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‘Fitness for use’-oriented process modeling

based on the SEQUAL-BPM framework

Master’s Thesis in the Master’s Programme
Quality and Operations Management

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Abstract

Process modeling is an activity that is performed by most organizations today. However, the underlying purpose of this activity is not always expressed, which implies difficulties when defining and evaluating quality of process modeling initiatives. An initial literature review of this thesis showed that purposes of process modeling are described in literature only volatilely without an organizational perspective. Moreover, no explanation of purposes' importance, their commonality or mutual relationships are not provided. The literature review also concluded that there exists a leading framework, named SEQUAL-BPM, that can be used to measure quality of process models. However, the framework lacks adaption to the underlying purpose of the process modeling initiative. To conclude, literature does not have a "fitness for use" perspective on process modeling – *use* referring to possible usage areas i.e. purposes, and *fitness* referring to adaption to the area of use.

The result of the literature review formed the basis of this thesis's purpose, which was, firstly, to elaborate on the quality definition "fitness for use" by providing insights on what are the main reasons to why organizations perform process modeling and how these reasons mutually relate to each other. Furthermore, the study aimed to provide insights regarding what quality attributes within the SEQUAL-BPM framework that should be emphasized, in order to fulfill underlying purposes of process modeling.

Interviews with 24 Swedish organizations, of different sizes and branches, showed that there exist a wide range of reasons to why process modeling is performed, where the most common are identification of strength and weaknesses in existing processes, distribution of roles and responsibilities, facilitation of training, fulfillment of external requirements and facilitation of organizational transformations. Through quantitative analysis methods a concluding model was drawn that shows how the in total 17 purposes relate to each other in regard to three different aspects. In relation to previous research, the model provides a more granular answer, expressed with practitioners' wordings, to why process modeling is performed.

Furthermore, the interviews confirmed that when designing and evaluating process modeling initiatives, the weight on different possible quality attributes of a model should be adapted to the modeling purpose. More specifically, the study has provided clear indications on which of the quality attributes within SEQUAL-BPM that should be emphasized in order to reach the right level of modeling for the most important of the identified purposes.

The conclusion of the study was that in order to increase the likelihood for success of process modeling, organizations should think through why they do it and what they want to accomplish. Based on this, it is possible to set quality goals and guidelines for each purpose that can be used for design and evaluation.

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1. Introduction

If someone asks the question: "Do you perform process modeling in your organization?", the answer would most likely be: "Yes". However, the answer on the follow up question: "Why do you do it?", might not be as evident. A pre-study performed in the early stages of this thesis, including interviews with five organizations, showed that organizations do not always have a clear idea of what they want to accomplish with their process modeling efforts. A low understanding on why they perform process modeling makes organizations blindfolded, and success could for example be measured by compliance to the process model even though that might not be the goal.

Above reasoning raises the questions: *Why do actually organizations perform process modeling?* and *What do they want to achieve?* If no explicit answer exists, there are no clear ambitions or demands on the process modeling initiative, which evidently makes it difficult to ensure quality. For this several frameworks have been developed, of which SEQUAL-BPM (Krogstie 2016) is the leading. The framework is comprehensive and covers a wide range of quality dimensions and attributes. However, this framework is not connected to underlying reasons, which makes it difficult for organizations to evaluate the success of the model. The issue could be compared to a football coach that evaluates all football-players in the team based on if they score or not, making for example the defenders look unsuccessful. In reality, the players as well as the process modeling initiatives have different purposes and should be evaluated against these. In order to increase the likelihood of success, it is important to understand what quality attributes that should be emphasized for each individual purpose, just as what qualities to appreciate of a defender.

The master thesis is thereby driven by the theory that quality evaluation of a process model should be based on its **"fitness for use"**. With other words, the better the model supports the purpose from the viewpoint of the user, the higher the quality is deemed. It is believed that if organizations would explicitly understand and express the purpose of their process modeling activities, and know what quality attributes they should emphasize in order to fulfill these, their process modeling would be more fruitful. Nuanced evaluation and clear goals of what they would like to accomplish enables creation of early results which increases buy-in and thereby the likelihood for greater accomplishments later on.

Taking above reasoning into consideration, **the explicit purpose of this study** is to elaborate on the quality definition "fitness for use" by providing insights on what are the main reasons to why organizations perform process modeling and how these reasons mutually relate to each other. Furthermore, the study aims to provide insights regarding what quality attributes within the SEQUAL-BPM framework that should be emphasized, in order to fulfill underlying purposes of process modeling.

2. Theoretical Framework

In chapter 3 the above mentioned purpose is broken down into research questions through a problem discussion. However, in order to hold such problem discussion in a nuanced way, it is deemed to be necessary to first increase the understanding on some theoretical aspects, which are:

- 2.1 What is process modeling?
- 2.2 Underlying purposes to process modeling
- 2.3 Quality of process modeling

2.1 What is Process Modeling?

Below sections aim to introduce the reader on what process modeling historically come from, what it is and how it can be executed.

2.1.1 Background to Process Modeling

As global competition and customer demands increase, organizations are forced to constantly evaluate and develop their market positions (Becker et al. 2003). In order to sustain a competitive advantage many organizations have, over the last decades, looked into quality management initiatives such as; ISO-standards, Total quality management (TQM), business excellence programs and methodologies as Six Sigma (Garvare 2002). Overtime the area of quality management has progressed from reactive quality inspections to proactive approaches focusing on the fulfillment of customers' true needs. To achieve this, modern quality management focuses on how the products are produced, instead of focusing on the finished product, which naturally makes processes a fundament of these organizations (Garvare 2002).

During the 1970's, the process view was generally restricted to distribution and production aiming on cost reduction through lower inventory levels and shorter lead times. These initiatives are often labelled as Lean Production or Just In Time (Schönberger 1986). During the 80's and 90's the process view was expanded to a corporate level, involving all functions of an organization. As the process view got a larger organizational grip, the perspective also changed from process control through statistical and scientific methods to process management including social and behavioral aspects (Dale et al. 2000). Porter's (1985) value chain (see figure 1 below), somewhat laid the foundation for the modern process view.

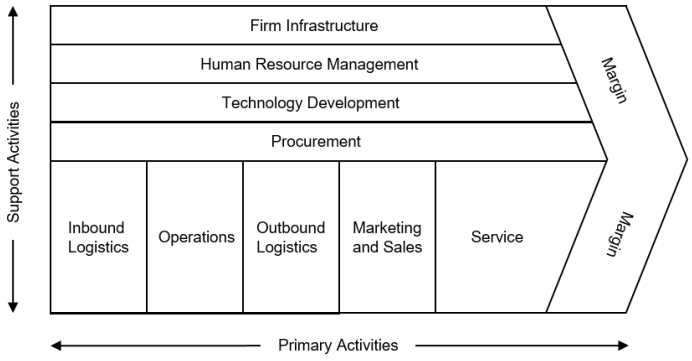


Figure 1: Illustration of Porter's value chain.

On this basis several doctrines, with differing definitions and directions, as Business Process Reengineering (BPR) and later Business Process Management (BPM) are developed (Jeston & Nelis 2008). According to Garvare (2002, p. 24) "one of the difficulties with process management is its terminology and great variety of definitions. Although process management is a relatively new area of research the literature on the subject is abundant". However a denominator of most process management doctrines is process modeling (Krogstie 2016).

2.1.2 Definition of Process Modeling

The core of every organization's activities is its business processes, defined as a "collection of related, structured tasks that produce a specific service or product to address a certain (organizational) goal for a particular actor or set of actors with the optimal use of resources" (Krogstie 2016, p. 1). The management of these processes is called Business Process Management (BPM), within which process modeling is an important activity (Krogstie 2016). To understand the need for process modeling, one can look back at the evolution of the human species where our ability to represent, reuse and transfer knowledge over space and time is an important reason why humans as a species has evolved. In our minds, we build mental models of knowledge and experiences that are spread through one-dimensional natural languages as English or Swedish. However, it is sometimes necessary to use two- and multidimensional knowledge representations to capture and spread all nuances of complex knowledge. One such multidimensional knowledge representation is conceptual models, which is defined as: "a description of the phenomena in a domain, at some level of abstraction, which is expressed in a semiformal or formal visual (diagrammatical) language" (Krogstie 2016, p. 18).

Included in the conceptual model spectrum is the concept of process modeling (Krogstie 2016). Developing process models can be explained as representing a domain, i.e. a specific area of interest, as a process model in order to achieve a certain goal. This activity then includes people, supporting tools and means for representation (such as languages or documents) and could be supported by existing resources that provide insights on earlier modeling experiences or standards. More formally, Bandara et al. (2006, p. 2) express the following definition:

"Process modeling is an approach for visually depicting how businesses conduct their operations by defining the entities, activities, enablers and further relationships along control flows."

2.1.3 Executing Process Modeling within Business Process Management

As mentioned above, Process modeling is frequently mentioned as a part of Business Process Management (BPM). A common way to execute process modeling will thus be explained through the BPM framework.

Von Rosing, Foldager, et al. (2015) describe that the BPM lifecycle involves six phases, starting with an *analysis* phase where the BPM project is prepared. This first phase includes understanding the business processes as they function today; their goals, involved stakeholders, functional areas etc. Next, processes are *designed* in phase two, i.e. they are refined and optimized in order to ensure support of the organization's goals. Phase three involves the *building* of processes, i.e. the actual modeling activity. It includes both modeling "as-is" processes and analyzing them to build "to-be"-models. When processes are modeled, phase four starts, including the *implementation* of processes. The new processes are here rolled out, with the help of incentives and rewards, and they are prepared for performance measurements. Phase five includes *maintenance* of processes, i.e. the implemented processes are governed and monitored. This

involves measuring process performance and rebuilding processes where necessary. Lastly, the life cycle enters phase six, *continuous improvement*, where processes are continuously optimized and developed.

As can be seen in the section above, the BPM lifecycle requires a large set of activities with the overall focus on organizational transformation or improvement. Jeston and Nelis (2008) use *the 7FE Project Framework* (figure 2) to describe mechanisms involved in a BPM project. The framework includes ten phases that in turn are divided into four groups. First, the *Foundation* of the project is built, followed by a *Findings & solutions* phase where processes are analyzed. The outcome of this phase are solutions that are implemented in the *Fulfillment* phase. Lastly, the *Future* phase refers to integrating the improvement projects in the organization. In addition, three *Essentials* are required in order for the project to move through the phases: *Leadership*, *Project Management* and *People Change Management*. Having the baseline defined in early phases of the project, that is an overall process structure and guidelines for modeling, the actual modeling of processes is mostly performed in the *Understand* and *Innovate* phases. In the *Understand* phase, *current* processes are modeled, whereas the *Innovate* phase involves modeling of *future* processes. Modeling is usually performed during workshops, using various methods and sometimes modeling tools.

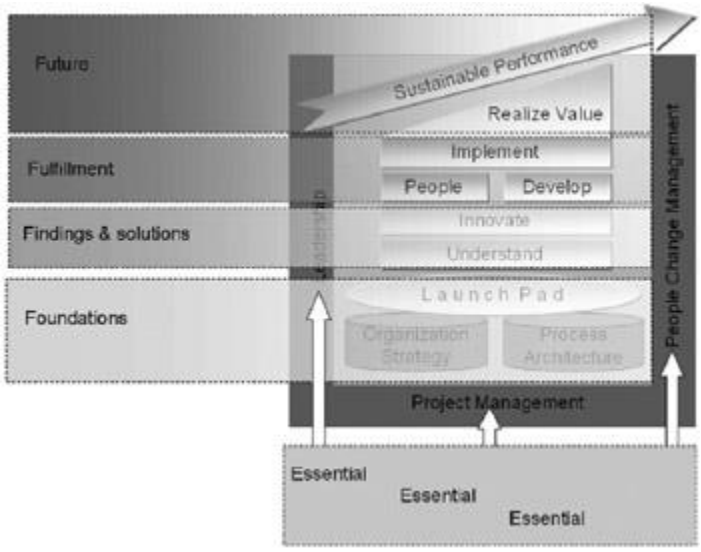


Figure 2: Illustration of the 7FE project framework. Source: von Rosing, Scheer, von Scheel, von Rosing, Foldager, et al. (2015).

2.1.4 Categorizing Process Models

An organization's processes are of different kinds and different levels of dynamicity, which makes it eligible to also approach them differently (Krogstie 2016). Porter's value chain (1985) (figure 1) describes an organization's activities and divides them into primary and supporting activities. This provide a basis for a process categorization method that is commonly used today, namely categorization by process types (von Rosing, Kemp, et al. 2015). In addition to process types, von Rosing, Kemp, et al. use three other aspects to describe the categorization and classification of processes. This approach aims to help to better understand processes and perform analysis on the correct level in relation to the context.

Process types focuses on the role of the process. There are three process types: management processes (concentrate on planning and control), main processes (that produce output) and support processes (essential for performing the main processes).

Process decomposition describes the extent to which processes are broken down into different levels, from an entire process area to specific activities.

Process nature categorization is based on process complexity, i.e. whether the processes are simple, static and repeatable or more complex, dynamic and changing.

Process tiers distinguish between strategic, tactical and operational processes. Strategic processes are such processes that involve the entire organization and its direction, visions and objectives. Tactical processes are derived from the strategic directions and involves less complex activities whereas operational processes are of simple and routine character.

A pre-study performed in this thesis confirmed that an organization's business processes are often modeled in a management system, where they are categorized according to process types. The management system shows an initial overview of the organization's business processes divided in management, main and support processes. These processes are then decomposed into several, more detailed, levels of abstraction. Hence, such management systems could be seen as including two of the different categorization aspects presented by (von Rosing, Kemp, et al. 2015).

2.2 Underlying purposes to process modeling

This section is a summary of the results of a literature review specifically made for identification of underlying purposes to process modeling. See section 4.3.2.1 for presentation on how this literature review was made. The results from the review will later be processed in chapter 3: *Problem discussion.*

Several different purposes to process modeling are described in literature. Some papers only name one or a few without giving a complete picture of purposes, while others describe models aimed to cover the whole perspective. Some general descriptions are:

- "...a 'method' to increase the awareness and knowledge of business processes, and to reduce the associated organizational complexity." (Sedera et al. 2004, p. 485)
- "The purpose of business process modelling is ultimately the improvement of the enterprise in order to deal with change. In general therefore, we advocate that change management should be seen as the process of identifying business goals and relating business processes to these goals." (Andpericlesloucopoulos 1999, p. 203)

Table 1 presents three papers that mention several purposes. Also Becker et al. (2003) present several possible purposes of process models, though a bit more exhaustive and descriptive than those in table 1. Hence these different purposes are summarized separately in table 2.

Bandara et al. (2006)	Becker et al. (2010) (from a case study)	Rosemann (2006)
process documentation process improvement compliance software implementation quality certification	certification system integration training knowledge management process optimization process documentation organizational re-engineering internal benchmarking	document business process cost business process simulate business process animate business process improve business process compliance (ISO, Sarbanes-Oxley, Basel II) software selection, evaluation, configuration and development Design of enterprise architectures HR capacity planning project management knowledge management document management relationship management

Table 1: Reasons behind process modeling according to Bandara et al., (2006), Becker et al. (2010) and Rosemann (2006).

Purpose	Description
Organization documentation	Creating transparent models for communication among all employees, i.e. for training purposes, or to use as job descriptions.
Process-oriented reorganization	Modeling as a part of business process reengineering initiative together with continuous process improvement efforts
Continuous process management	Long-term perspective on processes, involving planning, execution and control. Means comparison between process models and process execution in reality in order to find and correct deviations.
Certification pursuant to DIN ISO 9000	Modeling in order to receive a quality certification, requiring a high quality of the organization's quality assurance procedures as well as its process documentation.
Benchmarking	Comparing both process structure and process performance to a best practise, either internal or external.
Knowledge Management	Supporting the knowledge lifecycle including identifying, acquiring, using, developing and distributing know-how.
Selection of ERP-Software	Documentation of ERP software functionality, supporting system selection, implementation, use, upgrades and maintenance.
Model-based customization	Models as input when making decisions related to customization of enterprise system functionality.
Software development	Describing requirements for development of software.
Simulation	Using the models to analyze business process performance over a longer period of time, in order to identify weaknesses hard to discover if the model is only observed, or to perform calculations on e.g. personnel requirements.

Table 2: Underlying reasons to process modeling according to Becker et al. (2003).

While the papers above mention some purposes, some authors aim to cover the whole range of purposes within a few categories. Aguilar-Sav (2004) concludes that business process modeling is performed due to one of the following four reasons:

1. Descriptive models for learning
2. Process development and design
3. Decision making based on process control and monitoring
4. Software development

Another author that introduces a more holistic perspective of purposes is Krogstie (2016). He uses a model named *Application of business process modeling* (hereinafter referred to as *The smiley model*) (figure 3) to describe the spectrum of different purposes. In contrast to other authors, Krogstie has through this model more in depth described a wider range of underlying purposes and how they relate to each other. The foundation of this model is two possible states of the organization: The current state and the future state. Both states can be modeled for different purposes. The aspects of *The smiley model* are further described below.

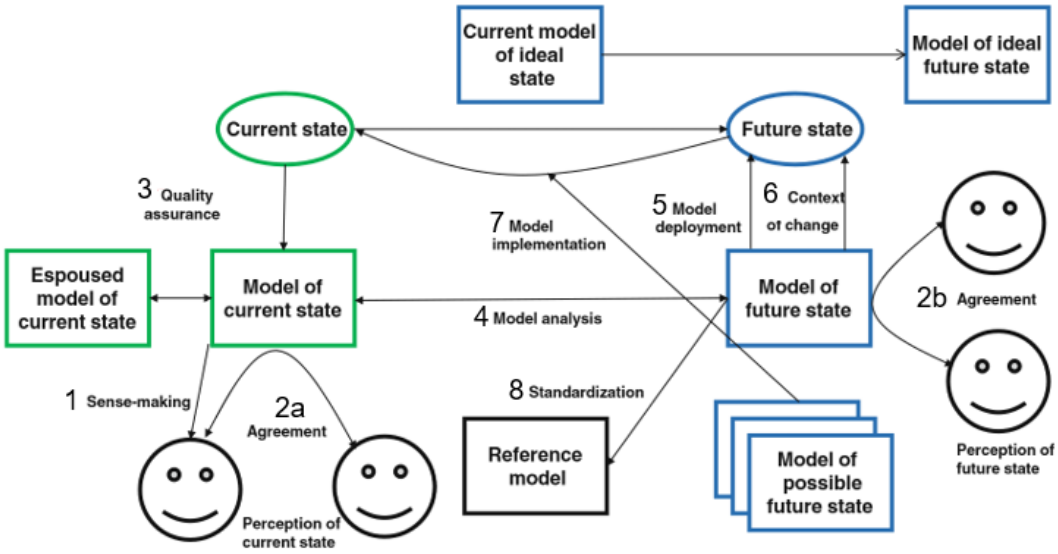


Figure 3: Visualization of goals with process modeling (The smiley model). Source: Krogstie (2016).

Model of current state:

- Human sense-making (1): Using the current state model to give people a picture of the current situation to understand and learn about it. One example of application within the sense-making area is the use of models for training purposes.
- Agreement (2a): Using the model as a common framework to facilitate communication among people to eventually reach an agreement.
- Quality assurance (3): An espoused model of the current state could represent requirements of some kind, and adjusting a model of the current state to fit this espoused model is described as a quality assurance activity.

- Model analysis (4): Using the model as an object for analysis of the current situation, finding gaps and comparing to a new, potentially better, model of a future state. This activity could also be performed with the model of a future state as a basis, identifying what must change in the current situation in order to fit the new model. One example is the implementation of an ERP system, where the current working procedures need to be adapted to fit the processes of the new system.

Model of future state:

- Agreement (2b): As for a current state model, a model of a future state could also be used to reach agreement, e.g. when new working methods need to be discussed and agreed upon.
- Model deployment (5): The model of the future state may be activated to become the actual future state, with the motive of changing the organization. This is done either automatically, where the model turns into an automated workflow system or manually, where people use the process models as guidance. An interactive activation is also possible, described as a cooperation between users and computers when interpreting the model.
- Context of change (6): Moreover, the model of the future state could play the role as a prescriptive model, also changing the organization but not aiming to be activated. Instead it provides a basis for information system design, development or implementation.
- Model implementation (7): In order to turn the future state into the current state and hence make organizational change, additional activities need to be performed besides using the actual process model to actually make people work in line with the new processes. Models of possible future state could be used in these cases.
- Standardization (8): When standards from outside the organization exists, the future state is modeled to fit these standards.

2.3 Quality of process modeling

After a literature review (see section 4.3.2.2), aiming at deciding a suitable quality framework against which the purposes could be measured, it was concluded that SEQUAL-BPM was most suitable. Due to this it is highly important to understand this framework. Hence, the purpose of this whole section is to build up to the necessary understanding of SEQUAL-BPM. As the framework is the product of a long-time evolution of quality frameworks, it is deemed that the most pedagogical way to build up an understanding for SEQUAL-BPM is to start from the initial version of the framework and describe how this has evolved overtime (this evolution is illustrated in figure 4 below). Since process modeling is a type of conceptual modeling the SEQUAL-BPM framework is in its core built on frameworks for quality of conceptual modeling. The green boxes in figure 4 represent the evolution steps that concerns conceptual modeling. Hence, this section will start at quality of conceptual modeling and work itself stepwise to SEQUAL-BPM. First the semiotic ladder, which is the core of the frameworks, will be discussed. Then the first framework, LSS, will be presented. Next, the SEQUAL framework will be described, which was developed from the LSS framework. Finally, SEQUAL-BPM will be discussed, which is an extension of SEQUAL.

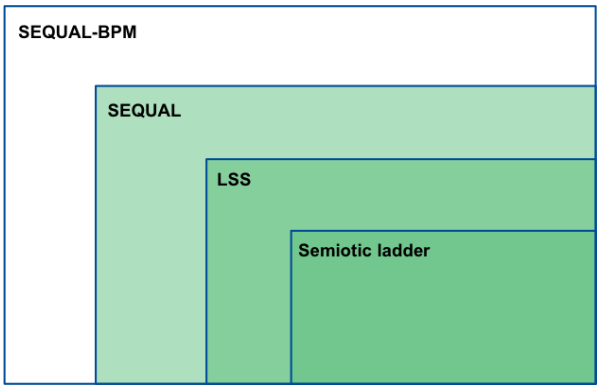


Figure 4: Evolution of SEQUAL-BPM

2.3.1 The semiotic ladder

One of the main ideas behind a conceptual model is communication. Thereby, the quality of a conceptual model closely relates to properties of communication. Communication and related issues can be analyzed through a so called semiotic framework. Such a framework is the semiotic ladder, which consists of six different layers, wherein each layer represents means for communication. As the prominent conceptual modeling frameworks are based on the semiotic ladder, a natural starting point to create understanding of these frameworks is to study the layers within the semiotic ladder. Thereby a brief description of each layer is presented in table 3 below (Krogstie et al. 1995).

Layer	Characteristics
Physical	The layer concerns physical appearance of the communication e.g. communication media and availability of the media.
Empirical	The empirical layer mainly focus on how to handle entropy and variations.
Syntactic	The layer concerns questions regarding language structures and language logics.
Semantic	The semantic layer concentrate on the validity and meaning of what is communicated.
Pragmatic	The pragmatic layer concerns questions regarding the underlying intention to the communicated statements.
Social	The social layer deals with the results of the communication process. Such results can be interest, beliefs, commitments or culture evoked by the communication.

Table 3: The semiotic ladder (Krogstie et al. 1995).

The layers in table 3 can be divided into two groups: technical and social. The technical group includes the physical, empirical and syntactic layers. The layers are stated to be technical since they can be answered through technical solutions. The social group, which involves the semantic, pragmatic and social layer, are strongly dependent on soft values, as knowledge and stakeholder interest, which require solutions of social character (Krogstie et al. 1995).

2.3.2 The LSS framework

The LSS framework was developed by Lindland et al. (1994) and it is the quality framework for conceptual models that lays the foundation for the leading quality frameworks of today. Hence, it is a natural next step when studying conceptual modeling quality frameworks. LSS deals with quality regarding both the model itself and the modeling process. Furthermore, the quality framework is unique since it distinguishes between quality goals (what's) and means (how's). Figure 5 below illustrates the four aspects of the LSS framework, which are; language (modeling language), domain, model and audience participation.

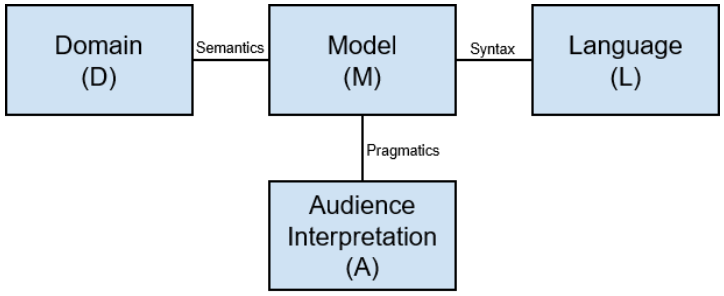


Figure 5: Illustration of the LSS framework.

The modeling language (L) aspect concerns all statements that can be made according to the language syntax, which often is an endless number of combinations. As with natural languages as Swedish and English, L is formed by grammar and an alphabet. The alphabet is the building block of the conceptual model and contains of modeling constructs, each with its own meaning. The grammar defines the rules that decide how the modeling constructs should be combined (Lindland et al. 1994).

The domain (D) is according to Lindland et al. (1994, p. 45) formally defined as "all possible statements that would be correct and relevant for solving the problem". A statement is a type of requirement or specification of what is demanded of the model, which implies that the domain in broader terms can be seen as the "reality", which is modeled. Thereby, every conceptual model has its unique and often evolving domain (Lindland et al. 1994).

The model (M) is the center of the LSS framework and consists of the statements that are actually formulated through the conceptual modeling. M can further be divided into two parts; the explicit model and the implicit model. The explicit model consists of statements explicitly made, while the implicit model consists of the statements that can be derived implicitly from the explicitly made statements (Lindland et al. 1994).

Audience interpretation (A) consists of the statements that the audience believes the model contains of. The audience refers to all actors that need to understand to model, which can be stakeholders in the development process, designers, users, customers, analysts, domain experts or even computers.

Between the model and each other aspect, Lindland et al. (1994) has defined unique relations (see figure 5 above). The semantics relates the model to the domain, the syntax relates the model to the language and finally the pragmatics relates the model to the audience interpretation. Based on these relations the LSS framework defines three quality dimensions; syntactic quality, semantic quality and pragmatic quality. Figure 6 below illustrates these three quality dimensions and what goals that relate to each of them.

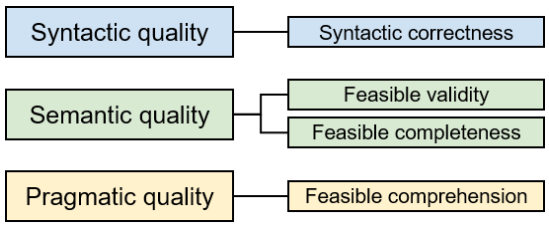


Figure 6: Illustration of LSS quality dimensions and corresponding goals.

Syntactic quality regards how well the model follows the language rules. The more the model follows the language rules, the higher the syntactic quality, and the other way around. Within syntactic quality one goal exists; syntactic correctness, i.e. all model statements are expressed according to syntax.

Semantic quality regards how similar the domain and the model are. The model can for example miss something that the domain contains or it can contain something that the domain does not have. Within semantic quality there are two goals; completeness and validity. Completeness is achieved if the model includes all statements about the domain, i.e. if the model leaves out aspects of reality, the completeness is low. Further, validity is achieved if all model statements are correct and relevant in relation to the domain, i.e. if the model contains parts that does not exist in reality, the model is deemed to be invalid. However, full completeness and validity is for anything else but very simple problems not achievable; trying to reach this would require endless time and resources. Hence, the LSS framework introduces the concept of feasibility. This means that the goal is not to develop the model until perfection, but instead stop the development when the model reaches a state where further development is less beneficial than utilizing it in its current state (Lindland et al. 1994).

Pragmatic quality regards how well the model is comprehended by its audience. Hence, there is one goal within pragmatic quality; comprehension. If the model is not understood by its audience, it does not matter how high the syntactic and semantic qualities are. When discussing comprehension, it is important to distinguish between comprehension (the model has been understood) and comprehensibility (the model's ability to be understood). The latter is not included in pragmatic quality.

As the audience often consists of groups with different background and knowledge, the level of comprehension is highly dependent on these groups' interpretations. Hence, comprehension is formally defined as that all audience members have completely understood the statements in the model that are relevant to them. However, as with semantic quality this goal is not feasible. Instead, the LSS framework introduces the goal *feasible comprehension*, which means that all members of the audience might not have understood the statements completely, but to a degree where the benefits of higher comprehension are lower than the effort required to accomplish further comprehension.

During a modeling process, the levels of the above-mentioned quality dimensions are intertwined and dependent on each other. At a starting-point the model is totally incomplete, but there are no problems with syntactic quality, validity or comprehension. As soon as one starts to put statements into the model, completeness increases, but validity and comprehension decreases. As the model continues to grow it becomes more and more complete, but at some time it reaches a level where the incomprehension and invalidity is too high. At this point the model must be consolidated, which will increase the validity and comprehension at the same time as the completeness is nearby standing still. After a while, further

consolidation will have marginal impact on the comprehension and validity, and the model can be expanded again. "Hence, modeling can be viewed as a pendulum swinging from expansion to consolidation and back again" (Lindland et al. 1994, p.48).

2.3.3 The SEQUAL framework

As the LSS framework, discussed above, only take three of the semiotic layers (semantic, syntactical and pragmatic) into consideration the framework was later extended to be more comprehensive and include all dimensions from Krogstie et al. (1995) (Krogstie et al. 2006). The framework has since 1994 been expanded in several phases and is today commonly known as the SEQUAL framework, i.e. the SEmiotic QUALity framework. The SEQUAL framework, as the LSS framework, is unique since it distinguishes between quality goals (i.e. quality characteristics) and means, i.e. how to achieve these goals. Below follows an explanation of the latest version of the SEQUAL framework and how it relates to the original LSS framework. Figure 7 illustrates the aspects of the SEQUAL framework and their relating qualities.

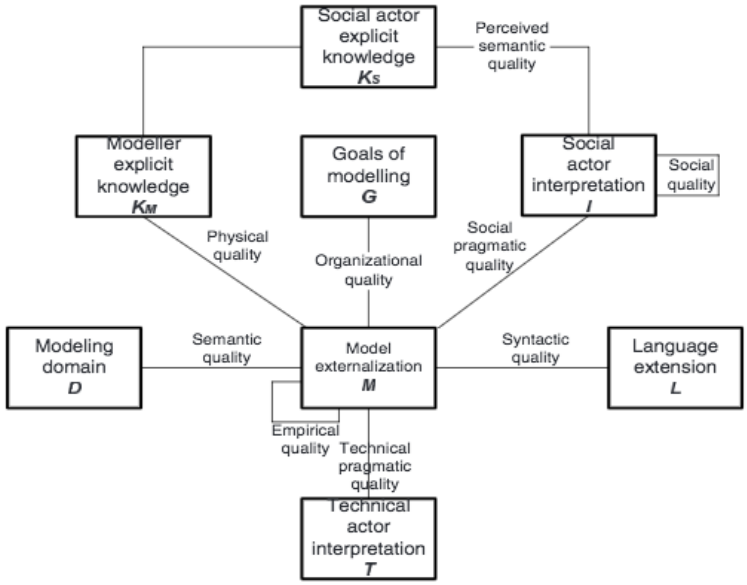


Figure 7: Illustration of the SEQUAL framework. Source: Krogstie & Jørgensen (2003).

2.3.3.1 Aspects within the SEQUAL framework

As within the LSS framework, the model (M) has a central position. Also, the modeling domain (D) and the language (L) are included. The audience interpretation (A) within the LSS is however split into technical actor interpretation (T) and social actor interpretation (I). On top of these five aspects the SEQUAL framework includes the aspects social actor explicit knowledge (Ks), modeler explicit knowledge (Km) and goal of modeling (G). All aspects of the SEQUAL framework are described below.

