was put outside the central corporate level. The main problem they faced was dividing their resources over the different projects. Every country had their own wishes for changes and new projects, but central IT only had limited resources. Another problem was the allocation of costs: if country A wants a certain report and country B uses it too, who has to pay for it?

4.3.2 Phases (old situation)

In the old situation for most processes the *initiation phase* was an unstructured, ad hoc, process. (All except G, which required specific documents). Developers were often contacted directly with requests (A, E, I, K). BI organizations were lacking points of contacts which made them often invisible for people without specific contacts (A, E, I, L). IT being not sociable enough is also seen as an issue (G, I, K).

Some organizations were lacking a defined *planning phase* all together (K, I). Several organizations had IT in control over the priorities of projects (A, D, I, M), in these cases the business was often left out in this phase. As a result the business didn't understand why certain changes were executed at later moments in time and consequently this led to lower trust and scepticism in IT. Like one interviewee stated:

"*The business has had enough from waiting on these long waterfall projects. I mean, it is a little bit similar to installing a new ERP system. It is also quite difficult for the business to really understand what it is going to bring them."*

In two organizations planning was mostly done by local IT departments instead of through a central unit within the company. This led to a lack of control over the BI portfolio, which leads to a proliferation of BI tools and reports and a lack of standardization and data definitions (D, M). Organization L seemed to have had the most mature planning process, although FIFO prioritization still played a major role. They defined in their process a triage (sorting changes into categories that reflect different levels of effort required), which was based upon whether something is a bug or a change. Afterwards they clearly defined two analyses steps, one by IT and one by the business, before the change was planned.

Because changes were not implemented by IT but by the business two organizations didn't use a specific development method in their *development phase (E, K)*. Like interviewee K described*: "They* [the business] *also build them in a certain way because they are not data architects, not data modellers, haven't got any expertise in how to link data. So they start to join tables, all kinds of different joins, I've seen reports with over 50 joins in them. […] Now sometimes these reporting tools are pointing at production data which is fatal, hence the term queries of mass destruction. You are bringing down production services because you are overloading the horse power of the box because of the queries."*

Some organizations had local IT departments developing (D, M), this led to redundant work according to the interviewees. Finally, multiple organizations used waterfall methods for development (G, L). This led to problems commonly associated with the waterfall method. For example the business had to wait too long to see results, lack of business involvement within the development process and an overall lack of communication with the business.

The organizations who used the waterfall method during the development phase both had formal acceptance testing steps defined in the *check phase* (D, M). In these two phases a major bottleneck was that the business did not deliver the required manpower for testing the developments. This slowed down the entire change process. Like one interviewee stated: "The business said: 'I'm too busy at this moment, I can only test in two months from now.' "

Multiple organizations lacked formal testing processes, which often caused confusion about who was responsible for the testing or it was not tested at all (E, I, K). Another problem organizations faced was that the wrong people were assigned to test the change (G, L). The interviewee stated: "*The people with the wrong knowledge were assigned to the testing, they were insecure to do the signoff, that's why they pushed forward the time. They were afraid to make the call, to give the sign off.*"

4.3.3 Cases (new situation)

To improve the situation in *organization A* the consultant decided to set up something called the business value network. The goal was to improve the rate of innovation in BI capabilities by creating a dialog between business, IT and their suppliers. They started planning periodical meetings, where they brought the business directly in contact with the supplier. Business analysts were involved to investigate which opportunities or projects there were to work together. Next to this business value network they also implemented a structured portfolio review in which the CIO's in combination with stakeholders from the business decided on the ranking of opportunities and projects. These two improvements delivered multiple benefits ranging from an increased number of innovations and faster implementations of these innovations as well as improved control over the BI portfolio and increased collaboration between IT and the business.

The goal of the improvement project in *organization D* was to create a central BICC which combines the forces of the eight business units and leverages their effort. They removed all the local BI representatives from their business units to put them in one central competence team. This central competence team was responsible to maintain the central processes, procedures, templates and whatever was required. There were concrete agreements made to specify what is allowed in the group environment and what is allowed on local level. On the group level everything was fully standardized and harmonized. Local basically had placed a fence around it: "*so these are the rules, this is what you are allowed to do, this is what you are not allowed to do, for the rest have fun.*" The structure they created enabled them to retain

the standardized definitions, group reports and tooling while retaining local flexibility. In the end they had a reduced number of redundant reports & tools, they greatly reduce cost for creating new reports, smaller business units gained access to increased capabilities and finally consolidating different data sources for group reports required less effort.

Organization E decided to create a governance model, which embeds a part of finance, IT and the business into one BICC. By creating this reporting house and the processes around it they would be able to manage it better. An important factor in setting up this governance model was to create understanding concerning who is responsible for which part of the process. The goal of this governance model was to improve data and report quality, improve alignment with the overall IT strategy and regain trust in reports from the customers of the process. Steering and sub-steering groups and groups for testing were appointed; this gave the organization more control over their portfolio of BI capabilities. Also there were made standards regarding sets of requirements for change requests and new projects.

Organization G faced the problem that their BICC was to IT minded: the gap between IT and business was too large. They tried to address these issues by adding business (knowledge) to the BICC. To reduce this gap between IT and business they also started working in a more agile way. The business got more involved because they received prototypes in earlier stages of the process. Getting requirements clear in the new situation also became a task of the BICC instead of just a task of the business. Overall, silo thinking got mostly eliminated and the BICC became more visible for the business and vice versa. The new way of working led to quicker results for business, which again led to more involvement from the business and eventually they regained their trust in the BICC.

The BI unit of *organization I* was recently set up and very immature. They were not in charge over their processes, used no methods for handling change and development and had an overall lack of knowledge within their department. The interviewed consultant helped setting up a structured process for change: they put processes in place to guard data definitions, created a central point of contact for the BI department, created a website for users to track their change requests and put metrics in place to measure the process. These measures increased data quality, decreased variation in process output, decreased cycle time for projects, increased control over the BI portfolio and increased their ability to manage expectations.

The goal of *organization K* was to optimize their BI capabilities. In the old situation IT had no control over their BI capabilities: everything was done by the business. During the project they brought IT back into control and standardized the tools they used. Furthermore they implemented IT development methods, mostly agile/scrum, for creating new BI capabilities. They analysed all the BI assets they had and reduced this to the necessary amount. This all brought significant cost reductions, speeded up their systems because of freed up computing capacity and most of all brought the company back into control. At the same time it was essential to make sure that IT truly understands what the business is about: this was the only way IT could keep control. In the end they brought the amount of BI tools back from fifteen to three.

Organization L's main problem was their cycle time for the implementation of changes, which was way too high in the eyes of the business. The consultant made an analyses and started redefining their entire change and development process. They standardized their portfolio/change management process, introduced scrum into the organization, set up a change advisory board (CAB) to handle proper prioritization and aligned the way of working with the rest of the organization. Next to these changes they had set up a service desk, which was the central point of access for the BI department. Eventually the

cycle time was extremely reduced, they worked in a more transparent way, the business was more involved and there variations on output were reduced.

Organization M faced problems due to their decentralized BI structure. This caused issues regarding data quality, communication, number of BI tools/reports and the allocation of costs. To resolve these issues the organization created a process in which the responsibilities of local and central IT, in combination with the business units involved, were defined. They had set up a CAB and created central data definitions. Through their new set up they improved communication between the actors in the process, they improved their control over their BI portfolio and they were able to approach BI from a more strategic perspective.

4.3.4 Phases (new situation)

In seven out of the eight organizations the *initiation phase* was (partly) standardized (A, D, E, G, I, L, M). In some cases this was done by defining requirements for a user requirements document (D, G, M), other organizations have set up single points of contact in the form of BI service desks (I, L) and also by defining exactly who can make change requests (A, L). Because determination of information needs can be very difficult and challenging for business users, some organizations set up the process in such a way that the BICC is already involved within the initiation phase (E, G). Therefore they can check early on the necessity and feasibility of the request. Organization I implemented a website through which the business could access the service desk and track the progress of their requests.

In most organizations the *plan phase* is the part of the process which changed the most. Six out of eight organizations decided to set up central organs responsible for the evaluation and prioritization of changes (A, D, E, I, L & M). Multiple organizations (I, L, M) set up triages in their process. They made distinctions considering the amount of effort they expect a change to cost (L, M) and whether it concerned a new project or changes to an existing project (I). Some organizations created a process which helped orchestrating the interests of the group and local units (A, D, M). This was done by setting up a monthly portfolio review (A), creating specific guidelines/policies on the duties and obligations of the group and local units (D) and by setting up a CAB which evaluates requests and balances interests (A, M). Organization A took a deviating approach by creating a business value network. They try to match potential business projects with technological developments of their tech suppliers, to stimulate innovation.

In the *development phase* three organizations introduced an agile/scrum way of working (G, K, L). This greatly improved the involvement of the business within the process, increased visibility and enabled them to handle changing requirements. In some cases (E, L) development shifted from the business towards IT in order to get proper controls. Interviewee K explained it as follows: "I*f you bring this into IT, somebody develops the reports in a high quality way, the reports are then maintainable because they are supported by an IT organization, there is some inventory and an archive of these reports and then there is a proper management of this environment is in place.*" Organization I implemented a testing process, using a testing environment. Organization D and M mostly aligned the local and group developments.

Finally, five out of the eight organizations set up a new process for the *checking phase*. This was done in four out of these five organizations by appointed key users (E, G, I, M) and in one case (L) by the CAB. Organization A changed the ending of their change process from being budget focused towards being focused on the periodical meetings.

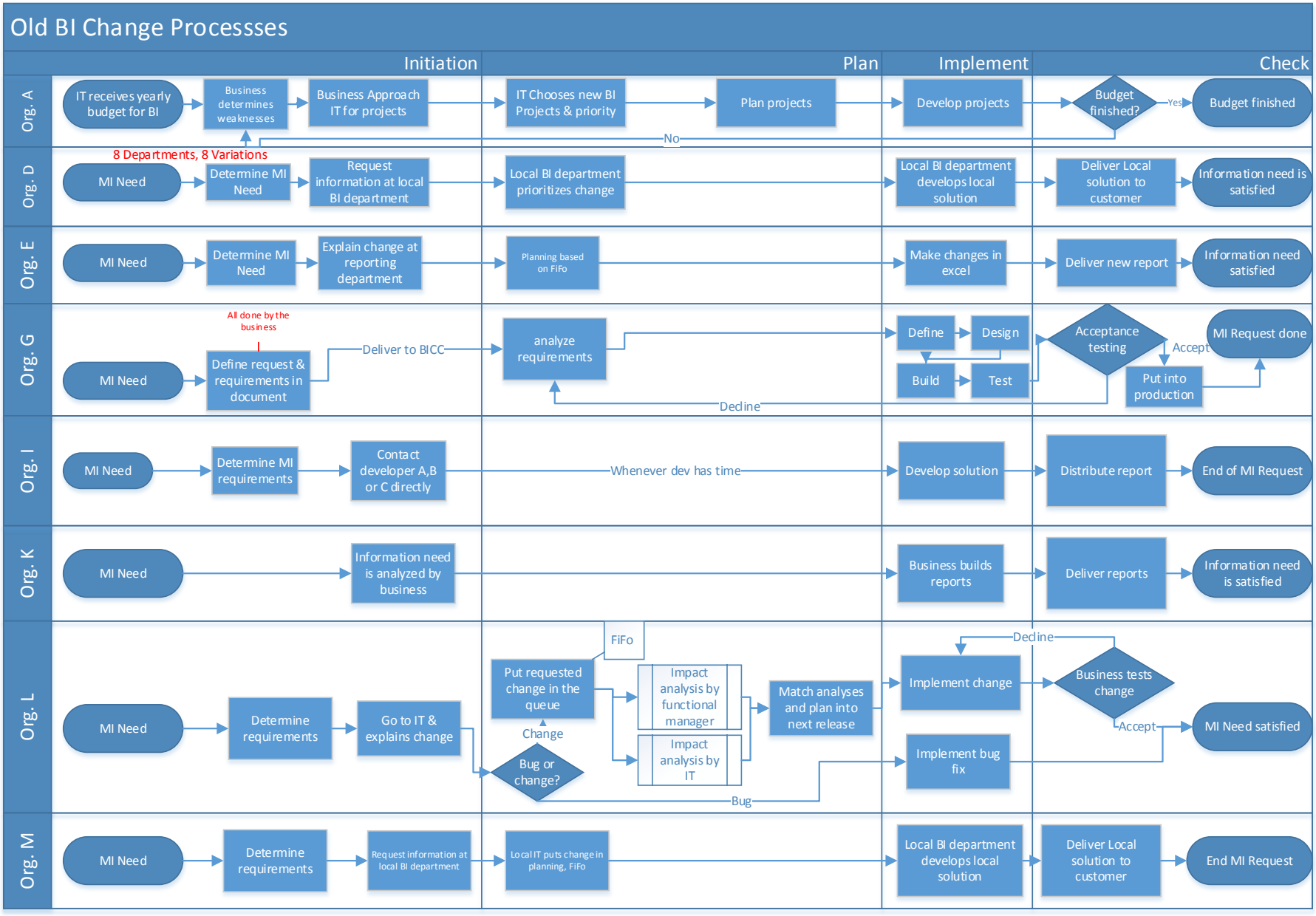

Figure 11 Old BI Modification Processes

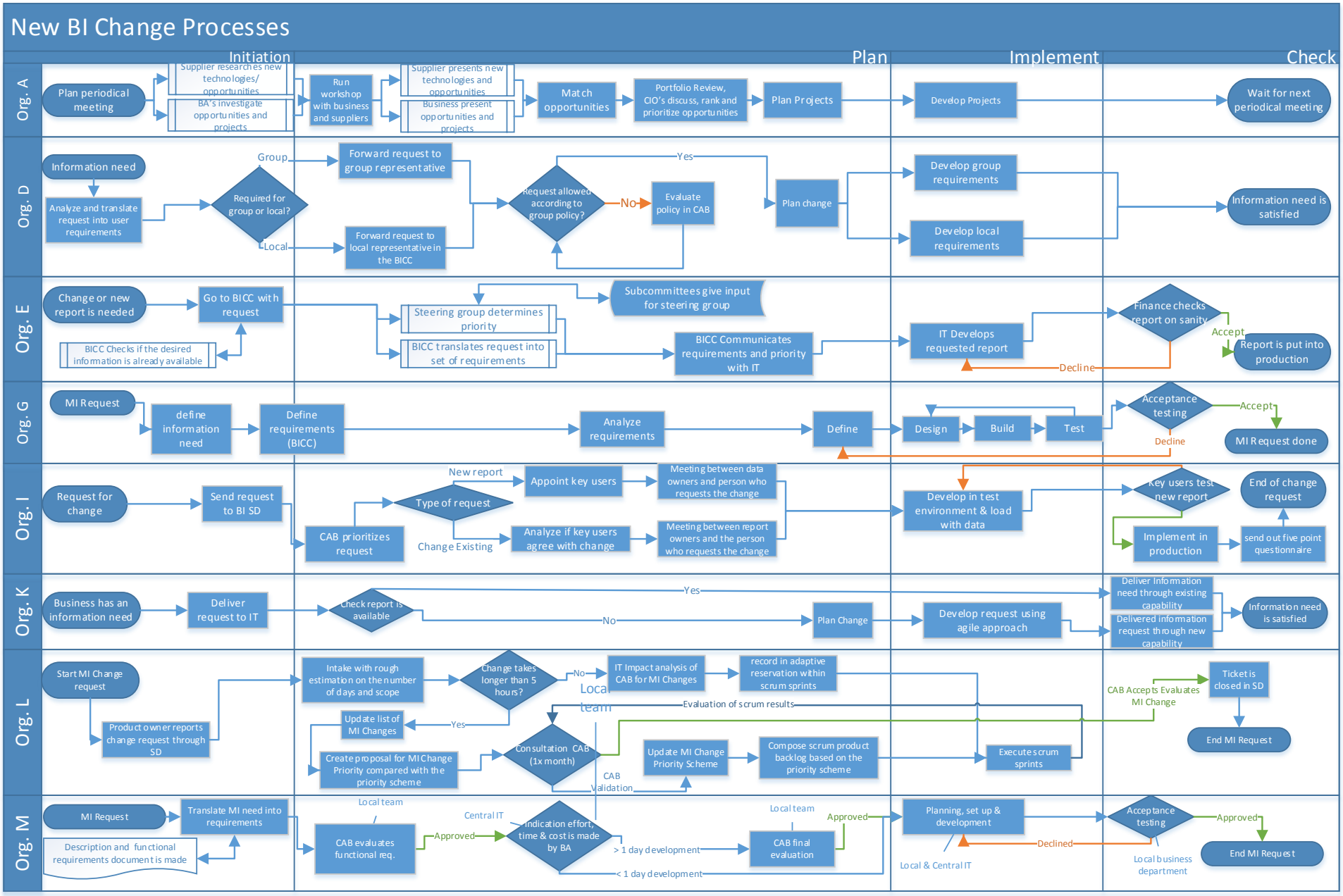

Figure 12 New BI Change Processes

4.4 TYPES OF WASTE IDENTIFIED

For the coding of the transcripts of the interviews, 11 types of waste, divided into 2 categories, were used. They were organized based on the types of waste found in literature: the seven types of waste as defined by the TPS (Ohno, 1988) and the four types of waste within IM (Hicks, 2007). In section 4.4.1 the results regarding the classic types of waste are presented, in section 4.4.2 the results regarding the types of waste within IM are presented.

