MASTER

Project based business end-to-end conceptual workflow

case study: project management workflow at a supplier in the construction industry

Wegmann, R.M.

Award date:
2018

Eindhoven University of Technology

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Case Study: Project management workflow at a supplier

in the construction industry

By

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BSc Industrial Engineering – TU/e 2016

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In partial fulfilment of the requirements for the degree of

Master of Science

In Operations Management and Logistics

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Series Master Theses Operations Management and Logistics

Subject headings: Project business, Business process Management, Workflow, Case management, Project management, Customer project

Abstract

This thesis focuses on the challenges which faced from a manufacturing company working in a project-oriented way. The main direction of solving the problems is by focusing on the business process management side of the business. The thesis starts with identifying which type of business process management system best supports the company needs. External knowledge is gathered from different companies using semi-structured interviews. A main proposal of a gate review process is presented, and the design chapter presents an end-to-end model for project business. This design covers all the phases of the project related to a company in the manufacturing industry. Lastly the implementation of the gate review process and flexibility is supported in the design.

Preface

This master thesis is the final result of the graduation project performed at Hilti AG in Liechtenstein. The thesis project was part the Operations Management & Logistics program at the Technical University of Eindhoven. The project was an interesting experience where I learned a lot. With the completion of this project I want to thank various people who have made this possible.

First of all, I want to thank Hilti for providing me with the opportunity of conducting my master thesis at their headquarters in Liechtenstein. I want to thank Bogdan, my direct company supervisor for all his support and valuable input for the project.

Second, I would like to thank my university supervisor Lijia for het help on the project. By replacing my old supervisor as good as possible. Thank you for your detailed view on the thesis.

Third, I want to thank my fellow thesis colleagues who were writing their master thesis at Hilti at the same time. Thank you for all the laughs and the hours spend on the bike in the Rhine valley!

Fourth, I want to thank my family for their never-ending support throughout my entire life.

Lastly, a big shout out to the guys of Meteoor without them the student life would not be such a great time!

Ruben Wegmann, November 2018

Management summary

Problem description

In today's project business world, projects are often known far ahead of time. But as a supplier to the construction industry it will not be decided until late in the process if one gets the project. Which makes the process deal with uncertainty. Project differentiates from standard business by its order size and order complexity. These two factors influence the lead time in a negative way.

In the current way of working a lot of different tools are used internally, the organization differs on a regional level and there is no global overview. The thesis is part of a bigger project in which is opted to find a solution to the workflow problem of project business ty a tool or software system. The main research question of this research is:

How can the project business workflow be designed to increase overall stakeholder transparency, communication, and improve the decision-making process and project steering on project business?

Complementary to this main research questions the following question were used to structure the research:

1. *What type of Business Process Management system provides the best fit for the conceptual design?*
2. *Which corresponding modelling technique can be used for the type of Business Process Management system?*
3. *How do other companies in the industry handle workflow on project business?*
4. *Which level of detail should be used when designing the conceptual model?*
5. *How can flexibility be implemented in the conceptual model?*
6. *How can the general gates and milestones be implemented in the design?*

Results

First of all, the research aimed on the different business process management systems. Where the conclusion was drawn that a mixed methodology for the workflow could be used. A mix of a fixed methodology followed by a flexible methodology. For the fixed methodology a classical workflow approach could be used in combination with the language of BPMN. The flexible methodology could be provided by the use of case management where the corresponding language would be CMMN.

The company comparison helped answering the outlook of the industry on the proposed problem. From the company comparison became clear that the proposed gate structure for the design was in line with the industry. However, the desired solution to have one system for the entire organization was not supported to be feasible. The believed direction to look for a solution was to have one central source of data with different systems interaction. Also was pointed out during the interviews that the people aspect of the problem should not be underestimated. If the future users do not accept the system, it will not be used optimally.

For the general gates and milestones, a gate review process was introduced. The review process should help to reflect on the progress of the project on fixed times in the process. Figure 1 presents the process of a gate review which can be introduces as a process within the conceptual design.

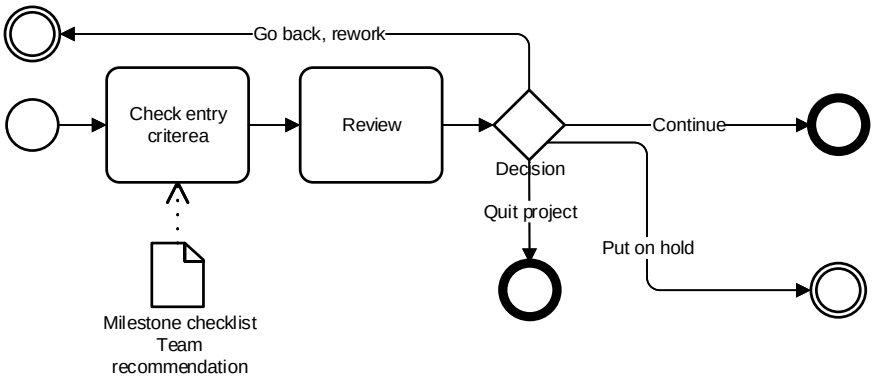

Figure 1 Gate review process, derived from Kerzner (2018) and Steenkamp & Bekker (2018)

Designed solution

Figure 2 presents a simplified overview of the conceptual design. The design was divided in 5 levels. The first three levels were modelled via a regular workflow BPMN methodology. The fourth level was modelled as a case management system. The fifth level provided to much detail and therefore was not seen necessary to model. Level 1 represents the 6 phases a project goes through. The second level is a result of grouped level 3 process blocks, as can be seen from the level 3 example beneath it.

Figure 2 Hilti Project Business Level 1 - Level 3 (snapshot)

Figure 3 presents the total overview of the conceptual design on the third level. Each of the grouped coloured blocks is a process of level 2. Where for the organization the red box presents processes on the project level and the yellow boxed are for processes on an application level.

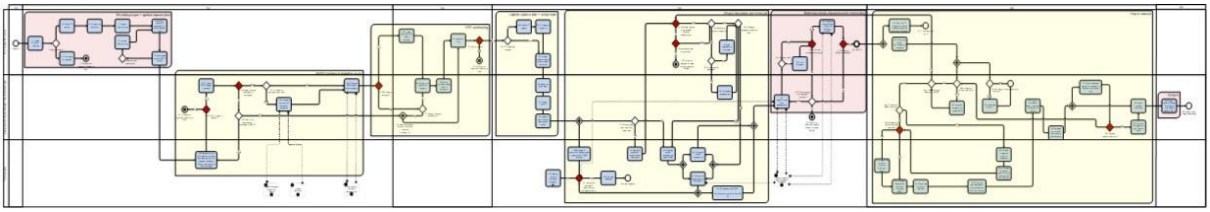

Figure 3 Final conceptual design level 3

Figure 4 is an example of how the fourth level of the conceptual design can be presented. Due to the size of the end-to-end process it was chosen to only present for one of the level 3 processes how it looks on the fourth level. A level 3 process is picked, where after it functions as a goal towards which the tasks in the figure work to.

Figure 4 An example of quotation process level 4

Conclusion

The research is a preparing step towards the new project system in Hilti. The design presents a graphical overview of the overall project process within Hilti. Where the designed solution could provide a new way of implementing a hybrid business process management system in the organization. In the future attention must be paid to the people aspect of the problem, which is of high importance according to the company comparison and according to literature. In the future attention has to be paid to the data aspect of projects.

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List of abbreviations

ACM	Adaptive Case Management	**LCN**	Logistic Center Nendeln
BOM	Bill of Materials	**LE1**	Manchester (GB, Ireland, Denmark, Sweden, Finland, Norway)
BPM	Business Process Management	**LE2**	Magny (Portugal, Spain, France, Belgium & Luxemburg)
BPMN	Business Process Model Notation	**LE4**	Milano (Italy, Greece, Israel, Slovenia, Croatia, BIH, Montenegro, Serbia, Macedonia, Albania, Romania, Bulgaria)
CHF	Swiss Francs	**LEC**	Kaufering (Germany, Holland, Poland, Switzerland, Austria, Hungary, Baltics, Czech, Slovakia)
CM	Case Management	**LRE**	Moscow (Russia, Kazakhstan, Belarus, Ukraine)
CMMN	Case Management Model Notation	**LW1**	Tulsa (USA, Canada)
CW	Central Warehouse	**LW2**	Panama (Mexico, Mid-America, Latin America)
E&I	Energy and Industry	**META**	Dubai (Turkey, Morocco, South Africa, Near East Agents, Eastern African Agents)
EPC	Engineer Procurement Construction	**MO**	Market Organization
eSCF	European Supply Chain Form	**PCM**	Production Case Management
FEED	Front End Engineering Design	**PMO**	Project Management Office
Glomex	Global Logistics Management Experts	**RW**	Regional Warehouse
HNA	Hilti North-America	**S&OP**	Sales and Operations Planning
ISB	Integrated System Business	**VAS**	Value Added Services
KPI	Key Performance Indicator	**WfMS**	Workflow Management System
LA1	Hong Kong (Rest of Asia, Australia, New Zeeland)		

1. Introduction

This thesis presents the results of the master thesis project as performed on the topic of project business. The thesis will be directed on the topic of workflow related to the end-to-end process. The project was conducted as a collaboration between Eindhoven University of Technology and Hilti AG, later to be called Hilti. The two organizations were brought together via a network within the university, the European Supply Chain Forum (eSCF). The aim of this thesis is to perform an analysis on the topic of project business within Hilti and to develop a design aimed at improving the current project business practices in the organization. With project business Hilti aims at customer projects, internal managed projects are not included.

The thesis is built around the topic of project business, which is in this case the fulfilment of customer projects. This topic has gained more importance since the 70's (Owusu, 1997). However, it is still relevantly new in the field of management science and there is still no holistic way in how to perform project business (Miterev, Mancini & Turner, 2017). In general, project business as a definition is well known in the current literature. The literature describes its main characteristics, as well as its challenge.

Project business plays an important role in manufacturing companies, because of large capital projects or a multitude of projects running at the same time (Kerzner, 2018). As an international manufacturing company, supplying the construction industry, Hilti is representative of project business in such kind of manufacturing companies. What is happening at manufacturing companies nowadays is exactly what is happening at Hilti. It can be described as (Kerzner, 2018): *"Manufacturing companies are driven to project management because of large capital projects or a multitude of simultaneous projects."*

In this thesis Business Process Management (BPM) plays an important role. BPM can be described as concepts and methods to support the design and analysis of business processes (Weske, 2007). Further details on the topic can be found in chapter 2.5.

The remaining of the introduction will be used to describe the company. After defining the problem, the research questions will be presented and finally the adopted methodologies will be introduced.

1.2 Problem definition

In this subchapter the problem faced by Hilti will be described.

It is almost always known far ahead that a construction project will happen. However, since Hilti is a manufacturer and supplier for the construction industry, they are at the bottom of the chain of stakeholders when it comes to construction projects. The project owners outsource the execution of the project. It is then divided over multiple sub-contractors, where each sub-contractor can choose their own suppliers and partners. These players are the customers of Hilti. Thinking of the timeline of a project, in case Hilti is chosen as a partner, there is not much time left until the execution of the project starts. This lack in time can cause trouble. Figure 5 shows the differences in lead time at different forms of fulfilling customer demand. When it comes to projects most of the time engineering is in involved. One can see the difference in lead time of "Engineer-To-Order" compared to the other forms of demand fulfilment. Due to the involvement of engineering, long lead times can occur in projects. When projects are large in terms of volume the lead times of "Make-to-order" and "Purchase-to-order" are relevant, which pile up when orders are large. And since the soon fulfilment date as a result of being at the bottom of the supply chain, it is not ideal lead times take so long.

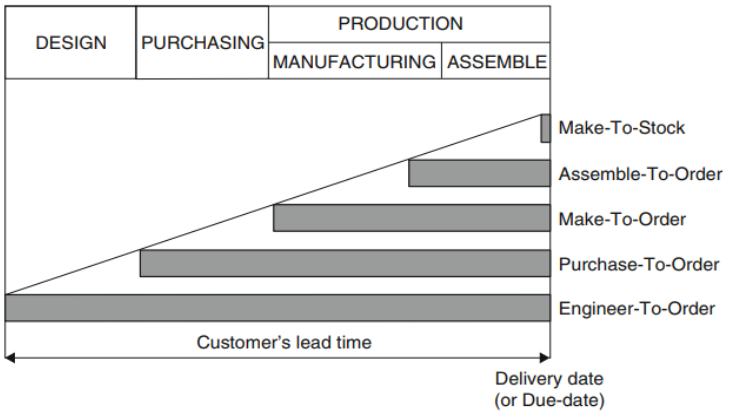

Figure 5 Responding options on market demand for manufacturing companies (Tonchia, 2018)

In the current form of project business, a multitude of different tools is used along the way of a project order. An overview is presented in Table 1. Besides the usage of different tools, there is no single source to comes to formalized data. Hence, there is no sufficient data which is available to use, nor a way to check the correction of relevant information.

Table 1 Software used in the Project business process

In the way of Hilti organizing today, the different regions are free to use what works best for them when it comes to the operations of the market organization. This results in different roles and responsibilities within the different Project Management Organizations (PMO's). The following example is of the Energy & Industry department (E&I), because this industry mostly consists of project like demand from the customer side. One can think of the construction of powerplants for example. Figure 6 shows the differences over regions. This figure gives a good overview of the global differences across the entire organization. For example, in Korea E&I operates a big portion of the to fulfil steps. HNA on the other hand has more divided tasks, since a big part of the project is done by the PMO.

Figure 6 Differences in Project Management Office (PMO) per region

The differences in organizational form require flexibility. Besides just the flexibility in general, it leads to a challenge at the same time. The ultimate goal of this study is to provide a global solution for the workflow problem with respect to project business at Hilti. Since the different regions use different organizational structures to fulfil project demand. In order to come up with one solution which can be used globally, project flexibility in terms of system use is required.

At Hilti, the end-to-end process for customer projects is one of the most complex processes. In a typical project, Hilti has defined six gates. For each gate, different key deliverables have been determined. The solution that is supposed to order this part of Hilti's business, is believed to be a workflow tool, or a way of business process management. Within Hilti, a workflow tool is described as one overlapping tool/solution which can help streamline the processes of project business. Whereas Hilti is currently using multiple different tools in different phases of a project, the workflow tool is supposed to be implemented from end-to-end, with inclusion of the gates in the solution.

Today Hilti does not have a global common platform for communication and collaboration that enables a structured and synchronized project coordination with an end-to-end view between all the different stakeholders for the customer projects. Where the earlier mentioned gates do exist but are not used as a global standard. Currently, different Market Organizations and Regions use different software solutions to capture planned and ongoing projects (the organizational differences were represented in Figure 6). This results in a lack of transparency, a "single view of truth". Reports in relation to projects are created using excel or power point which is time consuming to produce and is a lack consistency

The problems of today's project management and workflow communication are presented in the following cause and effect diagram in Figure 7.

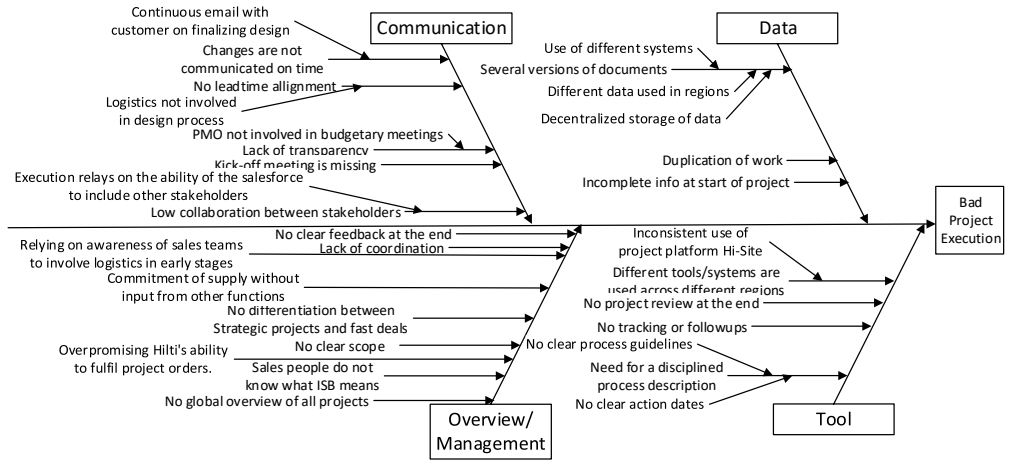

Figure 7 Cause and effect diagram

For example, a project starts from the sales team. This team is responsible for bringing in the project order. Due to the late involvement of other internal stakeholders in the process of a construction project, the other functions in the organization are not prepared for the project. Since the order conformation can come in late in the process not much time is left. When other stakeholders in the organization have not been involved earlier on in the process, this would result in an emergency state of operation. Where Hilti's ability to fulfil projects is overpromised. Process steps are determined by people on what they see fit as a next step, after which the next person called upon who believe should perform the next step. The form of communication is often by phone, an employee calls the next person one knows for the project. The sales team works in a way which results in data not always being up to date. It is harder for Hilti to forecast its overall demand when relevant input is missing from stakeholders. As a result it is hard to create a global overview of projects. The example results in a project which is managed in an emergency mode instead of a smooth project execution. The state is often addressed as a fire fighting mode.

In the end, the problems occurring while executing project business affect multiple stakeholders. Not being able to deliver can result in a decrease in customer satisfaction and trustworthiness as a company. This is only the customer side. Internally the problems lead to bad performance, shortages,

disbalanced stock levels and streams of goods. If it is still possible to supply, then the costs of delivery will be much higher because of the emergency mode and the maintained inventory balance are disordered.

1.3 Research questions

With this project, Hilti wants to define a global end-to-end communication and collaboration platform, covering all gates/phases and stakeholders of customer projects to improve the overall work efficiency and workflow. At Hilti is believed that a way of solving the problem is via a 'tool'.

A solution from the perspective of Hilti will provide:

1. Consistent information and transparency within and across all business units and functional departments
2. Clear guidelines for all stakeholders about requirements and milestones of a project
3. Flexibility to address different organizational structures and setups
4. The 'workflow' should be intuitive and simple to use

Apart from these requirements the project also has some system requirements, these requirements are not considered directly for the research itself but do offer value and direction for a solution.

1. The tool should be interactable with other systems
2. The solution should provide a graphical representation
3. The solution should include defined roles along the process

The project was executed as part of a larger project, where the goal was to come up with a new system to handle projects. The desired needs from the regions were derived for the overall project, as can be seen in Table 2. It also includes some technical specifications for a future system.

Table 2 Targeted solution per region

Research questions

Project business is known for its problems and challenges. However, there is still no holistic design or a way to tackle the problems which are faced with project business. One of the key problems is the amount of data the process operates around and the need for flexibility. The current state of project business at Hilti has no overview and a lot of it is executed in the firefighting mode. To improve the status of the situation, a workflow model shall be developed that can increase the overall transparency and improve decision-making in the end-to-end process. This research first directs to the question of which form of BPM system is best suitable, subsequently a modelling language is chosen. The result is a directive to help smoothen the problems occurring in a project business environment.

The main research question and supplemental research questions result from the business perspective combined with literature:

- *How can the project business workflow be designed to increase overall stakeholder transparency, communication, and improve the decision-making process and project steering on project business?*

Research questions:

1. *What type of Business Process Management system provides the best fit for the conceptual design?*
2. *Which corresponding modelling technique can be used for the type of Business Process Management system?*
3. *How do other companies in the industry handle workflow on project business?*
4. *Which level of detail should be used when designing the conceptual model?*
5. *How can flexibility be implemented in the conceptual model?*
6. *How can the general gates and milestones be implemented in the design?*

Scope

As discussed earlier in the thesis, there are more definitions when it comes to projects. For this thesis however, we see projects as one single definition: a customer project/project order. This is the order of a large set of goods or a customized order in which engineering is heavily involved. No distinction between different classifications of projects are made.

With the feasibility of the thesis in mind the data aspect of this topic will not be investigated. To get a clear idea of what the ideal project data should look like could be a project on its own. The thesis will be a recommendation for a to be design in the form of a conceptual design. The actual implementation will not be included in this thesis. Which makes the thesis a solution towards to the bigger project within Hilti.

1.4 Methodology

This section of the thesis describes the methodologies used in order to find the answers on the research question and its sub research questions. During the research, three main sources of information were used: the company, literature and company comparison interviews. The information from the company consisted of former research and documented workshops, which were held related to project business in Hilti. In a workshop a group is used to tackle a problem addressed in that particular session, which is a popular method in Hilti. The workshops were performed globally, since the project was carried out on the headquarter level. Second, information could be found in the current literature, which was acquired via the literature review. And third, information was gathered during company comparison interviews performed during the thesis.

1.4.1 Business process management system and language

Research question 1 is answered by first discussing the suitability of different business process management systems to the requirements of project business. For this discussion the different characteristics of project business are used for the comparison. For the basis of this analysis the book of Dumas (2013) and the research of Pillaerds & Eshuis (2017) was used.

In the second research question suitable modelling languages were chosen based on the results of research question 1. Special attention had been paid to the practicality of these languages. The language of choice had to match with the corresponding business process management system.