Goal of modeling (G): Goal of modeling refers to the organizational goals with the modeling activity. The aspect answers the question why conceptual modeling is done and what the organization wants to achieve through the initiative (Nelson et al. 2012).

Language extension (L): As within the LSS framework, the language extensions represent all possible statements that can be made according the vocabulary and syntax of the modeling language, which is an endless amount of combinations. There are three subsets of languages; informal (Li), semi-formal (Ls) and formal (Lf). Most languages include all three subsets (Krogstie et al. 1995).

Modeling domain (D): As within the LSS framework, the domain represents "reality", i.e. the set of all statements that are relevant and correct about the situation (Krogstie et al. 1995).

Model externalization (M): As within the LSS framework, the model externalization is in the center of the framework and represents all statements actually made. These statements can either be expressed explicitly or implicitly. For individual social actors, some subsets of the model have higher relevance. These individual subsets are called projections, hence a model (M) can be divided into several projections (Krogstie et al. 1995).

Social actor explicit knowledge (Ks) and Modeler explicit knowledge (Km): In the first version of the SEQUAL framework (Krogstie et al. 1995), no distinction between the knowledge of social actors and modelers was made. This version only took knowledge of audience, in which both modelers and social actors are included, into consideration. The audience knowledge included the aggregation of all participants' relevant explicit knowledge about the domain (Krogstie et al. 1995). Since the modeling teams' knowledge about the domain might be prominently different to the rest of the social actors, SEQUAL frameworks later distinguish between social actors explicit knowledge (Ks) and modeler explicit knowledge (Km). Km should in these cases be seen as a subset of Ks (Krogstie & Jørgensen 2002).

Social actor interpretation (I) and **Technical actor interpretation (T):** Early SEQUAL versions do not distinguish between social (I) and technical actors interpretation (T). The aspect is instead mentioned as audience interpretation. The audience interpretation is as within the LSS framework the set of statements that the audience thinks the model involves. The aspect can thereby be seen as a social projection of the model. Formally I equals the aggregation of each individual model perception, i.e. I1, I2, ..., In (Krogstie et al. 1995). Since the technical and social interpretations can be prominently different later SEQUAL frameworks have distinguished between these two. Technical actors include softwares like modelling tools and social actors refer to the human stakeholders (Krogstie & Jørgensen 2002).

2.3.3.2 Quality dimensions within the SEQUAL framework

The aspects described above are related to each other through nine quality dimensions, wherein pragmatic, syntactic and semantic quality are the same as within the LSS. The new quality dimensions within the SEQUAL framework are empirical, social, physical, perceived semantic, and organizational quality (Krogstie & Jørgensen 2002). Furthermore, the framework has divided pragmatic quality into social pragmatic quality and technical pragmatic quality. All these nine quality dimensions are listed in table 4 below, together with their respective goals and means. Below the table follows a brief description of each quality dimension.

Quality dimension	Goals	Means
Physical	Externalizability	Domain and knowledge appropriateness of the modeling language used
	Internalizability	Persistency and availability
Empirical	Comprehensibility	Context dependent means
Syntactic	Syntactical correctness	Syntax checks
Semantic	Validity/feasible validity	Insertion and deletion, and consistency checking
	Completeness/feasible completeness	
Perceived semantic	Perceived validity	Similar to the means of semantic quality
	Perceived completeness	
Social pragmatic	Comprehension/feasible comprehension	Empirical and Syntactical qualities are somewhat prerequisites for social pragmatic quality
Technical pragmatic/tool	Comprehension	See Social Pragmatic Quality
Social	Agreement/feasible agreement	Comprehension
Organi-zational/deontic	N/A	N/A

Table 4: Quality dimension goals and means within the SEQUAL framework.

Physical quality: Involves the component *externalizability*, i.e. the degree to which social actors are able to externalize their knowledge (K) about the domain (D) through a modeling language (L) (Krogstie & Jørgensen 2002). The dimension thereby answers the question "how well the conceptual representation expresses the tacit domain knowledge of the modelers" (Nelson et al. 2012, p. 6). The main mean to achieve this is through domain and participant knowledge appropriateness of the modeling language used. Furthermore, the physical quality dimension concerns *internalizability*, i.e. "that the externalized model is persistent and available, enabling the audience to make sense of it" (Krogstie & Jørgensen 2003, p. 356). The means for accomplishment of internalization are persistency and availability.

Empirical quality: The main goal is comprehensibility, i.e. "readability of a representation defined as the range of errors that occur across many readings of the same representation" (Nelson et al. 2012, p. 6). It is important to separate the goal comprehensibility (ability to be read) from comprehension (that it is understood), which is dealt with through the pragmatic quality dimension (Krogstie 2016). The means of comprehensibility are context specific.

Syntactic quality: As within the LSS framework, the syntactic quality dimensions refer to the correspondence between the language extension (L) and the model (M). The goal is syntactical correctness, i.e. that all model statements follow the language syntax (Krogstie et al. 1995). Common means to achieve this is syntax checks through the utilized modeling tool.

Semantic quality: As within the LSS framework, the semantic quality is the correspondence between the domain and the model. The domain is considered to represent the ideal knowledge about the issue that should be modeled. As for LSS, the goals of semantic quality are also completeness and validity or with the more achievable prefix: *feasible*. Means to accomplish completeness are insertion and deletion, and consistency checking like the pendulum described in section 2.3.2 (Krogstie et al. 1995).

Perceived semantic quality: The correspondence between the social actor interpretation (I) and the social actor knowledge (Ks) (Krogstie et al. 1995). As the knowledge of about the domain (KS) is a projection of the domain (D) and the interpretation (I) is a projection of the model, the correspondence between I and Ks relates to the correspondence between D and M, but on a projected level. The goals of perceived semantic quality are perceived validity and perceived completeness. The means for achieving these goals are similar to the means for reaching validity and completeness (Krogstie et al. 1995).

Social pragmatic quality: Almost the same as Pragmatic quality within the LSS framework, which is the correspondence between the social actors interpretation (I) and the model, i.e. to what extent the social actors understand the model. The goal of pragmatic quality is thereby comprehension. As when it comes to validity and completeness, the goal comprehension is assumed to be unreachable. Hence the goal *feasible comprehension* is introduced (Krogstie et al. 1995). Pragmatic quality is highly intertwined with empirical quality and syntactical quality, which means that these two quality dimensions should be addressed first (Krogstie 2016).

Technical pragmatic quality: The correspondence between the technical actors interpretation (T) and the model (M). i.e. to what extent tools can interpret the model (Krogstie 2016). This quality dimension is the same as Social pragmatic quality but between a technical actor, i.e. computer, and the model. This split was done since the circumstances and requirements for accomplishment of technical pragmatic quality are prominently different.

Social quality: The goal of social quality is agreement among stakeholders, which can be accomplished within the social actors interpretation. The SEQUAL framework segments agreement into four dimensions:

- Relative agreement vs. absolute agreement:
    - Relative agreement is when the social actors interpretations still are different but there do not exist any contradictions.
    - Absolute agreement means that all social actors interpretations are equal.
- Agreement in knowledge vs. agreement in model interpretation
    - Agreement in model interpretation is isolated around what is in the model, which is a more limited demand than agreement in knowledge.
    - Agreement in knowledge means that the social actors has agreed upon implicit statements in the model, i.e. what they think the model represents.

These four dimensions lead to four types of goals:

- Relative agreement in model interpretation: All Ii are consistent
- Absolute agreement in model interpretation: All Ii are equal
- Relative agreement in knowledge: All Ki are consistent
- Absolute agreement in knowledge: All Ki are equal

Since agreement at all these levels can be difficult to accomplish, the concept of *feasible agreement* is introduced (Krogstie et al. 1995).

The pragmatic goal, comprehension, is stated to be a mean for accomplishment of agreement. This because agreement without comprehensions is deemed to be meaningless (Krogstie et al. 1995).

Organizational quality/Deontic quality: Organizational quality, also referred to as deontic quality, is the correspondence between the goal of modelling (G) and the model (M) (Krogstie 2016). More specifically, organizational quality answers the questions if all the statements in the model contribute to the accomplishment of the organizational goals expressed in G and if all the goals expressed through G are addressed through the model (M). After the social actors have interpreted the model their knowledge (K) will increase and they are thereby able to transform the domain. Since changes of the domain often is the goal of the modeling (G), the degree to which the model drives a change is associated with the goal of organizational quality.

In addition to above mentioned quality dimensions some versions of the SEQUAL framework involve language quality, however this quality dimension is often viewed upon as a mean for other quality dimensions. A specifically developed language quality framework exist, where the language extension is put in the center. The relations between the language extension (L) and the other aspects in the framework are referred to as appropriateness (Krogstie 2016). Figure 8 below illustrates the language quality framework. Each relation answers questions on how language aspects are important in that case. However, due to the limitations of this thesis, the report will not go into further details of language quality.

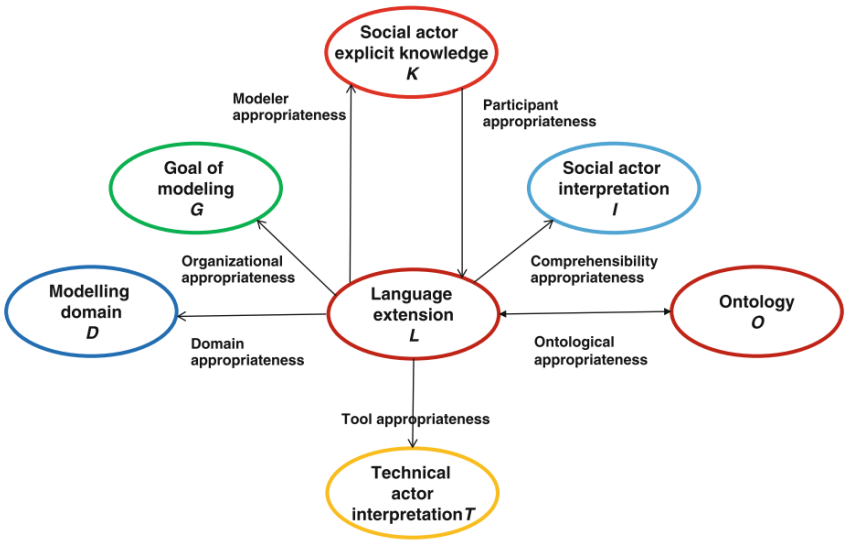


Figure 8: Language quality framework. Source: Krogstie (2016)

2.3.3.3 Dynamic SEQUAL framework

The SEQUAL framework is sometimes criticized for being too static, especially when it comes to the relationship between the model and the domain, i.e. semantic quality. In many cases the goal of modeling is to change the domain, which means that the domain is not static. This becomes especially relevant when considering process models, "which themselves often prescribe or even enact actions in the problem domain" (Krogstie et al. 2006, p. 91). Hence, there is a need for a more dynamic view of the SEQUAL framework. Such a revised framework was introduced by Krogstie et al. (2006).

A central definition in the revised framework is "active model", which is defined as: "a model is active if it directly influences the reality it reflects" (Krogstie et al. 2006, p. 91). Further, this means that if the model is changed it directly changes how the audience sees the reality. In order for a model to become active it has to be activated. According to Krogstie et al. (2006) models can be activated in three ways:

- **Automated**: Software automatically interpret the model
- **Manual**: The model guides the action of human actors
- **Interactive:** A semi-automated interpretation where some parts require user interaction

Models that should be automatically activated require full completion and formality, while models that are manually or interactively activated can be incomplete and informal (Krogstie et al. 2006).

A model is not just activated interactively, it can also **be** interactive, which refers to a co-evolution of the domain and the model. As soon as the interactive model is activated it changes the domain and will thereby immediately start to deteriorate. Hence, as the domain changes, an interactive model must be frequently updated in order to fully reflect the reality and the evolutions of human actor's understanding. This "process of updating an interactive model is called articulation" (Krogstie et al. 2006, p. 92). The interplay between articulation and activation represents the fundamental constitution of interactive models and the social context they represent (Krogstie et al. 2006).

2.3.4 SEQUAL-BPM

Krogstie (2016) has developed a revised version of the SEQUAL framework specialized for process models (SEQUAL-BPM). This framework is in its basis similar to the standard SEQUAL described in section 2.3.3, however the nine quality dimensions are contextualized to process modeling. The contextualized quality dimensions and their associated characteristics are presented in figure 9 and described in this section.

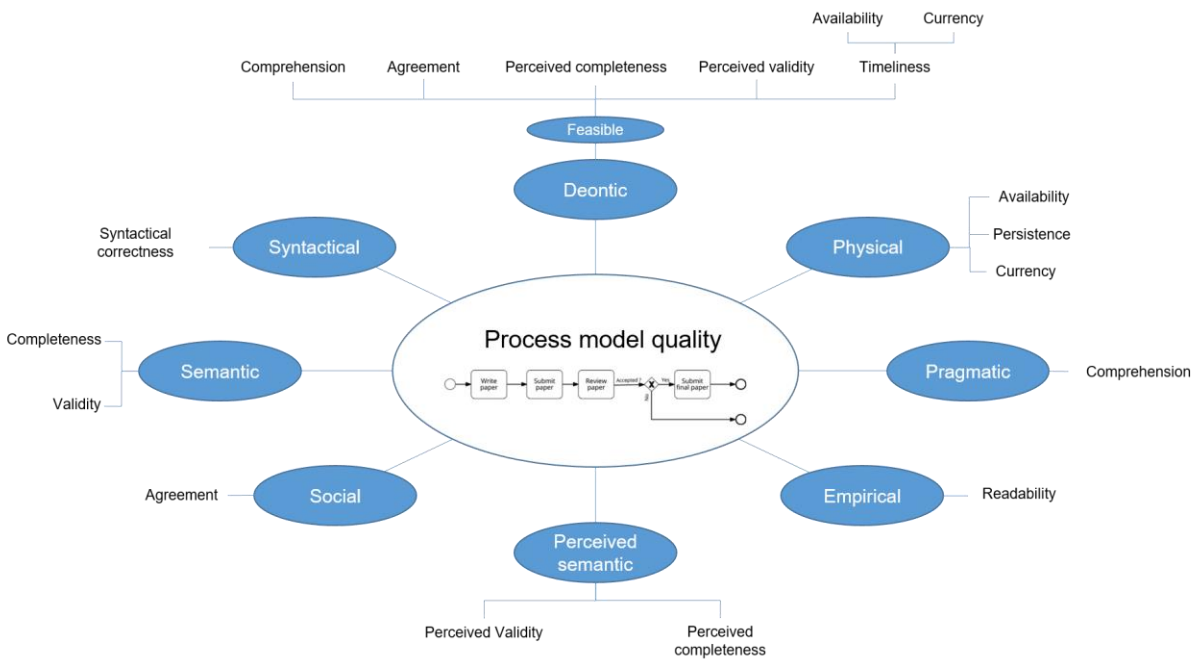


Figure 9: Illustration of the SEQUAL-BPM framework. Source (process model example): Krogstie (2016).

Figure 10 gives a simple example of a process model. In the example, the modeling goal is to support communication among authors, conference organizers and reviewers when it comes to the flow of research papers. The process model shows that first a paper is written and then submitted for review. After this the paper is reviewed, which can have two outcomes; (1) the paper is accepted and can be submitted as a final paper, or (2) the paper is not accepted. This process model will be utilized in examples throughout the description of the contextualized quality dimensions.

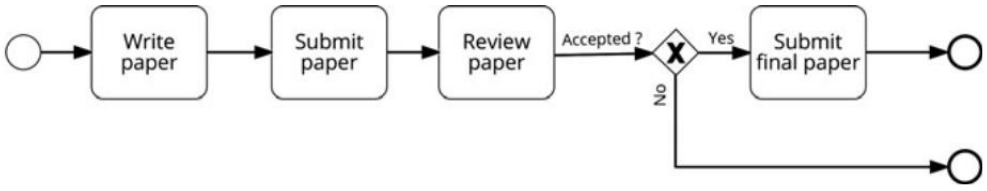


Figure 10: Example of process model for communication of the flow of research papers. Source: Krogstie (2016).

2.3.4.1 Physical quality of process models

Externalizability is as mentioned the main goal of physical quality and refers to the degree to which social actors are able to externalize their knowledge about the domain through a modeling language. A physical representation of a process model always exists in one shape or another, e.g. on paper, whiteboard or electronically. The following three quality features normally exist on this physical level.

Persistence: Regards storing of the model, i.e. efficient use of space as well as how well it is protected against anything that might happen to the process model.

Currency: Refers to the age of the modeling statements, i.e. how updated the model is in relation to the domain. A rapidly changing domain raises higher demands on currency.

Availability: That the model is made persistent is a prerequisite for availability, which describes how the model is available to the audience. Moreover, availability depends on distributability, i.e. how easy it is to distribute the model either electronically or physically. Additional aspects on availability are security aspects, i.e. who should the model be available to, and editability, i.e. if the model is made available in a format where changes can be made or not.

The term "timeliness" refers to a combination of currency and availability, where the model is current and available in time where it is usable.

2.3.4.2 Empirical quality of process models

As mentioned, the main goal of empirical quality is comprehensibility, or as phrased here, readability. Important to understand is that changes that are meant to improve empirical quality do not change the statements in the model. Empirical quality for process models can best be described through an example, which is illustrated in figure 11. The figure shows a process model that contains exactly the same statements and logic as figure 10, however the readability is clearly much lower.

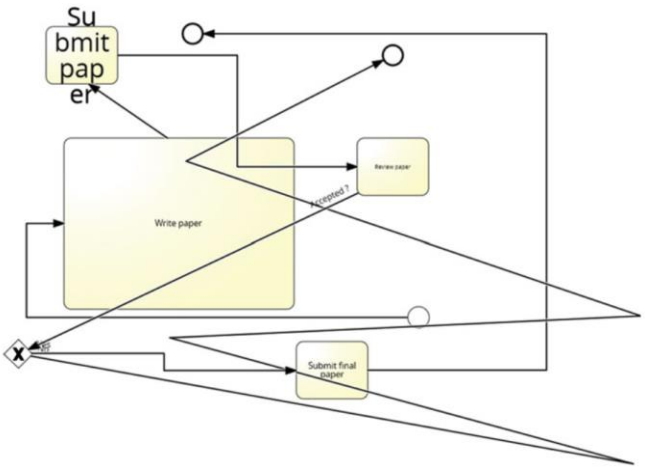


Figure 11: Example of model with low empirical quality. Source: Krogstie (2016).

Poor aesthetics in figure 11 is the main reason to why the readability is lower. Guidelines for how to achieve readability through graph aesthetics say for example that a model should:

- Minimize the area utilized
- Minimize the number of crossings of lines
- Minimize the total length of lines

The process model in figure 11 clearly breaks all these rules, which explains why the readability of the model is low.

Beyond guidelines for how to reach readability through graph aesthetics, several means for how to achieve readability have been devised. These means can be a question of tools that help to improve human-computer interfaces, guidelines in cognitive psychology and cartography, rules for color usage or rules for emphasis. However, it is important to remember that readability ultimately is a contextualized and subjective matter and the familiarity of the modeling language will thereby always be an important factor (Krogstie 2016).

2.3.4.3 Syntactic quality of process models

Syntactic quality refers to the correspondence between the language extension and the model, with the ultimate goal of syntactical correctness, i.e. that all model statements follow the language syntax. The only syntactic quality characteristic is **syntactical correctness,** and in relation to this, two possible syntax errors can occur:

Syntactic invalidity: The use of words or graphemes not included in the language. One example is a circle being used in a process model when the agreed upon modeling language only allows boxes.

Syntactic incompleteness: Refers to cases where the language's grammar is not followed. That is, if the model lacks necessary information or constructs, e.g. if activities in a model is not connected with necessary arrows.

Syntax checks could be provided in order to either prevent or detect these errors. However, early in the modeling development process it might be preferable to focus on semantic and pragmatic quality rather than trying to achieve syntactical correctness. Although the final goal is an error-free model, the risk is that the creativity during modeling is inhibited if too much focus is put on syntactic quality. Therefore, it is important to consider whether the syntax checks still should allow some syntactic invalidity or incompleteness at some point. In this case, it is desirable to let the user request when to perform a syntax check. Moreover, errors could be hindered through error correction, i.e. replacing incorrect statements with correct ones. One example of this in practice is a spell-checker, that does not really replace the word but suggest another correct one.

Besides language grammar and graphical issues, there are other grammatical aspects that could be considered when studying syntactic quality of process models. Such aspects could be agreed upon guidelines on e.g. how to name the process models or model activities. Figure 12 provides a version of figure 10 with lower syntactical correctness. The process activities are named as nouns instead of verbs as desired, and one of the arrows is labeled "Good" instead of the expected "Yes".

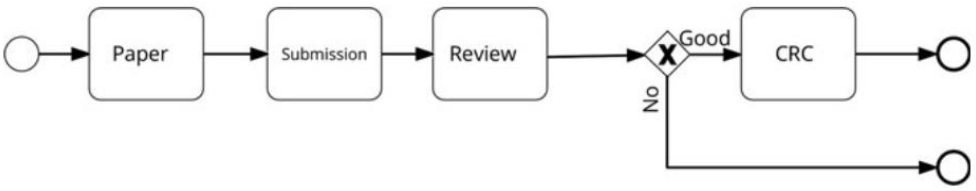


Figure 12: Example of process model with low syntactical correctness. Source: Krogstie (2016).

2.3.4.4 Semantic and perceived semantic quality of process models

As within the standard SEQUAL framework, semantic quality is the correspondence between the model and the domain and is associated with the two quality characteristics validity and completeness. As mentioned "validity means that all of the statements made in the model are regarded as correct for the problem" (Krogstie 2016, p. 120). Figure 13 below shows an invalid version of figure 10. This process model is deemed to be invalid since the activity "Go party" is according to most participants not a relevant statement in relation to the goal of the process model, which is communication of the flow of research papers.

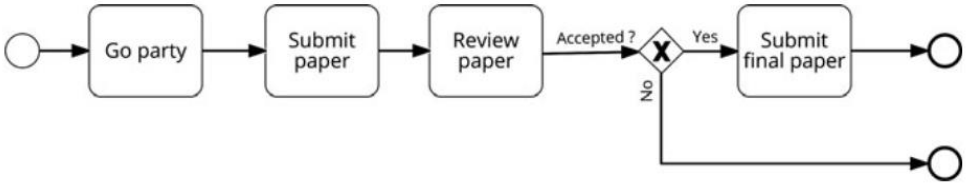


Figure 13: Example of process model with semantic invalidity. Source: Krogstie (2016).

Completeness means that "the model contains all the statements that would be correct and relevant about the domain" (Krogstie 2016, p. 120). An example of incompleteness can be provided by figure 10, which is missing statements about who is performing the activities. This quality characteristic would however mostly be interesting when it comes to very limited and well-defined domains. In most cases the process model will be a subset of the domain, which will not lead to completeness according to its real definition. An important question is instead what parts of the domain to leave out in order to avoid "analysis paralysis" (Krogstie 2016, p. 121). This question can be answered in relation to the goals of modeling and other modeling constraints. Hence, the example in figure 10 could be deemed as complete in relation to its goal, if the goal is not to communicate who should perform the activities.

As within the original SEQUAL framework, semantic quality is difficult to establish and check. This is because the intended correspondence between the domain and the model in reality is the correspondence between the participant's knowledge (K) about the domain and their interpretation (I) of the model. The model must be built through the participants' knowledge about the domain, and consequently when checking the model, the knowledge must be compared to the participants' interpretation of the model. Thereby, when the semantic quality of process models is established and checked, one actually refers to *perceived* semantic quality. Consequently, the suitable quality goals are perceived validity and perceived completeness. Perceived validity and perceived completeness open up for subjective judgements of the

participants. The example in figure 13 can be stated to be *perceived invalid* with the logic that "I (as the author) in the subjective role as an end-user, may claim that the "Go party" task is not part of the paper-writing process" (Krogstie 2016, p. 121). Further it can be deemed as *perceived incomplete* with the logic that I (as an author) state that the activity "print paper" is missing (Krogstie 2016).

2.3.4.5 Pragmatic quality of models

Pragmatic quality regards how well the model is **comprehended** by its audience, either a tool or a human audience, with the ultimate goal of comprehension. Difficulties in comprehending a process model could raise from a too large or complex model, the use of a modeling language that is formal or not familiar to the actor, or that interpreting important properties of a model requires a lot of effort. In relation to the human aspect, two errors can occur. Either some parts of the model have not been understood, or it is comprehended to include some statements that it does not include. Factors impacting comprehension are the process of process model development and tools used as well as the communication methods between participants. If the audience refers to technical actors, things such as code generation or simulation need to be comprehended by the tool used, and this could be achieved by using formal syntax and formal semantics. In both cases, however, it is important both that the process model has been understood and *who* has understood it. How familiar the actor is to informal statements and to the domain affects the ability to comprehend. Pragmatic quality can be achieved by e.g. one of the following activities:

- Participant training: Educate audience in properties of the modeling language used or on parts of the domain
- Model inspection: Testing model comprehension by letting actors that did not participate in the modeling activity "walk through" the model and explain it out loud
- Filtering: Highlighting specific parts of the model, e.g. only showing those nodes that are connected to a certain process activity
- Model translation: E.g. giving the possibility to translate the model to another language that is more familiar to the audience, or providing an explanation generator for answering questions regarding the process model
- Animation: Using moving pictures or icons to illustrate activities in the model

2.3.4.6 Social quality of process models

As within the standard SEQUAL, the goal of social quality is agreement. On top of the four types of agreement within the standard framework there are within SEQUAL-BPM two more; relative and absolute agreement in model. The two new types refer to when two models are made based on views of two different actors. Consequently, the six types of agreement within the SEQUAL-BPM are:

- Relative agreement in interpretation; All Ii are consistent
- Absolute agreement in interpretation; All Ii are equal
- Relative agreement in knowledge; All Ki are consistent
- Absolute agreement in knowledge; All Ki are equal
- Relative agreement in model; All Mi are consistent
- Absolute agreement in model; All Mi are equal

For further explanation of the first four types of agreement, see section 2.3.3.2. The agreement in model concerns the comparison of two models made by different actors. This comparison is fairly easy to do since it is a question of comparisons as semantics or syntax.

In the context of process modeling, relative agreement at all levels is the most relevant. This is because process modeling often involves participants from different parts of the organization, with different knowledge and interpretations. Hence, the idea of equal (absolute agreement) interpretations or knowledge is not achievable. As process modeling often want to link together different parts of the organization, relative agreement must be reached in the parts that are overlapping between the different sets of participants. When process improvements are the goal of modeling, all participants might have to reach relative agreement about the full model in order to be able to successfully implement the improvements.

The goal of pragmatic quality, comprehension, is stated to be a mean for accomplishment of agreement. This because agreement without understanding is deemed to be useless (Krogstie 2016).

2.3.4.7 Deontic quality of process models

Within the standard framework, deontic quality is referred to as organizational quality, which is the correspondence between the model and the goals of modeling. This quality dimension is important since "Modeling is not performed for the fun of it but to achieve some goal that is typically linked to some business and organizational goal" (Krogstie 2016, p. 134). Hence, deontic quality is evaluated on the basis that all stated goals have been accomplished. The means for accomplishing this is related to the fulfillment of the goals of the other quality dimensions within the framework, i.e. validity, completeness, comprehension, agreement etc. However, for everything but very simple domains these goals cannot be achieved. Hence, the feasible version (for further explanation see section 2.3.2) of these goals are more relevant within deontic quality. Attempts to accomplish total completeness, comprehension, agreement or validity would require an unlimited amount of time and money, and would not provide any higher goal fulfillment in the direction of the overall goal (G) of the process modeling initiative. Hence, what is feasible completeness, validity, agreement and comprehension should be decided by the overall goal (G). However, it can be difficult for organizations to make decisions regarding the trade-off between value add and further model quality fulfillment. Hence, a common way to decide upon what quality levels that are feasible is the settlement of modeling standards within the organization.

2.3.5 Quality of process models in practice

In relation to the quality dimensions presented above, Krogstie (2016, p. 103) explains: "In real-world modeling activities, we find that all quality levels are important, but the weight on the different levels is different based on the different goals of modeling". Krogstie further exemplifies this with two cases, of which on will be presented in this section.

2.3.5.1 Purposes of process modeling in the case

The case concerns a large global organization and their use of process models in order to develop and communicate harmonized work processes across several units. The purposes of modeling evolved through the harmonization project and some usage areas that were not initially stated purposes emerged along the way. Referring back to *The smiley model* in figure 3, these were the purposes or goals of modeling in the case:

Communication (2a and 2b): The use of the models to, within the specific business area, facilitate communication of different kinds. For example, this involved communication between experts in the domain, in order to suggest improvements in the work processes and achieve harmonization across

different units. The developed models were also used to share the identified best practices across different units of the organization.

Model analysis (4): Gap analysis to, with computer assistance, identify bottlenecks and possible improvements.

Model deployment (5): Using the models as a support in daily work, also for support in the use of developed software applications.

Context of change (6): Process models were used as a specification for an IS development.

Depending on the underlying purpose, different stakeholders were involved in the modeling. For example, the model used for *Model deployment (5)*, was modeled by a user, while for the purpose *Context of change (6)* a process modeler was the developer, using models developed for *Communication (2)* as a basis. Moreover, a local worker and a local operating manager were involved in the development of the models used for *Communication (2)* and *Model analysis (3)*.

Also the model interpreters ranged from everyone involved in the process when the purposes were *Communication (2)* and *Model deployment (5)*, to only process owners when the purpose was *Model analysis (4)*, and software designers when the goals were *Context of change (6)*.

2.3.5.2 Quality of process models in the case

The user satisfaction of the models varied depending on who was the user of the model. Below follow observations made regarding the different quality dimensions.

Physical quality: On a physical quality level, the success varied depending on who was the user of the model. The software developers claimed that the level of detail was not enough for the purpose *Context of change (6)*. Due to limitations in the tool and lack of resources, it was not possible to make changes or add aspects to the models. Consequently, the models were after some time outdated since they could not be updated.

Empirical quality: A top-level model (figure 14) was developed in order to give an overall picture over all the units. The focus within this model was to reach high empirical quality, i.e. readability, which was successfully fulfilled.

Syntactic quality: In all models, syntactic errors were detected. However, in no case these errors were of importance for the models' main usage areas. Hence, it can be stated that syntactic quality was less important for the purposes within the case.

Semantic quality: Difficulties in achieving semantic quality arose due to tool and resource limitations, which hindered models from being updated and consistent, and many areas of the organization was not modeled at the level of detail desired. Moreover, the models were aimed to be adaptable locally into parts of the organization with different characteristics. This resulted in models that could not be judged as right or wrong. Hence the semantic quality level differed among the different units.

Perceived semantic quality: When performing the gap analysis, the low level of detail resulted in that the model was perceived as better than it was in reality. Consequently, gaps were detected later than desired.

Pragmatic quality: For the top-level model (figure 14), a high comprehension was reached, since employees could find their own meaning in the model. However, difficulties in understanding the more detailed models arose, since the more detailed the model was, the less understandable it became for anyone else than those that on a daily basis worked in that process.

Social quality: As mentioned under *semantic quality*, the models had a higher level of detail in order to later in the context of each local unit settle further details. Consequently, it was not necessary to settle agreement between everybody on the entire process, which enabled high social quality on the top-level model. Also, when gap analysis later was performed, the level of detail of the models was low enough to reach an agreement between the stakeholders on the new processes. This increased the process loyalty, however as mentioned under perceived semantic quality the low detail level hindered gaps to be discovered early enough.

Deontic quality: Deontic quality was reached through change in the domain. The most important factor that contributed to the change in the domain, i.e. the way the organization worked, was not the models itself but the actual modeling process where a common understanding was reached through communication around the models. Moreover, the models contributed to change in knowledge, where models were used to both train the users, identify gaps and develop IT systems.

