Universiteit Leiden

ICT in Business

Best practices in Agile software development

A qualitative study on how organizations identify, analyze, improve, represent and document (best) practices to improve their software development processes.

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MASTER'S THESIS

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Acknowledgements

Index

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If we see an organization doing well, we want to reproduce the success; if we see one doing poorly, we want to prevent failure (Pentland, 1999).

1 Introduction

1.1 Preface

Agile software development organizations use (best) practices -also called good practices- to process their work more efficiently during the execution phase of a project.

A commonly used methodology to process software development projects is the waterfall methodology, which was introduced by Royce (1970). This traditional method uses rigid procedures and requires deep and precise plan driven approach. Over the years the waterfall method has been criticized, because the characteristics of this method are not suitable for software development processes. This is because the traditional plan driven waterfall methodology lacks the flexibility a software development process needs in order to and therefore it is not suitable to dynamically adjust these processes (Drowns, 2005). Research has shown that cross-functional teams enhance the product development success rate and that these teams are more effective when team members have various backgrounds and perspectives and are facilitated by a collective structure and processes (Shum & Lin, 2007; Dougherty & Hardy, 1996). As a reaction to the criticism of the waterfall methods, lightweight Agile software development methods like Scrum, Crystal Clear, Extreme programming and Dynamic System Development Method, evolved around 1995. By introducing these methods, a new approach for software development practices was industrialized (Vlaanderen, Jansen, Brinkkemper, & Jaspers, 2011).

Agile software development methods consist of (best) practices that practitioners can use. However, because this whole community is rapidly evolving and most organizations use short development iterations, it is difficult to find time to choose the most effectively best practices were they can benefit from. In addition, when organizations use successful practices, they want to share this success by documenting them for the use of knowledge sharing.

1.2 Problem domain

Although widely applied in practice and discussed in scientific literature, there is currently little research on how Agile practices can be identified, analyzed, improved, documented and represented in an appropriate manner. Generally, "processes are designed to standardize people to the organization, while Agile processes are designed to capitalize on each individual and each team's unique strengths" (Cockburn & Highsmith, 2001). Agile software development focuses on skills of individuals, which operate together in an group as self-organized teams (Cockburn & Highsmith, Agile Software Development: The People Factor, 2001).

While Agile practitioners want to keep the process flexibility and do not want to develop a waterfall method "v2.0", there is currently not much research conducted on how to coach Agile software teams (and projects). Coaches apply practices like textual descriptions, games and abstract visualizations to explain the Agile methods on a high level. In addition, Agile project teams use practices, like stand up meetings and burn-down charts for the development of their software product.

Because there are many practices, it is difficult to say which practice adds value to which process and which practice should we avoid using. In addition, it is necessary to know which information should be extracted and how should we document this information when these practices are executed, so that we can learn from it and use this knowledge to be able to work more efficient and more effectively. This lack of a common notation makes the implementation of Agile practices for organizations and teams tricky en difficult to coach.

1.3   Research objective

The objective of this research consists of two parts. The first part consist of a literature study where we will examine how (best) practices can defined, what organizational routines are and how we can identify, analyze and represent (best) practices in general. The second part consists of case studies and a cross-case analyses where we will examine how organizations identify, analyze, improve document and represent their practices. The results of this research are meant for process coaches and organizations to support their coaching activities and deal with (best) practices in an accessible and complete manner.

Based on the research objective we defined the following research question:

How organizations, employing Agile software development practices, identify, analyze, improve, represent and document (best) practices in an accessible and sufficient manner?

1.4   Scope and delineation

Currently, the most commonly used Agile method is Scrum. Each Agile method describes its own roles, artifacts and processes. To ensure that the research results correspond to equivalent roles, artifacts and processes, we choose to focus on organizations using Scrum.

Agile software development is an iterative process were self-organized teams divide the responsibilities within a project. Therefore it is difficult for an organization to control (or coach) these projects or team-members. Our goal is to visualize the processes based on narratives. We do not investigate antecedents or consequences of the patterns and processes we observe.

Many software development organizations use waterfall- and Agile methods simultaneously to while accomplishing a project. This research will mainly focus on Agile team practices which are related to software develop processes. Therefore we will not focus on practices that are used within a waterfall method.

This research will mainly focus on how organizations cope with (best) practices. Therefore we will not investigate the contents or meaning of all practices specifically.

2 Literature study

Subsection 2.1 describes the differences between the Agile software development process and Project management process. In addition, it describes the most commonly used Agile practices, development methods and the Agile Scrum method in detail. Subsection 2.2 describes the subject's organizational routines and best practices and subsection 2.3 describes methods to identify practices. Subsection 2.4 describes methods to represent practices and processes.

2.1 Agile software development and Project management

Subsection 2.1.1 describes the history and evolution of Agile software development compared to the project management process. Subsection 2.1.2 describes the evolution lightweight development methods and an overview of the most commonly used Agile method and Agile practices. Subsection 2.1.2.1 focusses specifically on the Agile method Scrum.

2.1.1 History Agile software development

The term "Agile", also called "lean"[1], is not a term that originates from the software development industry. The roots of Agile can be traced back to the Japanese manufacture industries, where they were used for manufacturing- and product development processes in the Toyota Production System (TPS) starting in the 1950s. The objective was to only use resources that could add value for the end customer. All other resources should be eliminated (Wang et al., 2012; Womack et al., 1990; Ohno, 1988). However, the software development community adopted this method not until the 1990s.

Before the 1990s, most software development organizations used the waterfall approach, which was introduced Dr. Winston Royce (1970). Royce presented this method in a presentation called "Managing the Development of Large Software Systems". Summarized, Royce argued that the software development process was similar to an automobile assembling process. The plan-driven waterfall process, which is visualized in Figure 1, stresses that each phase must be finished before the next phase can begin.

Figure 1: Waterfall process (Royce, 1970)
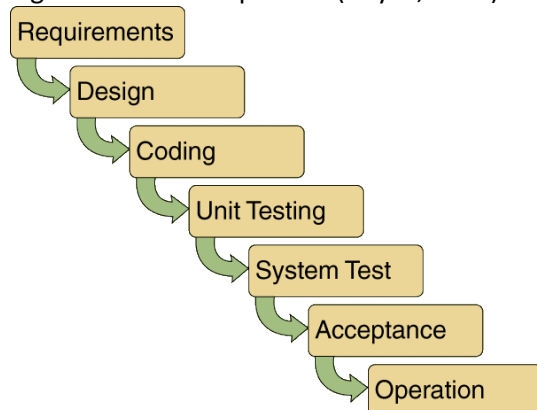
In the following years it became clear that the waterfall approach did not suit the software development industry very well, because stakeholders often don't know what they want and therefore it is almost impossible to define your objectives. Therefore Agile principles received attention as an alternative to plan-driven software development methods (Jalali and Wohlin, 2012).

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[1] Also, Jalali and Wohlin (2010) argue that there is no meaningful distinction between the two terms. Therefore we will use the most commonly used term "Agile" in this research.

Agile principles are based on the notion of incremental software development (Basili, Turner, 1975). In 2001, proponents of these development methods came together and established the Agile Manifesto. The "Manifesto for Agile Software Development" stated four core principles (Cervone 2010):

1. Individuals and interactions over processes and tools.
2. Working software over comprehensive documentation.
3. Customer collaboration over contract negotiation.
4. Responding to change over following a plan.

Additionally, they stated 12 principles of Agile software development. These principles have two main objectives: (1) To promote a better understanding of what Agile methods are, and (2) to guide the project teams to determine if they are in fact using an Agile method (Fernandes, Alemida 2010);

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity--the art of maximizing the amount of work not done--is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

In comparison with traditional (plan-driven) software development methodologies, Agile methods are more flexible, looking at the requirements changes, during all phases of the software development process (Jalali and Wohlin, 2012; Erickson et al. 2005). In addition, they embrace broad collaboration between customers and developers, and advocate small self-organized teams (Sharp and Robinson, 2005). Several comparisons between the plan-driven method and Agile method are presented in Table 1.

Table 1: Traditional software development vs Agile software development (Drowns, 2005)

	Plan-driven method	Agile method
Fundamental Assumptions	Systems are fully specifiable, predicTable, and can be built through meticulous and extensive planning	High-quality, adaptive software can be developed by small teams using the principles of continuous design improvements en testing based on rapid feedback and change
Control	Process centric	People centric
Management style	Command and control	Leadership and collaboration
Knowledge management	Explicit	Tacit

Role assignment	Individuals-favors specialization	Self-organizing teams, encourage role interchangeability
Communication	Formal	Informal
Customers Role	Important	Critical
Project cycle	Guided by tasks or activities	Guided by product features
Development model	Life cycle model (Waterfall, Spiral, or some variation)	The evolutionary delivery model
Desired Organizational Form/Structure	Mechanistic (bureaucratic with high formalization)	Organic (Flexible and participative encouraging cooperative social action)
Technology	No restriction	Favors object oriented technology

2.1.2 Existing Agile frameworks

In the mid-1990s, many software development projects followed a heavyweight development methodology. This heavyweight methodology encounters complete requirements documents, architecture and design, followed by coding and testing, based on an extensive test plan. The philosophy of this method was summarized as "do it right the first time", however this didn't happen very often (Williams, 2012).

As a response to heavyweight development methodology, Beck (2000) introduced a lightweight development methodology, called Extreme Programming (XP). Later on, other development methods, like Crystal, Scrum and Dynamic software development method (DSDM) were presented.

Just as there are many types of projects principles, there are also many different Agile methods (Cervone, 2010). Table 2 presents an overview of the most commonly used Agile methods.

Table 2: Description of main Agile development methods (Cervone, 2010)

Agile method	Description
Crystal methodologies	A family of methods for co-located teams of different sizes and criticality: Clear, Yellow, Orange, Red, Blue. The most frequently used method is Crystal Clear. The Crystal Clear methodology can be applied for projects working on systems that are not life critical. There are usually 6-8 co-located developers within the team. Crystal focusses on efficiency and people, not on processes or artifacts. Clear development has seven characteristics: frequent delivery, reflective improvement, osmotic communication, personal safety, focus, easy access to expert users, and requirements for the technical environment (Cockburn, 2004; Dybå and Dingsøyr, 2008)
Dynamic software development method (DSDM)	The DSDM provides a framework that supports rapid, iterative and collaborative software development. (Abrahamsson et al., 2002). According to the DSDM Consortium[2], a DSDM project has seven phases: Pre-Project, Feasibility Study, Business Study, Functional Model Iteration, Design and Build Iteration, Implementation and Post-Project. A DSDM project can consist of multiple teams and each team has 2 - 6 members (Stapleton, 2003; Dybå and Dingsøyr, 2008) .
Feature-driven development (FDD)	FDD Combines model-driven and Agile development with emphasis on initial object model, division of work in features, and iterative design for each feature. FDD is used for the development of critical systems and provides guidelines, tasks, techniques and five processes: Develop and Overall Model, Build a feature list, Plan by feature, Design by Feature and Build by Feature. (Palmer, Felsing 2002; Dybå and Dingsøyr, 2008).
Lean software development	An adaptation of principles from lean production and, in particular, the Toyota production system to software development. Lean development can be summarized by seven principles: eliminate waste, amplify learning, decide as late as possible, deliver as fast as possible, empower the team, build integrity, and see the whole (Poppendieck, Poppendieck 2003; Dybå and Dingsøyr, 2008).

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[2] http://www.dsdm.org/

Scrum	Scrum is an iterative and incremental framework and focuses on project management in situations where it is difficult to plan ahead. Scrum teams are self-organized and uses an incremental process (called sprints), product backlog (based on user stories) and burn charts to manage the project objectives. Team members daily stand-up meetings to discuss the daily objectives. The Scrum master is the team member who is responsible for the burn down charts and is the chairman of the daily meetings (Schwaber, 1995; Dybå and Dingsøyr, 2008).
Extreme programming (XP)	XP is intended to improve software quality and responsiveness to changing client needs, based on best practices and can be summarized by twelve principles: the planning game, small releases, metaphor, simple design, testing, refactoring, pair programming, collective ownership, continuous integration, 40-h week, on-site customers, and coding standards (Beck, 2000; Dybå and Dingsøyr, 2008)

Because this research is focused on the Scrum methodology, we will explain this method further in detail in the following subsection.

2.1.2.1   Scrum method

The Agile Scrum method was presented by Schwaber in 1995. Schwaber used the name Scrum, based on a term that is used in rugby[3] (see also Takeuchi and Nonaka, 1986). Scrum is an iterative and incremental framework for software development projects. In Figure 2 we see an example of the Scrum process.

Figure 2: Scrum process (Cprime, 2013)
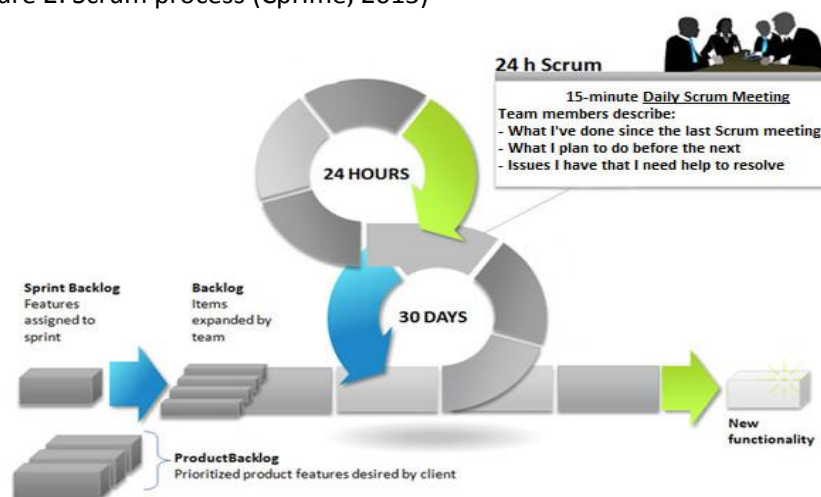
Scrum has the following characteristics (Schwaber, 1995; Levy, 2009);
- Flexible deliverable
- Flexible schedule
- Small teams; 6-10 team members
- Frequent reviews; 1 to 4 week cycles (also known as 'sprints'). Each review there must be a functional executable prepared
- Collaboration; Intra and inter-collaboration between the team members
- Object Oriented; Team will address a set of related object with clear interfaces and behavior

The Scrum model is built on three major components: roles, processes, and artifacts. (Cervone, 2010).

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[3] A tight formation of forwards who bind together in specific positions when a scrumdown is called (Schwaber, 1995)

Roles:
The Scrum Master (Project manager or team leader). *The product owner* knows the functional wishes of the end users based on a product backlog. *The Scrum team* typically is a cross-functional self-organizing team, where there is no fixed leadership role defined, rather each member has its own responsibilities. These responsibilities can changes during sprint periods, depending on the need of the executable iteration.

The Scrum method has five processes: the sprint planning meeting, the kickoff, the sprint, the daily Scrum, and the sprint review meeting (Cervone, 2010).

Processes:
The sprint planning meeting is a meeting of the Scrum team, the Scrum master, and the product owner at the beginning of each sprint (iteration). In this meeting the group defines the product backlog (see Scrum artifacts), determines the sprint objectives and finally defines the sprint backlog (see Scrum artifacts).

The kickoff meeting the group (same team members as in the *Sprint planning meeting)* defines a high level backlog and major project goals.
The sprint is the process were the team members work on the project objectives for a period of 1 – 4 weeks. After each sprint period, the team members deliver functionalities based on the product backlog.

The daily Scrum meeting is held every day and normally takes up to 15 minutes. The Scrum Master is the chairman of this meeting. The objective of this meeting is to reflect on the precious work, define the objectives until the next Scrum and talk about possible risks.

The sprint review meeting is held at the end of each sprint. In this (informal) meeting the functionality are presented to the product owner.

Artifacts:
Scrum artifacts include; the product backlog, the sprint backlog and burn down charts.

The product backlog is used to store the user requirements (usually based on user stories) and to get insight in the priorities of the backlog items. The product owner is responsible for this list. The product backlog can be seen as one of the most important deliverables within an Scrum project and is used as input for the sprint planning meeting. Throughout the sprint planning meeting, each product backlog item will be reviewed and the estimated work will be used to build a breakdown structure (Forecast). Subsequently, the backlog items are placed into size category. After the work is estimated, the group will decide which objectives will be reasonable to successfully complete a sprint.

The sprint backlog will be created only by the Scrum team members and contains a subset of product backlog items that are defined as part of the work for one sprint. The sprint backlog will be daily updated and usually contains not more than +/- 300 tasks. If necessary, product backlog items will be broken down or add items to successfully complete a sprint. These decisions are made without the product owner.

Burn down charts are used to focus on how much work needs to be done. Typically, Burn down charts are used for Sprints periods, Release periods and for the total Project period to see how the overall project progresses. As illustrated in Figure 3, each task is represented in terms of time (X-axis)

and duration (Y-axis). For example, an sprint burn down chart would represent the remaining sprint backlog hours. In an ideal situation there would be no work left at the end of the sprint period.

Figure 3: Example burn down chart (Wikipedia, 2013)
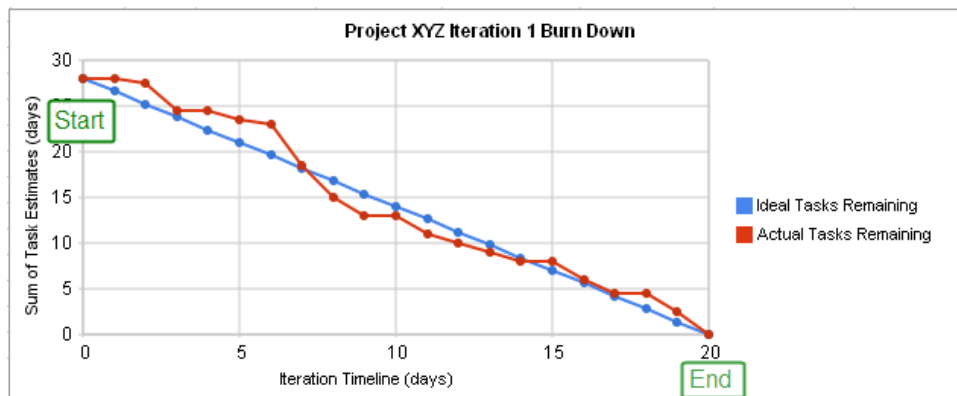
2.1.3   Agile practices

Each Agile method describes certain practices that need to be executed in order to successfully complete a software development process in an efficient and effective manner. To determine the weigh the communities view of the lightweight development methodology and use of associated practices, Williams (2012) conducted two surveys at North Carolina State University. As a result he presented the following overview[4].

Table 3: Agile practices (Williams, 2012)

Nr.	Practice	Nr.	Practice
1	Continuous integration	23	Small teams (12 people or less)
2	Short iterations (30 days or less)	24	Emergent design
3	"Done" criteria	25	Configuration management
4	Automated tests run with each build	26	Daily customer/product manager involvement
5	Automated unit testing	27	Release planning
6	Iteration reviews/demos	28	Test-driven development acceptance testing
7	"Potentially shippable" features at the end of each iteration	29	Team documentation focuses on decisions rather than planning
8	"Whole" multidisciplinary team with one goal	30	Informal design; no big design up front
9	Synchronous communication	31	Co-located team
10	Embracing changing requirements	32	Team velocity
11	Features in iteration are customer-visible /customer valued	33	Requirements written as informal stories
12	Prioritized product backlog	34	10-minute build
13	Retrospective	35	Task planning
14	Collective ownership of code	36	Coding standard
15	Sustainable pace	37	Kanban
16	Refactoring	38	Acceptance tests written by product manager
17	"Complete" feature testing done during iteration	39	Pair programming
18	Negotiated scope	40	Burn down charts
19	Stand up /Scrum meeting	41	Code inspections
20	Time boxing	42	Design inspections
21	Test-driven development unit testing	43	Planning Poker
22	Just-in-time requirements elaboration	44	Stabilization iterations

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[4] The weigh to communities view of these practices are not relevant for this research. Therefore this information is not shown in *Table 5*

2.2 Best Practices

When routines are used in practice, we want to know if this routine is the 'best practice' available to execute the processes in the most efficient and effective way (performative aspect). When one has an idea to improve the used practice(s) or has a concept of a new practice (ostensive aspect) that will improve the processes, we want to know how to collect and represent these practices so (Pentland, Feldman, 2005). However before a practice can be considered "good" or "best", we will examine what a definition of a "good"- or "best practice" is. Subsection 2.2.1 will describe the definition of best practices. Subsection 2.2.2 describes the definition and aspects of organizational routines.

2.2.1 Best practices

The term 'best practice' is a frequently used business-term to describe a development process and following a standard way of executing these processes in the most efficient and effective way. However the use of the word 'best' should not be considered in the superlative sense, because there can be more than one 'best' approach. Therefore some people prefer the term 'good practice' (World Health Organization Regonial office for Africa, 2008; FAO, 2013) The term 'best practice' can be defined as:

"… a technique or methodology that, through experience and research, has proven to reliably lead to a desired result. A commitment to using the best practices in any field is a commitment to using all the knowledge and technology at one's disposal to ensure success" (World Health Organization Regonial office for Africa, 2008)

"… a technique, a method, a procedure or a process which was implemented and which has improved the results of the entity." (Mendes, 1998; Maire, Bronet, & Pillet, 2005)

"… every practical, knowledge or knowhow which showed its effectiveness or its value in part of the organization and which is applicable to another part of the organization." (Prax, 2000; Maire, Bronet, & Pillet, 2005)

"… the process of finding and using ideas and strategies from outside your organization and industry to improve performance in any given area." (Maire, Bronet, & Pillet, 2005; Zahorsky, 2013)*.*

Most organizations are working on good practices in some degree (e.g. instruction manuals or 'how to' guidelines). Following we have to identify and share these good practices. To do this, we have to learn from others by extracting explicit and tacit knowledge (SDC-learningandnetworking, 2013).

Summarized
We agree with the best practice definitions of the World Health Organization (2008) and Mendes (2000) We partly agree with the definition of Prax (2000), because we think that when a practice is only applicable within another part of the organization, this practice should be called a "good practice" instead of "best practice". We consider best practices as practices that can be used for a whole industry of community. We disagree with the definition of Maire, Bronet, & Pillet (2005), because we think that best practices also can be identified within a organization by extracting tacit knowledge.

2.3 Methods to identify and analyze practices

There are many different methods to identify- and/or analyze practices. These methods can be based on qualitative analysis or quantitative analysis. Table 4 presents an overview of methods that one can use to identify- and/or analyze practices and/or processes.

Table 4: Overview identifying/analyzing methods

Method	Identifying practices	Analyzing practices	Qualitative analysis	Quantitative analysis
Narratives	V		V	
Organizational routines		V	V	
Best practice typology		V	V	
Process workshop	V		V	
Benchmarking	V	V	V	
Grammatical pattern-matching		V		V
Process mining	V	V		V

The presented methods in Table 4 are described in the following subsections.

2.3.1 Narratives

Pentland (1999) describes a narrative as a description of a process, in terms of a story, that connects the cause and outcome. The interaction of events in a process can be extracted from these narratives (Pentland, 1999; Bal, 1985; Barthes, 1977; Chatman, 1978; Rimmon-Kenan, 1983). This narrative can be used to build a theory (DiMaggio, 1995).

Narrative can be used to identify and analyze organizational processes, because narrative is not just a 'story' which someone tells, it is something which someone 'enact'. Each narrative, which is based on stories or fabula (also called; *meaning story*), has indicators for an underlying process theory (Pentland, 1999; Chatman, 1978; Rimmon-Kenan, 1983; Bal, 1985). These stories reveal the underlying structure of a narrative and can be used to explain the surface structure (Pentland, 1999; Rimmon-Kenan, 1983).

Narrative should at least contain sequence of events, but most narrative will have other information, that also can used to build a narrative theory (Pentland, 1999; Ball, 1985; Rimmon-Kenan, 1983; Bruner, 1990; Barthes, 1977). To be able to build a process theory based on narrative, Pentland (1999) introduced a framework, represented in Table 5, to understand the difference in structural levels of narrative theory.

Table 5: Relationship of Narrative properties to Organization Theory (Pentland, 1999)

Narrative Property	Indicator for
Sequence	Patterns of events
Focal actor(s)	Role, social network and demographics
Voice	Point of view, social relationships and power
Moral context	Cultural values and assumptions
Other indicators	Other aspects of context

Narrative properties

Sequence: Each narrative should have a beginning, central, and end in time. Event sequence is part of the underlying structure or a story. *Focal actor(s):* Each narrative contains actors which provide a line that links the events in a narrative together. *Voice:* A narrative is based on a story that someone tells. Because each narrative has its own story, a narrative voice cannot seen as part of an underlying structure. *Moral context:* A narrative expresses a common sense of 'what is right, wrong, appropriate or inappropriate, etc. As well as the narrative voice, the moral context is not part of underlying structure. *Other indicators:* Normally narrative text encompass more information than just events, patterns or routines. They also can contain information such as time, places, attributes of the actors, etc. This information can be essential for the researcher to interpreted the events, routines or patterns.

How to collect information

There are many ways to collect information. For example, we can extract data from *Organizational members*, *Published sources*, *Interviews*, *Electronic databases*, *Historical records, Student projects* (Pentland, 1999; Boje, 1991; Martin et al., 1983; Brown, 1998; Pentland, Reuter, 1994; Abbott, Hrycak, 1990; Sabherwal, Robey, 1993).

Although there are many ways to collect information, not much organizations describe a guidance in which this information should be registered. However, knowledge sharing about practices in the medical research domain is indisputably important. Therefore the World Health Organization (WHO) Regional Office for Africa (2008) and the European Commission of health and consumers (2010), provided guidelines to achieve this knowledge by presenting procedures to identify and document 'best practices' and 'Good Manufacturing Practices' (GMP).

World Health Organization

The goal of the WHO Regional Office for Africa is to 'maximize the impact of explicit and tacit knowledge, including health research and experiential knowledge, through effective knowledge sharing and application'. With the help of best practices they want to know 'what does not work and why it does not work', so that similar mistakes can be avoided by other programs and projects.

> *A commitment to using a "Best Practice" is a commitment to using the body of knowledge and technology at one's disposal to ensure success (WHO, 2008)*

Procedures for identifying and documenting "Best practices"

According to WHO (2008), the identification of "Best Practices" involves judgment. Such judgments require prior analysis using the following set of criteria (WHO, 2008):

Table 6 Criteria identification best practices (WHO, 2008)

Effectiveness	This is a fundamental criterion implicit in the definition. The practice must work and achieve results that are measurable
Efficiency	The proposed practice must produce results with a reasonable level of resources and time
Relevance	The proposed practice must address the priority health problems in the WHO African Region
Ethical soundness	The practice must respect the current rules of ethics for dealing with human populations
Sustainability	The proposed practice must be implemenTable over a long period of time without any massive injection of additional resources
Possibility of duplication	The proposed practice, as carried out, must be replicable elsewhere in the Region
Involvement of partnerships	The proposed practice must involve satisfactory collaboration between several stakeholders.

Community involvement	The proposed practice must involve participation of the affected communities.	
Political commitment	The proposed practice must have support from the relevant national or local authorities	

The identified best practices should at least include the criteria *effectiveness, efficiency* and *relevance* in addition to one or more of the other criteria. It is desirable that a best practice meets all the criteria that are mentioned in Table 6. However, it is not necessary, because a best practice can be all sort of things providing lessons learned (WHO, 2008).

Documenting Best Practices
To ensure readability and a clear presentation of what makes a practice innovative, interesting, informative, WHO (2008) presented a format, presented in Table 7, that should be used to document a best practice.

Table 7: Documenting "Best Practices" (WHO, 2008)

a	**Title of the "Best Practice"**	This should be concise and reflect the practice being documented.
b	**Introduction**	This should provide the context and justification for the practice and address the following issues: - what is the problem being addressed? - which population is being affected? - how is the problem impacting on the population? - what were the objectives being achieved?
c	**Implementation of the Practice**	- what are the main activities carried out? - when and where were the activities carried out? - who were the key implementers and collaborators? - what were the resource implications?
d	**Results of the Practice – Outputs and Outcomes**	- what were the concrete results achieved in terms of outputs and outcomes? - was an assessment of the practice carried out? If yes, what were the results
e	**Lessons Learnt**	- what worked really well – what facilitated this? - what did not work – why did it not work?
f	**Conclusion**	- how have the results benefited the population? - why may that intervention be considered a "Best Practice"? - recommendations for those intending to adopt the documented "Best Practice" or how it can help people working on the same issue(s).
g	**Further Reading**	- provide a list of references (not more than six) that give additional information on the "Best Practice" for those who may be interested in how the results have benefited the population.

In addition, WHO (2008) states that everyone should first use a submission form that should be used to accept or deny the best practice. If the submission is accepted, the documented best practice should not exceed 1500 words.

European Commission
There are two documentation types used to manage and record Good Manufacturing Practices (GMPs), namely (1) instructions (directions, requirements), presented in Table 3 and (2) records/reports, presented in Table 4. In addition the EU argues that controls are implemented to ensure the accuracy, integrity, availability and legibility of documents. They also argue that the

documentation of "good documentation practices" can be handwritten but in a in clear, legible and indelible way. When actions are taken, they should be recorded in a way that the manufacture process is tracable and that alteration should be signed and dated (European Commission, 2010).

Site Master File: A document describing the GMP related activities of the manufacturer. We think that the manufacturer can be translated to an Agile team which is "manufacturing" a software development project (European Commission, 2010).

Table 8: Instructions (directions, or requirements) type (European Commission, 2010)

Specifications	Describe in detail the requirements with which the products or materials used or obtained during manufacture have to conform. They serve as a basis for quality evaluation.
Manufacturing Formulae, Processing, Packaging and Testing Instructions	Provide detail all the starting materials, equipment and computerised systems (if any) to be used and specify all processing, packaging, sampling and testing instructions. In process controls and process analytical technologies to be employed should be specified where relevant, together with acceptance criteria
Procedures:	(Otherwise known as Standard Operating Procedures, or SOPs), give directions for performing certain operations.
Protocols	Give instructions for performing and recording certain discreet operations
Technical Agreements	Are agreed between contract givers and acceptors for outsourced activities

Table 8: Record/Report type (European Commission, 2010)

Records	Provide evidence of various actions taken to demonstrate compliance with instructions, e.g. activities, events, investigations, and in the case of manufactured batches a history of each batch of product, including its distribution. Records include the raw data which is used to generate other records. For electronic records regulated users should define which data are to be used as raw data. At least, all data on which quality decisions are based should be defined as raw data
Certificates of Analysis	Provide a summary of testing results on samples of products or materials1 together with the evaluation for compliance to a stated specification.
Reports	Document the conduct of particular exercises, projects or investigations, together with results, conclusions and recommendations

Building process theory with narrative

Pentland (1999) elaborated on the idea that stories can be understood as process theories, because narrative represents 'sequence' and 'time'. Abbot (1992) argues that narrative can be used for sociological research. Abbott (1990) identifies three categories of questions that one can address:

(1) the existence and classification of sequential patterns,

(2) the antecedents of these patterns

(3) the consequences of these patterns

In order to explain sequential patterns, we need to find sequences of events that connects the antecedents which are linked to the consequences (Pentland, 1999; Einhorn, Hogarth, 1986). Therefore we need to focus on the processes to be able to open the 'black box' (Lawrence, 1997).

Levels of Narrative Structure

To get insight in the underlying structure of a narrative, Pentland (1999) integrates four levels, which are represented in Table 9. The first three levels are commonly used in narrative theory and the fourth level (van de Ven, Poole, 1995) shows the underlying structure (generating mechanism) that drives the process (Pentland, 1999).

Table 9: Levels of structure in narrative (Pentland, 1999)

Level	Definition	Example
Text	Particular telling of a story by a specific narrator	Actual text of his or her story: "When I showed up at the interview"
Story	Version of a fabula form a specific point of view	A new employee's own version of how he or she was hired
Fabula	Generic description of a particular set of events and their relationships	How a particular person was hired: What happened, who did what
Generating mechanism	Underlying structures that enable or constrain the fabula	Overall recruiting process: How people in general are hired

2.3.2   Organizational routines

An organizational routine is a widely used term that is used by theorist, but can be seen from different perspectives. For example, a routine can show patterns of 'continuity over time', which can lead to the theory of 'inertia and stability'. However, when one closely observes these routines, they can expose 'continuously and endogenously', which can lead to the theory of 'flexibility and change'. In summary one can conclude that "Organizational routines are generative, dynamic systems, not static objects"(Feldman, Pentland, 2005).

According to Pentland et al. (2010), routines are difficult to conceptualize, observe and compare because they can be divided in three different layers; the deep level layer, the actual level and the empirical level. The deep level consists of underlying mechanisms (e.g. instructions or rules) and tendencies which can facilitate the appearance of patterns. The actual level show consistent ('regular') patterns of behavior. The empirical level shows 'representations of recurrent action patterns'. The representations of these patterns can be based on internal (cognitive, tacit) or external (explicate, codified) knowledge (Becker, 2005).

Feldman and Pentland (2003) summarize an organizational routine as repetitive, recognizable patterns of interdependent actions, carried out by multiple actors. They argue that an organizational routine consist of an *ostensive* aspect (the idea) and a *performative* aspect (the enactment), which is visualized in Figure 4.

The ostensive aspect is the ideal or schematic form of a routine. It is the abstract, generalized idea of the routine, or the routine in principle. The performative aspect of the routine consists of specific actions, by specific people, in specific places and times. It is the routine in practice (Feldman, Pentland 2003)

Figure 4: Organizational routines are generative systems (Pentland, Feldman, 2005)
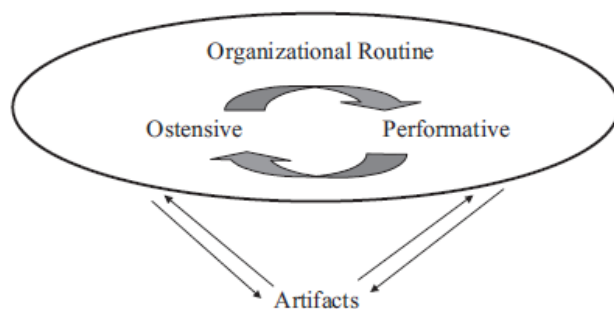
Later on, Pentland and Feldman (2005) included *artifacts* as a third aspect of routines. They argued that the deviation between the *ostensive, performative and artifacts* would lead to routine change (Schutlz, 2008).

2.3.3 Best practices typology

In the research of Maire, Bronet and Pillet (2005) a proposed classification method is presented to categories these practices based on a framework of for internal benchmarking. The classification method they used is partly based on classification guidelines of O'Dell and Jackson Grayson (1998).

The typology Maire, Bronet and Pillet (2005) present (see Table 10), consist of functions (horizontal), provided by a process (Axis, Action and Assistance), where Plan A describes frequent operations and Plan B describes infrequent operations. Vertically describes the type of means requested in setting up the process. There divide the means categories with Assets (knowledge of the organization) and Abilities (Know how)

Table 10: Typology best practices (Maire, Bronet, & Pillet, 2005)

<table>
<tr><th colspan="2"></th><th></th><th colspan="6">Functions</th></tr>
<tr><th rowspan="2" colspan="2">WHAT</th><th rowspan="2"></th><th colspan="2">AXIS*</th><th colspan="2">ACTION</th><th colspan="2">ASSISTANCE</th></tr>
<tr><th>HOW</th><th>Plan A</th><th>Plan B</th><th>Plan A</th><th>Plan B</th><th>Plan A</th><th>Plan B</th></tr>
<tr><td rowspan="9">Means</td><td rowspan="3">ASSETS</td><td>Material</td><td>A data base synthesizing the performance indicators</td><td>A spreadsheet to create a dynamic chart</td><td>A manufacturing machine</td><td>A conventional machine to reduce interruptions during production</td><td>A maintenance management software package</td><td>A folder which files maintenance carried out and that to come</td></tr>
<tr><td>Structure</td><td>All production sites under the responsibility of the same director</td><td>Partnership with an auxiliary lawyer with the company to resolve litigations</td><td>A quality technician in each workshop</td><td>Same quality technician in two different workshops</td><td>A service of knowledge capitalization for the whole company</td><td>Partnership with a specialist consultant in the capitalization of knowledge</td></tr>
<tr><td>Methods</td><td>A coordinating meeting every week between the production sites</td><td>More frequent meetings when the workload increases</td><td>To sort by sampling from the produced parts</td><td>100% control with of the parts produced when a machine shows a CPK<1.33</td><td>Resolution of problems using to the 4*4 method</td><td>Use of SIX SIGMA method for a particular problem</td></tr>
<tr><td rowspan="3">ABILITIES</td><td>Management</td><td>To preach measurement as the federator of a good decision</td><td>Calculation of customers returns in term of the cost of no-quality</td><td>To request autonomy on a work station</td><td>To congratulate the operator who improves the productivity and quality of his work station</td><td>Incite the trainers to listen to the trainees needs</td><td>Form the trainees using real examples that the trainer has experienced</td></tr>
<tr><td>Collective skills</td><td>The ability of a management team to define a clear strategy</td><td>Solidarity in the event of an error of strategy</td><td>The capacity of design to quickly offer a new product</td><td>Ability of a engineering department to take account of the solutions "on shelf" to develop product further</td><td>Faculty of the supervisors to divide the workforce up between them according to the needs of each workshop</td><td>Solidarity by the loan of personnel between supervisors when there is a delay in production</td></tr>
<tr><td>Individual skills</td><td>The capacity to direct several factories</td><td>Skills to carry out an exceptionally thorny meeting with METAPLAN method</td><td>Know-how on a manufacturing machine</td><td>Emergency know-how with the means available in production</td><td>Aptitude to repair any breakdown on a manufacturing machine</td><td>Ability of a person to create solutions for breakdowns (when the maintenance has not been carried regularly)</td></tr>
<tr><td colspan="2"></td><td colspan="2">DECISION</td><td colspan="2">PRODUCT or SERVICE</td><td colspan="2">RESOURCES</td></tr>
</table>

Identification of best practices

To identify the best practices, Maire, Bronet and Pillet (2005) proposed a method to (1) locate the best practices of a given process and (2) determine the priority when an internal benchmarking is executed (Maire, Bronet, & Pillet, 2005).