1.4.2 Interview

Research question 3 will be answered by conducting a company comparison. As a method, semi-structured interviewing was used, because these types of interviews provide the ability for the informant to express their views in their own words. Furthermore, semi-structured interviews provide the balance between the flexibility of an open-ended interview, and the focus of a more structured interview. Compared to an open interview, a semi-structured interview is likely to provide reliable and comparable qualitative data, and one can draw conclusions from a smaller sample size (Zorn, 2008). In the analysis with other companies, also information can be gathered for research question 5 and research question 6. Literature can help in the analysis as well (Kerzner, 2014).

To contact the external companies for the comparison, a multitude of networks was used. First, SCM World, which is a supply chain learning community consisting of a lot of different companies, is powered by the most influential supply chain practitioners, including Hilti. Second, the European Supply Chain Forum, which is an organization within the Technical University of Eindhoven, including 23 companies, was contacted to provide contacts for the benchmark. From both networks companies were selected which were active in a business were sales in the form of projects were relevant. From these companies the preferred people to talk to are people who have at least 4 years of project experience, preferably on a higher level in the organization. The desired companies were contacted via the network by sending an informative email about the research with the request of cooperation. However, most of the companies declined the invitation due to lack of time or lack of interest. As an alternative strategy the personal network of employees within Hilti were used to get contacts for this research. People within Hilti are linked to companies as key contacts to reach out to these companies. This was done in a brainstorm session where the former work experiences of direct team members of the project were checked. This resulted in a snowball like methodology of getting in touch with companies, most of the interviews were arranged in this way.

For the fourth research question a combination of resources was used. The knowledge gathered from the literature was combined with the preferences from the organization. The outcome of the first three research questions should provide direction for an answer on which level the process modelling needs to take place, according to the simplified 5 level model technique.

1.4.3 Flexibility and gate review

Research question 4 will be answered by investigating until which level of detail the cut off will be made between the two BPM approaches. Which will be done by discussing different scenario's and its effect on the overall process. For the discussion the 5-level modelling approach described in the next sub section will be used. For research question 5 a solution to the flexibility problem will be discussed with the use of CMMN in combination with a classic workflow model. The suitability of a hybrid use of the two will be proposed. For the 6th research question a general gate review process is discussed. A particular process is currently not in place at Hilti. For the research question a practical example has been used of a company implementation, where the company functioned on a project basis. The implementation of the company (Steenkamp & Bekker, 2018) was combined with literature on the subject from best practices(Kerzner, 2018).

1.4.4 BPM lifecycle

For the design of the conceptual design, this research made use of the BPM life-cycle approach. A graphical representation of the approach can be found in Figure 8.

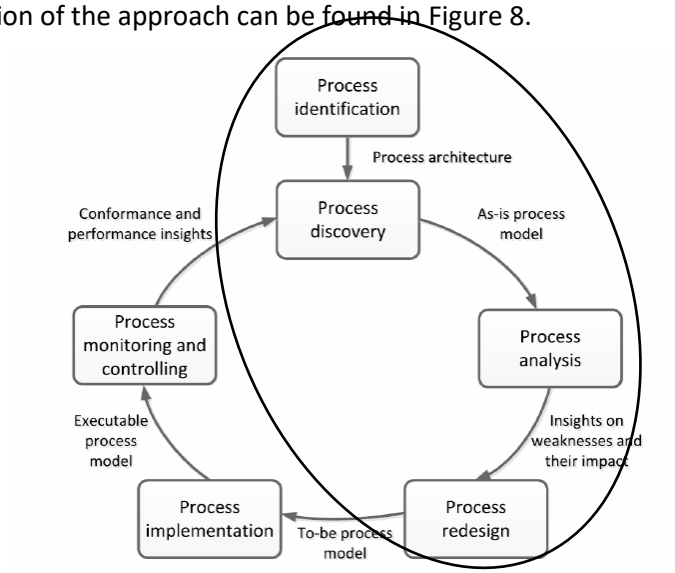

Figure 8 Business Process Management life-cycle (Dumas et al., 2013)

The BPM life-cycle starts with:

Process identification. This is the phase where the problem discovery takes place, and processes relevant to the problem can be identified. The outcome of this step is a process architecture which provides an overall view of the processes in an organization.

After this phase, the life-cycle enters the loop:

I. *Process discovery,* this phase is also known as the as-is process modelling phase. The current state of each process is documented. It is possible to have several as-is process models.
II. *Process analysis,* issues with the as-is process will be identified, documented and quantified. The goal is to get a structured collection of issues.
III. *Process (re-)design,* also known as the improvement phase. In this phase, the to-be design will be created. The most promising changes in the design will be implemented leading to the redesigned process.
IV. *Process implementation,* in this phase the changes required to move from the as-is phase to the to-be phase are prepared and performed. This stage covers organizational change management and process automation.
V. *Process Monitoring and controlling,* this phase data will be collected of the new system, how it is performing with respect to the objectives. If necessary, the process should go through the cycle again if bottle necks or negative performances occur.

For this research, only the first three phases of the BPM life-cycle have been used, see the circle around them in Figure 8. For the creation of the first design a project team was used to create the first design based on their knowledge. The first design was created in a revolutionary way since there was no process design in place yet. The design of the first draft was done in several sessions until a clear design was in place. The creation of the first design was done in an incremental way. After the design was in place it went through two redesign rounds, or as one could say two iterations. For the first redesign round the design was send and explained to multiple market organizations after which the feedback of these different market organizations was gathered individually. The gathered feedback was discussed with the project team. In the discussion was decided what actions to take on the individual comments. Where the options were to directly implement the comment, an adjusted

implementation of the comment or to not change anything at all. Besides having the changes based on the feedback also a process grouping took part. Where process groups were made by clustering groups of processes who could have all together as a block one incoming arrow and one outgoing arrow. The redesign after the first iteration functioned as the basis for the second redesign round. The second round of redesign was done in a workshop style at a global meeting in Moscow, from all over the world Hilti process experts were present to participate in this redesign workshop. The group was split in three parts where each group reviewed a part of the total process. Feedback was collected, evaluated and eventually by implementing the same steps as the former redesign round processed in the final design. By involving a lot of different experts in both redesign iterations the validation aspect has been addressed. A more detailed description of how certain parts of the cycle have been performed is described in chapter 5.

For the process hierarchy in the conceptual design, a simplified 5 level model will be used, as shown in Figure 9, more details can be found in Appendix H. The process hierarchy can be seen as a variation on the process architecture with three levels from the book 'fundamentals of business process management'(Dumas et al., 2013).

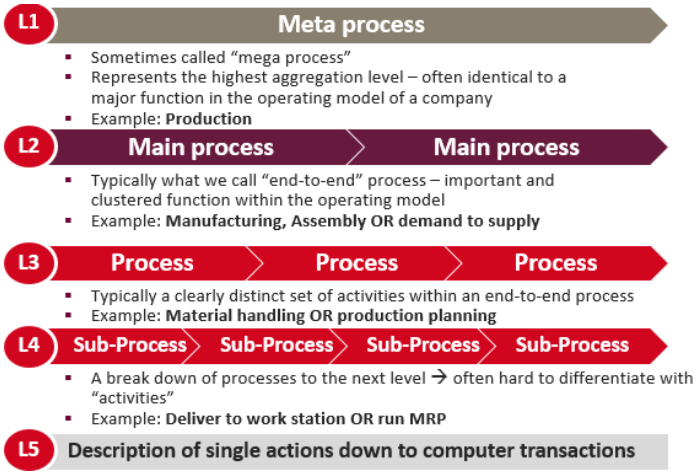

Figure 9 Business processes 5 level mapping approach, as used by Hilti.

This process hierarchy contains the following 5 levels:

1. Meta process

The meta process can also be called the mega process. The meta process represents the highest aggregation level. This level is identical to a major function, for example production.

2. Main process

The main processes together are what is called the end-to-end process. These are important and clustered functions within the operating model. Manufacturing or assembly are two examples.

3. Process

These are distinct processes within an end-to-end process. Two examples are material handling and production planning.

4. Sub-process

This is the breakdown of the processes, also known as the activities the process consists of. An example is deliver to work station.

5. Description of single actions down to computer transactions

The last level is the description of single activities within the sub-processes.

The Meta and Main process are driven by the business requirements. These describe the reasoning and desired results when conducting the processes. The business requirements are typically aligned with a strategic target of the company. The functional requirements can be found in the remaining three levels, the process, sub-process and single action descriptions. They state a to-be state how the desired outcome should be achieved when conducting the processes. The functional requirements give guidance for the system requirements. The system requirements describe how the system should work.

1.5 Thesis structure

provides an overview of the overall structure of the thesis. The current chapter outlays the problem definition and provides a company description. Later in this chapter the research questions will be presented, and the methodology will be described. Then first a literature study will be provided in the second chapter after which each chapter covers one or more research questions. Chapter 5 is devoted to the conceptual design for which the BPM life-cycle was used. The last chapter draws the conclusions from the thesis.

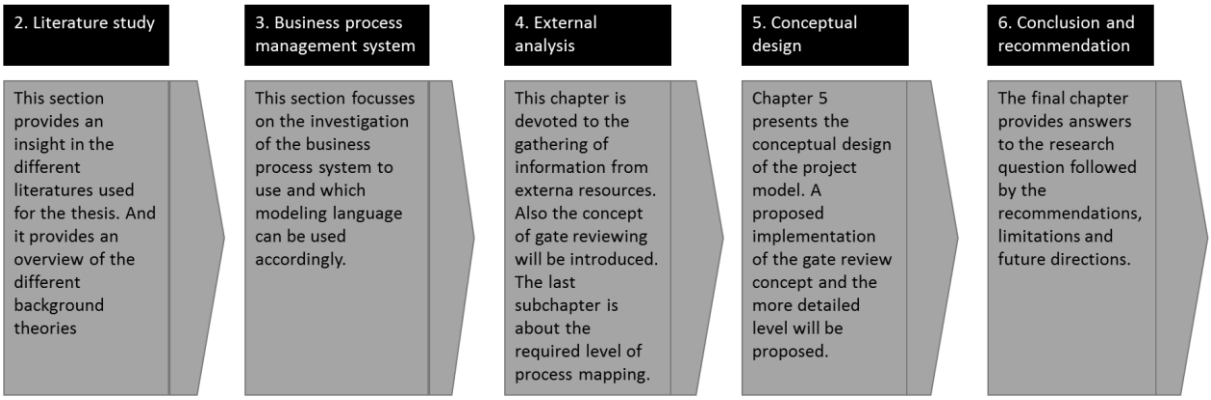

Figure 10 Thesis structure

2. Literature study

This chapter discusses the various relevant topics for this master thesis. Since the field of operations in which this research is conducted addresses the project side of Hilti, the first part of the literature is about project business. Subsequently project management is discussed, because it complements the working style required for projects. When measuring project performance business processes are a topic of the first level of measurement, therefore business processes, and business process management will be discussed in the remainder of this chapter.

2.2 Project business

Project business is a relatively new area of research in management science (K. Artto et al., 2011). Project business offers a business perspective for the management of projects, companies, and networks of projects and companies (K. Artto, Davies, Kujala & Prencipe, 2011). Project business can be defined as: "the part of business that relates directly or indirectly to projects, with a purpose to achieve objectives of a firm or several firms" (Artto & Wikström, 2005).

According to Artto and Wikström (2005), project business is: "the part of the business that relates directly or indirectly to projects in order to achieve the objectives of one or more businesses". To put it in a simpler form: "This is the concept of professional project management within a company".

In 2005, around 20% of the world-GDP was spent on project based arrangements (Bank, 2005). Lundin (2015) stated that the world economy is becoming more projectivized. Global businesses using project business as their main operations can be found in multiple areas (Sydow, Lindkvist & DeFillippi, 2004).

Since the late 1970's, the research field of project business has gained more interest, although different terms were used by different studies (Cattani et al., 2011; Hobday, 2000; Lindkvist, 2004; Owusu, 1997; Whitley, 2006). Artto (2011) stated that project business is still relatively new and unexplored. Later, after the project business had been reviewed from different angles, Miterev (2017) stated that there still is no such thing as a 'Holistic design'. Therefore, one can say that this research field has not reached a mature state yet. According to some, it is not possible to come up with one "how to" for running an organization which is operating in a project way. It is all dependent on the specific markets which the business is operating in, and the business model together with the strategy that is used. The variation of projects in which the organization is involved, makes it difficult to create one approach when it comes to execution of projects.

When is something considered a project? As Maylor et al. (2015) discussed that projects characterize themselves for their level of customization and thus a variety in the process. A graphical overview of this discussion can be seen in Figure 11, where big volumes are classified as "repetitive operations". However, one can argue, with the supply chain and its long lead time in mind, big volume orders can also be listed as a project. For example, when a project is won (a customer agrees to go ahead with Hilti by singing a contract), this has a big impact on the capacity of the supply chain. Then it is either big volumes which will be prioritized, and the normal business will suffer from the project, or the other way around. This is especially the case when the supply chain is not designed to have a big amount of overcapacity, a big volume order is likely to stress the capacity of the supply chain.

Project based organizations exist out of three critical phases of projects and their life cycles: the design phase, the commissioning phase and the operations phase. These are all critical for a project's success (Liinamaa & Wikström, 2009).

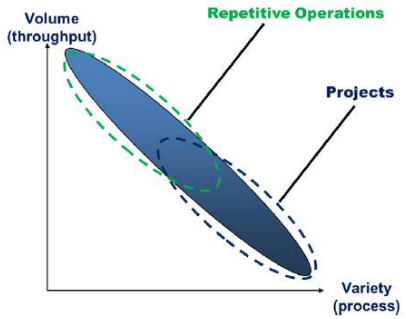

Figure 11 Volume/variety work distinction (Maylor et al., 2015)

Characteristics

In literature, different lists come up on characteristics of project business and lists on differences between project business in comparison to other fields of operation. The following list by Wikström (2010) can be formed on the differences of project business when compared with other business forms.

Differences of project business compared to other business forms are (Wikström et al., 2010): Specific relational context, Time-limitedness, Value creation properties, Type of complexity, High degree of uncertainty and Limited possibilities for standardization.

Next, characteristics of project business will be listed, combined from different sources (Alajoutsijärvi et al., 2007; Cova, Ghauri & Salle, 2002; Hellström & Wikström, 2005). The first three listed are also known as the DUC-framework (Mandják & Veres, 1998).

Characteristics of project business**:** Discontinuity, Uniqueness, Complexity, Financial outlays, Dynamic business, Long term focus on relationships, Time limitedness.

Project business STAR model

As previously mentioned, Miterev (2017) argued that the research field of project business needs a holistic design, which has not been made yet. For their research, they are using the STAR model designed by Galbrait (2014). The model is slightly adjusted compared the original one, a project can be seen as a project within a project-based firm which the model represents. The original STAR model listed five aspects: strategy, people, structure, rewards and process.

Miterev (2017) listed a total of 35 topics in their research, the literatures focused more on individual projects rather than the management of project-based organizations. Miterev (2017) concludes that project business has been researched more over the last years. Due to the limitation of just sticking to singular projects when it comes to project research, the organizational wide aspects are less developed. Figure 12 gives an overview of all the topics identified by Miterev (2017).

As an alternative to the STAR model, the McKinsey 7-S framework could be used. There are multiple models in literature, and every consultancy company is likely to have their own variant on the model. They are all likely to be sufficient for business analysis (Miterev, 2017).

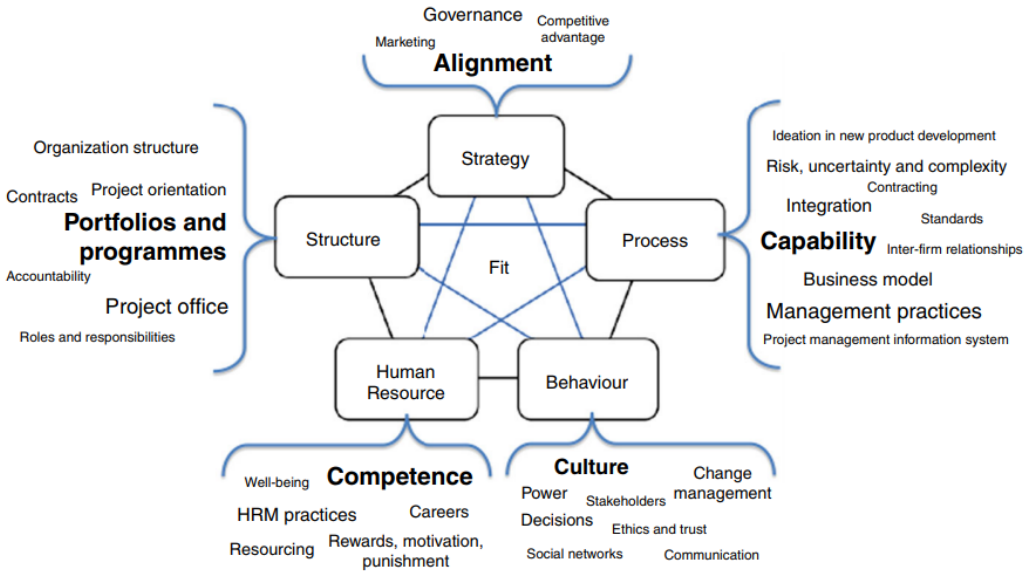

Figure 12 Miterev (2017): Graphical over view of the research topics.

Turner & Keegan's (1999) discovered that companies which adopted a fully project based way of working would lose their organizational cohesion and culture, so alternative structures need to be found to replace them. They suggested that it would be best if the company would maintain its functional hierarchy and find ways to let the functional hierarchy and projects to work together.

2.3 Project management

Project management in general is a challenge for companies, especially with the size and complexity of projects involved nowadays. When discussing the characteristics of project business, one can imagine the challenges faced with projects.

The key findings from 'best practices in project management' (Kerzner, 2018) are:

- "The better the project managers, the better the project results"
- "Managing the project was a greater challenge than just being able to technically execute the project"

However, organizations can take actions to solve the problems and streamline the process of project management. One way to do this is to develop a project management methodology. The form of methodology is dependent on the company and the characteristics of its. In smaller companies with projects smaller in size and with lots of variability, a standard methodology will either not be sufficient, or it will just be too costly to run, whereas it might be beneficial for companies with large comparable projects (Kerzner, 2018).

This lead us in the direction of a higher level fixed methodology and make it flexible when one gets more in the details of the project execution. This means that for the higher-level business processes on can develop a standard and for the actual execution there is freedom to act.

The benefits of a standard methodology on the short term can be (Kerzner, 2018): a decrease in cycle time and cost benefits, plans with a higher chance of meeting the time frame, better communications, and lastly feedback. On the long term a standard methodology could lead to the following benefits (Kerzner, 2018): faster project execution, lower risk, better risk management (which should lead to better decision making), greater customer satisfaction, emphasis on value added and customer satisfaction, and being treated as a partner of the customer. Kerzner stated (2018): *"A methodology*

is a series of processes, activities, and tools that are part of a specific discipline, such as project management, and designed to accomplish a specific objective."

Project management can be measured in levels of maturity, multiple frameworks exist. For example: CMMI, P3M3, and P2M in Japan, the best known being the Organizational Project Management Maturity Model—OPM3® (Project Management Institute, 2013). This uses 5 levels of maturity:

- Level 1: Initial Process
- Level 2: Structured Process and Standards
- Level 3: Organizational Standards and Institutionalized Process
- Level 4: Managed Process
- Level 5: Optimizing Process

One thing the multiple frameworks have in common is that the first few levels focus on structuring and standardizing the business processes. This is in line with the needs of the organization where the project is conducted, these first structured layers of processes are not in place.

2.4 Business processes

To describe a process, multiple definitions can be found in the existing literature. Horne and Hechter (2003) were the first to introduce the concept of processes in businesses, focusing on the division of labour.

A process contains a set of attributes and a specific order of steps, essential to be able to fulfil a task (Anand, Wamba & Gnanzou, 2013). Another complete definition can be found in the work of Hammer and Champy (1993): "A collection of activities that takes one or more kinds of input and creates an output that is of value to the customer." Many have tried to bring a structured categorization of business processes within an organization (Van Looy, De Backer & Poels, 2011). A general distinction was made by Kekre (1995), he divided the processes into operational processes, involving the value chain of a company, and management processes that control the overall functioning of a system (Mukhopadhyay & Kekre, 1995). Others have taken a more detailed distinction and introduced a third process, a support process (Armistead, Pritchard & Machin, 1999). Lastly a fourth category was added, the business network processes, that went beyond the boundaries of the organization (Earl, 1996). In conclusion, the purpose of process is to deliver a specified result, either by following a structured set of activities or by an unstructured collection of activities (Bukhsh, 2015).

Business process spectrum

A company carries out operations daily. These activities can be defined as business processes that help the company achieve its goal. The nature of the business process varies depending on the user, resources and the interaction with the associated IT systems (Dumas et al., 2005). McCready (1992) established the classification of operational processes, where the process is defined as ad-hoc, administration and production. Van der Aalst & Van Hee (2004) suggested a slightly different classification of business processes, which are strictly framed processes, flexible structured processes, an ad-hoc framed processes and unlimited processes.