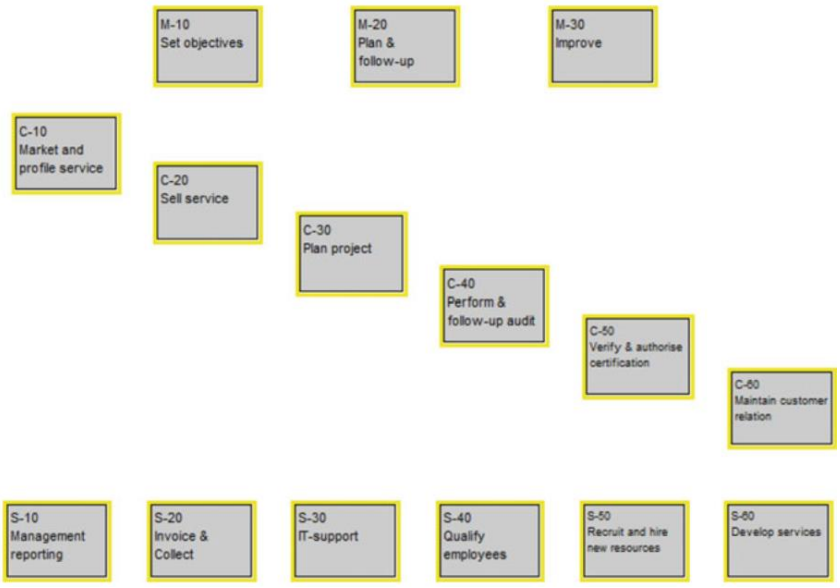


Figure 14: Top-level process model within case-study. Source: Krogstie (2016).

As presented, the case shows that different purposes of a model result in focus on different qualities and also different success in achieving those qualities. As an example, empirical and social quality are important when creating the top-level model for the purpose *Communication*. At the same time, less focus is put on syntactic and semantic qualities. When developing IS, however, semantic completeness should not be neglected. Moreover, when performing gap analysis, too high perceived semantic quality could hinder the analysis process. Krogstie (2016, p. 148) concludes: "Model use and types of users influence both how to view a process model's quality and which quality aspects to emphasize".

3. Problem discussion

This section is meant to problematize the purpose further and to break it down into research questions.

Purpose: The purpose of this study is to elaborate on the quality definition "fitness for use" by providing insights on what are the main reasons to why organizations perform process modeling and how these reasons mutually relate to each other. Furthermore, the study aims to provide insights regarding what quality attributes within the SEQUAL-BPM framework that should be emphasized in order to fulfill underlying purposes of process modeling.

In order to provide "fitness for use" two aspects are required: (1) an understanding of what the model should be *used* for and (2) what is *fitness* in relation to the area of use. When it comes to the understanding of what the model should be used for, literature mention some underlying purposes of process modeling (see section 2.2). However, a professor within the area, at Stockholm university, phrases in 2017 the common attitude towards why process modeling is performed as: "Within the academia, it is common sense why organizations perform process modeling". This attitude was also observed in literature wherein purposes were mostly listed in an unstructured way without deeper clarification of their meaning, their importance, commonality or mutual relations. It is deemed that due to the fact that academia somewhat takes the answer to why process modeling is performed for granted, less effort is put into holistically and in depth trying to answer this question. In contrast to this general attitude, Krogstie (2016) introduces a model (*The smiley model*) that explains a holistic range of purposes and how they relate to each other (see section 2.2). However, the model does not provide an understanding of importance and commonality of the purposes. Furthermore, the model seems to be developed within an academic setting and somewhat lacks practitioner's and organizational nuances.

Taking above into consideration, it is deemed that the literature does not provide satisfying answers, that could lay the foundation for a "fitness for use" quality approach. Consequently, it would be valuable to, from scratch, investigate, with a practitioner's perspective, what are the **common** reasons why **organizations** perform process modeling. Hence, part **A** of the first research question is:

RQ1A: What are common purposes to why organizations perform process modeling, and which of these are important?

Furthermore, it is deemed that *The smiley model* tends to focus too much on process improvement aspects, since it descends from business process management, which is mainly associated with organizational transformations. Due to the model's focus on improvements, its purposes and their mutual relations are associated with either a future or current state which through the pre-study was noted to not always be the practitioner's main focus. Moreover, it is deemed that the current-future state perspective is too static, since the current state is meant to be a description of the domain as it is now, which is difficult since the domain is dynamic. Krogstie et al. (2006, p. 92) explains the dynamicity of the domains as that the models "themselves often prescribe or even enact actions in the problem domain". Hence, the difference between a future and current state model sometimes becomes vague, and it is deemed that a further analysis of how purposes can relate to each other is of interest. This leads us to part **B** of the first research question:

RQ1B: Beyond future and current state, how do the identified purposes relate to each other?

Moving on to the second part of "fitness for use": *fitness* in relation to area of use, the concept of quality is central. As described in section 2.3.4, there exists a well-developed and well thought-out framework for

quality of process models; SEQUAL-BPM. The framework clearly describes what quality dimensions and related quality characteristics that correspond to the overall quality of process models (figure 15 below illustrates these quality dimensions and their related quality attributes).

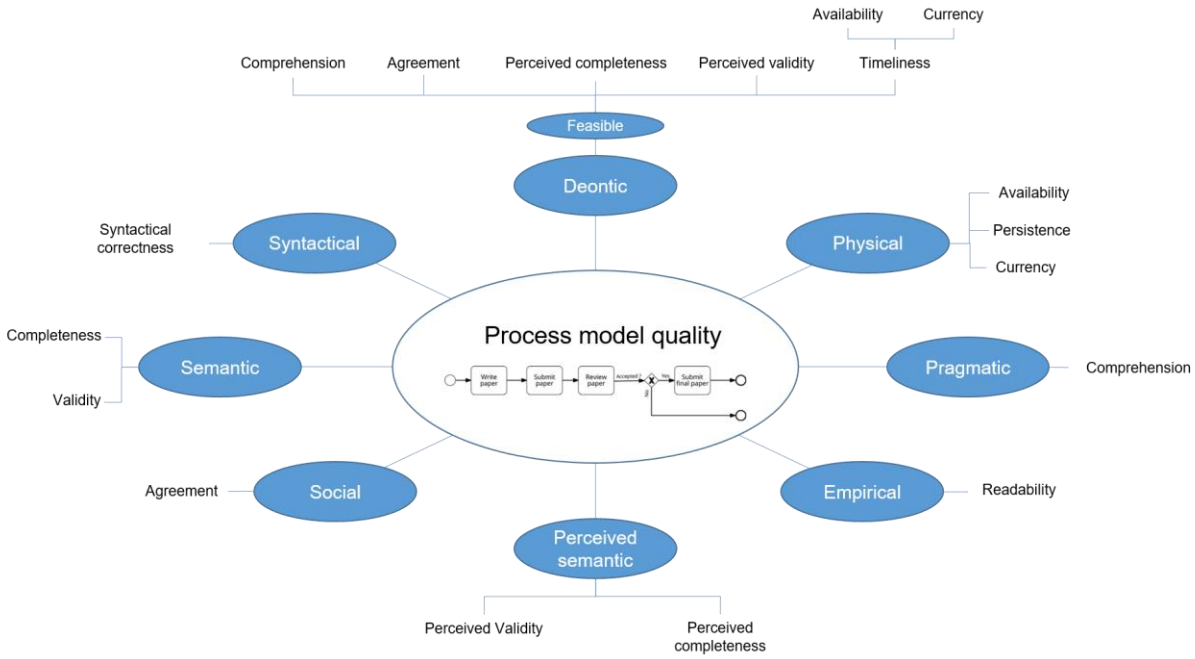


Figure 15: Illustration of process model quality, broken down into quality dimensions and quality characteristics. Source (process model example): Krogstie (2016)

A central point of discussion in the framework is feasibility levels of the quality attributes, i.e. the trade-off between "the value and the drawbacks of achieving a given model quality" (Krogstie 2016, p. 135). "The time to terminate a modeling activity is thus not when the model is "perfect" (which will never occur) but when it has reached a state where further modeling is regarded as being less beneficial than applying the model in its current state" (Krogstie 2016, p. 134). An example of a relevant question on this topic could be how much effort (time and money), that should be put into making the audience comprehend the process model in comparison to the contribution of fulfillment of its underlying purpose. In relation to this Rosemann (2006, p. 249) means that process modeling "is criticized for being over-engineered, time-consuming, costly and without (sufficient) value. Thus, the challenge is to find the right level of modeling for the underlying purpose".

The question is then how to determine what a feasible level of a quality attribute is. The issue can be dealt with through modeling standards within the organization; standards saying something like: feasible completeness is reached when X is accomplished. However, as with most "one-size-fits-all"-solutions, this will probably result in too much effort invested sometimes and too little effort invested other times. Instead it could be argued that the feasibility levels should be determined in relation to the underlying purpose of the modeling activity. This could for example regard what level of completeness that is required if the goal of the modeling is ISO-certification compared to providing daily support to employees.

Assuming that there is a limited amount of time and money that can be put into the modeling activity, further questions regarding what quality attribute(s) that should be emphasized and prioritized in order to accomplish the underlying purposes should be raised. In relation to SEQUAL-BPM, Krogstie (2016, p. 103) phrases this as: "In real-world modeling activities, we find that all quality levels are important, but the weight on the different levels is different based on the different goals of modeling". Further, Krogstie approaches this issue through two case studies (see section 2.3.5). The case studies clearly show that certain quality attributes within SEQUAL-BPM are more relevant than others in relation to the different underlying purposes. However, the case studies do just provide insights for a couple of purposes in the unique setting of those organizations and projects. Hence, this master thesis aim to continue this track and in a more generalizable way provide insights about what quality attributes that should be emphasized in process modeling, in relation to underlying purposes. This leads to the second research question:

RQ2: What quality attributes within the SEQUAL-BPM should be emphasized in order to fulfill each of the most important purposes?

The answers of the two research questions are deemed to be valuable for both academia and practitioners. This because academia currently is missing a more in depth understanding of why process modeling is performed. Moreover, how the quality attributes should be prioritized in relation to these purposes has not been concluded. For practitioners, the research is deemed to be helpful since it will provide ideas of what can be accomplished through process modeling and what quality characteristics to focus on in order to reach these goals.

4. Methodology

This chapter discusses what research methodologies that have been utilized in order to provide answers to the research questions. First, the delimitations that set the frame for the research, and consequently the methodologies chosen, are discussed. Then the research design is presented, which is followed by the research flow, presented step wise. Finally, the trustworthiness of the results in relation to the chosen methodologies will be discussed.

4.1 Delimitations

The main delimitation of this research is that it focuses on what quality attributes of process modeling to emphasize, rather than what means that would lead to the accomplishment of certain quality levels. Furthermore, the research is limited to investigating the quality attributes within SEQUAL-BPM, since it is the leading framework of today. The timeframe of this master thesis would not allow taking further less prominent frameworks into account. When investigating what quality attributes that should be emphasized, matters that concern what modeling language that is the most suitable are not taken into consideration. This is because modeling language is regarded as a mean for accomplishment of certain quality levels, which is outside the scope of this research. Due to the same reason, aspects regarding what kind of modeling tool that should be utilized are not taken into consideration.

Next, when collecting empirical data this study is delimited to only take organizations based in Sweden into account. The timeframe of this thesis does not allow for international sampling, since the researchers have limited access to such organizations. However, a sample based on Swedish corporations is still deemed to be enough to provide valuable insights for international practitioners and academia. Furthermore, the study is delimited to not provide insights regarding differences between types of organizations and business areas, since it is deemed that aggregated insights must be put in place before such segmentation would be valuable.

4.2 Research design

As the purpose and research questions of this thesis are directly derived from theory, this research should mainly be seen as deductive (Bryman & Bell 2015). Hence, this master thesis will result in a revised version of existing theories about underlying purposes to process modeling and quality in relation to these. As mentioned in the problem discussion, the thesis aims to revise existing theory in the sense of making already established insights more generalizable outside the context of specific case studies. More specifically, the research regards deciding the commonality and importance of underlying purposes and in a more generalizable way providing insights about what quality attributes that should be emphasized in process modeling, in relation to underlying purposes. In order to do so, quantitative or quantifiable data from a sample representing a larger population was deemed to be required. For this a cross-sectional research design, i.e. social survey design, is highly applicable (Bryman & Bell 2015). This because a cross-sectional research design entails "the collection of data on more than one case (usually quite a lot more than one) and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables (usually many more than two), which are then examined to detect patterns of association" (Bryman & Bell 2015, p. 62). It could have been valuable to apply a longitudinal

research design to capture changes over time, but due to the timeframe of this study it was deemed to not be reachable. When having the overall research design in place, the question regarding what research instruments that should be utilized remained. Due to the complexity of the data required it was deemed that a survey would not be applicable, since it would not allow for the interviewees to ask questions if they did not understand the survey questions. Hence, interviews were deemed to be an applicable research instrument. Based on these research characteristics a research flow was designed. The decisions regarding the research flow are presented in the following sections.

4.3 Research flow

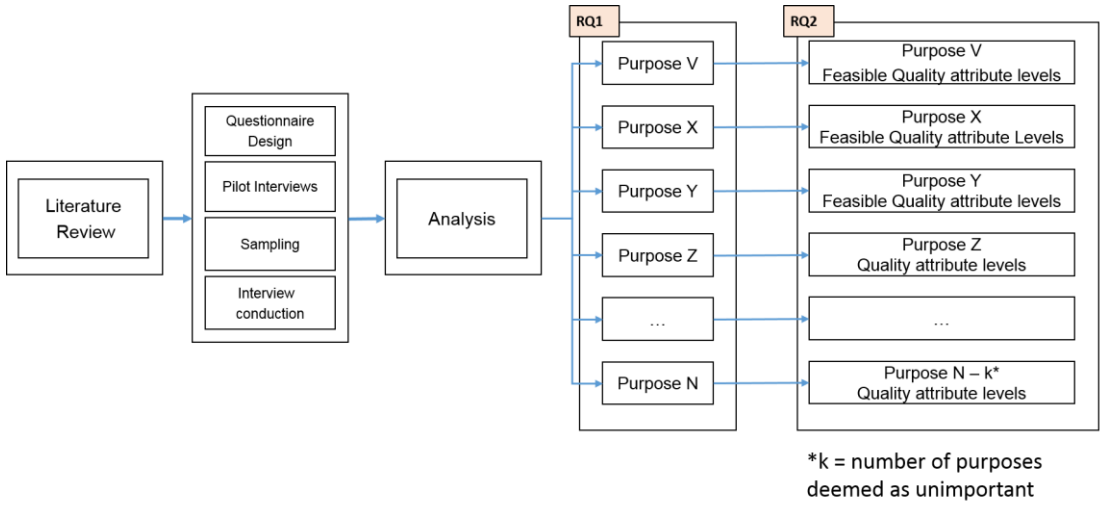


Figure 16: Illustration of the research flow of the master thesis.

In general terms, the research questions were answered through an initial literature review, conduction of interviews with a quantitative character and finally execution of quantitative and qualitative analysis of the data from the interviews, all of which is illustrated in figure 16 above. Each part of this research flow is discussed in this section.

4.3.1 Pre-study

In order to frame the problem and the direction of the thesis, an initial unstructured literature review on the subject of process management was made, which helped to provide a holistic view of the research field. Search words used were based on recommendations from supervisor, companies as well as own experience. The search words used were: *process management*, *business process management*, *business process reengineering*, *business process mapping and process visualization*. The databases SCOPUS as well as Chalmers library were used for the search.

The literature review was followed by interviews with six individuals in different organizations: two municipalities, two large enterprises, one public authority and one county council. The interviews were of open character and aimed to give an organizational perspective of process management as a whole. The researchers then summarized the results from the pre-study in a workshop, and the research topic could

be narrowed to concern the different goals with process modeling and how process modeling quality is related to those goals.

4.3.2 Literature review

The pre-study helped to narrow down the area of interest within academia and hence form research questions. The following literature review was then divided into two parts, with a more detailed study within each of the research questions.

4.3.2.1 Literature regarding purposes of process modeling

In order to get a deep understanding of purposes behind process modeling, an exhaustive literature review was made. Initially, the SCOPUS database was used to find books and articles. Furthermore, relevant literatures referred to from the articles were investigated. Search words used in the Scopus database, on title, keywords and abstract, were:

- process modeling
- process mapping
- process visualization,

each in combination with each of the complementary words: *objective*, *purpose*, *reason*, *goal*, *motive*, *usage* and *why*.

The relevant books and articles found were then studied, in order to identify expressed reasons or purposes behind process modeling. The findings from this literature review resulted in the final review of purposes presented in chapter 2.2.

4.3.2.2 Literature regarding process model quality

In order to answer the second research question, it was necessary to conduct a literature review aiming at deciding a suitable quality framework, against which the purposes could be measured against. The literature reviews were initiated in a structured way and later followed by snowballing. The structured literature search was done through the database SCOPUS and search words for title and keywords were:

- process modeling
- process mapping
- process visualization

each in combination with each of the complementary search words: *quality*, *success*, *measures*, *quality attributes*, *characteristics* and *aspects*.

Through the structured search, the paper "A systematic literature review of studies on business process modeling quality" from 2015, by Moreno-Montes de Oca et al., was found. As the title of the paper intends, the authors have systematically reviewed and categorized papers on business process modeling quality between 2000 and 2013. The review identified 72 articles that addressed quality aspects of business process models. These 72 articles were further studied, led by the conclusions drawn by Moreno-Montes de Oca et al., which contributed to a deep understanding of process modeling quality. This in combination with the structured search resulted in the conclusion that SEQUAL-BPM was the most suitable framework, for this master thesis, to measure quality against.

4.3.3 Interviews

As mentioned in the research design section, interviews were deemed to be the most suitable research instrument, in regard to the purpose of this study. The main reason why interviews were chosen is that it allows for personal contact and interaction between the interviewee and interviewer during the conduction (Bryman & Bell 2015). This was deemed to be important characteristics, since the research topic is complex and requires interaction in order to ensure that the interviewee has understood the questions properly. Furthermore, the interview format allowed for an in depth understanding of the interviewees' answers, since the interviewers could ask follow up questions aiming to capture the nuances. The in depth understanding was later highly important during the categorization analysis.

Due to the aim to provide generalizable insights, a structured interview format was chosen, since this would make the answers directly comparable and quantifiable. In order to be able to capture the nuances of the answers, the interviews were documented through notes and recording. The recording was deemed to be important since it allowed the researchers to go back and listen during the data analysis.

4.3.4 Design of questionnaire and pilot interviews

Since geographical barriers should not hinder the sample composition, the questionnaire was designed in such a way that the interviews could be held over Skype. Skype was chosen since it allows for video interaction and screen sharing. The video interaction increased the quality of the responses since the interviews felt more personal, which allowed for more engaged answers. The screen sharing enabled that interactive exercises could be held, which was deemed to be necessary in order to capture some of the data required. PowerPoint was chosen as communication tool, since it is a tool that most organizations are familiar with and it allows for interactive and graphical presentations and communication.

After deciding what medium and tools to utilize, the general structure of the survey was set. It was decided to design the questionnaire around three parts; (1) *Introduction*, (2) *Purpose section* and (3) *Quality attribute section*.

The *Introduction* was meant to provide context about the project to the interviewee, context to the interviewers about the interviewee's role and organization as well as an understanding of the interviewed organization's process modeling history and maturity. It was deemed that such background information would enhance the understanding of the answers in the following parts. The *Purpose section* was meant to provide data required to answer the first research questions, i.e. why the organization perform process modeling. Finally, the *Quality attribute section* was meant to provide data for the second research questions, i.e. data regarding what quality attributes that should be emphasized in order to fulfill the purposes identified through the *Purpose section*.

The main steering factor when designing the questions and exercises for each section was the time limit for the interview, which was initially set to one hour. The timeframe was evaluated after the pilot interviews, which showed that one hour was enough to collect the required data, while keeping the interviewees engaged throughout the whole interview.

With this timeframe as a baseline an initial set of questions and exercises were designed for each section. Two pilot interviews were then organized, in which the survey could be tested evaluated, and refined. The interviewee's participating in the pilots were informed that it was a pilot interview so that a feedback session could be held afterwards. The questionnaire was evaluated on the basis of to which degree the

empirical data would fulfill the purpose of the master thesis. After the first pilot interview the questionnaire was refined before the second pilot was held. After the second pilot interview the questionnaire was refined a second time and could then finalized. The finalized questionnaire that was utilized for all interviews is presented in table 5 below.

Category	No.	Question/Exercise
Introduction	**Introduction of master thesis project and interviewers**	
	Q1a	Who are you and what's your role within the organization?
	Q1b	Explain your organization and its process modeling history?
	E1	Please, position your organization's process modeling maturity and level of abstraction?
Purpose section	**Q2a**	What needs lay the foundation of your organization's process modeling efforts?
	Q2b	What does your organization utilize process models for today? 92,1 %
	Q2c	What are your goals/ambitions with your process model activities?
	E2	Based on your answers on questions Q2a - Q2b we have identified purposes with your process modeling (Interviewer 1 summarizes the answers and Interviewer 2 writes them in the PowerPoint). Could you please confirm these and let us know if you would like to merge, remove or add anything?
	E3	Please rank the purposes we concluded in the previous exercise after importance for your organization? You are allowed to rank purposes equally important
Selection of purposes		Before the last section; *Quality dimension section,* was initiated, the interviewers should select what purposes (identified through E2) to bring forward to the rest of the interview. Ideally the interviewers should select all purposes. If, however, there are too many purposes the most important (based on E3)/unique purposes should be selected. If too many purposes are brought forward in the following exercises it is deemed to lower the response quality.
Quality dimension section	**Intro**	A potential attribute of a process model is Y. If the purpose with your process modeling is X where would you ideally place X on this scale; where 1 is A and 5 is B. (X = each selected purpose, Y = one of the 7 quality attributes. A = explanation of lower end-point and B = explanation of higher end-point)

	E4A	**Currency** 1 = Singular modeling 5 = Continuous updates/Improvements
	E4B	**Availability** 1 = Available only for the modeler(s) 5 = Available for all actors involved in the process
	E4C	**Syntactical correctness** 1 = Not important to follow modeling language standard(s) 5 = Important to studiously follow modeling language standard(s)
	E4D	**Completeness** 1 = Symbolic description of the process, i.e. simplification of reality 5 = Detailed and complete description of reality
	E4E	**Comprehension** 1 = The process model content is only understood by the modeler(s) 5 = The process model content is understood by all actors involved in the process
	E4F	**Agreement** 1 = The model content is only agreed upon by the modeler(s) 5 = The model content is agreed upon by all actors involved in the process
	E4G	**Readability** 1 = Readable only for the modeler(s) 5 = Readable for all actors involved in the process

Table 5: Final version of questionnaire utilized for all interviews.

4.3.4.1 Design of introduction

After an introduction of the master thesis project and the interviewers, two questions were asked and an exercise was held. Q1a aimed to provide brief data regarding the interviewee's role and organization and Q1b aimed to provide a brief history about the organization's process modeling history. E1 aimed to provide data regarding the organization's process modeling maturity and process model characteristics in order to give the interviewers a deeper insight of each organization's understanding and level of process modeling.

For E1, the organizations were asked to position their logotype in a matrix (see figure 17). The phases of maturity are an interpretation of the phases presented in chapter 2.1.3, however simplified to avoid both complexity for the interviewee and an absolute connection to BPM. The position on the horizontal axis refers to the level of process maturity in the organization based on an average. Hence, organizations could be more/less mature in some processes but were asked to consider the average level all processes included. The vertical axis refers to level of abstraction on modeled processes as defined in chapter 2.1.4. Here, the respondents were allowed to add an arrow if they claimed that the organization has processes modeled on all levels.

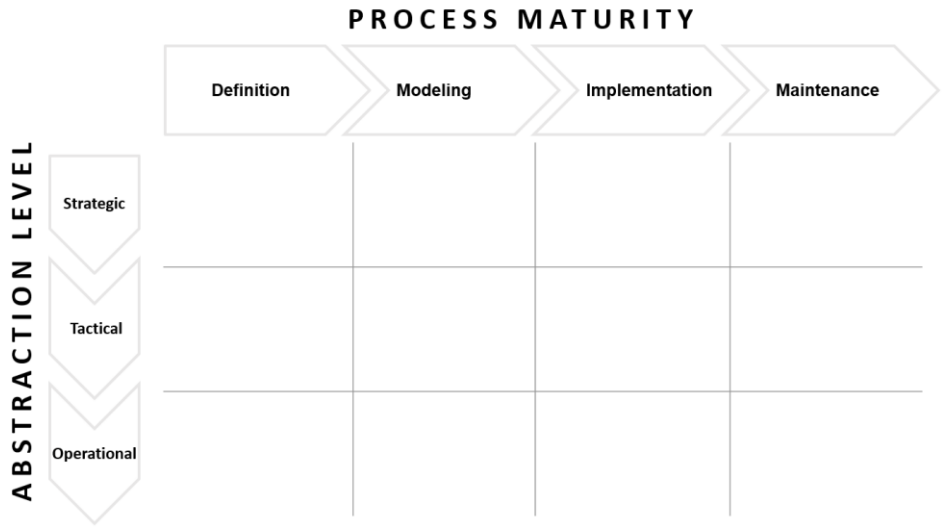


Figure 17: Matrix utilized for exercise E1.

4.3.4.2 Design of purpose section

The *Purpose section* consists of three questions and two exercises. However, this section initially consisted of one direct question asking why the interviewed organization performs process modeling. It was noticed, though, after the pilot studies, that the interviewees had difficulties to explicitly answer this question. Instead, this question was divided into three more indirect questions (Q2a - Q2c) and an exercise that would, based on the data gathered through the three questions, conclude the reasons why process modeling was performed. The three questions were formulated in such a way that the interviewee would explore reasons to why process modeling was performed from three perspectives: past, current and future. This design is illustrated by figure 18 below. Q2a was meant to indirectly provide reasons to why process modeling was performed. Q2b was meant to indirectly provide reasons to what process models actually are utilized for within the organizations and Q2b was meant to indirectly provide future goals with process modeling, i.e. where the organization is heading.

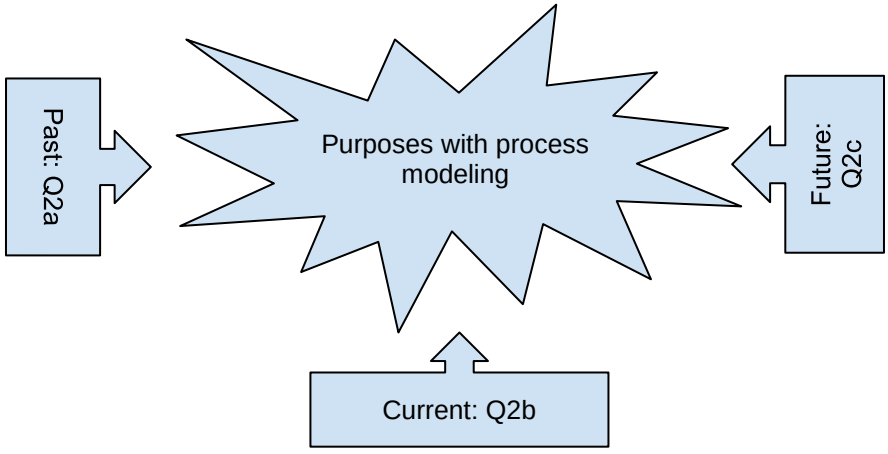


Figure 18: Illustration of questionnaire design for Purpose section

After these three questions were asked exercise E2 was held, wherein one of the interviewers suggested a list of purposes based on the answers given on question Q2a-Q2c. Simultaneously, the second interviewer wrote down these suggested purposes in the PowerPoint (which was screen shared with the interviewee), so that the interviewee could both read and hear the suggested purposes. When the interviewer formulated the list of purposes, the language of the interviewee was used so that nuances could be captured. After the list was presented the interviewee was asked to give feedback. Based on feedback the list was refined in iterations until the interviewee confirmed it. The last part of the *Purpose section* was exercise E3, meant to rank the purposes, identified through E2, after importance.

4.3.4.3 Design of Quality attribute section

The critical point in the design of the *Quality attribute section* was the selection of quality attributes. Furthermore, a critical point was the decision on how to communicate and describe the attributes to the interviewee in a comprehensive way. Referring back to the problem discussion and the purpose of this master thesis, it aimed to provide insights regarding what quality attributes that should be emphasized in order to accomplish the underlying purposes. The aspired end result was to deliver answers as: for purpose X it is most important to focus on the accomplishment of the quality attributes A and B, while little effort should be put into the fulfillment of C and D (A, B, C, D = Quality attributes). In order to be able to deliver such results a quantitative approach was selected, since it would make the results from the different interviews more comparable, which would allow for more generalizable conclusions.

4.3.4.3.1 Exercise design

Before the *Quality attribute section* was initiated, the interviewers should select what purposes (identified through E2) to bring forward to the rest of the interview. Ideally the interviewers should select all purposes. If, however, there were too many purposes the most important (based on E3) or unique purposes were selected. If too many purposes were brought forward to the following exercises it was deemed to lower the quality of the data.

This last section consisted of one larger exercise were the interviewee was asked to rate each of the selected purposes against seven selected quality attributes (how these quality attributes were selected see section 4.3.4.3.2 below). In the initial version of the questionnaire the interviewee was asked to score one selected purpose at the time, against all seven quality attributes simultaneously. However, after the pilots it was noted that the interviewees had difficulties to do this, since understanding all quality attributes at the same time was too complicated. Instead, the exercise was redesigned so that all selected was scored against one single quality attribute at a time. This allowed for the interviewers to carefully explain the meaning of each quality attribute before the purposes were scored. In order to make the results from the different interviews as comparable as possible, clear descriptions of the endpoints of each quality attribute scale was formulated (for further description of how the end points were formulated see section 4.3.4.3.3) and visualized through the PowerPoint. To exemplify, figure 19 shows how the scale for the quality attribute *Completeness* was visualized. Except the endpoint descriptions all scales were visualized in the same way.

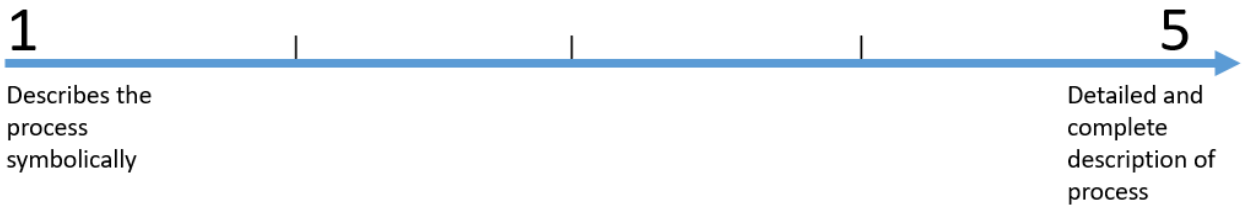


Figure 19: Example of scale utilized during E4.

After the interviewers carefully had explained quality attributes and the endpoints, and the interviewee had had a chance to ask questions, the interviewee was asked to place one purpose at a time on the scale. After one purpose was scored, one of the interviewers moved that purpose to that position in the PowerPoint. This allowed for the interviewee to really think through the answers, since she could see how she had answered. Above sequence was repeated for all selected purposes for each of the seven quality attributes.

4.3.4.3.2 Selection of purposes

Next, the quality attributes that should be included in the exercise were selected. Within SEQUAL-BPM, 16 quality attributes exist, which are listed in table 6 below. Due to the time limit of the interviews and the risk of the interviewee losing concentration if the exercise was too long, all 16 quality attributes could not be included. Hence a selection had to be made. However, such a selection would have had to be made anyhow, since not all quality attributes are relevant for practitioners. First it was deemed to be difficult to capture the nuances of the six types of agreement. As discussed in section 2.3.4.6, the most relevant of the types are the relative ones since absolute agreement is deemed to not be achievable in reality. Hence, all absolute types could be excluded. Further the agreement in model types could be excluded since they represented unique cases that would not be relevant for the study. Left was r*elative agreement in interpretation* and *relative agreement in knowledge*. Both these quality attributes were included in the pilot interviews, however it was during those interviews noted that *relative agreement in knowledge* was difficult to grasp for the interviewees. Thereby this quality attribute was excluded in the final version of the questionnaire. Left was the agreement type *relative agreement in interpretation*, which according to Krogstie (2016) is the most relevant in the context of process modeling.