Figure 5: Principles Best Practices Specification (Maire, Bronet, & Pillet, 2005)
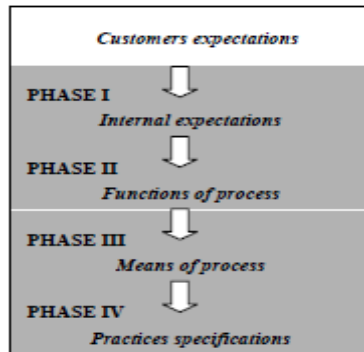
Maire, Bronet and Pillet (2005) developed a method, called Best Practices Specification (BPS), which is based on four principle as illustrated in Figure 5.

Relationship between customer's expectations and internal expectations (Figure 6): First, one must create a relation between the expectations of the customer (which is expressed by the final customers) based on specifications (output requirements of the process) who the actors of the process defined. Hereby it is important that requirements correspond with the customers voice.

Second, one should establish a hierarchy between the stated requirements and practices which have a significant incidence on the satisfaction of the customer of the process. The requirements that are considered as fundamental, will be used as focus point for the continuation of the deployment (Maire, Bronet, & Pillet, 2005).

Figure 6: Customer's expectations and internal expectations (Maire, Bronet, & Pillet, 2005)
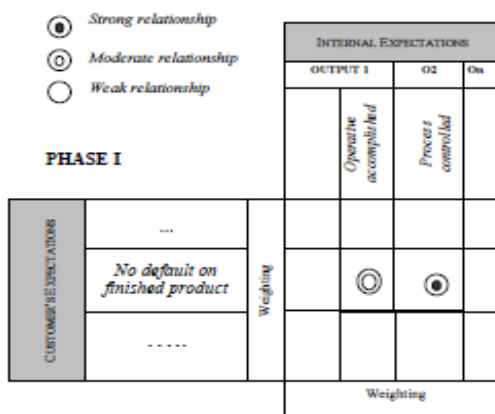
Relationship between internal expectations and functions of process (Figure 7): The second phase creates the link between the fundamental specifications that are defined in *phase 1* and the various functions to be assured by the process. The inventory of these functions are placed while following the *axis-Functions* used in the typology of best practices. "Axis (functions providing the strategic or tactical decisions of the process), Action (functions providing the products or services necessary to obtain the result of the process), Assistance (functions providing the resources useful for the realization of the process). This phase leads to the description of the main functions, i.e. of the functions declared as performing well and whose interactions with the requirements defined in-house on the process were declared as significant" (Maire, Bronet, & Pillet, 2005).

Figure 7: internal expectations and Functions (Maire, Bronet, & Pillet, 2005)
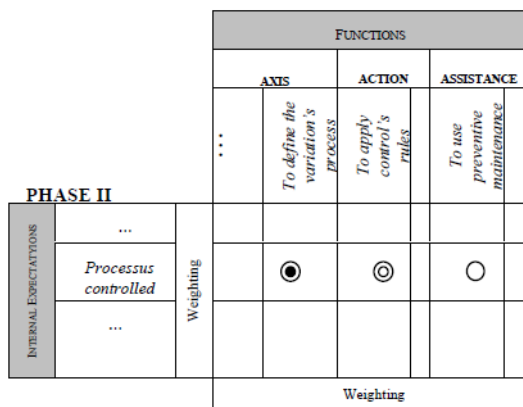
Relationship between functions and means of Process (Figure 8): The third phase describes the relationship between the fundamental functions of the process and all of the things that are necessary (means) for this process. These are recognized by crossing the axis *means* described in the typology: "Assets (materials, organizational supports and methods which have been put into place to guarantee that the process runs smoothly), and Aptitudes (management techniques, individual or collective skills which, developed or

acquired gradually, are useful for the improvement of the process). At the intersection of these functions and these means are the practices which have a significant link with the customer's expectations of the process examined. These practices will be specified in the next At the intersection of these functions and these means are the practices which have a significant link with the customer's expectations of the process examined. These practices will be specified in the next phase."

Figure 8: Means & Functions (Maire, Bronet, & Pillet, 2005)

Relationship between means and practices of Process (Figure 9): After completing this phase, it is possible to describe practices within the framework of an operation routine (Plan A) or as an unusual operation in the process (Plan B). Subsequently it is possible to identify the best (or good) practice(s). "The range (R) of a practice reveals the extent of its effect in the organization: effect limited to the process considered or, on the contrary, effect applying to the organization's other processes. The incidence (I) reports the importance of the effects of the implementation of the practice on the global performance of the process. Finally Facility (F) gives an indication over time which separates the implementation of this practice from the observation of its first tangible results on the performance of the process. The practices considered to be best will thus be those which will maximize the value of R*I*F between practices of comparable nature" (Maire, Bronet, & Pillet, 2005).

Figure 9: Practice Specifications & Means (Maire, Bronet, & Pillet, 2005)

2.3.4 The Process Workshop

Dingsøyr and Moe (2004) presented a method to develop process guides with the use of workshops. Their report was based on a large research project, Software Process Improvement based on Knowledge and Experience (SPIKE). This research project involved many corporate organizations, research institutes and universities.

Process guides are traditionally used within large organizations. However, often these process guides are not good documented or extensively large, which makes it unattractive to read them. A process description, in whatever form it is presented, should include the following basic elements (Dingsøyr & Moe, 2004):

Table 11: Basic elements of process descriptions (Dingsøyr & Moe, 2004)

Element	Description
Input	description of artifacts (such as documents, program code) that must be available for performing the process
Activities	descriptions of "how things are done", including an overview of the activities and details regarding the performance of each activity.
Roles	details regarding the roles and agents involved in performing the activities.
Related documents	details regarding the tools, templates and techniques used to support or automate the performance of an activity.
Output	description of artifacts produced in the process.
Artifacts	Diagrams, Tables, hyper-links and narrative

One can develop process guide in several ways. Dingsøyr and Moe (2004) used the method to develop the process guide in a workshop where the users of this process guide are involved in the development processs (Ahonen, Forsell, & Taskinen, 2002). They consider these workshops very importend, because they 'encourage organization employees to discuss their own work practice' (Dingsøyr & Moe, 2004).

> *"A process guide can be seen as a structured, workflow-oriented, reference document for a particular process, and exists to support participants in carrying out the relevant process"* (Dingsøyr & Moe, 2004)

Steps to define the process guide

First of all a moderator invites participants and assigns someone (e.g. secretary) to document the results. The workshop needs, next to a meeting room, a collection of self-adhesive stickers (e.g. post-its) in various colors, and walls that are covered with paper, so one can attach the self-adhesive stickers and draw Figures on the paper. It is also useful to use a camera to document the results of the workshop and to bring large process worksheets, as illustrated in Figure 10, to draw boxes for input, activities, output, roles and related documents involved in the process. The process is defined in six steps and five sub-steps as illustrated in Figure 11 (Dingsøyr & Moe, 2004).

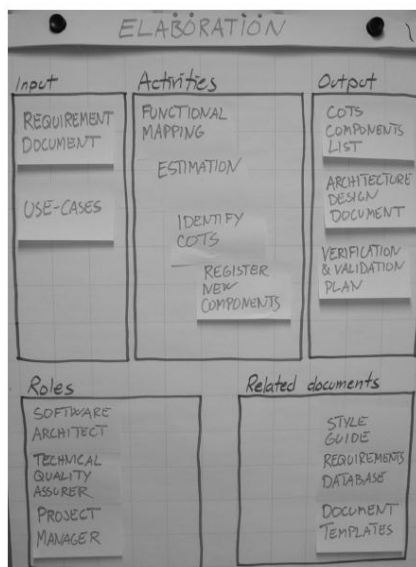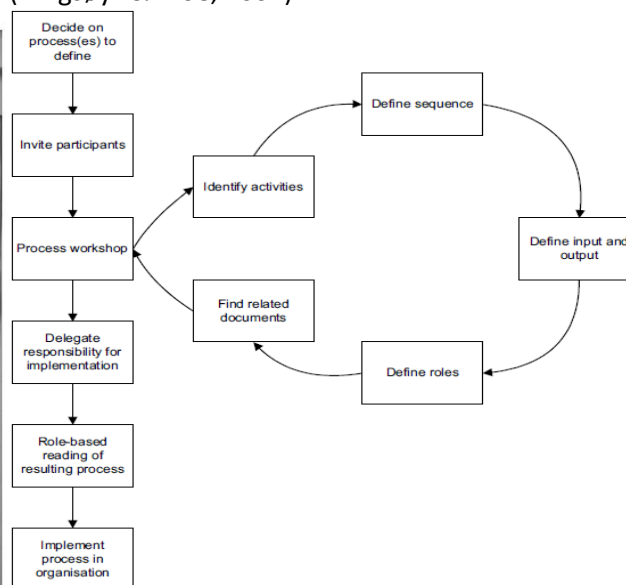Figure 10: A process worksheet (Dingsøyr & Moe, 2004)

Figure 11: Workshop process steps (Dingsøyr & Moe, 2004)

Explanation workshop process steps

Decide which process(es) you want to define in the workshop: Use examples to test the process (e.g. development process for small software products. Divide very large process into a series of workshops. *Invite participants:* Invite as many participants as possible who will be using the developed process guide. Divide the participants into groups if the number of participants is too large. Ensure that the participants from these groups are mixed by subsequent workshops (Dingsøyr & Moe, 2004). *Process workshop:* First, give a short presentation (15 min) of what the context of the workshop means if the participant have not participated a workshop before. Use a process worksheet, as illustrated in Figure 3, for each process that will be discussed in that workshop. Each process should follow the following sub-steps (Dingsøyr & Moe, 2004):

Identify activities: To identify the activities of the process, Dingsøyr and Moe, (2004) use KJ-method of Jiro Kawakita, a Japanese ethnologist who developed a method in the 1960s for brainstorming and documenting the result. Hereby the following steps need to be followed (Dingsøyr & Moe, 2004):

1. **Write down suggestions**: Let each participant write suggestions on the self-adhesive stickers in large letters. Give each participant time to document 5-10 suggestions.
2. **Present the suggestions**: Let each participant present their suggestions. Attach each sticker to the wall and describe the activity. "Do not let people criticize or discuss the ideas at this point".
3. **Group the suggestions**: Let the participants organize the self-adhesive stickers on the wall. "Ask them why they choose to move the stickers".
4. **Formulate headings**: Encourage participants to suggest headers that describe the stickers in each group. Try to use words so that other people, who are not participating in the workshop, can understand the meaning of them. Look for relationships between group and define sub-topics under more general groups.
5. **Document the diagram**: Document the diagram on the wall with groups and supporting activities on the self-adhesive stickers.

Define the sequence of activities: Take the activities from the *Identify activity-phase,* make a sticker for each activity and place them on the activities-field of the worksheet (time goes from left to right). Finally, find a suitable workflow between these activities. *Define input and output:* Describe the documents/artifacts that are needed (including preconditions) to start the process and documents (including preconditions) that mark the end of the process. Use different colors stickers to mark the input activities and output activities and place them to the worksheet. Conditions that must be satisfied to begin or exit the process can be described in checklists. *Define roles:* Define the roles (e.g. developers, project leader, manager) that should contribute to each activities and define responsibilities. *Find related documents:* Identify documents that already exist in the organization, and new documents that could be helpful in carrying out the activities (e.g. templates, checklists). *Delegate responsibility for implementation:* Give a participant the responsibility to make a draft process guide, based on the overall description of the processes, which is developed at the workshop. The chances are relatively high that activities need to be more elaborated, compare to the information showed on the work board. If necessary, divide the work between the participants. *Role-based reading of the resulting process*: Ask the participants to read the resulting descriptions and comment on them. You can assign the most typical roles involved in the processes to individual participants, and ask them to point out any information that is lacking or irrelevant for this role in the description. *Introduce the process in the organization:* When the process description is ready, it has to be introduced to the organization (if not everyone was involved in developing it). You can use a pilot project to gather further feedback before making the process available to everyone. You can organize a session on the process guide as a part of the kick-off meeting in the pilot project. A meeting where everyone in the organization or a department participates can provide a good forum for telling people about the defined process. People from the pilot project can also participate, to share their experience of following the defined process. Of course, internal newsletters or Intranet-news are also good

channels for informing about the process guide. Most organizations choose to make the process guide available on their Intranet.

2.3.5 Benchmarking

Originally the term "benchmark" refers to measured software performances on which different products from different manufactures are assessed. Currently the term benchmark is also used to enhance business processes with the goal of achieving the better products and services (Maire, Bronet, & Pillet, 2005). According to Camp (1989) benchmarks must integrate measurements of performance of activities for the manufactoring process of products and/or services.

Bechmarking has evolved from a "continuous and systematic process of evaluation of the products, services" (Camp, 1989) to a "continuous process of identification, learning and implementation of best practices in order to obtain compatitive advantages, wheter internal, external or generic" (Maire, Bronet, & Pillet, 2005; Murray, 1997).

Benchmarking is one of most effective approach to improve a organization's performance. There are two benchmarking approaches: (1) internal benchmarking (e.g. to compare performances between business units of the same group) and (2) External benchmarking (e.g. comparative analysis of performances between different firms) (Maire, Bronet, & Pillet, 2005). The aim to adapt practices is to improve the performance of business processes (Camp, 1989). Over that past decade benchmarking is also frequently used as part of a Total Quality Management system as we can see in Figure 12 (Balm, 1994)

Figure 12: Benchmarking as part of TQM (Balm, 1994)
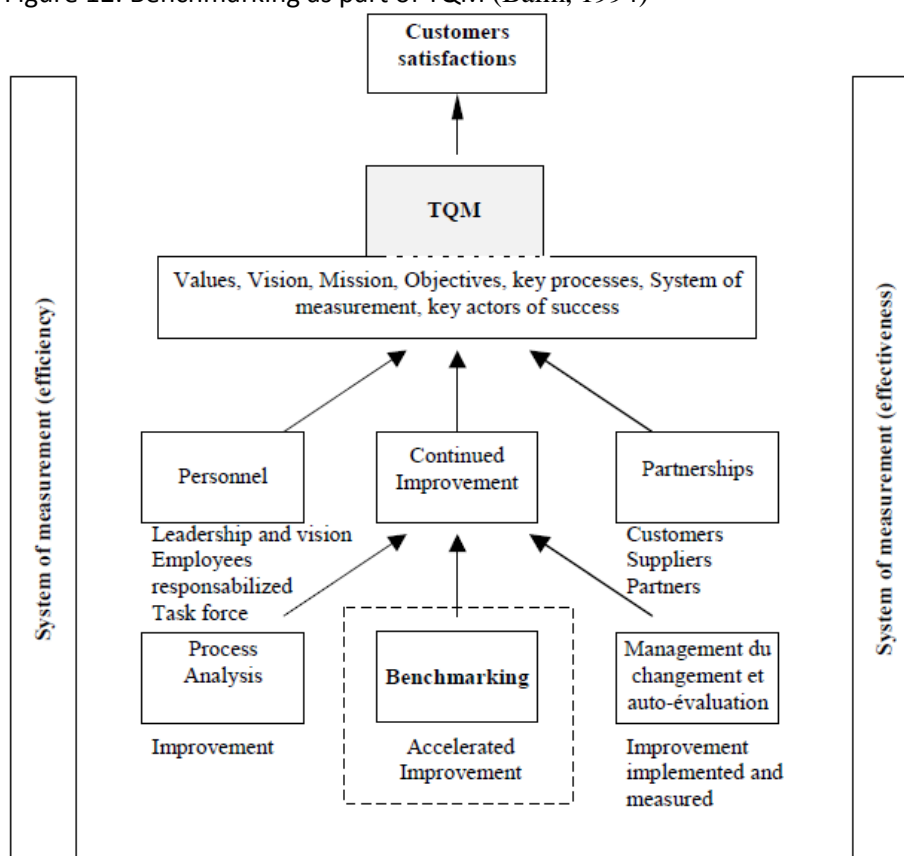
Bronet and Mare (2003) argue that there are two principles for adapting best practices, namely: (1) One should first define "what" a best practice is and determine which type of information and/or knowledge is relevant to use to improve a given business process and (2) one should be able to tell "how" to identify these best practices (Maire, Bronet, & Pillet, 2005).

Bull's Eye Method

The Hague Centre for Strategic Studies (HCSS) studied, on request of the Dutch Minister of Defense (MoD), the planning processes of 5 defence organisations (Australia, Belgium, Denmark, France, the United Kingdom) and of one non-defence organisation, the World Food Programme, so that the MoD is able to get a high value for the public money they are entrusted with. During their research they applied a benchmark method from the TNO (Toegepast Natuurwetenschappelijk Onderzoek) instituut, called the *Bull's Eye Method* (Spiegeleire, Hooft, Culpepper, & Willems, 2009).

The Benchmark Initiation Team

The first phase of the benchmarking process is the selection of the benchmark initiation team (BIT). This identification can take place by using the three layers of impact the topic benchmarked (TP) will have on the project stakeholders (See Figure 14). By using a taxonomy overview it is possible to describes the nature of a stakeholder's relationship to the issue at each concentric level (See Figure 13).

Figure 13: Concentric circles (Spiegeleire, 2006)

The core of the concentric circle is the starting point of the TP. The first concentric circle is populated by those who are most directly affected (e.g. end users) of the benchmark results. The next layer is populated by those who are indirect affected (e.g. operational planners). The outer layer is populated by those who are only marginally influenced or have professional interest in the topic benchmark.

Figure 14: Stakeholder Matrix (Spiegeleire, Dupain, & Willems, 2006)

Stakeholder Group	Nature of Interest in Policy Decision	Potential Impact of Policy	Relative Importance of Interest	Importance of group	Influence (Power) of Group
1° Stakeholders					
Stakeholder 1	Description	Low/High	Low/High	Low/High	Low/High
Stakeholder 2	Description	Low/High	Low/High	Low/High	Low/High
2° Stakeholders					
Stakeholder 3	Description	Low/High	Low/High	Low/High	Low/High
3° Stakeholders					
Stakeholder 4	Description	Low/High	Low/High	Low/High	Low/High
...					

A taxonomy can be used to describe the nature of the stakeholder's relationship to each concentric circle level. Each stakeholders level has a high/low score to visualize the potential stakeholders and to see how they are involved (impact) on the given benchmark. When the taxonomy en concentric circle is developed, the stakeholders can be invited to the BIT (Spiegeleire, Dupain, & Willems, 2006).

Selecting Categories to be Benchmarked
By organizing a brainstorm session, coupled with a structured mind mapping exercise (See Figure 15), the BIT is able to select the benchmark categories to be investigated. The goal of the mind mapping exercise is to provide a "coherent visual framework" to achieve a topic-to-metric decomposition and can be used as a forum to contribute their interpretations to define the categories and scope of the project (Spiegeleire, Dupain, & Willems, 2006).

Figure 15: Example mind mapping exercise (Spiegeleire, Hooft, Culpepper, & Willems, 2009)
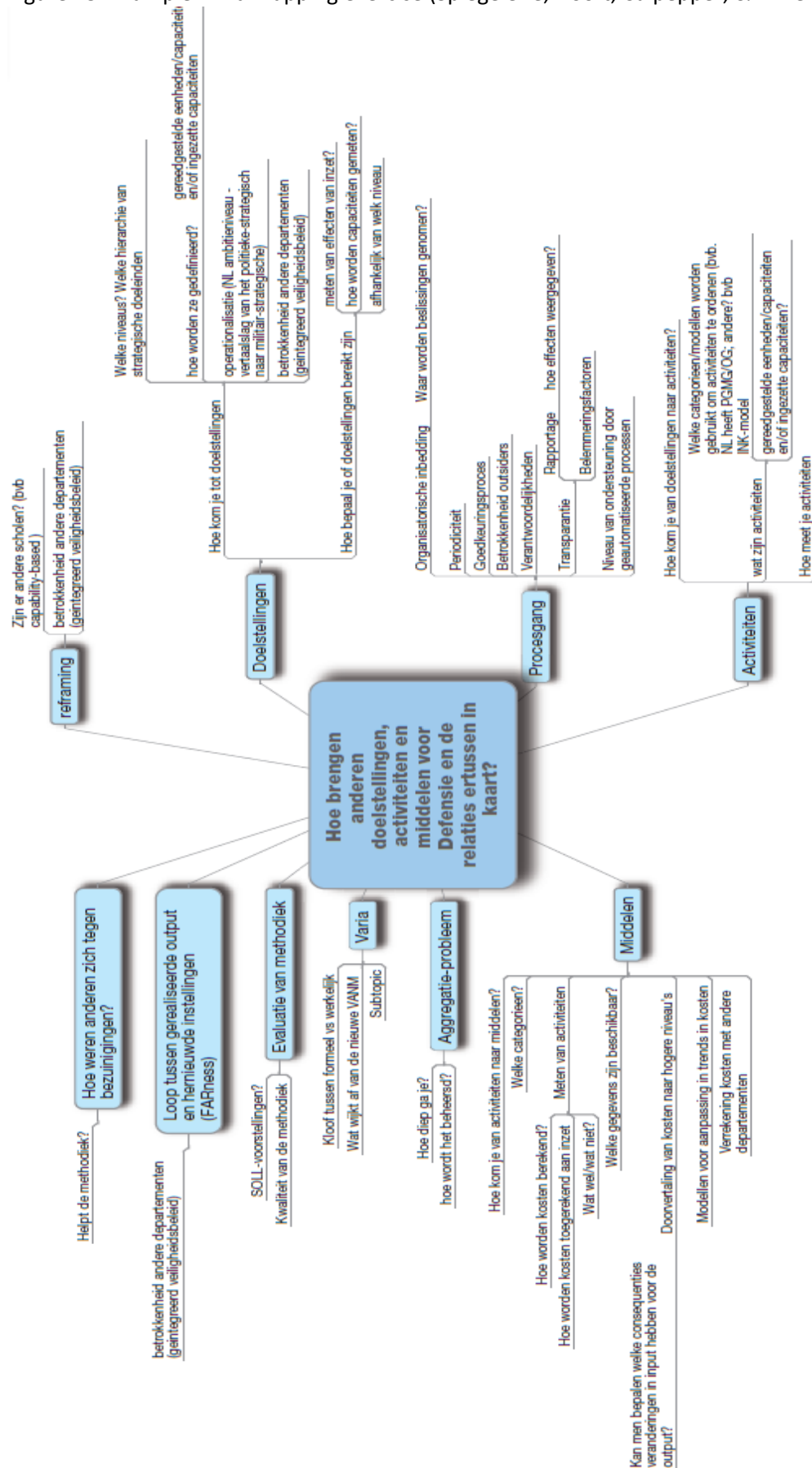
Selection of Referents to be Benchmarked

After the clarification of the benchmark categories, a dialog should be held with the BIT to be able to choose the most appropriate referent. To be able to choose a referent, one can choose the bull's eye method as shown in Figure 16 and explain in Table 12.

Figure 16: Bull's eye method (Spiegeleire, 2006)
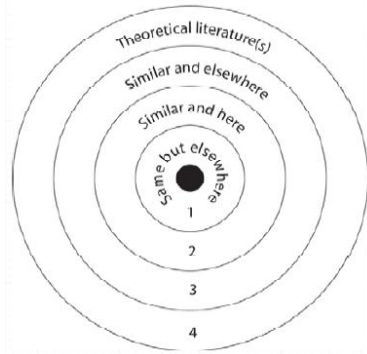
Table 12: Explanation bull's eye method (Spiegeleire, 2006)

Level	Explanation
1. Same but elsewhere	Situation with a comparable analytical value (e.g. retail stores in different sectors)
2. Similar and here	Not same, but similar activities within your community or location (e.g. online retailers in The Hague)
3. Similar and elsewhere	Activities with good reputation in a related field (e.g. best practices in retailing)
4. Theories, Literature	Theoretical underpinnings of the problem at hand (e.g. shopping behavior)

Subsection 2.3.2.1 describes a quantitative method to identify routines based on grammatical pattern-matching. Subsection 2.3.2.2 describes a quantitative method based on event-logs to discover process models (routines) and conformance the process models for enhancement.

2.3.6   Grammatical pattern-matching

Pentland and Reuter (1994) use a grammatical pattern-matching technique to describe sequential patterns. This method can be used for describing, summarizing and compare the patterns of actions (Pentland, 1999).

Mentzas et al. (2001) describes an activity based technique for representing a process. These activity based workflow models consist the following components:
- Workflows: a partial or total order of a set of tasks,
- Tasks: a partial or total order of operations, descriptions for human actions, or other tasks,
- Manipulated objects: documents, data records, images, phones, fax machines, printers etc.,
- Roles: a placeholder for a human skill or an information system service required to perform a particular task,
- Agents: humans or information systems that fill roles, perform tasks and interact during workflow execution

The activity based workflow model is visualized in *Figure 17*

Figure 17: Activity based workflow model
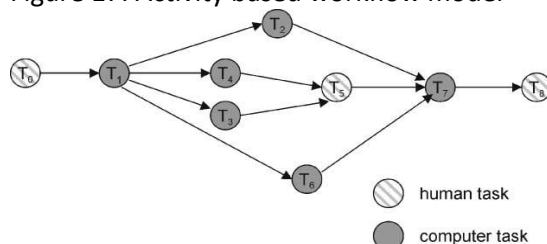
2.3.7 Process mining

Business process mining, also called process mining, is a method that can be used to find causal and dynamic dependencies. Process mining sits between de Business Process Management (BPM) and data mining domain. The practice of process mining looks similar to data mining, because it also uses large amounts of information, which needs to be extracted from databases. In addition, the similarity with BPM is that its goal is to get insight in business processes. A conceptual model of process mining is visualized in Figure 18 (Aalst, 2011).

Figure 18: Conceptual model Process mining (Aalst, 2011)
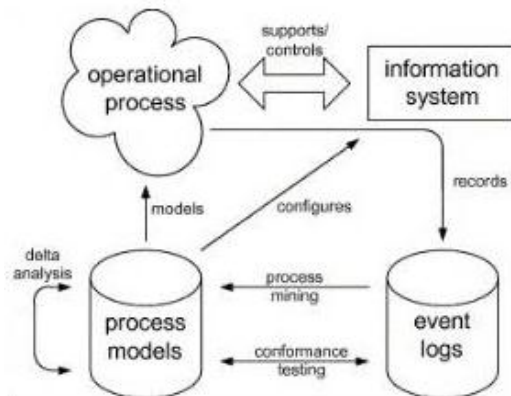
According to van der Aalst (2011, p.55) the performance of a process or organization can be defined in different ways. Typically, three dimensions of performance are identified: *time, cost* and *quality*. For each of these performance dimensions, different *Key Performance Indicators* (KPIs) can be defined. When looking at the *time dimension,* the following performance indicators can be identified:

- The *lead time* (also referred to as flow time) is the total time from the creation of the case to the completion of the case;
- The *service time* is the time actually worked on a case;
- The *waiting time* is the time a case is waiting for a resource to become available;
- The *synchronization time* is the time an activity is not yet fully enabled and waiting for an external trigger or another parallel branch;

Many systems have some kind of event log often referred to as ''history'', ''audit trail'', ''transaction log'', etc. The event log typically contains information about events referring to an activity and a case. The case (also named process instance) is the ''thing'' which is being handled, e.g., a customer order, a job application, an insurance claim, a building permit, etc. The activity (also named task, operation, action, or work item) is some operation on the case. Typically, events have a timestamp indicating the time of occurrence. Moreover, when people are involved, event logs will characteristically contain information on the person executing or initiating the event, i.e., the performer (van der Aalst, van Hee, 2002).

By using surface level data, based on workflow event logs, it is possible to visualize underlying generative mechanisms. These models are based on Petri nets (Van der Aalst et al., 2004; Salimifard, Wright 2001). These techniques can be used to represent the underlying generative mechanism (Pentland et al, 2010)

The idea of process mining is to discover, monitor and improve real processes (i.e. not assumed processes) by extracting knowledge from event logs (See example; *Figure 19*) readily available in today's systems. (van der Aalst, 2011).

Figure 19: Example event log (Wel, 2012)

According to van der Aalst (2011) event logs can be used to conduct three types of process mining, namely:

1. Process discovery
The first type of process mining is *discovery*. A discovery technique takes an event log and produces a model without using a-priori information. […] If the event log contains information about resources, one can also discover resource-related models, e.g., a social network showing how people work together in an organization

2. Process conformance
The second type of process mining is *conformance*. Here, an existing process model is compared with an event log of the same process.

3. Process enhancement
The third type of process mining is *enhancement*. Here, the idea is to extend or improve an existing process model using information about the actual process recorded in some event log. Whereas conformance checking measures the alignment between model and reality, this third type of process mining aims at changing or extending the a-priori model.

Currently, there are several process mining products. In Table 13 some examples are presented and categorized in *Commerciële tools (C), Academische tools (A) en Open-source tools (O)*. Figure 20 and Figure 21 illustrate examples of the process mining tools *Disco* and *Prom.*

Table 13: Process mining producten (Aalst, 2011)

Product	Type	Organisatie
ARIS Process Performance Manager	C	Sofware AG
Enterprise Visualization Suite	C	Businessscape
Disco	C	Fluxicon
Genet/Petrify	A	Universitat Politècnica de Catalunya
Interstage BPME	C	Fujitsu
OKT process Mining suite	O	Exeura
Process Discovery Focus	C	Iontas
ProcessAnalyzer	C	QPR
ProM	O	Process mining group
Rbminer/Dbminer	A	Universitat Politècnica de Catalunya
Reflect|one	C	Pallas Athena
Reflect	C	Futura Process Intelligence
ServiceMosaic	A	University of New South Wales

Figure 20: Example process model visualization Disco (Wel, 2013)

Figure 21: Example process model visualization ProM (Claes, 2011)

2.4 Methods to represent practices and processes

There are many different ways to represent business processes. Subsection 2.4.1 presents a framework of different methods based on *attributes, characteristics, strength and weaknesses based on an users perspective and strength and weaknesses bases on a modelers perspective.* Subsection 2.4.1 describes these business process modeling techniques further in detail. Subsection 2.4.3 describes business process representation techniques.

2.4.1 Business process modeling methods

Table 14: Business process modeling techniques framework (partly taken from Saven, 2004)

Method	Attributes	Characteristics	User perspective		Modeler perspective		Reference
			Strength	Weakness	Strength	Weakness	
RAD	Flow of individual roles	Detailed view. Degree of empowerment. No overview	Supports communication. Intuitive to read	Not possible to be decomposed	Include business objects	Different notations	(Saven, 2004)
IDEF0	Flows of activities, inputs, outputs, control and mechanisms	Based on SADT Sub-layers.	Shows inputs, outputs, control, mechanisms, overview and details	Trend to be interpreted only as a sequence of activities. Roles are not represented	Strict rules. Possible to build a software. Quick mapping		(Saven, 2004)
IDEF3	Precedence and causality Relationships between activities	Allows different views. Process flow descriptions and object state transition description diagrams Sub-layers	Easy to understand dynamic aspects in a static way	Many partial diagrams to describe a process	Strict rules and notation Possible to build a software	Need lot of data. Time consuming when modeling omplex systems	(Saven, 2004)
Petri Nets	Network of places, transitions and arcs	Hierarchical decomposition	Easy to understand how Individual processes interact with each other	Models are excessively large	Formal mathematical representation. Well defined syntax and semantics Possible to build a software data concept	Time consuming when modeling	(Saven, 2004)
EPC	Diagram consist of *Functions, Events* and Logical connectors	Process-oriented modeling (business oriented)	Easy to understand and used by business people	loss of important information contained in events and information /resource objects	Swim lanes are not appropriate for modeling advanced and precise organizational relationships	No logical OR-connector can give building problems. Need tool to analyze complex diagrams	(Aalst W. v., 2011) (Aalst W. , 1999)
BPMN	Simple diagram illustrates Flow, Objects, Data, Connecting Objects, Swim lanes, , Artifacts	Graphical notation that depicts the steps in a business process. Process-oriented modeling (business oriented)	Support business process management for both technical users and business users	Weakness in support to knowledge- and routine work	Well defined syntax and semantics. Implemented by many software tooling	Ambiguity and confusion in sharing BPMN models	(OMG, 2011)
UML	Contains action nodes, object nodes and control nodes	Object-oriented modeling (IT oriented)	Used to document the project during software development	No detailed description of business organization units	ability to support parallel behavior	Do not make clear the links between activities and objects	(OMG, 2007)
Archimate	Contains information nodes, behavior nodes, structure nodes, relation nodes	Architectural modeling	Total view of the business, application and technological layers	Models are excessively large and complex		Difficult to build because of the different architectures and modeling languages.	(Lankhorst, 2004)
PROforma	Contains Task and sub-classes (Plan, Decision, Action and Enquiry	Constraint satisfaction graphs. Decision making and task management processes during the execution of a clinical procedure	Representation of simple sequence. Specification of plans	Data also based on hypothesises	Graphical design package	Need three kinds of knowledge data (patient specific data, general medical knowledge and knowledge of medical procedures)	(Fox, et al., 1997)
GLIF3	Contains action nodes, object nodes and control nodes	Flow chart	Enables guideline viewing by different software tools	Does not include probabilistic models for decision-making	CompuTable specification and implementation specification (Based on UML & OCL)	Do not make clear the links between activities and objects	(Peleg, et al., 2000)
GUIDE	Contains Task frame, Specific Task Frame, Actual Task Frame (uses also Petri nets)	Flow chart	User-friendly graphical editor Optimal resource allocation, through simulation of a work-flow model, based on the sound Petri net theory	Models are complex	Formal mathematical representation. Well defined syntax and semantics	Time consuming when modeling	(Quaglini, et al., 2000)
RACI	Matrix with involvement of the roles (Responsible, AccounTable, Consulted and Informed)	Clarify roles and responsibilities in cross functional projects and processes	Supports communication	No activity relation visible	Strict rules and notation. Easy to set up		Bersvendsen, (2013)

2.4.2 Process modeling and notations

Modeling Patterns as frequencies of action
To easiest way to model the pattern of actions, which are generated by a routine, is to sum the frequency of each event. Hereby the use of the Markov model can helpful, because there this model doesn't take assumptions in to account between the sequential relations between actions (Pentland et al, 2007).

Modeling Patterns as network of action
If we include chronological information, we are able to model the patterns of action as a network. The presented network allows the researcher to ask new questions about the structure of these patterns. When these patterns are visualized, we are able to get insight in the 'commonalities and differences in the overall pattern (Pentland 1999; Pentland et al., 2007). The possibilities of visualizations of these patterns will be covered in *subsection 2.3.3.*

The modeling of business processes is becoming very popular. In order to model business processes, one needs to study what notations are most suitable. Software developers are becoming aware of the need to model and understand the business processes (Phalp, 1998). A process model can provide a comprehensive understanding of a process (Phalp, Shepperd, 2000; Saven, 2004).

Process modeling is important because the software being developed should support those business processes. Therefore it is important to understand the business need while developing a software product (Phalp, Shepperd, 2000)

Regardless of the existence of several formal process modeling notations, the majority use simple diagrammatic modeling techniques in the business reengineering community (Phalp, Shepperd, 2000). In order to elect the right method, one must know the purpose of the model to be created.

Phalp (1998) introduces a framework (Figure 22) for business process modeling which provides guidance without prescribing particular notations. He achieved this by describing business process modeling in terms of three iterative and generic categories of phases: (1) Capture, (2) Analysis and (3) Presentation. When modeling business processes, two important considerations are notation and method (Phalp, 1998).

Figure 22: Iterative CAP framework (Phalp, 1998)
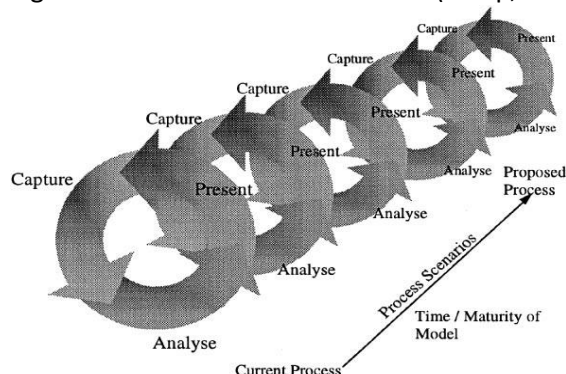
Capturing the business process: Business user need to invest time in understanding formal approaches. Thereby one have create meaningful dialogues with these users where understandable, classically diagrammatic notation is required.

Analyzing the business process: By using these models, one is able to understand the process more thoroughly compare to using simple diagrammatic techniques. In addition, when process analysis occurs, it is essential for the modeler to have more refined appliances that qualitative analysis of static diagrammatic models.

Presenting the business process: Simple diagrammatic notations can lead to complex models which are difficult to understand and follow. Therefore these models must be developed so that the users a capable to comprehend them.

Modeling and notation methods
Phalp (1998) uses the process modeling notation, called *Role Activity diagrams* (RAD), in his research, which he adapted from Miers (1994). However, one can also use other Business process modeling notations, such as Integration DEFinition (IDEF), Petri-nets, Event-driven Process chains, Business Process Modeling and Notation (BPMN), Unified Modeling Language (UML) and Archimate. A brief description of each method will be described in *subsection 2.4.2.1, subsection 2.4.2.2, subsection 2.4.2.3, subsection 2.4.2.4, subsection 2.4.2.5, subsection 2.4.2.6* and *subsection 2.4.2.7.*

Beside business process modeling methods, there are also methods, called *Medical computer interpreTable guidelines*, that are used for clinical practice guidelines (CPGs) to improve the quality of health care and to contain costs (Wang et al. 2002; Field, Lohr 1992). The Institute of Medicine (IOM) defined these practice guidelines as "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances" (Wang et al. 2002).