When looking at the structure of business processes a categorization can be made. Business procedures can be completely structured on one end of the spectrum, 'semi-structured', or unstructured at the other end of the spectrum (Van Looy et al., 2011). The category of structured processes are processes which can be precisely described ahead of time. Every one of the functions to be executed, the sequence in which they occur, and the related process control altogether is known upfront execution of the procedure. This classification contains operational business processes with a high rate of execution (Bukhsh, 2015), or as one could say these processes are entirely predictable.

The semi-structured procedures can be considered as a blend of both organized and unstructured processes. Not every next step is specified. Some are fixed and not changeable, others do not have predefined rules and there is no fixed order (Richter-von Hagen et al., 2005). The activities to be executed are known, the sequence is not resolved yet (Bukhsh, 2015).

The last side of the spectrum is much harder to predict. Unstructured processes can also be referred to as Knowledge-based processes, they are regularly used for developing new product ideas. These processes include a high level of creativity and have no fixed structure (Bukhsh, 2015), they have a low level of predictability. The knowledge aspect in these processes refers to data, where the data is used to structure and drive the process. Accordingly, unstructured processes give more expressive power and in this manner, the prerequisite of structure can be considered as restrictive (Liu, Rong & Kumar, 2005). Figure 13 gives an overview of the spectrum of business processes. On the right side it also includes the level of knowlegde intensive processes.

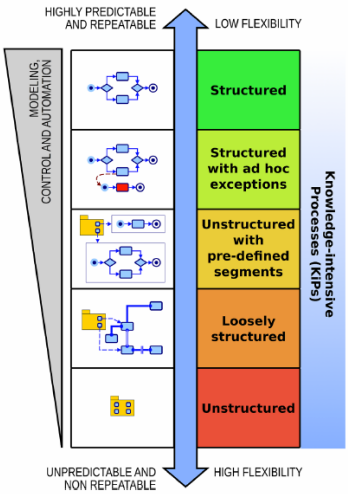

Figure 13 The spectrum of process management (Di Ciccio, Marrella & Russo, 2015)

Once an organization has effectively figured out how to make the perfect conditions for a process managed environment, it can begin to make a translation of these procedures into models. These process models will describe the organization's methods and working procedures, and will enhance efficiency (Aagesen & Krogstie, 2010). However, process modelling is not used with one particular goal in mind. Aagesen (2010) states this can clarify why there is such an extraordinary variety of approaches found. Five main categories can be distinguished (Krogstie, Dalberg & Jensen, 2006). Human sense-making and communication is the first category. The second category is computer analysis. Third there is quality management. Models in the fourth category are to model deployment and activation for the integration of the model in the information system. The fifth are models being utilized as a context for system development.

2.5 Business Process Management

Business Process Management (BPM) has become an area of growing importance in the industry and research, since it provides ways to achieve operational efficiency in times when resource optimization and performance improvement are challenged by organizations. Factors that drive organizations to embrace BPM, include the formalization of existing processes, identification of necessary improvements, organization of efficient process flows, increased productivity, complex problem analysis and regulatory compliance (Havey, 2005).

BPM is an active research field and is based on the observation that every product that a company delivers to the market is the result of interrelated activities, also known as business processes. Generally, an organization contains many business processes. BPM aims to understand the

organization and the relationship between these activities, possibly to manage and / or improve them (Weske, 2012).

Two primary intellectual histories exist for BPM, according to Hammer (2015). The first is the modern quality movement based on statistics and metrics to measure work to identify and address performance issues. This movement is shaped by approaches such as Total Quality Management in the 1980s. The second predecessor is in line with Hammer & Champy's proposed business Process Reengineering wave of the 1990s, which proposes the fundamental rethinking and radical reorganization of business processes to achieve sustainable improvements. The synthesis of these two approaches together with other influences such as Davenport's (1993) work on innovation processes, are the origins of modern BPM.

Business processes are the foundation of BPM. Numerous definitions have been proposed (Assimakopoulos, 2000; Hammer & Champy, 1993; Ould, 2005), however they all offer the thoughts of individuals or entities executing activities where inputs are changed into profitable outputs.

Information systems play a key role in BPM and a more than ever number of activities are supported by information systems or even totally automated (Weske, 2012). All together for an organization to achieve its objectives efficiently and effectively it is critical that information systems, employees and organizational business aspects are well coordinated (Weske, 2012).

The act of BPM is connected to activities that go beyond the main order of business processes: it covers their control, monitoring, analysis and continuous improvement. In this sense, BPM can be defined as:

- "…concepts, methods and techniques to support the design, administration, configuration, enactment and analysis of business processes" (Weske, 2007).
- "a structured, coherent and consistent way of understanding, documenting, modelling, analysing, simulating, executing and continuously changing end-to-end business processes and all involved resources in light of their contribution to business performance"(Aagesen & Krogstie, 2010).

Since business processes show up in extraordinary variety, BPM incorporates diverse sub-paradigms to deal with these processes. One can think of workflow management which is suitable for processes in which the activities and execution requirements can be predefined ahead of time, these can be classified as structured processes (Weske, 2012). However this form is not very suitable for managing less structured processes (Weske, 2012). In this manner BPM likewise incorporates the view of case management and groupware which are designed for dealing with these less structured processes.

Principles of process management

To gain better understanding in what BPM is, Hammer(2015) summarized the concepts of process management. While a portion of these are somewhat obvious, others end up being extremely valuable. One of these is "All work is process work", which implies that, not at all like the misconception that process management only applies to structured, transactional processes, it cannot be misunderstood as an equivalent word for routinization or automation. Another rule is: "One process adaptation is superior to many".

2.6 Concluding remarks

This chapter functioned to provide background materials on the following research. Where the general concept of project business and project management were introduced. Later combined with the introduction of business process management. The topics will provide a basis for the following research. The next chapter will continue with the investigation of multiple business process management systems.

3. Business process management system and language selection

The aim of this chapter is to answer research question 1 and research question 2, which were about what business process management system to use and the corresponding modelling technique for Hilti. In the previous chapter the definitions of business processes and business process management have been introduced. This chapter focusses on the different systems and a language which can be of used with the chosen system.

3.2 Business process management system selection

Before deciding on a Business Process Management system, it is necessary to evaluate which of the existing systems corresponds best to the needs of the project business process at Hilti. The purpose of this question is to compare the characteristics of project business to literature on different Business Process Management systems and decide on a type of system which will be used throughout the project. This sub chapter uses literature to answer the research questions because it provides a foundation to work on.

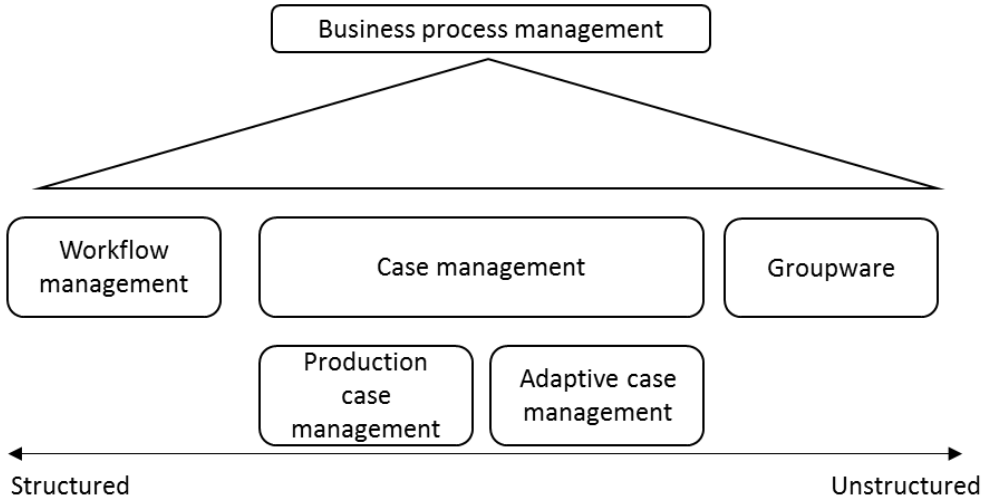

Figure 14 Business process management systems

In the current business process management environment there are several different systems one can use to manage the processes within the organization. An overview of the different systems can be seen in Figure 14. The different systems are presented on a scale of structure. One could see a similar scale on the process spectrum on the vertical axis in Figure 13. Here the overview also lists the level of knowledge intensiveness, which is related to the topic of project business due to its characteristics being: Specific relational context, Type of complexity, High degree of uncertainty and Limited possibilities for standardization. To find out which will suit the overall needs of a manufacturing company, which becomes more and more project oriented, best, two things will be done. Firstly, the overall different business process management systems will be discussed shortly. Subsequently it will be discussed which of the systems provides the best fit for our research problem.

3.2.1 Workflow Management systems

Workflow Management systems (WfMSs) are processes driven in general, rather than data-driven (Motahari-Nezhad & Bartolini, 2011). Although data can be implemented in WfMSs, it is generally utilized for routing, to provide probability changes of a route. The process does not depend on the employee in terms of decision making on the workers knowledge, since all the choices are pre-modelled (Reijers, Rigter & van der Aalst, 2003; van der Aalst, Weske & Grünbauer, 2005). One can state that nowadays all processes include a form of collaboration, however, traditionally WfMSs do not include data in the system and therefore do not support collaboration based on knowledge exchange (Herrmann & Kurz, 2011; Reijers et al., 2003; van der Aalst et al., 2005). Workers do not

need to get data from different information sources to continue the process for the most part (Herrmann & Kurz, 2011; Reijers et al., 2003; van der Aalst et al., 2005).

WfMSs are mainly designed for processes which are very structured, with a high predictability, in general (van der Aalst, 2013). The system is structured, which means that every task and choice needs to be modelled upfront, and therefore suitable for structured processes (Di Ciccio et al., 2015; Herrmann & Kurz, 2011). The nature of the systems makes it hard to react on dynamic events, which may influence the system (Reijers et al., 2003). A WfMS is more designed for processes than it is orientated on goals (Di Ciccio et al., 2015).

WfMSs are implemented for standardization and a high frequency of executing the processes (Reijers et al., 2003). The way of explicit structured modelling leads to inflexibility; therefore are these types of systems less suitable for work environments with changing conditions (Di Ciccio et al., 2015; Reijers et al., 2003; van der Aalst, 2013). One of their main benefits is that these types of systems are easy to understand, because of their high level of structure (Di Ciccio et al., 2015) and steady sequence (van der Aalst, 2013).

3.2.2 Case management

Case management was developed as a paradigm to facilitate the management of business processes with a rate of flexibility. A definition for case management is: “A paradigm for supporting the design, administration, configuration enactment and analysis of knowledge-intensive business processes, considering a case as its main focus” (van der Aalst et al., 2005). Case management as a paradigm for business process support was proposed by van der Aalst et. al. in (2003), where the difference between BPM and CM was explained as BPM focusing on what should be done and CM focusing on what can be done (van der Aalst et al., 2003). Case management facilitates the knowledge worker in: decision making, data capturing, and helps the user to respond to changing business circumstances (Swenson, 2013b).

A case can consist of multiple tasks (van der Aalst et al., 2005). To complete a case, the tasks have to be completed in order to meet the completion criteria of a case. Here the order of the to be performed tasks is dependent on the user, also known as knowledge worker (Van der Aalst et al., 2005). With the focus more on completion, one could say that case management is more goal oriented (Koehler, Woodtly & Hofstetter, 2015; van der Aalst et al., 2005). In comparison to earlier described workflow management systems, case management is driven by the dataflow. One can state that case management is therefore datacentric (Van der Aalst et al., 2005).

Case management is based on collaboration between knowledge workers (van der Aalst et al., 2005). Business procedures can include different process members who need to team up with a specific end goal to accomplish (Herrmann & Kurz, 2011). This requires communication and collaboration between users. It is therefore critical to keep track on who performed which action with which result, in order to guarantee transparency (Herrmann & Kurz, 2011).

Case management can be divided into two different approaches: production case management (PCM) and adaptive case management (ACM) (K. D. Swenson, 2013b).

3.2.2.1 Production Case Management

PCM systems are of good use when multiple knowledge workers are doing the same job (Pillaerds & Eshuis, 2017) and the exact process is not clearly defined. PCM provides flexibility, but is made for more repetitive tasks (Keith Swenson, 2012; Van der Aalst et al., 2005). The tasks can be defined upfront although the exact order does not necessarily have to be provided upfront(Swenson, 2013a). The way of the process is not always the same, but similarities between different instances of the process appear more often than is the case in adaptive case management (Swenson & Palmer, 2010).

PCM systems are suitable for data integration incorporation, the knowledge worker can get data from different sources (Swenson, Palmer & Done, 2012). PCM frameworks incorporate data and the users need experience to progress through the system (Swenson & Palmer, 2010). The user is guided by predefined goals, which cannot be changed throughout the process (Pillaerds & Eshuis, 2017).

The systems can keep track of multiple aspects: which users performed which task, why that task was performed, and the system supports collaboration amongst users on the exchange of knowledge (Pillaerds & Eshuis, 2017). The system is modelled by consisting of business rules and legal regulations directions (Pillaerds & Eshuis, 2017), they do provide limited possibilities for adaption of the process because of events.

3.2.2.2 Adaptive Case Management

Much the same as CM, ACM revolves around a case rather than a process (Herrmann & Kurz, 2011; Van der Aalst et al., 2005). There does not need to be a predefined process and the case is highly dependent on the user's decisions, which should be based on available case data as to achieve their objective (Herrmann & Kurz, 2011; Reijers et al., 2003). The uniqueness of ACM lies in the capacity of ACM to flexibly respond to unpredicted changes (Herrmann & Kurz, 2011). ACM aims to create patterns, as exceptions to the regular process occur more often (Reijers et al., 2003).

ACM frameworks are data-centric rather than process-centric, information is captured in a case file (Herrmann & Kurz, 2011). With this way of working an ACM system is able to provide necessary information to the user, which gives the user the ability to make decisions accordingly (Herrmann & Kurz, 2011; van der Aalst et al., 2005). ACM systems are goal oriented, the activities needed are not likely to be predefined, or at least not all of them. This creates room for the user on the decision which actions should be taken, in order to reach the goal (Herrmann & Kurz, 2011).

To let an employee efficiently work with an ACM system, the systems needs provide executable tasks, time constraints and information. Such a system should be able to trace back actions after completion of a case in order to be able to sufficiently manage it (Herrmann & Kurz, 2011). Finally, an ACM System should be able to give the user access to the organizations data and (intermediate) results of a case (Herrmann & Kurz, 2011).

3.2.3 Groupware

Groupware systems are targeted to support user collaboration and co decision, they offer a high level of flexibility and enable users to control the tasks and execute them freely (Dumas et al., 2013). The process is unpredictable (Di Ciccio et al., 2015) and data must often be derived from different sources (Swenson, Palmer & Done, 2012; Van der Aalst, 2013).

Due to the low level of process predictability, groupware systems are used for low volume processes, thus mostly for individual processes and not for the management of large repetitive processes (Reijers et al., 2003). Due to the flexibility of a groupware system it is able to handle flexibility. However, it is not possible to really model process sequences and therefore the systems are more goal and decision oriented (Reijers et al., 2003).

3.2.4 Comparison to project business

As could be read in the problem definition in chapter 1.2, there are multiple problems with the current way of working nowadays. These issues lead us in the direction of the knowledge intensive business processes, since the dependency on people and data is high. Besides that, the real process to follow does not seem to be clear at all.

In chapter 1.4, the process mapping methodology used within Hilti was elaborated. Here one can clearly see a distinction in detail of the processes where the higher levels of this mapping are more abstract and include more (sub-)processes in them. The lower levels of single activities are very much pinned down, or at least this was the company's target by choosing this methodology. This form of

process mapping was used to be able to clearly define all the necessary steps along the process. For a WfMS this would mean that all the steps must be set in a certain order to make a very structured overview. In the case of a CM system this would mean that the tasks could be grouped, but the exact order would not be fixed.

In the best practices of project management by Kerzner (2018), it is stated that to fulfil good project management one can make use of a higher level fixed methodology and a lower level flexible methodology. This would mean, in terms of business process modelling, that one would have the higher levels of the model in a classical WfMS way of modelling and the lowest levels in a more flexible way, a Case Management style. If one would be developing along this road, it should be first decided where to draw this cut off line, which will be further discussed in chapter 4.3.

This gives us a step up to the evaluation criteria for the different systems chosen to be compared. The evaluation criteria are derived from Hilti's targeted solution and the characteristics of project business:

- Predictability: How does the predictability of a process relate to the system?
  Are all steps/activities known upfront? With the former mentioned mix between a fixed and flexible methodology both levels of predictability have to be taken into account.
- Dynamic environment: Is the process affected by events that are not mapped up front?
  Is it necessary to know all activities upfront? When going into the details necessary steps might differ per project.
- Goal orientated: Does the process progress through the completion of tasks or does it evolve through the completion of goals?
- Evolving goals: Do the goals stay the same or are they likely to change along the way?
- Repeatability: Is the process repeatable?
- Transparency: Is it possible to trace back who did what at which step of the process?
- Frequency: Is it possible to process multiple instances at a high frequency?

The table evaluation can be viewed in Table 3. From this analysis the following conclusion can be drawn. A groupware system is not designed to support business processes (Dumas et al., 2013). Therefore, this form of BPMs will not be likely to provide a good fit for the conceptual design. It is one of the requirements to have a graphical representation of the processes needed, which could be in the form of a workflow template. Besides that, a groupware system is not suitable for repetitive actions. In the case of new development for projects, a groupware system would be suitable. However, the goal is to create a global standard. A groupware system will for this reason not be considered as a solution for the problem. This results in two distinctive systems, each on the other side of the perspective in terms of business process management systems, a WfMS and a CM system. The spectrum can be found back in chapter 2.4 in Figure 13. We will continue with the comparison of project business to these two forms of systems.

When comparing the two systems with the characteristics of project business as described in chapter 2.2 in general, one can see that this form of business requires flexibility due to the main characteristics: discontinuity, uniqueness, complexity. With this in mind one could make the link to the Case Management system.

When following the 5-level business process mapping approach, the mapping and agreeing on processes and its order, is easier when the level is higher. For example, a level 1 process, of which there are just a few, will be very structured and logic in order. However, when one gets to the more detailed levels of process mapping, differences between projects, and differences in market organizations can occur within Hilti. This makes it not possible to make one workflow that could fit all the market organizations.

	Workflow management system	Production case management	Adaptive case management	Groupware
Predictability	The system has a high level of predictability.	The system is not entirely predictable in terms of sequence, but the steps are known upfront.	It is not necessary to define everything upfront. Steps can emerge while the process takes place.	It is not necessary to define everything upfront. Steps can emerge while the process takes place.
Dynamic environment	Processes are not influenced by unknown events.	Processes are not influenced by unknown events.	The process is able to react to unknown events that affect the process.	The process is able to react to unknown events that affect the process.
Goal orientation	The process progresses through the completion of tasks.	The process progresses through the completion of milestones and goals.	The process progresses through the completion of milestones and goals.	The process progresses through the completion of milestones and goals.
Evolving goals	Process does not evolve through goals but progresses via the completion of activities.	Milestones are fixed upfront.	Goals can evolve overtime as the goals are reached and more knowledge becomes available.	Goals can evolve overtime as the goals are reached and more knowledge becomes available.
Repeatability	The process is repeatable, the process requires the same actions to receive the output.	The work is usually repeatable, with exceptions.	The process varies every time when executed, however parts can be the same as earlier instances.	The process in non-repeatable, no use of process elements.
Transparency	One can trace the track of actions performed.	One can trace the track of actions performed.	One can trace the track of actions performed.	No actions are traced of who did what to achieve which goal.
Frequency	The frequency of execution is high.	The frequency of execution should be high.	The frequency of execution is low.	The frequency of execution is very low and unique.
Collaboration	Low level of collaboration between workers.	High level of collaboration.	High level of collaboration.	High level of collaboration.

Table 3 Business process management systems comparison (Pillaerds & Eshuis, 2017)

In conclusion, on the higher levels of process definition, processes can be defined clearly, and the order can be fixed. This would make a WfMS sufficient for the higher levels, since it has a clear process structure and offers a great repeatability. It is therefore suitable for the development of a standard. The main research question also includes a general workflow. For the lower levels of process mapping, where the level of detail is higher and the differentiation between market organizations occurs, a Case Management system could be of use with the ability to only highlight key tasks to be performed. This solution leaves room for their exact execution order of the processes and it offers the ability to model optional tasks or introduce task while in process, which have not been modelled up front. However, as stated earlier in this chapter, the level where the distinction is made between a WfMS and a CM will be further discussed in chapter 4.3.

3.3 Business process modelling language selection

After having derived the options for a business process management system, a corresponding modelling language has to be chosen. The former sub chapter resulted in two systems, a workflow management system and a case management system. These two systems will be considered for the analysis. With the suitability of the language, the possibility of cooperation between the languages is considered.

3.3.1 Modelling

Many methodologies can be used when it comes to modelling business processes. Before implementing a process model into a workflow, it needs to be modelled properly. Business requirements need to be captured precisely by its processes, and it has to ensure a successful execution (Liu, Rong & Kumar, 2005). Process modelling gained popularity across multiple industries, and for many other purposes besides the development of software (Becker et al., 2000). The understandability of process models is of growing importance, because of the growing number of variety of model designers and users (Becker et al., 2000).