4.4.1 Waste (Classic)

Types of waste which could be classified according to the definitions given by Ohno (1988) were mentioned 57 times during the 13 interviews. In Figure 13 these results are represented both by the number of times mentioned relatively to the total mentions of waste and relatively to the number of interviewees who mention the type of waste. In the following section these types of waste in regard to BI processes are discussed.

Waste as a result of *defects* was most often mentioned (15 instances). Defects were mostly caused by data quality issues, the wrong application of business rules and mistakes in the design of the data models. Nine out of the thirteen interviewees mentioned issues regarding this type of waste. Although defects are an important type of waste, often within BI it goes unnoticed, Interviewee J explains: "*We were able to come up with the conclusion that the reports sitting on the CEO's desk, on some key KPI's they had incorrect figures. They had conducted their business on incorrect numbers for ten to fifteen years. But still somehow the organization was able to grow from 25 dollar a share to maybe 60 or 65 dollars a share. So they were able to make sound business decisions even though they had wrong data.*"

Waste as a result of *over-processing* was mentioned by 6 out of the 13 interviewees. This waste is often caused by the time spent on building new reports while the required report is often already (partly) available. Another form of over-processing is spending too much time on only a specific part of a BI tool. Interviewee C for instance says that most suppliers of BI overemphasize the importance of the visual part of a BI solution: *"A discussion I very often have with BI providers is that the focus is too much on the front end. It all has to look flashy and that kind of stuff. But if you ask them how to create a data model easily, the answer is often that you can add whatever you like. 'You can do excel, word, access databases, all fine.'*

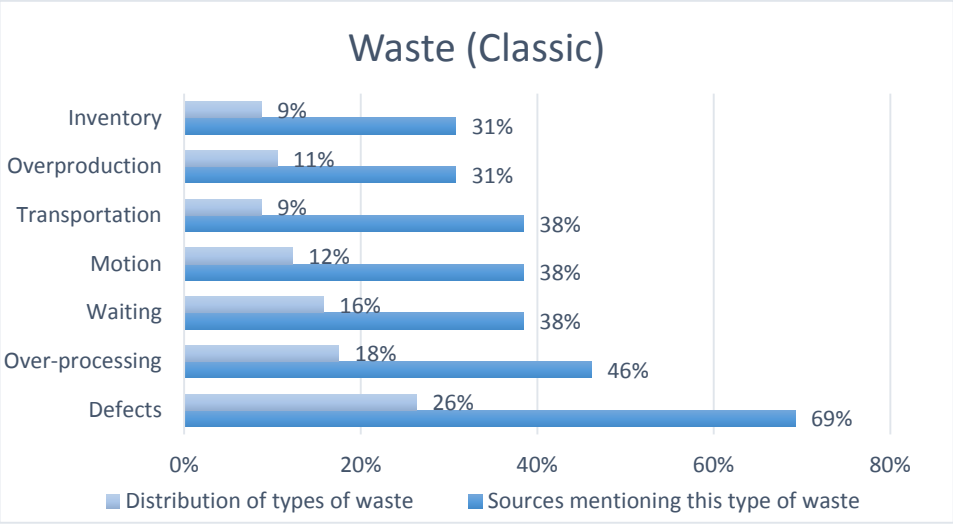

Figure 13 Wastes Identified (Classic, as defined in section 2.1.4)

But then I would say this still doesn't solve complicated data models. That whole thing about the data model, -thinking in data models-, is a very complicated concept for people in the business. If you get it wrong it is a dissatisfier but if you get it right, it is never a satisfier. Visual stuff can have the 'Wow' factor but if the data is not right it won't get you anywhere."

Interviewee K shares this view on over-processing; in his opinion over-processing is mainly caused by a lack of clearly defined user requirements: "*Define what you want this report to do. So you want an X number of values to display or you want a certain data manipulated in a certain way. Define that acceptance criteria clearly, that is all the developer should then work on. A developer shouldn't make choices about adding an extra column, which colour a sheet should be, what fonts to use or which fancy representations on the screen he should use. He should just develop what the requirements ask him to develop. A lot of waste comes in where developers and designers run a little bit rampant, creating things that look fantastic, have wonderful imagery, wonderful screen layout, but really doesn't do anything different than the user has asked for."*

Slow development of new BI capabilities and the wrong timing of delivery of data are often a reason that other actors in BI processes have to wait. *The waste of waiting* was mentioned 8 times by 5 different interviewees. Interviewee B explained: "*The whole report was only delivered when it was complete, while certain elements which the client needed were available way earlier. […] What we saw there was that they batched the work and they waited until this whole batch was filled before they delivered it."*

Often resources are spent on unnecessary process steps mainly because they can be automated or eliminated altogether. This type of waste, *unnecessary motion,* is mentioned by 5 out of the 13 interviewees. Interviewee B describes this type of waste with a very basic but clear example: "*If we look at the way they executed the process we saw that steps in the process did not connect or fitted very well, which led to many unnecessary tasks which were performed. A real basic example is about a report which had to be delivered to the board of directors. […] This report was printed and put in a bookbinder afterwards. The first thing the internal customer […] would do, was to take the documents out of the bookbinder, put it into the feeder, scan the documents and then e-mail these files digitally. This was not even the complete report which she put through!"*

The waste of *transportation* is mainly caused by the (unnecessary) movement of information or requests for information between departments and individuals. 5 interviewees mention this type of waste. Sometimes there is literally a big distance between the business, the BICC and IT itself, like interviewee G mentions: "*Especially in banking there is a big distance between IT and business. [..] Even for people within IT the distances are quite big. So for instance if you work for the IT management team, they don't work that close with the BICC either.*"

Overproduction within BI processes mainly shows through an excessive amount of reports. 4 of the interviewees mention this waste, in a total of 6 different instances. Often they don't have the proper control over their BI portfolio, they often make new reports while they already had the capability available. Interviewee K explains an example of reports which were putting serious constraints on resources while not being used by any customer: "*We found lots of reports which were running hours per day, using cycles of mainframes, delaying batch processing on the mainframe. [..] Nobody was using it because it was written eons ago. But it was still running because nobody decided we didn't need it anymore and it killed the process."*

The waste of *Inventory* is mentioned the least by the interviewees: 4 times by 4 interviewees in total. Inventory within BI mainly shows in large pools of unfinished projects and finished but unused reports/dashboards. Also when information is batched this can be seen as inventory waste. Interviewee K explains that although within IT inventory waste seems negligible, it can bring a lot of extra costs: *"You can develop thousands of reports, each of these reports take up some disc space. If you are building cubes or universes these things are only small, but incremental they will take up space. Then you need maintenance and back them up onto tapes or some other offline storage. All this costs money. it can all be small but if you got thousands of these growing over a few years you start to consume towards terabytes of data; in commercial storage solutions this is extremely expensive. You buy 3 terabyte disc in the store for a 100 dollars, but buy it for a mainframe and you are talking about half a million plus maintenance."*

4.4.2 Waste (Information Management)

Types of wastes which could be classified according to the definitions given by Hicks (2007) were mentioned 35 times by in total 11 of the 13 interviewees. In Figure 14 these results are represented both by the number of times mentioned relatively to the total mentions of waste and by the number of interviewees who mention the type of waste. In the following section these types of waste in regard to BI processes are discussed.

Waste regarding *Flawed flow* was mentioned a total of 15 times by 9 different interviewees. This type of waste is mostly caused by a lack of data quality or the wrong application of business rules. In the sense of BI flawed flow is exactly the same as the waste defects as defined by Ohno (1988).

Failure demand is mentioned 7 times by 5 different interviewees. This waste comes forward out of a lack of information in the form of reports or dashboards. Although the urge for a missing report is not always there within an organization, interviewee C explains: "*There might be reports missing, so we would say: 'You need reports for this.' But a manager can say 'I don't need reports, I manage this by walking around.' There is no one who tells him he can't; as long as their numbers are fine then there is no problem. But I do think you are missing the opportunity to be in control.*"

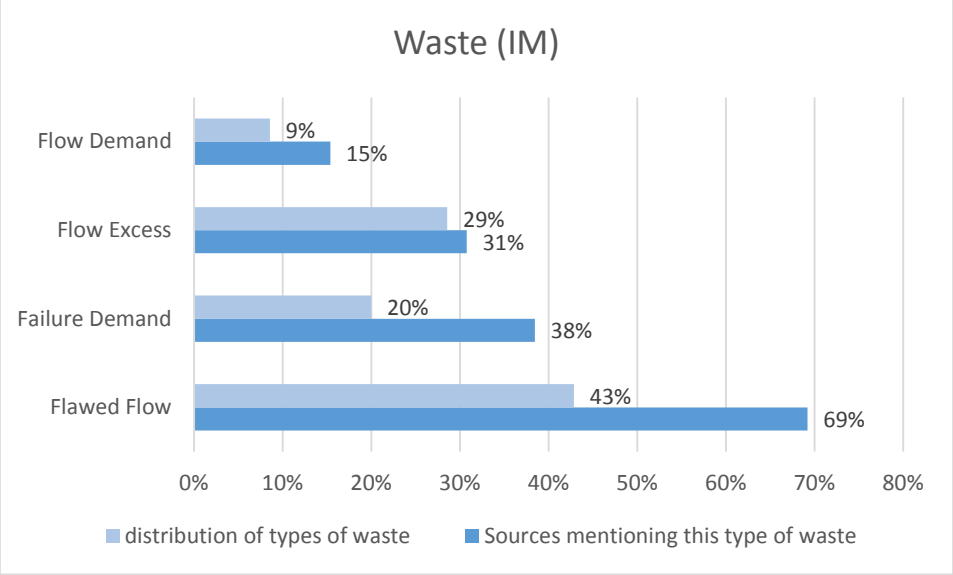

Figure 14 Types of waste identified (Information Management, as defined in section 2.4.4)

Flow excess is mentioned a total of 10 times by 4 different interviewees. Interviewees mostly mention flow excess in the context of badly designed reports, which contain unnecessary information or excessive amounts of created reports. Interviewee K explains: *"So with BI, I recently was on a project where they were asking for something like 200 plus reports from their BI system. But when you really looked at it they only needed something like 10 reports. […] Scrum, agile and lean try to break things down and only do things which add value. Once you actually get to that level, it doesn't really matter which type of implementation you are doing, you are only implementing what is actually required."*

The waste of *flow demand* is mentioned only three times by two interviewees in total. It was mentioned in the context of a lack of clear user requirements for BI capabilities. Interviewee L explains for instance that requirements for a specific KPI were only given on a high level: "*So it was on really high level, for instance they would say I want this KPI with these and these characteristics, but not into detail, no taking into account all the related function areas, calculation of KPI's, time scenarios or that kind of stuff."*

4.5 PERCEIVED CHALLENGES IN PRACTICE

During the analyses phase a total of 46 different challenges which caused underperforming BI processes were identified. These themes were organized in four main categories as represented in Figure 15: Process, Organization, Technology and Strategy Alignment. These coded themes were mentioned in the transcripts in 122 instances of which 41% were related to the process, 27% were related to the organization, 21% were related to the technology and 11% were related to the strategy. Because this thesis takes a process-based view on BI, these process-related themes will be discussed in dept. The organization-related challenges consisted mostly of a lack of involvement from the business, challenges regarding cost allocation of BI capabilities and a lack of knowledge regarding BI within the organization. The strategy-related challenges were mostly caused by a lack of alignment of the BI strategy with the strategy of the (IT) organization. Another issue was an overall lack of vision from the BI departments. Technology-related challenges included data management issues, excessive amounts of licenses, reports and tools, a lack of (standardized) tooling and poor report or data model design. Out of the process-related challenges the main subcategories identified were related to process execution (15), collaboration (14 instances), process design (14) and dependencies (8).

- *Process execution*. The most mentioned challenge is related to the actual execution of the designed BI processes. Often this execution differs from the designed and intended process. Through these grey or shadow processes organizations lose control over their processes. Also the poor execution of specific steps within the process (for example testing) was pointed out as a challenge. Finally in multiple cases the execution of a process took too long.
- *Collaboration.* In multiple cases, departments only took their own department into account when executing BI processes. They were not focused on the rest of the chain. Overall there often was a lack of communication between for instance the BICC and the business. This silo thinking is one of the biggest challenges according to the participants and solving this can bring a lot of benefits. Interviewee B for example explains: "*People there were used to doing tasks only from their own silo, not being aware of what the rest was doing in the chain. Providing that insight brings you a lot of benefits."*
- *Process design.* In about one third of the identified process challenges participants mentioned issues concerning the design of the process. Predominantly mentioned is the non-existence of a process design often in the form of ad hoc processes, process steps that are only defined on a high level and a lack of clearly defined responsibility and ownership.

- *Dependencies.* Four interviewees mentioned that the designed process was too dependent on certain individuals. These bottlenecks brought issues regarding the spread of the workload but it also puts the organizations at risk. Interviewee J explains: "*Basically, it was done by one person in the organization who was knocking on the door of retirement every day. He was such a crucial piece to delivery of these reports because he was the only person in the organization who knew how to run certain jobs, how to extract information from the mainframe systems, how to manipulate those extracts into a different layer of the processing of the information.*"

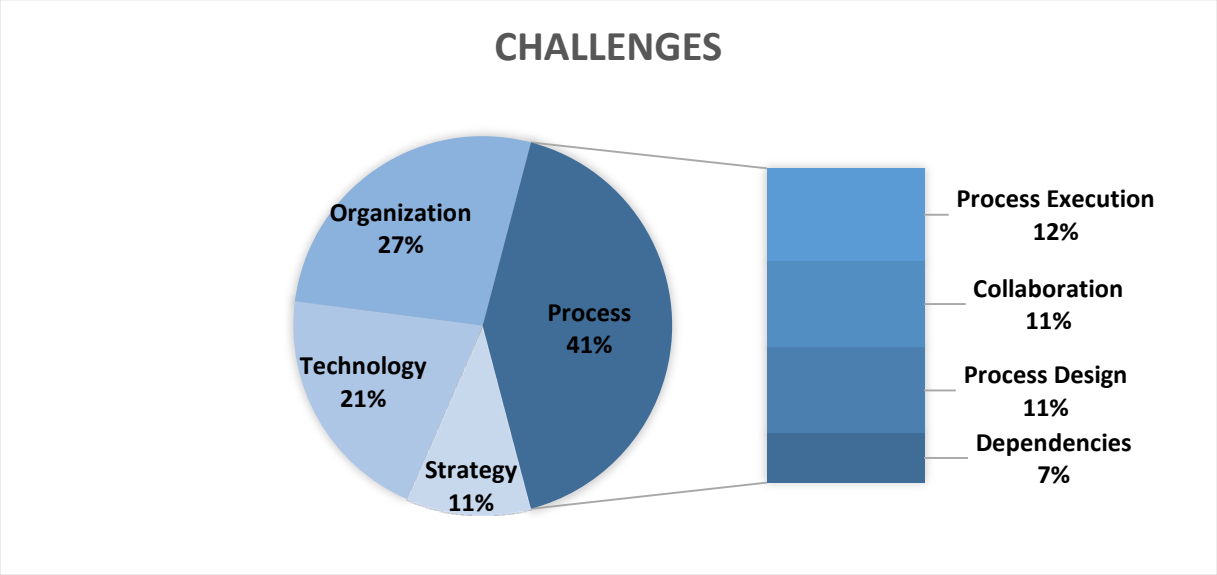

Figure 15 Challenges reported in case organizations

4.6 PERCEIVED BENEFITS IN PRACTICE

Through the description of the improved BI processes, the identified benefits emerged directly from the interviews. The benefits reported here have been mentioned by the interviewees and identified during the coding process alongside the challenges. The main categories identified were: process (mentioned 40 times), Organization (mentioned 14 times) and Technology (mentioned 4 times).