Next, validity and completeness could be excluded since Krogstie (2016) states that semantic quality in reality is a question of perceived semantic quality. Both perceived validity and perceived completeness were included in the pilot study, however it was noted that it did not make sense to ask questions about perceived validity; the practitioners did not understand when a process model with irrelevant statements would be useful. Hence, this quality attribute was excluded in the final questionnaire. Lastly, the quality attribute persistence was also excluded from the final questionnaire since it was noted during the pilots that it is always an important quality attribute independent of purposes.

Quality dimensions	Quality attributes	Included in questionnaire?	Motivation
Physical	Persistence	No	Excluded since practitioners deemed this quality attribute to always be important, independent of purpose
	Currency	Yes	Included due to high relevance
	Availability	Yes	Included due to high relevance
Empirical	Readability	Yes	Included due to high relevance
Syntactic	Syntactical correctness	Yes	Included due to high relevance
Semantic and perceived semantic	Validity/Perceived validity	No	Excluded since practitioners deemed this quality attribute to always be important, independent of purpose
	Completeness/perceived completeness	Yes	Completeness excluded due low connection with reality and perceived completeness included due to high relevance
Pragmatic	Comprehension	Yes	Included due to high relevance
Social	Relative agreement in interpretation	Yes	Included since it is the most relevant of the agreement types
	Absolute agreement in interpretation	No	Excluded since absolute agreement is not achievable
	Relative agreement in knowledge	No	Excluded since it was too difficult to capture
	Absolute agreement in knowledge	No	Excluded since absolute agreement not is achievable
	Relative agreement in model	No	Excluded since agreement in model represents unique cases
	Absolute agreement in model	No	Excluded since agreement in model represents unique cases
Deontic	Feasible Validity, Feasible Completeness, Feasible Comprehension, Feasible Agreement,	Indirectly included	N/A

Table 6: Motivation to what quality attributes that were included in the questionnaire.

In the end, 7 out of the 16 quality attributes within SEQUAL-BPM were included in the final questionnaire; Currency, Availability, Readability, Syntactical correctness, Perceived completeness (hereinafter Completeness), Comprehension and Relative agreement in interpretation (hereinafter Agreement).

4.3.4.3.3 Formulation of endpoints and descriptions

The next decision that had to be made was how to communicate the selected purposes to the interviewees and what descriptions to use for the endpoints of the scales. The endpoint descriptions utilized in the questionnaire are presented in table 7 below.

Quality attribute	**Endpoint descriptions**
Currency	1 = Singular modeling
	5 = Continuous updates/improvements
Availability	1 = Available only for the modeler(s)
	5 = Available for all actors involved in the process
Syntactical correctness	1 = Not important to follow modeling language standard(s)
	5 = Important to studiously follow modeling language standard(s)
Completeness	1 = Symbolic description of the process, i.e simplification of reality
	5 = Detailed and complete description of reality
Comprehension	1 = The process model content is only understood by the modeler(s)
	5 = The process model content is understood by all actors involved in the process
Agreement	1 =The model content is only agreed upon by the modeler(s)
	5 = The model content is agreed upon by all actors involved in the process
Readability	1 = Readable only for the modeler(s)
	5 = Readable for all actors involved in the process

Table 7: Endpoint descriptions for the quality attributes included in the final questionnaire

When deciding the endpoint descriptions some concretizations and assumptions had to made in order to make them comprehensible for the interviewees. The intuitive way to describe the endpoints was to utilize terms as for example: 1 = Low readability and 5 = High readability. However, it was necessary to set a scale that defined the meaning of low and high respectively. Such scale also made the answers comparable, because the purposes were instead scored against "solid ground". Below follows a discussion regarding how the chosen endpoints and descriptions correspond to the quality attributes they are derived from.

Currency: The quality attribute *Currency* has a scale ranging from "Singular modeling" to "Continuous updates/improvements". Hence, a score of 1 says that the purpose only demands a singular modeling effort. Further a score of 5 says that the purpose demands that the model is continuously improved and

updated. Since a process model neither can be updated less than once, nor more often than continuously, the answers on this scale are deemed to correspond directly to *Currency*.

Availability: The quality attribute *Availability* has a scale ranging from "Available only for the modeler(s)" to "Available for all actors involved in the process". Hence, a score of 1 says that the purpose only demands that the model is available for the modeler(s). Further a score of 5 says that the purpose demands that the model should be available to all actors related to the process. Even though *Availability* does not directly refer to who the model should be available for, it is deemed that the scale will provide indications on if availability should be prioritized or not. This because a purpose that demands that the model is available to all actors related to the process, would also require high availability, and the other way around.

Syntactical correctness: The quality attribute *Syntactical correctness* has a scale ranging from "Not important to follow modeling language standard(s)" to "Important to studiously follow modeling language standard(s)". Since *Syntactical correctness* regards that all model statements are expressed according to syntax, the right part of the scale corresponds to this goal. In contrast, a 1 on the scale signifies that modeling language is of low importance and thereby syntax errors are allowed.

Completeness: The quality attribute *Completeness* has a scale ranging from "Symbolic description of the process, i.e. simplification of reality" to "Detailed and complete description of reality". Hence, a score of 1 says that the purpose only demands a symbolic description of the real process, i.e. the model does not contain all statements of the domain, which means that completeness is allowed to be low. Further a score of 5 says that the purpose demands that the model should be a detailed complete description of reality, i.e. the model corresponds very well with the domain, which means that completeness must be high. Consequently, it is deemed that the answers on this scale provide direct indication on how *Completeness* should be prioritized.

Comprehension: The quality attribute *Comprehension* has a scale ranging from "The process model content is only understood by the modeler(s)" and "The process model content is understood by all actors involved in the process". Hence, a QA-score of 1 says that the purpose demands that the model only has to be understood by the modelers. Further a QA-score of 5 says that the purpose demands that the process model is understood by all actors involved in the process. Even though the definition of comprehension does not imply who should understand the process model, the answers on this scale are deemed to provide insights regarding if comprehension should be prioritized or not. This because if the purpose demand that only the modeler(s) have to understand the model, then no effort has to be put into the fulfillment of comprehension. The same argument but opposite holds for the other side of the scale.

Agreement: The quality attribute *Agreement* has a scale ranging from "The model content is only agreed upon by the modeler(s)" to "The model content is agreed upon by all actors involved in the process". Not included in this range are cases where there are several modelers and there exist no requirements to reach an agreement between these individuals. However, it was deemed that this situation will not occur, since in such cases only one modeler would be appointed to that task, and the left side of the scale is deemed to be appropriate. Also the right side of the scale is deemed to indicate on that agreement should be prioritized, since agreement between all stakeholders is the ultimate level of this quality attribute.

Readability: The quality attribute *Readability* has a scale ranging from "Readable only for the modeler(s)" to "Readable for all actors involved in the process". Hence, a QA-score of 1 says that the purpose only demands that the process model is readable for the modeler(s). Further a QA-score of 5 says that the purpose demands that the model is readable to all actors involved in the process. To further explain the

scales to the interviewees, the actual interview was used as an example: "If only the two interviewers were to read the notes from this interview, 1 on the readability scale would be sufficient. If, however, the notes would be shared to e.g. the interviewee or the thesis supervisor, a higher degree of readability would be preferable". Even though the definition of readability does not directly correspond with to whom the model should be readable, the answers on this scale are deemed to provide insights regarding when readability should be prioritized. This because readability would have to be high if the purpose demands that all stakeholders involved in the process should be able to read it, and the other way around. As mentioned in section 2.3.4.2, readability is a subjective matter, which implies that it will have different meaning to different actors. However, no matter subjectivity, the chosen scale is deemed to provide an indication on if readability should be prioritized or not.

4.3.5 Sampling

The first aspect to take into consideration when deciding the sample was the delimitations of the thesis, saying that research was limited to Swedish organizations. Due to this the overall population was set to all organizations in Sweden. In order to make the results as generalizable as possible it was decided to build a sample that would represent all organizations in Sweden. To accomplish this, research regarding the division of the Swedish workforce by sectors was done. Statistiska centralbyrån (Statistics Sweden, SCB) provided the most suitable data, which was utilized as a basis for the sample formation. Figure 20 shows the division of the Swedish workforce according to SCB. First of all, it was decided to exclude the nonprofit organizations from the sample since these represented a too small part of the workforce and were not seen as typical utilizers of process modeling.

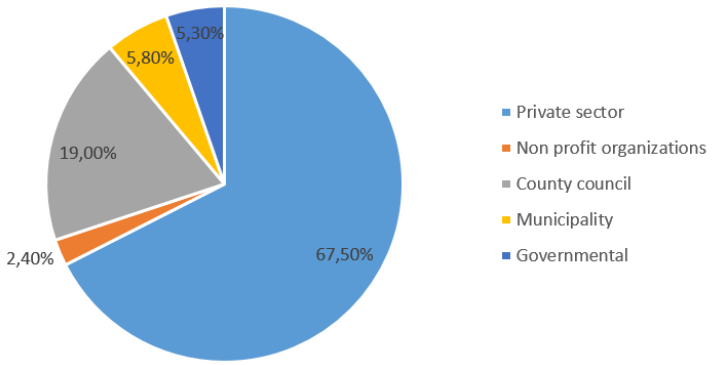


Figure 20: Division of the Swedish workforce by sector 2016. Source: (SCB 2016).

Next it was decided to breakdown the private sector further. A common way to divide the private sector is the by small-, medium and large sized companies. Once again SCB contributed with suitable data, which is presented in figure 21 below.

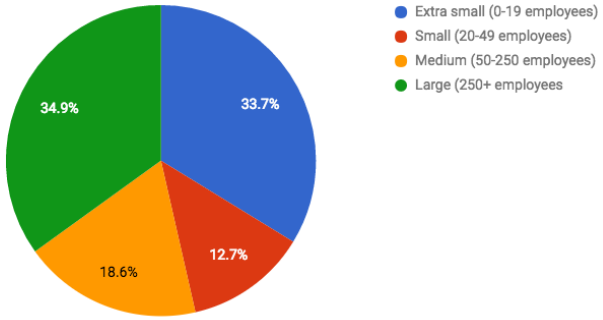


Figure 21: Divison of private sector. Source: (SCB 2014).

First, it was decided to exclude extra small organizations since the value of process modeling in such setting is not as prominent. Consequently, the private sector was divided by the remaining three segments; small, medium and large enterprises.

In reference to the data from SCB and above reasoning it could be decided how to build the sample in order to fairly represent the overall population. After excluding nonprofit organizations and extra small enterprises, the sample was set to consist of: 24% municipalities, 7% county councils, 7% governmental organizations, 12% small sized private corporations (20-49 employees), 19% medium sized private corporations (50-250 employees) and 31% large sized private corporations (250 + employees).

Having the division of the sample in place, the next question was to decide the sample size. Since the research aimed at providing generalizable insights, it was deemed to be necessary to have a fairly large sample in order to provide statistically significant results. According to Bryman & Bell (2015), the quality of the sample, i.e. the significance of the results, will become better the larger the sample is. However, the authors also mean that the decision regarding sample size must be put in relation to time and cost limits. Due to the fact that this master thesis had a limited timeframe and no budget, these resource limitations highly influenced the sample size. Furthermore, it was deemed to be more important to utilize the limited resources on conducting fewer in-depth interviews than conducting several brief interviews. The fact that the study was limited to not provide any insights regarding differences between segments allowed for a smaller sample, since statistical significance was enough on an aggregated level. In reference to above reasoning the sample size was set to 24 organizations, which was distributed by the quota percentages, presented before.

The final question regarding sampling was to set the screening criteria about what was required of the organization in order to participate and what roles within those organizations that were mostly suitable to participate. First it was decided that the organizations must have initiated a process modeling initiative. However, their process modeling maturity did not matter. Next, it was decided that the most suitable interview object within the organizations would be an individual that had a key role within the organizations' process modeling initiative and could provide a holistic view. This could either be someone within top management with operational responsibilities or someone responsible for the process modeling. When reaching out to the organizations a pre-discussion was held in order to decide if the organizations and interviewee matched with the criteria.

4.3.6 Analysis

After the interviews were conducted the data had to be analyzed. In order to be able to quantify the qualitative parts of the data from the interviews the answers initially had to be coded, i.e. categorized into purposes. The categorization process and the following analyses made are described in this section. Some of the minor and more obvious analyses made are not discussed in this section. Instead they are discussed in direct relation to those results.

4.3.6.1 Iterative categorization

The first step of categorizing the reasons from E2 into purposes of process modeling was to carefully study each answer to ensure that the interviewers had the same perception of the answers. If needed, the answers were clarified by listening to the recordings of the interviews.

Next, an iterative categorization was performed, starting with ten overall categories that after the interviews were evident to the interviewers. If one answer did not fit into one of the overall categories, it was put in a miscellaneous category. The answers in this category were then studied together and all except two answers (that stayed in the category *Miscellaneous*) could be divided into additional categories. Furthermore, some of the initial overall categories could be divided into more specific purposes.

4.3.6.2 Maturity Analysis

The organizations were divided into three maturity groups based on their answer on the E1. The first two levels, *Definition* and *Modeling*, were grouped together due to that many organizations positioned themselves on the border between these two stages. This naturally made it difficult to divide these organizations into two groups, but it also indicates that the two stages are similar.

	Maturity level 1 Definition/Modeling	**Maturity level 2 Implementation**	**Maturity level 3 Maintenance**
Number of organizations	11	6	7

Table 8: Number of organizations within each maturity level.

In order to compare the distribution of purposes among maturity groups, the frequency of each purpose within each maturity group was normalized with the number of organizations within each maturity group. The number of organizations within each maturity group is presented in table 8 above. The normalized value, hereinafter referred to as *Maturity Rate (MR)*, was calculated according to the formula below. In order to clarify the formula, the following example is provided: *Identify strengths and weaknesses* has in total been mentioned 20 times (*purpose x count in total =20)*. 10 out of these 20 organizations that has mentioned *Identify strengths and weaknesses* belongs to maturity group 1 (*purpose x count within maturity group = 10)*. There are 11 organizations within maturity group 1, which makes *Share of organizations within maturity group* equal to 45% (11/24). Consequently, the MR in this case is equal to (10/20)/0,46 = 1,09.

$$Maturity\ Rate\ (MR) = \frac{\frac{purpose\ x,\ count\ within\ maturity\ group}{purpose\ x,\ count\ in\ total}}{share\ of\ organizations\ within\ maturity\ group}$$

Based on the MR, analyses regarding the distribution of purposes within maturity levels could be performed.

4.3.6.3 Correspondence Analysis

In order to provide insights on how the purposes relate to each other, the frequency of coexistence between the purposes among a respondent was calculated and presented in a two-way frequency table. For example, if the purpose *Roles and responsibilities* was mentioned together with the purpose *Documentation* by organization no.1, that relationship was counted as one. The full two-way frequency table is presented in appendix A.

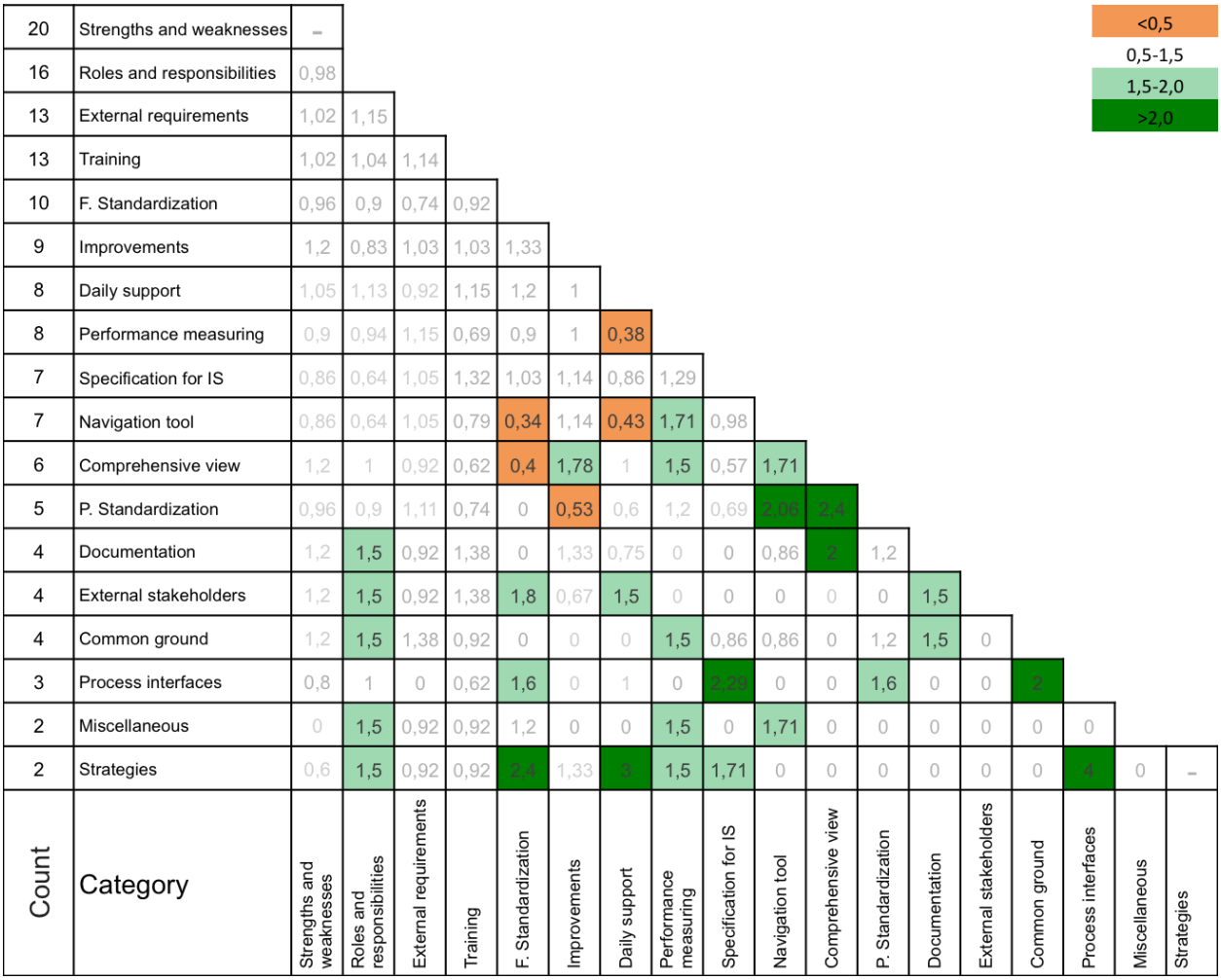
In order to make the results more comparable the count was divided with the number of total counts for each purpose. The full result from these percentages is presented in appendix B. A part of the table is presented in table 9 below in order to provide some examples from the results. The table shows, for example, that *Roles and responsibilities* was mentioned 16 times in total (see count column). In 81% (13 times) of these 16 cases where *Roles and responsibilities* was mentioned, *Strengths and weaknesses* was simultaneously mentioned. To clarify further, another example shows that the category *F. standardization* is mentioned 10 times. In 50% of these cases the category *Training* is mentioned simultaneously.

Count	Categories	Strengths and weaknesses	Roles and responsibilities	External requirements	Training	F. standardization	Improvements	Daily support	Performance measuring
20	Strengths and weaknesses	-	65%	55%	55%	40%	45%	35%	30%
16	Roles and responsibilities	81%	-	63%	56%	38%	31%	38%	31%
13	External requirements	85%	77%	-	62%	31%	38%	31%	38%
13	Training	85%	69%	62%	-	38%	38%	38%	23%
10	F. standardization	80%	60%	40%	50%	-	50%	40%	30%
9	Improvements	100%	56%	56%	56%	56%	-	33%	33%

Table 9: Part of the Correspondence analysis.

However, these results are not fully suitable to provide insight on how the purposes relate to each other. This is because the likelihood of coexistence between a frequent purpose (e.g. *Strengths and weaknesses)* and other purposes is higher than those with low frequency. In order to provide further insight, each percentage was normalized with the likelihood of coexistence. In order to clarify the normalized results the following example is presented: *Strengths and weaknesses* is mentioned by 20 out of 24 respondents, i.e. 83% of the times. This means that the likelihood of any other purpose to coexist with *Strengths and weaknesses* is 83%, e.g. 83% of the times that purpose X is mentioned it should statistically appear together with *Strengths and weaknesses*. It can thereby be stated that the above-mentioned result (in 81% of the cases where *Roles and responsibilities* is mentioned also *Strengths and weaknesses* is mentioned) aligns with the likelihood of coexistence. The normalized value (81% divided by 83%) is thereby 0,98 (see table 10). By normalizing all percentages in the same way, it can be identified what relationships that deviate from the likelihood of coexistence and insights can be provided regarding how the purposes relate to each other. Table 10 below shows all normalized values. Values below 1 mean that the purposes are less related to each other than the likelihood of coexistence suggests and opposite, values above 1 indicate that the purposes are more related to each other than the likelihood of coexistence suggests. Furthermore, values close to 1 (as in the example above) do not provide insights regarding how the purposes relate to each other. Lower values than 0,5 are highlighted in orange, higher values than 1,5 are highlighted green and values between 0,5-1,5 are shaded since it is deemed to not provide clear insights.

As can be seen in table 10, some values are equal to zero, which means that these purposes never have been mentioned together. These results have appeared due to the fairly low sample, which makes it impossible for the low frequency purposes to be selected together with all purposes. However, it is still deemed that the analysis will provide valuable insights in the cases where representation exists.



Count	Category	Strengths and weaknesses	Roles and responsibilities	External requirements	Training	F. Standardization	Improvements	Daily support	Performance measuring	Specification for IS	Navigation tool	Comprehensive view	P. Standardization	Documentation	External stakeholders	Common ground	Process interfaces	Miscellaneous	Strategies
20	Strengths and weaknesses	-																	
16	Roles and responsibilities	0,98																	
13	External requirements	1,02	1,15																
13	Training	1,02	1,04	1,14															
10	F. Standardization	0,96	0,9	0,74	0,92														
9	Improvements	1,2	0,83	1,03	1,03	1,33													
8	Daily support	1,05	1,13	0,92	1,15	1,2	1												
8	Performance measuring	0,9	0,94	1,15	0,69	0,9	1	0,38											
7	Specification for IS	0,86	0,64	1,05	1,32	1,03	1,14	0,86	1,29										
7	Navigation tool	0,86	0,64	1,05	0,79	0,34	1,14	0,43	1,71	0,98									
6	Comprehensive view	1,2	1	0,92	0,62	0,4	1,78	1	1,5	0,57	1,71								
5	P. Standardization	0,96	0,9	1,11	0,74	0	0,53	0,6	1,2	0,69	2,08	2,4							
4	Documentation	1,2	1,5	0,92	1,38	0	1,33	0,75	0	0	0,86	2	1,2						
4	External stakeholders	1,2	1,5	0,92	1,38	1,8	0,67	1,5	0	0	0	0	0	1,5					
4	Common ground	1,2	1,5	1,38	0,92	0	0	0	1,5	0,86	0,86	0	1,2	1,5	0				
3	Process interfaces	0,8	1	0	0,62	1,6	0	1	0	2,29	0	0	1,6	0	0	2			
2	Miscellaneous	0	1,5	0,92	0,92	1,2	0	0	1,5	0	1,71	0	0	0	0	0	0		
2	Strategies	0,6	1,5	0,92	0,92	2,4	1,33	3	1,5	1,71	0	0	0	0	0	0	4	0	-

Table 10: Normalized two-way frequency table.

In order to visualize these results, it was decided to run a correspondence analysis (CA). The idea behind a CA is to translate relations within a two-way frequency table into coordinates in a two-dimensional space. The rule of thumb is that the closer the purposes are positioned, the more related they are. Since the input of the analysis, in this case, is the frequency of coexistence, it means that the closer the purposes are positioned the more they are mentioned together. The program XLSTAT was utilized to run the analysis. The results from the analysis were validated by the findings presented in table 10. It could be identified that purposes closely positioned to each other also had high, normalized values and the other way around.

4.3.6.4 K-means Clustering Analysis

A cluster analysis is a method to gather objects that are similar to each other in classes (XLSTAT Support Center 2017). In this study, a *K-means clustering analysis* was performed in the software XLSTAT in order to examine the relations between purposes based on their quality characteristics. The example used in a tutorial found through XLSTAT Support Center (2017) was deemed to correspond to the data set of this

study, whereas the tutorial was used as a guideline to perform the analysis and interpret the data. The input to the analysis was the average scoring of quality attributes (QA-score) for each purpose (table 11).

Purpose	Currency	Availability	Syntactical correctness	Completeness	Comprehension	Agreement	Readability
Roles and responsibilities	3,1	4,1	3,4	3,3	4,0	4,3	3,4
Strengths and weaknesses	2,7	2,2	3,1	3,3	3,2	3,0	2,7
F. standardization	3,5	4,5	3,4	3,7	4,0	4,2	4,3
Documentation	4,0	4,0	3,3	3,0	4,3	3,0	3,8
External requirements	3,6	3,5	4,2	2,7	3,6	2,8	3,8
Training	3,6	4,6	3,5	3,2	3,7	2,8	4,3
Specification for IS	2,0	1,8	4,0	4,8	3,0	3,0	2,4
Daily support	4,1	5,0	3,3	4,3	4,5	3,5	4,6
Performance measuring	3,6	2,2	4,0	3,8	2,8	3,0	2,8
Navigation tool	3,7	3,9	3,3	3,1	3,9	3,4	4,3
Improvement	2,5	2,7	3,3	3,0	3,0	2,7	3,7
External stakeholders	3,0	2,5	3,0	2,5	2,5	4,0	3,0
Comprehensive view	2,7	4,7	4,2	2,3	4,3	3,8	4,8
Common ground	2,5	4,8	3,8	2,8	4,0	4,5	4,3
Process interfaces	2,3	2,7	3,3	3,0	3,0	4,3	3,7
Miscellaneous	1,5	5,0	1,5	3,5	2,0	4,0	2,0
P. standardization	2,6	2,4	3,2	3,8	3,2	3,4	2,0
Strategies	1,5	4,0	5,0	2,0	4,0	2,5	4,0

Table 11: Input data to K-means clustering analysis.

The *K-means cluster analysis* uses the data set to iteratively converge into an optimal solution of clustering (Addinsoft 2017). The objects of the data set (in this case purposes) are assigned to the class for which they are measured to be closest to the class center (that is randomly selected). The centers are then redefined based on the objects included in the class, whereupon the objects are reassigned in accordance with their distances to the new centers. The procedure is repeated until convergence is reached.

4.3.6.5 ANOVA

A *One-way ANOVA* (analysis of variance) is a statistical model to examine variability (XLSTAT Support Center 2016). It is suitable when the explanatory variables of the data set, as in the case of this study, are one qualitative variables with k levels. The ANOVA was performed ten times, for each *important purpose*, with the help of the software XLSTAT. The input was thus the quality dimensions (qualitative variables) with their assigned score for each answer (quantitative, dependent variables). Table 12 below shows the first part of the data set for the purpose *Navigation tool*.

Quality dimension	Scoring
Currency	4
Currency	2
Currency	4
Currency	5
Currency	3
Currency	5
Currency	3
Availability	2
Availability	3
Availability	4
Availability	4
Availability	5
Availability	4
Availability	5

Table 12: Example of input data to the ANOVA.

The ANOVA included a multiple comparisons test in order to determine whether there is a significant difference (confidence interval of 95 %) between the quality dimensions. The test chosen was Fisher's Least Significant Difference (LSD), that is one of the most common tests, testing the hypothesis that all the means for the different qualitative variables are equal (Addinsoft, 2017).

4.4 Trustworthiness

This study is in its basis qualitative, but the qualitative data is quantified through coding, which allows for quantitative insights and conclusions. Due to this the study can be seen as both quantitative and qualitative, which raises the question if the trustworthiness of this research should be evaluated through quantitative or qualitative criteria. However, it is deemed that the latter is mostly suitable, since the core of the data is qualitative. According to Bryman & Bell (2015), this can be evaluated in reference to four dimensions; *credibility*, *transferability*, *confirmability* and *dependability*. Each of these dimensions is in the context of this master thesis discussed in this section.

4.4.1 Credibility

Credibility regards how believable the findings are (Bryman & Bell 2015). The authors state that triangulation is a suitable method in order to ensure credibility, which involves the utilization of more than one method and sources of data, which ultimately will confirm each other.

Within this study the results have been triangulated through previous research, qualitative interview findings and answers from other interviews. The following example helps to understand how the triangulation was performed: An interviewee answered that a reason why they performed process modeling was to identify strengths and weaknesses and that *Availability* was not important in order to

fulfill this purpose. This result was triangulated through findings in previous research indicating that models like these do not have to be shared with employees. It was also confirmed by the fact that the interviewee when mentioning the purpose described that identification of strengths and weaknesses was made isolated in the process team.

Furthermore, the credibility was ensured through respondent validation (Bryman & Bell 2015). Letting each interviewee confirm the result of exercise E3 and each part of E4 achieved this. Hence, the credibility of the data from each respondent is deemed as credible, which lays a solid foundation for the aggregated credibility.

4.4.2 Transferability

Transferability regards the generalizability of the results, i.e. how applicable the results are outside the context of this study (Bryman & Bell 2015). Since the goal of this study was to provide generalizable insights, the question of transferability is highly relevant for this master thesis.

The main aspect of this study that influences the transferability is the decisions regarding sample. The sample was built so that it would represent the division of different organizations in Sweden, which is intended to make the results transferable to other organizations outside the study. The fact that the sample involves organizations of different sizes and types, and still significant trends can be identified, makes the transferability high. However, access to the organizations was achieved through the researchers' professional network, since it was deemed to be less time consuming, which might have influenced the transferability of the results. This because the organizations that belong to the researchers' network might not be a fair representation of the overall population. It is deemed, though, that this have been overridden by that fact that quotas of what kind of organizations that should be interviewed was set before, which forced the researchers to involve organizations of different parts of the network.

It could also be stated that the lower sample size lowers the transferability, since it represents such a small part of the overall population. However, the main conclusions rest on trends that are clear and even sometimes significant within the sample. Hence, it is fair to argue that these trends would also occur if the sample was larger.

4.4.3 Dependability

Dependability concerns if the findings apply at other times. This can be reached by keeping complete records of the research (Bryman & Bell 2015). This study is deemed to be highly dependable, due to the fact that the data was collected through structured interviews, whose questionnaire is well described and documented. Hence, it is possible for any other researcher to conduct exactly the same interview at another time. Furthermore, the recordings and notes from all interviews are well documented and stored so that the same raw data can be analyzed for other purposes. Also analyzes executed are well described in this master thesis so that they can be repeated at other times.

4.4.4 Confirmability

Confirmability concerns the objectivity of the research. The main question is if the researchers' values have intruded the results (Bryman & Bell 2015). The authors state that it is worth mentioning that qualitative research can never be fully objective, but it should give an essence that the research is carried

out with good faith. The interviews in this study were carried out with the intention to in depth understand why process modeling is performed and what quality attributes that correspond to these reasons. In order to truly achieve this, the questions regarding why process modeling is performed were open so that the researchers' preconceived ideas would not influence the answers. Furthermore, the wording of the interviewees, captured through these open questions, was utilized throughout the rest of the interviews, so that the quality attribute ratings truly corresponded to the reality of the interviewee. Above factors are deemed to have contributed to the confirmability of this study. The most sensitive point of the study, confirmability wise, is the coding, i.e. categorization, of the qualitative answers, which was indirectly influenced by the researchers' subjective interpretations. In order to minimize the subjectivity in this critical step, the recordings from the interviews were carefully listened to, thus capturing the true nuances before defining the code of the answers. Furthermore, the iterative coding process contributed to a higher objectivity.

5. Empirical data

This chapter presents the empirical data retrieved from the interviews. First, the different kinds of organizations are presented briefly. Then, the organizations' position in the matrix of E1 is presented, followed by examples of typical answers of questions E2, E3 and E4.

5.1 Interviewed organizations

Based on the sampling method presented in section 4.3.5, interviews were scheduled and held with 24 organizations, that are briefly described in table 13.