Although the importance of CPGs is recognized, currently most health care organizations pay more attention to guideline development, rather than guideline implementation to improve their routines (Audet et al., 1990). Zielstorff (1998) argues that Clinical Decision Support Systems (CDSSs) can improve clinicians compliance with CPGs, but the implementation of this strategy show some challenges. For example, he argues that it is difficult to translate CPGs into computer algorithms and that it is difficult to generalize the integration of guidelines systems with electronic medical records (EMRs).

Some examples of these guideline representation models are PROforma, GLIF and GUIDE/PatMan. All models contain primitives that denote specific clinical tasks and can classified into two categories, *actions* and *decisions.* In addition, they saw that most models use primitives to represent the intermediate state of a specific context during the application of CPGs. These intermediate states describe the clinical status of a patient (called *patient state*) or an *execution state* of a guideline implementation system. All primitives are briefly described in Table 15 (Wang et al., 2002). A brief description of the methods PROforma, GLIF and GUIDE/PatMan will be described in *subsection 2.4.2.8, subsection 2.4.2.9* and *subsection 2.4.2.10.*

Table 15: Task primitives (Wang et al., 2002)

Primitives	Description
Action	An action is a task (clinical or administrative) which should be executed, maintain or avoid during the process of guideline application
Decisions	A decision is a predefined selection of multiple alternatives in a guideline
Patient state	A patient state (in the context of a guideline) is a 'reification of a treated individual's clinical status' based on the action that were executed and the decisions that were made
Execution state	An execution state is a description of a guideline implementation system, based on the phase of a task, during the process of guideline application

2.4.2.1 Role Activity Diagrams (RAD)

Role activity diagrams (RADs) is a visual notation principle, used for the purpose of business process modeling. RADs originates from the work on coordination in programming environments, focusing on the perspective of individual roles and their responsibilities including the interaction between them (Badica & Badica, 2013; Holt, Ramsey, & Grimes, 1983). In Figure 23 a summary of the RAD notations is displayed followed by a description.

Figure 23: Example Role Activity diagram (Badica & Badica, 2013)
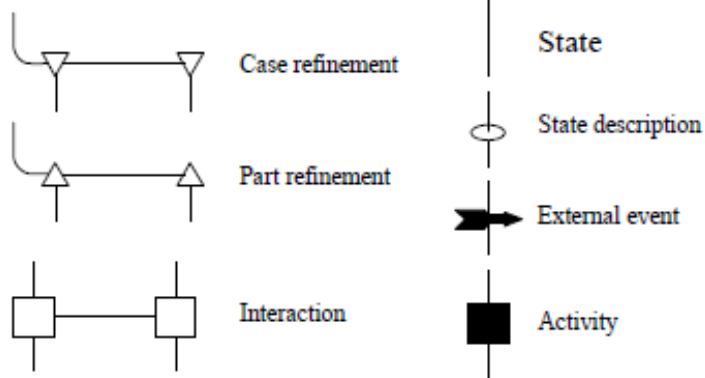
Roles are defined as a type of person, a group of persons or a system. Roles represent the unit of responsibility for performing the activities. A role describes a class of behavior and has one or more preforming threads containing sequential activities, parallel activities (*part refinement)* and choices (*case refi*nement). Each role has a thread of control. A point on this thread represents the *State* of the role. *Activities* are the building blocks of a role. All *activities* are connected with this thread and have a before and after state. An activity can be performed out in isolation or may need coordination with other activities in other roles. In the last situation the activity is called *interaction. External events* are points at which state changes going on the process environment influence on the process (Badica & Badica, 2013; Phalp, 1998).

2.4.2.2 Integration DEFinition

IDEF is initially an abbreviation of ICAM Definition, which is renamed in 1999. IDEF denotes a series (IDEF0 to DEF14) of modeling languages in the area of system- and software engineering. The most commonly used IDEF-methods are: *IDEF0 : Function modeling; IDEF1 : Information Modeling; IDEF1X : Data Modeling; IDEF3: Process Description Capture; IDEF4: Object-Oriented Design; IDEF5 Ontology Description Capture.* Each IDEF method is used for different applications. However, IDEF0 and IDEF3 are the most useful methods for business process modeling (FIPS, 1993) (Aguilar-Saven, 2003)

IDEF0
The IDEF0 method is designed for developing structured graphical representations of a system or enterprise. The use of this method allows the construction of models encompassing system functions (activities, actions, processes and operation), functional relationships and data (information or objects) that support system integration. This method should be used to analyze organization systems and promote effective communication between the analyst and the customer through simplified graphical devices. The two primary modeling components of IDEF0 are *functions* (represented on a diagram by boxes), and *data and objects* that interrelate those functions (represented by arrows) (Grover, Kettinger, 2000). Figure 24 illustrates an example of an IDEF0-process (FIPS, 1993).

Figure 24: Example IDEF0 Process
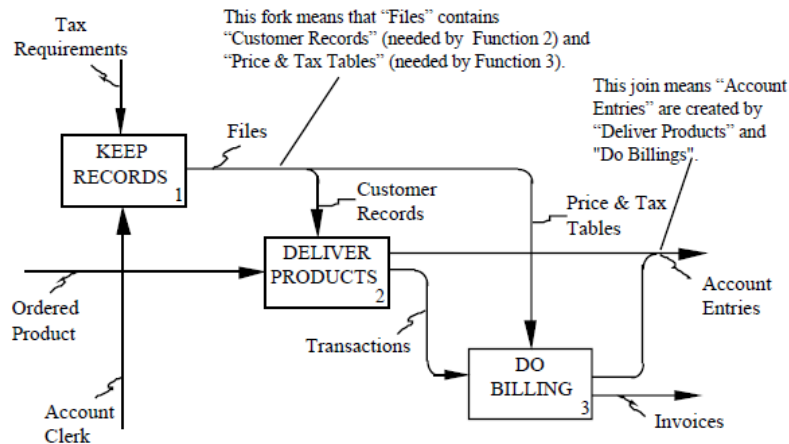
IDEF3

The IDEF3 method is designed to capture assertions about the objects within a process and illustrate descriptions of sequences, causality relations between processes and events to provide a way to capture and express knowledge of a particular process, system or organization. The IDEF3 method is used to represent Process flow description to visualize the relation between the actions and object state transitions to visualize the description of the states and conditions (Mayer, et al., 1995). Figure 25 presents the commonly used notations of IDEF3.

Figure 25: IDEF3 notations (Mayer, et al., 1995)
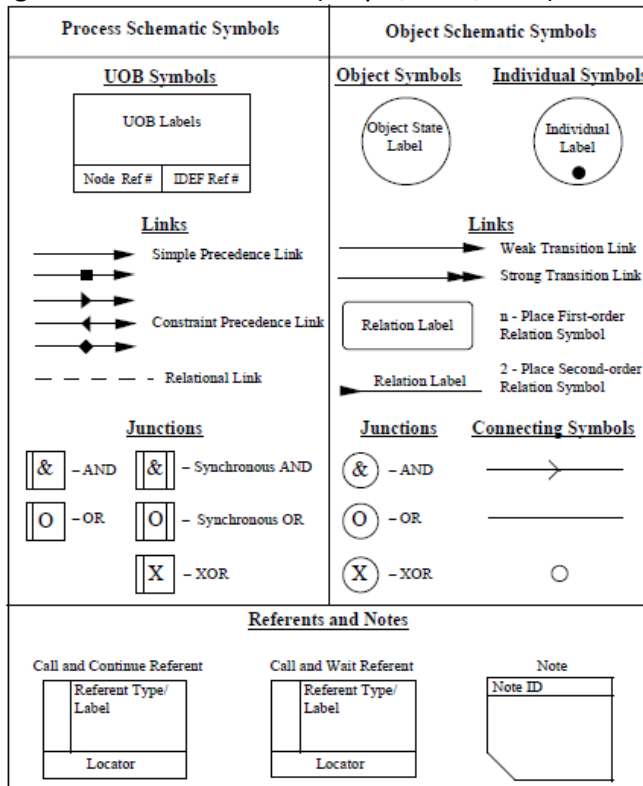
2.4.2.3 Petri Nets

A Petri net is a process modeling language, developed by Carl Adam Petri (1962), allowing graphical and mathematical modeling and analysis based on event logs (Aalst, 2011). The graphical notation is intuitive and simple, however, many analyze approaches can be used. This is also one of the reasons why the usage of Petri-nets isn't broadly accepted (Nyvlt, Rausand, 2012).

Petri nets are widely used to model discrete systems (eg. computer systems, manufacturing systems, communication systems), But when Petri nets contains large numbers of tokens, the number of reachable possibilities increases and therefore this puts a limitation to the use of this method (David, Alla, 2001).

Graphical representation
A petri net is an oriented diagram with two types of nodes, called *places (P)* and *Transitions (T).* The nodes are connected with arcs and the arcs are connecting places to transitions and vice versa. Places give information about the local state and a transitions represent an event that changes the state of a Petri net. In Figure 26, we see the basic elements of a Petri net. A circle represents a place (e.g. required resources, input data/signals) and the rectangle represents a transition (e.g. task execution, signal processing). Each place can have one or more tokens. A token (e.g. presence of a resource) represents the status of a place and is represented as an bullet inside the place.

Figure 26: Basic elements of a Petri net (Nyvlt, Rausand, 2012)
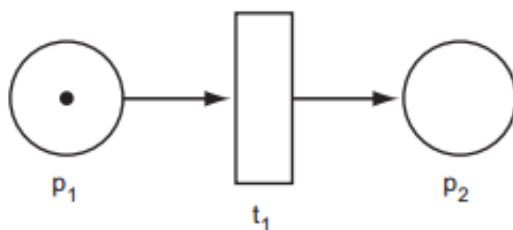
2.4.2.4 Event-driven Process Chains (EPCs)
EPC's are an intuitive graphical business process description language, introduced by Keller et al. (1992), that provide a classical notation to model business processes. The goal of this notation method is to represent logical business processes, easy to understand and used by business people. (Aalst, 1999; Aalst 2011)

An EPC diagram consist of *Functions, Events* and *Logical connectors* which is shown in Figure 27.
A *function* is the basic building block of an EPC diagram. The function relates to an activity (e.g. task, process step) which needs to be executed. A *event* describes the situation before/after a function is executed. *Functions* are connected by *Events. Events* can relate to the post-condition of one function and preforms as a precondition of another function. There are three types of *logical connectors,* (1) **V = OR** (2) **Λ = AND**, (3) **XOR** = Exclusive OR, which are used to connect activities and *events* (Aalst, 1999)

Figure 27: Notations of an EPC (Keller & Teufel, 1998)
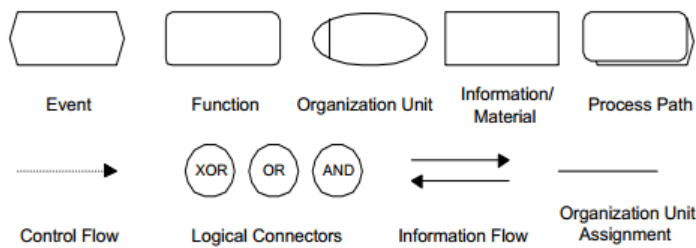
To formalize the use of EPCs, Keller et al. (1992) also made some restrictions. For example, it is forbidden to connect two *events* to each other. This restriction is adopted by BPM-tools like ARIS and SAP R/3 (Aalst, 1999).

2.4.2.5   Business Process Modeling Notation

The Business Process Modeling Notation (BPMN) standard is developed by the Object Mangement Group (OMG[5]) (OMG, 2011). The objective of BPMN is to provide a notation method that is easy to understand by all business users.

To create Business Process Models with understandable notations, OMG developed a small set of notation categories so that the reader of a BPMN can easily recognize the basic types of elements and therefore understand the diagram. Within these basic categories of elements, OMG added additional variations to support the requirements for complex Business Process Models. The five basic categories of elements are (1) Flow Objects (2) Data (3) Connecting Objects (4) Swimlanes (5) Artifacts (OMG, 2011). Figure 8 visualizes the BPMN notations.

Figure 28: Basic BPMN notations (BPMN, 2013)

39

Data Output		
Data Output Collection		
Data Store	Parallel Gateway	Parallel Event-Based Gateway to Start a Process
Group		
Text annotation		

Flow Objects are the main graphical elements to define the behavior of a Business Process. There are three *Flow Objects*: (1) Events (2) Activities (3) Gateways. *Data* is represented with the four elements: (1) Data Objects (2) Data Inputs (3) Data Outputs (4) Data Stores. There are four *Connecting Objects*: (1) Sequence Flows (2) Message Flows (3) Associations (4) Data Associations. There are two ways of grouping the primary modeling elements through *Swimlanes*: (1) Pools (2) Lanes. *Artifacts* are used to provide additional information about the Process. There are two standardized Artifacts, but modelers or modeling tools are free to add as many Artifacts as necessary. The current set of Artifacts includes: (1) Group (2) Text Annotation (OMG, 2011). Table 2[6] visualizes the list of the basic modeling elements.

2.4.2.6 Unified Modeling Language (UML) activity diagram

The Unified Modeling Language (UML) standard is developed by the Object Management Group (OMG). The UML activity diagrams exist to describe work flow and process models and are part of the UML behavioral modeling notation. By activity modeling sequences en conditions of actions are described. A Simple activity diagram, presented in Figure 29, contains an Action node, Object Node and Control Nodes (OMG, 2007).

Figure 29: Notations simple activity diagram UML (OMG, 2007)
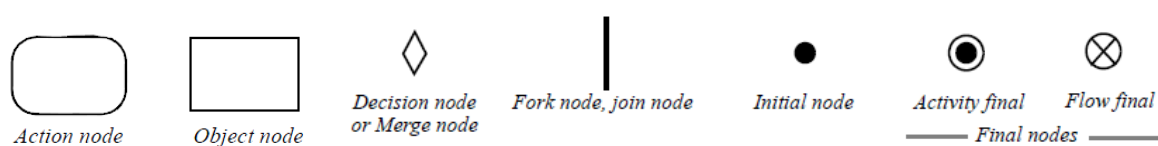
An *Action node* illustrates single automatic action steps within an activity (e.g. Received order). An *Object node* illustrates an abstract activity used by object flows in an activity (e.g. invoice). Object flows are used to visualize the activities between the action node and object node. The *Control nodes* are used to coordinate the activities between other nodes. The control nodes are, *initial node, activity final node, flow final node, decision node (merge node), fork node* and *join node.* Figure 30 illustrates an example of control nodes and action node (OMG, 2007).

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[6] See Appendix

Figure 30: Example UML diagram (UML-Diagrams, 2013)
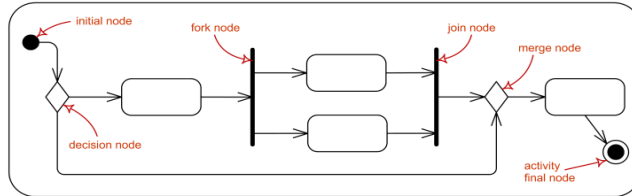
2.4.2.7 Archimate

With the use of architecture, organizations can adapt and anticipate business goals and customer requirements. This architecture should consist of principles, methods and models to design and implement organizational structures, business processes, information systems and infrastructure. However, because each domain has its own set of rules, model, language and techniques, it is difficult to integrate and control all these elements (Lankhorst, 2004).

Lankhorst (2004) antipaced in a project, called ArchiMate, that developed an architecture language and visualization techniques to visualize these domains and there comparison. The goal of this project was to provide architecture and instruments that support and improve the architecture process. In Figure 31 show an overview of the heterogeneous architecture domains and their relationships.

Figure 31: Heterogeneous architectural domains (Lankhorst, 2004)
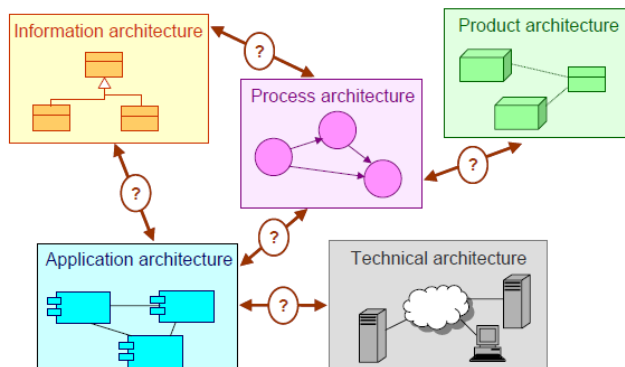
Due to the heterogeneity of these domains and the way they are currently documented, it is difficult to see the relationship between these domains. Therefore the project team focused on inter-domain relationships to model the (1) global structure within each domain and (2) the relationships between the domains (Lankhorst, 2004).

Because these architecture domains don't have a formal foundation that can be used to interpret these model for homogeneity and analysis, Lankhorst (2004) proposed an enterprise modeling language based on the service oriented architecture.

A service is defined as a unit of functionality that some entity (e.g., a system, organisation or department) makes available to its environment, and which has some value for certain entities in the environment (Lankhorst, 2004).

Figure 32: Layers (Lankhorst, 2004)
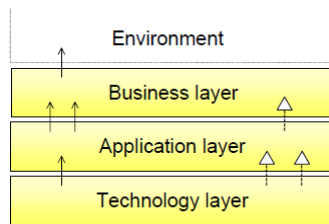
Lankhorst (2004) defines three man layers. _Business layer_: Offers product and services to external customers. These products and services are delivered with business processes performed by business actors. _Application layer_: Supports the business layer with applications services with (software) applications. _Technology layer_: offers infrastructure services (e.g. storage and communication services) that are needed as input for the applications.

The higher layers execute services formed by the lower layers. These relation are called: _use relations_. In addition, Lankhorst (2004) formed another relation layer, called: _realization._ Figure 33 shows the central structure that each layer consist.

Figure 33: Core concepts in three dimensions (Lankhorst, 2004)
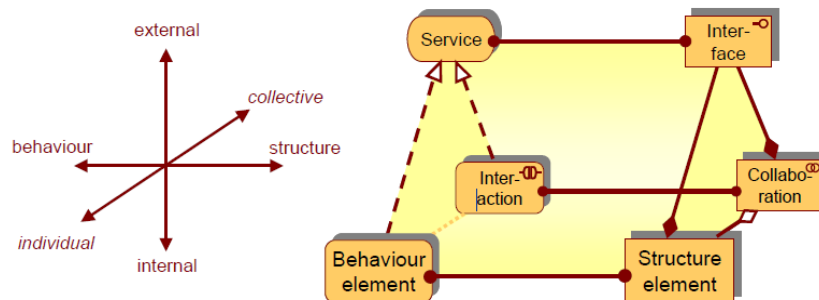
The left side shows the _behavioral_ or _dynamic_ aspect and the right side shows the _structural_ or _static_ aspect. First, the behavioral concepts are _assigned_ to structural concepts, to show who or what displays the behaviour. Second, the _external view_ is assigned to an _internal_ view on systems. Services are accessible through _interfaces_, which establishes the external view on the structural aspect (Lankhorst, 2004).

The development of organizations or systems, including their internal operations, knowledge about _internal realization_ of the services and interfaces is necessary. Therefore it is necessary to see the difference between behavior performed by an individual structural element (e.g. actor, role) and a collective behavior (interaction) performed by a collaboration of multiple structural elements (Lankhorst, 2004).

Lankhorst (2004) also argues the difference between _active_ structural elements (the business actors, application components and devices that display actual behaviour, i.e., the 'subjects' of activity) and passive structural elements (e.g. _objects_ on which behaviour is performed). In the domain of information-intensive organizations, these are usually _information objects_ in the business layer and _data objects_ in the application layer, but they may also be used to represent physical objects (Lankhorst, 2004). To visualize these concept and processes, the following notations are used.

Figure 34: ArchiMate notations (Lankhorst, 2004)
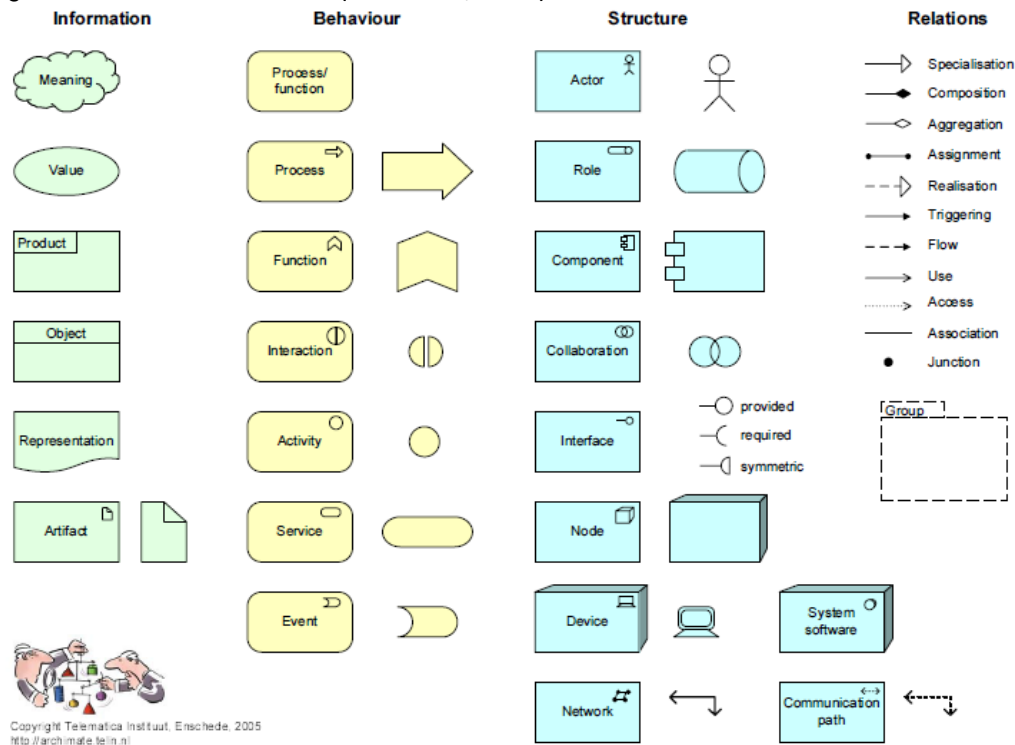
2.4.2.8 PROforma

The PROforma model was developed at the Imperial Cancer Research Fund in the United Kingdom (Fox, et al., 1997). The PROforma language is based on a generalized model of the clinical care process: the 'domino model'. This model, presented in Figure 35, shows an abstract view of the decision making and task management processes during the execution of a clinical procedure.

Figure 35: Domino model (Fox, et al., 1997)
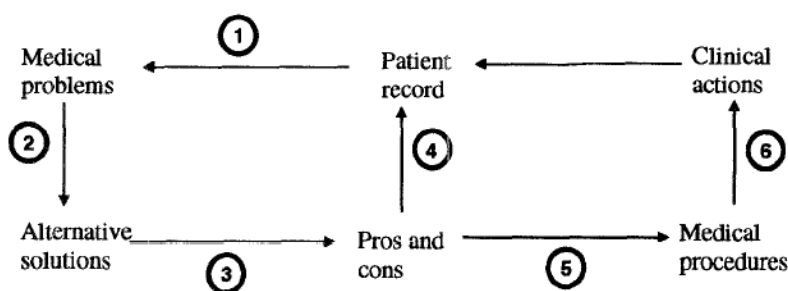
The nodes symbolizes concepts and the arrows symbolizes inference processes. According to Fox et al. (1997), the ontology of Proforma consist of a structure that is based on a "Task" and supports four different sub-classes; (1) Plan, (2) Decision, (3) Action, (4) Enquiry.

Figure 36: PROforma task ontology (Fox, et al., 1997)
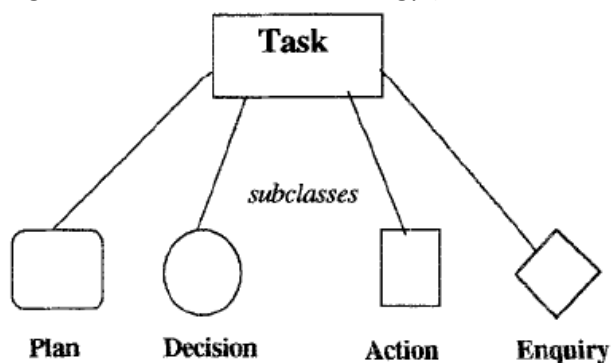
Table 16: Description subclasses (Fox, et al., 1997)

Sub-classes	Description
Plan	A plan is the basic building block were the guideline is stored for executing tasks and plans of any type in order to achieve an clinical objective.
Decisions	A decision node includes a set of options, including arguments , were one can choose from based current data values and 'commitment rules'. These commitment rules determine when the decision should take place.
Action	An action is a procedure linked to a clinical process which has to be carried out.
Enquiry	An enquiry is a request for information which is needed in order to complete a procedure or take a decision. The specification of an enquiry includes a description of the information required (e.g. lab result) and a method for getting it

2.4.2.9   Guideline Interchange Format (GLIF)

The Guideline Interchange Format (GLIF) method, developed by the InterMed Collaboratory, is used for structured representation of guidelines to facilitate sharing clinical guidelines. GLIF version 2 supports guideline modeling as a flowchart of structured steps, which enables illustrations of clinical actions and decisions. GLIF version 3 (described as GLIF3) supports guideline encoding at three levels: (1) a conceptual flowchart, (2) a compuTable specification for verification of logical consistency and completeness and (3) implemenTable specification used to incorporate into institutional information systems. GLIF3 has two goals, namely (Peleg, et al., 2000);

1. *Enable viewing of GLIF-formatted guidelines by different software tools*
2. *Enable adapting the guidelines to a variety of local uses*

The GLIF3 model is based on the Unified Modeling Language (UML) class diagrams. Additional controls are specified by using the Object Constraint Language (OCL), a part of the UML standard. In addition, GLIF3 uses macro's (like Visual basic) that define information that are needed to deploy a set of underlying GLIF steps. In Figure 37 an example is presented (Peleg, et al., 2000) (UML-Diagrams, 2013).

Figure 37: Example Marco and underlying GLIF steps (Peleg, et al., 2000)
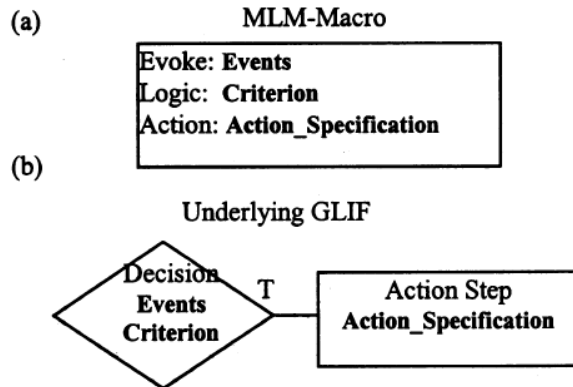
A decision step contains a *criterion* (logic slot) and is triggered by *events* (evoke slot). The event is followed by an *action step* that includes an *action specification* (action slot) (Peleg, et al., 2000).

GLIF3 facilitates using standard medical vocabularies and integrating shared guidelines into clinical information systems. The decision model is based on hierarchy of decision steps. These decision steps can be based on *choise steps* or *case steps.* The action specification model consist of two type of actions, (1) guideline flow relevant actions (e.g. ask for sub guidelines), (2) Clinically actions (e.g. making recommendations) (Peleg, et al., 2000)

2.4.2.10 GUIDE/PatMan

The GUIDE model is developed at the University of Pavia and developed for the management of acute ischemic stroke. GUIDE graphical editor used to contain medical knowledge based on guide lines. It is oriented for medical experts which and can be used with textual guide lines that are easily formalized (Quaglini, et al., 2000). An example of a workflow of the guideline for the acute ischemic stroke is presented in Figure 38.

Figure 38: Example notation & workflow acute ischemic stroke (Quaglini, et al., 2000)
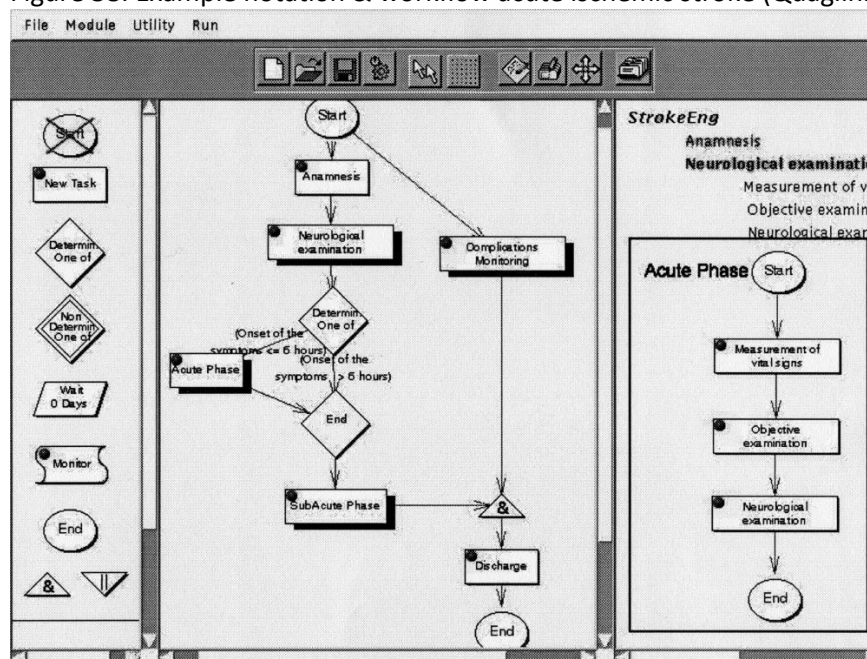
The guidelines is hierarchically structured. Therefore they can illustrate different abstraction levels. For example, shadowed rectangles represent non-atomic tasks, whose expansion is described in an inner page. The bullets (top-left) on the rectangles show the strength of the scientific evidence supporting the indication that is contained in the tasks (red_mandatory; green_recommended; yellow_suggested) (Quaglini, et al., 2000)

Guide provides a *Task Frame*, which stores all the attributes that specify that task. When a guideline is accepted within a clinical context, attributes of that task are added and become a *Specific task frame*. When the task is undertaken during a care plan, this instance of the task is called *Actual task*. Figure 39 illustrate the distinction between these task attributes (Quaglini, et al., 1998).

Figure 39: Task attributes (Quaglini, et al., 1998)
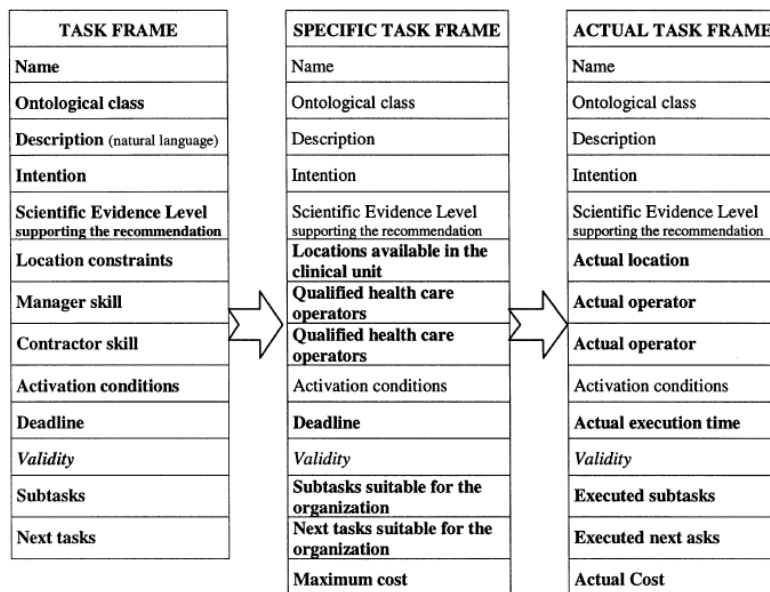
2.4.2.11 RACI

To clarify roles and responsibilities in cross functional projects and processes, one can use the RACI matrix, which derived in the 1970s from the project methodology called GDPM (Goal Directed Project Management) and was published by Grude, Haug and Andersen in 1984 (Bersvendsen, 2013).

RACI is an acronym which is derived from responsibilities types, called Responsible, AccounTable, Consulted and Informed. Table 17 explained the responsibility types in detail.

Table 17: RACI-type descriptions

Responsibility type	Description
Responsible	The role (or person) who is responsible to perform the task or activity. The Responsibility can be divided between several roles (or persons). The role who is responsible for a task or activity can also delegate this responsibility to another role (or person)
AccounTable	The role (or person) who is accounTable and has the final authority to a given task or activity. There can only be one role (or person) accounTable and this role cannot be delegated to other role (or person)
Consulted	The role (or person) who are consulted to help completing the given task or activity. The Consulted-role can be divided between several roles (or persons).
Informed	The role (or person) who will be informed when the task or activity is completed.

The responsibility types are linked to roles. A role can be performed by many persons and one person can have several roles. Figure 40 shows an example of a RACI-matrix.

Figure 40: RACI-matrix example (Wellingtone, 2013)

Deliverable	Project Manager	Technical Lead	Architect	HVAC Contractor	Electrical Contractor	Client
Approved Project Brief	AR	C				C
Approved Project Plan	AR	C	I			I
Completed Requirements	A	C	R	I	I	C
Approved Drawings	A	C	R	C	C	C
Completed Site Survey	A	R	I	C	C	I

2.5 Results of the literature study

2.5.1 Agile methods

The roots of Agile principle originate from the 1950s (Wang et al., 2012; Womack et al., 1990; Ohno, 1988), however the acceptance and support of this software development method was around 2001 when a group of proponents came together at the Agile Manifesto (Cervone, 2010) and created some principles to create a better understanding of what Agile methods are and to guide project teams who want to work with this principle (Fernandes, Alemida 2010). These principles were necessary, because the traditional plan-driven waterfall approach (Royce, 1970) did not suite the software development industry as the waterfall method is very difficult to use when you want to define your objectives beforehand. The software development community needed a method that was flexible (Jalali and Wohlin, 2012; Erickson et al. 2005) and was able to collaborate between customer and developers and advocate small self-organized teams (Sharp and Robinson, 2005). In the past few decades, many lightweight development methods (e.g. Crystal, Scrum and DSDM) arose as a response to the heavyweight methods that were based on "do it right the first time" (Beck, 2000; Williams, 2012).

Research shows (Williams, 2012) that practitioners, who adopted the Agile principles and methods, use a variety of practices to successfully complete their software development projects. However, when executed practices, called performative aspect of an organizational routine (Pentland, Feldman, 2005), become successful in the most efficient and effective way, we want to capture information about "Why" these practices are successful, "How" should we capture and executed them and "Which" artifacts we should use to execute them. In addition, we also want to capture and represent idea's, called ostensive aspect of an organizational routine (Pentland, Feldman, 2005), of new practices in order to decide if this practice is good or not (Pentland, Feldman, 2005; Pentland et al., 2010).

2.5.2 Agile (best) practices

We discovered that practices can be identified by using qualitative methods and quantitative methods and that the qualitative methods use narratives (Pentland, 1999) to capture the "ins and outs" of these practices. The World Health Organization (WHO) Regional Office for Africa (2008) and the European Commission of health and consumers (2010) also provide guidelines to achieve this

knowledge by presenting procedures to identify and document 'best practices' and 'Good Manufacturing Practices' (GMP). In the research of Maire, Bronet and Pillet (2005) a proposed classification method is presented to categories these practices based on a framework of for internal benchmarking. The classification method they used is partly based on classification guidelines of O'Dell and Jackson Grayson (1998). Dingsøyr and Moe (2004) presented a method to develop process guides with the use of workshops. They use the KJ-method of Jiro Kawatika to identify activities, based on brainstorm sessions and documenting the result. Spiegeleire, Hooft, Culpepper and Willems (2009) presented methods to identify practices to be benchmark, decide how to determine which participants should benchmark these practices and a method to benchmark the practices. The benchmark method they used, called the Bull's eye method, is based on an earlier research which was executed by TNO (Spiegeleire, Dupain, & Willems, 2006).

Next to qualitative methods to identify practices, one can also use quantitative methods, such as Process Mining (Aalst, 2011). By using Process Mining tooling, one can discover practices by building process models based on the event-log of the registered activities. In addition it is also possible to use these techniques to analyze the performance of the executed activities. Therefore by using this method (and tooling), one can (1) identify best practices, (2) improve existing process models and (3) analyze and enhance best practices performances over different software development teams.

Finally, when practices are identified, we want to share this knowledge by documenting them and represent them in the easiest way so that other users can reproduce its success. There are several business process modeling methods we examined, like RAD, IDEF0, IDEF3, Petri Nets, EPC, BMPN, UML, Archimate, PROforma, GLIF3, GUIDE and RACI, that are able represent process models in many different ways. However not all of them use simple modeling notations.

2.5.3   Research gap

Not much research has been done how (best) practices should be identified, analyzed and represented for the software development industry. An obstacle many organizations and researchers run against into is that many routines (and therefore potentially good- or best practices) are based on tacit knowledge (SDC-learningandnetworking, 2013).

Therefore we want to know: How is it done in practice? How do organizations cope with these practices? How do organizations know which practice to use for which purpose? How do organizations know if used practices are still relevant and do they analyze, improve and represent them? What is the difference in tooling and application in practice?

To answer these questions, we used the following methodology, described in *Section 3*.

3   Methodology

To get insight how organizations can control their ways of working in employing Agile software development practices, we need to visualize their patterns of action by engaging an inductive study, using qualitative methods. The use of these methods will be further explained in the following subsections.

3.1   Research Strategy

Research can be divided into two different categories; Qualitative research and Quantitative research. Qualitative research is based on the basic attitude that knowledge about reality can only be obtained 'through the eyes of the other. Quantitative research is based on the basic attitude that knowledge about reality can only be obtained 'through the eyes of the researcher' (Jonker, Pennink, 2004). Table 18 shows an overview of the research aspects between qualitative research and quantitative research.