Out of the process-related themes the most common found benefits were related to awareness & collaboration (17), cycle & process time (10), value creating activities (8). The distribution of themes across the categories can be found in Figure 16.

- *Awareness & collaboration.* Through the optimization of the processes employees became aware of the actual process and their role in this process. This brought clarity, increased trust and created understanding. For example interviewee M explained: "*They could now explain why it would take longer than the business expected. If America wanted a change that would normally cost one week, but would take two weeks because Germany also had a request, in old situation they had trouble explaining these holdups. With the new system they were able to communicate this in a better way, which created more understanding within the organization.*"
- *Cycle & process time.* In about half of the cases the time it took to execute the BI process was reduced. In some cases this was done by decreasing the time it took to execute certain sub processes. Interviewee J for example explained: "*We significantly reduced the time of the data processing. We*

made it much more efficient and effective by using some of the extracts he created for us and putting them in a SQL database. He didn't use any server database, he saved everything locally." In other cases they reduced the waiting time between certain sub processes, for example in organization L: *"What we saw was that the cycle time was extremely reduced. Mainly because the waiting time for business approval, functional specs that had to be approved and testing, were all minimized.*

- *Value creating activities.* 5 out of the 13 interviewees mentioned benefits regarding an increased number of value creating activities within organizations as a result of the improvements made to the BI processes. Often manual processes were automated which freed up time for employees to do more valuable work, interviewee F explained this as follows: *"This freed up time for the employees from doing dumb typing work towards spending time on actually analysing the data. There was one guy who spent half of his week on making a report with an excel sheet, starting on Monday and sending it out on Thursday. So he was delighted to shift his work towards more meaningful tasks."*

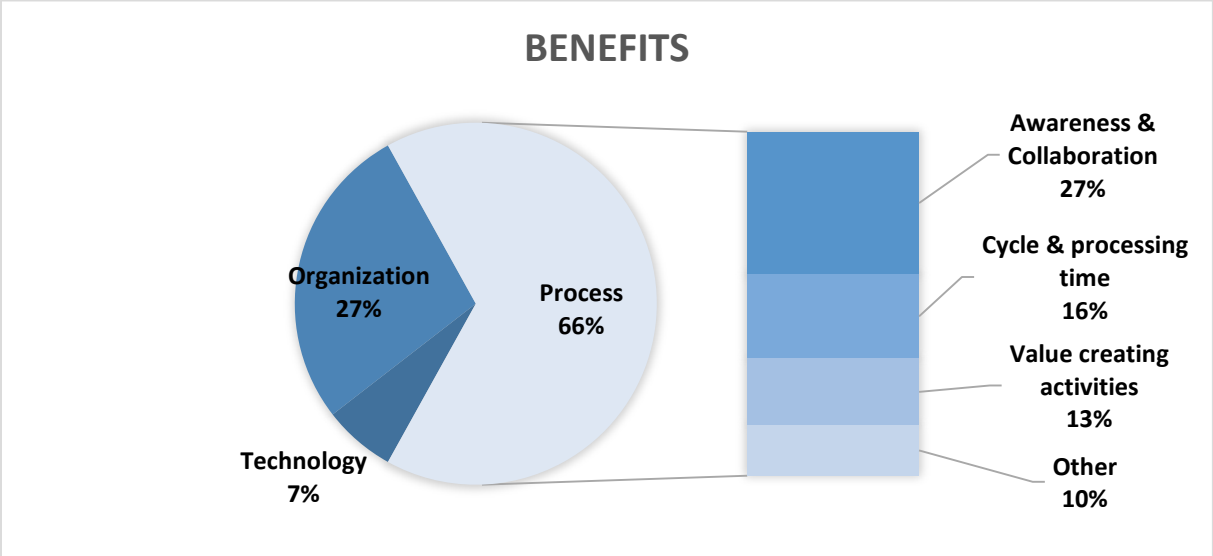

Figure 16 Benefits reported in case organizations

5 ANALYSIS AND DISCUSSION

In this section the gained insights regarding the optimization of BI processes will be discussed. In section 5.1 the levels of BI process maturity will be discussed, in section 5.2 the identified forms of waste will be discussed, in section 5.3 the applicability of lean principles on BI is discussed and finally in section 5.4 the benefits of a process-centric approach towards BI will be evaluated.

5.1 WHICH LEVELS OF BI PROCESS MATURITY CAN BE DEFINED?

Based upon the literature (Dekkers et al., 2007) and the empirical findings, BI processes can be generally split up into two categories: the execution of BI (reporting processes) and the modification of BI (change processes). In the following section the maturity models of both type of processes will be discussed.

5.1.1 Levels of process maturity in reporting processes

Based upon the interviews, four general process steps were identified within the execution of reporting processes. Starting with the data gathering phase, followed by the analysis phase, then the report generation phase and finally the distribution phase.

Based on literature, mainly the model of Bell & Orzen (2010), in combination with the cases analysed, four levels of maturity have been identified. The model is displayed in Figure 17. The first level is *Ad Hoc,* on this maturity level there are no processes defined also all the handlings are manual procedures. Outcomes of the process is inconsistent, it varies widely. Overall there is little to none control over the process.

The second identified level is called *Loosely Defined*, on this level processes are implicitly defined, some actions are automated but the process is still heavily reliant on manual exercises. The outcomes of the process are loosely consistent. Overall there is little control over the process.

The third level identified is defined as S*tandardized.* On this maturity level most data gathering and analyses activities are (semi-)scripted. Every step in the process is defined and documented. For the presentation of information standardized templates are in place, organizations on this level often are able to present this information in dynamic dashboards. The distribution of the reports and dashboards are controlled, which enables organizations to check and evaluate usage of their BI capabilities. The outcomes of the reporting process are generally consistent.

The fourth and final level is defined as *Integrated*. On this final level of maturity data is automatically extracted from source systems through the entire organization. Strict data governance is a necessity to enable this. The consolidation process is automated and analysis is done on mostly live data, quality checks on data are in place. The generation of dashboards is automated and there is a process in place to evaluate the relevance of KPI's and process performance indicators.

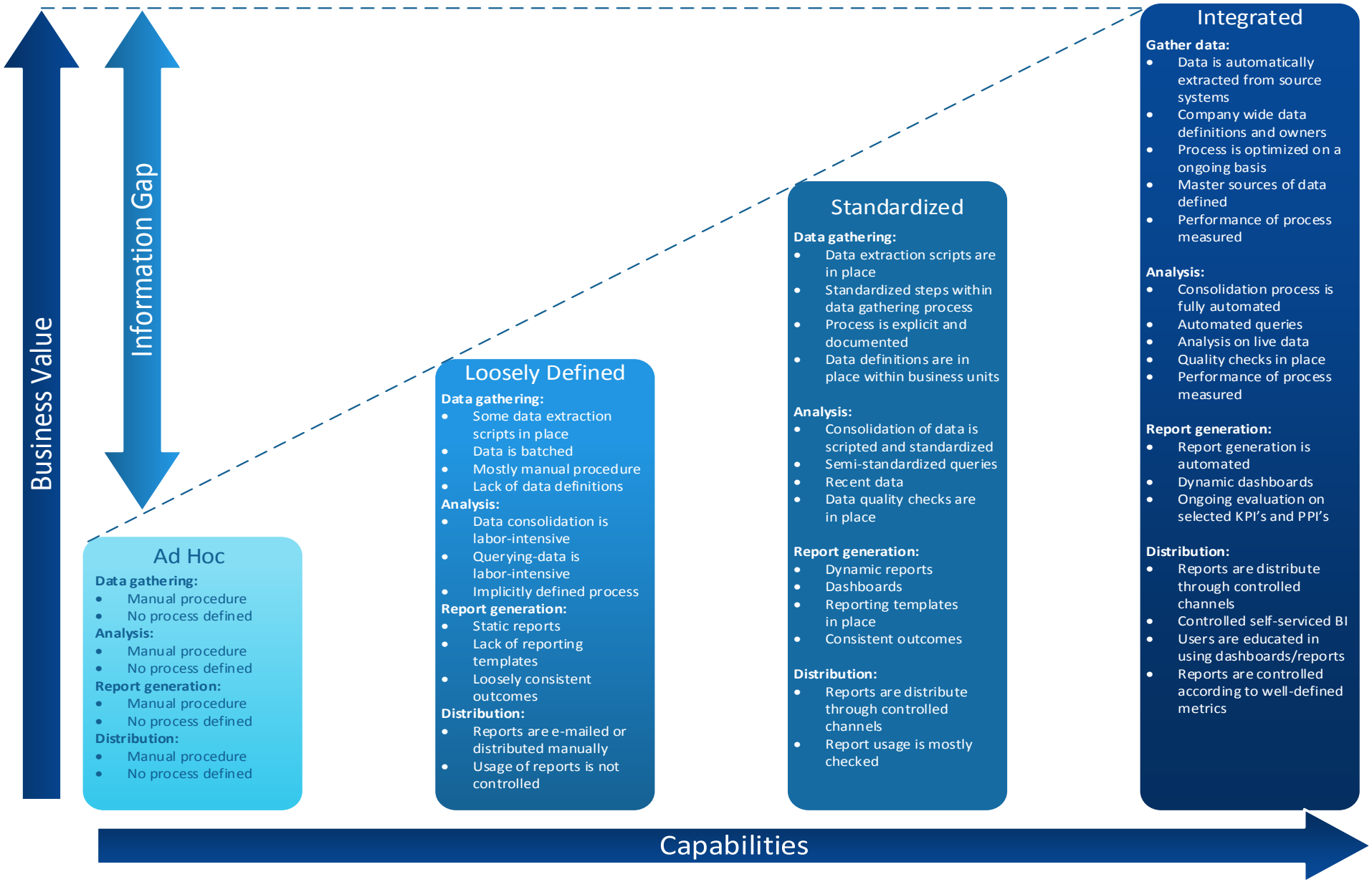

Figure 17 BI Execution Process Maturity Model

5.1.2 Levels of process maturity in BI change processes

Based upon the interviews, four general process steps were identified within the BI change or modification processes. Starting with the initiation phase, followed by the planning phase, then the implementation phase and finally the checking phase.

The same levels of maturity used in the BI Execution Maturity Model are used for the BI Development Maturity Model: *Ad Hoc, Loosely Defined, Standardized* and *Integrated*. The model is displayed in Figure 18. Again on the first level, *ad hoc,* there are no processes defined. Overall there is no control over the process.

The second identified level is called *Loosely Defined*, on this level processes are implicitly defined. For instance in the initiation phase some form of requirements definition is expected. Often it is unclear who is allowed to make change requests and who responsible for receiving these requests. The planning phase lacks proper prioritization processes and overall there is a lack of strategic planning. Again the planning process is implicitly defined. The implementation phase often does not (strictly) follow a development method and often lacks customer involvement. The checking phase consists merely out of IT checks.

The third level identified is defined as *Standardized.* On this level organizations have well defined (feasibility) checks in place within the initiation phase. Change requests are properly documented and information requests are properly defined. The planning progress is explicitly defined and there is a BICC in place consisting of members from the business as well as from IT. Prioritization is handled in a structured way. The testing procedures are standardized both within IT and within the business. Performance of the end-to-end process is measured, outcomes are consistent.

The fourth and final level is defined as *Integrated*. For the initiation phase the organization has a single point of contact in place. Business opportunities are matched with technological developments. For a new project a detailed project document is required and there are clear agreements on roles. In the planning process both IT and business are represented, there is a CAB in place which delivers support to the BICC by approving requested changes and assisting in the assessment and prioritization of changes. Overall group and local interest are orchestrated. During the implementation phase customer involvement is mandatory at defined stages within the process. The developed solutions are according to the standards set by the organization. The acceptance testing process is well documented within the checking phase. Overall the entire process is measured, including the time to complete sub processes. Also measurements for user satisfaction and overall quality are in place.

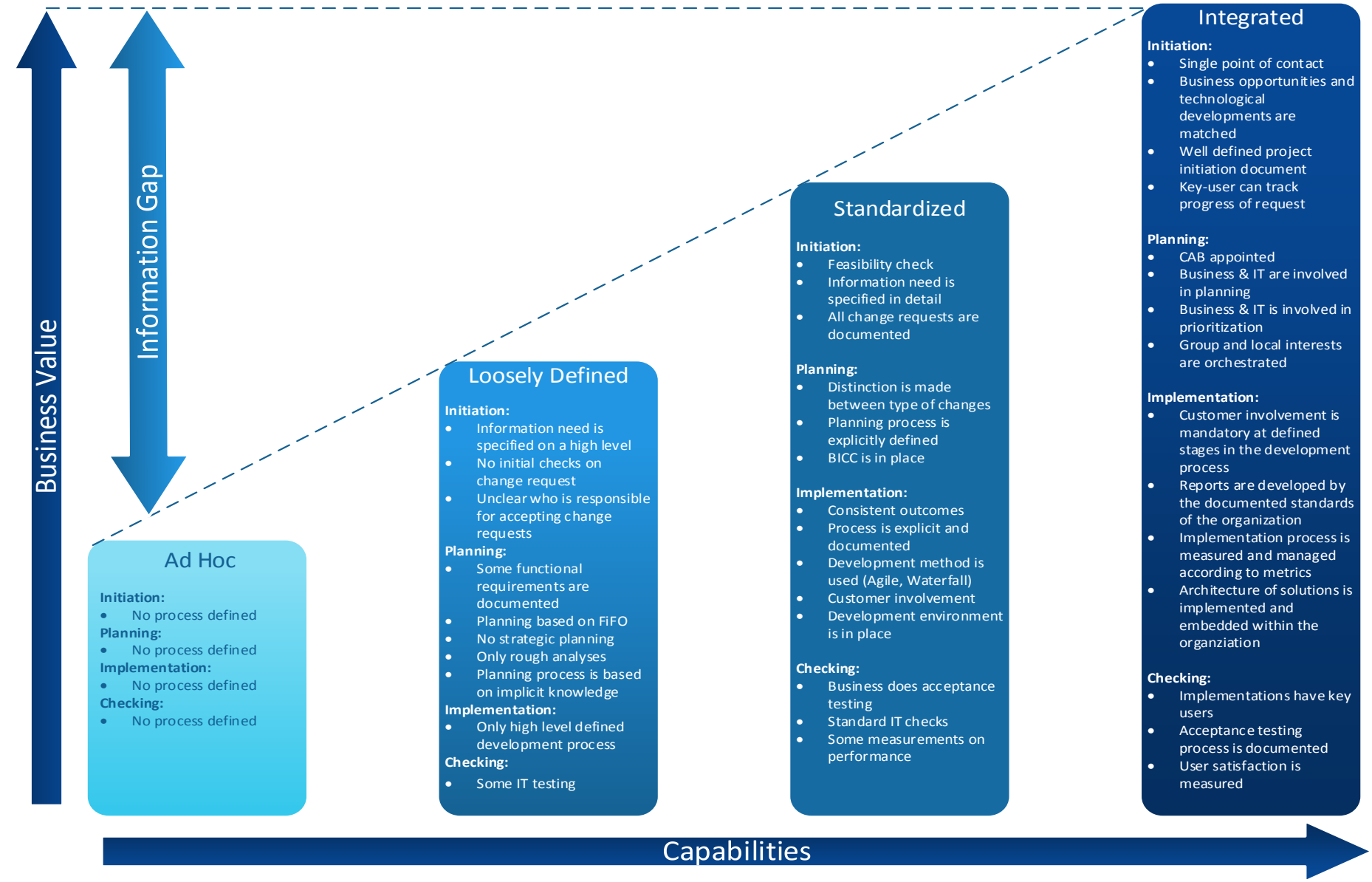

Figure 18 BI Modification Process Maturity Model

5.2 TO WHAT EXTENT ARE THE WASTE CATEGORIES IDENTIFIED BY HICKS APPROPRIATE FOR BI PROCESSES?

Hicks (2007) states that his model regarding value flow and waste, which is explained in section 2.4.4, can be applied to any information processing activity with the following condition: *"The value in the information (data) itself and further value must be generated by the virtue of the mechanisms by which it is organized, represented, exchanged and visualized.*" BI dimensions like gathering data, analysing and reporting suit these requirements. Hicks continues by defining waste as follows:

"*All additional actions and any inactivity that arise as a consequence of not providing the information customer immediate access to an adequate amount of appropriate, accurate and up-to-date information."*

During the coding of the transcripts Hicks types of IM waste were coded along with the types of waste as defined by the TPS. In total there were 36 instances coded of IM waste, while there were 56 coded regarding waste as defined by the TPS.