Code	Type	Description
A	Large organization	Chemicals
B	Large organization	Vehicle and aircraft components
C	Large organization	Internal IT department within retail company
D	Large organization	Construction equipment
E	Large organization	Construction
F	Large organization	Food
G	Large organization	Construction
H	Large organization	Forestry
I	Medium organization	Electronics
J	Medium organization	Medical aid
K	Medium organization	Process industry equipment
L	Medium organization	Shipyard industry
M	Small organization	Wholesale
N	Small organization	Electrical solutions
O	Small organization	Building installations
P	Small organization	Forestry industry logistics
Q	County council	Hospital
R	County council	Hospital
S	Municipality	Small municipality
T	Municipality	Medium municipality
U	Municipality	Department within large municipality

V	Municipality	Small municipality
X	Governmental	University
Y	Governmental	Public administration

Table 13: Interviewed organizations.

5.2 Exercise E1

The organizations' different positions based on process maturity and abstraction level of process models is shown in figure 22. The organizations positioned themselves first on horizontal level and then on vertical level. In some cases, the position was adjusted after completing the interviews and comparing with other organizations' answers. Most of the times, the organizations knew where they belonged in maturity, but in case of doubt they were asked to consider an average. Half of the organizations were able to place their process models on a specific abstraction level, whereas the other half claimed to have processes on several or all levels. Not all organizations that positioned their process models on operational level aim to use the models as a support in daily work, however all organizations that clearly stated such a purpose also positioned themselves on operational level. Also, some organizations expressed the difficulty in deciding the appropriate detail level of the process models; too detailed models are difficult to keep up to date since working routines are constantly changing. There tended to be different opinions within the organization on the appropriate detail level.

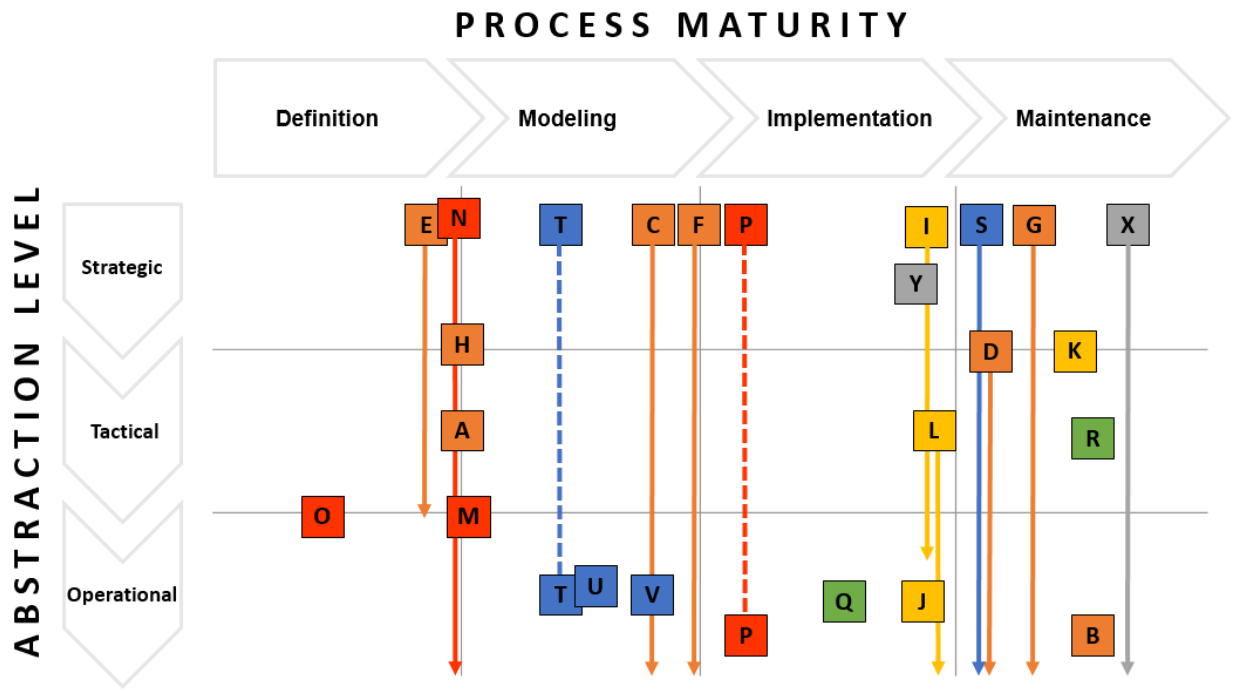


Figure 22: Distribution of answers for E1.

Between the organizations, the entry points on the vertical scale tend to vary. Most organizations start from the top with strategic process models, that are broken down into a more detailed operational level. These organizations highlight the importance of having the overall perspective in order to get any value out of process work. In contrast, there are also organizations that has a bottom-up perspective on their process work. The process modeling typically started within a specific project and then moved upwards.

5.3 Exercises E2 and E3

Through exercise E2 (see section 4.3.4.2) 141 answers came out in total. On average each organization gave 5,8 answers with a standard deviation of 1,4. The organization that gave the most answers gave 9 answers and the organization that gave the least, gave 3 answers. Through exercise E3 (see section 4.3.4.2), the importance ranking for each organization's answers came out. As the respondents were allowed to rank some purposes equally the maximum level of ranks turned out the be 6 and minimum level of ranks turned out to be 3. However, the average level of ranks turned out to be 4,4. Figure 23 below summarizes the number of answers on E2 and the number of levels of ranks in E3 for each organization.

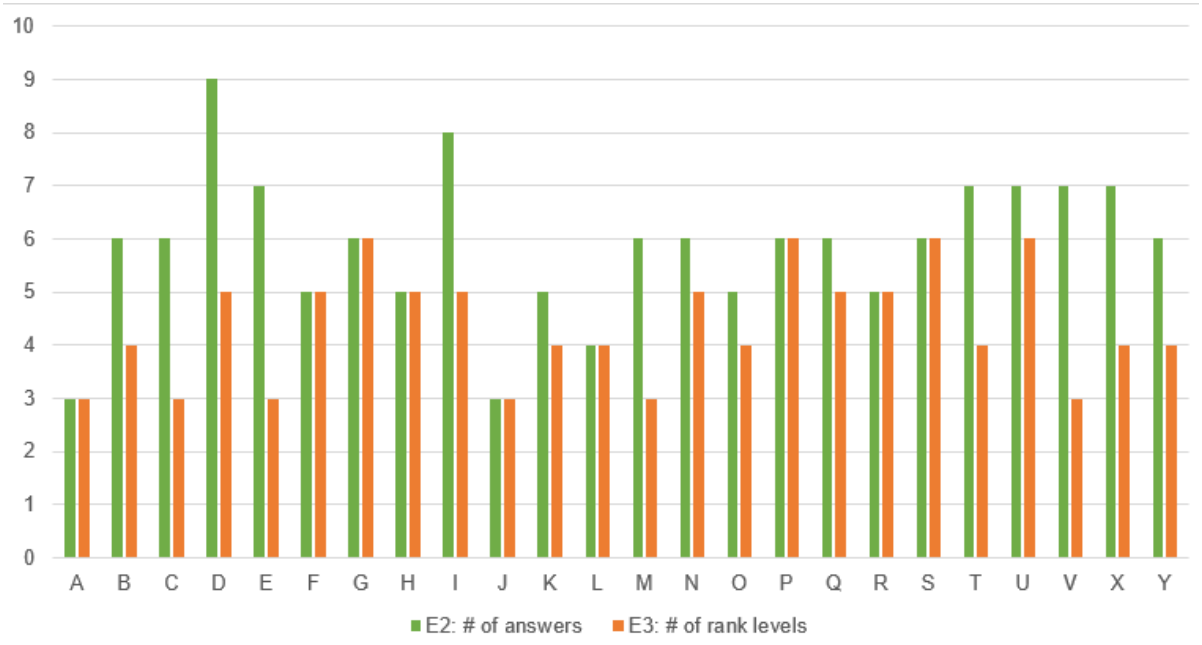


Figure 23: Number of answers on E2 and the number of levels of ranks in E3 for each organization.

All answers can be found in appendix C. Table 14 below provides an example of the answers from E2 and E3 from one of the organization, translated from Swedish.

Organization	Type	Translated answer	Rank
X	Governmental	Agree upon how we should work. Division of tasks and responsibilities	1
		Provide comprehension for how we work, i.e. provide comprehension for how the employee relate to the rest of the organization	1
		Tool for organizational development, which allows for identification of areas of improvements	2
		Provide a basis for standardization	2
		Training or hand-overs within the organization	3
		Ensure quality through ISO-certification and/or Rule of law	3
		Support in execution of operational tasks	4

Table 14: Example of answers from organization X on exercises E2 and E3.

5.4 Selection and exercise E4

As mentioned in section 4.3.4, a selection of the answers on E2 was made before going into exercise E4. Ideally all answers were selected. If, however, there were too many purposes the most important (based on E3)/unique purposes were selected. This was done because if too many purposes were brought forward into exercise E4 it would lower the quality of the responses. The selection resulted in that 19 answers were not brought into E4, i.e. 86% of the answers in E2 were rated according to the seven quality attributes. Table 15 below gives an example of the answers from organization X.

Organization	Type	Answer	Currency	Availability	Syntactcal correctness	Completeness	Comprehension	Agreement
X	Governmental	Agree upon how we should work. Division of tasks and responsibilities	2	3	3	3	5	5
		Tool for organizational development, which allows for identification of areas of improvements	3	1	1	3	4	4
		Training or hand-overs within the organization	4	5	3	3	5	1
		Support in execution of operational tasks	5	5	3	4	4	1
		Provide comprehension for how we work, i.e. provide comprehension for how the employee relate to the rest of the organization	3	5	3	2	5	5
		Provide a basis for standardization	1	2	4	4	5	1
		Ensure quality through ISO-certification and/or rule or law	5	3	4	4	5	1

Table 15: Example of answers on exercise E4 from organization X.

To make the results from E4 more understandable some example insights from organization X follows below. For example, it can be seen that when organization X perform process modeling in order to manage training or handovers the most important process model characteristics are *Availability* and *Comprehension*. Furthermore, it can for example be seen that when organization X performs process modeling in order to "*Provide a basis for standardization*" the most important process model characteristic is also *Comprehension*. In this case *Currency* and *Agreement* are not important characteristics for organization X.

6. Research question 1 - Analysis

As the first research question consists of two sub questions, this chapter is divided into two parts, each providing analysis and result for RQ1A and RQ1B, respectively.

6.1 RQ1A

This section consists of the analysis for RQ1A: *What are common purposes to why organizations perform process modeling, and which of these are important?* In order to provide an answer to RQ1A three main analysis are made. First the *Iterative categorization* provides the purposes. Secondly, a *Frequency*- and *Ranking analysis* discusses the purposes' commonality and importance. Finally, a concluding analysis is made in order to answer RQ1A. Hence, the disposition of this section follows this logic.

6.1.1 Identification of purposes

Based on the iterative categorization, described in chapter 4.3.6.1, 17 purposes were identified. An abbreviation for the purpose that will be used throughout the report is presented in brackets. Based on the qualitative data gathered from the interviews the 17 purposes are defined below. Consequently, these definitions will function as a point of reference throughout the rest of the report.

Identification of strengths and weaknesses (Strengths and weaknesses): The role of the process model is in these cases to, within the process team, provide a description of the process as it is today, which can be studied and analyzed in order to identify strengths and weaknesses. Most organizations mean that this is done in order to later make improvements. However, some of the interviewees also pointed out that there must not necessarily exist a problem within the process and therefore it must not always be improved. The modeling could, just as well, be a way to find out what the organization is doing right in order to form best practices. However, it is important to understand that this purpose is isolated to the identification process, i.e. not associated with the following improvement/best practice initiatives.

Distribution of roles and responsibilities (Roles and responsibilities): Interviewees expressed a need to agree upon who does what and in which sequence. The goal of this is twofold: avoiding that tasks are forgotten due to that the responsibility for the task is undefined, and avoiding duplication of work. Some organizations use the process model mainly as a tool to agree upon roles and responsibilities. That is, the focus is on the process modeling *activity*. Others, however, tend to highlight the importance of the *product* of process modeling, i.e. the process model itself is an operational tool to make sure everyone works according to their assigned roles and responsibilities. Two organizations expressed the usability of such a process model that they are able to "blame the process". When something has not worked out as intended one can refer back to the process model and use it as a neutral platform for discussion. Instead of raising conflicts between co-workers that are blaming each other, a team can bring out the process model and discuss how the process should be improved. Moreover, when the process model serves as a description of how the process should be performed, one can go back to it in case of a discussion and prove that "this is what we agreed upon".

Training (Training): A distinct purpose that refers to the utilization of the process model as a tool within training of employees. In most cases this regards training of new employees or when someone internally changes position. The training can vary from giving the new employee a brief idea of how the organization

functions holistically, similar to the purpose *Comprehensive view*, to giving the new employee detailed descriptions of how to execute certain tasks. The latter corresponds with the category *Daily support* described below, however in the case of training the process model is not meant to provide support after the training phase is over.

External requirements fulfilment (External requirement): The purpose refers to when process models are utilized in order to meet external requirements. The most common requirement among the respondents is ISO-certifications, which often demand the organization to have its operations modeled as processes. Other requirements can be demands from customers or laws within certain business areas. For example, municipalities have to, according to laws, model operations regarding "Socialtjänsten" (social services). The external push for process modeling is a common first reason why organizations initiate process modeling. As the organization evolve in process modeling maturity other process modeling purposes will naturally be realized and explored.

Facilitator for operational improvements/transformations (Improvements): Regards the cases when the process model takes the role as a facilitator of operational improvements or transformations. What kind of improvement or transformation that it concerns varies between the organizations. It can vary between the implementation of a new information system to the introduction of a new service offering. However, no matter what kind of change it is, the process model takes a focal position in the change process. Firstly, the purpose includes designing a process model of a future, improved state. This model will then function as a detailed blueprint for the new state and/or a constitution and management tool for the core project team. Before the process model fills the purpose as a facilitator of change it has often filled the purpose as an identifier of strengths and weaknesses.

Facilitator for standardization/harmonization (F. standardization): A similar purpose to the previous (*Improvements*), since standardization/harmonization is a type of operational improvement and transformation. There is a clear distinction between organizations that utilize the process model as a facilitator or prerequisite for standardization (see the next paragraph). The first refers to when the process model not only is a tool to develop a standardized way of working but also takes the role as a focal point within the standardization process. The process model can for example be distributed throughout the organization in order to provide the "truth" for how to operate.

Prerequisite for standardization/harmonization (P. standardization): Refers to when the purpose of the process model is just to lay the foundation for the standardization/harmonization initiative (i.e. the first part of *F. standardization)*. After the process model has been developed other activities or artifacts will take its role in order to facilitate the standardization. One example is one of the county councils (organization R), where the processes are modeled and spread within a specific process team. These models are then used as a basis when forming control documents and guidelines to be used on operational level, where the process model is not used at all.

Prerequisite for process performance measuring (Performance measuring): Refers to when processes are modeled mainly to enable performance measuring within an organization. The interviewees expressed, that having the organization's processes modeled is necessary to be able to determine which factors to measure in order to improve and follow-up the processes and the organization on longer terms.

Specification for information systems (Specification for IS): A distinct purpose within which the characteristics of the answers do not differ much. In all cases the process model is utilized as a blueprint

for the design and/or implementation of information systems. Processes are modeled in order to make the information system work according to the organization's operations.

Daily support in operations (Daily support): Refers to when organizations have the ambition to utilize the process model as support for employees in their daily operations. The idea is that the employees should, when needed, be able to look into the model in order to remind themselves how to execute certain tasks. Since many tasks requires the coordination between several individuals this purpose touches upon the purpose *Roles and responsibilities*. However, this purpose is more related to process models aimed at operations for individuals. Organization D brings a clear example of when the process model fills this purpose, whereat there exists detailed process models for how to register goods within their warehouses. However, most of the organizations that has mentioned this purpose, state that the process models are mainly utilized as support in "daily" work within tasks that are executed seldom, since the employees have difficulties to remember these. Tasks that actually are executed daily will naturally be remembered by their employees.

Navigation tool (Navigation tool): A term for explaining the organizations' need to use process models as a timesaving tool to structure documentations, instructions and routines. Through process models, such documents are distributed in their context and can easily be found through navigation in the process structure. Thus, the documents provide the operational support but are made available and put in context through process models.

Provision of comprehensive view (Comprehensive view): Refers to when the process model fills the purpose of giving employees an idea on how their work relate to the rest of the organization and/or the end-customer. Furthermore, the process model provides comprehension, for the employee, on how the organization functions. As it might be enough to study the process model a few times in order to get a comprehensive view the actual utilization of the model for this purpose, might just happen when the employee starts at the company. Thereby this purpose lies closely to some parts of the purpose *Training*. However, the organizations with low process modeling maturity will not have a comprehensive view until the processes have been modeled. In these cases, the process model fulfills the need for a comprehensive view for all stakeholders related to the modeled processes. Furthermore, the process model fills its purpose as a provider of a comprehensive view when changes take place within the organization.

Provision of common ground (Common ground): Similar to the purpose *Comprehensive view*, but first on a management- and process team level. The idea is that the process model provides a common ground/view for management and process teams to work upon. During the modeling process the purpose will be to generate a common ground and understanding of the current state. When the process model is done, it will function as the basis, one which further needs can be managed and reached. Furthermore, the goal can also be to distribute the model to the employees working in the process.

Identification of process interfaces (Process interfaces): Refers to when the process model fills the purpose to define and clarify the interfaces between processes. The purpose can be equalized with *Roles and responsibilities*, but on an organizational level. The need for this mainly occurs on a holistic organizational level where the hand-offs between different larger parts of the organization have to be defined.

Visualization for external stakeholders (External stakeholders): Includes answers where the interviewees use process models to describe the organization's operations for customers. For example, municipalities express that they utilize the process models in order to provide their citizens (customers)

insights in how the municipalities operate. Potentially, also other external stakeholders such as suppliers or board members could be target groups for such process models.

Visualization of strategies (Strategies): The purpose regards process models utilized for communication of overall strategies and visions within the organization. For example, organizations utilize holistic future state models in order to provide strategic directions. Furthermore, strategies regarding customer focus can be communicated through these kinds of process models.

Documentation (Documentation): Regards process models that purely fills the purpose of documenting how the organization operates. These organizations feel the need to document their operations, not because they would like to change or standardize the way they operate, but in order to make knowledge and how-to independent of individuals. At later stages the documentation can be used as the basis for other purposes as *Training*, *External requirements* or *Roles and responsibilities*.

Table 16 concludes the 17 identified purposes. Due to similarities between purposes, some of them could be grouped together as transformative or operational purposes. **Transformative purposes** are similar in the sense that both standardization purposes are derivatives from *Improvements*, *i.e.* standardization is a type of improvement. The main difference between the two standardization purposes is that *P. standardization* is process-oriented in the sense that other mediums will be utilized for the facilitation of the standardization, whereas *F. standardization* is both process- and product-oriented. Hence, the purpose of *P. standardization* is *included* in F. standardization. As for ***Operational purposes,*** they have in common that they aim at providing some kind of support at an operational level, to the employee. *Navigation tool* is partly included in this group since it will provide support to the employee, but through other mediums than the process model.

Transformative	Operational	Other
F. standardization P. Standardization Improvements	Comprehensive view Training Daily support Navigation tool	External stakeholders Performance measuring Common ground Documentation Specification for IS External requirements Strengths and weaknesses Roles and responsibilities Process interfaces Strategies

Table 16: Groups of purposes.

6.1.2. Frequency- and ranking analysis

In order to understand the commonality and importance of the 17 identified purposes the frequency and ranking of each purpose are studied in this section. Firstly, the frequency of each purpose is presented and commented upon. Secondly, the ranking is analyzed and put in relation to the frequency.

As mentioned the *Iterative categorization* is made in such a way that each respondent count maximum one, for each purpose. For example, this means that the count for the purpose *Strengths and weaknesses* (see the first bar in figure 24) which is 20, represents 20 unique respondents, i.e. 83% of the total sample have

given an answer that corresponds to the purpose *Strengths and weaknesses*. The total counts for each purpose is presented in figure 24 below.

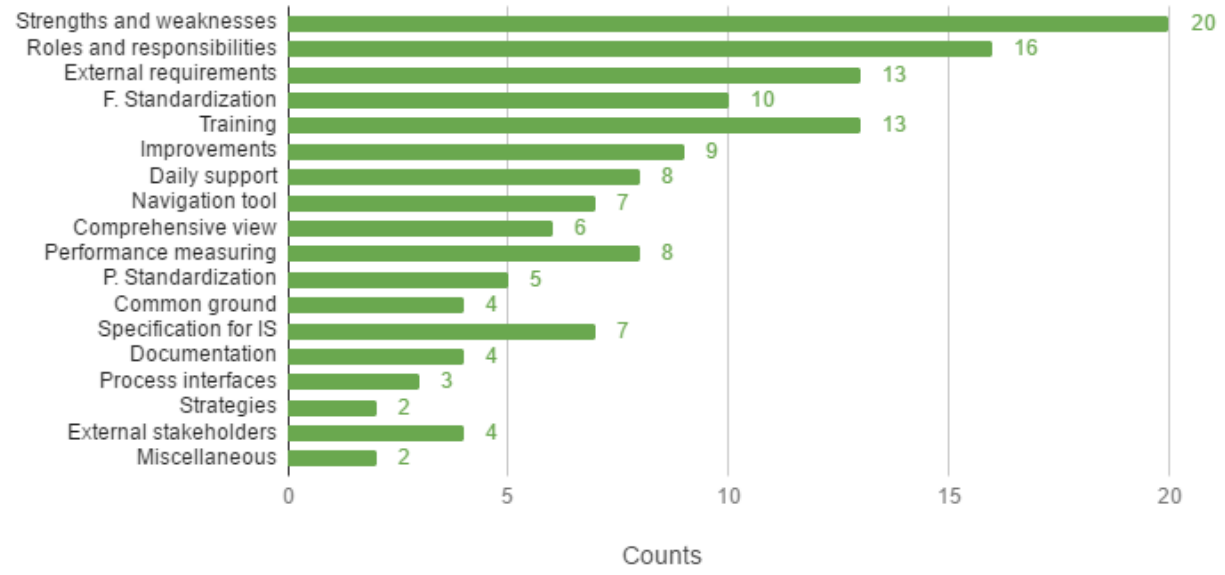


Figure 24: Frequency of identified purposes (N=141).

The top 5 purposes stand for 50% of the counts. The remaining 50% of the counts are divided over 12 purposes and a small group of miscellaneous answers. The 5 purposes are commented on below. As figure 24 shows, the most mentioned purpose clearly is *Strengths and weaknesses*. 83% of the interviewed organizations mean that they perform process modeling because they seek to identify strengths and weaknesses within their operations. The second most common purpose is *Roles and responsibilities* (67%). On a shared third position (54%) the purposes *Training* and *External requirements* are found.

On a a fifth position in the top 50% group, is *F. standardization* (42%) found. As mentioned in section 6.1.1, this purpose is highly related to *P. standardization*. The two purposes have different quality characteristics since there are different demands whether the model should be utilized as a prerequisite or facilitator. However, both purposes are directly connected to standardization and can therefore be merged when it comes to frequency. As *P. standardization* is mentioned by 21% of the respondents, both standardization purposes would sum up to 63% together, which makes it the third most mentioned purpose.

Beyond frequency, studying how the purposes were ranked importance wise will bring further insight regarding each individual purpose. Because of this the proportion of how the purposes are ranked when they are mentioned were analyzed, which is presented in figure 25 below. The diagram is sorted after the percentage of how often each purpose was ranked as the most and second most important purpose. For example the graph shows that Comprehensive view was ranked as most important in 67% (dark green bar) of the times it was mentioned and as third most important in 17% (light green bar) of the times it was mentioned. Worth mentioning is that when the respondents are asked to rank the identified purposes after importance, they do it in relation to the situation they are in right now, i.e. their process modeling maturity influenced their answers. This can be clarified by an example: 10 years ago one of the organizations initiated process modeling since they were going to design an information system. Today,

after the organization has accomplished their IS-design, they still mention the purpose *Specification for IS*, but they do not rank it as important as they would have 10 years ago. Instead other secondary purposes as Daily support might be ranked higher, because that is the main focus and challenge of today.

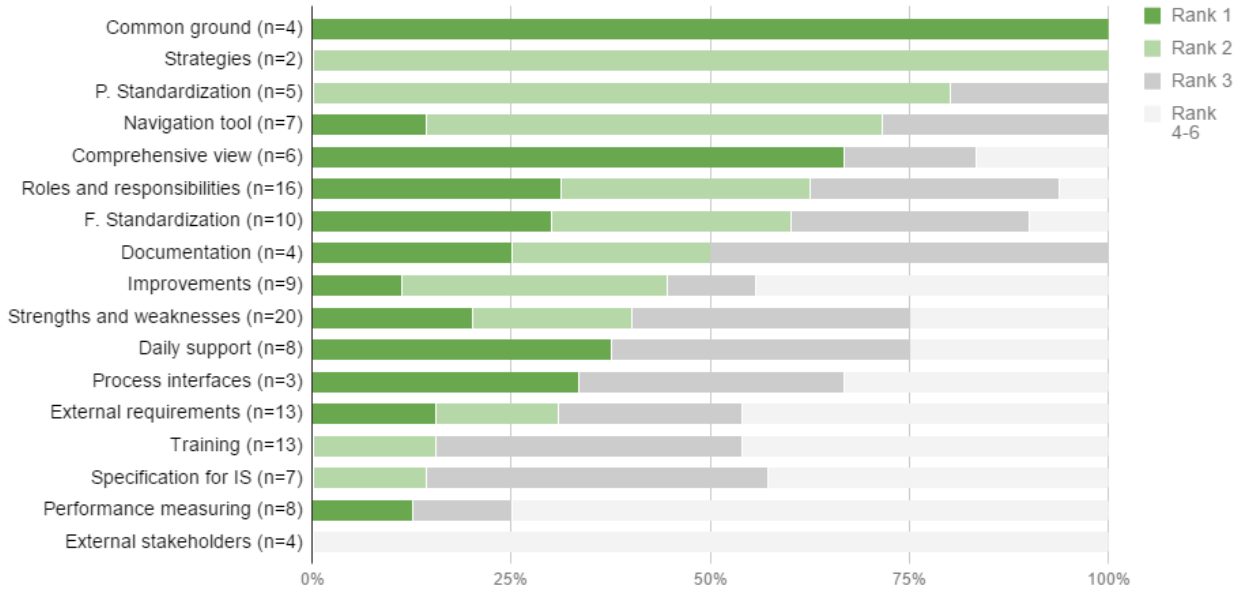


Figure 25: Division of ranking among purposes, sorted by the sum of rank 1 + rank 2.

In the top of the ranking analysis, the purposes *Common ground*, *Strategies*, *P. Standardization*, *Navigation tool* and *Comprehensive view* are found. *Common ground* is ranked as most important, 100% of the four times it is mentioned. *Strategies* is ranked as second most important 100% of the two times that it is mentioned. Furthermore *P. Standardization*, *Navigation tool* and *Comprehensive view* are ranked as 1 or 2 in 80%, 71% and 67% of the times they are mentioned.

Below this group of purposes, in the middle of the ranking analysis, the frequently mentioned purposes; *Roles and responsibilities*, *F. standardization*, *Improvements* and *Strengths and weaknesses* are found. This trend could be explained by the fact that frequently mentioned purposes are spread over more organizations, with different process modeling maturity and business needs, which naturally result in a spread between different ranks. Within the middle group the low frequency purpose; *Documentation*, can also be found.

In the bottom of the ranking analysis the purposes *Training*, *Performance measuring* and *External stakeholders* are found. This could indicate on that these purposes are not drivers for process modeling initiatives. They should rather be seen as "nice-to-have". In the bottom *Specification for IS* is also found, but this purpose should not be seen as a "nice-to-have". This because both literature and the interviews indicate on that *Specification for IS* often is a main reason why organizations initiate process modeling. The reason why it is low ranked in this analysis is that the organizations that mentioned it has already fulfilled this and are now looking into other possible accomplishments.

6.1.3 Summary of analyses and result RQ1A

This section combines the results from the frequency- and ranking analysis, in order to provide insights regarding the overall importance of each purpose.

A purpose is deemed to be important if it has a combination of average (or above) rank score and average (or above) count, or strong indications in one of the directions. The results are presented in figure 26 below. All purposes that are deemed to be important have green colored markers.

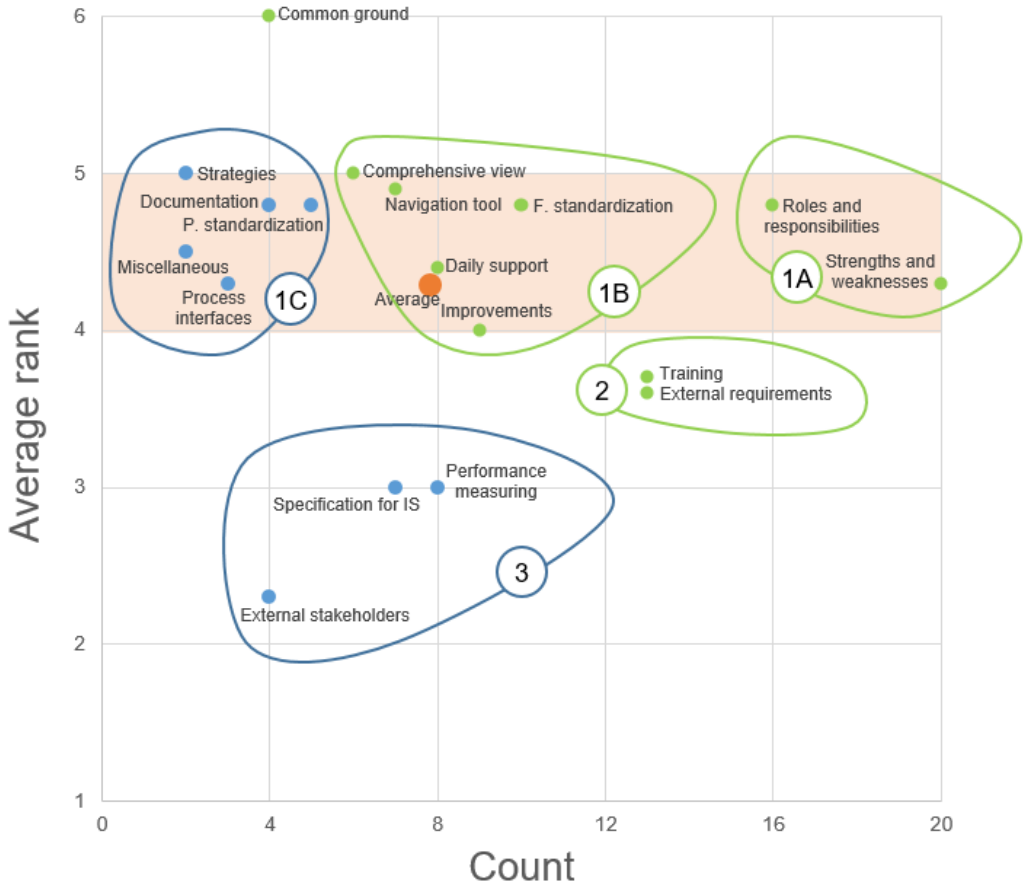


Figure 26: Frequency-ranking matrix.

On the y-axis the average rank score for each purpose can be found. The rank score is a translation of the ranking, wherein rank one is translated to the score six, rank two is translated to the score five and so on. On the x-axis the count for each purpose is found. This means that purposes in the upper-right corner are frequent and highly ranked, and purposes in the upper-left corner are highly ranked and less frequent. Opposite to this, purposes in the lower-right corner are lowly ranked, while they are frequent and purposes in the lower-left corner are lowly ranked and not frequent. As a reference point for the analysis the coordinate for average rank score and average count is marked.