Table 18 : qualitative research vs. quantitative research (Othman, 2013)

Qualitative Research	RESEARCH ASPECT	Quantitative Research
Discover Ideas, with General Research Objects	COMMON PURPOSE	Test Hypotheses or Specific Research Questions
Observe and Interpret	APPROACH	Measure and Test
Unstructured. Free Form	DATA COLLECTION APPROACH	Structured Response Categories Provided
Research is intimately involved. Results are subjective	RESEARCHER INDEPENDENCE	Researcher uninvolved Observer. Results are Objective
Small samples –Often in Natural setting	SAMPLES	Large samples to Produce Generalizable Results [Results that Apply to Other Situations]

We chose for the qualitative research method, because we need to discover ideas, opinions and interpret subjective interview results based on open-semi-structured interview questions which will be analyzed in with qualitative data analysis methods. Therefore we believe an inductive study with qualitative methods is the best strategy for this research.

The most frequently used qualitative research methodologies are: phenomenology, ethnography, grounded theory and case study. *Phenomenology* is a methodology used to describe phenomena, like "events, situations, experiences or concepts", as something that exists as part of our world. *Ethnography* is a methodology for descriptive studies of cultures and peoples. *Grounded theory* is a methodology used to develop a new theory based on the collection and analysis of data around a certain phenomenon. *Case study* research is a methodology used for in depth analysis of "a single or small number of units". Sometimes the case study methodology is used to describe a series of cases (Hancock, 2002).

We will execute in depth analysis of multiple real-life cases (Yin, 2009). Therefore we chose for the case study strategy. To conduct a good theory, we cannot only rely on the surface layers. Therefore

we also need to examine the underlying processes by executing in depth analysis (Sutton, Staw, 1995).

According to Yin (2009) one should treat each case separately when using multiple cases, however a case study can embrace more than one unit of embedded analysis. The results of each case can be used as information contributing to the entire study. One must decide which cases are going to be studied. The studied cases can be "unique in some way", "considered typical", "represent a variety of geographic regions" etc. (Spring, 2013)

The success of case studies is using multiple sources and techniques in the data gathering process. The researcher should determine what results need to be gathered and what techniques need be used to answer the questions. This data can be collected true surveys, interviews, documentation review, observations and/or physical artifacts (Spring, 2013).

When executing a case study, one should ensure the study is well erected to guarantee external validity, construct validity, reliability and internal validity (Yin, 2009; Spring, 2013).

Table 19: Case study strategy (Yin, 2009; Spring, 2013)

Research design	External validity	Reflects whether findings are generalizable past the investigated case(s). The external validity is increases when many variations (e.g. People, places and procedures) still conclude to the same result(s)
Data collection	Construct validity	Use multiple sources for evidence and use correct measures to study the data
Data collection	Reliability	Addresses stability, accuracy and precision measurement. Used procedures are well documented and can be repeated with the same results
Data analysis	Internal validity	To address rival explanations of multiple fragments of evidence from multiple sources. Establish a chain of evidence (forward and backward)

3.2 Case selection strategy

To increase our external validity, we wanted to examine organizations from different branches, which all have wide experience with Agile software development processes and use Scrum practices in specific. The collected data will mainly be gathered from interviews and observations.

The interviews should be held with participants who have wide experience with the Agile Software development process in detail and. In addition, they should know which (Scrum) practices are being used by the software development team. Therefore, when we approached the organizations, we looked for possibilities to held interviews with the following roles: (1) Head of the software development department, (2) experienced program manager, (3) experienced project leader and/or (4) experienced Scrum master.

We used social media (Linkedin) and personal networks (friends/colleagues/students) to achieve contact information and to approach potentially suitable organisations.

3.3 Data collection

Because we wanted to make sure that we would cover all our research objectives, we needed to prepare ourselves before we were able to conduct the interviews and observations (Yin, 2009).

3.3.1 Preparation phase

3.3.1.1 Interviews

Before we were able to execute the interviews, we needed to prepare ourselves because we needed to conduct multiple interviews with various participants in various organizations. To make sure that the course of the interviews were carried out in a similar manner, we created an interview guideline (see appendix) where we described the subjects we wanted to talk about and observation methods. The guideline steps included:

1. Step 1: Interview introduction
2. Step 2: Gather general organization- and interviewee information
3. Step 3: Identification and documentation of practices
4. Step 4: Analyze and benchmark discovered and used practices
5. Step 5: Thoughts of improving the use of (best) practices
6. Step 6: Presenting process visualizations, benchmark method & process mining method

Based on our interview guideline, we defined our interview questions. The primary data collection method is semi-structured because we also wanted to give the participant the opportunity to discuss other relevant subject. The research questions are focusing on 'How' questions, instead of the 'Why' question, to ensure that participants give full and open responses (Spradley, 1979; Strode et al., 2012).

Before the interviews were held, we tested the interview questions with a friend who has many years of experience in Agile software development, including the Scrum method. Based on his answers, I adjusted the interview questions before I officially conducted the interviews with the participants. We expected that the duration of each interview would be around 1 hour.

In order to keep track at the interview process, we created a workbook where we registered the interview steps, organization- and participants contact details, interview date/time and some additional notes to register our communication activities (e.g. 17-5 arranged interview date) per organization. The process activities we followed included:

1. Planned: The interview with the participant is scheduled for a specific date
2. Done: The interview was executed
3. Transcription concept: The transcription of the interview (including personal observations) is elaborated en stored as *v0.1*.
4. Send transcription: Transcription of the interview is stored without personal observations as *V0.2* and send to participant for approval
5. Received transcription: Transcription *V0.2* is received from participant with approval and adjustments and stored as *V0.3*
6. Finished: Observations from *V0.1* are added to the *transcription* which we achieved from the participants (v0.3) and created a final version *V1.0.*
7. Inapplicable: This status was only used when this person facilitated the interviews and did not participated one or when turned out that the organization was not suitable to conduct an interview

3.3.1.2   *Identifying methods*

Beside our goal to examine how organizations identify, analyze, improve, document and represent their practices, we also wanted to show the participants possible methods to identify-, represent - and analyze (best) practices and collect their opinion about it.

We discovered that there are many ways to identify and represent (best) practices. However we argue that not all of our examined methods are suitable for the organizations where we conduct the interviews. Therefore we decided to use the quantitative method *Process Mining* (Aalst , 2011) to and the qualitative method *Process guide workshop,* adopted from Dingsøyr and Moe (2004).

Because we wanted to be certain that these methods are applicable for the organizations we were going to interview, we used test cases and executed them beforehand. The results of the *Process Guide* were elaborated and used as input to represent four different representation methods. In addition, we used the results of the Process Guide also to create a sample-event log so that we can use it to with our process mining tool Disco.

Process guide workshop

In the case of the Process Guide process, we followed each process step that Dingsøyr and Moe (2004) described. The only exceptions we made were that we executed the workshop with only one experienced Scrum Master, instead of a whole development team and that we added punctuations to visualize the roles responsibilities. The results of this workshop resulted in a process model which shows an Agile iterative development process (see Figure 41). The results of this method were elaborated into four different representation methods called; Workshop model, RACI process model, Process guide (iterative development) and Information card and presented in the Appendix.

Figure 41: Examine Process workshop model
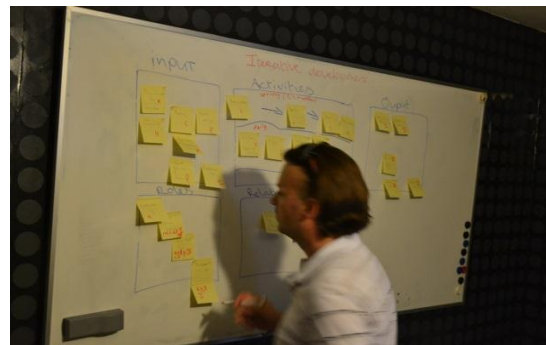
Process mining

The results of the Process Guide process gave us insight which activities can take place during iterative development process. In addition we were also able to link which role is responsible for each activity. Therefore we could combine this information and create a sample-event log for processing with the process mining tool Disco. To discover process models with process mining, one should use a Case-id, Activity name, Role-id and date-time stamp when. The information we used for our sample-event log is based on three iterative development periods. A part of this sample-event log is presented in Table 20. The results of the process mining tool Disco are presented in the appendix.

Table 20: Process mining sample-event log

Case ID	Activity	Date time	Role
Sprint 1	Planning game start	3-06-13 8:00	Scrum Master
Sprint 1	Planning game finish	3-06-13 10:00	Scrum Master
Sprint 1	Develop start	3-06-13 10:15	Developer
Sprint 1	Develop finish	3-06-13 16:00	Developer
Sprint 1	Test start	3-06-13 16:00	Tester
Sprint 1	Test finish	3-06-13 17:00	Tester
Sprint 1	Develop start	4-06-13 9:00	Developer
Sprint 1	Develop finish	4-06-13 16:00	Developer
Sprint 1	Test start	4-06-13 16:00	Tester

3.3.1.3   Representing methods

Workshop model:
First we developed the *Workshop Model* digital in Microsoft Word. The reason why we wanted to present this model is that if the interview participants found this representation method appealing, we can conclude that the process guide of Dingsøyr and Moe (2004) can be helpful to identify or improve (best) practices.

Process guide (iterative development)
During our process of developing the *Workshop Model* we discovered that it is difficult to see how the input, activities, output, roles and artifacts are related to each other. In addition, we also find it difficult to see which role is responsible or accounTable for delivering the input and, executing the activities and artifacts. Also we could not see when a specific role is informed when an activity is executed or which roles consulted in completing the activities. Therefore we wanted to develop a representation method that included these aspects. To make sure that all these missing aspects were well explained, we developed a process guide where the whole practice was writing down in text, without using any specific process modeling notation.

RACI process model
Although the *Process guide* contained all the information that is necessary to explain the practice, we did not find it an appealing representation method. Therefore we developed the *RACI process model* were we tried to visualize all the information that was written down in the *Process guide* on one page. To achieve this goal, we adopted the elements (input, output, activities, roles and artifacts) from Dingsøyr and Moe (2004), used swim-lanes, based on BMPN (OMG, 2011) and adopted the RACI-elements from Grude, Haug and Andersen (Bersvendsen, 2013) to distinguish the role involvement for the input, output and activities. The results of this representation method are visualized in the Appendix.

Information card
While the *RACI process model* included all the information of the *Process Guide*, we still did not find it appealing enough as a representation method that can easily be used to explain our practice. Therefore we contacted an architecture student to help us building a representation model that included all the information we visualized in the RACI-process model. During this process we discovered that is was very difficult to place all the information the model and still be attractive to use it. The concept version we developed is visualized in the Appendix.

3.3.1.4   Analyzing methods

Besides using methods to identify (best) practices, we also think that organizations should analyze their used practices to determine if these practices are still usable, efficient and effective. Hereby we chose to adopt two methods that can be used to analyze internal (e.g. organizations or software development teams) and external (e.g. software development industry) practices.

The first method we adopted was the *Bull's eye* method (Spiegeleire, 2006). We argue that this is a easy benchmark method that organizations can use to analyze used practices internally and externally. The second method we adopted was the *Process Mining* method. We argue that this method can be used to analyze (process discovery- and conformance phase) and improve (process enhancement phase) specific practices and/or software development processes.

To collect the opinions of our interview participants, we prepared ourselves by presented both methods on paper. For the Process mining method, we used the same Figure as presented to identify practices.

3.3.2 Collecting phase

To construct validity, we approached *multiple sources* (organizations/participants), of diverse branches, to collect our *evidence* (Yin, 2009; Spring, 2013). The organizations were positioned in the following branches; Consulting, Banking, Insurance, Navigation and Software. Two organizations applied Agile software development at other organizations (external). The rest of the organizations applied Agile software development for internal purposes.

The interviews were held with employees who are closely involved to software development processes. We decided to not send our interview question beforehand, because we wanted that the interviewee acted as informants instead of respondents (Yin, 2009). In four cases there were two interviews conducted. In one case there were three interviews conducted. In three cases there was one interview conducted. Each interview was conducted and elaborated according to the interview process, as described in subsection 3.3.1.1, to ensure the *reliability* of the process .To make certain that the interview we held and elaborated with *accuracy* and *precision*, we used an audio-recorder (Yin, 2009; Spring, 2013). The average interview duration was around 1,5 hour (minimum 1 hour, maximum 3 hours). The average process duration of each interview was around 3,5 hours (minimum 2,5 hours, maximum 6 hours).

To ensure the anonymity of the organizations we used the NATO phonetic alphabet to describe the name of the organization. To ensure the anonymity of the participants, we use the alphabetic letters "X" en/or "Y" en/or "Z". The organization sizes (in number of employees) were categorized in "Small organizations" (≥1 - <50), "Medium organizations" (≥50 - <250), "Large organizations" (≥250 - <1000) and "Enterprise organizations" (≥1000). An overview of the organizations, were we conducted the interview is presented in Table 21.

Table 21: Overview organizations

Organization	Industry	Organization size (small, medium, large, enterprise)	No. interview participants	Participant role(s)
Alpha	Consulting	Small	2	1. Architect 2. Consultant
Bravo	Consulting	Enterprise	2	1. Sr. Manager 2. Sr. Consultant
Charlie	Insurance	Medium	1	1. Program manager
Delta	Government	Enterprise	3	1. Head system development 2. Program manager 3. Project leader
Echo	Insurance	Large	2	1. Head internet portal 2. Sr. Information Analyst
Foxtrot	Navigation	Large	2	1. Program manager 2. VP Software development
Golf	Software	Enterprise	1	1. Product owner
Hotel	Consulting	Enterprise	1	1. Compliance manager

3.4 Data analyses

Each organization, where we conducted interviews, was analyzed and treated as a case and all cases were analyzed separately (Yin, 2009). Before we could analyze our coding, we translated all interview results into English. Finally we analyzed the all organization-cases with a Cross-Case analysis.

Our Case-analysis included the following subjects (see Figure 42):
1. Current way of identifying and using practices
2. Current way analyzing and improving used practices
3. Current way representing practices
4. Personal thoughts, improvement idea's and challenges
   a. Satisfaction using / improving / documenting practices
   b. How to represent for knowledge sharing

The results of the Cross-case analyzes are presented in Subsection 4.2 and include the following subjects:

1. Reasons of using, choosing and deploying practices
2. Identifying, Analyzing and improving practices
3. Representing and documenting practices
4. Perceptions on improvements
5. Perceptions on challenges
6. Most appealing representation example
7. Feasibility Bull's eye method
8. Feasibility Process mining method
9. Improvement proposals

To process the case analysis we used open coding analysis. Then, we applied the axial coding method (Strauss & Corbin, 1990) to determine patterns within the qualitative data. To execute our analyses we use the coding tool called QDAminer and Microsoft Excel. The open coding method was used for analysing the organization cases. The axial coding method was used for the Cross-Case analysis.

Figure 42: Categories QDA-miner

55
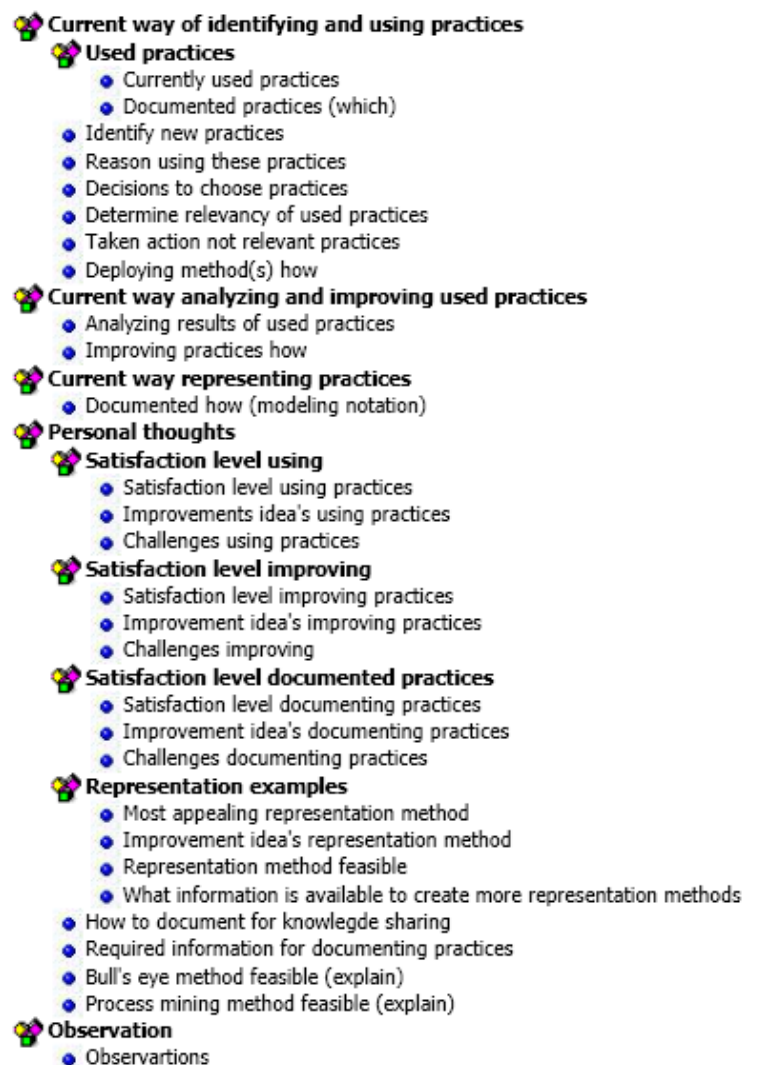
4 Results

4.1 Case Results

This subsection describes the results of the single case analyses of the organizations Alpha, Bravo, Charlie, Delta, Echo, Foxtrot and Hotel.

4.1.1 Organization Alfa

Case description
Organization Alfa is a consultancy organization which provides assistants, advisement and guidance for complex IT-projects in the areas of architecture and IT, project implementation, quality and control and testing. The organization has 50 employees, divided over the business units: Testing, Project Management and Architecture. Each business unit has its own director.

The conducted interviews were held with an IT-architect (called participant X) and a testing Consultant (called participant Y). Participant X works for the business unit Architecting and Participant Y works for the business unit Testing.

Current way of identifying and using practices
According to participant X new practices are identified by listening to the customers need, looking at development is relevant areas, visiting congresses and looking at project results. Participant Y stated that new practices are discovered unconsciously and by visiting the knowledge meetings of their business unit.

The reasons why participant X uses the practices is based on personal experiences, colleague experiences and organizations- goals and needs, customers assignment and critical success factors within this assignment. They don't use specific practices each assignment, because this depends on the situation. Therefore he sets up a strategy where he looks at the methods, techniques, practices, instruments and talk to the customer and (if possible) colleagues who already have work for this specific client. Participant Y uses the practices based on personal experience. The practices he uses have been developed over the years, but it also occurs that customers demand that specific practices should be used.

The organization has no organization policy that prescribes which practices should be used. The organization relies on the experience of their employees and expects that they will use the best methods and practices to complete the assignment.

According to participant X, the relevancy of a practice is based on the customer's assignment and if a practice is not relevant anymore for future use, it will be discussed between the colleagues and if necessary the management will be informed as well. Participant Y believes that people should decide for themselves if a practice is relevant or not. He stated that relevancy of used practices can be determined while executing retrospectives.

Current way analyzing and improving used practices
Participant X stated that the analyzing results are not documented or quantified. These subjects are discussed with colleagues during the monthly meetings. Participant Y analyses the results of used practices by evaluating the assignment (e.g. when a deadline is not reached).

Participant X stated that they register their learning experiences, use retrospectives and participate in monthly meeting with other colleagues from the business unit Architecting. During this meeting

they specifically talk about subjects where they can learn from each other. In addition they analyze failed project from which come on the news and see what they can learn from it. Participant Y stated that practices are improved automatically, based on experience.

Current way documenting and representing practices
Organization Alpha does not use a specific modeling notation or fixed representation structures to represent their practices. Their practices and lessons learned stored on a portal (Google cloud) which they can access from the internet.

According to both participants, the practices are represented with textual descriptions and process flows. They also use Microsoft PowerPoint to represent these practices to colleagues and customers. Participant Y uses Microsoft Visio the build these process flows and Participant X uses a tool, called Business Designer, which uses the modeling notations of BPMN and Archimate.

Personal thoughts, improvement idea's and challenges
<u>Satisfaction using / improving / documenting practices</u>
Both participants were satisfied looking at the usage of the practices. Participant X is satisfied about the way they improve their practices, however Participant Y argues that practices are only improved when it does not go well. Participant X thinks the way the document them is enough and Participant X is not satisfied about the way they document their practices.

To improve the usage of practices participant X argues that there should be more attention to identify, appointing, refining and improving practices. Participant Y stated that the use of practices should be analyzed more by evaluating them. He also stated that the attendance of the knowledge meetings, within his business unit, should be mandatory. To improve practices participant X argues that there should be more focus on the customers need by looking at industry developments and act on it. Participant Y argues that practices can be improved by creating a mandatory attendance of the knowledge meetings within his business unit and that there should be fixed evaluation moments under management control. According to both participants, the way of documenting practices can be improved by representing them more uniform with a format that is easy to read for everybody. Participant also stated that he prefers a Powerpoint presentation over a textual description and that these practices should be more accessible. Participant X wants to improve the amount of documented practices, because not all of them are currently documented.

The challenges participant X sees is to create enthusiasm in organizations (or by program managers), determine the Return of Investment (ROI). He also says that people usually only want to change when it hurts and that manager often think in short term. Participant Y says that people often don't want to change a chosen method and that the attendance of their knowledge meetings also involves a culture change. According to participant X, the challenge to improve practices is to persuade the value of practices to customers. Participant Y argues that often they don't schedule time to improve practices when deadlines are not reached. According to Participant Y, the challenge is that currently many practices are statically documented and they are described with too many details. He also states that it is a challenge to still document improvement/mistakes for knowledge sharing, even when there is a lack of time. Participant X argues that the challenge is to raise awareness of the benefits.

<u>How to represent for knowledge sharing</u>
In order to document practices for the use of knowledge sharing, Participant Y stated that they should be accessible, to the point, Pictures over text and have an easy modeling notation. Participant X argues that these practices also should be accessible for their customer's en both participants argue that it should be represented in a uniform way. According to participant Y, the information that is required in order to represent your practices, includes: Input, output, relation of activities and

output and the involvement of each role. Participant X stated that a practice should include: roles, simple process flows, relation between roles and activities, information exchange between roles, use of swim lanes, what starts an activity and what the result of an activity is when it is executed.

4.1.2 Organization Bravo

Case description

Organization Bravo is a consulting and outsourcings organization with over 250.000 employees located all over the world. They collaborate with clients to improve their business performance. The conducted interviews were held with a Sr. Consultant (called X) and a Sr. Manager (called Y).

Current way of identifying and using practices

According to participant X new practices are identified based on experiences and by contacting colleagues to use their knowledge and experiences. Participant Y identifies new practices with executing retrospectives and doing literature research. He also stated that departments within his organization focus on identifying new practices.

The reason why participant X is using, and determines the relevancy of used practices, is based on personal experiences where he also looks at market trends. He also stated that it depends on the customer's organization and the organizational structure the customer's uses. Participant Y stated that he uses the practices based on the experience of the client. Based on project- activities, deliverables and structure participant Y determines which practice should be used. In addition he looks at the customers communication and escalation lines and stakeholders management and uses a distributed delivery methodology. This methodology uses references such as client's experiences, literature and best practices. In addition the organization has an Agile diagnostic tool to determine the maturity level of the client.

Participant X stated that people should decide for themselves if a practice is relevant or not. When Participant Y determines that a practice is not relevant anymore, he stated that it will be removed from SharePoint in alignment with the customer. Subsequently, all the project owners will be informed and finally he will try to find a other (new) practice that is suitable (e.g. by contacting colleagues).

Both participants don't use a specific method to deploy their practices, because it depends on the assignment and customer's situation. However they consult with the customer which practices will be used and discuss them as well with the team members. Participant Y also stated that they always have a kickoff meeting with the stakeholders and project team members to explain the chosen practices will be explained.

Current way analyzing and improving used practices

Participant X stated that he does not analyze the results of used practices. He said that practices are automatically improved, based on experiences. Participant Y stated that he analyzes the results of used practices by using predefined KPI's. To improve practices he conducts story point analysis, measures team velocity and measures the delivery in story point.

Current way documenting and representing practices

Organization Bravo does not use a specific modeling notation or fixed representation structures to represent their practices. Their practices are represented on a portal which they can access from the internet.

Participant X stated that practices are documented with Microsoft Excel, Microsoft PowerPoint and defining the role responsibilities. Both participants stated that practices are also documented with textual description and participant Y showed that practices are also visualized with pictures on their portal.

Personal thoughts, improvement idea's and challenges

How to represent for knowledge sharing

According to participant X, practices should be clear and understandable for the use of knowledge sharing. When he represents practices at customers, he adopts and uses the modeling notation from the customer where he is assigned to. He usually uses Microsoft PowerPoint to present these practices, however he believes that it is not important to use a specific modeling notation. Participant Y argues that used practices should also be documented at the customers internal portal (e.g. SharePoint) and should be globally available as part of the Agile Community of Practice within Organization Bravo.

According to participant X, the information to represent practices should include Roles, process flows, on high level (to use for slights), using color for distanced, activities, roadmap and show the quick wins of the practice. Participant Y stated that the required information should include roles, activities, responsibilities, key milestones, release sprint planning, clients input, dependencies between project, processes and third parties.

Satisfaction using / improving / documenting practices

Participant X is very satisfied in the way practices are used and participant Y satisfied. When looking at the satisfaction level of the way practices are improved, participant X argues that practices are always improved and that this information is shared within the organization. Participant Y is very satisfied in the way practices are currently improved. Both participant were very satisfied, looking at the way practices are documented.

Participant X had no improvement idea's looking at the way of using their practices. Participant Y stated that it is important to start applying practices as soon as possible when executing an assignment/project. Participant X also did not have any improvement idea's, looking at they practices should be improved. He stated that he will improve them himself if necessary. Participant Y argues that to improve practices, they should be applied in an early stage, before the project starts. Hereby he uses the example to apply Agile in portfolio management. Participant did not have improvement idea's for documenting practices in a better way. The improvement idea of participant Y included that practices should be documented at the customers internal portal (e.g. SharePoint) and should be globally available as part of the Agile Community of Practice within Organization Bravo.

When looking at the challenges, participant X did not have any challenges, looking at the way practices should be used, improved and documented. Participant. Y stated that it is a challenge to convince business owners that Agile brings tangible value at a more earlier stage. He also stated that it is a challenge getting higher management commitment and support in adopting Agile practices, because the first couple of sprints may not achieve its predefined goals. The challenge to improve practices, is adopting at the business side and that it is difficult to change a current way of working (requires time). The challenge of documenting practices is that practices should be documented at the customers internal portal (e.g. SharePoint) and should be globally available as part of the Agile Community of Practice within Organization Bravo.

4.1.3 Organization Charlie

Case description

Organization Charlie is an insurance organization with over 4000 employees mostly located in the Netherlands. Organization Charlie facilitates residential and business customers for insurance in terms of damage, health care, pensions, mortgages and banking services. The conducted interview was held with a Program Manager (called X).

Current way of identifying and using practices

According to participant X new practices are identified when issues occur. Based on this issue the teams look for a solution. There are also weekly meetings planned, which are suitable to talk about these subject. The reasons why their practices are used is based on personal experiences and organization policy, however the team can deviate from these guidelines if they can explain why they want to do so. The program manager also has weekly meetings with his project managers and Scrum Masters where they decide which practices should be used. Finally, the organization also organizes an annual meeting where they talk about their decisions to choose and relevancy of their practices. If the program manager finds out that a practice is not relevant anymore, then he will stop using it and informs the process manager who is responsible for the standards and communication.

When a new program starts, participant X first starts by making a program plan, then he will, together with the stakeholders, determine the course and how the team members should act and which practices they should use. Finally the program manager decides with the team member which practices will be used to execute the program.

Current way analyzing and improving used practices

Participant X analyzes the results of used practices by measuring the difference in time in total, based on the user stories. The practices are improved during their meetings where the input must mostly come from the team, according to participant X.

Current way documenting and representing practices

Organization Charlie does not use a specific modeling notation or fixed representation structures to represent their practices. They use a free format with templates, textual descriptions and pictures. Their practices are represented on SharePoint.

Personal thoughts, improvement idea's and challenges

How to represent for knowledge sharing

Participant X likes the fact that they use SharePoint to represent their practices for knowledge sharing. This is because it is accessible and one can see who is responsible for the documented practice. According to participant X, the required information to represent practices should include; Input, output, roles, process flows, activities, responsibilities, cost-aspects, relation between activities and their interfaces with other processes and/or activities

Satisfaction using / improving / documenting practices

Participant X is satisfied in the way they use their practices within the program and very satisfied about the way they improve and document their practices.

The reason why participant X is satisfied with the use of their practices, is because of the autonomy of his team. Therefore they are able to push things thru, however he sees that this is more difficult when looking at the whole organization. To improve practices, participant X stated that they have to look at different situations (e.g. do you work at control management or project management). He

also stated that they often work ad-hoc, while looking at documenting their practices. He want to improve this by examining process review more often.

According to participant X, the challenge for using practices is getting money to invest and convincing the managing direction how to save costs by giving examples. The challenge to improve and document practices lies in the fact that one must reserve time to deliberately work on it.

4.1.4 Organization Delta

Case description

Organization Delta is a government agency with approximately 2000 employees and is legally obligated to control registration for, among other property and topography. The conducted interviews were held with Head system development (called X), a Project manager (called Y) and a Program manager (called Z).

Current way of identifying and using practices

According to participant X, new practices are identified by looking at developments in relevant areas, visiting seminars, doing literature research, the expertise group within the organization. They also ask their partners about new developments and have an architect system development who is responsible for identifying new practices. Participant Y stated that new practices are identified by executing retrospectives, during weekly meetings with the project managers and talking to customers. Participant Z stated that new practices are identified by executing the retrospectives.

The reasons why they used their practices is based on organization policy and experience. Participant X stated that they use Scrum practices because the business is more involved, however sometimes customers also want to use specific practices. Participant Y uses a project leader handbook, which defines the practices that should be used, however the stakeholders of a project can deviate from this predefined practices. Participant X expects that when a project starts, the key players have a meeting and decide which practices to use. They cannot deviate from the standard without explanation.

To determine the relevancy of used practices, participants X looks at the end results, market trend and developments. Participant Y argues that this happens automatically and they don't use any methods for this, other than having the retrospectives, to determine if they are doing the right things. Participant Z stated that the relevancies of used practices are discussed during evaluations. When the participants determine that a practice is not relevant any more, they stop using it. Participant X added that he will inform his architect, expertise teams and if the practice is related outside the development team, then he will discuss it with them as well. Participant Y and Z inform this information to all necessary parties.

Current way analyzing and improving used practices

The organizations analyze the results and improve of their practices by using predefined KPI's and using retrospectives. Participant Y also argues that this is based on experience and craftsmanship. They also use a cascade board where improvements can be noted. In addition, participant X stated that he also get this information from his architect and participant Z stated that they analyze this by evaluating every two weeks.

Current way documenting and representing practices

Organization Delta does not use a specific modeling notation or fixed representation structures to represent their practices. Their practices are represented in different forms on a portal (wiki). Participant X, Y and Z stated that the practices are represented by textual description. In addition,

participant X stated that they also use several tools (e.g. Sonar, Hudson, enterprise architect) to visualize these practices.

Personal thoughts, improvement idea's and challenges

How to represent for knowledge sharing

According to participant X, the expertise groups check if the guidelines of the practices are followed. He stated that practices should be documented on high level for knowledge sharing. Participant Y stated that the organization is not at the level to describe how these practices should be executed. However he argues that it should be represented so that it is useful for the teams and organization, accessible and someone should be responsible for sharing it. Participant Z thinks that it is not possible to work by documenting something in one way. At least not too much text. Maybe a video.

According to participant X, the required information to represent practices should include the involvement of each role, responsibility, documenting them in high level (including RACI). Participant Z stated that the required information to represent practices should include roles, activities and phases.

Satisfaction using / improving / documenting practices

Participant X is satisfied about the way practices are used, improved and documented. Participant Y is very satisfied about the way practices are used and satisfied about the way practices are improved and documented. Participant Z is reasonably satisfied about the way practices are used. He stated that the way practices are improved goes well within the projects and stated that he does not prefer to document, because it gets quickly outdated.

To improve the use of the practices, participant X stated that they need improve their deployment pipeline (continuous integration/delivery) so that they can test our software and get quick feedback. However he also sees this as a challenge to achieve. Participant Y stated that there should be more focus on the target group and make sure that only concerned parties work with them. In addition he stated that they should distinct practices for building software en managing software. Participant Z argues that people are usually too optimistic during planning sessions and that they should improve dealing more efficient with issues and changes.

To improve practices, participant X stated that there should be more alignment between projects and managing software and between projects itself. Participant Y also stated that there should be more alignment between projects and thinks that by setting up a task-force, bottlenecks can be visualized trough analyze and research. Participant Z argues that it begins with a mindset change for the whole organization.

To improve the way of documenting practices, participant X stated that all practices should be documented in detail (but not to0 much, because then it also does not work) by using more tooling like enterprise architect or Aris. Participant Y stated that when Scrum projects are finished, one should make an overview of all used practices. Participant Z argues that paper is maybe to old fashion and thinks a video or picture is better.

According to participant X, the challenge of using practices is more about behavior then rules. Another challenge he sees is the collaboration within the team (executing several roles) and the business (product owner). Participant Y sees the challenge in optimizing the relationship between using practices and different target groups. Participant Z stated that the challenge is about the mind-set of improvement with the team members and implementing it in a good way together with the external partners. Participant Y stated that it is challenging to make improvements on an organization level. Participant Z stated that is challenging to determine "how" and how much money

you would invest to ensure a pleasurable, efficient and effective manner (organization wide). Participant Y sees no challenges in documenting the practices, because he does not prefer documenting. Participant Z stated that it should be well documented, but not provide an overkill on information.

4.1.5 Organization Echo

Case description
Organization Echo is a Dutch banking insurance organization with over 6000 employees. The conducted interviews were held with a Senior Information analyst (called X) and a head of a business unit who is responsible for their internet portal (called Y).

Current way of identifying and using practices
Participant Y stated that he they don't look for new practices, only improve practices by using retrospectives. According to participant X they identify practices by visiting congresses.

According to participant X the reasons why they use practices is based on organization policy and experiences. The organization also formed a "Agile Lean Office" (ALO) where specialist decide which practices should be used. They do not use any method to deploy practices. The teams can choose for themselves. They only check if the used practices are executed properly. And that they want to manage this in the future with quality coordinators. Participant Y stated that they do not deploy these practices because they work their current way for a long time. Therefore they only coach people.

Both participants stated that the teams decide which practice they want to use. Participant X stated that if the team thinks a practice is not relevant anymore, they don't use it. According to participant Y, they can determine the relevancy of practices during standup meetings and using the retrospectives.

Participant X stated that the organization had a main software development process and if they determine that the process steps are not correct anymore, then it will be adjusted. According to participant Y there is no policy to take action when there is determined that a practice is not relevant anymore. He expects that these things will be made visible.

Current way analyzing and improving used practices
According to participant Y, the results of the practices are not all ways analyzed. When they are analyzed, this happens during the retrospectives. In addition they also work with function point analyses, but during this process they do not always relate it with their used practices. Participant X finds it difficult to decide if something is good and how this is measured.

To improve practices, participant X stated that they use checklists that measures the (product quality & process quality). They use these checklists to enable a dialog with the team. Participant Y stated that the ALO team and retrospectives are used to improve the practices.

Current way documenting and representing practices
Organization Echo does not use a specific modeling notation or fixed representation structures to represent their practices. Their practices are represented in different forms (e.g. conceptual models) on a portal (wiki). Both participants stated that the team practices (e.g. standup meeting) are not documented. According to participant X, other practices are represented by using textual descriptions and pictures

Personal thoughts, improvement idea's and challenges

How to represent for knowledge sharing

Participant X like the fact that they use pictures on the portal where people can click on for more details, but he does not know how often they use it.. Participant Y stated that it is importned that people use the portal interactively but he also does not like to document too much. The believes that if a practice works well, it becomes common knowlegde

According to participant X, the required information to represent practice should be based on high level conceptual models. Participant Y stated that he never thought about this, probably because he did not need to. The only thing that they have registered is the allocation of the roles of the team members.

Satisfaction using / improving / documenting practices

Participant X is satisfied about the way the use, improve and document practices. Participant Y is Very satisfied about the way the use practices and satisfied about the way they improve and document their practices.

To improve the use a practices, participant X argues that many team members want to invent "the wiel" again and that guidance is needed when new methods are introduced. Participant Y stated that they sometimes need to tell people that they are responsible (new way of working) and that this is also a culture aspect to encounter. To improve practices, participant X stated that they are going to improve this with the ALO specialist and quality coordinators. Participant Y wants to improve the drive of the teams. To improve the way of documenting and representing practices, participant X suggests that it should be easier to find. Participant Y stated that the speed of documenting can be improved and successes should be shared more.

Participant X stated that the challenge of using the practices is the change the mind-set of improvement with the team members. Participant Y stated that the team members need to keep challenging each other, looking for improvements. He also argues that, as a manager, he does not always see the weak links anymore, because the team tolerates it. According to participant X, the challenge of documenting practices is to create a common process that works for everybody and that resources are commonly shared.   Participant Y stated that it is challenging to motivate people to document more.

4.1.6 Organization Foxtrot

Case description

Organization Foxtrot is an organization who provides navigation products and services and has more than 3000 employees worldwide. The conducted interviews were held with the Vice President of Software Development (called X) and a Program Manager (called Y).