Process modelling is fundamental for companies engaging in BPM initiatives. Models can be used for the communication of the current state of processes as well as the possible future state. Curtis et al. (1992) and Krogstie et al. (2006) recognize five main categories of objectives and uses of process modelling: Facilitate human understanding and communication, Support process improvement, Support process management, Automate execution support, Automate process guidance. Some modelling approaches are more suitable for one specific purpose than others. Therefore the identification of the modelling purposes and uses is of importance (Aguilar-Saven, 2004).

Business process modelling is representing a process through a model. A process model:

- "describes, typically in a graphical way, the activities, events and control flow logic that constitutes a business process" (Indulska et. al., 2009);
- "consists of a set of activities and execution constraints between them" (Weske, 2007).

3.3.2 Modelling languages

After deciding which BPMs to use, it is decided which modelling method will be used to model the process. Due to the indecision of fixed and flexible processes, Business Process Modelling Notation (BPMN) and Case Management Modelling Notation (CMMN) are both possibilities.

From the former part of this chapter, where the suitability of different business process management systems is discussed, direction can be derived. The chosen systems each were on the opposite side of the business process spectrum. For the two sides of the spectrum there are two main modelling languages provided by the Object Management Group. The first one is BPMN, which is a modelling language that is accepted as a common standard for modelling business processes, especially with the modelling of workflow (OMG, 2011). There are multiple reasons to choose BPMN as a language for the WfMS. For example, it's ease of use and understandability for a wide group of users, ease of adaption that can be made to a graphical model, and the ability to almost directly implement a BPMN model in a software system. The last argument was very important since eventually the implementation of a business process management systems is the higher goal of the project within the company. With this practical need in mind BPMN provides a better fit compared to other more academic modelling languages. Recently the Object Management Group introduced a language which is targeted on the modelling of less structured business processes, the Case Management Modelling Notation (OMG, 2014). This language was designed in a way that it could be used in combination with BPMN. When it comes to case management there are more options when it comes to modelling languages in the academic world. Alternatives for both languages will be discussed in the last sub chapter of 3.3.2. First a short introduction of the languages will be given, after which alternatives will be discussed and lastly a comparison will be made of the two languages.

3.3.2.1 BPMN

Throughout the years, different approaches and notations have been utilized for Business Process Modelling and workflow. With its origin in multiple past languages, the Business Process Modelling Notations (BPMN) is considered as a standard (Aagesen & Krogstie, 2010). BPMN is a graphical modelling notation that aims to model the 'end-to-end' business process. Its primary objective is to function as a notation that is understandable by all users, from the analyst at the stage of origin to the technical developers and in the long run to managing the business and monitoring the processes (Bukhsh, 2015). A business process diagram is composed of a set of graphical components which are distinct from each other and mundane to most modelers (Wolf, 2016). Four basic categories of elements exist: flow objects, connecting objects, swim lanes and artefacts.

BPMN was at first proposed by Business Process Management Initiative (BPMI). Due to mergers, OMG adopted it. BPMN 2.0, offers an exceptionally rich set of modelling notations. OMG (2011) provides a detailed description of BPMN as process modelling language.

3.3.2.2 CMMN

Case Management Model and Notation (CMMN) is a relative new modelling standard, proposed by OMG (2014). CMMN. It guarantees to model the case or unstructured business process in a way that can express their run-time flexibility (OMG, 2014). Normally, an unstructured business process is coordinated by a single or group of knowledge worker(s). These knowledge workers are responsible for the planning of the task sequence, decision making and require ad-hoc collaborations, which are all during run-time (Man & De Man, 2009).

Business artefacts established the foundation for CMMN Grudzinka (2013). Bhattacharya et. al., characterized the business artefact as 'a business entity that is used to store the information to a given process context' (Marin, Hull & Vaculin, 2012). The business artefacts have an entire lifecycle with clear states from begin to end. Guard-Stage-Milestone (GSM) approach captures the information model of business entities and additionally their states (Hull et al., 2010). CMMN could be influenced by GSM (Grudzińska-Kuna, 2013; OMG, 2014).

There are three types of core elements of CMMN: The case model component presents the idea of the case as a main container which constitutes all related components. The information model element consists of case files that contains all the case related information. The plan model elements are the most visible components on a case model. It incorporates events, plan items, milestones, tasks, sentries, and planning tables. A more extensive explanation of these elements can be found in the standard specification of CMMN (OMG, 2014).

3.3.2.3 Alternatives

Eventually the goal is to find a good balance in the languages used to provide enough structure as well as flexibility. The balance between an imperative approach (structure) and a declarative approach (flexibility). As an alternative methodology for the project a stage gate process approach could be considered. However, since this project also has a relative high level of predictability in its projects a stage gate process model would not be sufficient since it is typically suited for new product development (Cooper, 2008). Another alternative would be Goals Based BPMN, also referred to as Goals Based Business Process Modelling (GPMN). This is an approach which aims to bring the goals and the processes into the same diagram. The approach brings new modelling languages with it. Examples could be: GPMN-Edit, Go-BPMN and Go4flex. However, the technique being quite recent the approach is not as accepted as BPMN in the business world.
For CMMN the Guard-Stage-Milestone approach could function as an alternative, where CMMN is based upon this approach. However due to the practicality of the solution and the direct possibility of implementation of CMMN in combination with BPMN the chosen language provides a better fit.

3.3.3 BPMN CMMN Comparison

From the former description of the different languages, it was decided to compare BPMN and CMMN for the remainder of this chapter. BPMN offers a great ease of use for a workflow like setup, which was selected as the system of choice for the fixed part of the methodology. CMMN is designed to function as a language which can be used to model processes in a case management methodology. Furthermore, CMMN is compatible with BPMN without making additional changes.

Both languages model business processes, but differ in their methodology of modelling and their level of structure. The difference between BPMN and CMMN is in the modelling paradigm. BPMN is imperative, focusing on control flows (Wohed et. al., 2005), whereas CMMN is declarative, focusing on capturing flexible processes (Grudzińska-Kuna, 2013).

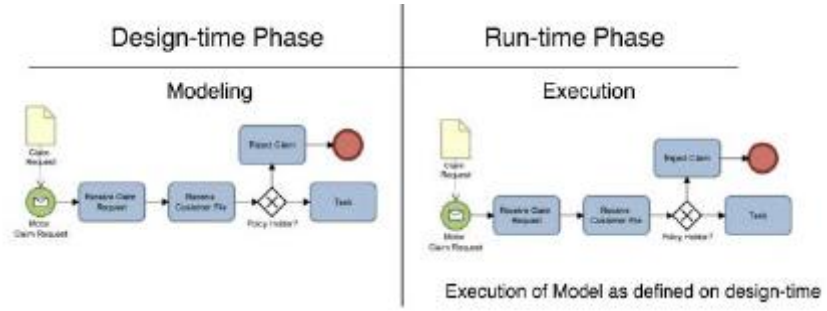

Figure 15 Definition and Execution of BPMN Model (Bukhsh, 2015)

Different are the two methodologies in design-time definition and the actual run-time execution. Figure 15 represents this definition for a process designed using BPMN. One can see that the two phases are the same, which means that during the execution, the process follows the path designed during the design phase. This way of working leaves no room to add activities during the execution phase.

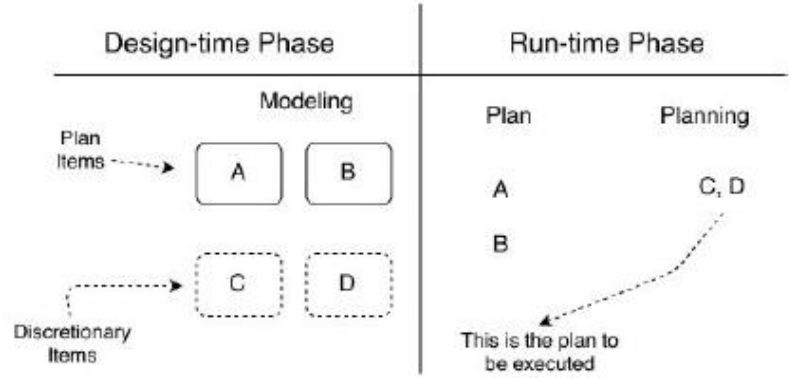

Figure 16 Definition and Execution of CMMN Model

In contrast the CMMN model is different when it comes to this aspect. Figure 16 represents the overview of the difference in design-and run-time for CMMN. During the design time, the planned items are defined. The optional to be executed items are defined as well at this stage. However, there is no predefined execution order for the processes. During run-time the plan items will be executed, whereas the optional (discretionary) items are planned at that time. It is important to know that the discretionary items do not have to be performed necessarily.

CMMN is more flexible than BPMM. Although it is possible to model some flexibility with BPMN extensions, it will not reach the same level of flexibility as CMMN does. Both modelling methods have their pros and cons. When one tries to model flexibility in BPMN this results in complex models, and

when one implements extensions for BPMN the readability is likely to decrease (Bukhsh, 2015). The down side of CMMN is that it lacks a clear way of expressing the process execution sequence. A structured overview of the down sides and benefits of the two methodologies can be found in Table 4.

	Benefits	Down sides
BPMN	Sequential process flow provides good readability	Notations of ad-hoc processes is not expressive on process model
	Ability to define business rules/tasks provides transparency	Low support for ad-hoc processes
	Users can be assigned to lanes	Sequential flow limits flexibility
CMMN	Easy to understand in comparison to extensions of BPMN	The process is hard to follow due to the missing sequence of processes
	Due to milestone concept there is a quick overview of the project	No ability to model structured processes
	The concept of optional tasks is provided	Users cannot be assigned to specific tasks

Table 4 Comparison BPMN to CMMN (Bukhsh, 2015)

In line with the choice of a suitable business process management system, the choice of language is also dependent on the level and detail of process mapping. When the process needs to be modelled in a structured way, it is logical to opt for BPMN as the language of choice. However, when the other side of the spectrum is chosen, a less structured and more goal-oriented approach, CMMN will provide a better fit.

Nowadays there are lots of different software vendors who offer a classic workflow solution. However, there are less of them in the market who offer a solution which can also provide case management in their solution. For the software which offer suitability for both one can take a look at the so called intelligent Business Process Management suites. These best performing systems in this field can be found in researches like “Magic Quadrant for Intelligent Business Process Management Suites” (2017) or “The Forrester Wave: Cloud-Based Dynamic Case Management” (2018). One can think of a software vendor like Pegasystems, Appian or Newgen.

3.4 Concluding remarks

To conclude this chapter, we could argue to model the process on higher levels with a traditional BPMN method. Where the exact execution of the processes becomes less clear, one could use the processes of the BPMN model as goals, from which one will continue in the language of CMMN, by providing the tasks that are necessary for this so-called goal and the ones which are optional. With this approach one could create a goal-oriented process model, while still maintaining the possibility to model the process at a more detailed level. The detailed level would include the activities of which one knows to be in there anyway, no matter the variation of the process model. This idea of modelling can be linked to the concept of using a higher level fixed methodology and keep it flexible on the lower levels of the organization by Kerzner (2014). Furthermore, the sort of business process management system depends on the detailedness of the process mapping and/or detailedness of the conceptual design. Apart from this argument BPMN provides transparency due to its ability to define business rules and tasks, which fulfils one of the main need for transparency of Hilti regarding the project. In BPMN lanes can be assigned in the model by which it is clearly distinguishable which process belongs to which stakeholder. CMMN is easy to understand in comparison to other BPMN extensions, offers a clear overview of the project due to its milestone concept and it provides the option of optional tasks.

4. External analysis

This chapter focusses on three parts of the research. Firstly, a company comparison will be performed to gain more insight on the practical side of the research. The aim is to get the more hands on solutions from a real business environment. The ideas of the research have been compared to the current practices and wishes of different companies. Secondly, it will be analysed between which of the 5 levels of process mapping the distinction is made between the fixed and flexible methodology. Finally, a proposal will be made on how to implement gates and milestones in the conceptual design.

4.2 Company comparison

Table 5 represents an overview of the companies which were interviewed during the process. The table represents the industry and the size in employees and annually revenue per company. The companies are working on different industries and they use different networks. The aim of Hilti was to get insight on how other companies in the industry are handling the problems that come with project business. As a side project of the thesis, Hilti also wanted to gain insight in the systems different companies working in a project environment were using. This explains the specific question on which systems were used. The construction industry is one of the slowest developing industries, which makes it interesting to look at different industries for comparison.

Company	Industry	Country	Number of Employees in thousands	Revenue in millions
Alpiq	Electricity Utility	Switzerland	8.5	CHF 6,078.00
Ericsson	Telecommunication	Sweden	97.85	SEK 201,300.00
General Electric	Industry	USA	295	$ 122,000.00
Georg Fischer Company	Industrial Automation	Switzerland	14.4	CHF 3,640.00
Panasonic	Electronics	Japan	257.533	¥ 7,982,000.00
Philips	Healthcare, consumer electronics	the Netherlands	114.188	€ 24,510.00
Siemens	Building Automation	Switzerland	28.069	CHF 6,523.00
Danfos	Climate & Energy	Denmark	25	DKK 2,357.00
Teradata	Data warehousing	USA	10.093	$ 2,300.00
Oracle	Enterprise software	USA	138	$ 37,730.00

Table 5 interviewed company overview

Table 6 lists the current positions of the interviewees with their current time at the company. If it was applicable, also their former experience was listed with the duration that experience lasted.

The questions used for the interview can be found in Appendix A, the used questions were beforehand agreed upon by the project team. This team will be described in chapter 5. While executing the interviews at least two of the 4 team members participated in the interview. The results of the interview will be discussed per question. After discussing every single question, the main takeaways from the company comparison will be discussed, as well as the recommended direction for the thesis and Hilti.

The interviews were conducted via Skype, since the interviewed persons where stationed all over Europe. During the interview, extensive notes were made. These notes were as soon as possible worked out in full detail. The interview answers in detail can be found in Appendix B

. The next subchapter will be devoted to the analysis of the company comparison interviews.

Company	Position	Time at company	Former experience	Years
Alpiq	Head professional management BIM	6 years	Wust Huastechnik - Member of the management board	11 years
Danfos	Business excellence consultant	1 year	Siemens	5 years
Ericsson	Senior program manager	12 years		
General Electric	Service plant manager	13 years		
Georg Fischer Company	Head of strategic CRM	2 years	Hilti - Head of sales	3 years
Oracle	Business development consultant	2 years		
Panasonic	Sales engineer	1 year	Pentair - Sales engineer	3 years
Philips	Director EMEA site planning	20 years		
Siemens	Global process manager, project execution	5 years		
Teradata	Business Development Executive	2 years	Clarizen - Territory manager	2 years

Table 6 Company comparison interviewee overview

4.2.1 Interview analysis

The results of the interviews will be discussed per question, since each question highlights a part of the topic. The main takeaways of the interviews will be discussed and if applicable together with recommendation. As described, all the interviews were worked out in full detail directly after the interview. The answers of all the participants per question were grouped together. From these answers on the questions, the main points per respondent were highlighted, as can be seen in appendix B. Subsequently provided these main points the basis for the discussion of the questions. Big conflicts in the responses did not occur.

1. *What do you consider a customer project? Typical size/scope/duration?*

This question was introduced to align with the interviewed companies on what a project is. As a verification that they would have the same definition of a project as Hilti has. Lastly it was used to check the different ways to measure projects in terms of size, scope and duration.

Most of the companies participating to the comparison had their own way of differentiation customer projects. This could vary based on: value, units, amount of people needed for project or risk. In one case a company classified projects based on their level of customization required. In terms of the duration of a project it depended per company, but in general projects tented to last long, which was comparable to Hilti's situation. This question was used to check with the interviewees if we were talking about the same sort of projects, since the topic would be specific on customer projects, not internal or any other type of project.

From this question the following main recommendations could be derived: clearly define what a project is to Hilti and make this definition market specific. Since the variation in terms of size of the market differs, what is a big project in one market organization can be a small project in a larger market organization.

2. *How are you organized to manage these projects?*

This question was introduced to find out how the company was organized to manage projects. As to get an idea of the organization and to see if differences could be derived.

The companies tended to have different ways of organizing for projects, but one thing they had in common was their strong presence of a project manager. The key role of this person was to be responsible for the complete project, in some companies they had a very strong presence. It was stated that good project management is dependent on good project managers, which is in line with the finding on the importance of people from the book on Best Practices by Kerzner (Kerzner, 2018).

Compared with Hilti there was a difference in organization. Hilti does not have such thing as one person having full responsibility of a project. It is not always clear who is responsible. The main recommendations to Hilti are the following: early involvement of a Project Manager/PMO in the sales phase. There should be a clear handover point from sales to the project manager, to make sure there is a clear understanding of who is responsible for the project. In order to get all the stakeholders involved and up to date, have a project kick-off meeting implemented in the processes related to projects.

3. *How are projects initiated?*

The third question was used to check how projects were initiated. In Hilti they are provided through an internal sales team, however there are more ways for a company to bring in projects.

Based on the different ways the organizations were structured, the sales process differed. In most companies a project started after the sale had been made, so when revenue for the project was ensured. Another option was that they had a clear pre-project sales phase. With the interviewed companies there was a differentiation between having their own sales team and having an external sales team. Where it was believed that having an internal sales team has a better chance of improving transparency across the company. Because the data is already in the company.

At Hilti this process is a little different. Hilti does have a direct sales model for the entire organization. However, as a supplier of tools and custom solutions for the construction industry, they are in the later stages of the construction project. The contractor will decide on the tool and parts supplier, which leaves Hilti with a long-time uncertainty. Therefore, Hilti's projects are based on probability of success. This means it is possible that the actual project conformation can come late in the project. A large part of the project is carried out without the certainty of the sale by the customer. Both the direct and indirect sales models do have their pros and cons. With the direct sales model Hilti uses it provides a better chance when it comes to improving the transparency in the company, since it is internally managed. This gives Hilti an advantage in that way. In the future it would be favourable to have a clear handover point from sales to the PMO.

4. *What kind of project management software do you use for customer projects?*

This question was mainly focussed on the goal of the project within the company. Where it was used to find out if there was a common system used by these companies.

Among the different interviewed companies, only two stated that they had a fully integrated system to run their projects. For one of them nothing could take place outside of the system. Also, a down side of a big fully integrated system was addressed; it is hard to use and not easy to understand.

Besides this, it would take very specific technical knowledge to adapt or make changes to the system. Throughout the respondents there was a large differentiation in systems used which were related to projects. An overview of the different software systems used can be found in Appendix B. From the ones that did not use a fully integrated system, it became clear that in the future they wanted to have one, or at least bring all the data into one system. With the intention to have the data in one place, multiple different systems/tools could interact with this data. One of the respondents stated the importance of user acceptance. The current tool that should be used for their project management is not accepted by the workforce, and therefore the system is not used optimally. This statement is in line with the finding from the book "Fundamentals of Business Process Management" (2013) where it is stated that the change process is harder than the BPM process itself.

A single preferred project management software could not be found from this company comparison. Which was a disappointment for Hilti since it was their most important research goal. As a first step in the direction of a system it would be advisable to have at least all the data in one place, which creates one single true data source. Lastly, with the development of a system in the future of the project the people aspect of the systems users should not be taken lightly. Since it is one of the key factors for the successive use of a new system.

5. *How do you ensure that all inputs have been received and activities completed before a project moves to the next phase?*

With a project style of working there are more ways to manage projects. Every project has to deal with inputs to the project. As Hilti wanted to work with phases this question checks how it can be ensured all the inputs are received and former activities have been completed.

Compared to what Hilti is willing to implement, most of the companies had a form of project phases in order to manage the project processes. It was observed that the companies who were in the bigger offshore and/or oil projects used clear milestones for their projects, to track progress. This could be done by weekly and monthly project meetings. However, these milestones were not clear within every project, in either one form or another the milestones were in place.

For Hilti it would be advisable to implement the following things regarding to project management: define clear milestones per project. In order to track project progress, develop a gate review process and introduce a structured way of project updates with weekly and monthly project meetings. This suits the need of the final research question.

6. *What is the common form of internal communication with regards to customer projects?*

One of Hilti's desires is to have one system for everything, including communication. This question is to investigate how the interviewed companies handled their communication.

This part of the interview had similar answers from all of the interviewed companies, except for one. Most of them said they used all different forms of possible communications, even if everything was fully integrated in one system. However, one respondent stated he preferred to do all the communication over the system. However, this was hard to do since not all colleagues wanted to work in this way. So in this case the majorities opinion was honoured.

With a possible new future system in mind for Hilti, with regards to project management, it is advisable to have the option of communication implementation, or at least the achieving of key communications. Secondly, the standardization of project documents can improve the trackability and the comparison between multiple projects. This form of standardized working could also improve the possible collaboration internally. The standardization is in line with the development of a standard project methodology. However, apart from these answers the question on communication was one

of the questions in the company comparison interview which was more focused on the functionality of the eventual system itself.

7. *What is your future perspective on customer project management?*

Out of interest for the future perspective of the different companies this future minded question was introduced.

For the future of project management solutions companies aim to be more customer oriented. When developing a system, the goal is to bring as much as possible together. When possible, their solution should be able to interact with other systems/databases if necessary. Nowadays a lot of time is spent on finding the right data, whereas visualizing and making reports in the future these systems should be more user friendly. Too much time is spent on controlling instead of value added activities. One last takeaway from this question was again the importance of the people in projects: it is more important how the users are using the system than the system itself is. A system should be a guidance through the process.