As can be seen in figure 26 most purposes have an average rank score between 4 and 5 (see orange colored area). Within this range, three groups can be identified; (1C) a group of rarely mentioned purposes (n<5),

(1B) a group of frequently mentioned purposes ($5 \leq n \leq 12$) and (1A) a group of **very** frequently mentioned purposes ($n>15$). 1A is a clear case since these purposes have such a high count that they should be deemed as important even though they would have had lower average rank scores. Group 1C is a clear case in the opposite direction, since these purposes are rarely mentioned and do not have a deviating average rank score. Hence the purposes within 1C should not be deemed as important.

Group 1B involves borderline cases. Some purposes have a lower average rank score than the average and others have lower count than average. That *Improvements* has a lower rank score than average is evened out by its higher count than average, which makes it important. *F. standardization* and *Daily support* should be deemed as important since they both have higher rank score and count than average. Furthermore, *Navigation tool* should be deemed as important since its lower count than average is evened out by its significantly higher rank score. The same holds true for *Comprehensive view*. Hence, all purposes within the group 1B are deemed as important.

Both purposes within group 2 are also deemed to be important since their lower average rank score, clearly is evened out by their significantly higher average count. All purposes within group 3 are deemed to not be important since they have average counts in combination with low average rank scores. Finally, the "lonely wolf" *Common ground* should be deemed as important since it has a much higher average rank score than the rest of the purposes.

To conclude, the answer to RQ1A: *What are common purposes to why organizations perform process modeling, and which of these are important?*, is that the common purposes to why process modeling is performed are the 17 purposes in described in the beginning of this chapter and the most important of those are (without mutual order): *Comprehensive view*, *Common ground*, *Strength and weakness*, *Improvements*, *F. standardization*, *Navigation tool*, *Training*, *External requirements*, *Daily support* and *Roles and responsibilities*.

6.2 RQ1B

This section consists of the analysis for RQ1B: *Beyond future and current state, how do the identified purposes relate to each other?* Based on qualitative reasoning of interview findings and literature insights, the following aspects of purposes' relations to each other can be concluded:

- **Starter-follower aspect:** The purposes' relations in regard to if the purpose is deemed to be a starter or follower i.e. if the purpose is deemed to be a natural starting point for a process modeling initiative, or if the purpose can be reached mainly after other purposes are fulfilled.
- **Process-product aspect:** The purposes' relations in regard to if they have a process or product focus i.e. if the purpose is achieved through and during the actual modeling or if the purpose is fulfilled through the model itself as a product.
- **Purpose evolution aspect:** The purposes' relations in regard to what purposes that are likely to lead to another.

In order to decide the purposes' relations within each of the three aspects, suitable analysis methods were chosen. Table 17 below presents what main analysis method that was utilized for each of the aspects. In the cases where the chosen analysis could not provide clear insight, the results were supplemented with qualitative insights from the interviews and analysis corresponding to one of the other aspects or RQ1A. For further discussion of the underlying analysis methods, see section 4.3.6.

Aspect	Main analysis method
Starter-follower	Maturity analysis
Process-product	K-means cluster analysis
Purpose evolution	Correspondence Analysis

Table 17: Main analysis methods corresponding to each of the three aspects.

6.2.1. Starter-follower analysis

The analysis about which purposes that tend to be starters/followers is mainly based on the *Maturity analysis*. Since the analysis gives an indication of which purposes that tend to be in focus at different levels of maturity, it provides an insight in which purposes that are common starting points, and which are more likely to be followers.

The number of purposes within each maturity level was put in relation to the number of organizations within each maturity level, as described in chapter 4.3.6.2. All purposes with an MR (maturity rate) below 0,6 or above 1,4 are deemed to provide insights and are presented in table 18 below. Due to a fairly low sample sizes, MRs outside this range are deemed to not provide distinct insights and are therefore excluded. Important to notice is that no absolute conclusions can be drawn based on the MR. This is because organizations were asked to position themselves on the maturity scale based on an average. This means that mature organizations most likely are immature within some specific areas or processes, and vice versa. However, the results give an indication of which purposes tend to be in focus at different levels of maturity, and hence which purposes that are common starting points and which are more likely to be followers. A discussion of each of the purposes is provided below the table.

Purpose	Count in total	MR: Maturity level 1	MR: Maturity level 2	MR: Maturity group 3
Common ground	4	1,64	0	0,86
Documentation	4	1,64	1	0
F. standardization	10	0,87	1,6	0,69
P. standardization	5	0,44	0,8	2,06
Daily support	8	0,55	1	1,71
Navigation tool	7	0,62	1,14	1,47
Specification for IS	7	1,25	0,57	0,98
Comprehensive view	6	1,09	1,33	0,57

Table 18: Purposes with deviating MR:s.

Common ground: This purpose has a higher MR in the first group; three of the four organizations mentioning this purpose belong to maturity group one, which indicates on that *Common ground* is a starter. This is confirmed by one of the organizations that describes the common ground purpose as an "initial step to get an understanding for how we actually perform our work".

Documentation: The purpose *Documentation* has a count of four, three of which appear within maturity group 1. This finding i confirmed by the fact that the organizations mentioning this purpose describes it as a starting point. Consequently, *Documentation* is deemed to be a starter.

Specification for IS: The table shows a smaller focus on *Specification for IS* within maturity group 2, which indicates on that *Specification for IS* is a starter. One explanation for this could be that this purpose does not require change of human behavior in the implementation phase. Hence, once the specification is done the process model is activated automatically by the system, and the process model is taken out of focus. It is therefore natural that this purpose rather emerges at early stages. Also, several of the interviewees, representing different maturity levels, expressed that implementation from IS was what started process modeling initiatives in their organization.

Comprehensive view: *Comprehensive view* is mentioned fewer times than expected in maturity group 3; only one of the 6 answers originates from an organization in this group. An explanation could be that whereas immature organizations struggle with providing a comprehensive view in order for the organization to function, this objective might already be reached in organizations with high process maturity. Hence, the results lead to the conclusions that *Comprehensive view* is a starter.

F. standardization and P. standardization: The MR of *F. standardization* shows that this purpose appears more in maturity group 2, while *P. standardization* is more common in maturity group 3. This indicates on that both these purposes are followers. At first sight, the results could be interpreted as that P. standardization is a follower to *F. standardization*, since *P. standardization* appears more in maturity

group three. However, according to the definition of the purposes in chapter 6.1.1, *P. standardization* is included in *F. standardization*. Hence, these purposes cannot follow each other. Instead, the numbers indicate that the more mature the organization is, the more it uses other tools and methods than the process model to actually facilitate the standardization.

Daily support: The high MR on *Daily support* within maturity group 3 indicates that being ahead in process maturity, i.e. having processes modeled and implemented, facilitates the use of process models within daily operations. Hence, *Daily support* is most commonly seen as a long-term goal, and thus a follower.

Navigation tool: This purpose is more common in later stages. This could be explained by the fact that it is not until a structure of modeled processes exists that organizations see the benefit of using this structure as a tool for navigating when searching for documents. If only a few processes are modeled, only a few of the organization's gathered documents could be put in their context and the "navigation tool" would not function well due to lack of information. Consequently, *Navigation tool* is deemed to be a follower.

To conclude, 8 purposes could be classified as starters or followers through the maturity analysis. The classifications are summarized in table 19.

Starters	Followers
Common ground Documentation Specification for IS Comprehensive view	F. standardization P. standardization Daily support Navigation tool

Table 19: Conclusions from Maturity analysis.

In order to analyze the remaining nine purposes in relation to the s*tarter-follower* aspect, additional analyses were used. Firstly, classification could be done based on findings from *The frequency- and ranking analysis*, in which it is mentioned that *External stakeholders* and *Performance measuring* are "Nice-to-have", due to their low ranking and frequency. It is thus deemed that these "nice-to-have" purposes are more likely to be followers, since it is something that the organizations will focus on after they have accomplished their main purposes. *Strategies* also has low frequency, but high ranking. Due to this, in combination with that this purpose does not have to be preceded by another purpose, *Strategies* is classified as a starter.

Furthermore, two purposes could be classified due to their similarity with other purposes. *Improvements* is classified as a follower since *F. standardization* and *P. standardization* are types of improvements, and the same characteristics should hold for the three purposes. Also, *Training* is deemed to be a follower due to its similarity with *Daily support*.

Lastly, valuable insights were provided from the interviews. *External requirements*, such as for example ISO-certification, is often mentioned to be a reason why process modeling was initiated. Also Strengths and weaknesses is due to its nature deemed to be a starter, on which other purposes could build. Finally, both *Roles and responsibilities* and *Process interfaces* aim to agree on handovers - between people or between processes. This is also by the interviewees described as an initial step.

The concluding classification with respect to the *starter-follower* aspect is presented in table 20.

Starters	Followers
Common ground Documentation Specification for IS Comprehensive view External requirements Strengths and weaknesses Roles and responsibilities Process interfaces Strategies	F. standardization P. standardization Daily support Navigation tool Improvements Training External stakeholders Performance measuring

Table 20: Summary of findings in Starter-follower analysis.

6.2.2 Process-product analysis

When analyzing the purposes in a *process-product* perspective, it was helpful to study similarities between purposes based on their quality characteristics. This was provided from the *K-means cluster analysis*, which resulted in three clusters of purposes. Table 21 presents the average score for each quality attribute and cluster (QA-score), and what purposes that belong to each of them. Below follows a discussion about the specific characteristics of each cluster, and what conclusions that can be drawn regarding the *process-product* perspective.

Class	Purpose	Currency	Availability	Syntactical correctness	Completeness	Comprehension	Agreement	Readability
1	Strengths and weaknesses	2,7	2,2	3,1	3,3	3,2	3,0	2,7
1	Improvement	2,5	2,7	3,3	3,0	3,0	2,7	3,7
1	P. standardization	2,6	2,4	3,2	3,8	3,2	3,4	2,0
1	External stakeholders	3,0	2,5	3,0	2,5	2,5	4,0	3,0
1	Process interfaces	2,3	2,7	3,3	3,0	3,0	4,3	3,7
	Average	**2,6**	**2,5**	**3,2**	**3,1**	**3,0**	**3,5**	**3,0**
2	Roles and responsibilities	3,1	4,1	3,4	3,3	4,0	4,3	3,4
2	Training	3,6	4,6	3,5	3,2	3,7	2,8	4,3
2	F. standardization	3,5	4,5	3,4	3,7	4,0	4,2	4,3
2	Daily support	4,1	5,0	3,3	4,3	4,5	3,5	4,6
2	Navigation tool	3,7	3,9	3,3	3,1	3,9	3,4	4,3
2	Comprehensive view	2,7	4,7	4,2	2,3	4,3	3,8	4,8
2	Documentation	4,0	4,0	3,3	3,0	4,3	3,0	3,8

2	Common ground	2,5	4,8	3,8	2,8	4,0	4,5	4,3
	Average	**3,4**	**4,4**	**3,5**	**3,2**	**4,1**	**3,7**	**4,2**
3	External requirements	3,6	3,5	4,2	2,7	3,6	2,8	3,8
3	Performance measuring	3,6	2,2	4,0	3,8	2,8	3,0	2,8
3	Specification for IS	2,0	1,8	4,0	4,8	3,0	3,0	2,4
3	Strategies	1,5	4,0	5,0	2,0	4,0	2,5	4,0
	Average	**2,7**	**2,9**	**4,3**	**3,3**	**3,3**	**2,8**	**3,3**
4	Miscellaneous	1,5	5,0	1,5	3,5	2,0	4,0	2,0

Table 21: Cluster belonging and QA-score for each purpose and cluster.

The first cluster, as can be seen in table 21 above, is mainly characterized by a lower *Agreement* and a higher *Syntactical correctness* than the other clusters. This indicates that what is specific for the third cluster is that the product (i.e. the result of the process modeling activity) is in focus, since the language of the finished model is more important than that everybody has agreed on the process' content. Studying the definitions of the purposes included in this first cluster the above reasoning is confirmed, since process models that aim to fulfil *External requirements*, *Performance measuring*, *Specification for IS* and *Strategies* are all models that someone else than the modeling team is expected to use - the product is thereby of high importance. The average score in table 21 also shows that *Currency* and *Availability* are low compared to cluster 2, which could indicate on that the process is in focus. However, studying the score of each purpose in detail one can see that the average score is not representative in this case since there are extreme values in combination with a smaller sample, which brings the average score down. For example within *Currency* the values ranges from 1,5 - 3,6, wherein the value 1,5 brings the average down.

Also the second cluster is characterized by a low average on *Currency* and *Availability*, however in this case the range of individual scores are more centered around the average, which makes this indication more trustworthy. Furthermore, the cluster is characterized by a higher score on *Agreement*, in relation to cluster 1. The lower QA-score on *Currency* means that these purposes require only a single or few times of modeling in order to be fulfilled. As for *Availability*, the score indicate that the models do not to a large extent require distribution outside of the process team. Lastly, in relation to the previous cluster the *Agreement* needs to be somewhat higher. In combination, this indicates that purposes within this cluster focus mostly on the modeling activity itself rather than emphasizing the result. Hence, the process model is within these purposes used as a tool to analyze a process or reach agreement over it - the process is of high importance. *Strengths and weaknesses* and *P. standardization* are evident examples of this. However, the modeling activity must not be in focus just because *Currency* and *Availability* are lower. Such is the case for *Improvements*, where the model as a product facilitates an improvement initiative, and could be the result of a one-time modeling of a predefined process that required lower emphasis on the modeling activity.

The third cluster includes purposes where the result - the product - is important in all cases. Here, the process is usually not modeled only once but kept up to date by revisions, as shown by the higher *Currency* score in relation to cluster one and three. These are thus process models that are "alive" to a higher extent than those of the former cluster. These "living" models should be available and readable to a larger

population, that is those involved in the process, which is indicated by the high score on *Availability* and *Readability*. In addition, *Comprehension* is an important aspect in this cluster. This means that it is desirable to perform activities that ensure that the process model is understood by the process participants.

Before classifying all purposes from cluster 1 and 3 to as product focused purposes and cluster 2 as process focused, a qualitative discussion regarding five of the purposes is necessary. The remaining 12 purposes can, based on the *K-means cluster analysis*, be classified according to table 22.

Product-focused purposes	Process-focused purposes
External requirements Performance measuring Specification for IS Strategies Training Daily support Navigation tool Comprehensive view Documentation	Strengths and weaknesses P. standardization Process interfaces

Table 22: Conclusions from K-means cluster analysis.

Below follows a discussion of each of the five purposes where insights from the interviews required an supplementing analysis to the K-means clustering.

Roles and responsibilities, *F. standardization* and *Common ground*, all included in the third cluster that, as presented above, tend to have a high product focus. However, these purposes are somewhat different since they are fulfilled both during the modeling and afterwards as a finished process model. One indication of this is that all three of them have a higher score on *Agreement* than the other purposes in cluster 3. Hence, the process of agreeing around a process model is important. This was also confirmed by the interviews and the definition of the purposes. For *Roles and responsibilities*, it was clear that some organizations use the process model mainly as a tool to agree upon roles and responsibilities, whereas others tend to highlight the importance of result. Since *F. standardization* include both developing standardized processes and standardize them with the help of a process model, this purpose should also have both a process and product focus. As for *Common ground*, it is defined as a purpose where it is first important to get an understanding of the process during the modeling, then to use the model as a basis to work upon. Based on this, these three purposes are classified as hybrids between process and product.

Improvements is included in the second cluster that is mostly process focused. However, as stated above and in the definition of this purpose, it also includes implementation of the improvement using the process model. Hence, also this purpose is classified as a hybrid between *Product* and *Process*.

External stakeholders is included in the second, process focused cluster. However, such process models clearly fulfil their purposes as a product. This because in all cases this purpose was mentioned, it is described as the need to *visualize* a ready process model for customers, not to, evidently, develop a model together with the customers. This qualitative judgement should be more trustworthy than the K-means results, since quality scoring was performed by only two of the four organizations mentioning this purpose. Hence, *External stakeholders* is classified as product-focused.

The concluding classification with respect to the product process aspect is presented in table 23.

Product-focused purposes	Process-focused purposes	Hybrids
External requirements Performance measuring Specification for IS Strategies Training Daily support Navigation tool Comprehensive view Documentation External stakeholders	Strengths and weaknesses P. standardization Process interfaces	Roles and responsibilities F. standardization Common ground Improvements

Table 23: Summary of findings in Process-product analysis.

6.2.3 Purpose evolution analysis

This section provides insights related to the *Purpose evolution aspect*, i.e. what purposes that are likely to lead to another. First, the *Starter-follower* - and *Process-product analysis*, above, provide important insights for the aspect. This because a *starter* is more likely to be succeeded by a *follower* and process-oriented purpose is more likely to be followed by a product-oriented purpose. However, the insights from these analyses tell little about which follower will lead to which starter or which process-oriented purpose that will lead to which product-oriented purpose. Hence, in order to be able to understand this, further analysis was required. A *Correspondence analysis* (CA) was chosen (for discussion of this choice, see section 4.3.6.3). In addition to this, qualitative reasoning, based on insights from the interviews, was made in order to validate and confirm the results from the CA.

In order to be able to interpret the results from the CA some understanding of how it was performed is necessary. Hence, a brief description of how it was performed and how the results should be interpreted is presented here (the full description of the analysis can be found in section 4.3.6.3). The idea behind a CA is to translate relations within a two-way frequency table into coordinates in a two-dimensional space. The two-way frequency table utilized as input for the analysis was based on frequency of coexistence between the purposes. For example, if the purpose *Roles and responsibilities* was mentioned together with the purpose *Documentation* by organization X, that relationship was counted as one. The full two-way frequency table is presented in appendix A. Figure 27 below shows the output coordinates from the CA for each purpose.

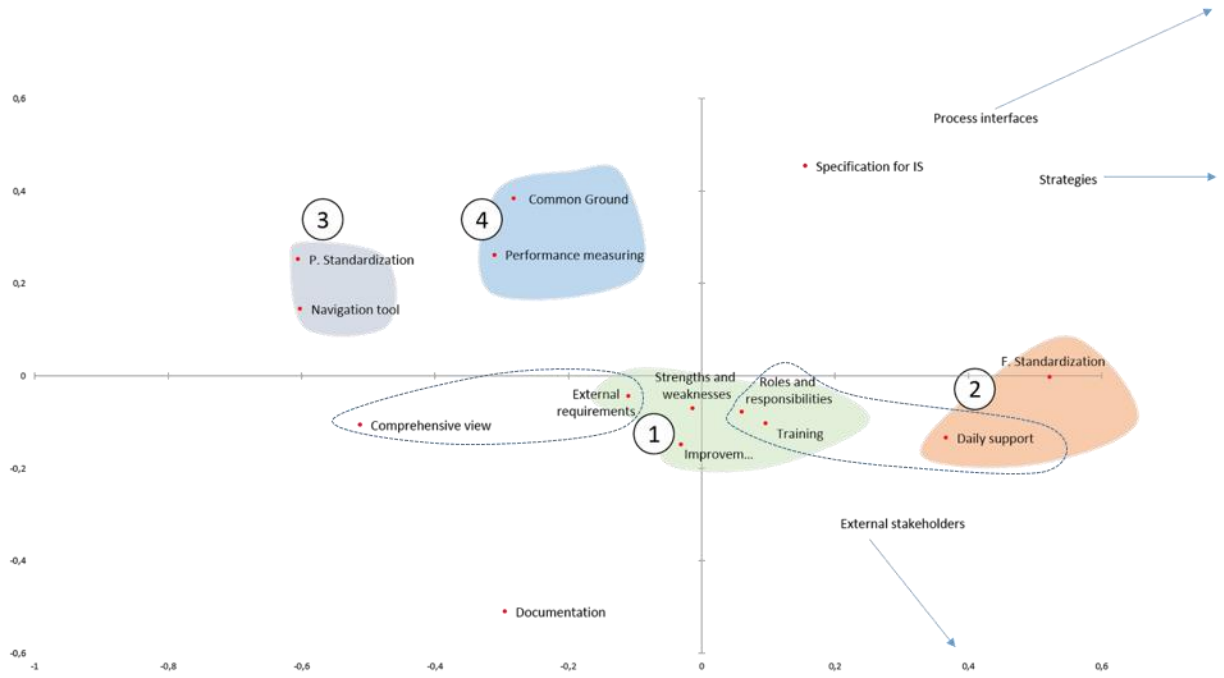


Figure 27: Visualization of CA. The purposes Strategies, External Stakeholders and Process interfaces are excluded due to graphical reasons.

When analyzing a CA-plot the rule of thumb is that the closer the purposes are positioned, the more related they are. Since the input of the analysis, in this case, is the frequency of coexistence, it means that the closer the purposes are positioned the more they are mentioned together. Due to this, frequently mentioned purposes are likely to be positioned close to the origin since they are mentioned together with most other purposes and have to be fairly close to all of the rest. To make the readability of figure 27 higher, some of the least frequently mentioned purposes; *Strategies*, *External stakeholders* and *Process interfaces* were not included in the plot. The low frequency of these purposes makes the CA position them far away from the rest of the purposes, which lowers the granularity of the plot in the region where most other purposes are positioned.

So what does the CA results mean in relation to the *purpose evolution* aspect? If purposes tend to be mentioned together, it could indicate on that these purposes supplement each other. This because it is not likely that purposes, that are mentioned together, fill the same need. Combining such insights with insights from the *starter-follower* and *process-product* aspects tell which purpose that is more likely to lead to which.

In figure 27, four clusters of purposes have been marked out. In the center cluster (1) the purposes: *Strengths and weaknesses*, *Roles and responsibilities*, *External requirements*, *Improvements* and *Training* are found. All these five purposes are among the top six most frequently mentioned purposes, and are thereby mentioned together with most other purposes which explains why they end up in the center of the plot. Next, the most valuable insight that the CA provides is how the rest of the purposes are positioned around this center group of purposes. If purposes are positioned on separate sides of the center group, it means that their correspondence is lower than if they were positioned on the same side. In figure 27, such separation can be identified.

On the right side of the center group a smaller cluster (2), consisting of *F. standardization* and *Daily support* can be found. The fact that these purposes are more often selected together indicates on that they supplement each other. This is confirmed by the definition of F. standardization, which says that the standardization is facilitated by making the process models accessible for the employees, during the standardization process. In order to make the standardization sustainable a supplementary step could be to use the model for *Daily support*. Moreover, the *Process-product analysis* shows that *F. standardization* is a hybrid and *Daily support* is a product-oriented purpose, which confirms that *F. standardization* is followed by *Daily support*.

On the left side of the center group two clusters (3 and 4) are found. Within cluster 3 the purposes *P. standardization* and *Navigation tool* are found. Also here, this indicates on that these purposes supplement each other. This finding aligns with the qualitative perception of the purposes (see section 6.1.1). Organizations that limit their process modeling initiative as a prerequisite for standardization tend to utilize other activities/documents for the actual facilitation of the standardization. A possible way to facilitate the standardization could be to utilize process models as a navigation tool for distribution of routines and steering documents. Furthermore, the finding is confirmed by the fact that *Navigation tool* is deemed to be product oriented and *P. standardization* is deemed to be a hybrid. Consequently, it can be stated that *P. standardization* is likely to be followed by *Navigation tool*.

Within cluster 4 *Common Ground* and *Performance measuring* can be found, which indicates on that these purposes supplement each other. This finding somewhat aligns with qualitative findings, which show that organizations that have process models that are meant to provide common ground, first utilize these models within the management and/or process teams. Also *Performance measuring* is a purpose of interest for the management and/or process teams. Hence, a possible explanation to this result could be that management and/or process teams first seek a common ground, on which performance measuring can take place. The insight is further confirmed by the fact that *Common ground* is deemed to be both a starter and process-oriented and *Performance measuring* is deemed to be both a follower and product-oriented. Consequently, it can be stated that *Common ground* is likely to be followed by *Performance measuring*. It is however important to notice that *Performance measuring* is deemed to be a "nice-to-have", which indirectly means that it could be a supplement to most other purposes. As long as there exists a process model of some kind decisions regarding performance measuring can be taken.

To summarize the findings discussed above, the CA clearly shows that:

- F. standardization tends to be followed by Daily support
- P. standardization tends to be followed by Navigation tool
- Common ground tends to be followed by Performance measuring

Further, the CA provides some other patterns that could provide insights for the *purpose evolution* aspect. These findings are not as clear as the ones above discussed, but are still deemed to be valuable, since they can be confirmed by other findings. These patterns are circled with blue dotted lines in figure 27.

The first pattern (blue dotted circle to the left) shows that *Comprehensive view* is closest positioned to *External requirements* of the frequently mentioned purposes within the center cluster (1). From the *Starter-follower analysis* it is stated that *External requirements* is a natural starting point for the organizations mentioning it. Hence, the pattern indicates on that a likely next step after *External requirements* is to provide a comprehensive view. This can be further confirmed by qualitative findings, saying that after

fulfilling the purpose *External requirements*, e.g. being ISO-certified, the next step could be to utilize these process models as support to the employees. The first thing such models can provide is a comprehensive view to the employees. Consequently, *External requirements* is deemed to likely be followed by *Comprehensive view*.

The second pattern (blue dotted circle to the right) shows that *Daily support* is closest positioned to *Roles and responsibilities* and *Training* of the frequently mentioned purposes within the center cluster (1). This indicates on some kind of relationship between the three purposes. According to the definition of the purposes, *Daily support* and *Training* are similar and hence deemed to belong to the group *Operational purposes*. However, *Training* and *Daily support* are different in the sense that *Training* is only focused on providing support to new employees while *Daily support* aims to provide support to all employees. The relationship between them both can be seen as that *Daily support* is a question of taking *Training* to the next level. Consequently, it can be stated that *Training* is likely to be followed by *Daily support*. Further the qualitative analysis shows that *Training* and *Daily support* often concern communication of who does what and when, which is closely related to the purpose *Roles and responsibilities*. In these cases, *Roles and responsibilities* is a prerequisite for *Training* and *Daily support*. This insight, in combination with the fact that *Roles and responsibilities* is both a starter and partly process-oriented, while both *Training* and *Daily support* are followers and product-oriented, leads to the conclusion that *Roles and responsibilities* is likely to be followed by *Training*, which is in turn likely to be succeeded by *Daily support*.

Furthermore, the CA can provide insights for the purposes that are positioned isolated from the rest, which are: *Specification for IS* and *Documentation*. These results could be interpreted as that these purposes are not more likely to lead to one purpose than to another. In addition to this, it is known from the *Starter-follower analysis* that both of them are deemed to be starters. Hence, it could be stated that both of these purposes could evolve into almost any purpose. However, due to qualitative findings it is deemed that *Documentation* is more likely to lead to some of the purposes within the operational group, since *Documentation* is initiated due operational needs. Hence, a continuation on this track is deemed to be natural.

Finally, some pure qualitative reasoning in combination with findings from the literature lead to the conclusion that *Strengths and weaknesses* is a prerequisite to all of the *Transformative purposes: P. standardization*, *F. standardization* and *Improvements*.

Important to notice is that in reality, there is an endless amount of possible combinations of which purpose that could lead to which. However, the insights provided in this section are deemed to give indications on what relationships that are more likely than others. All findings from this section, and what analysis that confirms the findings, are summarized in table 24 below.

Findings	Indicators			
	CA	**Process-product**	**Starter-follower**	**Qualitative**
F. standardization tends to be followed by Daily support	Strong	Strong	None	Strong
P. standardization tends to be followed by Navigation tool	Strong	Strong	None	Stong
Common ground tends to be followed by Performance measuring	Strong	Strong	Strong	Weak
External requirements tends to be followed by Comprehensive view	Weak	None	None	Strong
Roles and responsibilities tends to be followed by *Training,* which in turn tends to be followed by *Daily support*	Weak	Strong	Strong	Strong
External requirements tends to be followed by Comprehensive view	Weak	None	None	Strong
Specification for IS and *Documentation* are starting points that tend to evolve into purposes that provide support to the employee	Average	Weak	Weak	Weak
Strengths and weaknesses tends to lead to Transformative purposes as P. standardization, F. standardization and Improvements	Weak	Strong	Strong	Strong

Table 24: Summary of findings in Evolution purpose analysis.

6.2.4 Summary of analyses and result RQ1B

In order to answer the research question RQ1B: *Beyond future and current state, how do the identified purposes relate to each other?*, the results from the analyses above were brought together. Hence, table 25 below summarizes the findings from the *Starter-follower*, *Process-product* and *Purpose evolution analyses.*

Purpose	**Insights**		
	Starter-follower	**Process-product**	**Purpose evolution**
Strengths and weaknesses	Starter	Process	Strengths and weaknesses tends to lead to Transformative purposes as P. standardization, F. standardization and Improvements
Roles and responsibilities	Starter	Hybrid	Roles and responsibilities tends to be followed by Training, which in turn tends to be followed by Daily support
Training	Follower	Product	
Daily support	Follower	Product	
F. standardization	Followers	Hybrid	F. standardization tends to be followed by Daily support
External requirements	Starter	Product	External requirements tends to be followed by Comprehensive view
Comprehensive view	Starter	Product	
Common ground	Starter	Hybrid	Common ground tends to be followed by Performance measuring
Performance measuring	Follower	Product	
Documentation	Starter	Product	Documentation is a starting point that tends to evolve into purposes that provide support to the employee
P. standardization	Follower	Process	P. standardization tends to be followed by Navigation tool
Navigation tool	Follower	Product	
Specification for IS	Starter	Product	Could take several directions
Improvements	Follower	Hybrid	N/A
External stakeholders	Follower	Product	N/A
Process interfaces	Starter	Process	N/A
Strategies	Starter	Product	N/A

Table 25: Summary of all findings from section 6.2.1-6.2.3.

It was deemed that the most suitable way of concluding the result of RQ1 would be to develop a model that integrated the findings that contributed to answer each of the sub-questions. The concluding model is visualized in figure 28 below. In the model all 17 purposes, identified through the iterative categorization, are presented. Further, the radius of the purposes (circles) shows the purposes' frequency weighted by their average rank score. Hence, the larger the purpose is, the more common and important it is and the other way around. These circles thus correspond to the answer of RQ1A. As for RQ1B, this question is responded by the purposes' position in the model, derived from the *Process-product*, *Starter-follower* and *Purpose evolution analyses*. The relations from the *Purpose evolution analysis* is presented by the arrows in the figure. Small arrows with no connection symbolize that these purposes are not more likely to lead to one purpose than to another, but they are often in some way connected to another purpose. Hence, the model as a system, i.e. all dimensions together, provides the basis for the full answer.

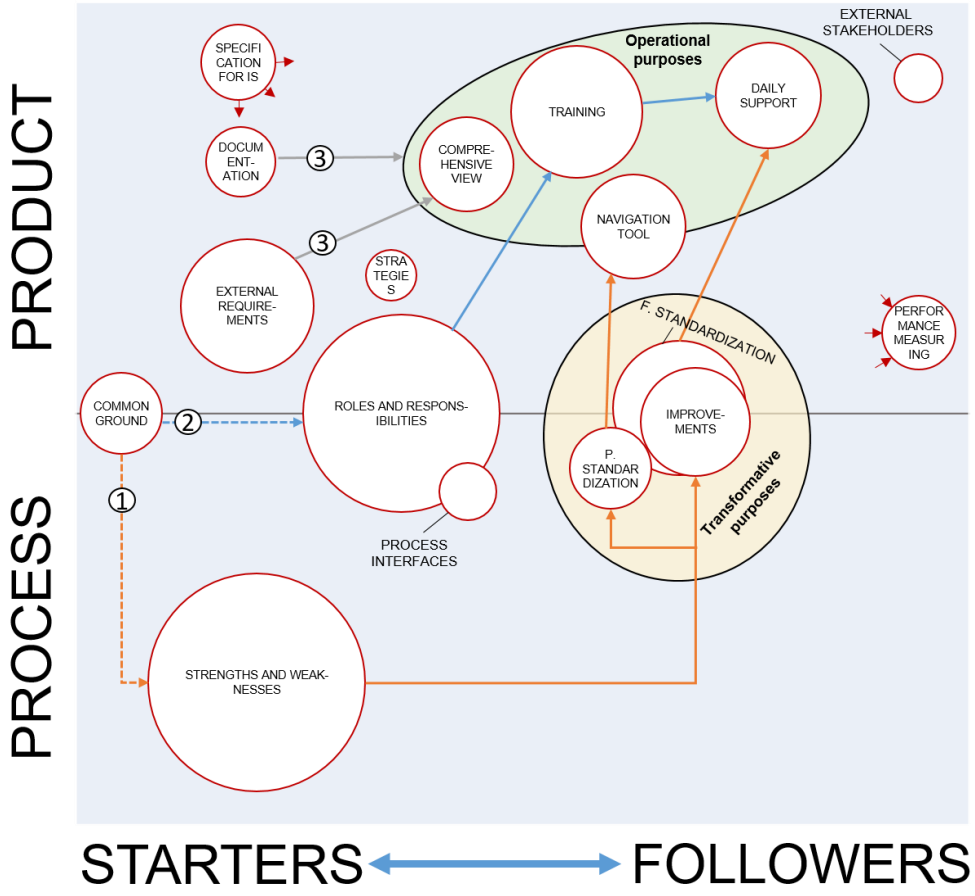


Figure 28: Concluding model describing reasons behind process modeling, their importance and mutual relationships. Y-axis is ternary (process, product or hybrid state) and X-axis is linear. The size of the purposes is scaled by their importance.