Current way of identifying and using practices

According to participant X, new practices are identified, improved and analyzed for relevancy during annual meetings, but they can also be identified within the team. He also stated that they are ISO9001 certified and therefore internal and external audits are executed to review the practices and processes. Also ones a year the process owners check what can be improved. Participant Y stated that new practices are identified during the retrospectives, but he also stated that they already have many experiences with software development that their used practices do not need to improve much.

Participant X stated that they use Scrum practices, because they think this is the most efficient way to develop (no waste). They also execute improvement project to determine which practices should be used, tested and documented. They do not use specific deployment methods because they develop continuously. Teams have certain freedom to decide if they don't want to use a practice, but they have to explain why they do not want to use them.

According to participant Y it depends on the project size which practices are chosen, however mainly the practices are used to manage and control his team. For example he stated that standup meetings are very successful, because you know what everybody is doing and that these practices are also useful looking at the performance progress and commitment of team members. Participant Y stated that the do not actively determine the relevancy of practices. He does not use deployment methods, because they only train new people on the job.

Current way analyzing and improving used practices

According to participant X the results of their used practices are also discussed during their annual meeting and that their process owners check each year what can be improved. Participant Y stated that they do not actively analyze the results of used practices.

To improve their practices practices, participant Y stated that they improve practices reactive by use KPI dashboard that measures the team's performance,

Current way documenting and representing practices

Organization Foxtrot does not use a specific modeling notation or fixed representation structures to represent their practices. Their practices are represented in different forms on a portal (wiki) and SharePoint.

According to participant X, the practices are represented on high level, using Microsoft Visio, pictures (also from the internet) and textual descriptions. They also often refer on their wiki to a Scrum practice book. Participant Y stated that the practices are reprensented with textual descriptions. The have manuals for training purposes, but they don't use those because the train people on the job

Personal thoughts, improvement idea's and challenges

<u>How to represent for knowledge sharing</u>

Participant X argues that can share knowledge about practices by reading books. He sees no reason to rewrite them for organizational purposes. In the past the made some training material for new employees. These were visualized with slides using Microsoft PowerPoint. Participant Y stated that it is important that the documented practices are accessible. His improvement idea was to make their wiki pages more accessible so that their whole community can use it.

According to participant X, the required information to represent practice should visualize output, roles, activities and quality criteria for the output and input (e.g. what is definition of done). According to participant Y is should include the relations activities and output, the relations activities and input, roles, responsibilities and impediments

<u>Satisfaction using / improving / documenting practices</u>

Participant X stated that he is not unsatisfied but never satisfied looking at the way practices are used. This is the reason why the annual meetings take place. However he is very satisfied in the way practices are improved and documented. Participant Y is less enthusiastic about the way practices are currently used, slightly satisfied about the way practices are improved and not satisfied about the way how practices are documented, because there is not much documented and they are not easy to find.

To improve the use of practices, participant X suggests that there should be better tooling for tractability from customer requirements to user stories and test cases. In addition he suggests optimizing the tradeoff between quality early estimates and defining requirements. Finally he suggests improving the process to ensure that user stories fit into sprint. Participant X has no suggestions, and sees no challenges, to improve or document the practices in a better way.

Participant Y is less enthusiastic about the way practices are used, compare to two years ago. He stated that this is more about the quality of the teams. He suggests to improve the estimation process, because he sees that many people are too optimistic in the beginning. In addition he suggests to improve releasing sellable quality (after a sprint it must be finished). He argues that one can learn more by sharing with each other and that all practices must contribute to the delivery of a feature. In addition he stated that it is difficult for many developers to build in an Agile manner. Hereby he means that developers often think in a way to build a complete product, while the should only focus on the requirements of the sprints to build the feature. Participant Y believes that this also is related to the way the developers are currently educated.

Participant Y believes that the responsibility of improving practices lies at the Software Discipline Manager (participant X), however in practice they notice that the Software Discipline Manager thinks that this activity should lie at program manager level. To improve practices, participant Y suggests that they should be audited. Also he suggests to build a roadmap for this. To improve that way practices are documented he suggests to make them living documents, because they are not present at the Table of their development teams. Therefore he suggests that they are more accessible for everybody.

Looking at the challenges of using practices, participant X stated that the freedom of development teams can not result in sloppiness. Then he argues that there should be more control on the teams, there should be measured more and show the team members the effects when they are sloppy. According to participant Y it stays challenging that people still need to be confronted that they should use the predefined practices and to find people that pick up this role so that practices can be improved.

4.1.7 Organization Golf

Case description
Organization Golf is an enterprise software organization with over 94.000 employees worldwide. The conducted interview was held with a product owner (called X).

Current way of identifying and using practices
Participant X stated that they constantly look at the market and see if they can adopt suitable practices. They use their current practices, because these practices have proven their success in the past. The team decides for themselves which practices they want to use, however they have to track their books in a tool called Team Foundation Services. Participant X stated that they determine the relevancy of practices based on gut feeling. They do not measure this with "hard data". Because the team can decide for themselves which practices to want to use, they do not take specific action when they determine a practice is not relevant anymore. To deploy their practices the organization uses a sprint playbook which describes the practices their using. His team is constantly developing and never starts with a complete new team, so they do not have any deployment method that is used when a new project starts. In addition, participant X stated that the whole organization went to a Scrum training. Also, they set up meetings how the team would work. These meetings were very socially oriented, no top-down policy.

Current way analyzing and improving used practices
The do not analyze the results of used practices with "hard data". They analyze them based on gut feeling. To improve their practices they use retrospectives where they deliberately look at what went well and what can be done to make the next sprint better. Every two sprints participant X has a meeting with people from other teams a talk about progress and problems and get suggestions from the management. In addition he schedules a meeting with his manager on frequently base to talk about strategies and practices.

Current way documenting and representing practices
Organization Golf does not use a specific modeling notation or fixed representation structures to represent their practices. Their practices are represented in different forms on a portal (wiki) which anyone form the organization can change. According to participant X, the practices are not represented in a uniform way. They use picture and textual descriptions to represent their practices.

Personal thoughts, improvement idea's and challenges
How to represent for knowledge sharing
Participant X argues that he is not interested what individual practices another team uses. If he thinks they work in a good way, he will document it and share it with other teams. He relies on learning about it in forms of time and on the management chain between those teams (cross communication).

Satisfaction using / improving / documenting practices
Participant X likes the fact that they have complete autonomy in the way of using their practices. He is slightly satisfied about the way they improve their practices are improved and not very satisfied about the way the document their practices, because nobody keeps them up to dat. However he is not sure it is worth the investment.

To improve the way of using the practices, participant x believes that there can be learned more by sharing with each other. Also by deliberately schedule iterations where they deliberately don't schedule as much work as they do now, so that we can spend more time improving things.

The challenge to learn but still maintain the autonomy (no command and control culture). The challenge to improve practice is, according to participant X, better scheduling to give teams enough challenge to work as an unified team but give them time to decompress and look at problems.

4.1.8   Organization Hotel

Case description
Organization Hotel is a consultancy organization which provides IT-, consulting- and outsourcing services worldwide with over 125000 employees. The conducted interview was held with an compliance manager (called X).

Current way of identifying and using practices
According to participant X, new practices are identified based on project results publications and literature. The reason why they use these practices is based on organization policy, experiences, customers' requirements and being an attractive partner for clients (added value and good price/quality ratio). They also measure from their knowledge management system the number of times a practice is consulted by employees. If a represented practice is often consulted they can decide to secure this practice in their process. Participant X argues that it is difficult to determine the relevancy of a practice. However, when decided that a practice is not relevant anymore, the most important user receive an email when changes occur. People can also subscribe to subject within their knowledge management system and if something is added or deleted they automatically get a message. The deployment methods are always discussed in consult with the customer.

Current way analyzing and improving used practices
According to participant X, the results of used practices are analyzed after each assignment based on evaluations. All the evaluations will be analyzed each year, together with the customer's satisfaction grade so they know how their method have worked. To improve this process, their goal is to get certified for Capability Maturity Model Integration (CMMI) level 5 (Optimizing) in 2015.

To improve their practices, participant X stated that this is based on evaluation (responsibility project manager) and if it is valuable, it can be placed on their knowledge management system. In addition they also have someone who look specifically for Agile software development improvements.

Current way documenting and representing practices
Organization Hotel does not use a specific modeling notation or fixed representation structures to represent their practices. Their practices are represented in different forms web based on a knowledge management system.

They use a tooling which uses BPMN as a modeling notation to represent their practices. In addition their practices are also represented with textual descriptions in Microsoft Excel and Microsoft PowerPoint. The methods Scrum, SMART, Agile co-creation are documented.

Personal thoughts, improvement idea's and challenges
How to represent for knowledge sharing
Participant X stated that this should be done in two separate levels: (1) You need to document for people how quickly have to know, "what do I need?, who do I need?, what has to be done?"
(2) Document for people implementing it (incl. training to understand the whole process) and taking into account your certificate demands (ISO). This is more text, while training is more pictures.

Organization Hotel uses Rational Method Composer to define artifacts, roles and tasks. According to participant X, these are the base elements you need. Then he stated one can also choose for event-

driven to see which activities must be executed related to other streams and that you can also add documents, checklist etc.

Satisfaction using / improving / documenting practices
Participant X is satisfied about the current way of using and documenting their practices and slightly satisfied in the current way of improving their practices.

Participant X stated that the use pretty good standard methods in many areas. To improve the use of their practices he suggests limiting the number of variations. To improve practices, participant X stated that there should be money available for it, however during this crisis situation you must see what works well. Sometimes there is no money to pay attention to this. Participant X had none improve suggestions looking at the way their practices documented and represented.

According to participant X, the challenge is to standardize and industrialize the use of practices, but at the same time convincing the customers of using them, because customers can be suborn and confident and want to use their own methods. The challenge of improve the practices is to relate improvements to statistical process measurement (CMMI level 4/5). The challenge of documenting the practices is to improve the search engine of their knowledge management system.

4.2   Cross-Case results: all organizations

Subsection 4.2.1 describes the reasons why organizations use and choose specific practices and how they deploy these practices. Subsection 4.2.2 describes how organizations identify, analyze and improve practices. Subsection 4.2.3 describes how organizations represent and document their practices. In addition this subsection describes what elements are necessary to represent practices and how should practices be documented for knowledge sharing. Subsection 4.2.4 describes the perceptions on improvements. Subsection 4.2.5 describes the perceptions on challenges. Subsection 4.2.6 shows which of our visualized representation method looks the most appealing to the participants (including improvement ideas). Subsection 4.2.7 describes the feasibility of our presented Bull's eye method (Spiegeleire, 2006). Subsection 4.2.8 describes the feasibility of our presented Process mining method (Aalst, 1999).

4.2.1   Reasons of using choosing and deploying practices

Figure 43: Using Practices (Why)

	Personal/organizational experiences	Customer demand	Industry developments
#	23	5	2
%	77%	17%	7%
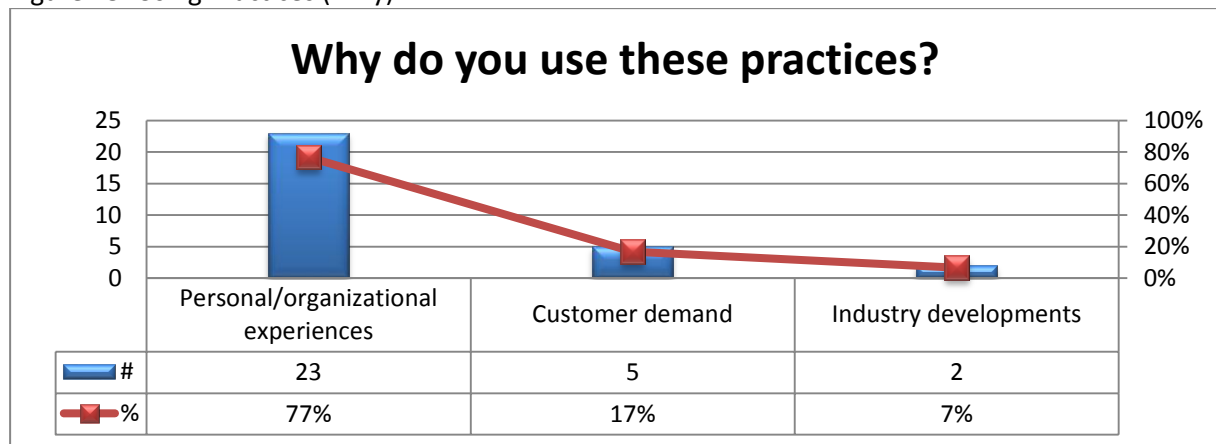
Figure 43 shows that the reason why the organization use their practices is mainly because of personal or organizational experiences (23). We see that the organizations Alpha, Bravo, Delta and Hotel have to consider that customers want to use certain practices (5). Organization Alpha and Golf choose these practices because they have been successful within the industry (2). Organization Charlie, Delta, Foxtrot use specific practices, according to organization policy.

Figure 44: Decisions to choose practices

	Personal/organizational experiences	Based on project/assignment	Customer demand	Industry developments	Spontaneous
#	10	4	2	2	1
%	53%	21%	11%	11%	5%
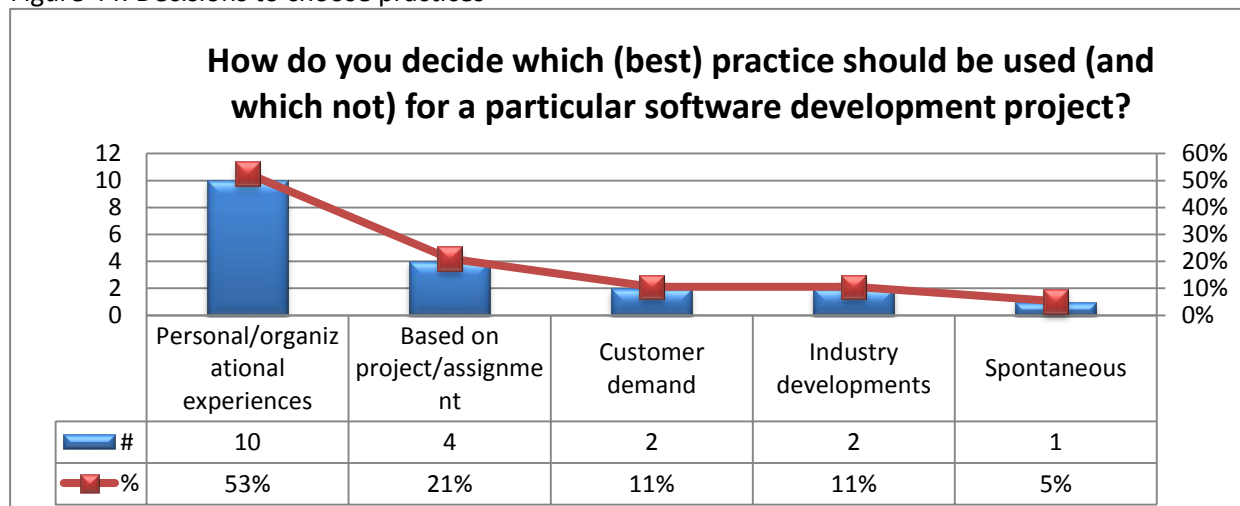
Figure 44 shows that the main reason why organizations choose specific practices for specific projects/assignments is based on personal or organizational experiences. The other reasons why specific practices are chosen is because it depends on the project/assignment (4), customers demand (or organization structure) (2). Organization Bravo also stated to look at industry developments (2). In one case, participant from organization Delta stated *"[...] Not sure if this happens consciously or unconsciously. You feel that something is not working (e.g. a team member can say if something is working efficient or not) [...]"*.

Figure 45: Deploying methods

How do you deploy these practices?

	Organizational process standard	Project based
#	15	10
%	60%	40%
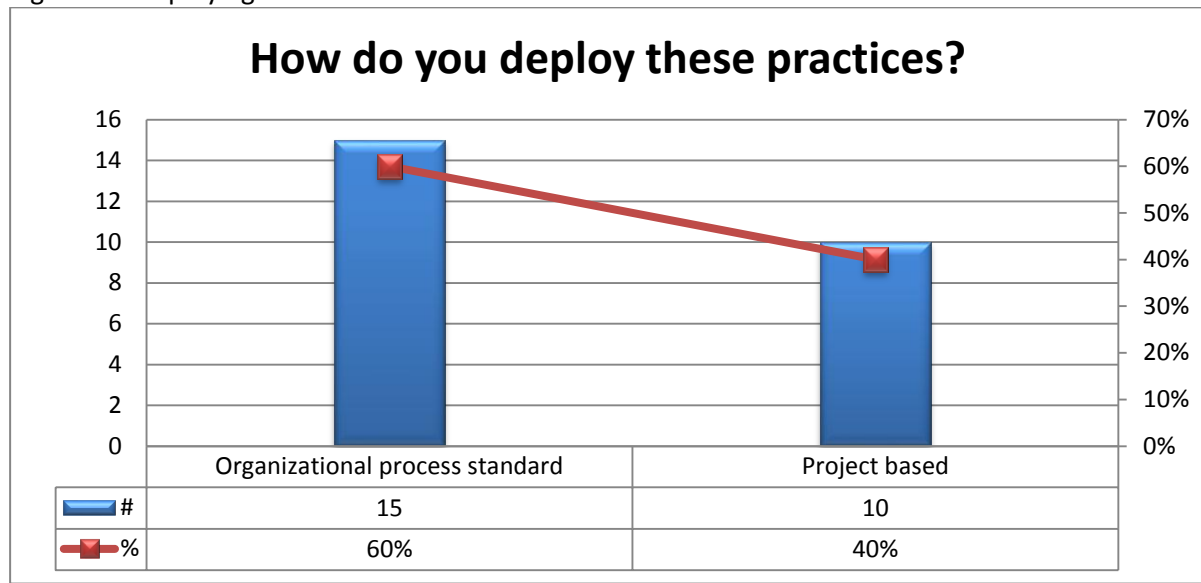
Figure 45 shows that the deployment methods depend on if they are used as an organizational process standard (15) or project based (10). Organizations Bravo, Charlie, Delta, Echo, Foxtrot and Golf deploy their practices according to an organizational process standard. Organization Alpha, Bravo, Charlie, Delta and Hotel deploy their practices based on the project assignment. To get better insight in the specific deployment methods we zoom in on the organizational process standard category and project based category in Figure 48 and Figure 49.

Figure 46: Deploying methods 1/2

How do you deploy these practices 1/2
(Project based)

	Depends on assignment	Using specific method	Discuss with team
#	6	3	1
%	60%	30%	10%
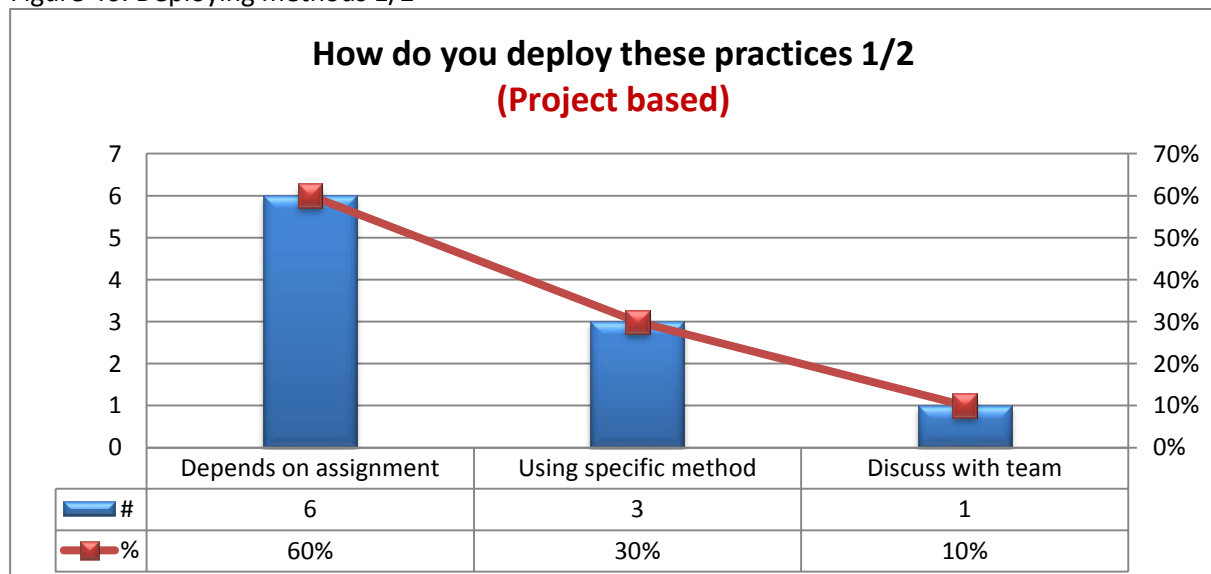
Figure 46 shows that the consulting organizations all state that they do not use one specific method, because this depends on their customer's assignment (6), however participant X stated that he does use a method set up a *"[…] strategy (methods, techniques, practices, instruments) to deploy the assignment and (if possible) talking to a colleague who already have work for this specific client and share experiences […]"*. The program manager from organization Charlie and project manager from organization Delta stated to use specific project management methods to deploy their project (3). Only participant Y from organization Bravo stated to discuss the practices with the team by organizing a kickoff meeting with the stakeholders and project team (1).

Figure 47: Deploying methods 2/2

How do you deploy these practices 2/2
(Organizational process standard)

	Not necessary	Practices manual	Train people	Discuss with team	Depends on assignment
#	4	3	3	3	1
%	29%	21%	21%	21%	7%
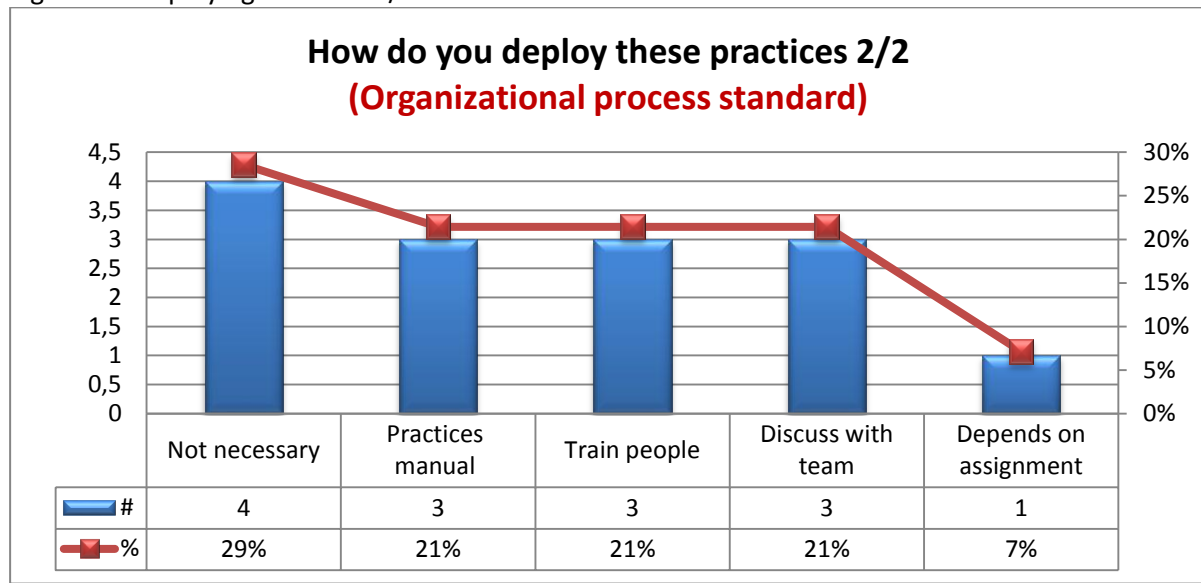
Figure 47 shows that if we look at the standardized processes, 4 participants, from the organizations Echo, Foxtrot and Golf stated that they do not apply any deployment methods, because *"[…] we develop continuously […]"*. & *"[…] teams can decide themselves which practice they use […]"*. Organization Bravo, Charlie and Golf have a manual where the used practices are described (3). Organization Delta trains employees on the job and all team members from organization Delta and Golf went to a Scrum training. In three cases the deployment methods are discusses with the team members (3) and one participant stated that it depends on the assignment.

Figure 48: Determine relevancy (How)

How do you decide if the used practice is still relevant?

	Evaluation (qualitative data)	Gut feeling	Customer demand	Not Applied	External audit
#	12	4	2	2	1
%	57%	19%	10%	10%	5%
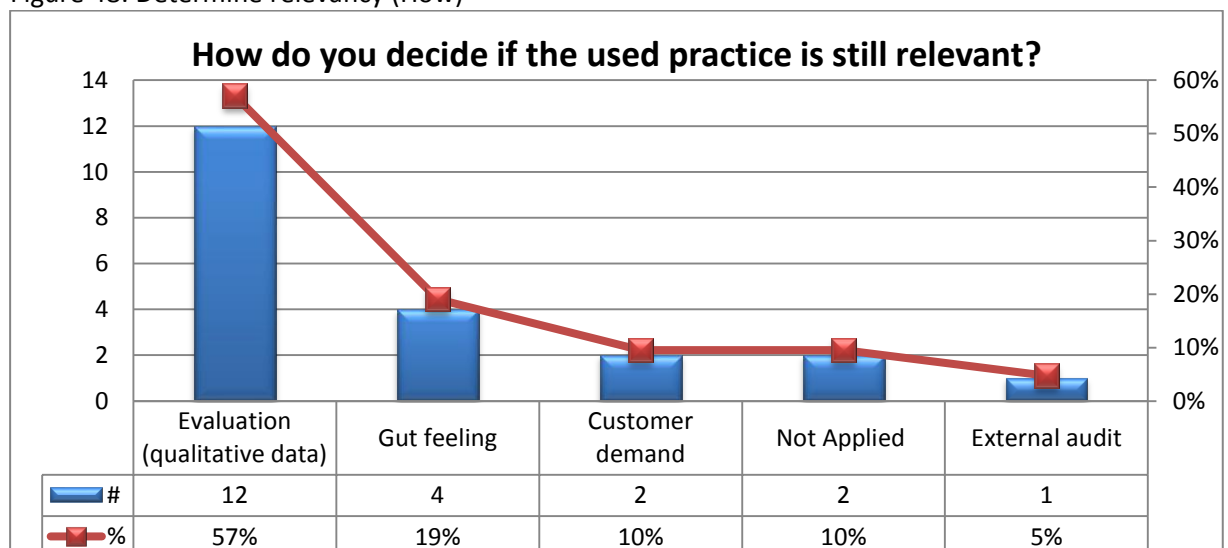
Figure 48 shows that the organizations mainly determine the relevancy of use practices based on evaluations (12). Participant Y from organization Alpha, participant Y from organization Delta and participant Y from organization Echo stated that the relevancy of practices will be determined during the retrospectives (3/12). Participant X from organization Delta determines the relevancy by looking at the end results of the project (4/12). Both participants from organization Echo stated that their teams determine if practices are relevant or not (6/12). Participant X from organization Foxtrot and participant X from organization Charlie stated that they determine the relevancy of practices during annual meetings (8/12) and in organization Foxtrot the process owners check ones a year what can be improved (9/12). Participant y from organization Echo stated that during the standup meetings the team members can decide if practices are relevant (10/12). Participant Z from organization Delta stated that this happens during evaluations (11/12) and participant X from organization Golf stated that they do this during evaluations but not with hard data (12/12)

We also see that the relevancy is determined based on gut feeling (4) and based on the customers' demands (2). Participant X from organization Charlie does not apply (1) any method or technique to determine the relevancy of use practices, however they discuss the subject during their annual evaluation. He stated that they realize that this needs to be done, but this cost time and money. Participant Y from organization Foxtrot stated "[…] we are not actively working on this […]" (Not applied, (1)), but participant X from organization Foxtrot stated that they are ISO9001 certified and therefore apply external audits (4%) determine the relevancy of their practices.

Figure 49: Taken action not relevant practices

What do you do if you decide the practice is not relevant anymore ?

	Inform team / management	None	Stop using it	Remove practice	Find suiteble practice
#	9	6	6	3	1
%	36%	24%	24%	12%	4%
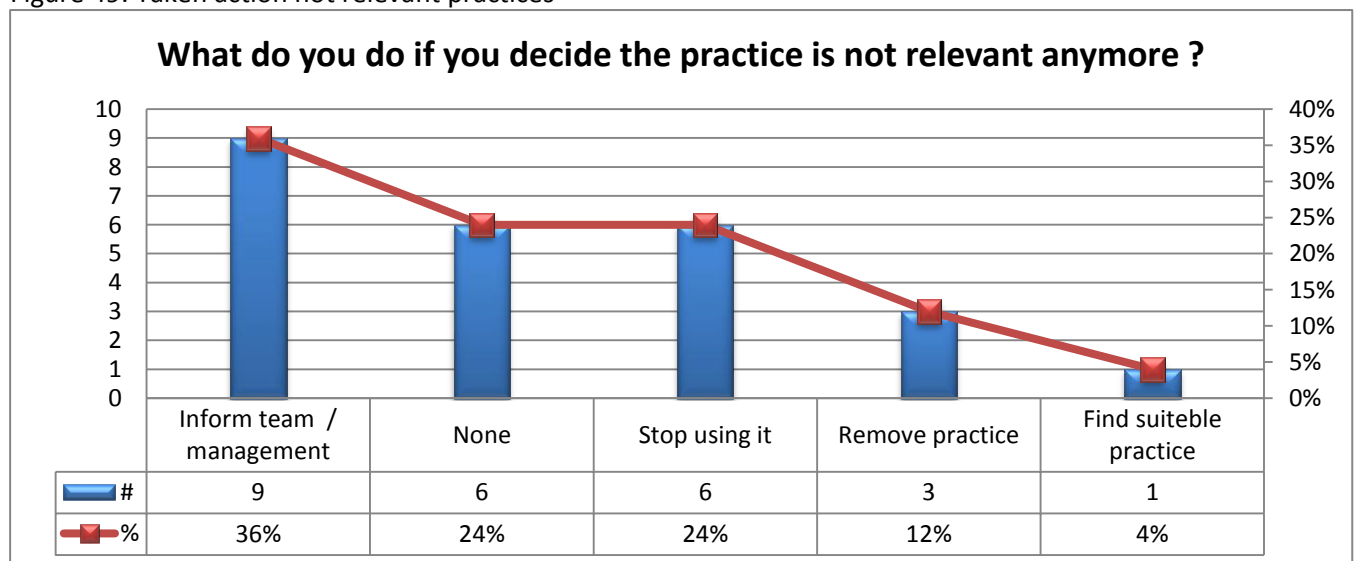
Figure 49 shows that in nine cases the people will get informed when practices are not relevant anymore (9). In 6 cases participant stated that they will not take any action. For example, because *"[…] the team can decide themselves which practice they use […]"* and *"[…} we are not actively working on this […]"*. In 6 cases the participants stated that they will stop using it (6). In four of the six cases, which were given by organization Charlie and Delta, they inform the necessary parties. In three cases the practice will be removed from the location where it is documented. Only one participant from organization Bravo stated that he will *"[…] Try find a practice that is suitable (e.g. contactin colleagues) […]"*.

4.2.2 Identifying Analyzing and improving practices

Figure 50: Identify new practices (how)
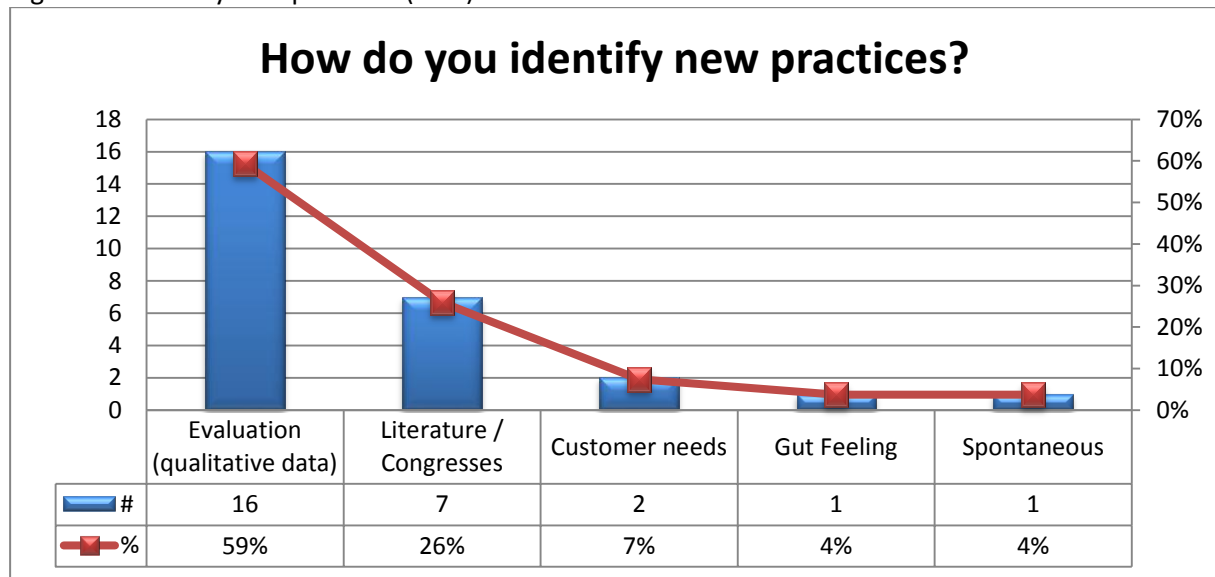
Figure 50 shows that most practices are identified based on evaluations (16). The results show that the majority of these evaluations (5/16) are held within the development team (e.g. by executing retrospectives). The consulting organizations, organization Alpha & Hotel stated to identify new practices by looking at the project results (7/16). Organization Alpha, Charlie and Delta organize meetings (10/16) on frequently base to share knowledge and discuss new ideas. Organization Foxtrot organizes annual meetings were this subject will be discussed (11/16). Organization Charlie stated that new practices are also identified when his team is dealing with issues and they are looking for a solution (12/16). Organization Delta also identifies new practices by talking to their customers and partners (13/16). In addition they have expertise groups that focus on this subject (14/16). The participants from organization Bravo also contact colleagues to identify new practices (16/16).

Secondly, we see that new practices are identified by executing literature research and visiting congresses or seminars (7). In three cases the organizations Alpha, Delta and Echo stated that they identify new practices by visiting congresses or seminars (3/7). In four cases the organizations Bravo, Delta, Golf and Hotel stated to execute literature research and constantly looking at the market developments (7/7).

Organization Alpha and Delta identify new practices by looking at the customer's needs (2).

In addition one participant from organization Bravo stated to identify new practices based on experiences. We categorized this as "gut feeling" (1). One participant from organization Alpha stated new practices are identified unconsciously. We categorized this as "spontaneous" (1).

Figure 51: Analyzing results (how)
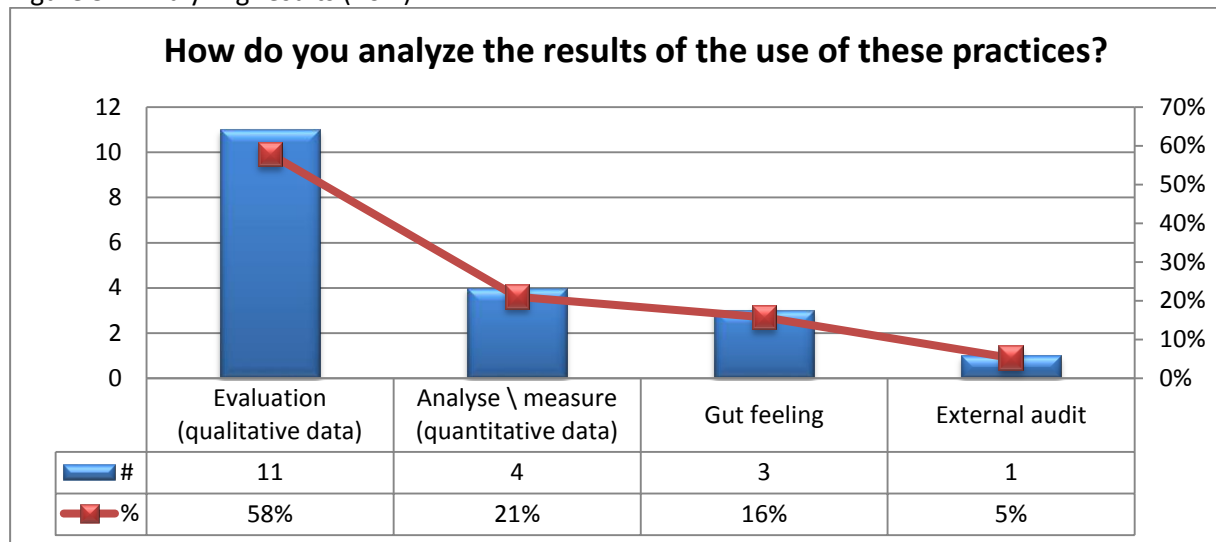
How do you analyze the results of the use of these practices?

	Evaluation (qualitative data)	Analyse \ measure (quantitative data)	Gut feeling	External audit
#	11	4	3	1
%	58%	21%	16%	5%

The results show that organization Alpha, Delta, Echo, Foxtrot, Golf and Hotel analyze the results of used practices by executing evaluations (11). Organization Alpha evaluates these results based on project evaluations and during monthly meetings with colleagues (2/11). Four participants from organization Delta and Echo stated to analyses the results during retrospectives (6/11). One participant from organization Foxtrot stated that results are analyzed during annual meetings and one a year process owners check what can be improved (8/11). Organization Golf stated that these results are evaluated, but not with hard data (9/11). Organization Hotel stated that these results are evaluated after each assignment and all evaluations are analyzed each year, together with the customer's satisfaction grade to see if their used methods were successful (11/11). Three participants from organization Delta, Echo and Golf analyze the result based on gut feeling (3). Four participants from organization Bravo, Charlie, Delta and Echo analyze the results with quantitative data. This quantitative data is, for example, measured by using predefined KPI's. One participant stated that he analyzes the results of practices by *"[…] Measuring the difference in time in total, based on user stories [...]"*. Although participant X of organization Foxtrot stated that they are ISO9001 certified and therefore apply external audits (1) to review their processes and practices, participant Y stated that they do not actively analyze the results of practices. One participant from organization Bravo stated that he does not analyzes the results of used practices.