Although the types of waste which Hicks defines are certainly useful for specific parts of BI processes, they are incomplete for other parts. For example: Hicks maps *Failure Demand* directly to over-processing. While hicks focusses on the waste which is generated by a lack of information, multiple interviewees emphasized that a lot of waste within BI is caused by gold plating or the over-development of certain aspects of reports or dashboards. Another example is motion within BI. According to Hicks motion doesn't play a role within information waste, arguable you could say that manual exercises because a lack of scripts or templates is a form of motion waste. Also arguable the waste of motion can be caused by wrong report design, this means that while the information is correct and available, still extra effort has to be spent on interpreting the information. Finally, not all interviewees agreed with the notion that the waste of inventory is negligible. One interviewee (K) pointed out that commercial data, including the mechanisms to manage it, can be quite expensive.

Hicks makes a strong point in making the distinction between digital and analogue waste. And while his approach to waste seem usable for BI, this thesis suggest that a fifth category is missing related to the over-processing or over-analysing of information. This sad, the classic waste types as defined by the TPS could be detected within reporting processes as well as change processes. The conclusion is made that while Hicks types of waste can help with focussing purely on the information stream, the classic types of waste still have their value for BI organizations.

5.3 TO WHAT EXTENT ARE LEAN PRINCIPLES APPLICABLE TO BI PROCESSES?

Dine (2013b) described five lean principles which were applicable for optimizing BI processes: (1) focus on customer value, (2) see the whole picture, (3) iterate quickly, (4) reduce variation and (5) pursue perfection.

1) The first principle is focus on customer *value* which means that everything which consumes resources and does not deliver value is considered waste. In practice this focus is very relevant for BI organizations, all improvement projects addressed one or more forms of waste. One of the most identified forms of waste was over-processing. Interviewee K directly made a very strong comparison with the production of cars: "*Toyota teaches that one of the biggest wastes is over engineering. Doing more than what is required. Quality is a fine balance, Toyota can probably build an engine that would last 2 million miles, but very little people are going to keep their vehicle for 2 million miles. So they don't engineer it to that level of quality because it is waste, you are over engineering, over processing. So therefore with a report, it needs to do what it needs to do, but it doesn't need all the bells and whistles. If you build a report and a developer spends lots of time on the font, changing the colours, moving stuff around, for what benefit? Does it actually add any value? So if you look at quality, it is important to balance quality with the cost of investment to deliver the function. If you deliver good functionality with reasonable form, you are doing what Toyota cars are all about. They are not the most exciting vehicles, not the beautiful lines of a Ferrari or some Italian car, but trust my they will last a lot longer than a Fiat."*

2) The second principle is *"See the whole picture"* organizations should learn to see beyond individual decisions and consider them in a wider context. Silo thinking is one of the biggest challenges according the participants and solving this would be beneficial for the entire BI process. By seeing the whole picture departments understood that they were part of the problem and the solution as well. In the case of interviewee L the business only communicated their requirements on a high level, meanwhile they were blaming IT for all the issues regarding BI. He explained: "*they [the business] realized that they are a part of the issue themselves. They didn't really knew what kind of measures they wanted, where they steer on. So that were actually more fundamental questions where the business did not wanted to give transparency on. […] So this was actual the hidden issue behind it."*

3) The next principle is *"Iterate quickly"*: by iterating quickly the scope of each iteration can be reduced while the flow is increased. This is a subject which is very closely related to the agile movement. The necessity for this type of development is mentioned multiple times by six interviewees. Interviewee J emphasizes that flow can be enhanced by looking at reporting in the form of a conveyor belt process: *"If you think about as a conveyor belt process right than you have this data warehouse or information flow and then you have these robot hands right? Putting things on the conveyor belt, integrating all these different end products and what not. I think that is a very interesting way of looking at it. It definitely makes end user reporting standardized, streamlined, lean and definitely agile. That makes it efficiently and effectively."*

4) A lack of standardization in processes, design, procedures development and practices, causes variations in BI. *"Reduce variation"* is the fourth principle. Every single project discussed became more standardized in the end. Standardization and process design was a key focus for almost all projects. The non-existence of a process design was identified as one of the key challenges for organizations.

5) The fifth and final principle is *"pursue perfection",* which is closely related to continuous improvement. BI teams should free up enough time to work on lean initiatives to improve their processes. Although all the projects were about improving BI processes, there were no initiatives documented regarding the instilling of continuous improvement practices within the organization. Some organizations did however instil certain measures in their process, to measure and evaluate performance. This principle seems sensible, but no evidence of it is found in the empirical data.

Four out of five lean principles defined by Dine were recognised in practice. Based on these case studies the lean principles, when slightly adjusted towards the field of BI, are to a very large extent applicable to BI processes.

5.4 TO WHAT EXTENT CAN BUSINESS INTELLIGENCE CAPABILITIES BENEFIT FROM A PROCESS-ORIENTED VIEW?

Over 40% of the challenges identified in the interviews were process related. Most of these issues were regarding process execution, process design, collaboration and dependencies. By taking a process oriented view a lot of these problems could be identified within organizations and addressed properly.

By determining the level of BI process maturity organizations can be aided in spotting the weaknesses in their processes and it can guide them into direction in which they need to grow.

Within process improvement theories lean plays a central role. The principles of lean, when slightly adjusted towards BI, can be of great value to organizations. Four out of the five principles were regularly mentioned and confirmed within the interviews. While there is debate whether the forms of waste as defined by the TPS are directly applicable to mostly digital processes. In practice this way of thinking aids organizations is focussing their efforts on becoming more efficient and effective.

The studied cases showed that issues were often difficult to spot from one single point in the process but almost directly visible when considering the whole process. The benefits for organizations taking this process-centred approach were mostly in the area of improved collaboration and awareness, reduced cycle and processing times and enabling employees to spend more time on value creating activities.

Based on the studied literature in combination with the data from practice, which led to the considerations which were just pointed out, BI capabilities can certainly benefit from a process-oriented view.

6 CONCLUSION AND RECOMMENDATIONS

This thesis aims to answer the question to what extent business intelligence capabilities can benefit from a process-oriented view*?* There is little literature available regarding process-centric BI improvement. To address this question thirteen BI optimization projects were analysed using semi-structured interviews. Approximately 800 minutes of interviews were recorded and over 45.000 words were transcribed. Over 600 instances were coded within these interviews. To analyse the old and new BI processes 26 process maps were drawn. Based on the analysed literature, interviews and process maps two BI process maturity models were created. One regarding the execution and one regarding the improvement of BI capabilities

The empirical data suggests that the principles of lean are directly beneficial for BI processes. The focus on value, flow, consistency and the focus on the bigger picture were all identified as useful in regard to BI. A focus on reducing waste helps organizations continuously make improvements.

Following the perception of the interviewees, organizations are lacking a strategy and direction for the development of their BI capabilities. Using the created maturity model, organizations could be guided into the direction of integrated reporting solutions. The findings with regard to the improved processes represent best practices for firms that have successfully improved their BI capabilities.

Based on the findings and discussion, the conclusion of this study is that a process centric approach to BI can help organizations to align their BI activities, which leads to direct and long term improvements over the whole BI process. These improvements close the information gap, which result in more value for decision makers.

6.1 VALIDITY CONCERNS

Considering the fact that even though the interviews took approximately one hour each, the semi structured form of the interviews combined with anonymity of the participants obviously provides room for frank conversations.

Regarding external validity, the consideration should be made that the interviewees were all in a consultant role within the case they described. Meaning while they did have excellent knowledge regarding the issues within the discussed organization and all have a brought range of experience, they could possibly be slightly biased regarding the success of their projects.

Considering internal validity, the discussed cases could have been investigated more vigorously by including multiple viewpoints on the discussed cases, while this does require more time and resources. However the current approach allowed this research, given the time constraints into account, to consider multiple cases and enables it to generalize the findings as a result.

6.2 RECOMMENDATIONS FOR PRACTICE

Organizations should adapt a process-centric approach towards BI. They can use the five lean BI principles, customer value, see the whole picture, iterate quickly, reduce variation and pursue perfection, as a guideline for focus points on where to improve their processes. Next to theses focus points organizations should spend effort on clearly defined targets for their BI capabilities. Where do want to be in 6 months from now? Which parts of our reporting process is lacking? The process maturity models, which have been set up in this thesis, can act as a guidance for these questions.

6.3 RECOMMENDATIONS FOR FUTURE RESEARCH

Future research could focus on further evaluating the maturity model created within this thesis. It would be interesting to gain deeper knowledge on the specific steps required to reach higher levels within the maturity model. Additionally, a case study directly following a process-centric BI improvement project could bring new insights regarding the topics discussed in this thesis.

This thesis focusses mostly on the improvement of processes within BI, through lean methods. Another important aspect of lean are the ideas regarding the development of people and culture, in order to drive out waste. This is an aspect of lean which is not touched within this research and would be an interesting topic for future research on lean BI.

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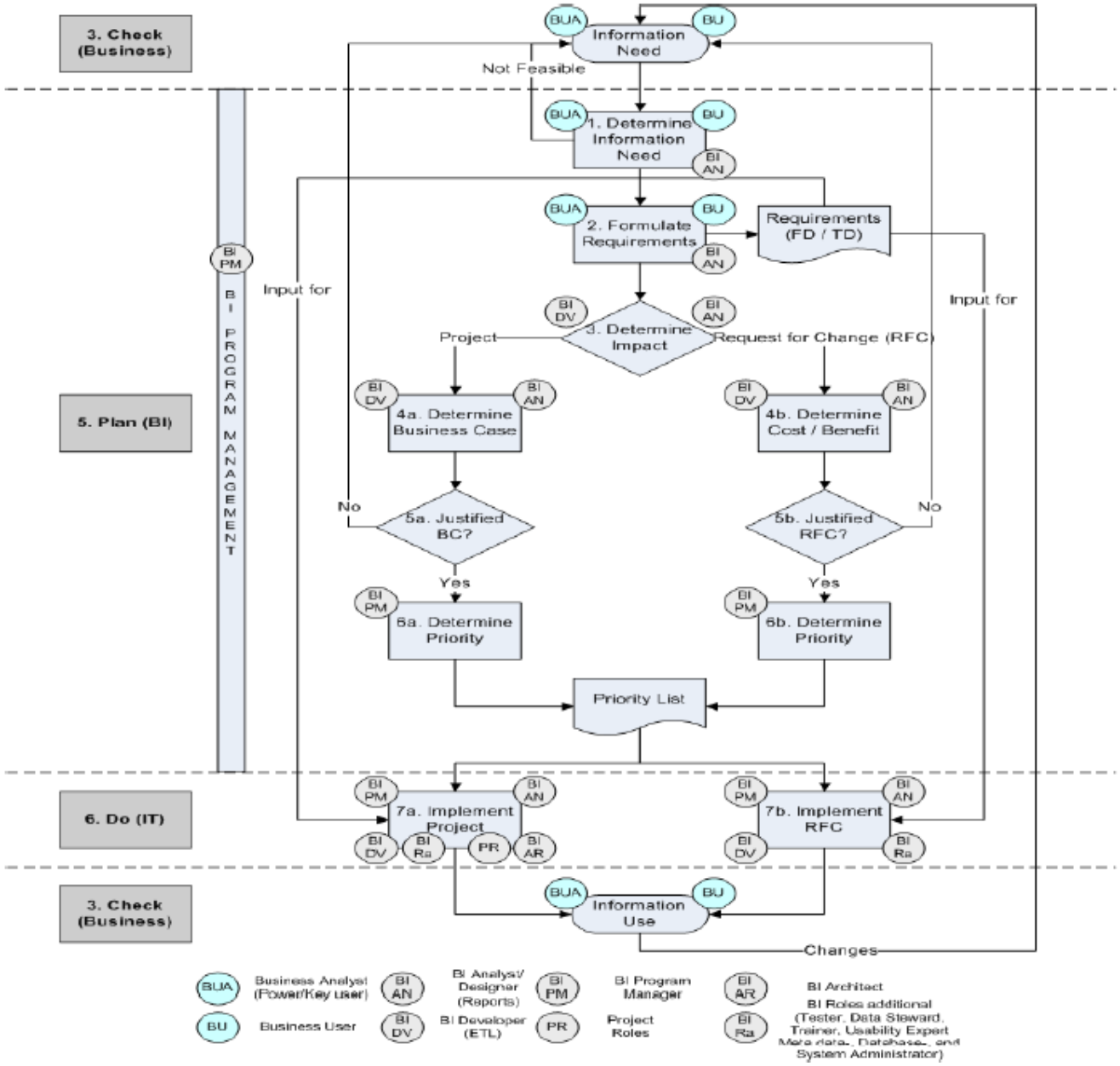
8 APPENDIX

8.1 APPENDIX I – BI FRAMEWORK

Appendix 1 presents the flowchart as the visual expression of the integrative BI framework, introduced by Dekkers et al. (2007). Followed by a detailed description of the model elements given by the authors, which is based on http://www.cs.uu.nl/groups/OI/Bled/BI_framework_details.pdf.



Description of the BI-Framework

Activities and BI roles

1 **Determine information needs** by business user, business analyst, and BI analyst/designer.

- The purpose of BI is to provide cross-organizational business analysis capabilities to all business users in the organization. Demand for information comes from various business users located within different functional departments.
- BI analyst/designer gather and specify the information needs coming from business users. The determination of information needs can be very difficult and challenging and therefore business users need guidance. Determining the information needs is in practice also harder to structure than other phases of the BI process. The BI analyst/designer support the business users in determining and specifying their information needs.
- A demand for information might not be feasible due to the complexity and size of the information need, the required development time, the authority of the business user, or the data is not available.

2 **Formulate Requirements by business** user, business analyst, and BI analyst/designer.

- When the information needs are specified, the second step is to determine what is required to satisfy the demand for information. This step entails identifying the required data and data sources, formulating the functional and technical requirements.
- The functional requirements consist of which types of information are required including a definition, description and reasoning for which business users the reports are developed. The technical requirements consist of how the reports have to be developed, including required data, data sources and the architecture of the BI system.
- The requirements are documented into a functional and technical design that needs to be validated by the business users to assure agreement on what needs to be developed.

3 **Determine Impact** by BI analyst/designer, and BI developer.

- When the functional and technical design is validated, the third step is to determine the impact of the reports as they differ in development time and impact on the required architecture. The BI analyst/designer and BI developer, based on the functional and technical design, determine the required activities and effort (time and costs) to develop the reports for business users.
- The two categories used for determining the impact and classifying development efforts are *Request for Change* (RFC) and a *project*. The categories are based on and extracted of Prince2 and IT Service Management theories. The distinguishing factors are difference in scope, size of the required efforts and the number of people involved. A project has a broader scope, requires more development time and has more impact on the architecture and infrastructure than a RFC. For a project also a formal project organization including steering committee, project manager and project team needs to be set up. A RFC is a formal request to change or extend existing reports. At the end of this step, the reports to be developed are categorized into Projects and RFC's.
- The succeeding steps are similar but treated separately due to extend, size and level of detail in which they are performed, and the number of people involved. No boundary line is provided to distinguish between a RFC and Project.