For the future of the project within Hilti it is very important to focus more on the people side of the project instead of the pure software/solution side since they are the new users of the provided system. A system which is able to interact with various systems is advised. A pitfall could be to believe that having a system alone will solve the problem, however, the people who use the system will solve the problem with its help.

8. *How do you measure project progress and performance?*

Lastly project performance, how is it measured. A lot can be found in literature about performance management. But as a general question it completes the interview.

One of the options to measure project progress and performance is to make use of various KPI's. These can be found in multiple forms, including guidelines on how to create suitable ones for project management (Kerzner, 2018). Lastly, the use of milestones and a structured review and process tracking is highly recommended for the future of project business within Hilti.

As a recommendation to Hilti the concept of gate reviews could be introduced. Whereas different KPI's could be created when it comes to projects next to the current KPI's in place.

4.2.2 Concluding remarks company comparison

From the company comparison a few conclusions can be drawn. First of all, successful execution of customer projects is mostly dependent on good project managers. Here it is important they are proficient in their job, which is in line with the "Best practices in project management" (Kerzner, 2018) where they stated that "the better the project managers, the better the project results". None of the companies stated using a system or specified tool for their project management. When it comes to a system, it is more important how the people are using it than the system itself. One of the respondents stated they had a low user acceptance with their systems of choice, which resulted in bad performance. From the fundamentals of business processes (2013) can be seen that the challenge of BPM is not on the system design but the implementation and change management afterwards. The process is people dependent. The thesis, when considering the STAR model (Miterev, Turner & Mancini, 2017), is directed in the dimension of processes. However, it was clear from the company comparison that the topics of behaviour and structure are of great importance as well. The process part will not work when these two pillars do not function as supposed to. This can be considered when conducting further research in a different direction, which will be mentioned in the last chapter of this thesis.

In terms of project management at Hilti, the current project definition is in the right direction. However, one could argue to make the project definition market specific. Perspectives depend on

whether something is a project or just a big order. This would mean that Hilti also calls a repetitive operation from Maylor (2015), when it is big in terms of size, a project.

For the execution of projects, one could develop a process template, a standard form that can be used as a guideline for customer projects. Via this way one could implement a form of standardization until a certain level.

For a project, most of the companies worked with intermediate milestones, which they used to check if the project was on schedule and on track. The project status was reviewed in different forms, of which the common forms in companies with big projects were weekly or monthly project meetings. From the company comparison and the literature on project management, it became clear that in order to be able to structure a project around milestones or intermediate goals a review process for these milestones needs to be designed and implemented. How this can be done will be further discussed in chapter 4.4.

4.3 Level of process mapping and flexibility

Before the conceptual design can be made, it needs to be investigated on which level the split in process mapping, the division between the fixed and flexible methodology, should be made. The decision needs to be made to give direction to the conceptual design, until which level a WfMS will be implemented. This is discussed in this sub chapter. Furthermore, the implementation of flexibility in the conceptual design will be captured.

4.3.1 Level of process mapping

This research question investigates the level of process mapping to use. It reasons forth on the outcomes of the earlier research questions. When looking at the answers one can see that a decision must be made in order to make progress, since it is of great influence on the conceptual design.

The original company goal of the project was to map the full end-to-end process of project business. However, since the company operates globally with its market organizations acting as their own organizations, which each differ in size. Hence, a specific end-to-end solution will not be suitable for all of them.

A decision needs to be made on the level of process fixation. On which level of process mapping do we want to create a fixed process flow? In chapter 3 came with the result to use a workflow management system and a case management system for the conceptual design. The next step is to decide to which level the WfMS will be used and from which level the case management system will be used.

Based on Kerzner (2018) the fixation of a project methodology should be until a certain level, for which it should be able to generalize projects. Considering the 5-level process mapping used for the project, there are several options for the split between the levels. One can implement the split after the first, the second, third and fourth level. Figure 17 shows what the first two levels look like. If the distinction in process mapping is made after the first level, the fixed part of the conceptual design remains too vague. In reality it only consists of 4 stages. With the cut off at this level, a lot of room is left in terms of execution and mandatory steps.

The second option would be to split off after the second level. However, the second level is used to better define some of the large blocks. These result in some of the level two processes consisting of more than one sub process, where two of the main phases (S3 and S5) still consist out of one process block. Therefore, one can recall on the same argument to not have the split of after level 2 as was the case for level 1.

The next option is to have the split of after level 3, which seems to be a reasonable option. From the snapshot of the conceptual design in Figure 17 one can see the amount of detail which can be

presented in the third level. This means that the process can be fixed in some level of detail, but it still leaves room for flexibility in the lower levels. The last option is to put the fixation point after the fourth level. Looking forward in this thesis, one can see the level of detail of a level 3 process in chapter 5.6. Another impression can be found in appendix I. To fixate all these steps in the conceptual design would mean that there will be only limited room for flexibility. Since it is desired to have a global standard which can be used in all the different market organizations, it is best to have a distinction between fixed and flexible process mapping between level 3 and level 4.

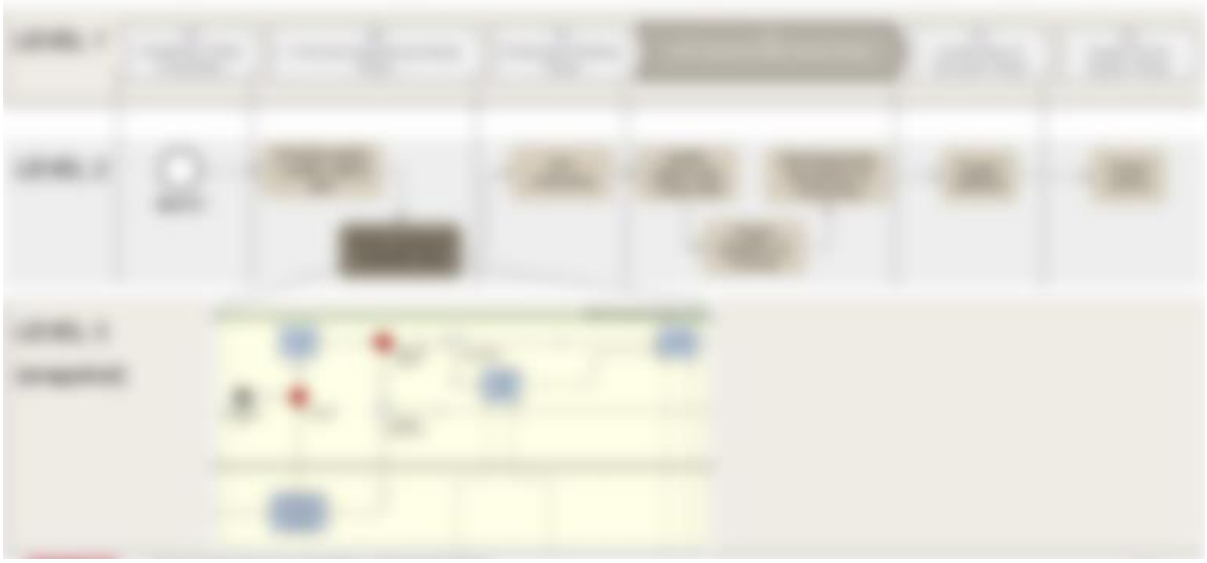

Figure 17 Hilti Project Business Level 1 - Level 3 (snapshot)

The argument to go for a fixed methodology up until level 3 and a more flexible one afterwards can also be argued with the devil's quadrangle from "The fundamentals of business processes". Here it is stated that a positive adjustment on one dimension is likely to result in a negative result on one of the other remaining dimensions. As can be seen from Figure 18, the devils quadrangle consists of four dimensions: Time, Flexibility, Quality and Costs. For example, if one improves the flexibility of the process design, the throughput time of a project in the process would increase, and thus be influenced in a negative way. Where these stated trade-offs by the quadrangle need to be taken into account when design decisions are made.

The fixation of the third level of the process mapping can be the basis of a project handbook as used in one of the companies from the company comparison. The project handbook includes more information than just the business process management model of the processes in place for the operations of project business at the organization.

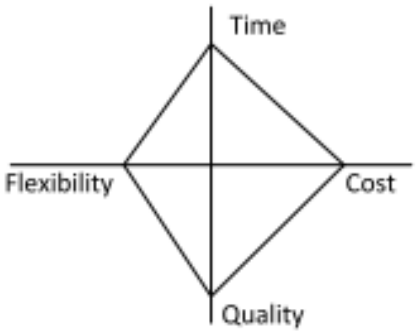

Figure 18 The Devil's Quadrangle (Dumas et al., 2013)

4.3.2 Flexibility in the conceptual design

This sub chapter focusses on how the use of case management can bring flexibility in the design, which is fixated from the third level.

The earlier decision to make the design structure fixed on the third level of the process does not leave much room for flexibility. The next step would be to introduce flexibility. This needs to be done in a way for the conceptual design to be flexible. This flexibility can be found on the lower levels. The conceptual idea is to only map until level 4 and leave the exact activities up to the employees who are executing the process. This flexibility should occur on the fourth level of the conceptual design when one takes a process from the third level and uses the process as a case. Within the case it will be determined which processes are necessary and which are optional. The goal of the case would be the completion of the process as defined in level 3. Dependent on the process from level three, the amount of sub processes for each process differs. However, it is likely that for all of them it would be too much and too detailed to include them in the level 3 design.

For this level, the modelling language CMMN could be used as previously discussed in chapter 3. In Figure 19 an idea is displayed on how to execute the proposed concept. On top of the figure, a general workflow idea is drawn, activities follow each other in a pre-defined sequence. After all the activities (process) have been completed the end is reached and the job is done. However, each of these processes can be defined with more details and may consist of multiple steps, as the example shown in chapter 5.6. Instead of linking the steps from the processes in the same way as in a regular workflow system, an alternative is proposed. The idea is to take the main process and turn it into a goal. The end result of this level is to take the main process and use this process as the general goal of a case, where the process steps needed to achieve the goal are modelled in a case management style. Via this way, optional processes and flexibility can be included and the exact execution order is not fixed. This results in the linkage of goals instead of processes as can be seen in the lower part of Figure 19.

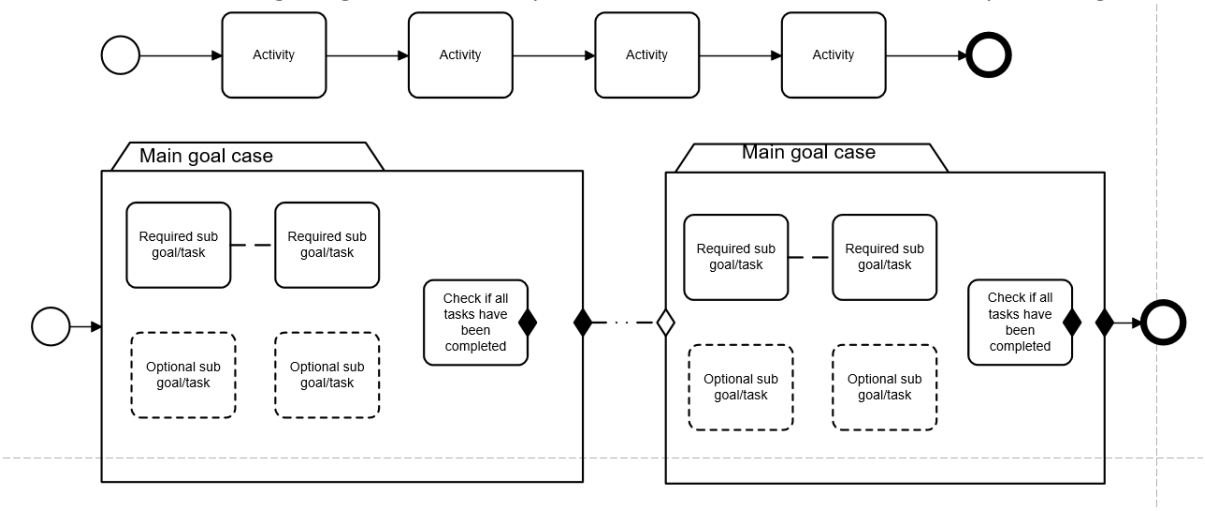

Figure 19 From process to goal

4.3.2.1 Flexibility of CMMN

As mentioned previously in chapter 3.2.2, case management is developed to manage cases and give the user more flexibility and freedom. The users make use of the case management which is often characterized by a "negligible predefined encoding of the work to be performed" (OMG , 2014), which means that only a small part is pre-defined, and the planning of the remaining tasks is an important part of the run-time.

4.4 Gate review concept

One of the research requirements is finding out how to cope with the gates and milestones of projects, especially how to handle them and implement them in the process. Since currently in Hilti such a process is not in place. From the company comparison it became clear that most of the companies interviewed had some form of project control, either it be a review process or just fixed project meetings. Where by Hilti there is a desire to have a structured review process in place in order to make sure the company learns from its operations. This sub chapter focusses on answering research question 6, which is about the implementation of gates and milestones in the design. After the design phase, it will be discussed how the gate review process can be implemented in the conceptual design.

In the end-to-end process the challenge is to make the process more transparent for the stakeholders. Milestones can partly solve the transparency problem, since they give a good opportunity for reporting and communication. With the gate reviews, risks and issues can be identified earlier. A better overview of the available skills and experience of personnel is created. Due to the structure in the process, communication is insured. Recourses can be better allocated, since it is clearer what and how much are needed, leading to the process becoming more accurate. A better estimate can be made if the company is able to deliver the desired project on time. Due to a better overview, risks can be taken in a more calculated way. The overall benefit of having a general review in place, is that one can learn from the executed processes and the good practices can be adopted(Walker, 2009).

Gate review(Walker, 2009) p.34:

> ” Happens at the end of a project phase or at some other defined point in the project’s lifecycle. It typically represents a decision point, using the outputs from an evaluation to decide whether continued investment in the project is justified.”

In project orientated companies, project managers are responsible for running and controlling the project. This includes quality assurance of plans, deliverables, other artefacts, status and risk tracking. Independent peer review can also be initiated by the project manager to support the review activity.

Main principles of a gate review (Walker, 2009):

- Guaranteeing the maturity of the project and the resource availability. Confirming resource availability, facilities, tools, obsolescence and process issues. Feedback on lessons learned.
- Gate reviews are organized when other related reviews have passed; to avoid double effort, gate reviews consider the ¬findings and actions of other related reviews.
- Provide structured assessment which is performed independently for the management. Project should be assessed on the “Four Eyes Principle”, the person who reviews the project is not the same person as the one who leads the project.

One way to ensure that the phases are completed in the right way is to make use of so-called *gate reviews*. A review team checks if all the criteria of the gate review are met, after which they decide on the next step in the process. A gate review process could be implemented as a sub process in the business process management model.

The gate review process can be implemented as a process in each of the levels of the conceptual design, of which only a few will take place if they were to be executed at the first level. Another option could be to introduce the process as a smaller review on level 4 if needed. The results of the so called sub-reviews could improve the bigger gate reviews, but they can also slow down the process in general, because of the amount of reviews/checks. Too many stages in a process can lead to unnecessary bureaucracy and extra costs (Kerzner, 2018). With this being said, it is likely that a gate

review will happen in the first or second level of the conceptual design, since those levels are the two levels with the least processes.

A process overview of a gate review is shown in Figure 20. The first step of the review process is to check all the entry criteria for the specific review. When everything needed is in place, one can continue to the next step of the review process, the actual review itself. In this phase the checks will be made for the phase which needs passing. After all the criteria have been evaluated, the review committee should decide in which direction the project should be heading. This should be one out of four options:

- Continue: where one continues the process after the review is done. The logical process sequence will be taken.
- Go back, rework: the project needs rework. It needs to be decided which parts of the previous processes need rework in order to pass the gate.
- Put on hold: the project will be put on hold. The project passed the gate review, but one will not continue with the project. The project is put on hold until further notice.
- Quit project: In the review is decided that the organization will no longer continue with the project.

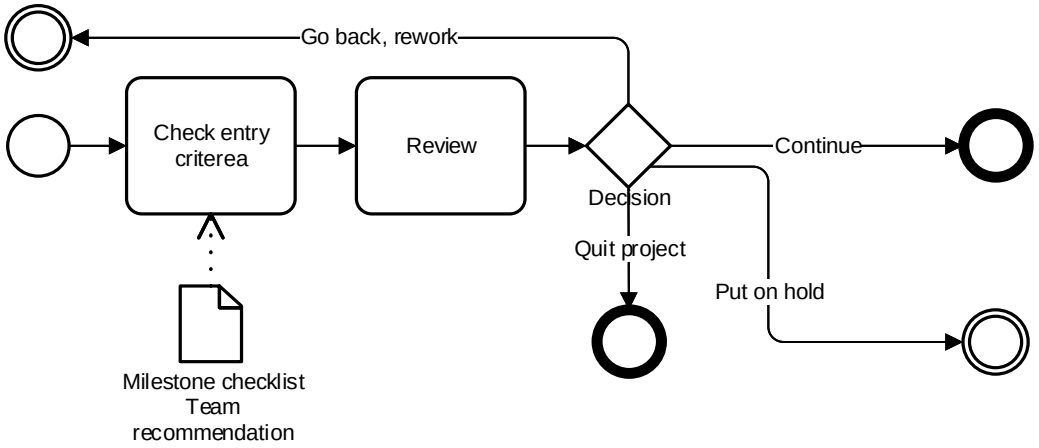

Figure 20 Gate review process, derived from Kerzner (2018) *and Steenkamp & Bekker* (2018)

For the input of a gate review one can think of the examples given in Table 7 and for the output one can look at Table *8*.

Documents and supporting materials	These are especially useful for preliminary reading to understand the project and develop an interview protocol.
Interviews	These are often the main tool for probing and understanding what is actually happening on the project.
Status reports, risk registers, self-assessment checklists and associated artefacts	These are all useful for telling us about the perceived current state of the project.
Workshops	As an alternative or supplement to interviews, workshops can be a good way to gather and analyse information.
Prototypes and other examples	A good way to get a handle on project outputs and deliverables.
Observation	You can learn a lot about what is happening on a project simply by observing how people are working, their communication patterns, the ad-hoc meetings they are calling to address issues, and so on.

Table 7 Gate review inputs

Information to inform a decision about the project	This may be a decision as to whether to continue investment in the project, for example a gate review that informs a go/no-go decision. It may be a decision about when to announce a new product, or about whether to initiate contingency actions on a dependent project. This information is primarily intended to help stakeholders outside the project team.
Information to inform the way we run the project	This may be recommendations to improve project management processes, or identification of risks that need to be managed, or escalation of issues that need attention by the sponsor, and so on. This information is intended primarily for people within the project team.

Table 8 Gate review outputs

Gate reviews should take place in a planned and structured way (Oakes, 2016; Walker, 2009). Each time a gate review is executed it should be seen as a system. This system is made up out of input, controls and output.

The following activities should be addresses when executing a review:

- Initiate: Form the team who is doing the review
- Information-gathering: Project information is shared. Further information can be gathered if needed.
- Evaluation: Identification and evaluation of high risks.
- Report: Individual reports are gathered in a summary report; a final decision is made.

The following control parameters are needed for process guidance:

- Stage-gate guidelines and standards: An official document is needed which can function as a reference to define the requirements.
- Baseline: Defines the prior agreements made before the review and anything relevant to the specific topic (Walker, 2009).
- Focus criteria: Provides guidance of the review over a time line, reviews can be shortened when well-planned (Walker, 2009).

Information should be fed back to the project for validation. Within mind to:

- Ensure that all project discoveries are caught in the final report (Walker, 2009); and
- provide feedback, the organization should learn by updating the control parameters (Walker, 2009).

The standard elements of the review framework are the basis for a gate review could be for example (Steenkamp & Bekker, 2018): the gate review mechanism, project governance, project life-cycle process, gate description, the gate review process, gate review team, gate review outcome, industry specific guidelines.

The importance of a structured review framework is to ensure that an organization learns from earlier experiences. Kululanga and Kuotcha (2008) found that lessons learned from the gate reviews could be lost, and they concluded this was due to the lack of a structured review framework.

4.5 Concluding remarks

In this chapter three topics were discussed: a company comparison, which level of process mapping was suitable for which methodology, and how a gate review process could take place. One of the main beliefs at Hilti was that the process of project business can be taken care of by a system entirely. A system could be responsible for all the decisions made, reducing the dependency on people for successful execution. However, from the company comparison and the literatures on project management, it can be concluded that a system is not going to guarantee successful project business execution. It became clear that these big projects are dependent on good people. A system to streamline the processes can help to improve success, but it is not guaranteed or the most important factor when it comes to projects.

For the conceptual design and its differentiation between the process levels and the corresponding system and language, it was decided to make the cut off between level 3 and level 4. The main reason for this was the amount of detail needed in level 4, which does not make it possible to have the process in a structured way up until this level, with remaining the ability to implement a global standard. The cut off between level 3 and 4 was the second to lowest level where a cut off between two levels was possible.