It is important to notice that the positioning in regards to *process-product* aspect is ternary, i.e. the purpose is either process, product or hybrid (hybrids are positioned on the line separating the process and product field). Thereby there are no mutual arrangements within the process and product quadrants. However,

the positioning in regards to the *starter-follower* aspect is linear. Hence, the further right the purpose is positioned the later it is deemed to be actualized.

Through the model, three likely paths are identified. As for the *purpose evolution* conclusions, it is important to notice that in reality there exists an endless number of possible paths. However, the paths presented below are deemed to be the most likely.

The improvement path (1): The path represents a traditional view on process modeling, closely related to BPM and *The smiley model*. The goal is to achieve some kind of organizational transformation, which in most cases regard a standardization initiative. In cases where the process is immature, the starting point could be to reach a common ground within the process/management team. This can for example be achieved through the generation of a traditional "current state model". On the basis of such a current state model, strengths and weaknesses can be identified within the process team. However, the path could also start here, if the process is somewhat mature and a common understanding of it exists. When strengths and weaknesses are identified, a future state model can be developed. This development is represented by one of the *Transformative purposes*. The path has now reached a crossroad, where a decision, regarding if the process models should be utilized as a facilitator for the transformation or not has to be taken. If the purpose is either *F. standardization* or *Improvement*, the process model takes a focal point as a facilitator in the transformation process. In order to make the transformation sustainable a supplementary step could be to use the model for *Daily support*. However, it could as much be a question of providing training to the employees. If the transformative purpose is *P. standardization*, however, the model is not used as a facilitator for the transformation. Instead other means are used, e.g. *Navigation tool* can help to support the standardization initiative.

The agreement path (2): The path represents modeling initiatives that aim to provide structure and agreement within the organization, rather than transforming it. This path starts with providing a common ground of the process on a process team/management level, to further work upon in order to reach agreement among roles and responsibilities within the process. The dotted line between these two purposes represents the fact that, in cases where the process is more mature and a common understanding of it exists, the path could start with *Roles and responsibilities*. The models developed could then serve as operational support and fulfil either or several of the purposes *Comprehensive view*, *Training*, *Navigation tool* or *Daily support*. However, the most likely path is to use the models for training of new employees, which later can be taken to the next level by providing daily support to all employees in the process.

The operational path (3): The path represents modeling initiatives that start with a focus on documenting operations for internal use, later resulting in operational support for employees. The purposes *Documentation* and *External requirements* are common starting points. They each *describe* how operations in the organization are performed, but for different reasons. The interpreters of these models are deputies or different authorities that make demands, but the models can later be reused in operational work. Thus, instead of just describing the work, they could actually function as enablers of one or several of the *Operational purposes*. This is especially true for the most common of the two, *External requirements*. Several organizations described that e.g. ISO certification was the driver of their process modeling initiatives, but as this purpose was fulfilled they realized that the models could be reused in order to provide operational support.

The denominator for all three paths is that they end in the upper-right corner of the model. Hence, it can be concluded that no matter why process modeling was initiated the final outcome seems to be to support

the employees in their operation. However, it has to be noted that organizations do not always have to "walk" the full path. Depending on what they would like to accomplish, it could be satisfactory to, for example, identify roles and responsibilities or strengths and weaknesses. Moreover, the model gives an indication on what steps that have to be accomplished before seeking to fulfil some of the following purposes. If jumping ahead, there is a risk that the initiative fails as a consequence of that an essential foundation is missing. However, the organizations seldom are explicitly aware of exactly what they want to accomplish. Thus, several purposes are in reality melded together, which makes it difficult to judge if all fundamental pieces are in place. This model is thereby intended to provide practitioners distinct view and understanding of their process modeling initiatives.

The remaining question is now what quality attributes that should be emphasized in order to fulfill each of the purposes, which lead to the second research question, analyzed in the next chapter.

6.3 Concluding model related to The smiley model

Referring back to the *Problem discussion*: RQ1A and RQ1B were formulated since it was deemed that literature did not provide satisfying answers to underlying reasons why process modeling was performed. Further, it was concluded that the most comprehensive answer was provided through *The smiley model*, which provides a holistic range of purposes and how they relate to each other. However, some remarking factors of the model were discussed:

- Does not provide understanding of importance and commonality of the purposes
- Lacks practitioners and organizational nuances
- Focusing too much on process improvement aspects
- Mutual relations being only associated with either a future or current state, which was deemed to be too static in the context of a dynamic domain

Taking off RQ1A and RQ1B in a discussion about *The smiley model*, a natural wrap up of this chapter is to compare the findings, expressed as the *Concluding model*, with *The smiley model*. Hence, such a discussion follows below.

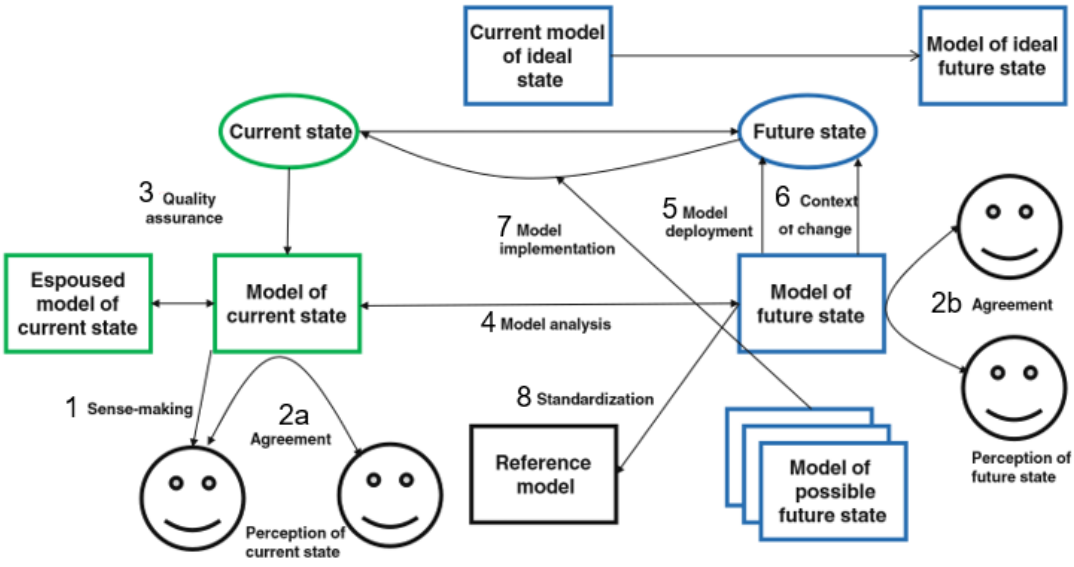


Figure 29: Visualization of goals with process modeling (The smiley model). Source: Krogstie (2016).

When comparing the purposes within the *Concluding model* to the goals expressed in *The smiley model*, it is clear that several purposes could correspond to the same goal. By for example looking at *Sense-making*, *which is* described as aiming to provide employees with an understanding of the current situation. This description corresponds to several of the purposes within the *Concluding model*, such as: *Daily support*, *Training*, *Documentation*, *Common ground* and *External stakeholders*. This shows that sense-making is more granular than expressed by Krogstie (2016) In reality, *Sense-making* can concern different modelers and different interpreters, depending on the context. These totally different circumstances imply different requirements on the modeling, which demand different modeling focuses, in regard to what quality attributes to emphasize on. Consequently, it can be concluded that the *Concluding model* provides a practitioner focused perspective, where the indistinct goals are broken down to more hands-on descriptions, which ultimately makes it easier to decide what quality attributes that should be emphasized. The same argument holds true for the other goals within *The smiley model*.

Next, the paths identified in the *Concluding model* can be put in relation to *The smiley model*. Doing so, it can be seen that *The smiley model* corresponds to the *Transformative path*, since both are focused on the facilitation of organizational transformation. Furthermore, it can be identified that neither the *Operational path* or the *Agreement path* are included in Krogstie's model. This is because both these paths occur in context of the current state, which in *The smiley model* is just briefly described. The fact that this thesis has captured that organizations process modeling initiatives often are isolated to the current state, confirms that describing the purposes' mutual relations in the context of current and future state, is limiting.

To conclude, it can be stated that the C*oncluding model* provides a more granular answer, expressed with practitioners' wordings, to why process modeling is performed. Furthermore, it provides the purposes' commonality and importance, and mutual relationship beyond the future and current state perspective. The latter reveals that process modeling often solely is performed in the context of here and now, rather than focusing on organizational transformations. All of which *The smiley model* was criticized for. On an

aggregated level this allows for a more dynamic view on process modeling, which is deemed to better match with organizations reality.

On the down-side *The concluding model* is not as easy to grasp. Hence, it is suggested to spend further time on increasing its comprehensibility.

7 Research question 2 - Analysis

The purposes that were deemed to be important in section 6.1.2 are in this chapter studied further in order to answer research question 2: *What quality attributes within the SEQUAL-BPM should be emphasized in order to fulfill each of the most important purposes?* In order to answer the question the answers from E4 were aggregated and analyzed through an ANOVA analysis.

This chapter starts by describing the analysis made. Next, the results for each individual purpose is analyzed in order to in the last section summarize the findings and answer the research question.

7.1 Quality attribute analysis

Table 26 summarizes the important purposes and the count for each of them together with their average score for each quality attribute (QA-score). As described in section 4.3.4, some of the purposes were not brought forward to the quality attribute exercise. Consequently, the QA count is different to the overall count for some of the purposes. For example, the purpose *Improvements* has an overall count equal to eight. However, only six of these answers were brought forward to the quality attribute exercise, thus in table 26 the count for *Improvements* is equal to six. For these answers, on e.g. *Currency*, the six interviewees gave individual answers which gave an average score of 2,5.

Purpose	Count, answers with QD-scoring	Currency	Availability	Syntactical correctness	Completeness	Comprehension	Agreement	Readability
Strengths and weaknesses	19	2,7	2,2	3,1	3,3	3,2	3,0	2,7
External requirements	12	3,6	3,5	4,2	2,7	3,6	2,8	3,8
Roles and responsibilities	12	3,1	4,1	3,4	3,3	4,0	4,3	3,4
F. standardization	10	3,5	4,5	3,4	3,7	4,0	4,2	4,3
Training	10	3,6	4,6	3,5	3,2	3,7	2,8	4,3
Daily support	8	4,1	5,0	3,3	4,3	4,5	3,5	4,6
Navigation tool	7	3,7	3,9	3,3	3,1	3,9	3,4	4,3
Improvements	6	2,5	2,7	3,3	3,0	3,0	2,7	3,7
Comprehensive view	6	2,7	4,7	4,2	2,3	4,3	3,8	4,8
Common ground	4	2,5	4,8	3,8	2,8	4,0	4,5	4,3

Table 26: QA-scores for each purpose.

An ANOVA analysis helped to, within each purpose, highlight those quality attributes that differ from each other by determining whether the differences between the QA-scores for each quality attribute are statistically significant, with a confidence interval of 95%. See section 4.3.6.5 for further discussion about the ANOVA analysis.

Each purpose, their QA-scores and ANOVA results are visualized through spider diagrams in order to be make the results more comprehensible. Each spider diagram can be found in section 7.1.1-7.1.10. Below follows an example of how to interpret these diagrams.

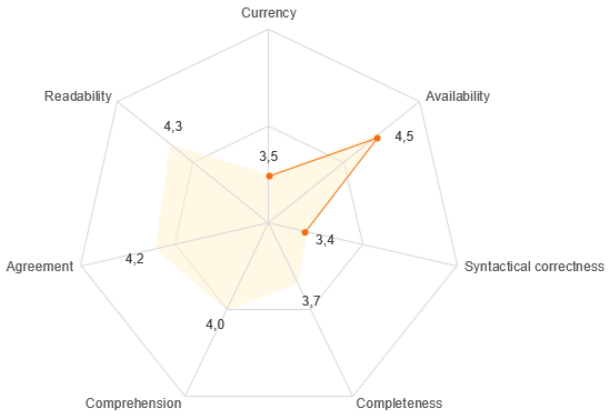


Figure 30: Example of spider diagram

Figure 31 illustrates the QA-scores of *F. standardization*. This diagram ranges from a QA-score of three, in the middle of the diagram, to a QA-score of five on the diagram border. The range is different in each diagram and is selected in order to give the best possible visualization of QA-score differences. However, one circle in the diagram is always represented by an integer. In addition, those differences in QA-score that are statistically significant are highlighted within the diagram. In figure 31, these are *Availability* vs *Currency* and *Availability* vs *Syntactic correctness* as illustrated by the orange line. This means that it is statistically significant to say that *Availability* is more important than *Currency* and *Syntactic correctness*.

Before going into the specific results of each purpose, a general discussion on how these results should be interpreted has to be made. First, it must be stated that the results should be seen as an indication on what QA that should be emphasized, rather than the "truth". The differences that have appeared as statistically significant should be deemed as stronger indications. However, it should be noted that the underlying data points are gathered under qualitative circumstances, where the quality of the answers was checked and evaluated carefully by the interviewers. If the interviewers noted that the interviewee had misunderstood the question, the interviewee guided in the right direction, to ensure high quality answers. Hence, differences without statistical significance are also deemed to provide valuable insights. Furthermore, it should be noted that the underlying data is given in the context and subjective opinion of the interviewee and its organization. However, the sample was composed in such a way that such subjectivity should have been eroded on an aggregated level. Lastly, the answers are dependent on what endpoints and descriptions that were chosen for the interview. For an elaborative discussion on the implications of the endpoints see section 4.3.4.3.3. The conclusion in that section is that the QA-scores can be stated to correspond to a fair representation of the quality attributes they are aimed to measure.

Hence, the results presented in the sections below are deemed to provide direct answers on the second research question.

7.1.1 Quality attribute analysis - Roles and responsibilities

The spider diagram for *Roles and responsibilities* shows that *Agreement* is with statistical significance more important than *Completeness* and *Currency*. Furthermore, it shows that also *Availability* is with statistical significance more important than *Currency*. It is also worth to be noted that *Comprehension* has a high importance. The QA-score for this quality attribute is almost as high as for *Availability*. Hence, it can be stated that according to these results, *Agreement*, *Comprehension* and *Availability* should be prioritized when the purpose is to distribute roles and responsibilities in a process.

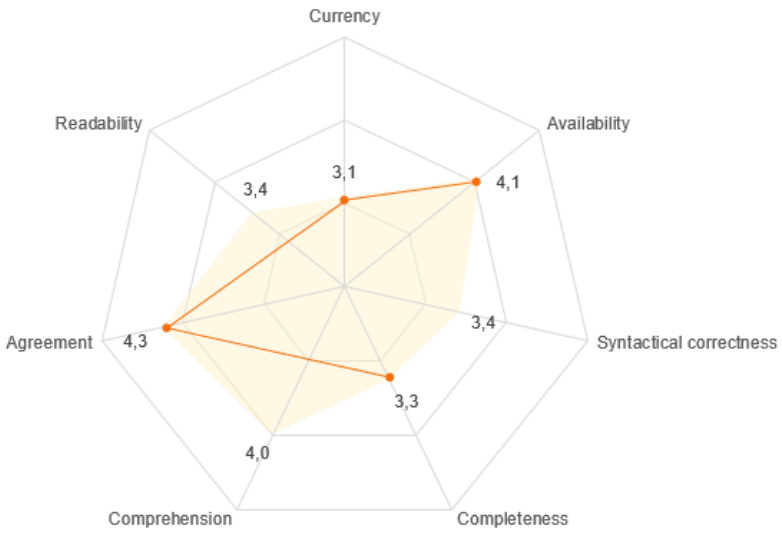


Figure 31: Spider diagram - Roles and responsibilities

Referring back to the nature of this purpose, it seems natural to focus on agreement since the underlying need is to coordinate a larger set of stakeholders. Without agreement between the involved actors the initiative is doomed fail. However, it is not enough to reach agreement, the model also has to be made available for and comprehended by its stakeholders. Comprehension will also lead to a higher level of agreement, since it is stated to be a mean for accomplishment of agreement.

The fact that currency is low can be explained by that role and responsibility distribution is often made on a fairly high level, which is indicated by the relatively low QA-score for completeness, and thus does not require to be updated as much as detailed models. Also, as demonstrated by the case in section 2.3.5.2, if the processes are modeled on a higher level, it is easier to reach high social quality since it is not necessary to agree upon every detail. With other words, a lower level of completeness facilitates agreement and it is thus desirable to model on a higher level when agreeing upon the distribution of roles and responsibilities. Sometimes, however, it is necessary to increase the detail level to really ensure that the process functions. In those cases, it is important to be aware of that reaching agreement will require a lot of the process team.

7.1.2 Quality attribute analysis - Strengths and weaknesses

The spider diagram for *Strengths and weaknesses* shows a fairly low QA-score for all quality attributes. Among these low scores, it can be seen that *Availability* is with statistical significance less important than *Syntactical Correctness*, *Completeness*, *Comprehension* and *Agreement*. It is also worth to be noted that *Readability* and *Currency* are slightly lower than above mentioned attributes, and for most other purposes. Hence, it can be stated, according to these results, that *Availability*, *Readability* and *Currency* should not be prioritized when identification of strengths and weakness should be accomplished.

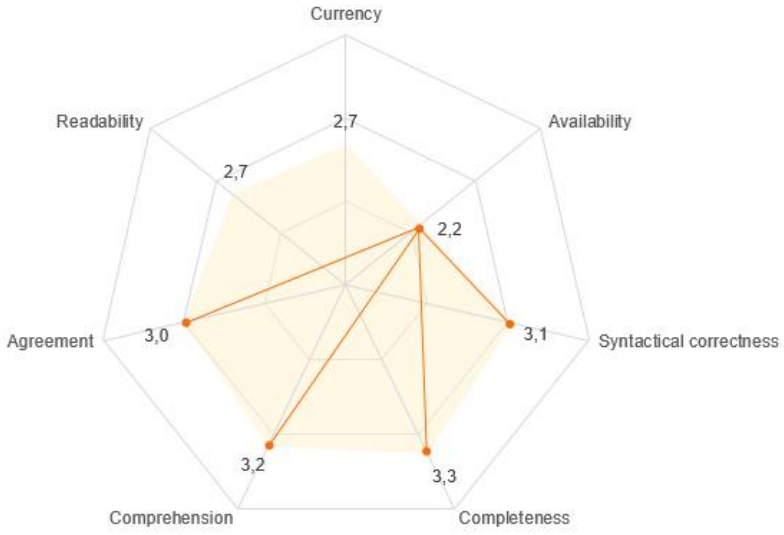


Figure 32: Spider diagram - Strengths and weaknesses

The overall low QA-scores can be explained by both the low score in *Availability* and *Currency*. The low *Currency* score shows that the modeling most often is done a few times, without keeping the model alive. Further, the low *Availability* score shows that the model is kept among the modeler(s), rather than sharing it with external actors. Both these circumstances naturally lower the demands on the rest of the quality attributes. There is no point of making large efforts in trying to making the model complete, comprehended, syntactical correct or agreed upon in order to identify strengths and weaknesses within the modeling/process team. Instead the focus should lie on the identification of strengths and weaknesses. However, the results show that none of the quality attributes, except availability, can be ignored. One example of an attribute that could sometimes be prioritized is *Completeness*, as exemplified by the case in section 2.3.5.2; in some cases the completeness needs to be high in order to actually find the strengths and weaknesses of the process.

7.1.3 Quality attribute analysis - Training

The spider diagram for *Training* shows that *Availability* is with statistical significance more important than *Syntactical correctness*, *Completeness* and *Agreement*. Furthermore, it shows that *Readability* is, with statistical significance, more important than *Agreement* and *Completeness*. Hence, it can be stated, according to these results, that *Availability* and *Readability* should be prioritized when the purpose is to perform training through process models.

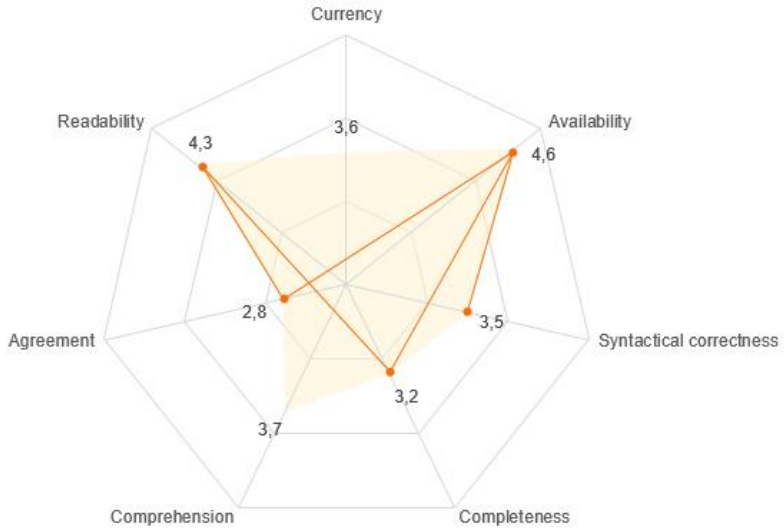


Figure 33: Spider diagram - Training

The importance of *Readability* and *Availability* together could be explained by the mutual need to share these process models with a large set of the stakeholders, that are new to the organization. The new employees may not be familiar with process models and how to process the knowledge they provide, which demands that the models are self-explanatory, i.e. have high *Readability*, and are easy to access, i.e. high *Availability*. Furthermore, the lower score on *Agreement* can be explained by the fact that these new employees just have to accept what they are told. Hence, little effort has to be put into reaching agreement on the model content. Worth to be noted is however that *Comprehension* has a fairly high score in relation to Agreement, which shows that, instead of reaching agreement, it has to be made sure that the process content is understood by the new employees. i.e. the training should not only include training in working routines but also in use of the model. The fact that *Completeness* has a lower score shows that *Training* models should have a fairly high abstraction level. It can thereby be stated that, when modeling for the purpose of *Training*, the focus should not be to make a detailed description of reality, which could be explained by the fact that the new employees would then be overwhelmed. Other mediums for communication of the details in their new job would probably be more suitable.

7.1.4 Quality attribute analysis - External requirements

The spider diagram for *External requirements* shows that *Readability* and *Syntactical correctness* is with statistical significance more important than *Agreement* and *Completeness*. However, it has to be taken into account that the QA-scores for *Currency*, *Availability* and *Comprehension* also are fairly high in relation to *Agreement* and *Completeness*. Hence, it can be stated, according to these results, that the quality attributes *Completeness* and *Agreement* should not be prioritized, when the purpose with process modeling is to fulfil external requirements as for example ISO-standards. Among the remaining quality attributes, more emphasis should be put into the accomplishment of *Syntactical correctness* and *Readability*.

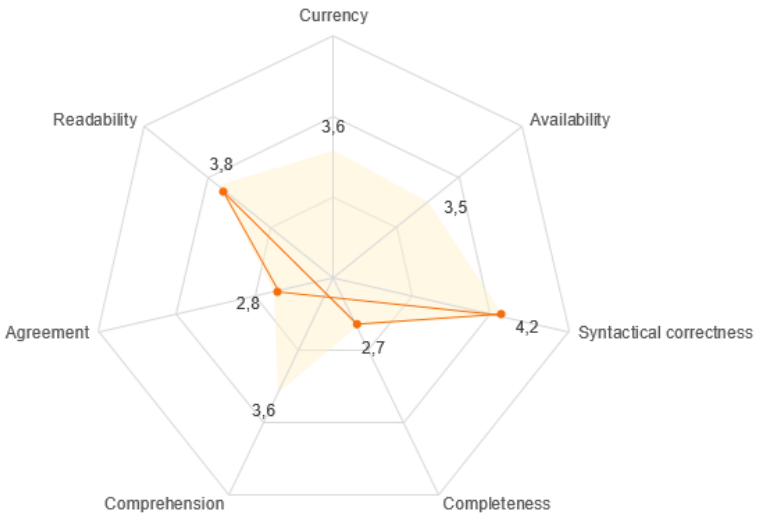


Figure 34: Spider diagram - External requirements

These results align well with the nature of the underlying purpose. As concluded in previous sections, *External requirements* is often a reason why organizations initiate process modeling. The main focus in such a phase is to meet the external requirements rather than to deliver value to the organization and its employees, which explains both the low focus on *Agreement* and *Completeness*. One of the interviewees explain the low prioritization of completeness by saying: "We don't want the model to be detailed, because then we will fail the audits, since the model will not correspond with how we work on such low abstraction level". However, the desired level of *Completeness* is of course dependent on how the requirements are expressed. It is mainly the external demands that set the rules for the modeling activity. The higher prioritization of *Readability* and *Syntactical correctness* is driven by the need to make the models comprehensible for the external actors, which might demand special modeling formats and standards.

7.1.5 Quality attribute analysis - F. standardization

The spider diagram for *F. standardization* shows that *Availability* is, with statistical significance, more important than *Syntactical correctness* and *Currency*. However, it has to be taken into account that *Comprehension*, *Agreement* and *Readability* also are high in relation to *Syntactical correctness* and *Currency*. Hence it can be stated, according to these results, that *Syntactical correctness* and *Currency* should not be prioritized when the goal is to facilitate standardization. The rest of the quality attributes have to be emphasized, with special focus on *Availability*.

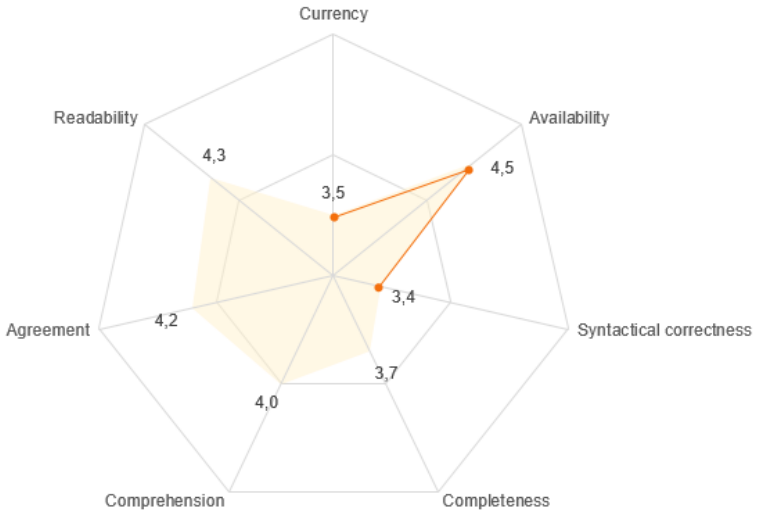


Figure 35: Spider diagram - F. standardization

As concluded in previous sections, *F. standardization* is a part of a change process within the organization. The goal is to facilitate this change with the process model as a focal point. This explains why the results show that most of the quality attributes has to reach a high level and thus the demands on the model are high. The exception *Currency* can be explained by the fact that the model is a future state model, which implies that the model will have a longer life-span if the change process is extensive. Hence, the model does not have to be regularly updated. The quality attributes that should be prioritized are both technical and social. The technical quality attributes *Availability* and *Readability* can be reached fairly easy with technical means. However, the social attributes *Agreement* and *Comprehension* require large efforts in order for the standardization effort to be successful.

7.1.6 Quality attribute analysis - Improvements

The spider diagram for *Improvements* shows no statistical significance. Studying the individual score of each answer, this can be explained through that scores vary a lot between the respondents. What can be stated is, however, that *Readability* has a relatively high score on all answers, which is also visualized in the diagram.

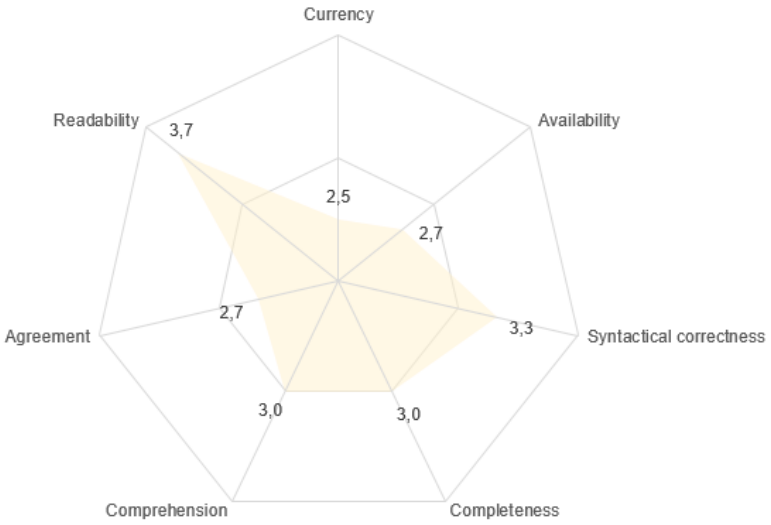


Figure 36: Spider diagram - Improvements

Since models within this purpose aim to facilitate improvements, with many actors involved, it is natural that *Readability* is of high importance, which also holds true for all *Transformative purposes*. What is included in improvements initiatives could variate widely, and the large variety of different kinds of organizations, at different maturity levels, that mentioned this purpose, could explain that no clear patterns can be seen in the QA-scoring.

7.1.7 Quality attribute analysis - Daily support

The spider diagram for *Daily support* shows several QA prioritizations that are statistically significant. Firstly, *Availability*, *Readability* and *Comprehension* are more important than both *Agreement* and *Syntactical correctness*. In addition, *Availability* is more important than *Currency*. Lastly, both *Currency* and *Completeness* are more important than *Syntactical correctness*. Hence, it can be stated that in order for process models to be used for daily support, *Availability*, *Readability*, *Comprehension* and *Completeness* should be prioritized. Also *Currency* is fairly important whereas *Agreement* and *Syntactical correctness* should not be in focus.

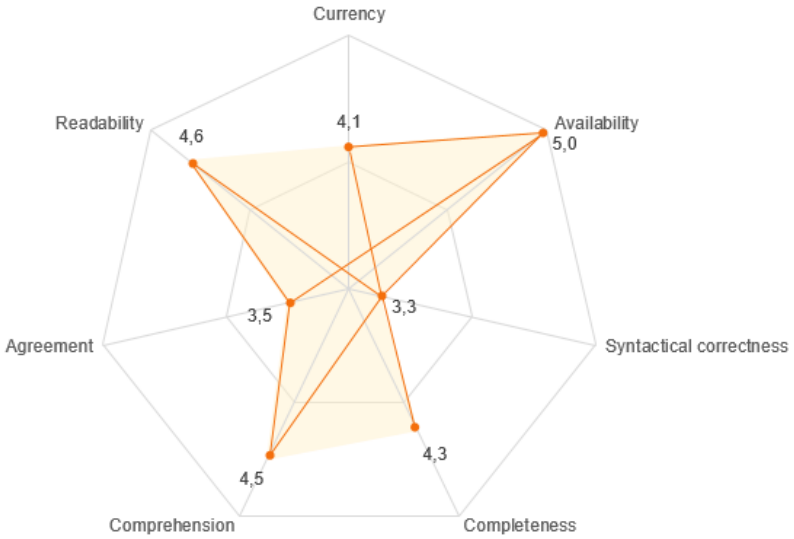


Figure 37: Spider diagram - Daily support

Referring back to the nature of this purpose, it is evident why *Availability*, *Readability*, *Comprehension* and *Completeness* should be prioritized. Daily support could not be provided without an absolute focus on availability, since the model should be distributed to included actors in an easy way. When fulfilling this purpose also the term *Timeliness* becomes relevant, i.e. that the model is current and available in time where it is usable. A model that is not updated provides low quality daily support and thereby risks to lose interpreters' confidence in trusting the models. Furthermore, *Readability* and *Comprehension* need to be high in order for the models to be usable. Lastly, since the purpose is named *Daily support*, the level of *Completeness* needs to be high. This because models aim to provide support and guidelines in daily working operations on a detailed operational level.