4 **Determine Business Case or Cost/Benefit** by BI analyst/designer, and BI developer.

- In this step, for a Project and an RFC, the required information justifying the development and implementation is identified. It is important to show a balance between the costs involved and the benefits gained.
- The benefits of having the reports and information has to be expressed in measurable quantities for instance, increased revenue, profit, customer satisfaction, gained market share and costs savings. The costs of software, hardware and labour of implementation and development have to be estimated.

5 **Justified Business Case or RFC?** By BI Program manager

- Once the benefits and costs are defined, the next step is to compare them and provide a justification. Based on the required development time/costs weighed against the expected benefits, a decision should be made whether or not a project and RFC is justified and should be implemented.
- If the investment of the project and RFC can be justified and/or is authorized (YES), the next step is to determine its priority. However, if the business case is negative, cannot be justified or is not authorized (NO), the RFC and project will not be implemented. In this case, the reports are not developed and thus the information needs of business users are not answered.

6 **Determine Priority** by BI program manager.

- Demand for information will come from various business users. Therefore, all the different types of information needs have to be listed and prioritised which is not an easy task because departmental differences and cross-departmental politics must be reconciled and resolved.
- One of the risks of BI activities is the lack of prioritisation and coordination of BI development activities. Therefore, analyse and prioritise the different information needs coming from various business users within the organization.
- After this step, the different justified BI projects and RFC's are prioritized. The output of this step is a list with an overview of the RFC's and projects to be implemented. To keep a good overview of the BI activities the two categories have to be combined. This improves the allocation of people and resources.
- The RFC's and projects can also have dependencies regarding used data, data sources, problems and required information. The priority list contains a planning for the execution of the RFC's/projects and used to monitor and control the development progress.

7 **Implement Project or RFC** by BI program manager, BI analyst/designer, BI developer, and additional BI and project roles.

- Based on the priority list, the functional and technical design and their dependences the projects and RFC are implemented. The research focused on the coordination and communicating between the business users and the IT organization and therefore the technical aspects, like the actual BI architecture, actual implementation was considered out of scope.
- After implementation, the reports and information is made available to business users and can be used to assess the performance of the organization. Due to changing environments and the use of information, the information needs of business users change which leads to a new demand for information.

Program Management. The vertical bar in the framework represents BI program management, which is an integral approach to better plan and coordinate BI activities (Den Hamer, 2005). BI program management represents:

- aligning the BI activities with the strategy of the organization,
- promoting the value and benefits of BI to the organization,
- reconciling and solving departmental differences and politics,
- planning and allocating BI people and resources,
- standardising and stimulating the use of BI tools, templates, models and definitions,
- creating a common set of best practices, policies and governance rules for the organization,
- defining and monitoring the required BI architecture and infrastructure,
- deploying initiatives to monitor and improve data quality,
- managing vendor relations and licensing,
- executing change management to change the way in which information is valued and applied.

8.2 APPENDIX II – INTERVIEW QUESTIONS

General questions:

1 What is your role and responsibility within your organization?

2 How long are you in your current position and within your organization itself?

3 What is your current assignment?

4 What is your experience with Business Intelligence (BI) & BI Governance?

5 In what way were you involved in improving BI processes?

Old process

6 Can you describe to me, step by step, what the old BI process looked like before the improvement project?

7 What were the main challenges/inefficiencies of the old BI process?

8 Was the process measured using specific metrics? If yes, which metrics were used?

9 To what extend would you call the old BI process standardized?

New Process

10 Can you describe to me, step by step, what the new BI process looked like after the improvement project?

11 Can you describe the advantages of the new BI process to me?

12 Are you satisfied with the new process, are there remaining challenges/inefficiencies?

13 Is the process measured using specific metrics? If yes, which metrics are used?

14 To what extend would you call the new BI process standardized?

Improvement project

15 Can you describe to me, step by step, how to improvement project looked like?

16 What were the main challenges during the improvement project?

17 Which stakeholders were involved during the improvement project?

18 Did you use a specific methods for the improvement project?

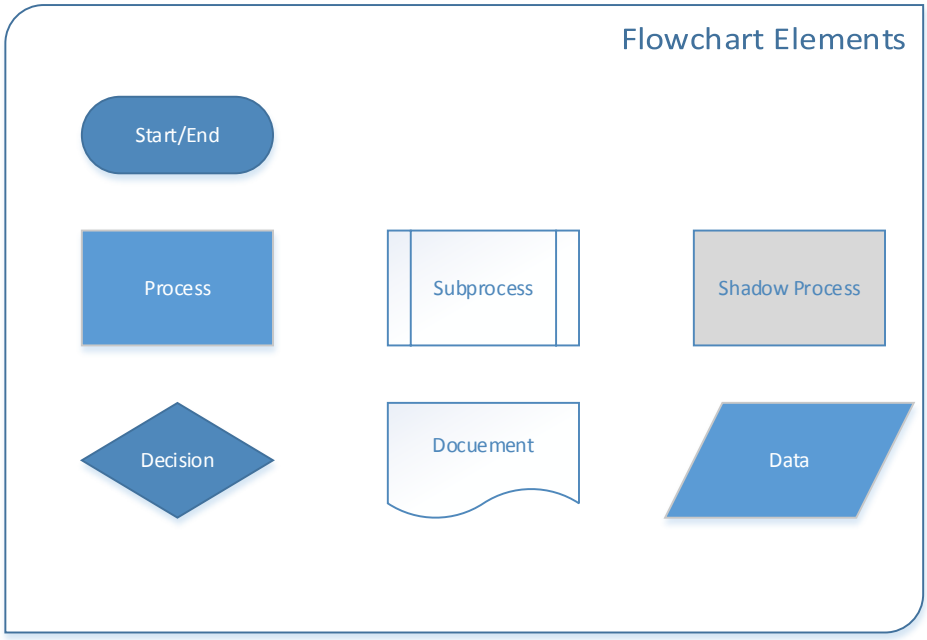
Feedback

19 Do you have any feedback on this interview?

20 Can I contact you for any follow-up questions on your answers?

8.3 APPENDIX III – PROCESS MODELS

In the following appendix the process models are visualized per interview for comparison between the old and the new processes. First the reporting processes (Organization B, C, F, H & J) are displayed, followed by the BI change processes (Organization A, D, E, G, I, K, L & M).



Abbreviations

BICC = Business Intelligence Competency Centre

MI = Management Information

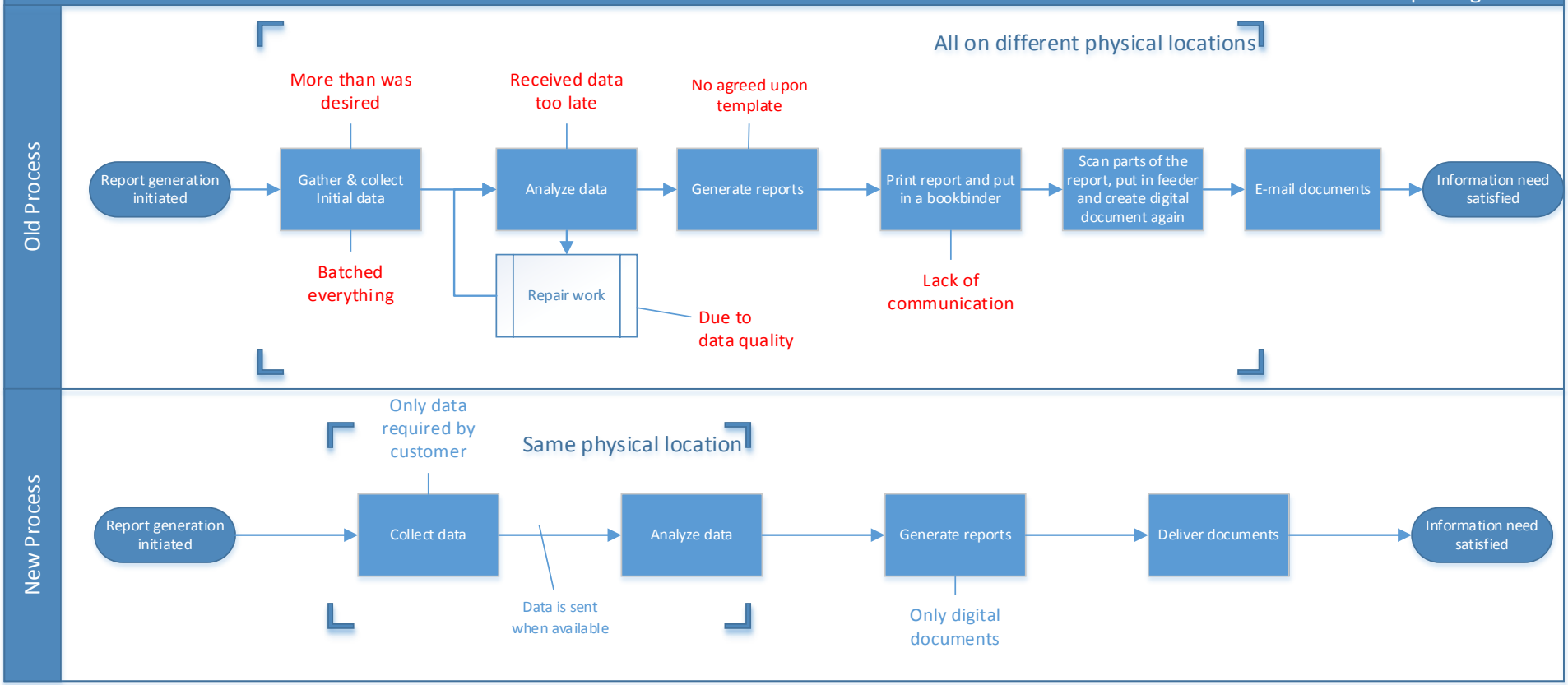
SD = Service Desk

CAB = Change Advisory Board

SG = Steering Group

Organization B – Financial Industry, Private sector

Reporting Process



Issues

- Data quality
- Silo thinking
- Lead time was too long
- Many workarounds/rework
- Process only defined on a high level
- Poorly designed process
- Lack of communication
- Non-value creating activities

Solutions

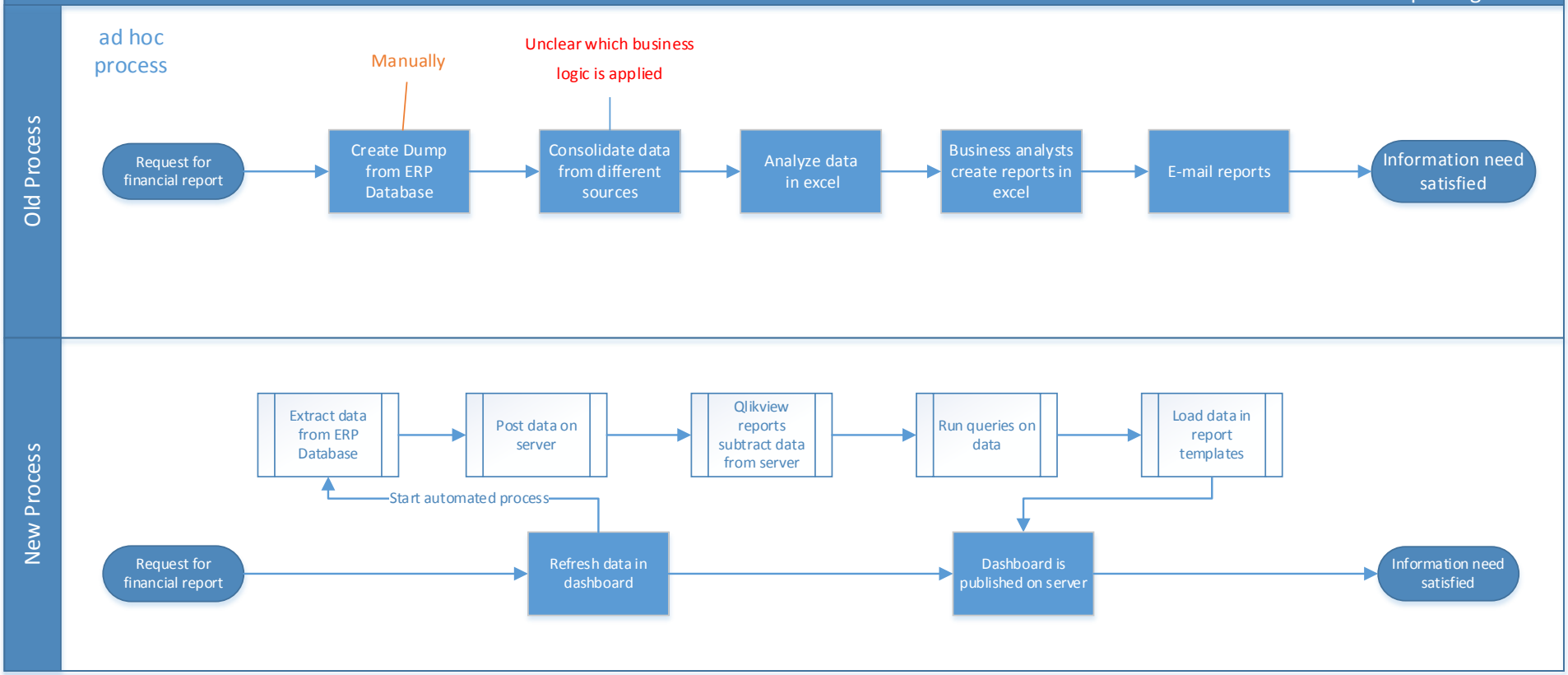
- Voice of the customer analysis
- Kano analysis
- Remove a lot of unnecessary data which was not required
- Removing a lot of transport, waiting, rework and overproduction
- Spread workload
- Create common vision on process

Benefits

- Increased visibility & awareness which led to more collaboration
- Cycle time decreased with 40%
- More value creating activities
- Clearly defined process

Organization C – Government, Public Sector

Reporting Process



Issues

- Data quality
- Lack of alignment with corporate strategy
- Lack of vision
- Excessive amount of reports
- Lack of proper tooling
- Business doesn't see impact on IT
- Shadow processes

Solutions

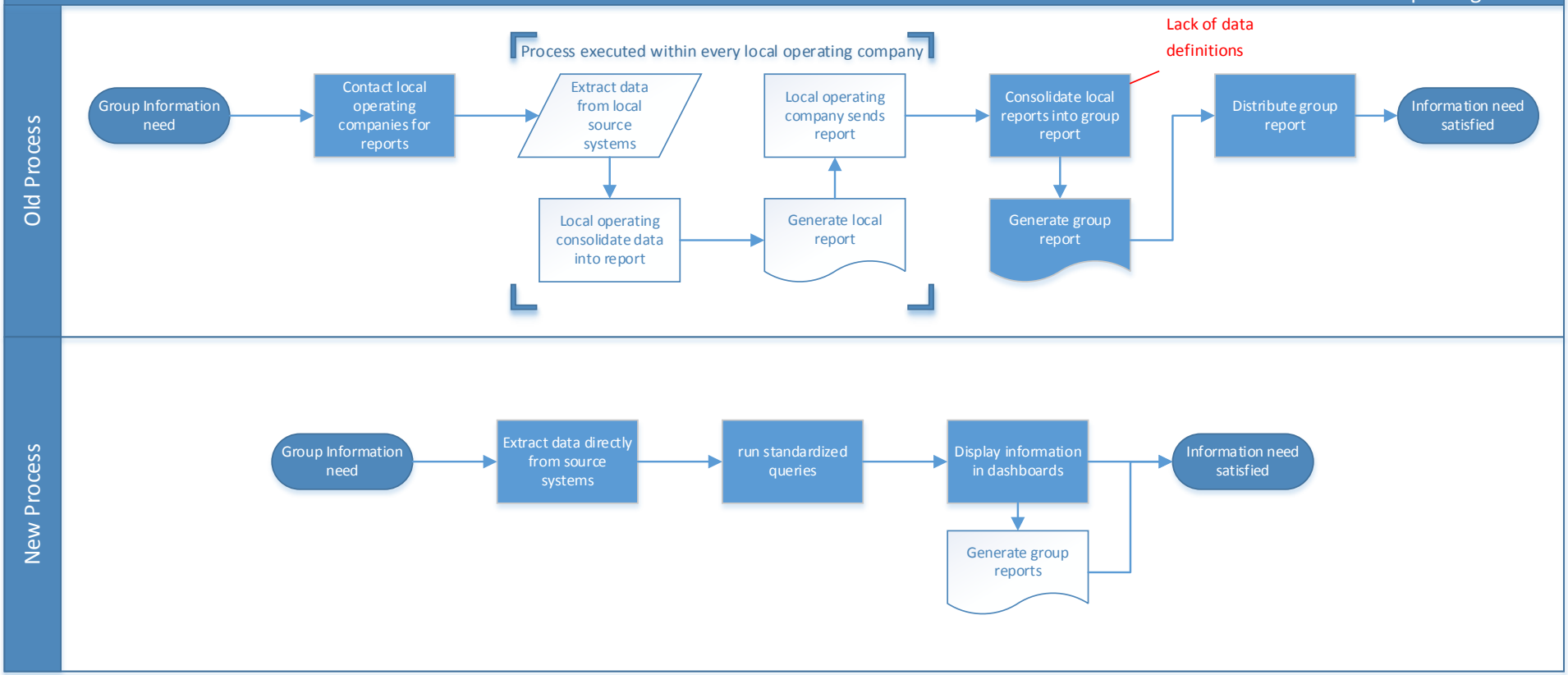
- Automate manual handlings
- Put report usage checks in place
- Standardize data definitions in reports and backend systems
- Define master sources of data
- Create reusable reporting templates