Most of the companies used some form of review structure to manage continuous progress of their projects. Resulting from the company comparison and the needs of Hilti a structured review process offers a direction as a solution for this part of the research. How a review process should look was described in the former sub chapter. If the gate review process is necessary for all projects is something which has to be investigated in the future. One could start with implementing the process for all projects, later when one has gathered information on different projects, conclusions can be drawn for which projects a gate review is necessary and for which projects not.

5. To-be conceptual design

The former chapters have all built up to the conceptual design in this chapter. Where chapter 2 provided the basis on the topic of business process management. As a result, from chapter 3 the conceptual model will be in the form of a workflow model on the higher level and a case management model on the lower levels. Chapter 4 provided the insight from external companies on the topic and provided a gate review concept. How the gate review concept can be implemented will be shown in the end of this chapter. The results and insights of former chapters have been used to develop the conceptual design. The conceptual model focuses on the level-3 by the using of the BPM life-cycle which consists of two rounds of validation followed by redesign. The conceptual design of the third level, the workflow management system and the BPMN language are employed in the conceptual design. As described in chapter 1, Hilti currently does not have a project process in place. This makes the presented design in this chapter a revolutionary design.

The level 1 process represents the full flow from the first customer contact until the end of the project on the highest level. This is initiated to define the end-to-end process. For a smooth execution of the whole project, inter collaboration is needed in the organization. For this reason, the goal of the design is to tackle the current problems faced with the execution of customer projects.

The level 1 workflow consists of 6 phases, as can be seen in Figure 21. They are stated with numbers "S(x)". The process is closed with a feedback and review (closure) phase, which is used to gain insight in how the process went. This workflow mapping is made to create a general overview of the customer process. When referring to the 5-level modelling approach, this is the first level.

The customer workflow depends on type of project. For example, when a product is demanded that requires engineering to existing or new products, the engineering steps in the process will be more intensive compared to an order where just large volume is demanded.

Figure 21 Level 1 conceptual design

Within these phases smaller steps must be taken to move on to the next step. The phases are presented in Table 9, which provides an overview of the phases including the process steps per phase, and the key deliverables per step, as they were determined. The table is used as a basis when the initial modelling and mapping phase starts, which will be described in the next part of this chapter.

Table 9 Customer level workflow phases description: Phase, Process steps, and Key deliverables

The design process is graphically represented in Figure 22. Here the process starts with design phase one, where a draft design is created from the collected requirements, together with the project team,

which will be introduced in the next sub chapter. When the draft is finished, feedback from the regions will be collected, processed and a redesign phase takes place. After the first redesign phase the adjusted design will be put through a second validation cycle, this time within a global workshop where process experts from all the regions gather to participate.

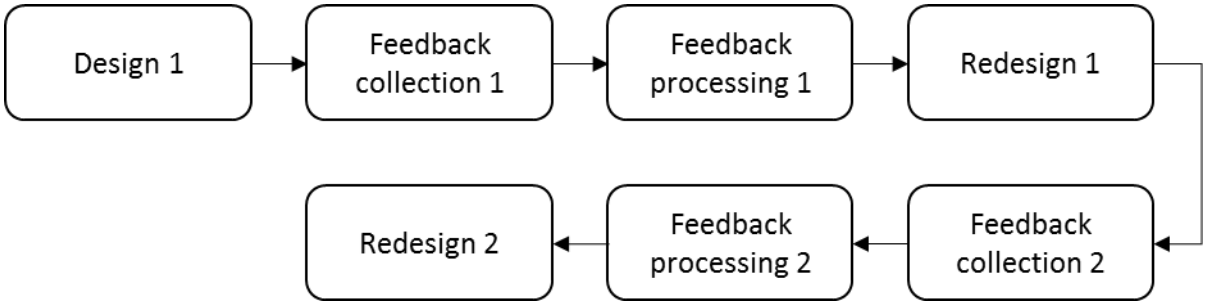

Figure 22 Design process based on the BPM life-cycle

5.2 Design phase 1

For the mapping of the to be process a team of process expert was put together. The team consisted of five Hilti employees from different departments. Table 10 lists the overview of their functions and the department they are active.

Department	Function
REE Account & Project Management	Head of Account & Project Management
GLD Global Transport & Warehousing	Global Process Manager Distribution
REE Account & Project Management	Product Manager Project Tools
REE Account & Project Management	Project Sales Manager
REX Corporate PMO	Bid & Proposal Manager

Table 10 Project team

The team was active in the main departments that are involved with the project side at Hilti. The logistics and fulfilment take place throughout the process from the 'quotation and forecast' to 'project fulfilment'.

From former workshop documentation within Hilti, the higher structure of the workflow could be defined. This includes the complete definition of the first level. The level 1 workshop documentation resulted in the process map for the first level shown in Figure 21, this form of mapping can alternatively be called the value stream(Dumas et al., 2013).

Now we are going to develop the design of the third level, which is the level in the middle when referring to the five-level process mapping approach, the processes. This approach consists of : meta processes, main processes, processes, sub-processes and lastly singular actions.

The third level was directly mapped after the first level was defined. When the level 3 design was in place, process grouping had been conducted to define the level 2 processes. The process grouping was conducted during the second validation and redesign round. The level 3 mapping process was done in a brown paper session. For the level 3 mapping, a workshop setting with the project team was used. The mapping process took several meetings. It was modelled according to the expertise of the process experts in the team. During the first workshop a quick draft was made, to have a single overview to start working with. This draft was used to start with the phases of the level 1 level, after which different necessary steps were implemented, and later linked. Decision points were

implemented where necessary. In the second workshop, the team went through the overview created in the first workshop to see if the steps were correct, and if not, where and how to change them.

During the design phase, it was decided to make use of three rows which represented different roles in the process. The capture team, which is responsible for selling the product and closing the deal, was represented by the first row. The second row of the responsible party is the business department/organization, or the key project manager for the project. The third and last row represents Engineering and logistics. This division was chosen to clearly involve these departments in the project process.

This decision was made to get early a clear idea of what the process could look like. With this idea the overview could be verified in the first round, to gather feedback in an early stage.

Al in all this resulted in an overview of the desired workflow, as provided in Figure 23. This overview would function as a base point for the first validation cycle.

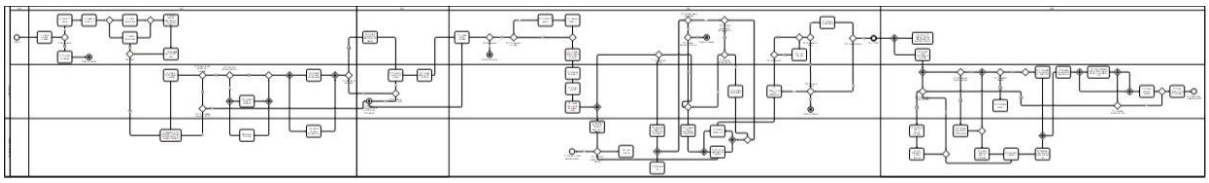

Figure 23 Level 3 workflow after first step BPMN life-cycle

5.3 Validate and redesign 1

In order to improve the design, the proposed design was validated with the different market regions. A review document was created, which was supposed to function as the guide for the review. Besides functioning as a guide, the form also made sure the feedback was structured and easy to document. At each region an employee was assigned to evaluate the design with a team within his region which would be able to represent the whole process sequence. They did this while making use of the form provided in Confidential information.

Appendix C. The form also included the preferences for their content modules which were functioned to gain information for the continuation of the project in general. The content modules were basically the processes, or functions they wanted to develop after a common process was in place. In the design which was send for evaluation, all the processes were numbered so they were easy to refer to by both parties. To evaluate the feedback with each of the regions, a call was scheduled to discuss their feedback on the created design and how we should interpret their provided feedback. The feedback calls were done with Skype.

An overview of the participated regions and the functions of the employees can be found in Confidential information.

Table 14, appendix K.

The feedback that was received from the regions can be read in Table 11, where actions are assigned to the comments. The former design was transformed in a model where BPMN was used in a way that would bring more clarity. Furthermore, the model was not clear in terms of if the point arrows would split, or if multiple arrows were needed in order to start a process. From the comments received from the regions, not all of them were implemented.

A few of the comments will be highlighted into more detail.

The first comment stated that the initiation of the capture plan should be before the Hi Site entry. This change was not fulfilled. However, after the initiation of the capture plan, an or decision was put in place which checked if the capture plan was approved. This made sure the process could continue with a sufficient capture plan. If this was not the case, the capture plan could be updated and checked again. To make the update capture plan a clear defined process it was put as a separate process and excluded from the initial process “Initiate/update capture plan”. The changes are presented in Figure 24

The changes as result of the eighth comment are presented in Figure 25. After the feasibility study, a decision point to continue with the project was added. The point stated: “Continue with project?”. Apart from that, the or decisions were presented in a way which was believed to be clearer. This was done by not merging the two arrows out of the “preparation for the non-budgeting process” before they went into “Prepare FEED specs documentation”. In this way it is clear that only one of the two arrows are needed to start with the next process.

The changes in response to the eleventh are shown in Figure 26. The detailed engineering and bill of materials update were placed before the preassembly and logistics. It was also decided to remove the connection from the software support to the customer visit. This makes “the software needed(?)” process a process which stands on its own. With this change the customer visit is now an implemented part of the process. Lastly, it was decided that one would go to the next process to continue the process, which makes sure all the previous steps are executed and no steps will be skipped. This was done by putting the customer visit as part of the process, where in the old version it was a dead end in the design.

Table 11 Selected feedback validation round 1, actions are presented by a 0 for no action, a 1 for comment directly implemented and a 2 for partly implemented.

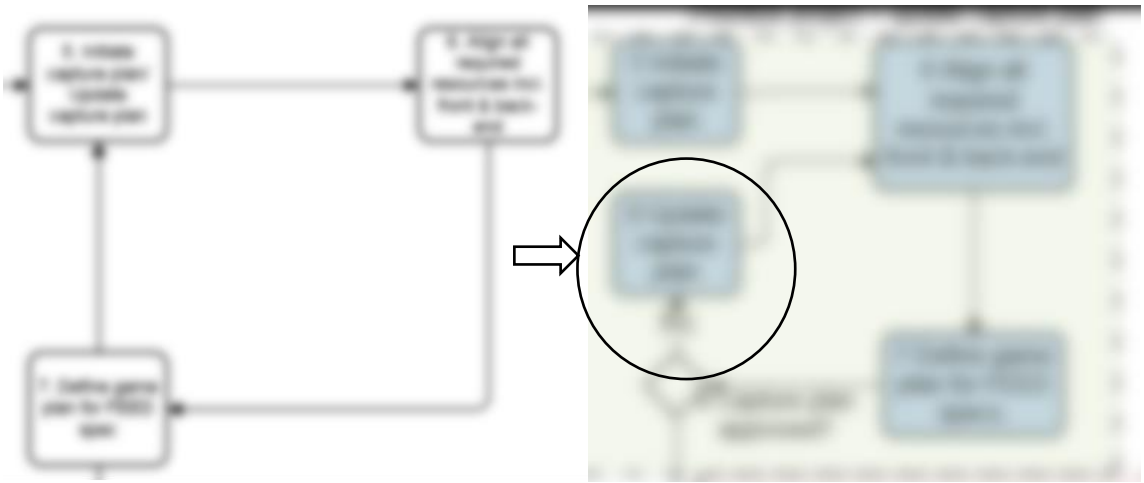

Figure 24 Phase S2 update capture plan

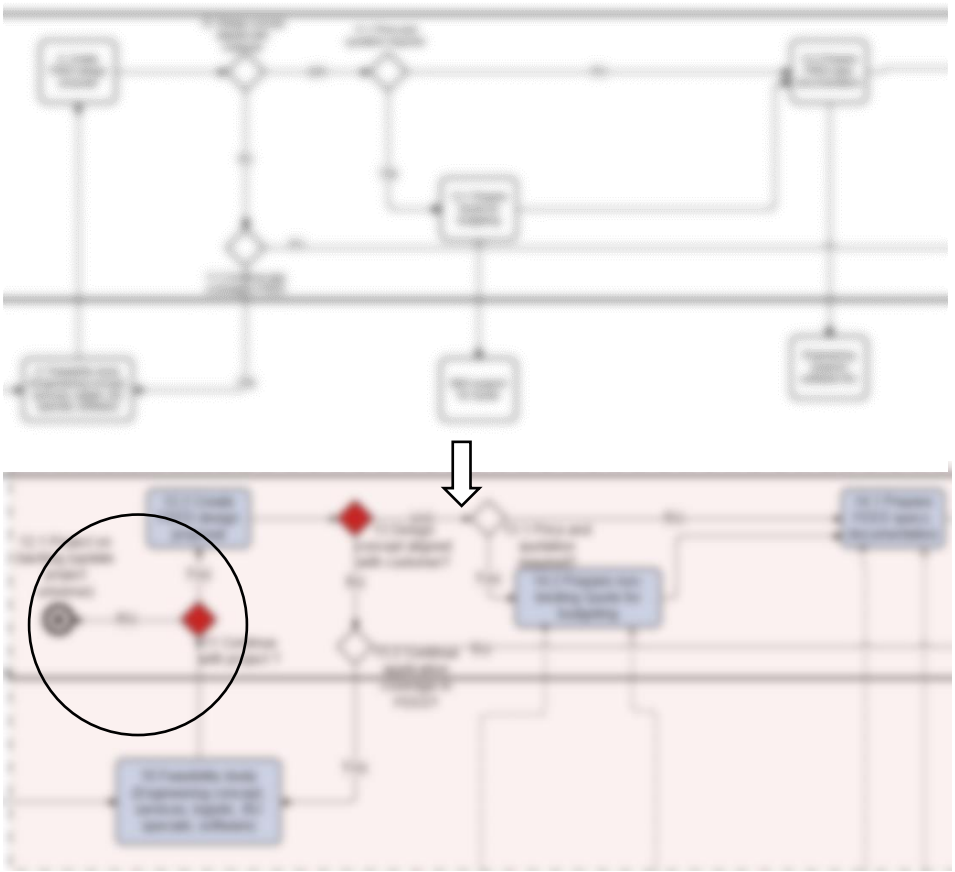

Figure 25 Adjustments on comment 8, reorganizing S2

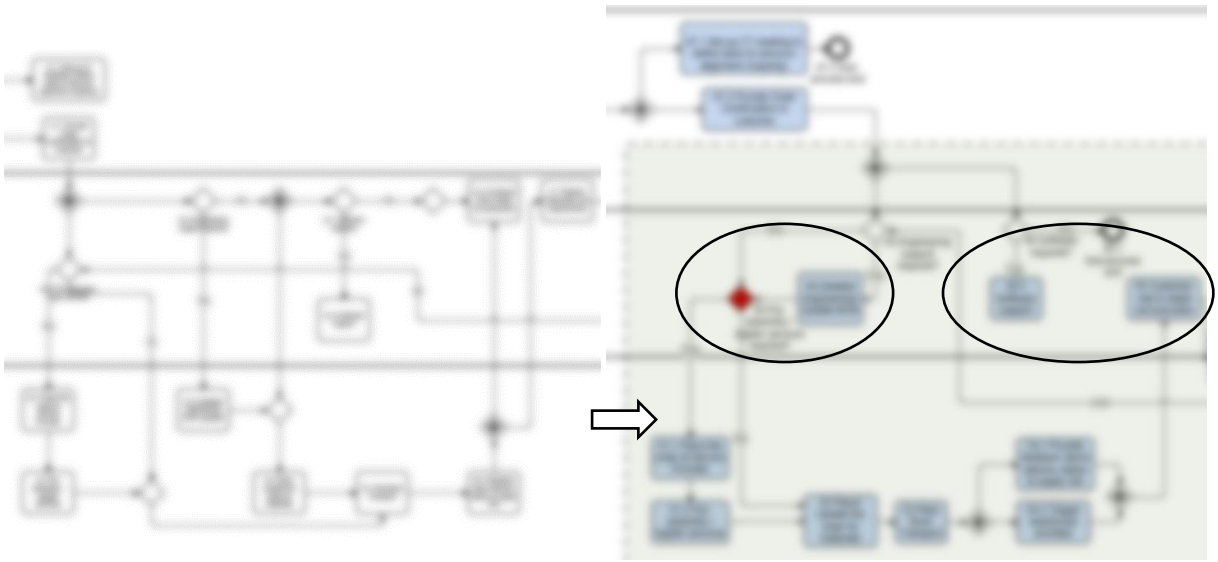

Figure 26 Changes in S5

Apart from these updates, also the processes in the design the level 3 were grouped. The grouping of processes was done by bundling process groups which had a single arrow input and a single arrow output, although some exceptions are made. More details on this part will be provided in Appendix J.

An updated version of the design can be found in Figure 27.

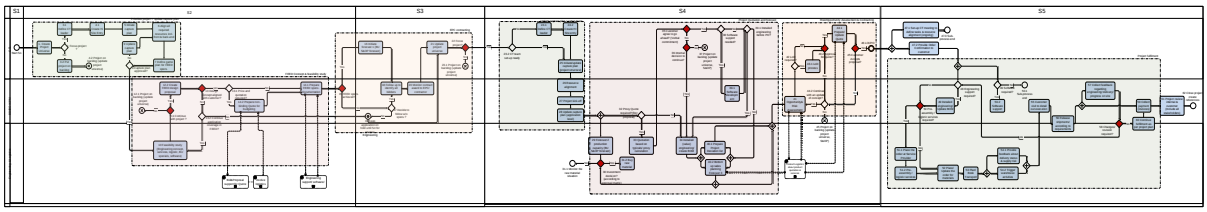

Figure 27 Level 3 conceptual redesign 1

5.4 Validate redesign 2

The last round of redesign was made at a global workshop meeting in Moscow. At this meeting process experts from all the regions were present. They are defined by department and function in

Table 12. In this workshop, the design was split in different phases and the group was split up into 3 smaller groups. Each group had to review a certain phase of the process and propose changes and feedback accordingly. Group 1 reviewed phase 2 and 3, group 2 reviewed phase 4 and group 3 reviewed phase 5. All the groups received a printed version of their part of the design and proposed their changes. All the items on the design were numbered, via this way the feedback could be noted down while referring clearly to a part of the process.

Table 12 Glomex review team

After the workshop all the feedback was collected and discussed with the original project team where in a single meeting all the changes were applied. Not all the proposed changes were processed in the end process model.

The feedback received from the workshop participants can be found in Table 13. Here actions are assigned to the comments.

A few of the comments will be discussed into more detail.

Nr.	Feedback	Action
1	Step 12.1 should include in the description to update Hi-Site.	1
2	How is step 16 linked to the S&OP system?	0
3	Step 21 change description project universe to Hi-Site.	0
4	Step 49, when the bill of materials changes a feedback loop needs to occur to re do the steps when changes need to be implemented.	2
5	Step 52 needs a feedback loop in case of changes.	1
6	Step 27, address the importance of a project kick-off meeting.	0
7	Step 29, make clear that this is on an application level.	2
8	Implement value added services (VASC) after step 40.2.	1
9	From step 36, there is no link to software development.	1
10	A link between step 30 and 41 is missing.	1
11	A general idea to split the project management office and logistics in two.	0

Table 13 Feedback validation round 2, actions are presented by a 0 for no action, a 1 for comment directly implemented and a 2 for partly implemented.

The following changes were made to the design. The last row, which was formerly Logistics and engineering was changes to project management office (PMO) and Logistics.

From the fifth comment a change was made to extend the process loop after decision 49.2, in which the material handling is checked, and if needed updated. Now the update step is in this loop before the process continues. Apart from that, an extra check is implemented after step 48 (Engineering required?), where is checked if the change affects the bill of materials. The overview can be seen in Figure 28.

Resulting from the eighth comment after step 40.2 an extra process was added in which the Value-Added Services forecast was placed. With this change an extra check/step is in place in order to make the value-added service part of the project run smoothly. The change can be seen in Figure 29.

The change from the ninth comment can be seen in Figure 29 in the top part of the figure where the software need for the project is handled. An extra step was added to see if the software could be developed by the organization itself. If this was not possible the process communicates this to the customer. This step is of value since not all software can be developed internally.