Figure 52: Improving practices (how)

How do you improve your software development practices and processes ?

	Evaluation (qualitative data)	Analyse \ measure (quantitative data)	Gut feeling	Other
#	12	4	2	1
%	63%	21%	11%	5%
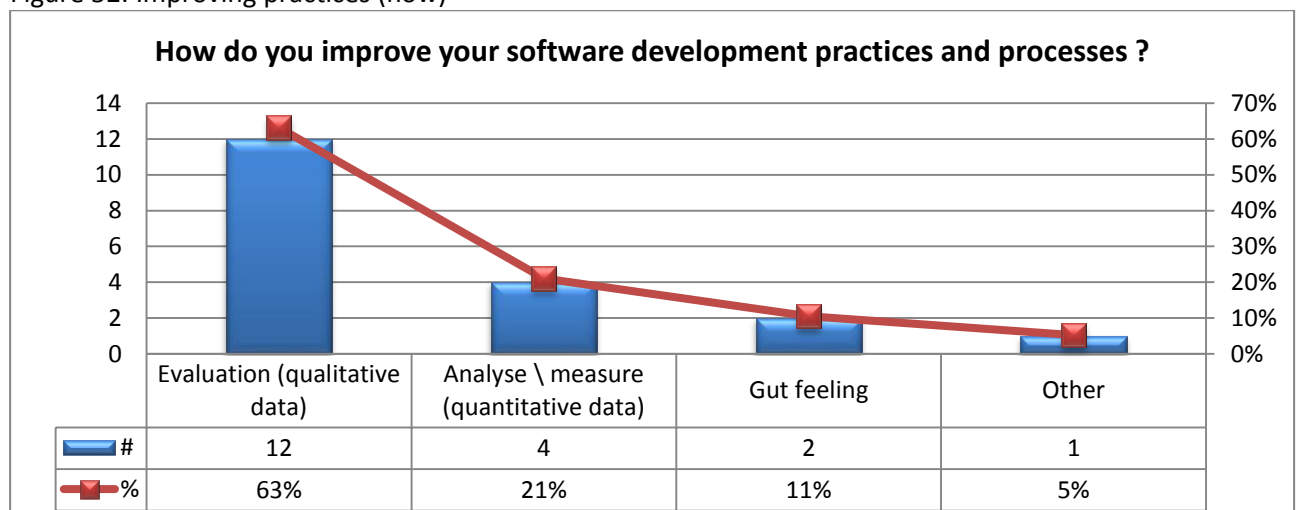
Figure 52 shows that in most cases practices are improved during evaluations sessions (12). Organization Alpha evaluates failed project and registers learning experiences. In addition they evaluate during meetings with colleagues and evaluate during retrospectives (3/12). Organization Charlie improves practices during weekly meetings (4/12). Participant X from organization Delta receives information from his architect, who is responsible for improving practices (5/12). Participant Z stated that they evaluate every two weeks (6/12). Organization Echo uses checklist that measures product quality and process quality. They use these checklists as input to start a dialogue with the team (8/12). In addition they also use retrospectives to improve their practices (9/12). Participant X from organization Foxtrot stated that their practices are improved during their annual meetings (10/12). Participant X from Organization Golf uses retrospectives to improve their practices, but he also have scheduled meetings every two sprints where they talk about progress and problems and get suggestions from the management (11/12). Organization Hotel improves their practices based on evaluations when assignments are finished and they also have an employee that looks specifically for Agile software development improvements (12/12).

In four cases they are improved by using quantitative data (4). Participant Y from organization Bravo stated that practices are improved by measuring the team's velocity and by measuring the delivery in story points (2/4). Participant Y from organization Delta and participant Y from organization Foxtrot stated that they use KPI dashboard that measures team performances (4/4).

In two cases we see that practices are improved based on gut feeling (occurs automatically / based on personal experiences)(2). Organization Delta also uses a Cascade board where team members can write down improvement idea's (1).
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4.2.3 Representing and documenting practices

Figure 53: Overview used and documented management and team practices
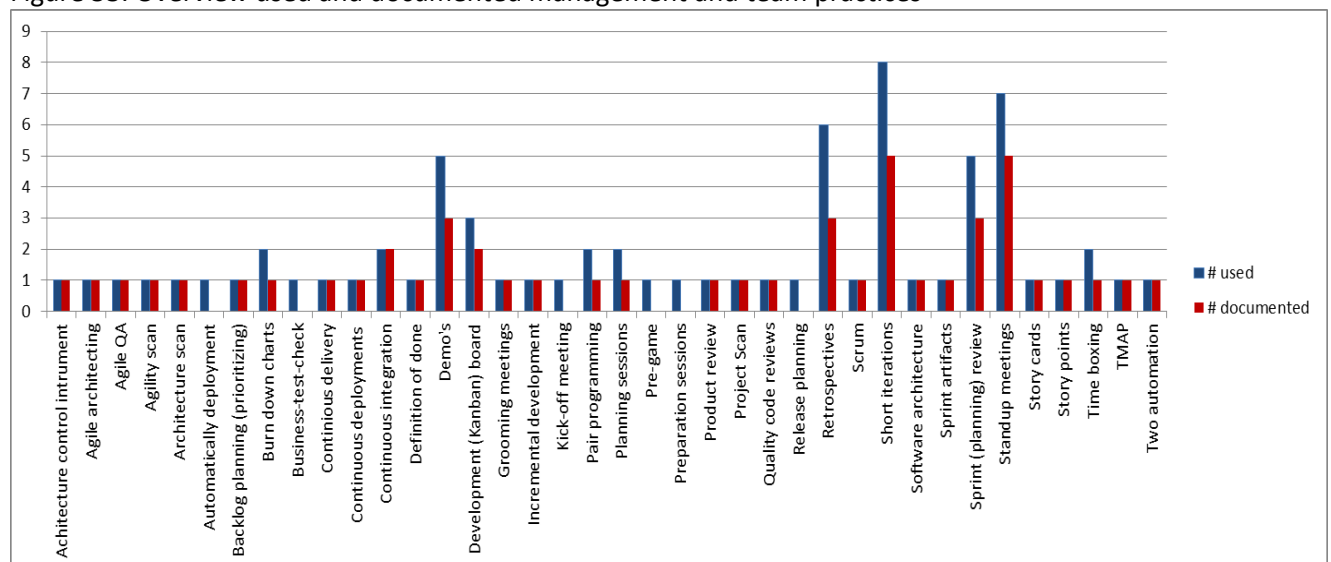
Figure 53 illustrates the 38 different kind of practices the organizations use and have documented. Organization Alpha, Delta, Echo and Hotel have not documented all their practices. Organization Bravo, Charlie, Foxtrot and Golf stated that all their practices are documented.

Table 22 shows that none of the organizations use a specific modeling notation to represent all their practices. Table 23 shows that almost all organizations, except Charlie, use a portal to store and represent their practices. Organization Charlie uses SharePoint to represent their practices.

Table 22: Modeling notation & Representation structures

Representing	Alpha	Bravo	Charlie	Delta	Echo	Foxtrot	Golf	Hotel
Specific modelling notation	No	No	No	No	No	No	No	No
Fixed representation structures	No	No	No	No	No	No	No	No

Table 23: Modeling notation & Representation structures

Storing practices	Alpha	Bravo	Charlie	Delta	Echo	Foxtrot	Golf	Hotel
Organization Portal	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Sharepoint			Yes			Yes		

Figure 54: Representation method

	Textual Descriptions	Pictures	Software program
#	21	13	3
%	57%	35%	8%
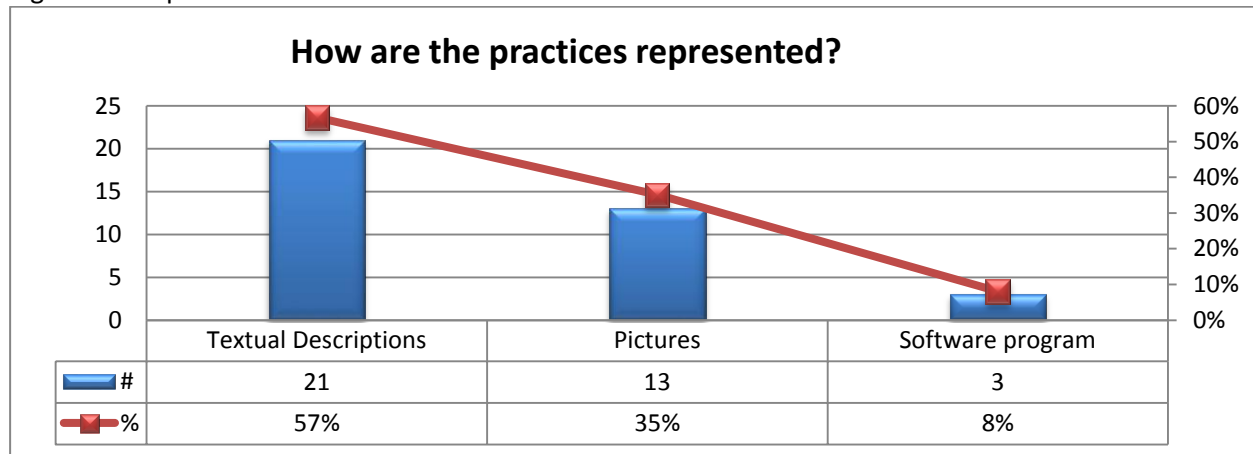
Figure 54 shows that most practices are represented with textual descriptions (21). In thirteen cases the participant stated that the practices are represented by pictures. Organization Hotel uses Rational Method Composer. Organization Alpha uses Business Designer, which uses BPMN and Archimate as an modeling notation. Organization Delta uses Sonar, Hudson and Enterprise architect.

Organization Alpha, Delta, Echo and Foxtrot and Hotel have not documented their software development practices in detail. Participant X of organization Echo stated that *"[…] team practices are not documented […]"* Participant X from organization Bravo stated that this information generally is not available, but participant Y from organization Bravo stated that they use similar models in their internal portal and knowledgebase.

Although the results show that many organizations do not represent their practices in detail, we see that when we asked the participants which information is required to represent practices, they gave us enough information to determine how practices should be represented for knowledge sharing. Figure 55 summarizes the required information to represent practices.

Figure 55: Required information for representing practices

Which information is necessary for you in order to document your practices?

	Roles	Activities	Relation	Responsibilities	Input	Output	Artifacts	Tasks
#	11	6	5	5	4	4	4	1
%	28%	15%	13%	13%	10%	10%	10%	3%
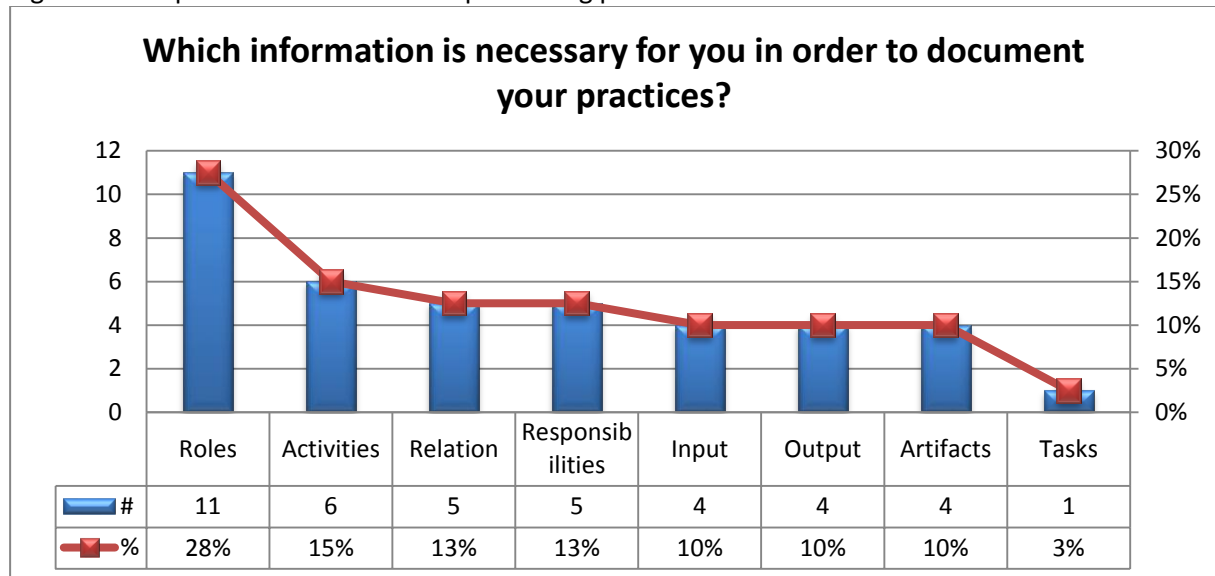
Eleven of the fourteen participants think that roles should be represented (11). Six participants think that the executed activities should be included (6). Five participants think that responsibilities should be included (5). Four participants would include the element input (4), four participants would include output (4) and four participants would include artifacts (4). One participant stated that they use Rational Method Composer which defines tasks (1) and that these tasks are merged to describe activities.

Figure 56 illustrates the category answers to document practices for knowledge sharing.

Figure 56: Documenting for knowledge sharing

How do you think these practices should be documented for the use of knowledge sharing?

	Requirement	Preference	Practice
#	12	7	7
%	46%	27%	27%
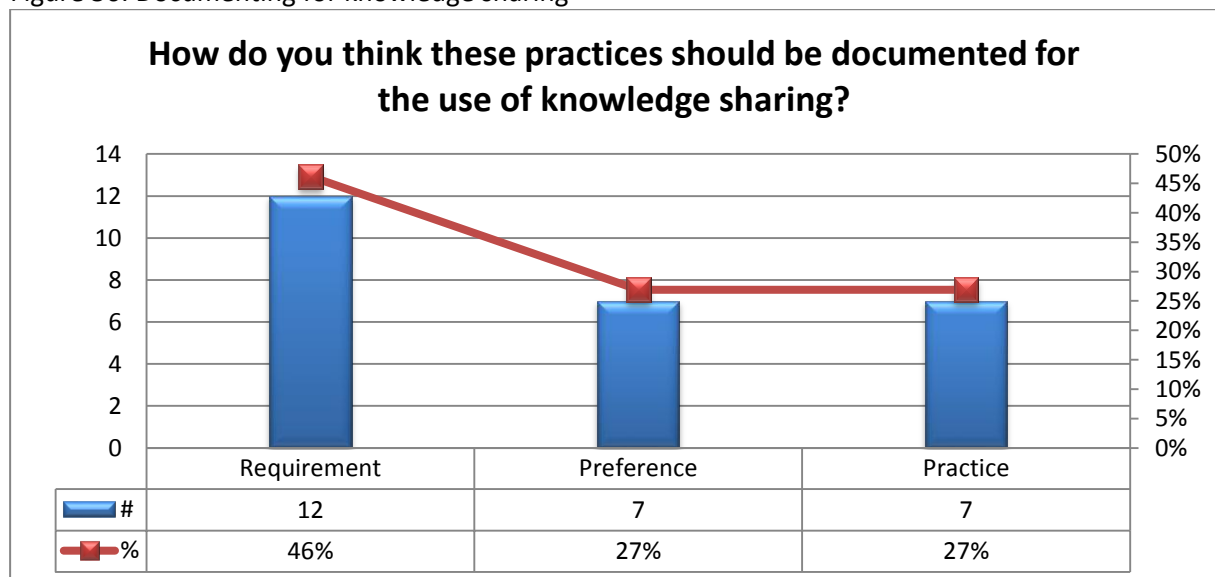
We categorized the results in Requirement, Preference and specific Practice examples and summarized the answers in the following Table.

Table 24: Categories documenting for knowledge sharing

Requirement	Preference	Practice
Accessible	PowerPoint over text	Share customer internal portal / knowledgebase with Agile community
To the point	Easy modeling notation	Place it on SharePoint
Uniform	Not important to use specific modeling notation	Place it on wiki for review
Clear and understandable	Document High level	Represent with video instead of text
Adopt modeling notation from client	Prefer use of practices from books	Make it interactive (clickable)
Useful for teams and organizations	PowerPoint	Training material
Role responsibility for sharing		Only document and share when necessary, provide cross communication
Important to use portal interactively		
Document on two levels: quick reference (pictures) & detail (text)		

In total we gathered 12 requirements (9 different requirements), 7 preferences (6 different preferences) and 7 practice suggestions.

Requirements

Participant X and Y from organization Alpha and participant X from organization Charlie stated that the practice should be accessible. Participant Y from organization Alpha stated that the practice should be "to the point". Participant X and Y from organization Alpha also stated that the practices should represented in a uniform manner.

Participant X from organization Bravo stated that the representation should be clear and understandable. In addition he stated that he also adopts the modeling notation from the client where he is working. Participant Y from organization Delta stated that *"[…] it should be useful for the teams and organization, accessible and someone should be responsible for sharing it […]"*.

Participant Y from organization Echo argues that it is important that people use their portal interactively. Participant Y from organization Foxtrot argues that their wiki-pages should be accessible for the whole community within the organization.

Participant X from organization stated that one should document on two different level: *"[…] 1. You need to document for people how quickly have to know, "what do I need?, who do I need?, what has to be done?" 2. Document for people implementing it (incl. training to understand the whole process) and taking into account your certificate demands (ISO). This is more text, while training is more pictures […]"*.

Preferences

Participant Y from organization Alpha prefers Microsoft PowerPoint sheet over text with and easy modeling notation. Participant X from organization Bravo also prefers to use Microsoft PowerPoint. In addition he stated that it is *"[…] not important to a use specific modeling notation […]"*.

Participant X from organization Delta prefers to document on "high level". Participant X from organization Foxtrot also to uses Microsoft PowerPoint and stated *"[…] all Scrum practices are already described in books. No need to rewrite […]"*.

Practice

Participant Y from organization Bravo suggests to document the used practices at the customers internal portal and make it available as part their Agile community. Participant X from Charlie suggests storing all practices on SharePoint because it accessible and you can see who is responsible for the documentation. Participant X from organization Delta stated that they "[…] already have a wiki (also reviewed) were the expertise group checks if the guidelines are followed […]". Participant Z from organization Delta thinks that it is not possible to work by documenting something in one way. In addition he stated that it should not be with too much text and suggests representing the practices with a video. Participant X from organization Foxtrot stated that the use training material for new employees which is represented with Microsoft PowerPoint. Participant X from organization Golf stated *"[…] If we think we work in a good way I will document it and share it to other teams,I rely on learning about it in forms of time,I rely on the management chain between those teams (cross communication) […]"*

4.2.4 Perceptions on improvements

Figure 57: Improvement ideas (Using practices)

Improvement ideas using practices

	Applying	Developing	Sharing knowledge	Analyzing	None	Limit variations	More attention
#	11	4	3	2	1	1	1
%	48%	17%	13%	9%	4%	4%	4%
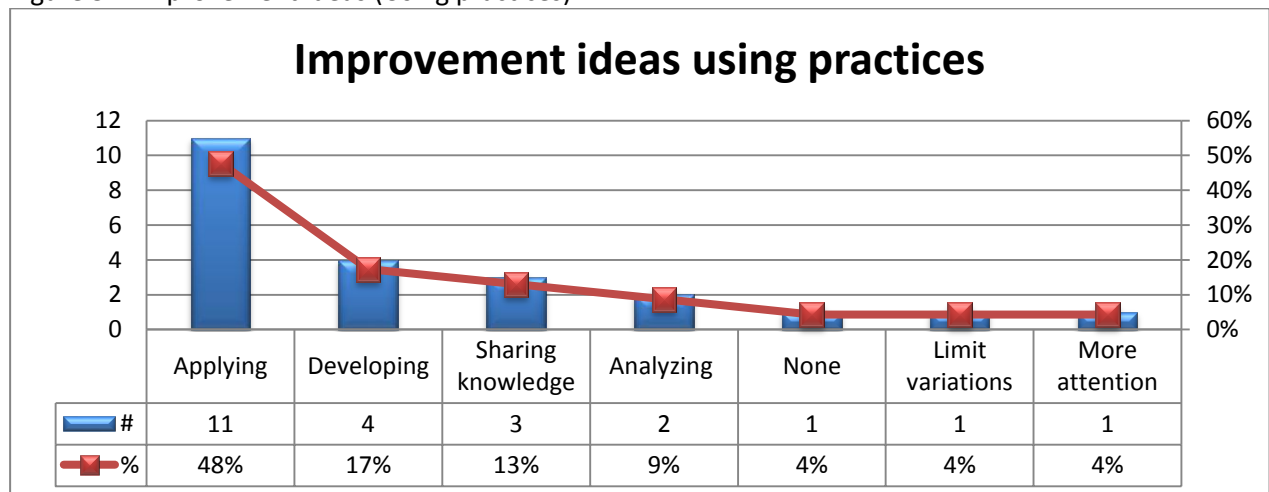
Figure 57 shows that most improvements ideas are based on the execution (Applying) of the practices (12). For example, participant Y from Organization Foxtrot wants to improve the estimation process, improve the releasing process ("after a sprint it must be finished"), all practices must contribute to the delivery of a feature and also by confronting people that they should use the predefined practices to improve the quality of the teams. (4/12). Participant X from organization Foxtrot want improve the use of practices to ensure that user stories fit in one sprint. Participant Y from organization Echo stated *"[…] sometimes we need to tell people that they are responsible (new way of working). This is also a culture aspect […]"* (5/12). The participants from organization Delta stated that they want to improve the deployment pipeline, distinct practices for building software and managing software and make sure that only concerned parties work with them (12/12). Participant Y from organization Bravo argues that practices also should apply before a project starts (e.g. Applying Agile practices in portfolio management).

In four cases the improvement ideas are based on developing (4). The participant from organization Delta stated to improve practices to improve their deployment process and dealing more efficient with issues and changes (2/4). Participant X from organization Foxtrot is looking for better tooling for tractability from customer requirements to user stories and test cases. In addition he wants to optimize the tradeoff between quality early estimates and define requirements (2/4).

In four cases the improvement ideas are based on knowledge sharing (3). Participant X from organization suggests a mandatory attendance in knowledge meetings within his business unit "Testing" (1/3). Participant X from organization Echo stated *"[…] many team members want to invent "the wheel" again. We need to provide guidance when we introduce a new method […]"* (2/3). Participant X from organization golf argues to learn more by sharing with each other (3/3).

In two cases the participants from organization Alpha and Foxtrot stated that the use of practices should be analyzed/measured more. One participant (organization Hotel) want to limit the number of variations and one participant (organization Alpha) wants to give more attention to *"[…] identify, appointing, refining and improving […]"* the practices.

Figure 58: Improvement ideas (improving practices)
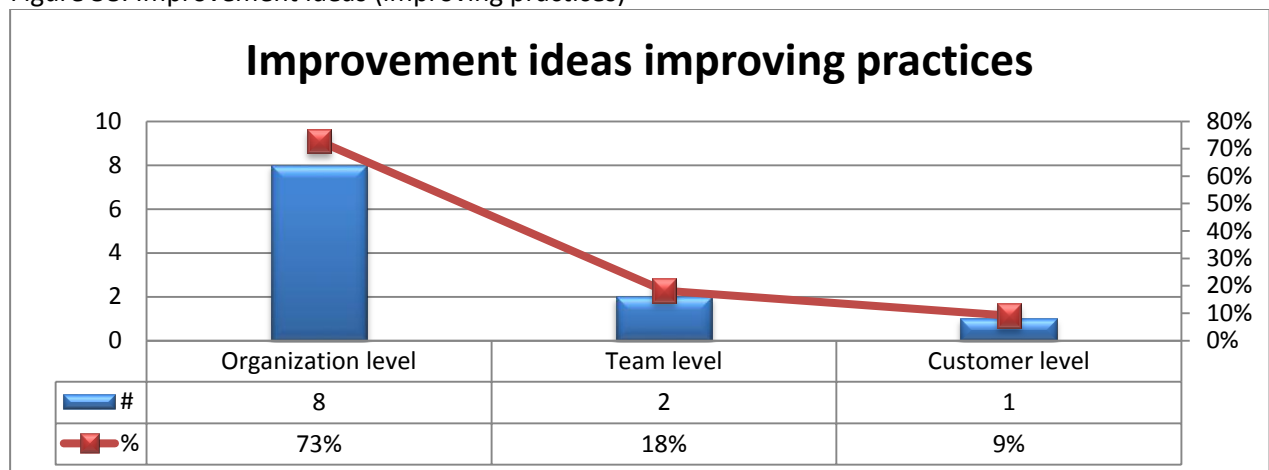
Figure 58 shows that most improvement ideas are lying at the organizational level (8) of the organizations. In two cases the improvements are at team level and in one case the participant stated that the practices should be*"[…] more focused on the customers need […]"*. Because the improvement ideas of the participants are focusing on several aspects, we summarized the results of the categories *Organizational level* and *Team* level in the following Table.

Table 25: Improvement ideas summary

Organizational level	Organization	Team level	Organization
Applying more industry developments	Alpha	Mandatory knowledge meetings	Alpha
Determine applicability per business unit	Charlie	Creating time to improve things	Golf
Alignment between projects and managing software	Delta (2x)		
Setting up taskforce	Delta		
Define role responsibilities to improve	Foxtrot		
Audit	Foxtrot		
Investing money to spend time to improve	Hotel		
Build a roadmap	Foxtrot		

Although Organization Foxtrot described some improvement ideas, they also stated *"[…] because we already developed so much we do not need to improve much […]"*

Figure 59: Improvement ideas (documenting practices)

Improvement ideas documenting practices

	More accessible	None	Documenting more/all practices	More audits and update	More uniform	Use easy modeling notation	Document used practices per…	Documenting practice successes	Use video or pictures instead…
#	3	3	3	1	2	2	1	1	1
%	18%	18%	18%	6%	12%	12%	6%	6%	6%
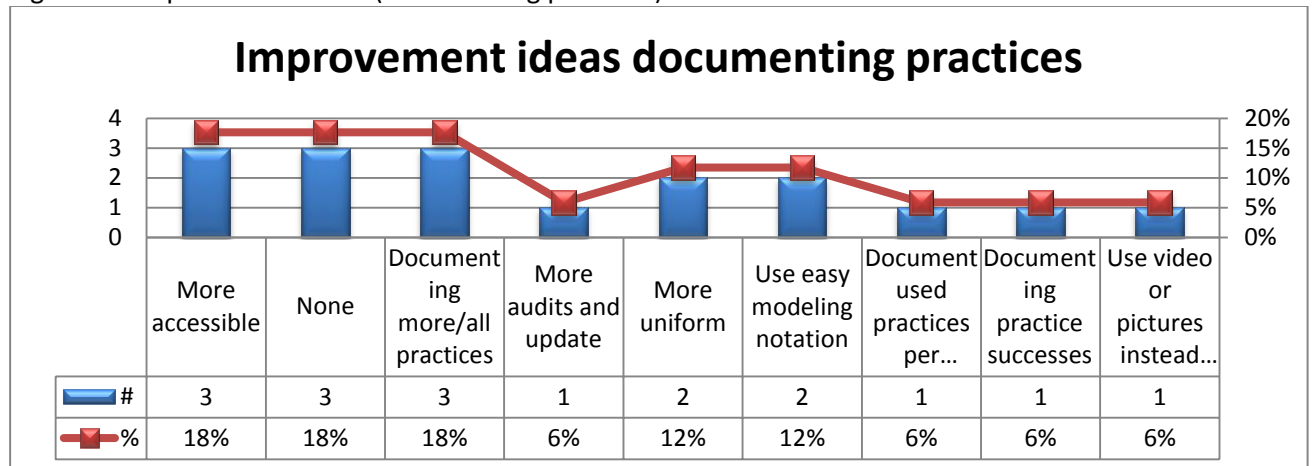
Figure 59 shows that there are many different improvement ideas collected. We see an increasing value that several participants want to improve the accessibility. Participant Y from organization Alpha, participant X from organization Echo and participant Y from organization Foxtrot suggest improving documenting practices by making them more accessible.

Participant X from organization Bravo, participant X from organization Foxtrot and participant X from organization Hotel had no improvement ideas for document their practices in a better way.

Participant X from organization Alpha, Participant X from organization Delta and participant Y from organization Foxtrot suggest documenting all practices. Participant X from organization Delta suggests using more tooling like Enterprise architect or Aris.

Participant X from organization Charlie suggests examining (audit) more process-reviews, because at this moment they often work ad-hoc.

Both participants from organization Alpha suggest improving their practices in a more uniform manner and find a format that is easy to read for everybody.

Participant Y from organization Delta suggests that "[…] if a Scrum project is executed, make an overview of all used practices. Discipline to use them […]".

Participant Y from organization Echo suggests that practice successes should be documented and shared more.

Participant Z from organization Delta stated that *"[…] Maybe paper is old fashion. Maybe it is better using a video or picture […]"*.

4.2.5 Perceptions on challenges

Figure 60: Challenges using practices
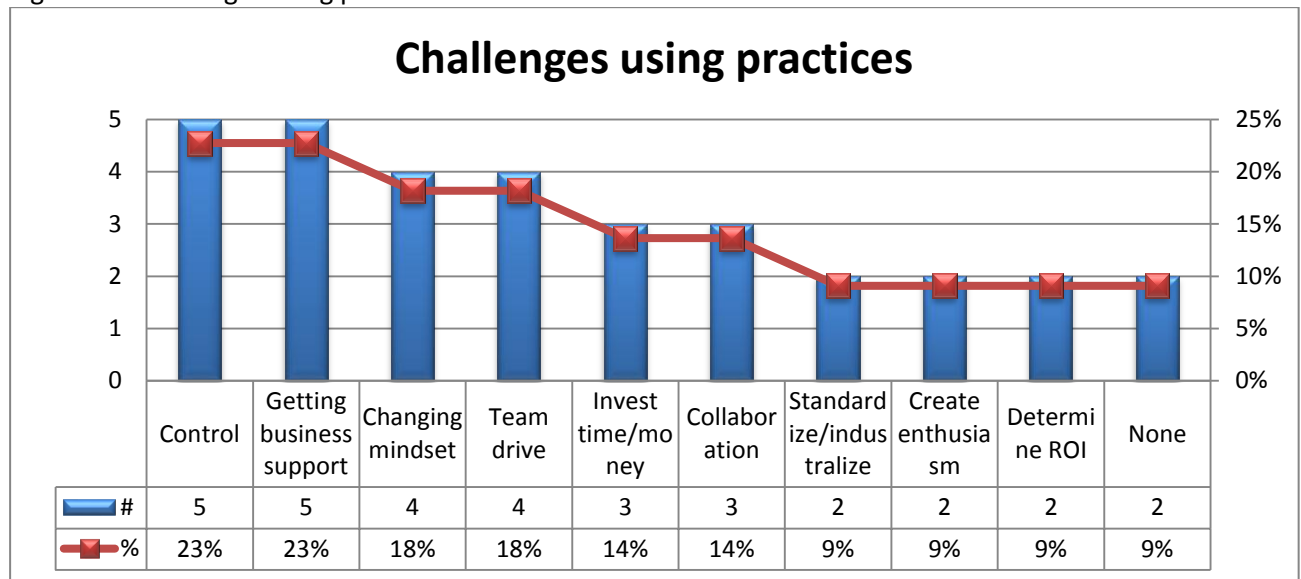
According to organization Alpha, people often don't want to change a chosen method when it does not hurt them. Participant Y from organization Bravo also sees challenges in changing the current way of working, but also stated that this requires some time. Participant Z from organization Delta argues that "[...] it begins with a mindset change for the whole organization. We must keep learning and improving [...]".

Organization Echo sees challenges in managing the team members, because when a team has a weak link (employee) the team tolerates it. Organization Foxtrot want to have more control over the teams and organization Golf sees challenges in "[...] sharing to learn but still maintain the autonomy (no command and control culture) [...]"

According to participant X from organization Alpha, participant X from organization Hotel and participant Y from organization Bravo it is challenging to convince the value of (new) practices to customers/business owners. Organization Charlie sees challenges in convincing the managing direction to deploy new ideas and Participant Y from organization Delta finds it challenging to make improvements on organizational level.

According to participant X from organization Delta the challenges of using practices are related to the behavior of the team members. Organization Echo sees challenges to change the mindset of improvement of the team members. In addition they want that the team members keep challenging each other, looking for improvement.

Organization Delta sees also challenges looking at the level of collaboration within the team (execute several roles and the business (product owner). In addition they stated that the business should be more involved and be able to implement it in a good way together with external partners.

Organization Hotel sees challenges in standardize/industrialize the practices and organization Delta sees challenges in optimizing the relationship between using practices and different target groups.

Participant X from organization Alpha argues that it is challenging to create enthusiasm in organizations (or by program managers) and to determine the Return of investment (ROI).

Participant Z from organization Delta stated that it is challenging to "[…] determine "how" and how much money you would invest to ensure a pleasurable, efficient and effective manner (organization wide) […]".

The participant from organization stated that it is challenging to getting money to invest (reserve time). Participant Y from organization Alpha stated that it is challenging to improve your practices when deadlines are not reached. Participant from organization Golf stated "[…]Give teams enough challenge to work as an unified team, but give them time to decompress and look at problems (better scheduling) […]".

Participant X from organization Bravo and participant X from organization sees no challenges in the current way of using practices.

Figure 61: Challenges improving practices

Challenges improving practices

	Invest time / money	Getting business support	Changing mindset	None	Control	Determine ROI	Improve development process	Standardize / industralize
#	3	3	2	2	1	1	1	1
%	21%	21%	14%	14%	7%	7%	7%	7%
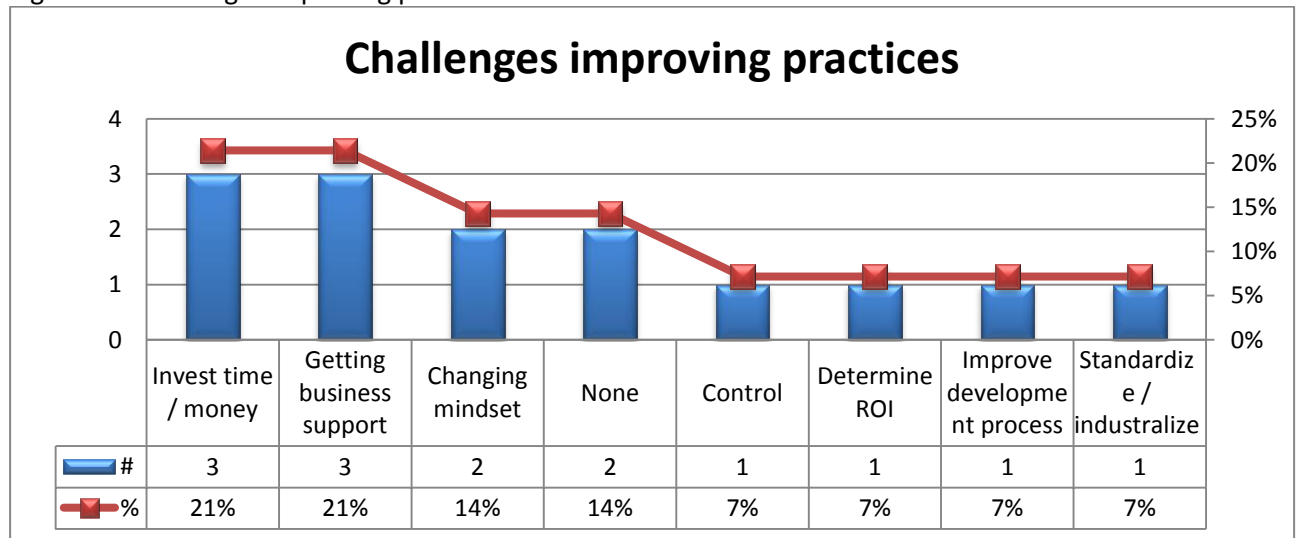
Participant X from organization Alpha stated that it is challenging to improve practices when deadlines are not reached. Participants from organization Charlie and Golf find it challenging to reserve time to improve the practices.

According to participant X from organization Alpha it is challenging to convince the value of practices to customers. Participant Y from organization Bravo stated that it is challenging to adopt at the business side. Participant Y from organization Delta stated that it is difficult to make improvements on organizational level.

Participant Y from organization Bravo that it is challenging to change the current way of working and participant Z from organization Delta stated that it begins with a mindset for the whole organization.

Participant Y from organization finds it challenging to find people that are motivated to pick up this role.

Participant X from organization Bravo and participant X from organization Foxtrot saw no challenges in improving the practices.

Participant Z from organization Delta finds it challenging to *"[…] determine "how" and how much money you would invest to ensure a pleasurable, efficient and effective manner (organization wide) […]"*.

84

Participant X from organization Hotel finds it challenging to *"[…] relate improvement to statistical process measurements (CMMi level 4 and 5) […]"*

Participant from organization Delta finds it challenging to implement and improve practices to improve their deployment pipeline.

