

# Implementing Software Product Management During The Productization Process

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## **Abstract**

Currently there are software vendors that want to move from customer specific software to a standard software product. A software product can be governed by software product management (SPM) and the productization process describes the process a software vendor undergoes to change from customer specific software to a standard software product. Currently the SPM capabilities are not linked to a stage of the productization process. This exploratory research links the SPM capabilities to a stage of the productization process, identifies the investments in terms of working days that are related to a SPM capability and identifies change aspects that should be considered for the implementation of SPM during the productization process.

The results of this research are an overview of the SPM capabilities implemented at the case company during each stage of the productization process and the investments in terms of working days related to these SPM capabilities. A preliminary framework is created that links the SPM capabilities to a stage of the productization process. And lastly a set of guidelines is identified from literature that indicates the aspects of change that should be considered for the implementation of SPM during the productization process.

Keywords: Software product management, productization, software process change, customer specific software, standard software.

# 1 Introduction

Currently there are two types of software that is being developed, customer specific software and product software. The customer specific software is in general developed for one specific customer where product software is developed for the market, which is targeted at a large group of potential customers (Regnell and Brinkkemper, 2005). The pressure for product software lies in the time to market where custom-made software focuses more on the cost (Sawyer, 2000). Xu and Brinkkemper (2007) define product software as “a packaged configuration of software components or a software-based service, with auxiliary materials, which is released for and traded in a specific market”.

Software vendors that want to move from customer specific software to product software need to change their processes they use to develop their software. A software product can be governed with software product management (SPM). To support the use of SPM within an organization the SPM competence model can be used (Bekkers, Weerd, Spruit & Brinkkemper, 2010). The SPM competence model gives an overview of important focus areas and stakeholders relevant to the development of product software. The implementation of the focus areas is support by implementing capabilities related to the focus area.

The transformation from customer specific software to product software is described in the productization process by Artz, Weerd, Brinkkemper and Fieggen (2010). The productization process consists of six stages that start with individual projects and will end with a standard product or a customizable product. The productization process gives a global overview about what percentage of the level of software product management should be implemented in each stage.

The productization process does not state what specific SPM capabilities need to be implemented during each stage. Therefore there is no clear path of which SPM capabilities that at least needs to be implemented to move to the next stage in productization process. Organizations have no clear guideline in which stage to implement specific SPM capabilities. The SPM capabilities as defined by Bekkers, Weerd, Spruit and Brinkkemper (2010) do not describe what investments are needed to implement a specific capability expect for any prerequisite capabilities.

For software vendors it is not clear what SPM capabilities need to be implemented during each stage of the productization process. And there is no clear indication what kind of investments in terms of resources needs to be made to implement a SPM capability. Therefore it is unclear what the investments are to move to the next phase in the productization process. Furthermore there is little to no literature available that describes the aspects of change that need to be considered for the implementation of SPM (capabilities) during the productization process.

This leads to the following research question:

*When should software product management capabilities be implemented in the productization process and what chance aspects and investment are needed to implement these capabilities?*

This research will specify what capabilities at least need to be implemented in during each stage of the productization process to move to the next stage. Secondly it will specify what kind of investment in terms of working days is needed to implement a SPM capability. Lastly it will identify change aspects that need to be considered for the implementation of SPM during the productization process.

## **2 Research approach**

This section gives an overview of the research question and the sub questions, followed by the method that will be used during the research.

### **2.1 Research questions**

The lack of guidelines in terms of investments, SPM capabilities to be implemented and change aspects for moving to the next stage in the productization process as described in section 1 leads to the following research question:

*RQ: When should software product management capabilities be implemented in the productization process and what change aspects and investment are needed to implement these capabilities?*

To answer the research question the following four sub questions will be answered:

SQ1. What is Software Product Management and productization?

SQ2. Which SPM capability can be linked to which productization stage?

SQ3. What are the investments associated with these SPM capabilities?

SQ4. Which aspects of process change and which success factors should be considered for the introduction of SPM during the productization process?

### **2.2 Research method**

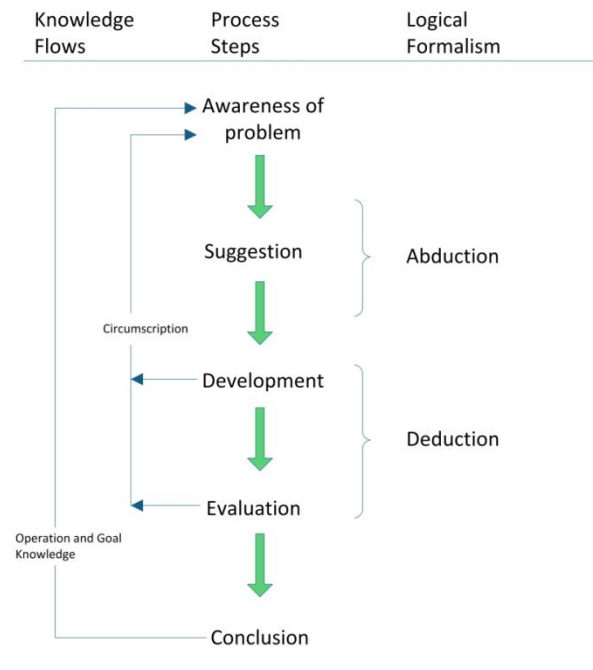
This research will mainly be an exploratory research. The first sub question will provide a theoretical background by describing what software product management and productization is. A case study and a literature review will be used to aid the exploratory research sub questions two to four. The second sub question will result in a preliminary framework. To aid the creating of the preliminary framework design science research will be used.