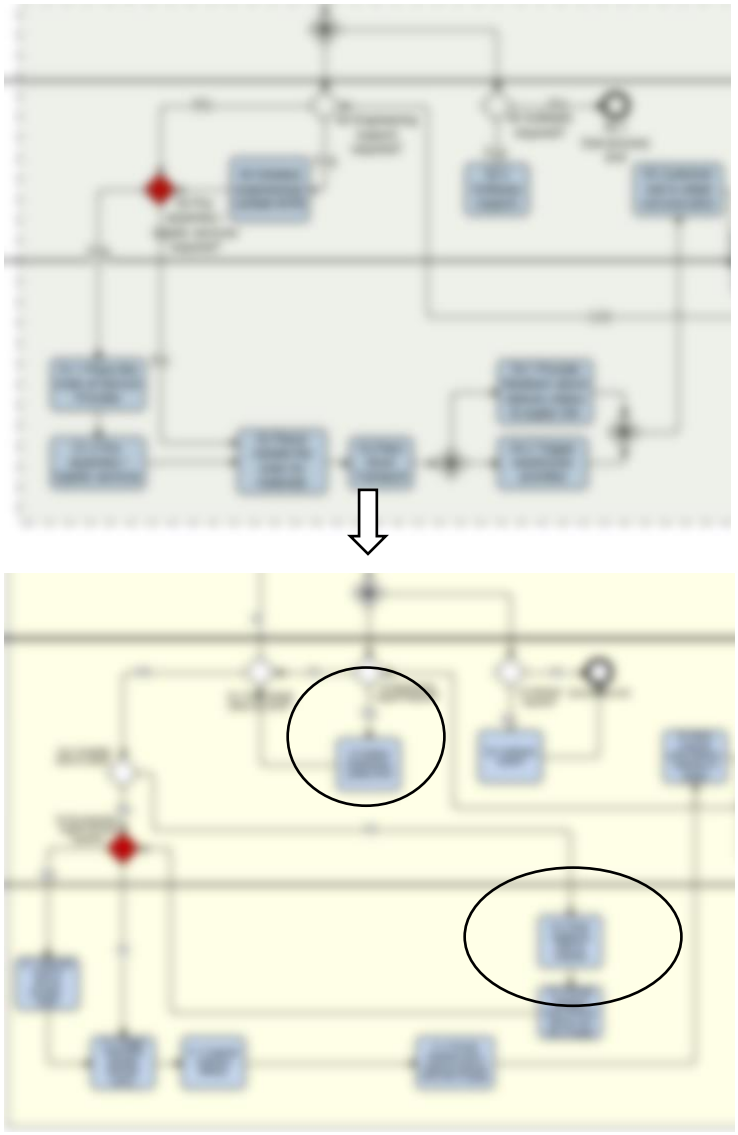

Figure 28 Changes in S5, (Top old, bottom updated version)

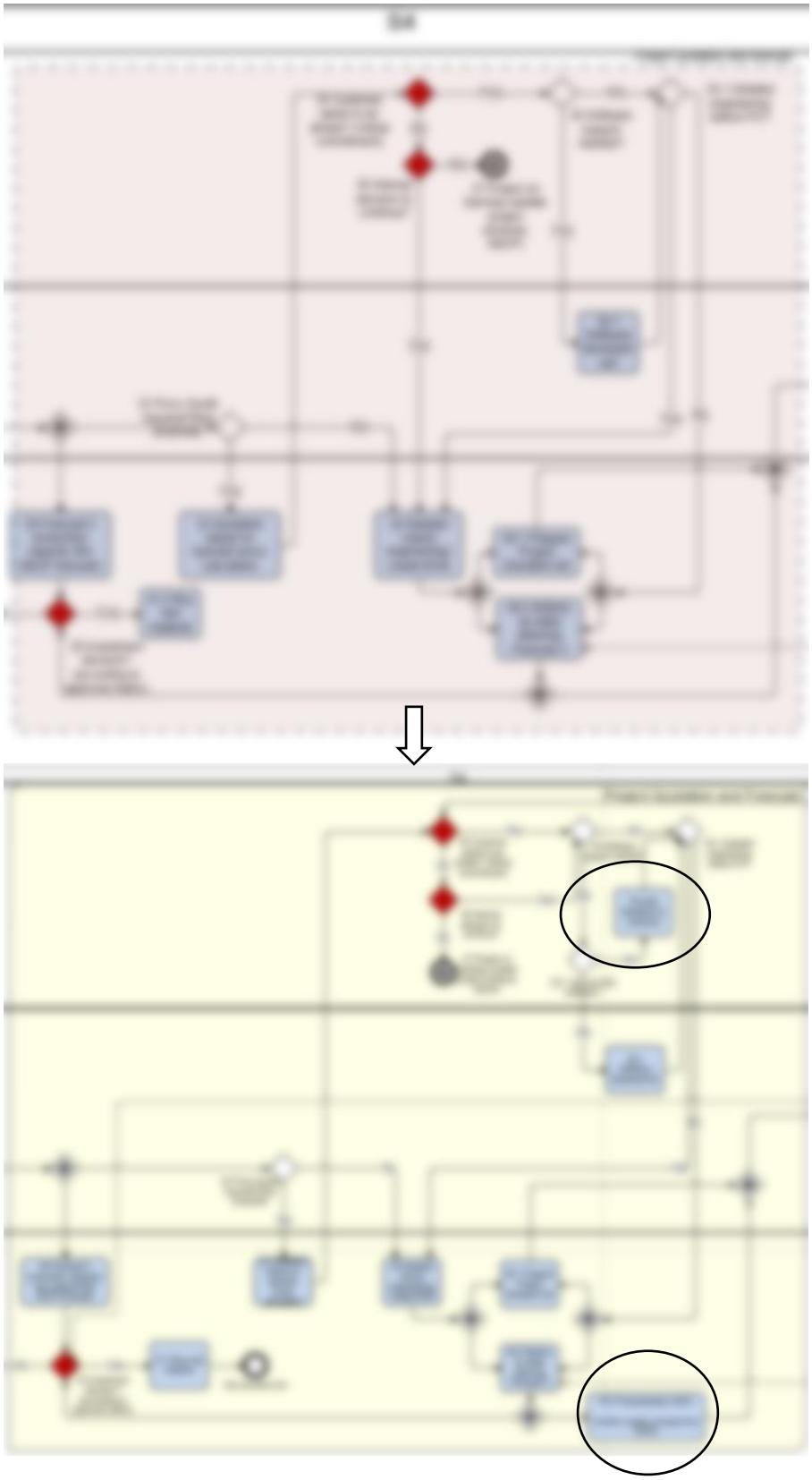

Figure 29 Multiple changes in S4 (Top old, bottom updated version)

Finally, after processing all the feedback of the different regions, the conceptual design was modelled in a software program called Signavio. This program was used to check the soundness of the model and if all the connections were right. In the future a tool like Signavio can be used to forecast the

effects of changes made to the conceptual model. With these effects one can think of the effect on process time, expected process route or capacity needed per process step.

The final version of the conceptual design can be seen in Figure 30. The design is provided in Appendix D in pieces for better readability.

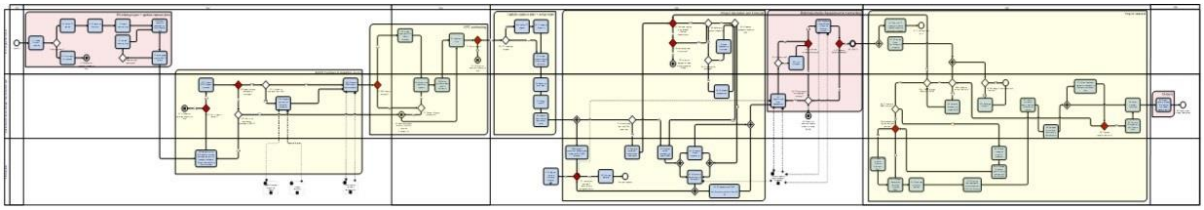

Figure 30 Final conceptual design level 3

The level 1-3 processes can be found in Figure 17, where one clearly can see the different processes of which level one consists and how this translates to the level 3 design.

From this review session, the benefits of the project could be derived by the regions head. They believed the project would benefit on the following points. It could help to create an early involvement of logistics and the PMO. Planning could be done not only on the project level, but also on the application level. Project information can be provided earlier to the stakeholders. It will increase transparency. One can see changes in the process once a standard is agreed on. The project process is simplified. Duplication of work is reduced. The project will be beneficial for project management and better decision making.

Lastly, from the international workshop, the benefits of the project were derived. The participants stated the project would result in early involvement of Logistics and PMO in the project. Planning on application level for the project can be done. Because the process has a clear structure and one knows where it is likely to be available in the project, information can be provided earlier. Due to the clear process the transparency on projects will likely improve. The final goal is to have one source of data when it comes to projects. However, this is a future desire for. The overview and the data source should provide the possibility to be able to see changes. The generalization of the process has led to process simplicity. Work is less likely to be duplicated. When one is better informed and involved in the project decision making can be improved in this way. Due to the process clarity of projects it is easier for project managers to do their job effectively. The way of working with project gates will result in more progress when it comes to project, because of the clear midterm goals. There are no missing steps in the process. Benefits are the saving of time, costs and resources. Form the customers perspective, Hilti can be seen as a more professional organization when it comes to project management.

A more detailed description of the conceptual design and its steps can be found in Appendix J.

5.5 Implement the gate review concept in the conceptual design

The second to last sub chapter will be devoted to showing how and where the gate review will be placed in the design. In chapter 4.4 has been discussed on which level the gate reviewing process should take place.

The gate review process, can be implemented in the level 2 of the conceptual design in the following way. When one takes the process blocks of level 2 as process stages a review will take place after every process block. The red block in Figure 31 represents a gate review in phase S2, the review is as it was presented in Figure 20. The gate review positioned in this place benefits the start of a project, where it checks the soundness of the capture team defined for the project. And the capture plan is double checked. Which should result to a better performing capture team. Figure 32 presents how

the reviews are placed in the design on the second level. The smaller grey blocks each represent a level 2 block from the conceptual design, as the conceptual design was presented on the third level and the processes were grouped. For the last review one can question its necessity, since the project closure is only a feedback collection and project review, which is likely to happen anyway. It leaves the process with 7 effective review times in a process, assuming no rework had to be done in order to move to a next block. This is in line with the process methodology guidelines of Kerzner (2018), which stated an ideal project methodology consisted of roughly 6 stages. It is of great importance that the expiries and lessons learned won't be lost after the process is finished. Therefore, the last process in phase S6 includes a project review, which makes the it not necessary to conduct a gate review after this process.

Alternatively, performing the gate review on the first level could have been chosen. However, in practice there is no difference between the first and second level in S3 and S5. S6 is not considered since it is the project closure phase. The only phases where more gate reviews take place would be S2 and S4.

It is advised to start with placing the review project after each of the second level process blocks. When it turns out that the reviews at some of the blocks are too short after one and other, one can decide to change this by bypassing the review between two blocks. Also, it is not clear if the review process is necessary for each of the different projects. For example, when a project is too small in terms of size it might not be beneficial, earning wise, to do the gate review. However, in the beginning it is wise to test the review process, and when experience has been gathered, make specific changes per project type.

Figure 31 Gate review in S2

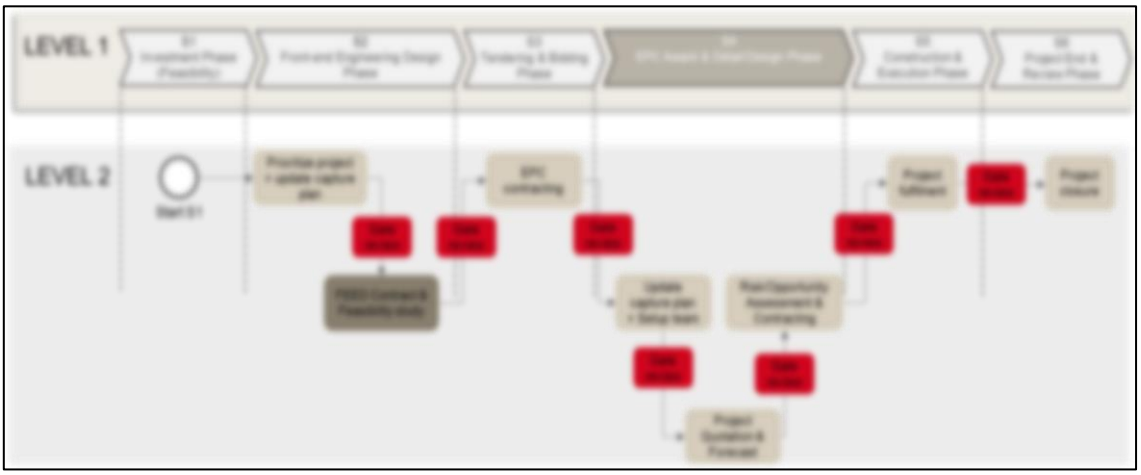

Figure 32 Gate review process implemented in level 2

The key deliverables from Table 9 form a suggestion on the review criteria for the gate review processes. For example, in the first gate review it could be checked what the quality and feasibility of the capture plan and its team is.

A similar review can be done after the first block in the S4 phase, with special attention to the project kick-off meeting. This meeting can be used for communication across the organization in a specific step in the process. The kick-off meeting is of great importance since in this relative early stage in the project it offers an opportunity to inform all stakeholders of the project. By having this communication all taking place in one moment it is likely it would improve communication and transparency across the organization. In the review after the project kick-off meeting four outcomes are possible, in chapter 4.4 they were discussed as: continue, put project on hold, rework and cancel. For example, when the outcome of the review it to do rework this would mean that the previous steps are repeated. The need to do rework could have several reasons, from a lack of quality to uninformed stakeholders. By performing the review, the quality of the project will be guaranteed.

After the S4 phase in general to contract is signed. In this review cycle one can pay extra attention to the ability to fulfil the project demand of the particular project. However, these examples also state the challenge with the gate reviews when it comes to projects. Projects tend to be unique, so no gate review will have the same review criteria. It could be the case that these changing conditions and requirements make the gate review process a high effort process. One could question the usefulness of the process for all the different projects.

Generally is described how the gate review process should take place in the BPMN model. However, it is important to find the specific review criteria. For this aspect of the review process it is advised to develop a standard list with review criteria for projects in general. Besides this standard list an optional project/subject specific sub list could be made. From this extra list the necessary review criteria could be taken into account for the specific project. Table 9 could function as a basis for the standard list. When Hilti has more experience with project reviewing the lists could be revised and adjusted when necessary.

5.6 Level 4 design

Lastly an example is given how the proposed idea of the level 4 presented in chapter 4.3.2 can be implemented.

Every single one of the steps in the level 3 design can consist of multiple sub steps. Imagine the same for one level lower when one wants to describe the process on an activity level, which would result in a multitude of steps. For this reason, only one of the processes of level 3 was picked and further processed into the level 4 design. Otherwise the identification of all sub processes and the modelling of it would be a time-consuming task. And, it would be harder to express a complete end to end model of the whole process.

The process of choice is the quotation process. A fixed mapping of the process can be found in Appendix I. For the proposed quotation design in a case management style, the design has been taken and verified which of the processes are necessary and which are optional. In the CMMN language the difference in required and optional steps is presented with the use of a line for mandatory steps or a dotted line for the optional steps. The quotation process can be seen in Figure 33.

These cases can be linked to each other in the order of the level 3 design. Via this way the proposed processes in the level 3 design can be executed in such a way suggests the order and initiates optional processes. With this form of execution flexibility is added to the functional design. It provides the ability to model the process without a specific route. As the work on projects requires more not standardized work in comparison to normal orders at Hilti, the use of a case management style provides the guidance when it comes to executing projects. Case management is a more goal

orientated approach in comparison to the regular workflow modelling. In this case the model aims to the completion of projects.

Where flexibility is one of the offered strengths of a case management model. It also brings difficulties to the table. It is harder to model a specified order of steps in comparison to a classic workflow model. One can model a proposed execution order of steps but is not necessary to follow these steps. Compared to a workflow model modelled with the use of BPMN a case management model can be harder to read or understand of one does not know the language.

Figure 33 An example of quotation process level 4

5.6.1 Alternative approaches

In the current world there are other ways of handling the flexibility aspect within the topic of BPM. Here one can call it variability management or process model customization. In the world of process model customization there are four different directions of approaches: Node configuration, Element annotation, Activity specialization and Fragment customization (Rosa et al., 2017).

In the domain of node configuration, one has the configurable workflows where one has a huge process overview covering all the possibilities and one chooses the ones applicable for the case. However, this would mean that a rather large process model has to be developed. This would mean that for the level 4 design different workflow models need to be developed. The user can make a choice which one of these to use.

In the area of fragment customization, one has the option of Process Variant by Options, also known as Provop. With this approach change operations are applied to a base model. This would result in an expanded or reduced process compared to the base model.

5.7 Reflection on deliverables

As a last part of the design chapter will be reflected on the cause and effect diagram as presented in chapter 1.2. Firstly, the targeted solution will be discussed. And secondly the cause and effect diagram will be discussed.

The conceptual design is developed in such a way that it is clear for the entire organization how the overall process looks like. This will provide more transparency by using a clear graphical representation. In the conceptual design was decided to make use of a three-user role definition, by

introducing three lanes. This meets the clear role requirement. The intractability with other systems is something which only can be taken care of with the implementation of a software vendor. For this option the possibility of intelligent Business Process Management suites has been proposed as a direction for a future solution. Regarding the milestones of a project, the methodology has been discussed with regards to gate reviewing. This is only a proposed methodology and a preparation, the gate review criteria still need to be defined.

Reflecting on the cause and effect diagram the conceptual design addressed the following problems which were stated. On the subject of communication, the proposed design forces communication with the use of feedback loops and the implementation of the gate review process. With the defined roles the different stakeholders are clearly addressed. The missing kick-off meeting is implemented in the design. By having a clear overview, it is tried to create more stakeholder involvement and transparency.

When it comes to the “overview/management” several issues have been addressed. Clear feedback points have been implemented via the gate review concept. The design provides a global standard of how a project should be executed.

On the topic of data, the proposed design is a step towards a new system to use. Where it should avoid rework to occur. In the future the design should be implemented in an organization wide system which should decrease the amount of different systems used. The data aspect is not considered in this thesis, which leaves this aspect of the project open for further investigation.

Lastly the aspect of the tool. The conceptual design provides a clear process. An improvement could be to add an expected timeline in the model. However, it could be more beneficial to have this timeline project specific. There tends to be a big differentiation in the size and length of projects, which makes one timeline not the best option. The gate review process implemented provides the requested feedback loops and the end of project review. In the future to develop system clear project tracking and follow-ups could still be implemented.

6. Conclusion & Recommendations

This chapter concludes this master thesis project, starting with a summary of the answers on the research questions.

6.2 Research conclusions

This section is a summarized version of the answers given on the different research questions.

The main research question asked for a design to solve the problem, which was presented in chapter 5. It shows and end-to-end design of a project cycle at Hilti.

The first research question was based around the different Business Process Management systems which could be used. In order to investigate these, different systems were described with using literature on the topic. It turned out that the system of choice was dependent on the level of process hierarchy. Where the higher levels needed less flexibility a traditional workflow system could be used. The lower levels, which could differ between different markets in terms of layout and processes, required more flexibility. A case management style approach would be favourable.

The second research question opted to find a corresponding language for the process in general. It turned out to again be dependent on the level of process mapping. In the higher level, where less flexibility was required, BPMN would be sufficient as a language, as it is standardized and widely accepted among the industry. For the lower levels one could make use of CMMN, which was developed by the same company and had possibility for integration with BPMN.

A company comparison was performed to seek an answer to the third research question. It was investigated how other companies in the industry, which were working on a project-based basis, handled the problems Hilti was facing. The research resulted in mixed findings for Hilti. Where Hilti hoped to find a solution for the problem in the form of a system or common tool. It turned out the project processes were dependent on people and their skills, instead of an atomized intelligent process.

The level of process mapping was investigated with the fourth research question, where one could conclude that a cut-off point between level 3 and level 4 would be sufficient. Up until level 3 it was possible to standardize the processes, so they would be covering all the market organizations. With this decision, a process template was created, where the exact execution of the process was dependent on how the organizations handles the process.

The fifth research question was introduced to find a way of getting flexibility in the executional process. It was opted to use the processes of the level 3 process as goals for the level 4 mapping, which was done in CMMN.

Lastly the gate review process was investigated. This research question proposes a way of what they should look like and how they can be performed. A graphical overview was given where in the process they could be placed.

It was found in literature that there was still not one holistic way in performing project business, various business aspects could be picked when one wants to try to relax the challenges faced. This research tries to relax the challenges faced with project business with BPM as a direction for the solution, which could be related to the dimension of processes in the STAR model. The research finally opts to combine two forms of BPM, when it comes to the level of operations of the company. This represents the combination of a standard fixed and flexible methodology. However, from the investigation of the company comparison and literature on project management, it can be concluded that in order to achieve results in the project management world, a system on itself is not the complete solution. The organizational goal was to solve many problems via the system aspect. However, it was found that the people side of the project was of more importance. By using the lanes with defined

roles, the design tried to bring stakeholder responsibility more visible. However the people side is something that needs to be taken care of when a system will be implemented in the future.

6.3 Recommendations

For the project it is recommended to further implement the structured project management in the organization. Which will help the company mature when it comes to their level of project management. The development of the project management should be done as a way of working within the current company. Where companies function better when they do not run in a complete project orientated way. As stated in the company comparison, it will be wise to make the market definition of what a project is market specific. No organization is the same, very likely what is considered a project will not fulfil the requirements in another market. When the market definition fits none of the organizations, it is of no use.

In terms of the gate review process, first implement the review process for any given project. In this way the company can learn by experience on which projects the review process is placed well, and on which ones it is not necessary. In the future when experience is gathered on the execution of project review a decision can be made on which projects to keep the review process and on which it is not necessary. However important stays to keep learning from the projects reviews since it was one of the common mistakes in companies where knowledge was lost due to bad project end reviews.

As could be found in the research from literature and the company comparison, the people aspect of the business is very important. One could start by training employees to handle projects better. Apart from the training the users of the new system need to fully accept the new way of working for optimal use. Secondly Hilti could focus on the gathering of qualified personnel with project experience to add knowledge in the employee pool.