Figure 62: Challenges documenting practices

Challenges documenting practices

	Goal-driven documenting	None	Uniformity	Encourage to document	Creating time/money	Accessibility
#	5	3	2	2	1	1
%	36%	21%	14%	14%	7%	7%
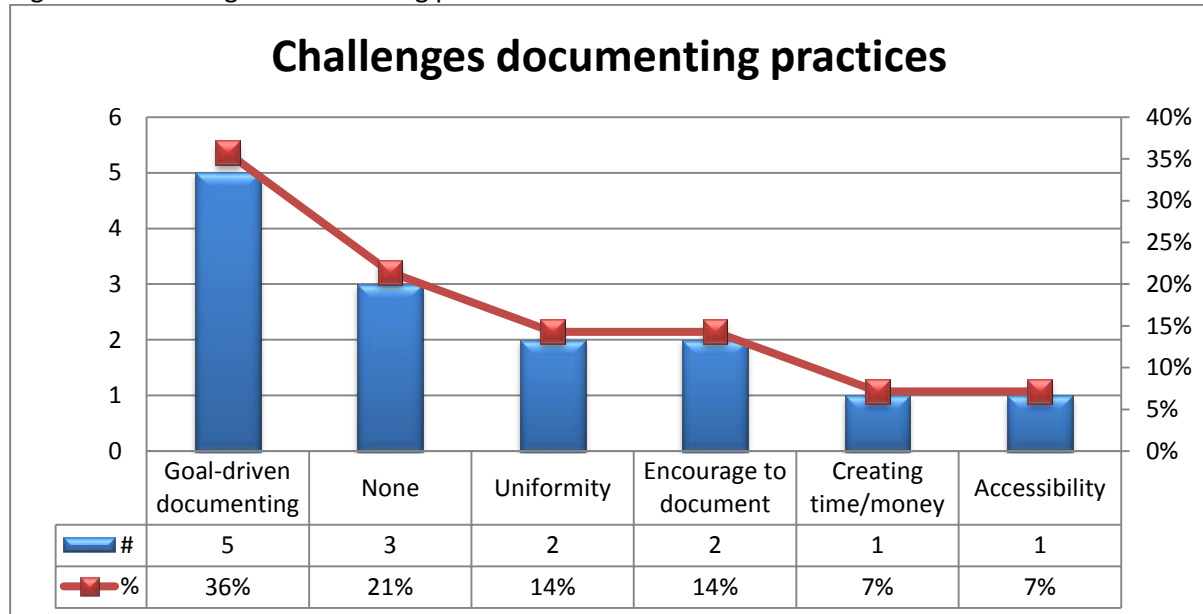
According to participant Y from organization Alpha, practices are often statically documented with too much detail. In addition he argues that improvement/mistakes should also be documented for knowledge sharing (also when having lack of time). Participant Y from organization Bravo sees challenges in documenting customer's organization portal/knowledgebase for sharing it within their Agile community. Participant X from organization Delta stated that *"[…] If you document them to much in detail, then it also does not work […]"* and participant Z stated *"[…] It should be well documented but not provide an overkill on information […]"*.

Participant X from organization Bravo, participant Y from organization Delta and participant X from organization Foxtrot stated that they see no challenges in documenting practices at this moment.

Participant X from organization Delta sees challenges in using *"[…] more tooling like enterprise architect or Aris, however if they can't be used for this, then this could lead to bureaucracy/waste […]"*. Participant X from organization Echo see challenges to create a common process that works for everybody and that resources (e.g. templates) can be commonly shared.

Participant X from organization Alpha and participant Y from organization Echo see challenges to raise aware of the benefits and to motivate people to do this more often.

Participant X from organization Charlie sees challenges in making time available for it (time=money).

Participant X from organization Hotel stated to see challenges in improving their search engine.

4.2.6 Most appealing representation example

Figure 63: Results most appealing representation method

Which representation method is the most appealing?

	Information card	RACI process model	Workshop model	Process guideline
#	51	33	33	17
%	38%	25%	25%	13%
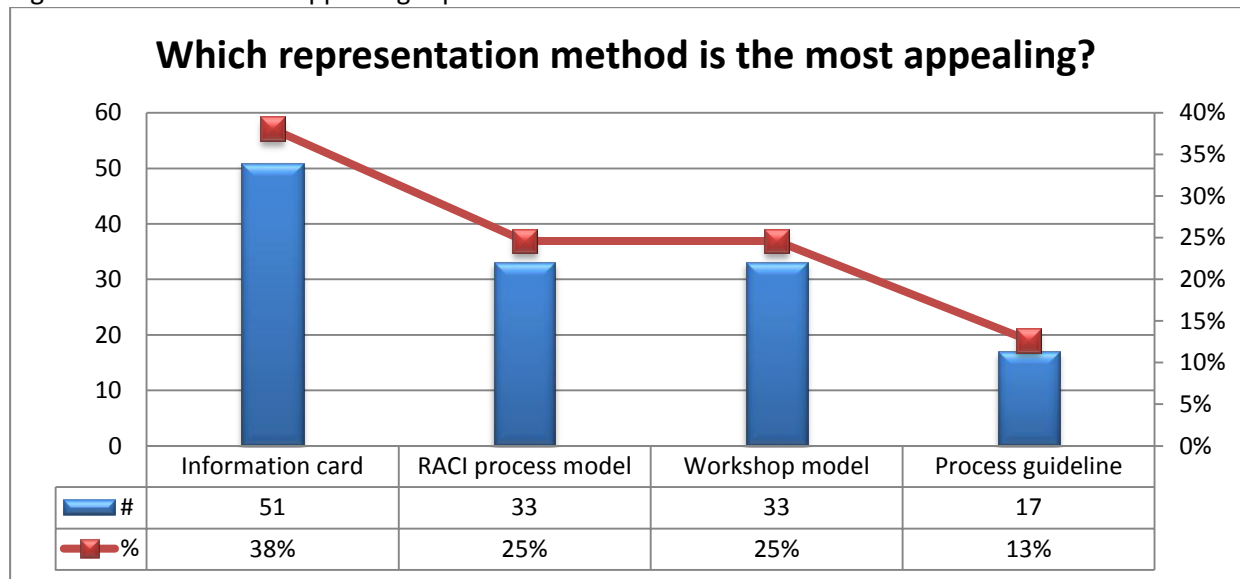
Figure 61 shows that the most appealing representation example was our developed information card. The RACI-process model and Workshop model scored equally and in general the participants found the textual process guideline the least appealing representation method. In Table 26 and Table 27 we summarized the improvements ideas of the representation examples the participants found the most appealing.

Table 26: Improvement ideas information card

Improvement ideas information card	#
Add more text	1
Adding "start and end", and describe artefacts	1
Create multiple layers	2
Use it interactively	3
Visualize involvement of roles (looking at input and output)	1
Visualize results of the output	1
Visualize the direction of the practice	2
Interaction between input/output	1

Table 27: Improvement ideas workshop model

Improvement workshop model	#
Put some pictures on the roles and a iconography to separate people from roles and activities	1
More pictorial like the information card (loop)	1
Put less influence in the inputs and outputs	1
Add the objective of the practice	1

4.2.7 Feasibility Bull's eye method

Bull's eye method

Table 28 presents the results of the feasibility of the Bull's eye method. The results-categories are placed on left (rows). The columns show the organizations and the letters shows the answer of the participant (X,Y,X)

Table 28: Feasibility Bull's eye method

	Alpha	Bravo	Charlie	Delta	Echo	Foxtrot	Golf	Hotel
Yes	X,Y	X,Y	X	X,Y	X,Y	Y	X	
No						X		
Possibly			Z					
I don't thinks so								X

The results show that eleven of the fourteen participants find the bull's eye method feasible. Participant X of organization Foxtrot stated that he *"[...] would not invest in this [...] every situation is different [...] I think that if you have a conversation with the employees and talk about the practices then we Figure it out within 30 minutes [...]"* .

We categorized the interview results in *Analyzing* purposes and *Identifying* purposes and visualized the results in Figure 64.

Figure 64: Bull's eye method

How can the Bull's eye method be used?	Analysing	Identifying
#	7	6
%	54%	46%
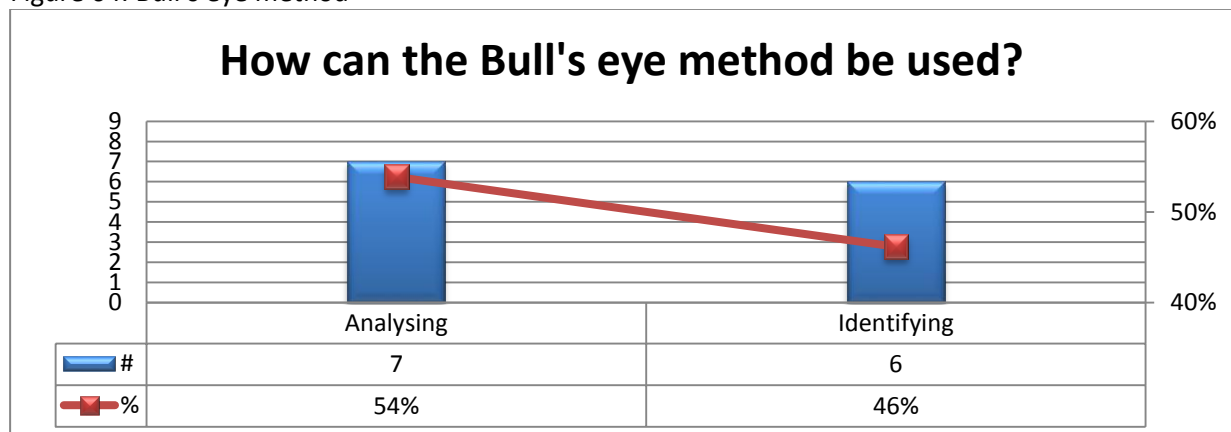
Figure 64 shows that gave enough feedback (13) to determine that the Bull's eye method can be used for analyzing and identifying purposes. Looking at the *Analyzing category* results (7/13), Organization Alpha suggests to add all practices a organization is using and look which practice are used the most. In addition, they think it can be used to analyze successfully and less successfully projects. Organization Delta suggests that the results of KPI-boards can be the trigger to start using this method and that it can be used with help of retrospective at overall level. Organization Echo stated that it can be used *"[...] to start a dialogue [...]"* and to use it to " *[...]address other teams that have better results or work differently [...]"*. Organization Foxtrot suggests that it can be used to relate it to their process analyses.

While looking at the results of the identifying category (6/13), organization Alpha stated that it is *"[...] a nice method to get insight, but I see the danger that people will draw conclusions only based on these results [...]"*. Organization Delta suggests to use the practice based on successes within the organization and from other organizations. Organization Echo stated that this method can give them

more insight and that it can be used to build schemes in different areas, including a scheme over all their development teams. Organization foxtrot things that this method gives more structure to get things clear.

Although most participants stated that the Bull's eye method is a feasible method for benchmarking practices, some participants also commented on the applicability of the practice. For example, organization Alpha stated that this method is only applicable in large software development organizations and not for consulting organizations. Participant X of organization Bravo stated that this method can be used to decide which practice should be used for which project, however that it is not suitable for knowledge sharing, because junior employees don't execute large projects. However, participant Y stated that the advantage is that this information can be shared but that it is important to think about how to analyze further when you use it. Organization Golf stated that *"[…] it would be interested to see it per practice, but also per business unit (geography) and show which practices are used (or by project) […]"* and suggests that this method possibly can be introduced as a practice game for product owners.

4.2.8   Feasibility Process mining method

Process mining method

Table 29 presents the results of the feasibility of the process mining method. The results-categories are placed on left (rows). The columns show the organizations and the letters shows the answer of the participant (X,Y,X)

Table 29: Feasibility Process mining method

	Alpha	Bravo	Charlie	Delta	Echo	Foxtrot	Golf	Hotel
Yes	X,Y	Y	X	X		Y	X	
No					Y	X		
Possibly		X		Y,Z	X			X

The results show that seven of the fourteen participants find the bull's eye method feasible. Two participants do not think that this method adds value and five participants think that process mining can possibly add value.

Participant Y of organization Alpha stated that this method can be used to get insight, however he is afraid the user will draw conclusions only based on the results. Therefore he argues that *"[…] it can be used with the precondition that further research is executed when inconsistencies are discovered […]"*. Participant X of organization Alpha stated "[…] *This method should be used with the bull's eye method. First process mining for analyzes, then (if necessary) Benchmarking and then talking to the people who are using the practices for knowledge sharing and improvement of the efficiency of practices […]".* Participant X of organization Bravo stated that organizations use different kind of tools, like Jira, Greenhopper, HP Agile manager, to visualize the progress of the development. According to participant X, these tools register the development tasks as well. They use the, so called, Kanban boards to depict visually the end-2-end delivery process. Participant X of organization Charlie stated that this method is ads value, but he argues that his organization is not at this level of process improvements. Participant X of organization Delta stated that it can be used with the condition that it should not take too much time and should be judged by people who understand the total picture and can look "lean". Participant X of organization Foxtrot stated that it can be used to visualize mentality issues, however in practice the do not have the capacity to act on it. He also stated that he expects that people will give resistance when they are required to register start/stop time, but if it is possible to extract the even logs from tooling than it would be useful. Participant X of

organization Golf stated that it is *"[…] A great way for an individual organization to help self-development […]",* however he is worried for correlation assumptions where they do not exist. In addition, he stated that the event-logs should be collected automatically.

Participant X of organization Bravo stated that Portfolio management can possibly use this method to get insight. Participant Y of organization Delta stated that it can work, but he thinks that this gives people a miniature feeling of autonomy and that it asks for a whole other mentality of the people and maturity level of the organization. According to participant X this method should be applied at the highest level of the Capability Maturity Model Integration (CMMI). Participant X of organization Echo stated that the process mining method can be combined with the Bull's eye method, but he does not expects that the differences in the results are not significant. Participant X of organization Hotel stated that it can help for statistical analyses, however it brings a large administrative burden on each project.

Participant X of organization Echo does not think the process mining method is feasible, because he thinks *"[…] that there are better ways to do this. For example, using a sprint retrospective and use this to talk about all practices (also applicable for Scrum of Scrums) […] ".* Participant X of organization Foxtrot will not invest in this method, because every situation is different. He believes that having conversation with the employees and talk about the practices for 30 minutes is enough to Figure things out.

Participant X from organization Charlie, Participants Y and Z of organization Delta and participant Y of organization Foxtrot also wanted to know what the ROI is.

5 Discussion

This section will discuss the main research question:

How organizations, employing Agile software development practices, identify, analyze, improve, represent and document (best) practices in an accessible and sufficient manner?

5.1 Reasons of using choosing and deploying practices

When we combine the Cross-Case results of the reason "Why" the organizations use their practices and the reasons "How" they choose their practices, illustrated in Figure 65, we see that the main reason why organizations use their practices is based on personal and organizational experiences.

Figure 65: Combination reasons Using (Why) & Choosing (How)

Combination reasons using and choosing practices

	Personal/organizational experiences	Customer demand	Based on project/assignment	Industry developments	Spontaneous
#	33	7	4	4	1
%	67%	14%	8%	8%	2%
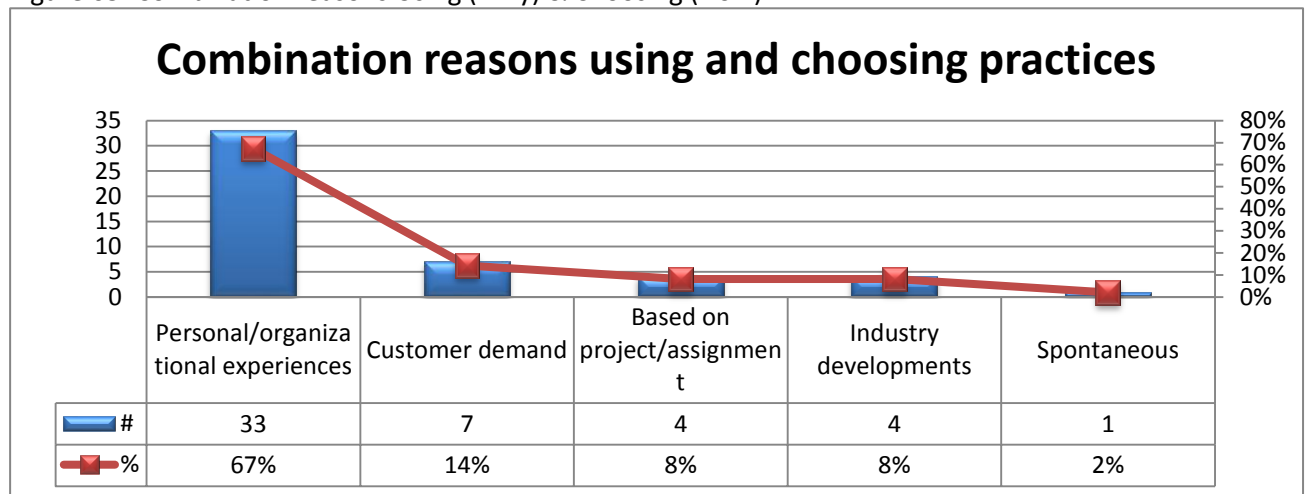
The research results of the Cross-case analyses show that the organizations use deployment methods based on projects and some organizations imbedded there deployment method within standardized processes of the organizations. Organizations Bravo, Charlie, Delta, Echo, Foxtrot and Golf deploy their practices according to an organizational process standard. Organization Alpha, Bravo, Charlie, Delta and Hotel deploy their practices based on the project assignment.

Project based
The consulting organizations (organizations Alpha, Bravo and Hotel) state that they do not use one specific deployment method, because this depends on their customer's assignment, however participant X stated that he does use a method set up a *"[…] strategy (methods, techniques, practices, instruments) to deploy the assignment and (if possible) talking to a colleague who already have work for this specific client and share experiences […]".* The program manager from organization Charlie and project manager from organization Delta stated to use specific project management methods to deploy their project. Only one participant stated to discuss the practices with the team by organizing a kickoff meeting with the stakeholders and project team. Organization Bravo and Charlie discuss the practices with the team members before starting with an assignment.

Organizational process standard
Four participants, from the organizations Echo, Foxtrot and Golf stated that they do not apply any deployment methods, because *"[…] we develop continuously […]".* & *"[…] teams can decide themselves which practice they use […]".* Organization Bravo, Charlie and Golf have a manual where the used practices are described. Organization Foxtrot trains employees on the job and all team members from organization Delta and Golf followed Scrum trainings.

The result of the Cross-case analyses shows that the organizations mainly determine the relevancy of use practices based on evaluations (Pentland, 1999). Organization Alpha, Delta and Echo evaluate the relevancy of practices during the retrospectives. However organization Delta also determines the relevancy by looking at the end results of the project.

The development teams from organization Echo determine if practices are relevant or not and can choose which practice they want to use. Because the team members of organization Echo identify, choose and analyze their practices independently, they control the ostensive and performative part of their organizational routines (Pentland, Feldman, 2005). Organization Delta uses a Cascade board where team members can write down improvement idea's. We can link this to the ostensive part of organizational routines (Pentland, Feldman, 2005).

Organization Charlie does not apply any method or technique to determine the relevancy of use practices, but they discuss this subject during their annual evaluation. He stated *"we realize that this needs to be done, but this cost time and money"*. We also noticed that Participant Y from organization Foxtrot stated that they do not "actively" determine the relevancy of practices, however participant X from organization Foxtrot stated that they are ISO9001 certified and therefore apply external audits to determine the relevancy of their practices.

5.2   Identifying Analyzing and improving practices

Identifying practices

The cross case analyses shows us that most practices are identified based on evaluations. Secondly, we see that new practices are identified by examining literature research and visiting congresses (or seminars). Organization Alpha and Delta also identify new practices by looking at the customer's needs. In addition, we see that in some cases new practices are spontaneous (personal experiences) identified and based on gut feeling, however these identified practices are not documented for knowledge sharing.

Figure 66: Identify practices (How)
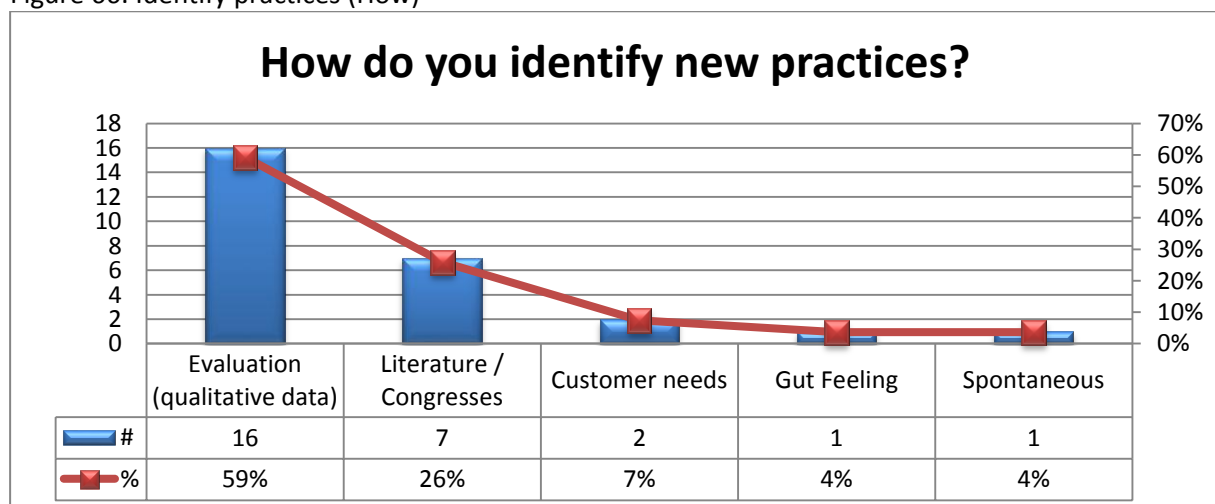
During our literature research we discovered that one can identify practices with narratives (Pentland, 1999). To collect this information, one can extract data from *Organizational members*, *Published sources*, *Interviews*, *Electronic databases*, *Historical records, Student projects* (Pentland, 1999; Boje, 1991; Martin et al., 1983; Brown, 1998; Pentland, Reuter, 1994; Abbott, Hrycak, 1990; Sabherwal, Robey, 1993). In addition one can also identify practices by executing workshops

(Dingsøyr and Moe, 2004), Benchmarking (Maire, Bronet, & Pillet, 2005) and process mining (Aalst, 2011).

In the following Table we related the interview results with literature results.

Table 30 Overview used methods to identifying practices

	Narratives	Benchmarking (internally/externally)	Process Workshop	Process mining
Evaluation (qualitative data)	v			
Literature / Congresses	v			
Customer needs	v			
Gut feeling				
Spontaneous				

Table 30 shows that the organizations identify practices based on *Narratives* (Pentland, 1999). Narratives can be used to analyze organizational processes, because narrative is not just a 'story' which someone tells, it is something which someone 'enact'. Each narrative, which is based on stories or fabula (also called; *meaning story*), has indicators for an underlying process theory (Pentland, 1999; Chatman, 1978; Rimmon-Kenan, 1983; Bal, 1985). These stories reveal the underlying structure of a narrative and can be used to explain the surface structure (Pentland, 1999; Rimmon-Kenan, 1983).

We are not able to categorize the research results *Gut feeling* and *Spontaneous*, because in both cases the results show that the achieved information is internal (cognitive, tacit) knowledge (Becker, 2005) and therefore cannot be recognized as a method that organizations use to identify practices.

None of the interview organizations execute workshops, like (Dingsøyr and Moe, 2004), to identify practices. As described in the methodology subsection, we executed the process workshop method of Dingsøyr and Moe (2004) to identify a practice, called iterative development. The results of this practice were used to build four different representation methods, which are illustrated in the appendix, and were integrated in our interviews to see which representation method the participants found the most appealing and see what improvement ideas they had.

While we executed the process workshop of Dingsøyr and Moe (2004), we also noticed that we were missing relevant information to get a total overview of our identified practice. For example, the workshop instruction does not describe how to relate the elements (Input, Activities, Output, Roles and Artifacts) to each other. In addition, we could not see the involvement (e.g. responsibilities) of the described roles in the practice. To solve this problem, we used numeric values (e.g. 1,2,3,4 or a,b,c,d) within the predefined elements. Figure 67 illustrates the extra activities we included to complete our workshop.

Figure 67: Workshop process steps (Dingsøyr & Moe, 2004)
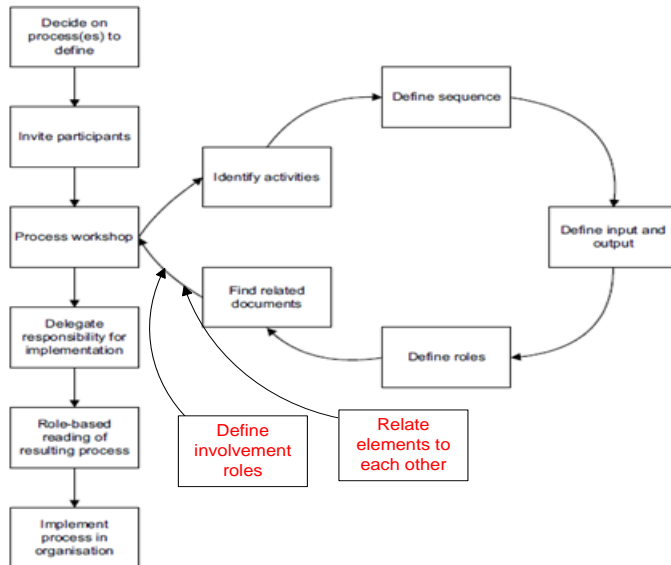
Analyzing practices

The results show that organization Alpha, Delta, Echo, Foxtrot, Golf and Hotel analyze the results of used practices by executing evaluations. These evaluations are based on project evaluations, annual/monthly/weekly meetings and retrospectives. Organization Hotel also analyzes all evaluations each year together with the customer's satisfaction grade to see if their used methods were successful. In addition they measure how often practices are consulted from their knowledge base. Three participants from organization Delta, Echo and Golf analyze the result based on gut feeling. Four participants from organization Bravo, Charlie, Delta and Echo analyze the results with quantitative data. This quantitative data is, for example, measured by using predefined KPI's. Although participant X of organization Foxtrot stated that they are ISO9001 certified and therefore apply external audits to review their processes and practices, participant Y stated that they do not actively analyze the results of practices. One participant from organization Bravo stated that he does not analyzes the results of used practices.

Improving practices

In most cases practices are improved during evaluations sessions. Organization Alpha evaluates failed project and registers learning experiences. Organization Foxtrot stated that their practices are improved during their annual meetings. Organization Delta and organization Hotel have specifically appointed someone who is responsible for looking at (possible) practice improvements. Organization Echo uses checklist that measures product quality and process quality. They use these checklists as input to start a dialogue with the team. Four participants stated to improve parties by using quantitative data. They do this by measuring the team's velocity, the delivery in story points, KPI dashboard that measures team performances. In two cases we see that practices are improved based on gut feeling (occurs automatically / based on personal experiences). Organization Delta also uses a Cascade board where team members can write down improvement idea's.

The following figure illustrates a combination of the Cross-case results how organizations analyze their practices and how do organizations improve their practices.

Figure 68: Combination results analyzing and improving practices

Combination analyzing and improving practices

	Evaluation (qualitative data)	Analyse \ measure (quantitative data)	Gut feeling	External audit	Other
#	23	8	5	1	1
%	61%	21%	13%	3%	3%
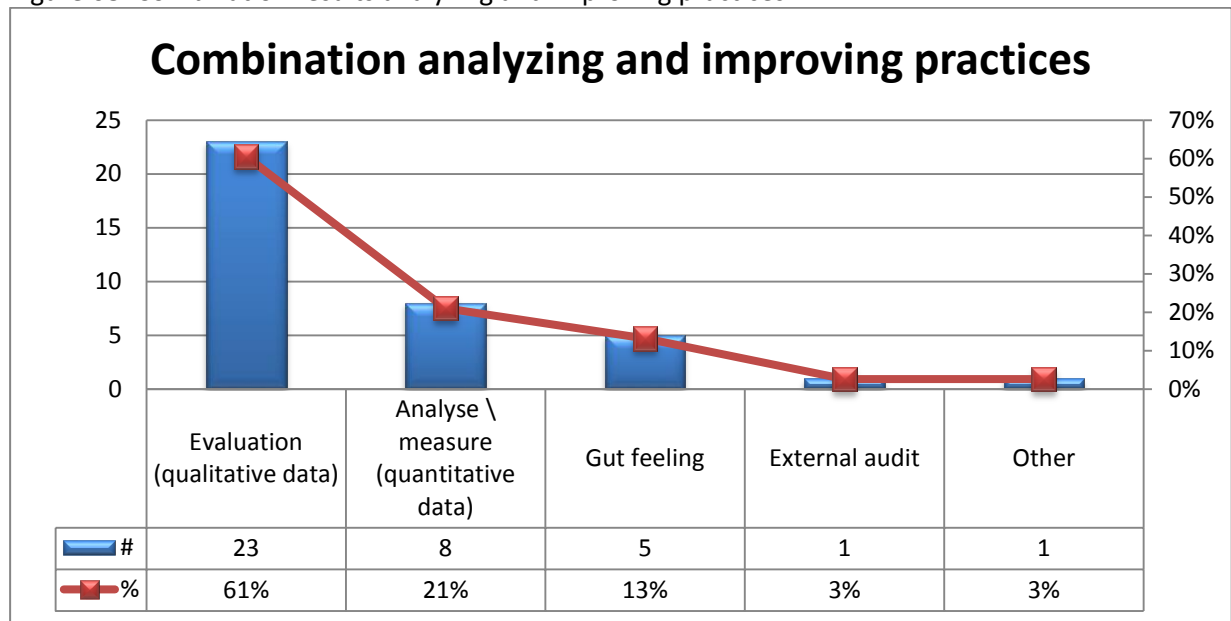
Looking at the results we see that none of the organizations use any kind of internal or external benchmark methods to identify, analyze or improve practices. The results show that in most cases the practices are analyzed and improved during evaluations (Pentland, 1999). In eight cases these evaluations, also called retrospectives are held after a sprint period. The consultancy organizations analyze their practices after they finished the assignment, also called project. Only one organization analyzes and improves their practices ones a year, during an annual meeting, external audit and process reviews by process owners.

5.3 Representing and documenting practices

We registered 38 different kinds of practices. Organization Alpha, Delta, Echo and Hotel have not documented all their practices. Organization Bravo, Charlie, Foxtrot and Golf stated that all their practices are documented.

Phalp and Shepperd (2000) argue that it is important to model processes, but also see that the majority of organizations use simple diagrammatic modeling techniques. We can confirm this by looking at the research results of the Cross-case analyzes. The results show that most practices are represented with textual descriptions and none of the organizations use specific modeling notations to represent all of their practices or fixed representation structures.

Almost all organizations, except for one, use a portal to store and represent their practices. The organizations use a wide variety software programs to represent their practices. Some of these software programs use modeling nations, like BPMN (OMG, 2011) and Archimate (Lankhorst, 2004). Five of the eight organizations have not documented their software development practices in detail.

According to Dingsoyr & Moe (2008) descriptions of software development processes are an important instrument for making software development more efficient and for delivering software of higher quality. Although the results show that many organizations do not represent their practices in detail, we see that when we asked the participants which information is required to represent

practices, they gave us enough information, illustrated in Figure 69, to determine how these practices should be represented for knowledge sharing.

Figure 69: Required information for representing practices

Which information is necessary for you in order to document your practices?

	Roles	Activities	Relation	Responsibilities	Input	Output	Artifacts	Tasks
#	11	6	5	5	4	4	4	1
%	28%	15%	13%	13%	10%	10%	10%	3%
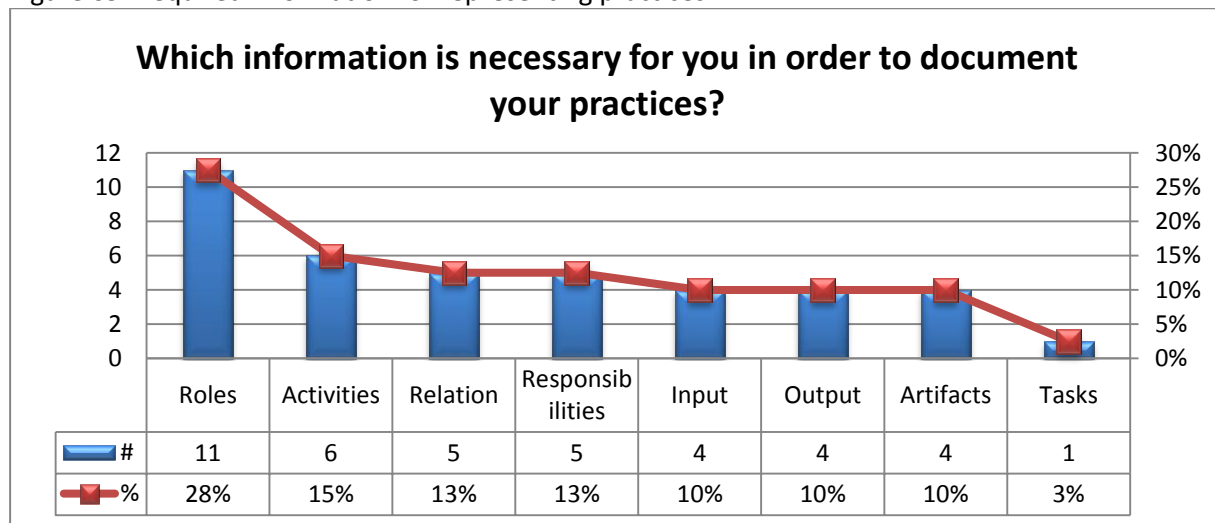
Eleven of the fourteen participants think that roles should be represented. Six participants would include activities. Five participants would include relations between activities and output, activities and input, roles and activities and activities and their interfaces with other processes/activities. Five participants would include responsibilities. Four participants would include the element input. Four participants would include output and four participants would include artifacts. One participant stated that they use Rational Method Composer which defines tasks and that these tasks are merged to describe activities.

According to Dingsoyr & Moe (2008) electronic process guides may include the following basic elements:
- Activities: descriptions of "how things are done", including an overview of the activities and details regarding each individual activity;
- Artifacts: details of the products created or modified by an activity, either as a final or intermediate results of the activity or as a tempory result created by one of the steps;
- Roles: Details of the roles and actors involved in performing the activities;
- Tools en Techniques: details of the tools and techniques used to support or automate the performance of an activity.

Based on our research results we can relate our elements Activity and Tasks to the element Activity. We can relate Artifacts and Output to the Artifacts element. We can relate Roles and Responsiblities to the element Roles and we can relate our relations between activities and output, roles and activities and activities and their interfaces with other processes/activites with Roles/Artifacts. We can not relate our two elements Input and Relation between activities and input with the basic elements from Dingsoyr & Moe (2008).

Figure 70 illustrates the results how the participants think practices should be documented for the use of knowledge sharing. We categorized the results in Requirement, Preference and Practice.

Figure 70: Documenting for knowledge sharing
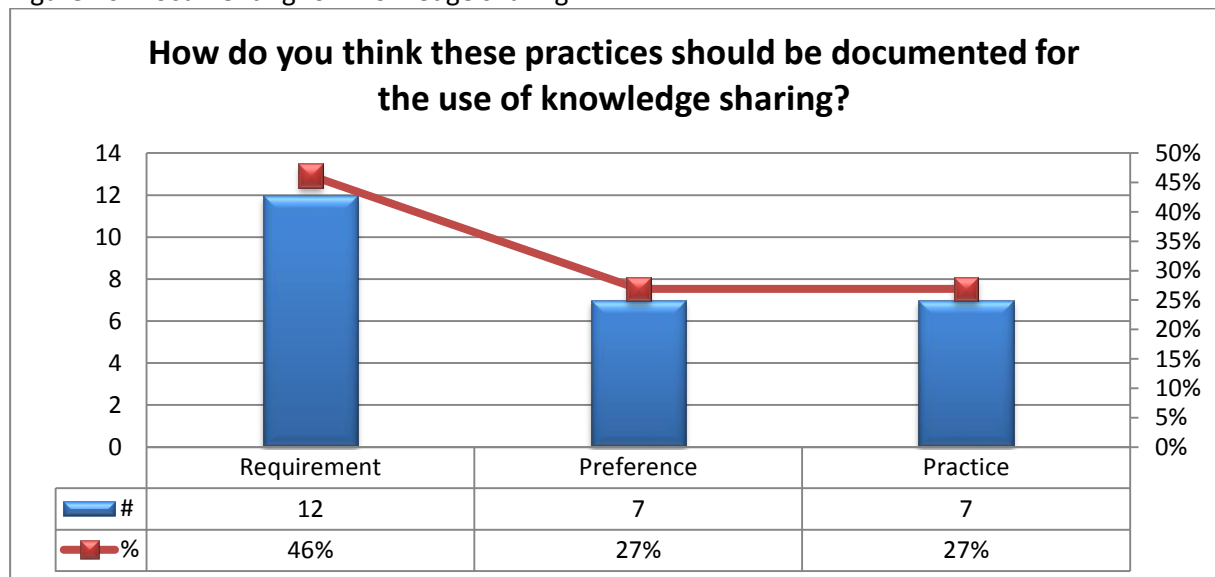
We summarized the category results in the following Table.

Table 31: Category results documenting practices for knowledge sharing

Requirement	Preference	Practice
Accessible	PowerPoint over text	Share customer internal portal / knowledgebase with Agile community
To the point	Easy modeling notation	Place it on SharePoint
Uniform	Not important to use specific modeling notation	Place it on wiki for review
Clear and understandable	Document High level	Represent with video instead of text
Adopt modeling notation from client	Prefer use of practices from books	Make it interactive (clickable)
Useful for teams and organizations	PowerPoint	Training material
Role responsibility for sharing		Only document and share when necessary
Important to use portal interactively		Provide cross communication
Document on two levels: quick reference (pictures) & detail (text)		

In total we gathered 12 requirements (9 different requirements), 7 preferences (6 different preferences) and 7 practice suggestions. Organization Alpha and organization Charlie stated that the practice should be accessible. Participant Y from organization Alpha stated that the practice should be "to the point". Organization Alpha also stated that the practices should be represented in a uniform manner.