Benefits

- Improved data quality
- Reduced amount of unused reports
- Improved processing time
- Less manual labor required
- Less prone to error

Organization F – Consumer Products, Private Sector

Reporting Process



Issues

- Local, unstandardized reports
- Manual work required for consolidation
- Way of working is prone to errors
- Generation of reports take too long

Solutions

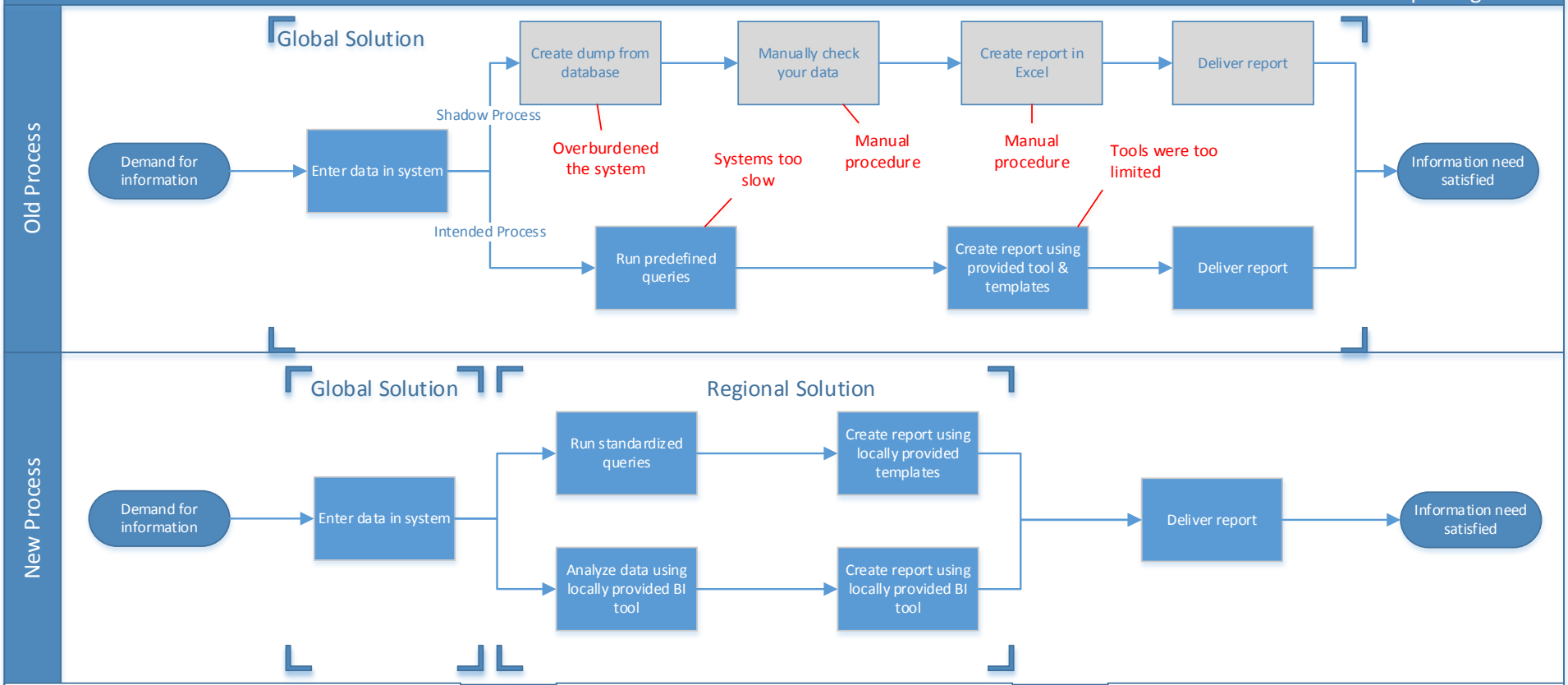
- Create common data definitions
- Extract data directly from local source systems
- Create reusable reporting templates
- The solution has to benefit the local operating companies as well.

Benefits

- Increased data quality
- Elimination of manual exercises
- Decreased cycle & processing time
- More time for value creating activities
- Data is more up to date

Organization H – Professional Services, Private Sector

Reporting Process



Issues

- Shadow processes
- Manual/Ad Hoc report building
- Lack of education
- Technical issues
- Extensive maintenance
- Lack of trust
- Lack of business involvement

Solutions

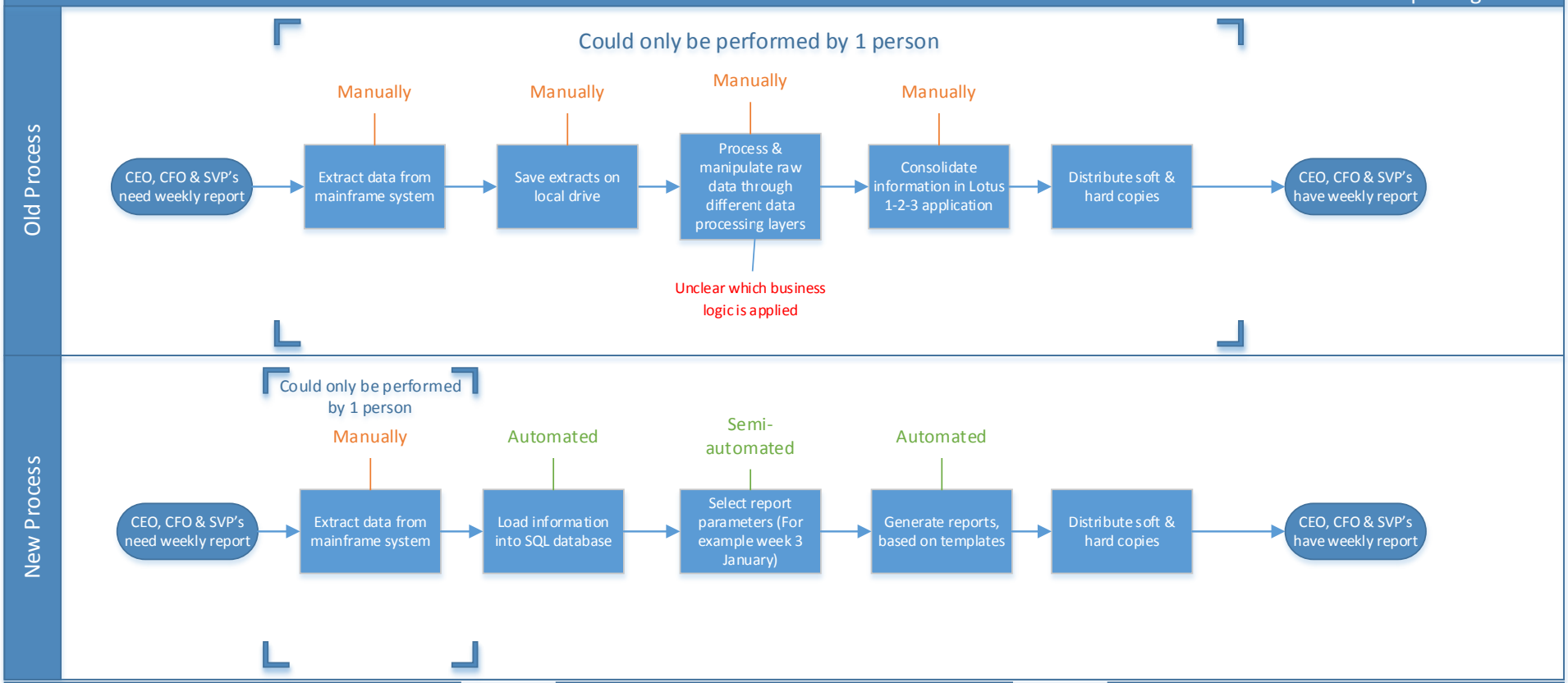
- Regional delivery centers
- Locally optimized BI tools
- Educate users
- Involve business in development phase
- Create project steering board
- Implementing SAP HANA

Benefits

- Increased flexibility
- Increased trust from users in reports
- Increased stability
- Increased speed

Organization J – Consumer Products, Private Sector

Reporting Process



Issues

- Data Quality
- Dependency/Risk
- Information strategy alignment
- Inefficiencies
- Manual procedures & lack of documentation
- Legacy applications used
- No audit trail on reporting data

Solutions

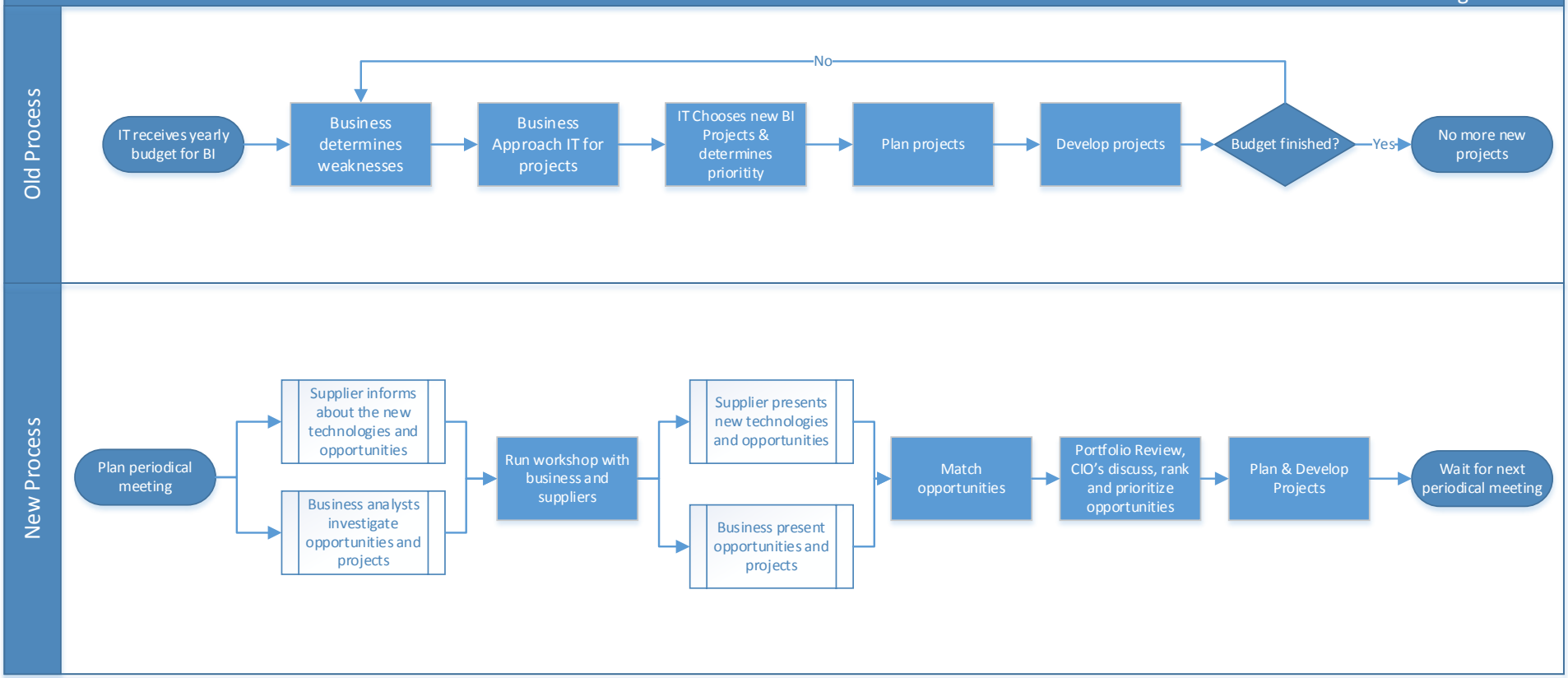
- Eliminate legacy application
- Simplify process
- Create reusable reporting templates
- Transfer knowledge
- More transparent view on applied business rules

Benefits

- Increased data quality
- Environment is more future proof
- Decreased processing time
- Increased flexibility
- Decreased dependency on a single person
- Instilled a more analytical culture
- Less variation

Organization A – Oil & Gas Industry, Private Sector

Change Process



Issues

- Lack of innovative projects
- Lack of alignment with the information strategy
- Too Expensive
- Lack of vision

Solutions

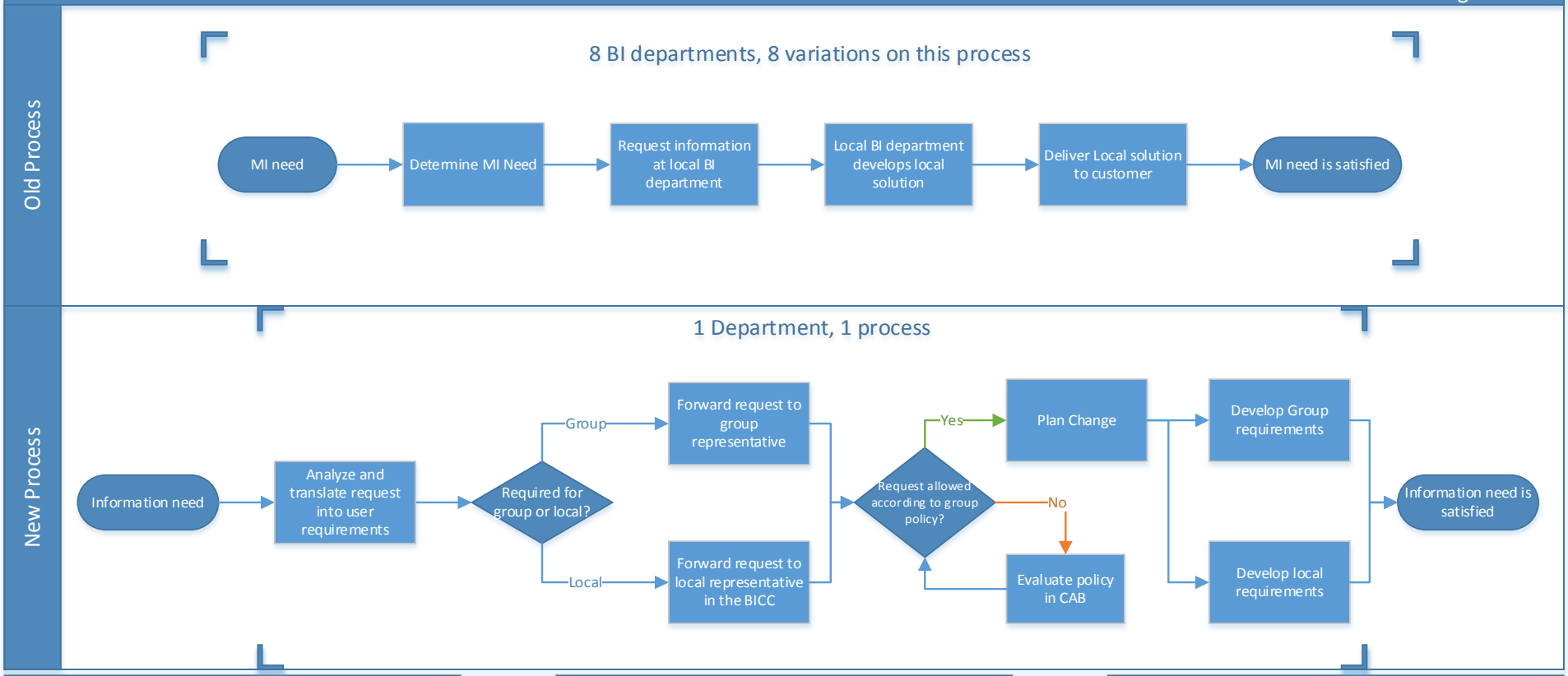
- Business value network, bring the business directly in contact with the supplier
- Portfolio review
- Focus on strategy instead of budget