On the long term, the focus on the system side of the project would be to first bring all the data together in one system as was done in multiple companies. It is possible to have multiple systems interact with the data. With this approach for each party a suitable system could be implemented without having to compromise. These different parties could for example be the sales team, the manufacturing team and the project fulfilment team. With the requirement that they must be able to interact with the same data source. It would be possible to first use the conceptual design as a standalone system which is purely for directive purposes. Later it could be implemented or combined with the data system. This makes the design even more a step towards the solution of the final project.

6.4 Limitations

The performed research has some limitations. The limitations are discussed below.

Firstly, the research is focused on processes which are mainly used at projects. However, the regular transaction business of the company was not taken in consideration. Processes from the standard business can be of influence on the performance of the project processes. Where Kerzner (2018) stated firms operation in a project way should do this next to their regular form of business and not develop a complete projectivized work method. With this statement in mind it would be interesting to see how the project process behaves next to the regular process.

Secondly, the conceptual design was created around projects. However, projects consist of the project as a whole and a project itself consists of multiple applications. Not every application needs the same steps from the process. The design could have incorporated this split in the level between project and application.

Thirdly, when a company has multiple projects, it is likely to perform some sort of project portfolio management. This is not considered in this research, it would be part of phase S1 which is just the

starting phase. A project comes from the project portfolio management phase. The thesis could have developed these portfolio project requirements for different forms of projects.

Fourthly, the company comparison only includes one company in the same industry as Hilti. However, one of Hilti's customers is included. All the other companies perform business in different industries but do this in a project way. Besides being in differentiated across industries, all of the company interviews were performed with employees of the organizations within Europe. This could bring an European bias to the research.

Fifthly, the design validation only focussed on the validation of the level 3 design, because of its direct and practical use for the company. The fourth level of the design was only proposed as a directive solution for the future, where a system can combine the two methodologies of a business process management system. The validation was conducted together with the redesign phase, however it would provide more value to have the design validated lastly by an objective stakeholder. By involving a lot of people in the redesign phase a validation aspect could be included.

And lastly, from a practical point of view, it would have been of value if the design was already implemented in a working software package which could be actually worked with, instead of just a check of correctness in a business process management modelling system. More valuable information could have been gathered in this way about the effects of the different processes.

6.5 Future research and future work

For future research on this topic one can think of the following directions described below in this chapter.

With the limitations in mind one can think of a research where the project business is combined with the processes of the standard form of business. One can opt for a single source of truth when it comes to a BPM system.

A study could be conducted where the differences between industries regarding to project business is investigated.

As was stated by Turner & Keegan's (1999) it could be researched within the company how the further implementation of the project style of working could be done smoothly within the current working environment. With this research one could opt to address different dimensions of the star model together with the process dimension in mind.

In the future for Hilti it is important to implement the proposed solution in the organization. Decisions need to be made on which part to standardize on a global level, and what to leave up to the different market organizations. As concluded from the company comparison, a market definition needs to be made for the definition of a project.

As already stated in the recommendations part, the company can focus on acquiring a solution which brings all the data regarding projects into one place.

7. References

Aagesen, G., & Krogstie, J. (2010). Analysis and design of business processes using BPMN. In *Handbook on Business Process Management 1* (pp. 213–235). Berlin, Heidelberg: Springer.

Aalst, W. Van Der, Hee, K. Van, & Hee, K. van. (2004). Workflow management: models, methods, and systems.

Aguilar-Saven, R. S. (2004). Business process modelling: Review and framework. *International Journal of Production Economics*, *90*(2), 129–149.

Alajoutsijärvi, K., Mainela, Tuija, Salminen, Risto, Ulkuniemi, … Pauliina. (2007). Ambiguous Nature of Project Business - How the Project Business Companies Try to Deal with Project Business Characteristics. *23rd Annual IMP-Conference 2007*, 1–20.

Anand, A., Wamba, S. F., & Gnanzou, D. (2013). A literature review on business process management, business process reengineering, and business process innovation. *Heidelberger Platz*, *3*, 1–23.

Armistead, C., Pritchard, J. P., & Machin, S. (1999). Strategic business process management for organisational effectiveness. *Long Range Planning*, *32*(1), 96–106.

Artto, K. A., & Wikström, K. (2005). What is project business? *International Journal of Project Management*, *23*(5), 343–353.

Artto, K., Davies, A., Kujala, J., & Prencipe, A. (2011). The Project Business: Analytical Framework and Research Opportunities. In *The Oxford Handbook of Project Management*.

Artto, K., Martinsuo, M., Kujala, J., Artto, K., Martinsuo, M., & Kujala, J. (2011). *Project business*.

Assimakopoulos, N. A. (2000). Workflow Management Coalition Terminology & Glossary. *ISA Transactions*, *39*(2), 153–167.

Bank, W. (2005). *Litle Data Book: The World Bank Development Data Book*. Washington DC.

Becker, J., Rosemann, M., von Uthmann, C., & Uthmann, C. Von. (2000). Guidelines of Business Process Modeling. *Business Process Management*, *1806*, 241–262.

Bukhsh, Z. A. (2015). Master Thesis BPMN Plus : A Modelling Language for Unstructured Business Processes Master Thesis BPMN Plus : A Modelling Language for Unstructured Business Processes Zaharah Allah Bukhsh Graduation Committee :

C. Horne; Hechter;, M. (2003). Theories-of-Social-Order-A-Reader.pdf. Stanford University Press.

Cattani, G., Ferriani, S., Frederiksen, L., & Täube, F. (2011). Project-based organizing and strategic management: A long-term research agenda on temporary organizational forms. In *Project-based organizing and strategic management* (pp. xv--xxxix). Emerald Group Publishing Limited.

Cooper, R. G. (2008). *Perspective: The Stage-Gate® Idea-to-Launch Process-Update, What's New and NexGen Systems Perspective: The Stage-Gate ® Idea-to-Launch Process-Update, What's New and NexGen Systems*. *Journal of Product Innovation Management* (Vol. 25).

Cova, B., Ghauri, P., & Salle, R. (2002). *Project marketing: Beyond competitive bidding*. Wiley.

Curtis, Bill and Kellner, Marc I and Over, J. (1992). Process modeling. *Communications of the ACM*, *35*(9), 75–90.

Davenport, T. H. (1993). *Process Innovation Reengineering Work through Information Technology*.

Di Ciccio, C., Marrella, A., & Russo, A. (2015). Knowledge-Intensive Processes: Characteristics,

Requirements and Analysis of Contemporary Approaches. *Journal on Data Semantics*, *4*(1), 29–57.

Dumas, M., Aalst, W. van der., Ter Hofstede, A., & John Wiley & Sons. (2005). *Process-aware information systems : bridging people and software through process technology*. Wiley-Interscience.

Dumas, M., Marcello, ·, Rosa, L., Mendling, J., & Reijers, H. A. (2013). *Fundamentals of Business Process Management*. *Qualitative Process Analysis*.

Dunie, R., Kerremans, M., Baker, V. L., & Wong, J. (2017). Magic Quadrant for Intelligent Business Process Management Suites.

Earl, M. J. (1996). Business process reengineering: a phenomenon of organization. *Information Management. The Organisational Dimension*, 53–76.

Galbraith, J. R. (2014). *Designing organizations: Strategy, structure, and process at the business unit and enterprise levels*.

Grudzińska-Kuna, A. (2013). Supporting knowledge workers: case manageament model and notation (CMMN). *Information Systems in Management*, *2*(1), 3–11.

Hammer, M. (2015). What is Business Process Management? In *Handbook on Business Process Management 1* (pp. 3–16). Berlin, Heidelberg: Springer Berlin Heidelberg.

Hammer, M., & Champy, J. (1993). Business process reengineering. *London: Nicholas Brealey*, *444*.

Havey, M. (2005). *Essential business process modeling*. O'Reilly.

Hellström, M., & Wikström, K. (2005). Project business concepts based on modularity--improved manoeuvrability through unstable structures. *International Journal of Project Management*, *23*(5), 392–397.

Herrmann, C., & Kurz, M. (2011). Adaptive case management: Supporting knowledge intensive processes with it systems. In *International Conference on Subject-Oriented Business Process Management* (pp. 80–97). Springer, Berlin, Heidelberg.

Hobday, M. (2000). The project-based organisation: an ideal form for managing complex products and systems? *Research Policy*, *29*(7–8), 871–893.

Hull, R., Damaggio, E., Fournier, F., Gupta, M., Heath, F. T., Hobson, S., … others. (2010). Introducing the guard-stage-milestone approach for specifying business entity lifecycles. In *International Workshop on Web Services and Formal Methods* (pp. 1–24).

Indulska, M., Green, P., Recker, J., & Rosemann, M. (2009). Business Process Modeling: Perceived Benefits. *28th International Conference on Conceptual Modeling*, (November), 458–471.

Keeble Kululanga, G., & Shaibu Kuotcha, W. (2008). Measuring organisational learning through project reviews. *Engineering, Construction and Architectural Management*, *15*(6), 580–595.

Kerzner, H. (2014). *Project management best practices; achieving global excellence*. (H. Kerzner, Ed.) (Third). New York: Wiley.

Kerzner, H. (2018). *Project management best practices: Achieving global excellence*. John Wiley & Sons.

Koehler, J., Woodtly, R., & Hofstetter, J. (2015). An impact-oriented maturity model for IT-based case management. *Information Systems*, *47*, 278–291.

Krogstie, John and Dalberg, Vibeke and Jensen, S. M. (2008). Process Modeling Value Framework. In: Manolopoulos Y., Filipe J., Constantopoulos P., Cordeiro J. (eds) Enterprise Information Systems. *International Conference on Enterprise Information Systems*, *3*, 309–321.

Krogstie, J., Dalberg, V., Jensen, S. M., & Krogstie, John and Dalberg, Vibeke and Jensen, S. M. (2006). Process modeling value framework. In *International Conference on Enterprise Information Systems* (Vol. 3, pp. 309–321).

Liinamaa, J., & Wikström, K. (2009). Integration in project business: mechanisms for knowledge integration. *Int. J. Knowledge Management Studies*, *34*(34), 331–350.

Lindkvist, L. (2004). Governing project-based firms: promoting market-like processes within hierarchies. *Journal of Management and Governance*, *8*(1), 3–25.

Liu, Rong and Kumar, A. (2005). An analysis and taxonomy of unstructured workflows. *International Conference on Business Process Management*, 268–284.

Lundin, R. A., Arvidsson, N., Brady, T., Ekstedt, E., Midler, C., & Sydow, J. (2015). *Managing and working in project society*. Cambridge university press.

Man, H. De, & De Man, H. (2009). Case Management : A Review of Modeling Approaches. *BPTrends*, *2009*(January), 1–17.

Management, C., & Clair, L. (2018). The Forrester Wave ™ : Cloud-Based Dynamic The Forrester Wave ™ : Cloud-Based Dynamic Case Management ,.

Mandják, T., & Veres, Z. (1998). The D-U-C model and the stages of project marketing process. *14th IMP Annual Conference Proceedings*, *3*(January), 471–490.

Marin, M., Hull, R., & Vaculin, R. (2012). Data Centric BPM and the Emerging Case Management Standard : A Short Survey Case Management Modeling and Notation (CMMN): An emerging OMG standard, *257593*(September), 24–25.

Maylor, H., Turner, N., & Murray-Webster, R. (2015). “It worked for manufacturing. . .!”. Operations strategy in project-based operations. *International Journal of Project Management*.

McCready, S. (1992). There is more than one kind of workflow software. *Computerworld*, *2*.

Miterev, M., Mancini, M., & Turner, R. (2017). Towards a design for the project-based organization. *International Journal of Project Management*.

Miterev, M., Turner, J. R., & Mancini, M. (2017). The organization design perspective on the project-based organization: a structured review. *International Journal of Managing Projects in Business*.

Motahari-Nezhad, H. R., & Bartolini, C. (2011). Next Best Step and Expert Recommendation for Collaborative Processes in IT Service Management (pp. 50–61). Springer, Berlin, Heidelberg.

Mukhopadhyay, T., & Kekre, S. (1995). Business value of information technology: a study of electronic data interchange. *MIS Quarterly*, 137–156.

Oakes, G. (2016). Project reviews, assurance and governance.

Object Management Group (OMG). (2011). Business Process Model and Notation (BPMN) Version 2.0. *Business*, *50*(January), 170.

OMG (Object Management Group). (2014). Case Management Model And Notation, (December).

Ould, M. (2005). Business Process Management: a rigorous approach.

Owusu, R. A. (1997). The nature and development of relationships in international project business: A network approach. In *Proceedings of the 13 th IMP Conference, Lyon. Lyon: Groupe ESC*.

Pillaerds, J., & Eshuis, R. (2017). Assessing Suitability of Adaptive. In *25th European Conference on Information Systems (ECIS)* (Vol. 2017, pp. 566–580). Guimarães, Portugal.

Project Management Institute. (2013). *ORGANIZATIONAL PROJECT MANAGEMENT MATURITY MODEL (OPM3 ®), Knowledge Foundation-Third Edition*.

Reijers, H. A., Rigter, J. H. M., & van der Aalst, W. M. P. (2003). The Case Handling Case. *International Journal of Cooperative Information Systems*, *12*(03), 365–391.

Richter-von Hagen, Cornelia and Ratz, Dietmar and Povalej, R. (2005). Towards self-organizing knowledge intensive processes. *Journal of Universal Knowledge Management*, *2*, 148–169.

Rosa, M. La, Aalst, W. M. P. Van Der, Dumas, M., & Milani, F. P. (2017). Business Process Variability Modeling. *ACM Computing Surveys*, *50*(1), 1–45.

Steenkamp, Jacob Rudolph and Bekker, M. C. (2018). Validating a Project Life-Cycle Review Framework for Mining Projects At Exxaro. *The South African Journal of Industrial Engineering*, *29*(1), 74–85.

Swenson, K. (2012). Case Management: Contrasting Production vs. Adaptive, 1–8.

Swenson, K. D. (2013a). Designing for an Innovative Learning Organization. In *2013 17th IEEE International Enterprise Distributed Object Computing Conference* (pp. 209–213). IEEE.

Swenson, K. D. (2013b). White paper State of the Art In Case Management. *Fujitsu America, Inc*, (March), 16.

Swenson, K., & Palmer, N. (2010). Mastering the unpredictable: how adaptive case management will revolutionize the way that knowledge workers get things done.

Swenson, K., Palmer, N., Done, M. P.-W. G. T., & 2012, U. (n.d.). Case management: contrasting production vs. adaptive. *Books.Google.Com*.

Sydow, J., Lindkvist, L., & DeFillippi, R. (2004). Project-Based Organizations, Embeddedness and Repositories of Knowledge: Editorial. *Organization Studies*, *25*(9), 1475–1489.

Tonchia, S. (2018). *INDUSTRIAL PROJECT MANAGEMENT: International Standards and Best Practices for Engineering and Construction Contracting*. Springer.

Turner, J. R., & Keegan, A. (1999). The versatile project-based organization: governance and operational control. *European Management Journal*.

van der Aalst, W. M. P. (2013). Business Process Management : A Comprehensive Survey. *ISRN Software Engineering*, *2013*, 1–37.

Van der Aalst, W. M. P., Stoffele, M., & Wamelink, J. W. F. (2003). Case handling in construction. *Automation in Construction*, *12*(3), 303–320.

van der Aalst, W. M. P., Weske, M., & Grünbauer, D. (2005). Case handling: a new paradigm for business process support. *Data & Knowledge Engineering*, *53*(2), 129–162.

Van Looy, A., De Backer, M., & Poels, G. (2011). Defining business process maturity. A journey towards excellence. *Total Quality Management & Business Excellence*, *22*(11), 1119–1137.

Walker, D. H. T. (2009). Project Reviews, Assurance and Governance. *International Journal of Managing Projects in Business*.

Weske, M. (2007). Business Process Management: Concepts, Languages, Architectures. *Springer*, 3–23.

Weske, M. (2012). Business Process Management Architectures. In *Business Process Management* (pp. 333–371). Berlin, Heidelberg: Springer Berlin Heidelberg.

Whitley, R. (2006). Project-based firms: new organizational form or variations on a theme? *Industrial and Corporate Change*, *15*(1), 77–99.

Wikström, K., Artto, K., Kujala, J., & Söderlund, J. (2010). Business models in project business. *International Journal of Project Management*, *28*, 832–841.

Wohed, P., Van Der Aalst, W. M. P., Dumas, M., Ter Hofstede, A. H. M., & Russell, N. (2005). Pattern-based analysis of the control-flow perspective of UML activity diagrams. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *3716 LNCS*, 63–78.

Wolf, J. De. Analysis of the advantages and disadvantages of implementing Case Management (2016).

Zorn, T. (2008). Designing and conducting semi-structured interviews for research. *Waikato Management School, Waikato*, 11.

Appendix A

Company comparison interview template

Hilti Company comparison

1. What do you consider a customer project? Typical size/scope/duration?

2. How are you organized to manage these projects?
    a. What are the various roles?
    b. Do you have a project management office (PMO) structure?
        i. Global or regionalized
    c. Does this vary based on the project type and location?

3. How are projects initiated?
    a. What is the triggering point?
    b. Do you have a S&OP process in place?

4. What kind of project management software do you use for customer projects?
    a. How do you use it and what is your experience? (Pro's/cons)
    b. Do you use the software as a task/workflow management tool?
    c. Is the dataflow integrated into the system? (Pro's/cons)
    d. How is flexibility in the process incorporated in the system?
    e. How are exceptions handled?
    f. What are the costs for the software solution?
    g. What have been the reasons to come up with the existing solution?

5. How do you ensure that all inputs have been received and activities completed before a project moves to the next phase?
    a. What are the phases/gates that your projects go thru?
    b. Who are the project stakeholders?
    c. How are gate reviews managed?

6. What is the common form of internal communication with regards to customer projects?
    a. Fully integrated system, email, phone, face to face, else?
    b. How do you make sure that changes to for example BOM are communicated well?

7. What is your future perspective on customer project management?
    a. What would you consider as system improvements?
    b. What ways of working would you improve?

8. How do you measure project progress and performance?

Appendix B

Confidential information.

Appendix C

EPIC project

Workflow verification

General expectations:

Verification of workflow draft from core team by market experts

Prioritization of existing elements (content modules) & add missing elements

Minimum 2-3 experts from front-end & 2-3 experts from back-end to be involved in the review

Minimum one feedback from mainstream business expert

Consolidate / summarize input from all experts into one form (see below)

Suggested approach for review process

Review meeting (2-3h) to be scheduled with all experts together for your region

Submit pre-reading (incl. workflow & content modules)

Participants involved in review meeting		
Name	Function	MO

Appendix D

Confidential information.

Appendix E

Confidential information.

Appendix F

Confidential information.

Appendix G

Confidential information.

Appendix H

Five level process mapping approach

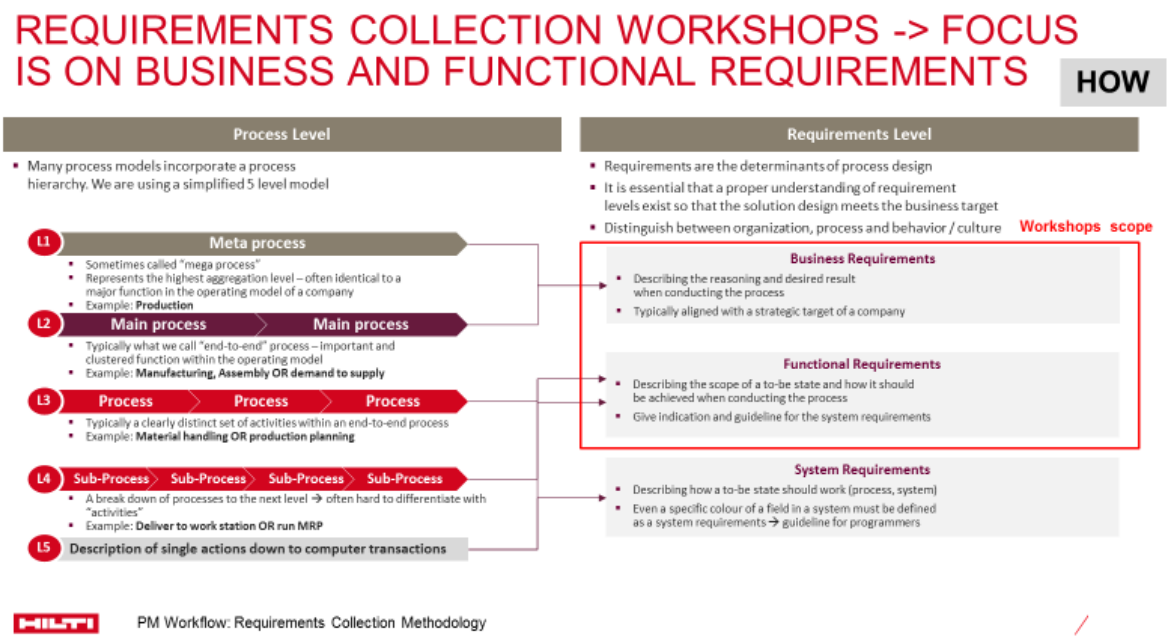

Figure 34 5 level process mapping

Appendix I

Confidential information.

Appendix J

Confidential information.

Appendix K

Confidential information.

Table 14 Regions feedback loop and redesign