7.1.8 Quality attribute analysis - Navigation tool

The spider diagram for *Navigation tool* shows that *Readability* is with statistical significance more important than *Completeness*. Furthermore, it can be noted that the QA-scores are fairly equal and that none of the QA:s is of low importance. However, *Availability* and *Comprehension* could be somewhat higher prioritized.

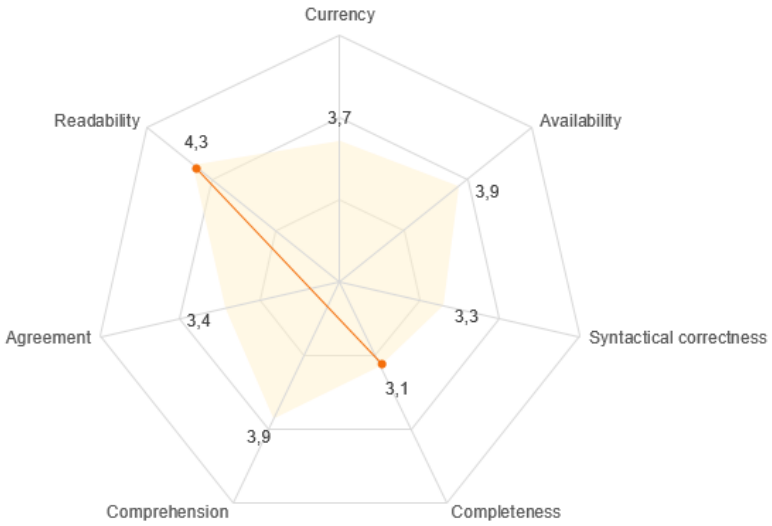


Figure 38: Spider diagram - Navigation tool

Referring back to the definition of this purpose, the aim is to create a structure that facilitates navigation of documents. Thus, *Availability* should be prioritized since the ultimate goal is to easily make documents accessible in the right context, and high *Readability* helps to quickly find requested documents. The high score on *Comprehension* could be explained by that in order for the navigation tool to actually be timesaving, it is necessary that the users of it has understood how it should be used. As stated, this purpose does not demand a high *Completeness*. However, this is of course dependent on the amount and detail level of the different documents. If the documents are many and contain very specific documentation, the *Completeness* needs to be increased in order for everything to fit into an assigned position. One should keep in mind, though, that too much details might decrease *Comprehension* and thus not be so timesaving after all.

7.1.9 Quality attribute analysis - Comprehensive view

The spider diagram for *Comprehensive view* shows several QA prioritizations that are statistically significant. All of the five QA:s *Availability*, *Readability*, *Comprehension*, *Syntactical correctness* and *Agreement* should be prioritized over *Currency* and *Completeness*.

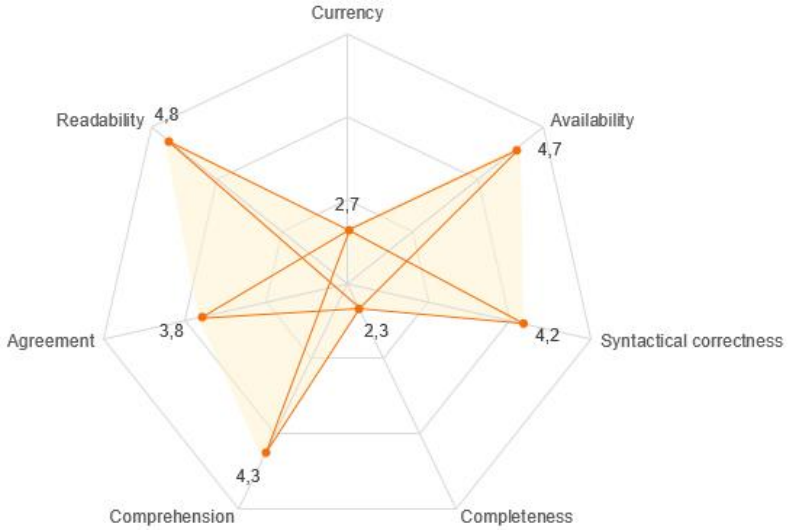


Figure 39: Spider diagram - Comprehensive view

From the QA-score it can be stated that this purpose aims to provide an overview of processes, i.e. not on a complete, detailed level which is also indicated by the low score on *Completeness*. It is however strongly important to develop models that are readable and to ensure availability among all stakeholders. Moreover, model *Comprehension* should be ensured and *Syntactical correctness*, which should also be high, could contribute to this. It is furthermore recommended to make sure to reach *Agreement* among stakeholders in order to accomplish a model in which there exist no contradictions. A high level of *Comprehension* is a contributing factor to reach *Agreement*.

7.1.10 Quality attribute analysis - Common ground

The spider diagram for *Common ground* shows that both *Availability* and *Agreement* is, with statistical significance, more important than both *Currency* and *Completeness*. Furthermore, it is statistically significant to say that *Readability* is more important than *Currency*. Studying the other QA-scores, also *Syntactical correctness* and *Comprehension* are fairly high. Hence, it can be stated that in order to provide a common ground of a process, *Readability*, *Availability* and *Agreement* should be emphasized over *Currency* and *Completeness*, and that *Syntactical correctness* and *Comprehension* should not be neglected.

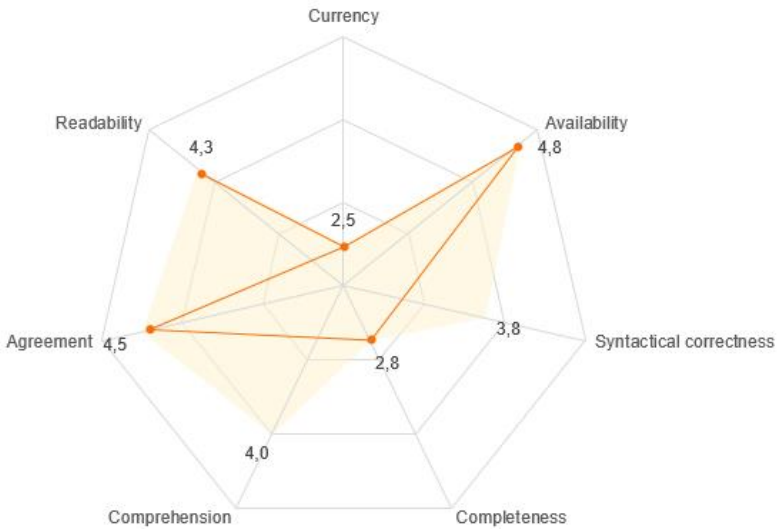


Figure 40: Spider diagram - Common ground

A prerequisite for being able to use this model as a basis on which further needs can be managed, which is the goal of this purpose, is naturally to reach an agreement. After agreement has been reached within the process team the model can be shared to actors external to the modeling team, which why *Availability* should be emphasized. Furthermore, the model needs to be readable and comprehended by those actors, preferably by few syntax errors. However, neither *Currency* nor *Completeness* should be emphasized; the goal of this purpose is just to get a common ground of the overall process, i.e. not on a detailed level, which also leads to that it is not necessary to keep it constantly updated.

7.2 Summary of analyses and results RQ1B

The results from the analyses above are summarized in this section in order to provide an overview of the results. Hence, table 27 below summarizes the findings from the each of the analyses in this chapter.

Purpose	Quality attributes to emphasize
Roles and responsibilities	Agreement, Availability, Comprehension should be prioritized
Strengths and weaknesses	Intermediate focus on Agreement, Syntactical correctness, Completeness and Comprehension. Availability, Currency and Readability can be down-prioritized
Training	Availability and Readability should be prioritized
External requirements	Completeness and Agreement should not be prioritized. More emphasis should be put into the accomplishment of Syntactical correctness and Readability.
F. standardization	Syntactical correctness and Currency should not be prioritized. The rest of the quality attributes have to be emphasized, with special focus on Availability
Improvements	No conclusions can be drawn
Daily support	Availability, Readability, Comprehension and Completeness should be prioritized. Also Currency is fairly important whereas Agreement and Syntactical correctness should not be in focus.
Navigation tool	None of the QA:s is of low importance. However, Availability and Comprehension could be somewhat higher prioritized
Comprehensive view	All of the five QA:s Availability, Readability, Comprehension, Syntactical correctness and Agreement should be prioritized over Currency and Completeness
Common ground	Readability, Availability and Agreement should be emphasized over Currency and Completeness, and Syntactical correctness and Comprehension should not be neglected

Table 27: Summary of findings for RQ2.

Important to notice is that the full answer of the second research questions is not the table. This is because the quality attribute prioritizations have to be seen in the true context of each purpose, which is presented in section 7.1.1-7.1.10. However, a concluding answer on an aggregated level will be provided below.

Referring back to the *Problem discussion:* RQ2 was formulated since it was deemed that it would be valuable to in a more generalizable way provide insights about what quality attributes that should be emphasized in process modeling. It is deemed that this master thesis has accomplished this goal, since the results clearly show that the modeling focus varies a lot depending on purpose and it also provides clear indications on what the focus in each case should be.

Zooming out, the organizational issue is that there is a limited amount of time and money that can be put into process modeling initiatives and the value it will provide is not always obvious. As Rosemann (2006) phrases it: "process modeling is criticized for being over-engineered, time-consuming, costly and without

(sufficient) value. Thus, the challenge is to find the right level of modeling for the underlying purpose". The results presented in this chapter are believed to help the organizations to find the right level of modeling and consequently invest their limited resources on the right things. Furthermore, the knowledge about what to prioritize allows for nuanced evaluations, which enables creation of early results that might increase the buy-in and belief in the process modeling initiative.

8. Conclusions

The explicit purpose of this study was to elaborate on the quality definition "fitness for use" by providing insights on what are the main reasons to why organizations perform process modeling and how these reasons mutually relate to each other. Furthermore, the study aimed to provide insights regarding what quality attributes within the SEQUAL-BPM framework that should be emphasized, in order to fulfill underlying reasons to process modeling.

In order to elaborate on the quality definition "fitness for use" two aspects were required: (1) an understanding of what the model should be *used* for and (2) what is *fitness* in relation to the area of use. Hence, this study has first, through interviews with 24 organizations, showed that there are several reasons why organizations perform process modeling. After categorizing the answers from the interviews, 17 different purposes could be defined, of which:

- Identification of strength and weaknesses
- Distribution of roles and responsibilities
- Facilitation of training
- Fulfillment of external requirements (e.g. ISO-certification)
- Facilitation of organizational transformations, which often is a question of standardization initiatives

are the most frequently mentioned. Furthermore, the study has showed how these 17 purposes relate to each other in regard to three different aspects. These aspects combined laid the foundation for a concluding model, which in relation to previous research provides a more granular answer, expressed with practitioners' wordings, to why process modeling is performed. Furthermore, it provides the purposes' commonality and importance, and mutual relationship beyond the future and current state perspective. The latter reveals that process modeling often solely is performed in the context of here and now, rather than focusing on organizational transformations. On an aggregated level this allows for a more dynamic view on process modeling, which is deemed to better match with organizations' reality.

Moving on to the second part of "fitness for use": *fitness* in relation to area of use, this study has showed that the modeling focus has to shift depending on what the underlying purpose is. More specifically, the study has provided clear indications on which of the quality attributes within SEQUAL-BPM that should be emphasized in order to reach the right level of modeling for the most important of the identified purposes.

Having the two aspects of "fitness for use" in place allows for an elaboration of what this really implies for organizations. In order to do this the below example is provided. The example shows a process modeling initiative where the end goal is to facilitate and sustain a standardization. The first step in the initiative is to through a model of the current state identify strengths and weaknesses in the process, which is done within the process team. When strengths and weaknesses are identified a future state model, that aims to bridge the identified deficiencies, is developed. The next step is to facilitate the standardization with the future state model as a focal point in the change process. After the organization has transformed in accordance with the plan, the next challenge is to sustain the new way of working. Hence, it is desirable to provide daily support to the employees working in the process, which is done through process models. During the initiative, process modeling is supplemented with other activities in order to make the change happen. However, process modeling is always the focal point. Consequently, it

is highly important to ensure quality of the process models during the whole initiative. In reference to the results of this study, the quality goals vary as the initiative proceeds, since the purpose of the process modeling changes. Hence, different quality attributes have to be emphasized in each phase in order to ensure process modeling quality. The figure below (28) shows what quality attributes that should be emphasized in each of the phases in the example above.

Purpose	Identification of strength and weaknesses	Facilication of standardization	Provision of daily support
Focus area	*Intermediate focus on Agreement, Syntactical correctness, Completeness and Comprehension. Availability, Currency and Readability can be down-prioritized*	*Syntactical correctness* and *Currency* should not be prioritized. The rest of the quality attributes have to be emphasized, with special focus on *Availability*	*Availability, Readability, Comprehension and Completeness should be prioritized. Also Currency is fairly important whereas Agreement and Syntactical correctness should not be in focus.*

Table 28: Illustration over how the emphasized quality attributes changes along the Improvement path

As can be seen in the figure the demands on the process model during the identification of strengths and weaknesses are intermediate, since the modeling takes place in the process team. The demands increase drastically in the next step. The model now has to be made available and readable for the employees working in the process. Furthermore, efforts must be made in order to ensure that the model is comprehended and agreed upon, which can be achieved through educations and workshops. However, low emphasize should be put into keeping the model updated (*Currency)*, since it is a model of the future state. In the next phase, provision of daily support, the demand increases on *Completeness* and *Currency*. A model that is not updated and complete provides low quality daily support and thereby risks to lose interpreters' confidence in trusting the models. In order to fulfil the demanded quality levels in each phase, new models might have to be made and organizational mechanisms have to be put in place. As for example in the last step, it requires a lot from the organization to ensure that the model actually is updated and complete.

Based on the results presented above, the concept of "fitness for use"-oriented process modeling can be established. The concept involves, in relation to process modeling initiatives, the consideration of the following questions:

1. *"WHY do we do this?"* - The answer to this question will most likely be one or several of the 17 purposes identified.
2. *"WHAT should be accomplished?"* - First the path for the initiative has to be set, i.e. what other purposes that have to be reached before others in order to build a solid foundation. When the path is set, the organization can aim to focus on the right QA's for each purpose along the path. It is important to be aware of that when the purpose transforms, new QA levels are demanded.

3. *"HOW do we accomplish this?"* - This is a larger question not elaborated upon within this thesis, requiring further research.

In conclusion, this report provides practitioners with ideas of what can be accomplished through process modeling. Furthermore, it serves as a guideline when designing and evaluating process modeling initiatives. In relation to the design, one interviewee stated:

"We are actually cheating; we do not follow the guideline for how process modeling should be conducted."

This study argues that having one single guideline that is to be used in all cases is not desirable. Instead, the process modeling initiative should be designed in relation to its underlying purpose. Several other interviews stated that:

"We have not really succeeded; nobody actually follows the process model."

In reality, evaluating process model quality is not as simple. The extent to which employees follow the models could be one way of measuring model quality, but only in some contexts. Hence, organizations should really think through why they model a process and what they want to accomplish with each initiative, possibly with help from the different purposes presented in this thesis. Then it is possible to set quality goals and guidelines for each purpose that can be used for design and evaluation. This leads to that, for example, the quality of a process model that is out of date and not available to everybody could still be high, if the purpose was for example to identify strengths and weaknesses with the process. By knowing where to focus, organizations can be satisfied with their efforts instead of constantly seeking to achieve something that does not correspond to the underlying purpose. As a result, the buy-in for process modeling as a whole can increase and process modeling can contribute to a more efficient organization.

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Appendix A

Appendix A: Full two-way frequency table.

Count	Categories	Strengths and weaknesses	Roles and responsibilities	External requirements	Training	F. Standardization	Improvements	Daily support	Performance measuring	Specification for IS	Navigation tool	Comprehensive view	P. Standardization	Documentation	External stakeholders	Common ground	Process interfaces	Miscellaneous	Strategies
20	Strengths and weaknesses	20	13	11	11	8	9	7	6	5	5	6	4	4	4	4	2	0	1
16	Roles and responsibilities	13	16	10	9	6	5	6	5	3	3	4	3	4	4	4	2	2	2
13	External requirements	11	10	13	8	4	5	4	5	4	4	3	3	2	2	3	0	1	1
13	Training	11	9	8	13	5	5	5	3	5	3	2	2	3	3	2	1	1	1
10	F. Standardization	8	6	4	5	10	5	4	3	3	1	1	0	0	3	0	2	1	2
9	Improvements	9	5	5	5	5	9	3	3	3	3	4	1	2	1	0	0	0	1
8	Daily support	7	6	4	5	4	3	8	1	2	1	2	1	1	2	0	1	0	2
8	Performance measuring	6	5	5	3	3	3	1	8	3	4	3	2	0	0	2	0	1	1
7	Specification for IS	5	3	4	5	3	3	2	3	7	2	1	1	0	0	1	2	0	1
7	Navigation tool	5	3	4	3	1	3	1	4	2	7	3	3	1	0	1	0	1	0
6	Comprehensive view	6	4	3	2	1	4	2	3	1	3	6	3	2	0	0	0	0	0
5	P. Standardization	4	3	3	2	0	1	1	2	1	3	3	5	1	0	1	1	0	0
4	Documentation	4	4	2	3	0	2	1	0	0	1	2	1	4	1	1	0	0	0
4	External stakeholders	4	4	2	3	3	1	2	0	0	0	0	0	1	4	0	0	0	0
4	Common ground	4	4	3	2	0	0	0	2	1	1	0	1	1	0	4	1	0	0
3	Process interfaces	2	2	0	1	2	0	1	0	2	0	0	1	0	0	1	3	0	1
2	Miscellaneous	0	2	1	1	1	0	0	1	0	1	0	0	0	0	0	0	2	0
2	Strategies	1	2	1	1	2	1	2	1	1	0	0	0	0	0	0	1	0	2

Appendix B

Appendix B: Percentages of coexistence.

Count	Categories	Strengths and weaknesses	Roles and responsibilities	External requirements	Training	F. Standardization	Improvements	Daily support	Performance measuring	Specification for IS	Navigation tool	Comprehensive view	P. Standardization	Documentation	External stakeholders	Common ground	Process interfaces	Miscellaneous	Strategies
20	Strengths and weaknesses	-	65%	55%	55%	40%	45%	35%	30%	25%	25%	30%	20%	20%	20%	20%	10%	0%	5%
16	Roles and responsibilities	81%	-	63%	56%	38%	31%	38%	31%	19%	19%	25%	19%	25%	25%	25%	13%	13%	13%
13	External requirements	85%	77%	-	62%	31%	38%	31%	38%	31%	31%	23%	23%	15%	15%	23%	0%	8%	8%
13	Training	85%	69%	62%	-	38%	38%	38%	23%	38%	23%	15%	15%	23%	23%	15%	8%	8%	8%
10	F. Standardization	80%	60%	40%	50%	-	50%	40%	30%	30%	10%	10%	0%	0%	30%	0%	20%	10%	20%
9	Improvements	100%	56%	56%	56%	56%	-	33%	33%	33%	33%	44%	11%	22%	11%	0%	0%	0%	11%
8	Daily support	88%	75%	50%	63%	50%	38%	-	13%	25%	13%	25%	13%	13%	25%	0%	13%	0%	25%
8	Performance measuring	75%	63%	63%	38%	38%	38%	13%	-	38%	50%	38%	25%	0%	0%	25%	0%	13%	13%
7	Specification for IS	71%	43%	57%	71%	43%	43%	29%	43%	-	29%	14%	14%	0%	0%	14%	29%	0%	14%
7	Navigation tool	71%	43%	57%	43%	14%	43%	14%	57%	29%	-	43%	43%	14%	0%	14%	0%	14%	0%
6	Comprehensive view	100%	67%	50%	33%	17%	67%	33%	50%	17%	50%	-	50%	33%	0%	0%	0%	0%	0%
5	P. Standardization	80%	60%	60%	40%	0%	20%	20%	40%	20%	60%	60%	-	20%	0%	20%	20%	0%	0%
4	Documentation	100%	100%	50%	75%	0%	50%	25%	0%	0%	25%	50%	25%	-	25%	25%	0%	0%	0%
4	External stakeholders	100%	100%	50%	75%	75%	25%	50%	0%	0%	0%	0%	0%	25%	-	0%	0%	0%	0%
4	Common ground	100%	100%	75%	50%	0%	0%	0%	50%	25%	25%	0%	25%	25%	0%	-	25%	0%	0%
3	Process interfaces	67%	67%	0%	33%	67%	0%	33%	0%	67%	0%	0%	33%	0%	0%	33%	-	0%	33%
2	Miscellaneous	0%	100%	50%	50%	50%	0%	0%	50%	0%	50%	0%	0%	0%	0%	0%	0%	-	0%
2	Strategies	50%	100%	50%	50%	100%	50%	100%	50%	50%	0%	0%	0%	0%	0%	0%	50%	0%	-

Appendix C

Appendix C: Interview answers from E2 with assigned purpose categories.

Organization	Answer (in Swedish)	Purpose
A	Identifiera svagheter och styrkor i arbetssätt	Strengths and weaknesses
A	Ge systemstöd förutsättning att fungera över olika sighter - maximera nyttan av affärssystemen över olika enheter	F. standardization
A	Arbetsdokument i förändringsarbete	Improvements
B	Svara på krav från kunder, underleverantörer och myndigheter - yttre krav	External requirements
B	Upplärning	Training
B	Framtagande av informationssystem	Specification for IS
B	Skapa förutsättning för mätning	Performance measuring
B	Hantera, rutiner och mallar, sätta i sammanhang	Navigation tool
B	Lägga grund för standardisering och gemensamma arbetssätt --> Effektivisera	P. standardization
C	Koordinera med source partners - roll och ansvarsfördelning upstream för leverantörer.	Roles and responsibilities
C	Standardisera och skapa gemensamma arbetssätt	F. standardization
C	Specifikation för system	Specification for IS
C	Ge dagligt stöd i arbetet	Daily support
C	Integrera processerna på en total nivå	Process interfaces
C	Skapa och dela en vision	Strategies
D	Roll och ansvarsfördelning (produkten)	Roles and responsibilities
D	Identifiera styrkor och svagheter i arbetet	Strengths and weaknesses
D	Harmonisera arbetssätt mellan olika enheter	F. standardization
D	ISO-certifiering (kvalitetsförbättringsperspektivet)	External requirements
D	Utbildning av nyanställda	Training
D	Stöd i individuellt operativt arbete gällande uppgifter som görs sällan (påkopplade instruktioner)	Daily support
D	Möjliggöra för mätning	Performance measuring
D	Visualisering av framtida läge - styrdokument i förändringsarbetet, huvudsakligen drivet av affärssystemsimplementation och uppdatering	Improvements
D	Sprida och verkställa övergripande strategier - exempelvis: kunden förhåller sig till x y z	Strategies
E	Skapa sammanhang - Hur saker relaterar till varandra - rollfördelning och ansvar (produkt/process)	Roles and responsibilities
E	Identifiera utvecklingsalternativ	Strengths and weaknesses
E	ISO-certifiering	External requirements
E	Skapa utgångspunkt för lärande/upplärning	Training
E	Kravställa för IT-system med fokus på information	Specification for IS
E	Ge förutsättningar för att mäta	Performance measuring
E	System för ledning och styrning - samsynsdokument	Common ground
F	Identifiera styrkor och svagheter för att utveckla processerna	Strengths and weaknesses
F	Kommunikationsplattform för att harmonisera mellan olika enheter (standardisering)	F. standardization
F	Introduktion för nyanställda	Training
F	Skapa specifikation för affärssystemsbyte	Specification for IS
F	Förståelse för helheten och gränssnitt mellan processer	Process interfaces
G	Analysera och identifiera problem	Strengths and weaknesses
G	Utbildning och kunskapsspridning	Training
G	Framtagande av system och applikationer	Specification for IS
G	Minska frustration som uppkommer när man vet hur man ska jobba - dagligt stöd i arbetet	Daily support
G	Gemensamma kunskapsstandarder	Navigation tool
G	Driva förändring - styrdokument	Improvements
H	Identifiera brister och problem --> Skapa framtida läge	Strengths and weaknesses
H	Följa upp problem för att öka kvaliteten i ett utfört arbete (förutsättning för mätning och kontroll)	Performance measuring
H	Sätt rutiner i sammanhang	Navigation tool
H	Förstå sin del av helheten mot kund (funktionsnivå --> rollnivå)	Comprehensive view

H	Skapa förutsättning för standardisering	P. standardization
I	Roll-och ansvarsfördelning (process/produkt)	Roles and responsibilities
I	Identifiera problem och ta fram förbättringar	Strengths and weaknesses
I	Dokumentation av administrativa rutiner	Documentation
I	ISO 9000-certifiering	External requirements
I	Distribuera styrande dokument, instruktioner	Navigation tool
I	Genomföra förändringar	Improvements
I	Ge en bild av helheten för kunder och anställda	Comprehensive view
I	Förutsättning för standardisering - gemensamma arbetssätt	P. standardization
J	Förbättra arbetssätt genom identifikation av problem	Strengths and weaknesses
J	Uppfylla krav - ISO/CE/lagregleringar etc.	External requirements
J	Vägledning i operativt arbete	Daily support
K	Roll- och ansvarsfördelning (processen)	Roles and responsibilities
K	Möta kvalitetskrav från regelverk och kunder	External requirements
K	Upplärning (övergripande nivå/ ge helhetsbild)	Training
K	Strukturera och sprida, rutiner, instruktioner, befattningsbeskrivningar = navigationsverktyg	Navigation tool
K	Framtagning av tillverkningsscheman - projektrapporter	Miscellaneous
L	Roll- och resursfördelning	Roles and responsibilities
L	Bring everyone in line with how the organization want to work - standardisering på en managernivå	F. standardization
L	Identify weaknesses and opportunities in the project, in relation to the agreed upon process	Performance measuring
L	Support in daily work - checklist for managers to make sure we are on the right track	Miscellaneous
M	Komma överens om hur vi jobbar - Roll- och ansvarsfördelning (processen)	Roles and responsibilities
M	Identifiera förbättringsmöjligheter	Strengths and weaknesses
M	Dokumentera	Documentation
M	ISO-certifiering	External requirements
M	Överlämning/upplärning av nyanställda	Training
M	Skapa förståelse för hur vi arbetar - samsynsdokument. Definiera vad och hur vi jobbar idag.	Common ground
N	Neutral diskussionsplattform "skylla på processen"	Roles and responsibilities
N	Identifiera förbättringsmöjligheter och risker	Strengths and weaknesses
N	ISO-certifiering	External requirements
N	Förutsättning för mätning för att återkoppla mot mål	Performance measuring
N	Skapa ett navigations-verktyg för distribution av rutiner och dokumentation	Navigation tool
N	Gemensam bild av verksamheten - helhetssyn och samsyn (samsynsdokument)	Common ground
O	Rollfördelning	Roles and responsibilities
O	Identifiera brister	Strengths and weaknesses
O	Dokumentera kunskap för standardisering	Documentation
O	Grund för upplärning av nyanställda	Training
O	Åskådliggöra för kunderna	External stakeholders
P	Roll- och ansvarsfördelning, roll- och ansvarstagande (produkten+processen)	Roles and responsibilities
P	Analysera och identifiera problem (produkten)	Strengths and weaknesses
P	Standardisering	F. standardization
P	Upplärning av nyanställda	Training
P	Stöd i arbetet (operativt)	Daily support
P	Kommunicera arbetsmetodik mot kund	External stakeholders
Q	Identifiera förbättringsområden	Strengths and weaknesses
Q	Skapa ett likartat arbetssätt mellan enheter - jämlik vård (detaljer styrs via riktlinjer och styrdokument och på enhetsnivå)	F. standardization
Q	Ge förutsättning för mätning	Performance measuring
Q	Distribuera riktlinjer och styrdokument i sitt sammanhang	Navigation tool
Q	Utveckla och förbättra vårdprocessen (genomföra förändringen) - styrdokument	Improvements
Q	Vägledning för var i processen man befinner sig - bild av helheten - operativ nivå	Comprehensive view
R	Rollfördelning - underlätta för samarbete (processen)	Roles and responsibilities
R	Identifiera problem (operativ nivå)	Strengths and weaknesses
R	Skapa förståelse för processteamen - gemensam samsyn	Common ground

R	Identifiera kopplingar till andra processer - gränssnittsidentifikation	Process interfaces
R	Skapa styrdokument och riktlinjer för operativt och "lokal" nivå	P. standardization
S	Roll- och ansvarsfördelning	Roles and responsibilities
S	Identifiera problem	Strengths and weaknesses
S	Standardisera - Gemensamma arbetssätt för att säkerhetsställa kvalitet	F. standardization
S	Författningen av ledningssystem, kunna inspektera, uppfylla utomstående krav	External requirements
S	Stöd i arbetet för individen	Daily support
S	Transparens för medborgaren	External stakeholders
T	Skapa gemensam bild för rollfördelning och ansvar (processen)	Roles and responsibilities
T	Effektivt identifiera problem på en övergripande nivå	Strengths and weaknesses
T	Skapa standarder för gemensamma arbetssätt	F. standardization
T	Krav från ovan gällande kvalitetsledningssystem	External requirements
T	Introduktion av nyanställda	Training
T	Introduktion av nya arbetssätt - påkopplingar av NYA aktiviteter på existerande verksamhet	Improvements
T	Visualisera för kunden (medborgare)	External stakeholders
U	Samverkan mellan roller, koordinera, visualisera (Roll- och ansvarsfördelning - produkten)	Roles and responsibilities
U	Identifiera förbättringar. Nuläge ---> nyläge	Strengths and weaknesses
U	Förhållningsätt till lagstiftning (PUL, Skollagen, EU etc.)	External requirements
U	Kravställning inför IT-System (design)	Specification for IS
U	Ge underlag för mätning	Performance measuring
U	Införa ett nytt sätt att arbeta	Improvements
U	Gemensam bild av verksamheten - förstå min del av helheten	Comprehensive view
V	Roll - och ansvarsfördelning (produkten + processen)	Roles and responsibilities
V	Identifiera styrkor och svagheter	Strengths and weaknesses
V	Dokumentera för att minska sårbarhet - kunna ersätta vid frånvaro	Documentation
V	Upplärning av nyanställda	Training
V	Dagligt stöd i arbetet för individen	Daily support
V	Visualisera idealt läge och driva förändring dit - styrdokument	Improvements
V	Helhetsperspektiv - se sin del av helheten	Comprehensive view
X	Komma överens om hur vi jobbar - ansvars- och rollfördelning - (processen)	Roles and responsibilities
X	Utvecklingsverktyg för att identifiera förbättringsmöjligheter	Strengths and weaknesses
X	Kvalitetssäkring (rättssäkerhet, ISO)	External requirements
X	Upplärning/Överlämning	Training
X	Stöd vid utförande	Daily support
X	Skapa förståelse för hur vi arbetar - ge en bild av helheten (organisationskarta)	Comprehensive view
X	Standardisera och dokumentera (standardisering/harmonisering)	P. standardization
Y	Visualisera hur vi jobbar för att identifiera problem och ta fram åtgärdsförslag	Strengths and weaknesses
Y	Skapa enhetligt arbetssätt - Enhetsnivå	F. standardization
Y	Rättsäkerhet (EU-lagstiftning till internt satta krav)	External requirements
Y	Lära upp/ överföra kunskap mellan kollegor	Training
Y	Verksamhetsanalys inför systembygge (specifikation för IS)	Specification for IS
Y	Driva förändring med hjälp av framtida läge, skruva på processen (styrdokument). Medarbetarna skruvar. verksamheten utvecklar	Improvements