Benefits

- Increased innovation
- Increased number of value creating activities
- Faster implementations of new technologies
- Improved control over portfolio
- Increased collaboration

Organization D – Chemicals, Private Sector

Change Process



Issues

- Excessive amount of tools
- Proliferation of BI Tools
- Lack of control over BI Portfolio
- Lack of data definitions
- Lack of standardization

Solutions

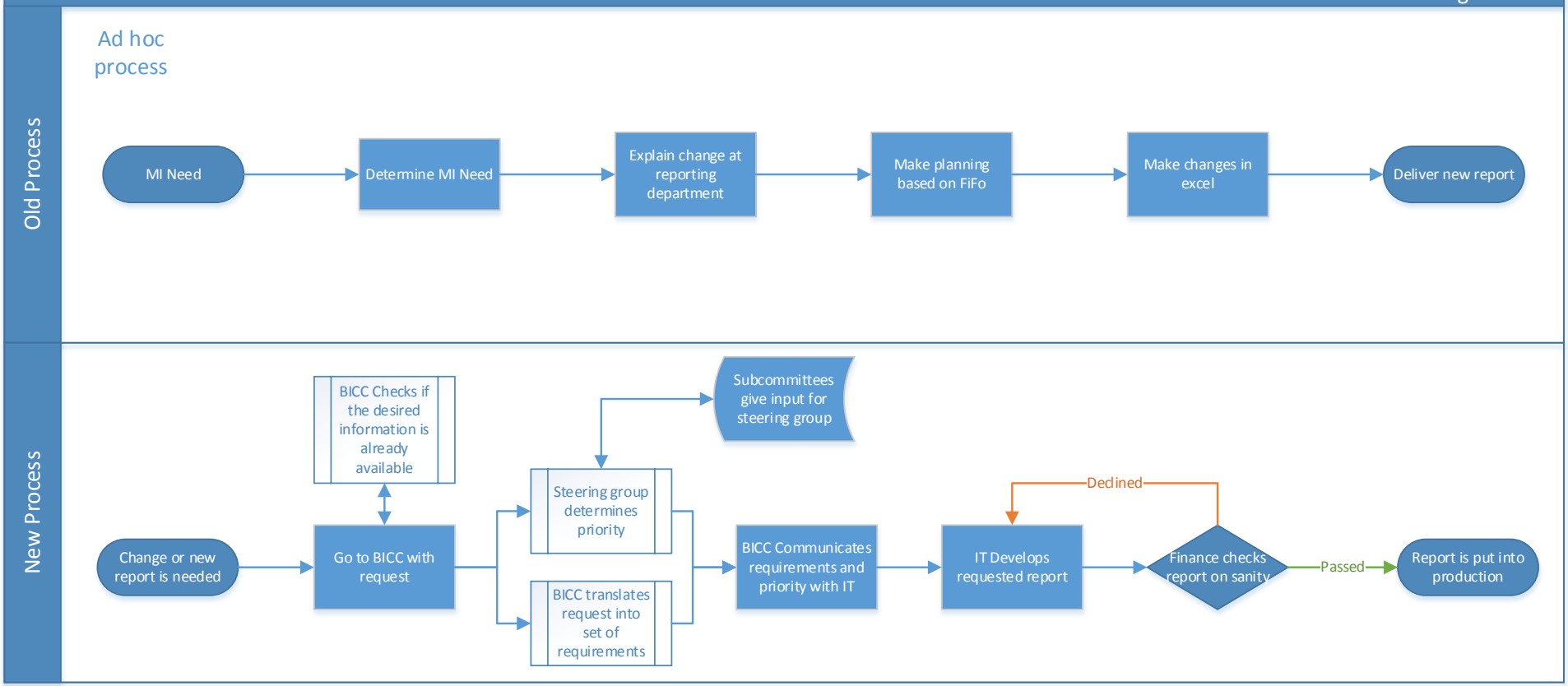
- Standardized definitions
- 1 Group BI department, (virtual competence team)
- Local representatives
- Standardized tooling
- Standardized group reports
- Room for local variations on reports
- Clearly defined policies

Benefits

- Reduced number of redundant reports & tools
- Cost reduction for creating new reports
- Access to increased capabilities for local departments
- Less effort for consolidating different data sources

Organization E – Infrastructure, Semi-Public Sector

Change Process



Issues

- Data quality
- Data definitions
- Ad hoc/manual work
- No clear responsibilities
- No trust in reports
- No alignment with IT strategy
- Lack of technical knowledge

Solutions

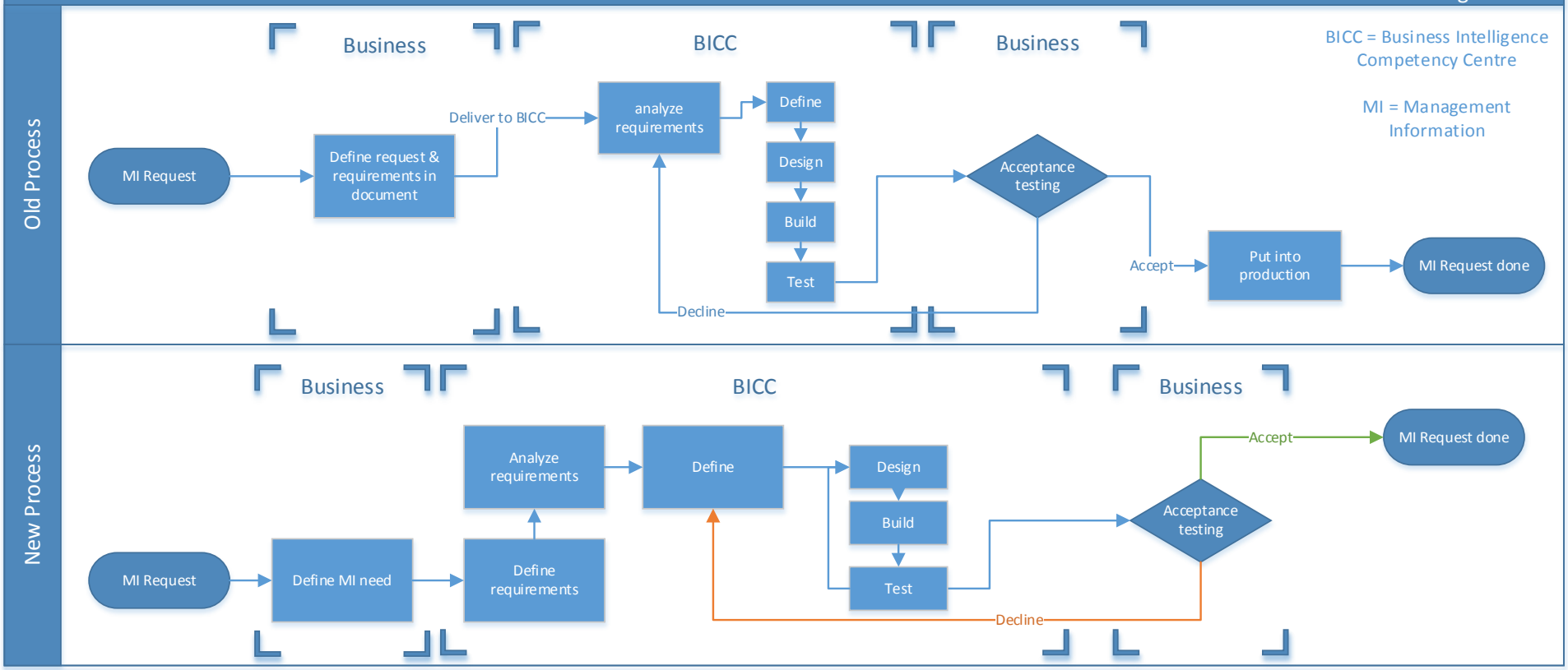
- Create governance model
- IT, Finance & business combined in a BICC
- Quality checks
- Reduce manual proceedings

Benefits

- Clear responsibilities
- Awareness of data quality
- Awareness of organizational structure
- More transparent process

Organization G – Banking, Private Sector

Change Process



Issues

- BICC too IT minded
- BICC not sociable enough
- BICC lacks visibility
- New reports took too long to develop
- Business skips IT & hires consultants
- Little collaboration between I T & Business

Solutions

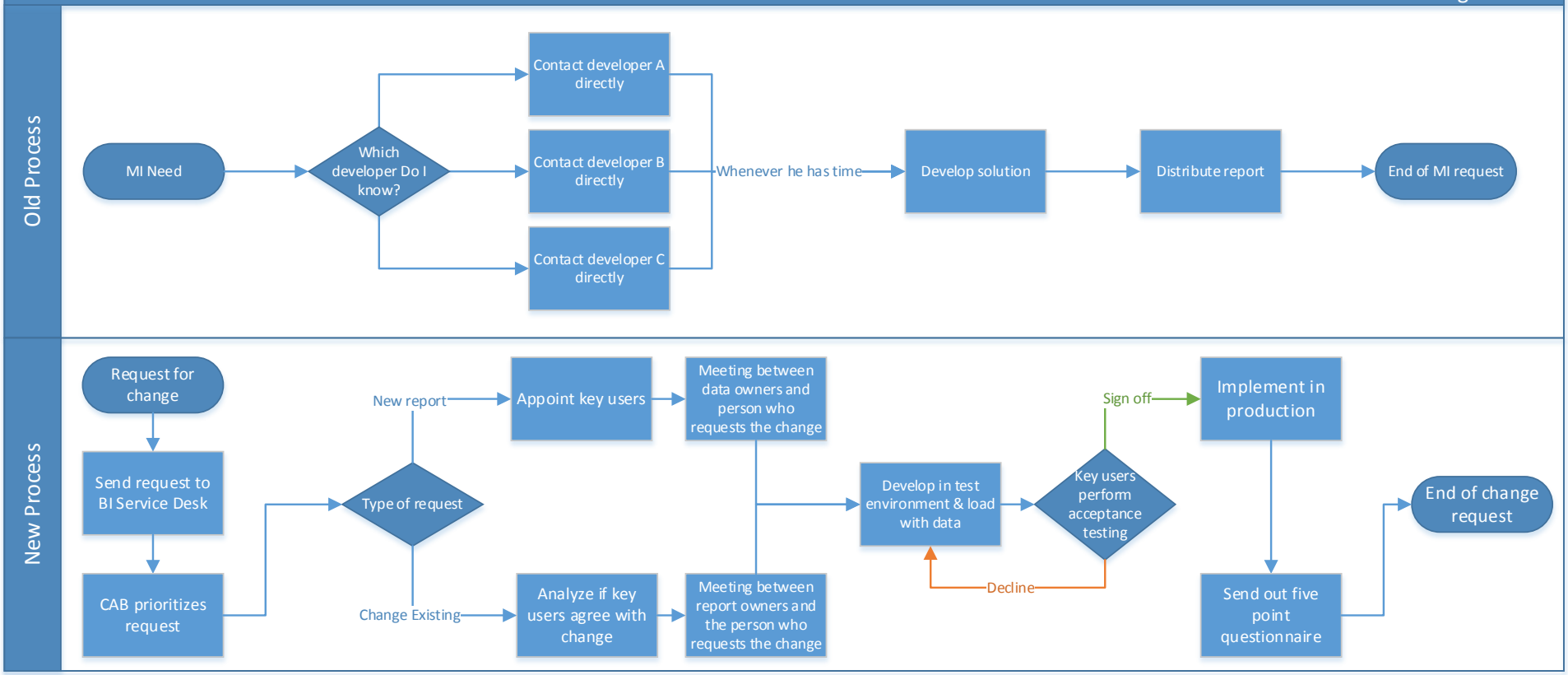
- Add business knowledge to BICC
- Introduce agile way of working
- Spend extra effort on getting requirements clear
- Early prototypes

Benefits

- Business is more visible for BICC
- BICC is more visible for the business
- Ability to handle changing requirements
- Increased trust in BICC
- Quicker results for business leads to more involvement from the business

Organization I – Electricity, Private Sector

Change Process



Issues

- Shadow processes
- BI department was not in charge
- No structured way of implementing change
- No structured way of reporting
- Lack of knowledge within BI department
- Unrealistic business expectations
- Lack of standardization/definitions
- Excessive number of reports
- Lack of data integration

Solutions

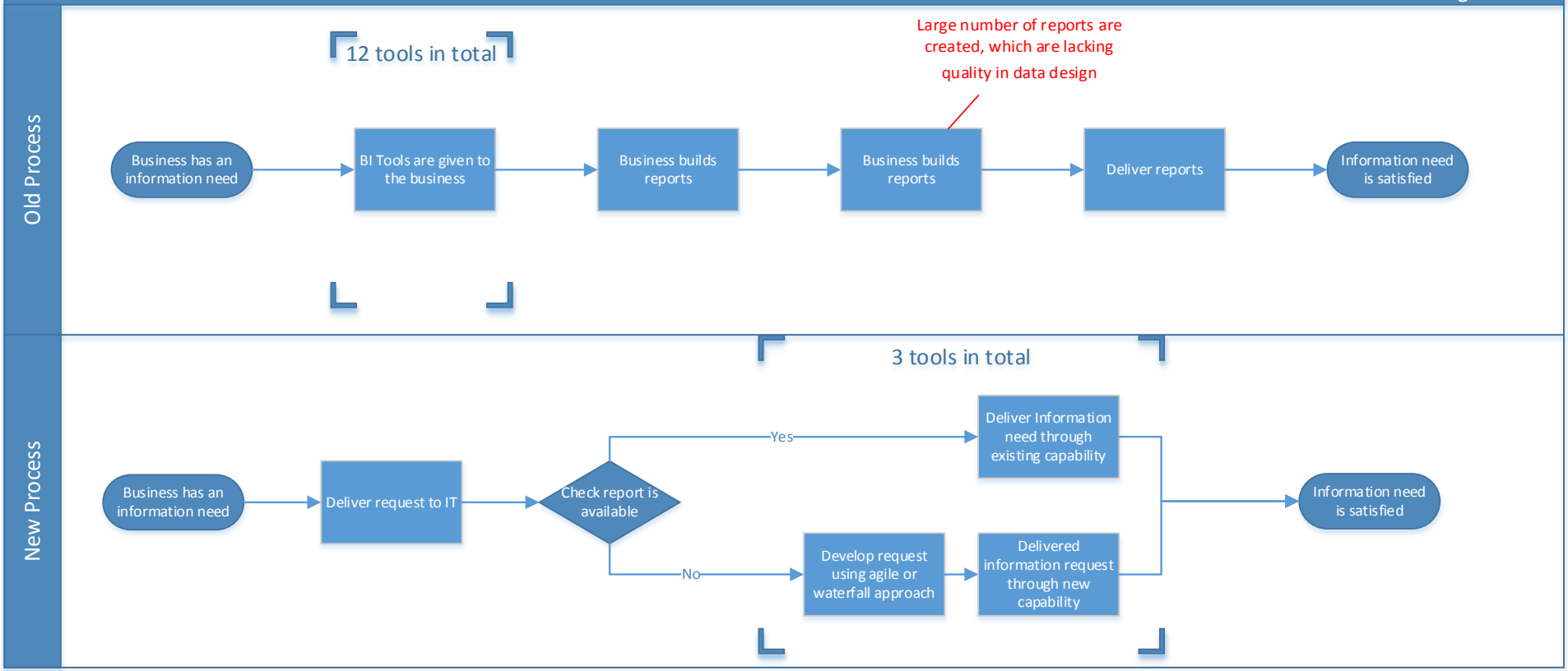
- Create structured (change) processes
- Website for tracking change process
- Force common definitions
- Train BI employees
- Measure individual steps in process through time metrics
- Measure user satisfaction
- Central point of contact (Service Desk)