One participant from organization Delta stated that *"[…] it should be useful for the teams and organization, accessible and someone should be responsible for sharing it […]".*

Organization Hotel stated that one should document on two different levels: *"[…] 1. You need to document for people how quickly have to know, "what do I need?, who do I need?, what has to be done?" 2. Document for people implementing it (incl. training to understand the whole process) and taking into account your certificate demands (ISO). This is more text, while training is more pictures […]".*

If we look at results from Table 31, we see that most preference comments are related to the first level of documenting which were defined by the participant from organization Hotel.

5.4   Perceptions on improvements

Improvement ideas using practices
Most improvements ideas for using practices are based on the execution of the practices. For example, the participants stated to (1) improve the estimation process, (2) improve the releasing process ("after a sprint it must be finished"), (3) make sure that all practices contribute to the delivery of a feature and (4) also by confronting people that they should use the predefined practices to improve the quality of the teams.

One participant from organization Echo stated *"[…] sometimes we need to tell people that they are responsible (new way of working). This is also a culture aspect […]"*. One participant from organization Echo argues that they need to provide guidance when a new method is deployed, because *"[…] many team members want to invent "the wheel" again […]"*. According to Dingsoyr and Moe (2008), employees who participate in organizational development have greater commitment to the organization, more motivation to perform and increased desire for responsibility.

The participants from organization Delta stated that they want to improve the deployment pipeline, distinct practices for building software and managing software and make sure that only concerned parties work with them. One participant from organization Delta wants to improve practices to improve their deployment process and dealing more efficient with issues and changes. One participant suggests from the consultancy organization Alpha suggests a mandatory attendance in knowledge meetings.

The results of the case study from Dingsoyr and Moe (2008) show that when employees participated in process workshops showed a higher degree of usage, used a larger number of functions and expressed more advantages and disadvantages than the employees who did not participate process workshops.

All participants from organization Alpha and Foxtrot stated that the use of practices should be analyzed/measured more. Organization Hotel want to limit the number of variations and one participant from organization Alpha wants to give more attention to *"[…] identify, appointing, refining and improving […]"* the practices.

Improvement ideas improving practices
Most improvement ideas are categorized being at the organizational level of the organizations. In two cases the improvements are at team level and in one case the participant stated that the practices should be*"[…] more focused on the customers need […]".*

Organization Alpha suggests to apply more industry developments. One participant from organization Delta suggests setting up a taskforce to improve practices.

Organization Foxtrot suggests auditing their used practices so that they can be improved and also sees improvement when one uses a roadmap. Although Organization Foxtrot described some improvement ideas, but they also stated *"[…] because we already developed so much we do not need to improve much […]"*.

Improvement ideas documenting practices
Three participants from organizations Alpha, Echo and Foxtrot suggest improving documenting practices by making them more accessible. Three participants from organization Alpha, Delta suggest documenting all practices. One participant from organization Delta suggests using more tooling like Enterprise architect or Aris. Organization Charlie suggests examining (audit) more process-reviews, because at this moment they often work ad-hoc. Both participants from organization Alpha suggest improving their practices in a more uniform manner and find a format that is easy to read for everybody. One participant from organization Delta suggests "[…] if a Scrum project is executed, make an overview of all used practices. Discipline to use them […]".One participant from organization Delta stated that *"[…] Maybe paper is old fashion. Maybe it is better using a video or picture […]"*.

One participant from organization Echo suggests that practice successes should be documented and shared more. One participant from organization Alpha argues that improvements and mistakes should be documented for knowledge sharing. We can relate these improvement thoughts with the thoughts of the World Health Organizations who also wants to know, with the help of practices, *"what does not work and why it does not work"* (WHO, 2008).

5.5   Perceptions on challenges

Challenges using practices
According to organization Alpha, Bravo and Delta, the challenges of using practices related to changing the mindset of people. According to organization Alpha *"[…] people often don't want to change a chosen method when it does not hurt them* […]"*.

Organization Echo, Foxtrot and Golf realize that their also are challenges related to control. This means managing the team members, having more control over the teams and boundary between maintaining the autonomy and organizational control.

Organization Alpha, Bravo, Charlie, Delta and Hotel see also challenges in getting more business support. Organization Alpha, Bravo and Hotel are consulting organizations and therefore they also have to deal with the wishes from the organization where they are fulfilling the assignments. Because not all customers are familiar with Agile software development, including the strategy and used practices it can be *"[…] challenging to convince the value of (new) practices to customers / business owners […]"*. In addition, organization Alpha stated that it is challenging to create enthusiasm in organizations (or by program managers). On the other hand, organization Charlie and Delta, who are developing software internally, also have challenges in convincing the managing direction or make improvements on an organizational level. Organization Delta sees challenges looking at the level of collaboration within the team (execute several roles and the business (product owner).

Organization Delta and Echo see challenges to improve the team drive. Organization Delta argues that this is more related to the behavior of the team members, instead of the rules. Organization Echo finds it challenging to ensure that the team members keep challenging each other looking for improvements. According to Dingsoyr & Moe (2008) employees who participate in organization developments have greater commitment to the organization, more motivation to perform and increased desire for responsibility.

Challenges improving practices
Organization Alpha, Charlie and Golf find it challenging to reserve time to improve the practices. One participant from organization Alpha adds that this is especially difficult "[…] when deadlines are not reached […]".

Organization Bravo stated that it is challenging to change the current way of working. One participant from organization Delta this can be improved by changing the mindset of the whole organization. However he finds it challenging to *"[…] determine "how" and how much money you would invest to ensure a pleasurable, efficient and effective manner (organization wide) […]".*

The goal of organization Hotel is to get certified for Capability Maturity Model Integration (level 5) and finds it challenging to *"[…] relate improvement to statistical process measurements […]"*

One participant from organization Delta finds it challenging to implement and improve practices to improve their deployment pipeline. Camp (1989) argues that the goal is to adapt practices to improve the performance of business processes. Dingsoyr & Moe (2008) argue that the use of process workshops will improve the practices.

According to organization Alpha, Charlie, and Golf it is challenging to determine how much time (and therefore money) one should invest to improve the usage of practices.

Challenges documenting practices
According to one participant from organization Alpha, practices are often statically documented with too much detail. In addition he argues that improvement/mistakes should also be documented for knowledge sharing (also when having lack of time).

One participant from organization Bravo sees challenges in documenting customer's organization portal/knowledgebase for sharing it within their Agile community. Participant from organization Delta stated that *"[…] If you document them to much in detail, then it also does not work […]"* and *"[…] It should be well documented but not provide overkill on information […]".*

Participant X from organization Bravo, participant Y from organization Delta and participant X from organization Foxtrot stated that they see no challenges in documenting practices at this moment.

One participant from organization Delta sees challenges in using *"[…] more tooling like enterprise architect or Aris, however if they can't be used for this, then this could lead to bureaucracy/waste […]".* One participant from organization Echo see challenges to create a common process that works for everybody and that resource (e.g. templates) can be commonly shared.

Two participants from organization Alpha and Echo see challenges in raising awareness of the benefits and to motivate people to do this more often.

Organization Charlie sees challenges in making time available for it (time=money).

One participant from organization Hotel stated to see challenges in improving their search engine.

5.6 Most appealing representation example

The results show that the participants found the Information card the most appealing representation example. The RACI-process model and Workshop model scored equally and in general the participants found the textual process guideline the least appealing representation method. In Table 32 we summarized the improvements ideas of the representation examples the participants found the most appealing.

Table 32: Improvement ideas information card

Improvement ideas information card	#
Add more text	1
Adding "start and end", and describe artefacts	1
Create multiple layers	2
Use it interactively	3
Visualize involvement of roles (looking at input and output)	1
Visualize results of the output	1
Visualize the direction of the practice	2
Interaction between input/output	1

Because the participants found the information card the most appealing, we will try to adopt their improvement ideas, adjust the representation example and ask for their opinion. The results will not be included in this thesis, because we depend on the timeframe to complete this thesis.

5.7   Feasibility Bull's eye method

Table 33: Feasibility Bull's eye method

	Alpha	Bravo	Charlie	Delta	Echo	Foxtrot	Golf	Hotel
Yes	X,Y	X,Y	X	X,Y	X,Y	Y	X	
No						X		
Possibly				Z				
I don't thinks so								X

The results in table 33 show that eleven of the fourteen participants find the bull's eye method feasible to use within the software development process. Only one participant from organization Foxtrot does not think this method add value in identifying or improving practices, but the other participant from organization stated that it can be used to relate it to their process analyses. Organization Delta suggests to use the practice based on successes within the organization and from other organizations. Organization Echo stated that this method can give them more insight and that it can be used to build schemes in different areas, including a scheme over all their development teams. Organization foxtrot thinks that this method gives more structure to get things clear

Organization Alpha stated that it is *"[…] a nice method to get insight, but I see the danger that people will draw conclusions only based on these results […]"*..

Although most participants stated that the Bull's eye method is a feasible method for benchmarking practices, some participants also commented on the applicability of the practice. For example, one participant from organization Alpha stated that this method is only applicable in large software development organizations and not for consulting organizations. One participant from organization Bravo stated that this method can be used to decide which practice should be used for which project, however that it is not suitable for knowledge sharing, because junior employees don't execute large projects. However, the other participant from organization Bravo stated that the advantage is that this information can be shared but that it is important to think about how to analyze further when you use it.

Organization Golf stated that *"[…] it would be interested to see it per practice, but also per business unit (geography) and show which practices are used (or by project) […]"* and suggests that this method possibly can be introduced as a practice game for product owners.

Based on these results we adjusted the structure of the Bull's eye method as an improvement idea so that it can be used within the software development industry. The results are shown in Subsection 5.9.

5.8 Feasibility Process mining method

In spite of the fact that the interviewed organizations do not identify or analyze their practices with quantitative methods, seven participants found the presented Process mining method feasible and five participants think that process mining can possible ad value in identifying and analyzing their software development process.

Looking at the results of the Cross-case results we see that four participants gave answers that indicate that further research must be executed and one should not draw conclusion based on the first results. We relate this to the process discovery phase of the process mining method (Aalst, 2011).

Four participants stated that this method will not work very well when the event-logs are manually registered. According to participant Y of organization Bravo organizations use different kind of tools, like Jira, Greenhopper, HP Agile manager, to visualize the progress of the development and that these tools register the development activities as well. In addition, he stated that these organizations use Kanban boards to depict visually the end-2-end delivery process.

The existence of Kanban originates from the 1950s when Taijchi Ohno created a method to support his "just in time" principle to reduce inefficiencies throughout the whole supply chain (Ohno, 1988) Kanban is usually used with a white board and sticky notes (Budau, 2013). The Kanban board uses swim lanes to visualize the development process and the sticky notes are used to describe the work that has to be done. While the development process is executed, the team members move the sticky notes within the predefined columns. An example of a Kanban board is illustrated in Figure 71.

Figure 71: Example Kanban board (Mitchell, 2013)
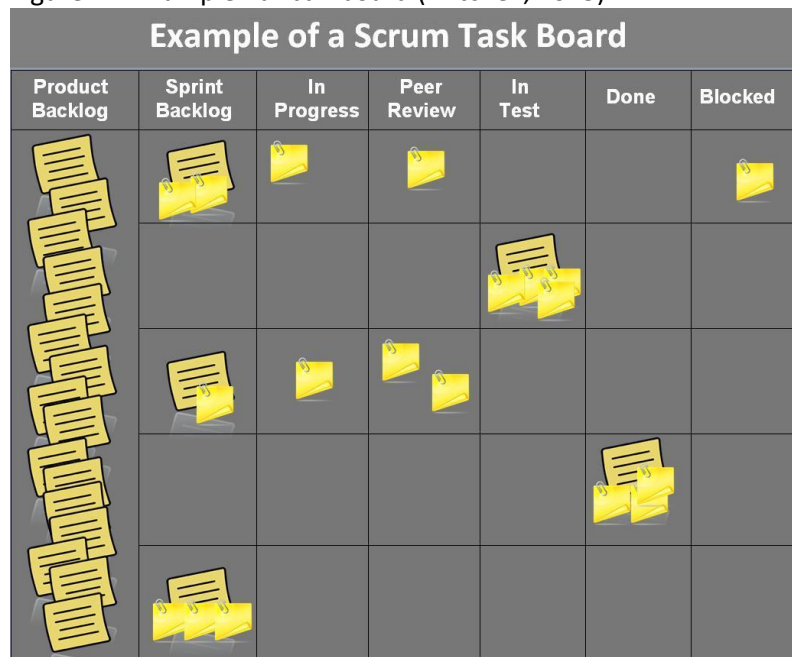
Based on these results we created a conceptual model as an improvement idea to improve the software develop process. The results are shown in Subsection 5.9.

5.9 Improvement proposals

This subsection describes an improvement idea related to the Bull's eye method (Spiegeleire, 2006) in subsection 5.9.1 and a improvement idea related to the process mining method (Aalst, 1999)

5.9.1 Improvement idea 1

At this moment none of the organizations use any kind of internal or external benchmark methods to identify or analyze practices. However the research result show that eleven of the fourteen participants find the bull's eye method feasible and gave enough suggestions how this method can be used in a software development environment.

Benchmarking is one of most effective approach to improve a organization's performance. There are two benchmarking approaches: (1) internal benchmarking (e.g. to compare performances between business units of the same group) and (2) External benchmarking (e.g. comparative analysis of performances between different firms) (Maire, Bronet, & Pillet, 2005)

Looking at the results of (1) why organizations choose their practices, (2) How they determine the relevancy of practices and (3) how to improve the deployment and (4) the feasibility results of the Bull's eye method, we think that the structure of the Bull's eye method add value in identifying, analyzing and managing (best) practices.

Because the original structure is developed for retail organization we changed it to make it suitable for software development community. Based on the category results of the *Combination reasons using and choosing practices* we adjusted the levels to: *Organization Practices, Industry Practices, Literature / Congress Practices*. We argue that the levels Customer Demand and Spontaneous are not suitable for the adopted Bull's eye method and therefore will not be included in the model. Figure 72 and Table 34 illustrates the original Bull's eye method and explanation (Spiegeleire, 2006). Figure 73 and Table 35 illustrates the transformerd Bull's eye method and explanation, suitable for the software development organization.

Figure 72: Bull's eye method (Spiegeleire, 2006)
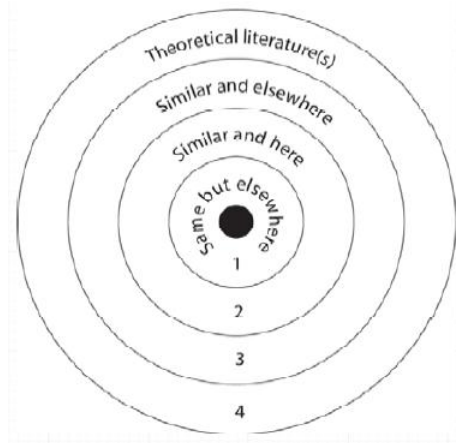
Table 34: Explanation Bull's eye method

Level	Explanation
1.Same but elsewhere	Situation with a comparable analytical value (e.g. retail stores in different sectors)
2.Similar and here	Not same, but similar activities within your community or location (e.g. online retailers in The Hague)
3.Similar and elsewhere	Activities with good reputation in a related field (e.g. best practices in retailing)
4.Theories,literature	Theoretical underpinnings of the problem at hand (e.g. shopping behavior)

Transformation

Figure 73: Transformerd Bull's eye method

Table 35: Transformed Bull's eye method

Level	Explanation
1.Company practice	Currently used (or predefined) practices within the organization/business unit that have proven their results
2.Industry practice	Practices that are used within the industry
3.Literature / Congresses	Practices that have been discussed in literature or at congresses but have not been used within the industry

5.9.2 Improvement idea 2

Because some Kanban-tools are able to extract the registered event-logs, we argue that process mining is an applicable method to identify (Process Discovery), analyze (Process Conformance) and improve (Process Enhancement) software development processes and practices. Figure 74 illustrates our developed conceptual model.

Figure 74: Conceptual model Agile software development
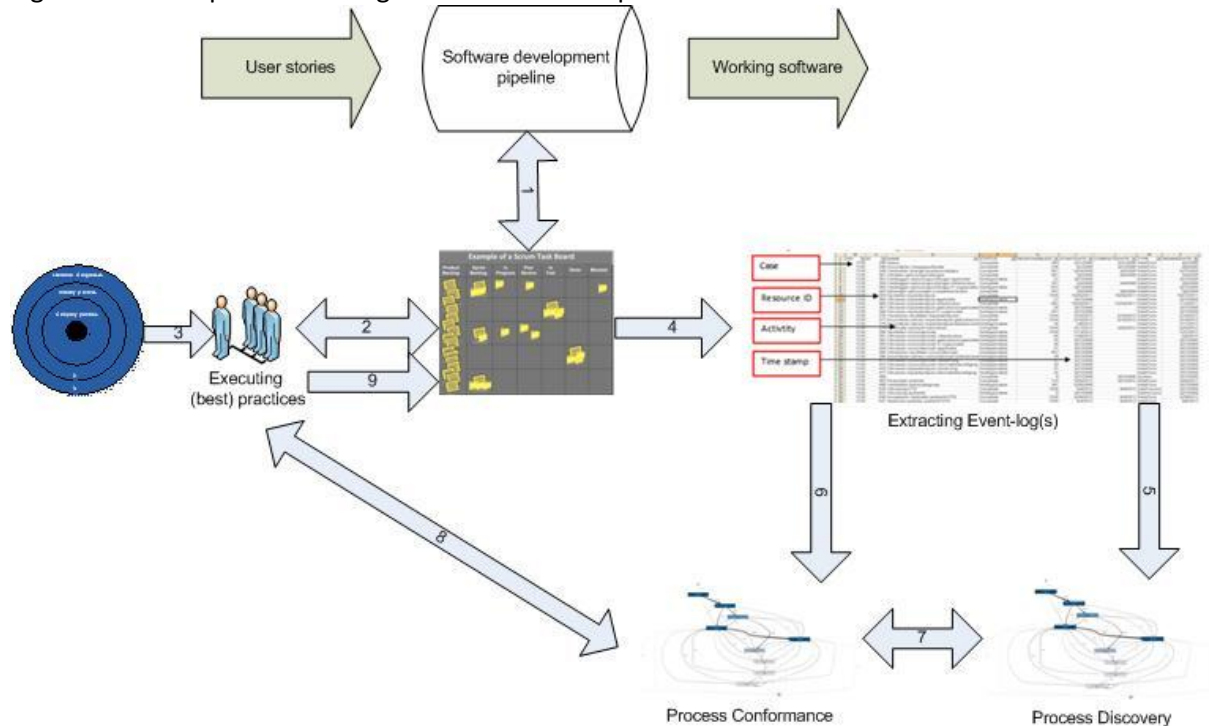
Figure 74 illustrates the conceptual model of the software development process including the process mining method (Aalst, 1999) and our transformed Bull's eye method:

All the development activities are registered and processes in the digital Kanban-tool (1). The team members execute the activities and register this information within the Kanban-tool (2) in order to follow the progress of the development. The team develops based on chosen practices (3). After a development peri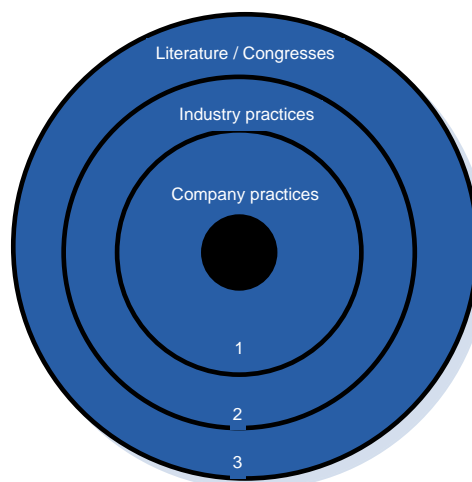od (e.g. 1-2 sprints) one can extract the event-logs from the Kanban-tooling (4) and import the event-log into the process mining tool (5) to execute the process discovery phase. When the process model is developed by the process mining tool, this model should be stored and another process model should be created (6) after a new development period (e.g. sprint 3-4). The results of the process models can then be analyzed in the process conformance phase (7). The results should be evaluated (8) with the team member (e.g. during a retrospective session). During this evaluation session the team members can discuss their used practices, how to improve their used practices or discuss practices that they have not adopted yet. After this evaluation session the team members can document their evaluation and execute the changes that were made to improve the development process (9). Because the software development process is iterative, one can check the results for improvement after each new development period.

6   Conclusions and recommendations

In this research we examined how (best) practices can be identified, analysed, improved, represent and document to improve the efficiency of the software development process. We were able to conduct fourteen interviews at eight different organizations.

A literature study was executed to examine which methods were available to identify, analyse and represent (best) practices. In addition we examined the process workshop (Dingsøyr & Moe, 2004) with an experienced Agile Scrum master to identify a commonly used practice. We used the results of this process workshop to create four different representation methods. One of these representations methods was developed in co-operation with a student who studies architecture.

The conducted interviews were open- and semi structured. During the interviews we examined how organization identify, analyse, improve, represent and documents their practices. Then we asked the participants for improvement ideas and challenges, related to using, improving and documenting practices. Finally we presented our four developed representation examples, the Bull's eye method (Spiegeleire, 2006) and some examples of the process mining method (Aalst, 1999) to examine if the participants found these methods feasible for using it wihtin their software development environment and ask for improvement idea's. The interviews results of the Bull's eye method and Process mining method have resulted in improvement proposals (Subsection 5.9). The results of the represenation examples will be used to improve the information card and the updated version will be examined by the participants when it is completed.

6.1   Conclusions

Our first conclusion is related to the lack of awareness of using and improving practices within organizations. Although every interviewed organization seems to be generally satisfied with their used methods and practices to develop software in an Agile manner, it also looks like they accepted most practices that are used within the entire industry and are not actively focused anymore to develop or improve their practices for their own software development process.

Many organizations analyze the progress of their software development progress, however in most cases they analyze the result which is related to the sum of all used practices. Therefore it is difficult to determine which practice adds value, which practice does not add value and which practice should be improved for the software development process.

It seems to be that the lack of representing practices in detail and the accessibility of practices can be related to the fact that many employees are Scrum certified (or trained on the job) and that organization uses common industry practices.

The results show that organizations struggle with the balance between the autonomy of the development teams and organization control. Consultancy organizations have to take specific customer requirements into account which will not always improve the development progress. Organizations whose core business is not software development are struggling getting business support and organizations whose core business is software development want to have more control over the teams to improve the software development process.

6.2 Recommendations for further research

Based on the research results we concluded the following questions for further research;

- Which methods/techniques can be used to convince people to change a chosen software development method or current way of working?
- How organizations, applying agile software development methods, maintain the autonomy of the development teams and keep organizational control?
- How can process mining add value in improve the software development process?
- How can organizations determine when practices should be analyzed for improvement?

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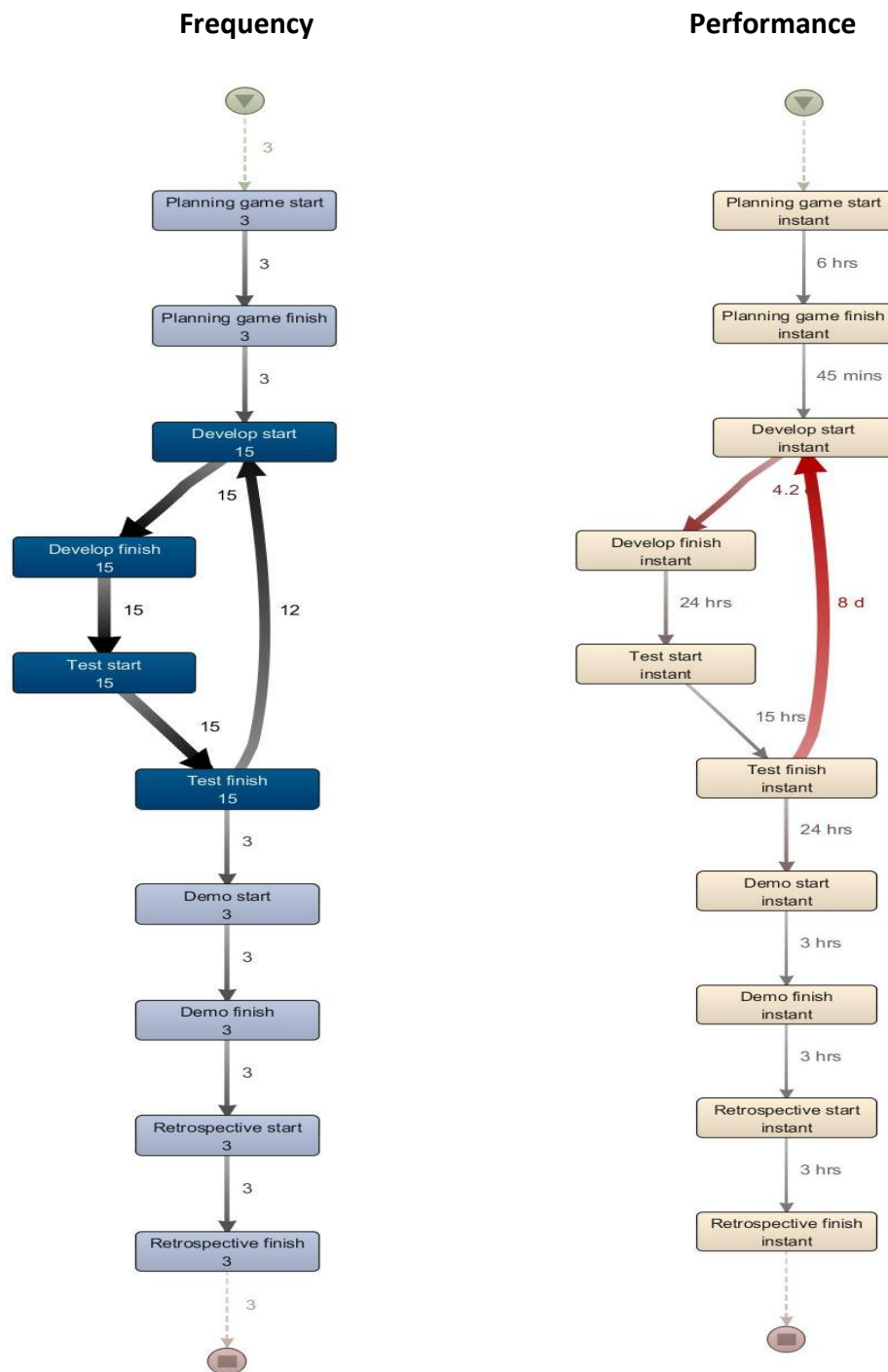
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Appendix

7   Identify & analyze (best) practices with process mining

Frequency

Performance

8 Process representation methods

8.1 Workshop model

Output

Working Software **I**	Updated backlog **II**
Sprint report (velocity, action, etc.) **III**	Updated Default Definition of Done **IV**
Overview Impediments Resolved **VI**	Updated impediments list **V**

Activities

Planning game **1**	Develop / Test iteration **2**	Demo **3**	Retrospective **4**

Related Documents

- Scrum Agile process description **α /β/ µ/ Δ**
- Document Templates **α /β/ µ/ Δ**
- Coding Guidelines **Δ**
- Test Standards (Heuristics) **Δ**

Roles

- Customer **α(ε) A/3**
- Product Owner **β (Backlog) (A)/3/C/D/F/II / IV**
- Scrum Master **µ (Team) E/G/ III/ V**
- Developer/Tester /Techlead **Δ 4/6/7/8/D/I/VI**

Input

(Requirements document / Use Case) **A**	Sprint planning **E**
Reference architecture **B**	Impediment list **G**
Backlog **C**	
User story -Acceptance criteria **D**	Impediment **H**
Default Definition of Done **F**	

8.2 RACI process model

Iterative development process

Input	Responsible	Accountable	Consulting	Informed	Activity	Output
Product Backlog / Reference Architecture / Requirements document	Scrum Master	Product Owner	Developer			
Defaul Definition of Done	Scrum Master	Scrum Master	Developer / Product Owner			
	Scrum Master	Scrum Master	Developer / Product Owner		Planning Game	Sprint Planning
	Scrum Master	Scrum Master	Developer / Product Owner			
Impediment list	Developer	Scrum Master				
Coding Guidelines / Test Guidelines (standards)	Scrum Master	Scrum Master / Developer	Developer		Develop / Test	
	Scrum Master	Scrum Master	Responsible	Product Owner		Working software
	Scrum Master	Scrum Master	Developer			Impediments resolved
	Developer	Scrum Master	Customer		Demo	
	Product owner / Scrum Master	Product owner	Customer	Customer		Updated backlog
	Scrum Master	Scrum Master	Developer			Sprint reports (statistics)
	Scrum Master	Scrum Master	Developer		Retrospective	
	Developer	Scrum Master	Product Owner	Product Owner		Updated impediment list
	Scrum Master	Product Owner	Developer			Updated Defaul Definition of Done

Period 2-4 weeks

117

8.3 Process guide Iterative development

Process guide

Iterative development process
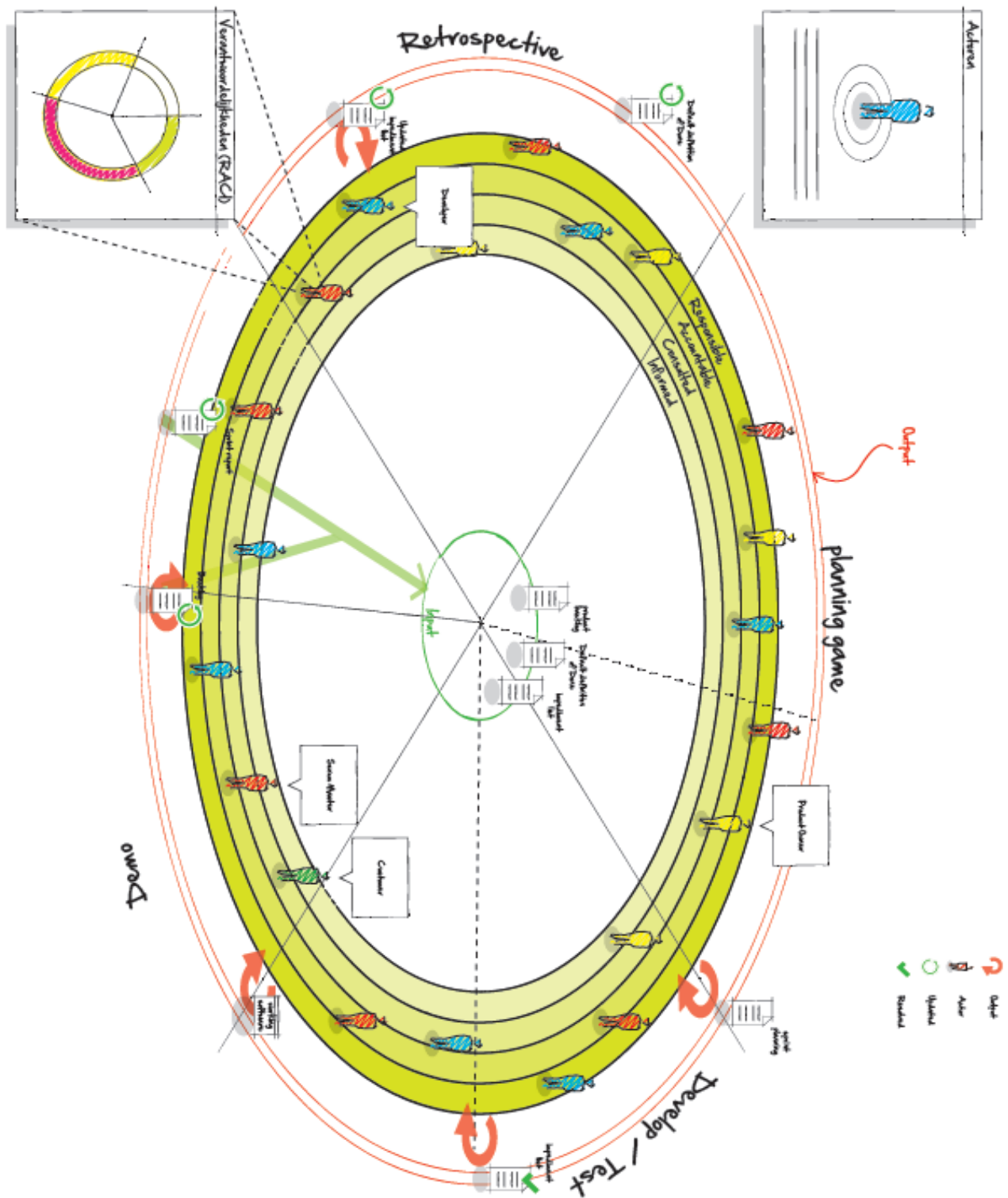
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Date   04 juni 2013

Status   Concept

Initiator   Ing. R.H.J.C. van Wel

Author   Ing. R.H.J.C. van Wel

Index

8.4   Information card

9 Interview guideline

Step 1 Interview introduction
In the introduction phase, I will introduce myself, explain which study I follow and the topic of my Thesis. Then I will ask for permission to record the interview with a memo recorder and explain that the interview results will not be used for other purposes then my Thesis. In addition I will tell that I will not use the organizations name, nor the name of the interviewee in my research. The transcription of the interview will be send by email to the interviewee for approval. If the interviewee has additional whishes/questions, I will try to address them.

Step 2: Gather general organization- and interviewee information
After the introduction, I will ask the interviewee what his/her role and responsibilities are within the organization and how long he/she is working on this current position. Then I will ask how long he/she works for the organization and what their experiences and current involvement are with (Agile) software development processes.

In addition, I will ask questions about the structure of the organization and ask where the interviewee is working. Then I will ask if there is a central administration office of projects and how the synergies between the projects are handled (e.g. by using a program manager). Finally I will ask questions about how the organization coupes with learning experience (lessons learned) shared across the project teams.

Step 3: Identification and documentation of practices
In Step 3 I will ask questions about which management- and team practices they use within their software development process. Then I will ask how these practices are deployed, why these practices are used and how these practices are documented (do they use a particular modeling and notation method for this?). Then I will ask the interviewees opinion how he/she think these practices should be documented for the use of knowledge sharing. Finally I will ask how new practices are identified.

Step 4: Analyze and benchmark discovered and used practices
In Step 4, I will ask questions about how they decide which (best) practices should be used (and which not) for a particular software development project and If they use methods to analyze the results (efficient/effectiveness) of the use of these practices. Finally I will ask how they act if they discover that a certain practice is not relevant anymore.

Step 5: Thoughts of improving the use of (best) practices
In Step 5, I will ask the interviewee how satisfied he/she is with the current way of using, improving, and documenting the practices/processes. Then I will ask what can be improved and what the challenges are.

Step 6: Present examples
Present four process visualizations
I will present four different methods (textual process guide, workshop notation, my own build model (RACI) and an information card), based on a iterative development process, to document practices and ask which method is the most appealing, what should be improved, if he/she would use one (or more) of these methods for their organization (feasible) and what information is available to create such models. During this process I will observe the interviewee and make notes to see which method he first look in too and ask why they did this. Hereby I will also look for non-verbal communication.

Benchmarking
Then I will present the bull's eye method to benchmark best practices and ask them if this is something they can/will use.

Analyzing
Finally I will show two process mining Figure and explain how these models are visualized (which data is needed) and how they can be used to analyze the performance of a practice. Then I will ask them if this is some they can/will use.

10 Interview questions

General organization- and interviewee questions:

Interviewee information
1. What is your role and responsibilities within the organization?
2. How long are you working on your current position?
3. How long do you work for the organization?
4. What are your experiences with (Agile) software development?
5. What is your involvement in the software development process at this moment?

Organization information
6. Ask the participant for a *high level structure* of the organization?
    a. Which part of the organization do you work for?
7. Does your organization have a central administration of projects (e.g. project management office)?
8. How are synergies across the projects handled? (do you have a program manager)
9. Are learning experience (lesson learned) shared across the project teams?
    a. If so, how?

Identification and documentation of practices:

10. Which management- and team practices do you use within the software development process (e.g. development in short iterations, standup meetings, time-boxing, retrospectives, burn-down charts)?
    a. How do you deploy these practices (e.g. new team/process)
    b. Why do you use these practices? (e.g. Based on experience, Organization policy, etc.)
    c. Are these practices documented (e.g. Development software like Jira, Excel/Word document or SharePoint)?
        i. If so, which practices are documented?
        ii. How are they documented?
        iii. Do you use any modeling notation to describe these practices (if so, which)?
    d. How do you think these practices should be documented for the use of knowledge sharing?
    e. Which information is necessary for you in order to document your work processes (actors, roles, actions)?
    f. How do you identify new practices?

Analyze and benchmark discovered and used practices:

11. How do you improve your software development practices and processes (or processes in general)?
12. How do you decide which (best) practice should be used (and which not) for a particular software development project?
13. How do you decide if the used practice is still relevant?
    a. How do you analyze the results (efficient/effectiveness) of the use of these practices?
    b. What do you do if you decide the practice is not relevant anymore (e.g. inform colleagues, management, SharePoint owner)?
    c.

Thoughts of improving the use of (best) practices:

14. How satisfied are you with the current way of using your practices/processes?
    a. What do you think could improve the use of these practices/processes?
    b. What are the challenges?
15. How satisfied are you with the current way of improving your processes/practices?
    c. What do you think could improve the current way of improving these practices/processes?
    d. What are the challenges?
16. How satisfied are you with the current way of documenting your processes?
    a. What do you think could improve in documenting these processes?
    b. What are the challenges?

Present examples:

Documenting
Workshop iterative development results:
17. Which one is the most appealing?
    a. What would you improve (looking at the most appealing one)?
    b. Is this something you would use in your organization (explain)? Is it feasible?
    c. What information is available to automatically create such models?
Benchmarking
18. Is this something you would use in your organization (explain)? Is it feasible?
Analyzing with process mining
19. Is this something you would use in your organization (explain)? Is it feasible?