Benefits

- Increased data quality
- Less variation in process output
- Decreased cycle time
- Increased control
- Decreased dependency
- More value creating activities
- Increased expectation management

Organization K – Automotive Industry, Private Sector

Change Process



Issues

- Excessive amount of tools, reports & licenses
- Dependency on individuals for reports
- Lack of traceability
- Lack of maintenance
- Badly designed reports (queries of mass destruction)
- Lack of control over BI Portfolio

Solutions

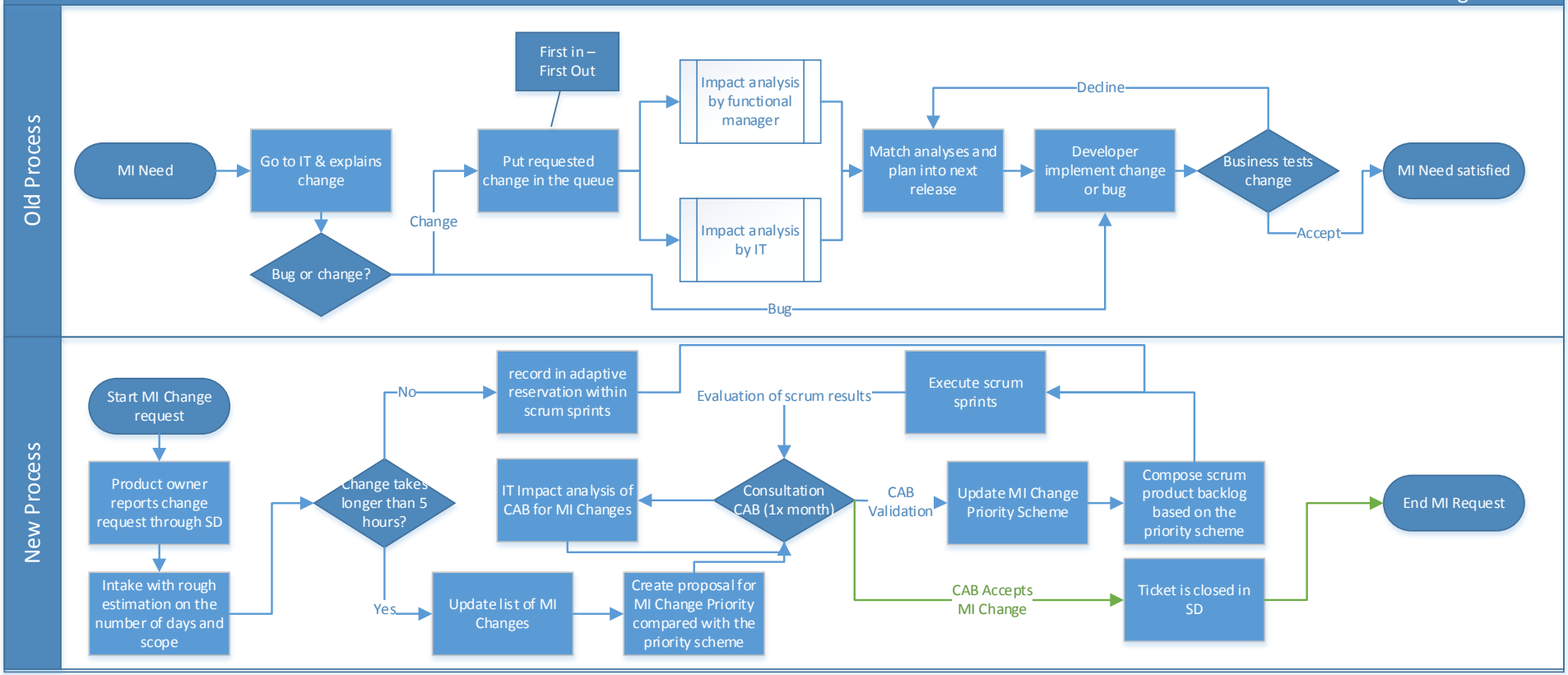
- Bring IT back in control
- Use the agile approach
- Analyze report usage
- Reduce number of tools, reports & licenses
- Nemawashi
- Standardization

Benefits

- Significant cost reduction
- Reduced number of redundant reports
- Overburdening reports reduced, freed up a huge amount of batch time on the mainframe

Organization L – Geography, (Semi) Public

Change Process



Issues

- Changes took too long (6 months on average)
- Large pool of projects
- Lack of measuring prioritization
- Analyses were too high
- Changes were planned too late
- Business does not see impact on IT
- Lack of knowledge
- Silo Thinking
- Poor testing
- Switching resources too often

Solutions

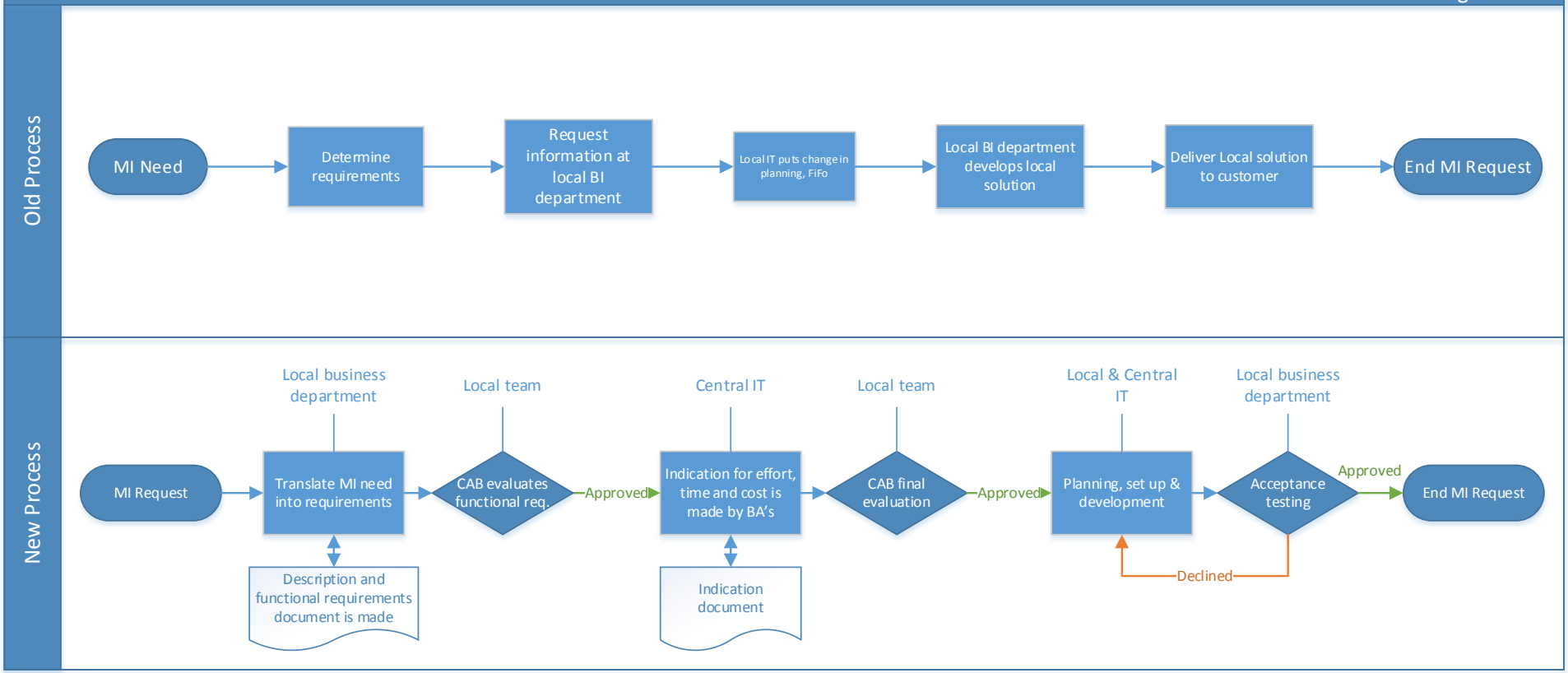
- Set up change advisory board
- Align way of working with the rest of the organization
- Scrum cycles
- Standardization of portfolio/change management process

Benefits

- Extremely reduced cycle time
- More transparent way of working and communicating
- More involvement from & increased awareness of the business
- Improved portfolio management
- Less variation

Organization M – Information Technology, Private Sector

Change Process



Issues

- Data quality
- Cost allocation
- Silo thinking
- Prioritization between requests of different countries

Solutions

- Central data definitions
- Structured Process
- Change authority board (CAB)
- Pre-defined documents

Benefits

- Better business insights
- Clear responsibilities
- Less variation
- Improved cost allocation

8.4 APPENDIX IV – CODEBOOK

Codes used in results and discussion section.

Code	*Sub-category*	Sources	References	Description
Benefits		13	57	Benefits of the conducted projects
Organization		8	17	Organizational and cultural improvements
Better Business Insights		3	6	Better insights regarding the performance of the business through improved BI capabilities.
	Accountability	1	1	Employees can be held accountable for their results by reports
	Increased Data Quality	4	4	Data quality is improved, regarding its completeness, validity and reliability.
Clear Responsibilities		1	1	The responsibilities were clear within the organization
Improved Portfolio Management		4	5	Portfolio management is decreased
	Decreased number Redundant Reports	2	2	The number of redundant reports was reduced,
	Faster Implementations	1	1	Innovations are earlier implemented
Increased Control		2	2	The organization gains more control over their BI process.
Increased Enthusiasm		1	1	There is more enthusiasm regarding the BI capabilities of the organization.
More Involvement From Business		2	2	The Business is more involved in BI projects
Process		13	36	Improvements related to the BI process
Decreased cycle or processing time		6	8	
	Decreased Cycle Time	4	4	The cycle time is decreased.
	Decreased Processing Time	4	6	The processing time is decreased

Code	*Sub-category*	Sources	References	Description
Decreased Costs		2	2	Cost of the entire BI operation is decreased
Decreased Dependency		1	1	Dependency on specific persons is decreased
Increased awareness & collaboration		9	15	Visibility & Awareness within the organization is increased. Actors in the process have a better understanding of the effects of their actions on the process,
Increased Flexibility		1	1	Improvements related to increased flexibility of the BI environment.
Less Variations		1	1	Variations were decreased
More Value Creating Activities		5	8	Employees can spend more time on value creating activities.
Technology		3	4	Technology related improvements
Clear Definitions		2	3	Clear definitions which are agreed upon within the organization.
Increased Innovation		1	1	The BI organization is more able to innovate.

Code	*Sub-category*	Sources	References	Description
Challenges		**13**	**122**	**Issues and challenges organizations faced regarding their BI capabilities.**
Organization		**9**	**33**	**Organization related issues**
Business Doesn't See Impact		3	6	The business does not see what impact their actions have on the IT organization.
Business Not Involved		4	5	The business is not involved in the BI process
	Ice Berg	1	1	The invisible layers in reporting are often neglected by the business
	Skeptical About IT	1	1	The business is skeptical about IT
Business Is In Control		2	4	The business is in control over the BI process
Cost Allocation		2	2	Business units get disagreements about cost allocation
Immature Organization		2	2	The organization is immature
	Too Expensive	2	4	The BI solution a business unit requires is too expensive.
Lack Of Definitions		3	3	Lack of data definition alignment across the organization
Lack Of Knowledge Or Capabilities		5	11	Overall lack of required skills for BI within the organization
	Lack of Knowledge Transfer	1	1	Knowledge about build reports is not transferred
Process		**13**	**51**	**Process related issues**
Collaboration		8	14	Departments only take their own department into account. They don't focus on the rest of the chain. Silo Thinking
Dependency		4	8	The process is too dependent on certain employees.
Process Design		7	14	The process is poorly designed
	Ad hoc processes	4	5	Unstructured Processes
	No clearly defined customer of process	1	1	
	No Business In BICC	1	1	The business side is not represented in the BICC
	No Clear Responsibilities	2	2	Responsibilities are not clearly defined within the (BI) organization
	Only High Level	1	2	The process was only standardized on a high level.

Code	*Sub-category*	Sources	References	Description
	Planning	1	1	Changes were planned too late in the process.
	Steps in process not aligned	1	1	
Process Execution		7	15	Issues regarding the execution of the process.
	Analyses	1	1	Analyses are incorrect, For example deliberately making too high analyses to be safe.
	Development time	4	4	The customer has to wait too long on new reports.
	Doesn't Keep Prioritization	1	1	IT doesn't comply with the prioritization made by the BICC/Steering group.
	Many Workarounds	1	1	
	Reality Differs From Theory	2	2	
	Shadow Processes	3	3	Shadow or grey processes
	Switching Resources	1	1	
	Testing	1	2	The testing process was poorly executed/designed
Strategy		**8**	**13**	**Issues regarding the alignment of information and projects to business strategy,**
Lack Of Alignment		4	5	Way of working doesn't fit with the way the organization works or the strategy of the organization
Lack Of Measuring Prioritization		1	1	
Lack Of Vision		5	6	
Too Large Steps		1	1	Organizations want to reach their ultimate goal directly instead of achieving it by taking small steps towards their target.
Technology		**9**	**25**	**Issues regarding applications and their underlying infrastructure required to deliver the right BI solutions.**
Data Management		5	10	Issues regarding the processes and organizational structure required to ensure the integrity and alignment of information.
	Data Quality	4	9	
	From Process	3	3	The logic applied to the data leads to problems regarding data quality
	From Sources	1	3	The data quality from the sources used in the BI tool/process is not up to the required level.

Code	*Sub-category*	Sources	References	Description
	Lack Of Data Integration	1	1	While data is available in different systems, this data is not integrated into their BI reports.
Excessive Amount Of Licenses		1	1	The organization has an excessive amount of licenses
Excessive Amount Of Reports		4	5	The organization has an excessive amount of reports
Excessive Amount Of Tools		3	3	The organization has an excessive amount of BI Tools
Lack Of Tooling		3	3	
No Standard Tooling		2	2	
Report Design		1	1	Reports or the underlying data models are badly designed

Code	Sources	References	Description
Waste	**13**	**92**	**Forms of waste identified in BI improvement/optimization projects.**
Waste Classic	**13**	**56**	**Wastes as defined by the TPS**
Defects	9	15	Making mistakes in the production process that results in generating reworked or scrapped products
Inventory	4	4	The build-up of excessive or unnecessary raw materials, work-in-progress (WIP), and finished products.
Motion	5	7	Unnecessary movements of workers or machines before, after or during processing. Jobs that need excessive human movement should be analyzed and redesigned to reduce the required amount of motion.
Over-processing	6	10	Extra processing steps which are not required for the customer.
Overproduction	4	6	Overproduction occurs when producing an item that is not intended for immediate use is manufactured.
Transportation	5	5	transportation waste results when material/information is moved more than is necessary
Waiting	6	9	Waiting occurs when a worker has to wait for the work to be released from another worker, another manufacturing process, or for material to be delivered
Wastes IM	**11**	**36**	**Wastes in Information Management**
Failure Demand	6	8	The resources and activities that are necessary to overcome a lack of information. This may include generating new information and/or acquiring additional information.
Flawed Flow	9	15	Includes the resources and activities that are necessary to correct or verify information. It also includes the unnecessary or inappropriate activities that result from its use.
Flow Demand	2	3	Concerns the time and resources spent trying to identify the information elements that need to flow.
Flow Excess	4	10	Relates to the time and the resources that are necessary to overcome excessive information.

8.5 APPENDIX V – RAW INTERVIEW TRANSCRIPTIONS

This part of the appendix is delivered separately.