Hevner, March, Park and Ram (2004) describes the fundamentals of design science research with seven guidelines:

1. Design as an artifact: The result of design science should be an IT artifact that solves an organizational problem.
2. Problem relevance: The design science research should solve a business problem.
3. Design evaluation: The designed artifact must be evaluated by well-executed evaluation methods.
4. Research contributions: The design research must provide contributions in the areas of the design artifact, foundations and/or methodologies.
5. Research Rigor: The construction and evaluation of the artifact should be rigorous.

6. Design as a search process: For the creation of the artifact the use of all available means within the problem environment should be used.
7. Communication of the research: The results of the research should be presented technically orientated and management orientated.

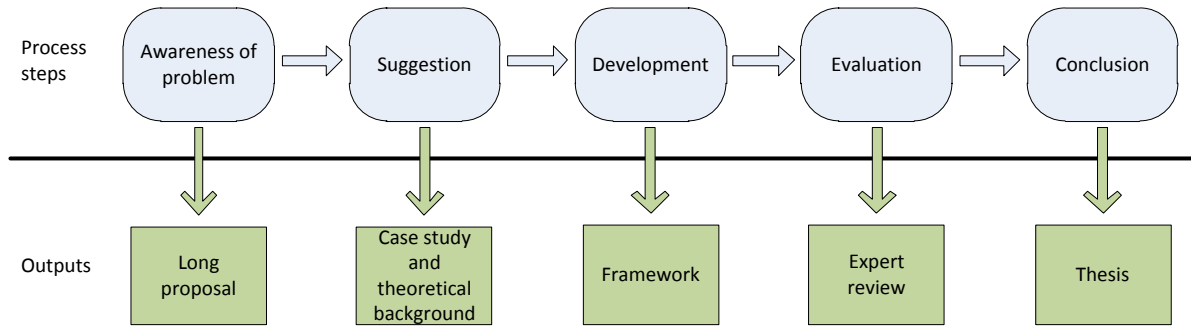
These guidelines describe the design science research and will be considered during the research of the second sub question. For the execution of the research there is chosen to follow the design cycle of Vaishnavi and Kuechler (2004). This method consists of more concrete steps compered to Hevner, March, Park and Ram (2004). Figure 1 depicts the design cycle of Vaishnavi and Kuechler (2004). The design cycle consists of five process steps: awareness of problem, suggestion, development, evaluation and conclusion.



**Figure 1: Design cycle by Vaishnavi and Kuechler (2004).**

For this research the processes steps can be matched with outputs of the research. Figure 2 shows the process steps with the outputs that will result from this research. Followed by a description of how the process steps will be applied within this research.





**Figure 2: Process steps with outputs of the research.**

**Awareness of the problem:** In this phase a problem is discovered, possible source for the problem can be new developments in the industry or from a reference discipline. The output of this phase is a research proposal. During the long proposal the problem was defined into sub question two.

**Suggestion:** In the suggestion phase the information that is needed to create the artifact is collected. The information that will be used to create the artifact consists of two parts. The first part is the theoretical background literature of software product management and productization. The second part is the case study at a software vendor.

**Development:** In this phase the result of the suggestion phase are used to create the artifact. The artifact will be a preliminary framework that will give an indication of which SPM capabilities should implemented in each stage of the productization process.

**Evaluation:** In this phase the developed artifact will be evaluated, this can be done by either quantitative or qualitative methods. In this research the developed artifact will be evaluated with an expert review. Depending on the results of the reviews the framework can be adjusted.

**Conclusion:** In this phase the results and conclusions are presented. This will be presented during the conclusion of this thesis.

The case study in this research will be used to aid the answer of the second and third sub questions. The case study will be performed by the guidelines of Yin (2003). The case study will be performed at the Dutch software vendor Relyon. The case study will identify the implemented SPM capabilities during the different stages of the productization process and looks at the time invested in using those capabilities in terms of working days. The case study approach and case company are described in chapter 4. The literature review in this research will be used to answer the fourth sub question. The literature review will identify change aspects that can be used as guideline for implementation of SPM during the productization process. The literature review will be using the steps described by Okoli and Schabram (2010) as a guideline to create the literature review approach. The literature review approach can be found in chapter 7. The process deliverable diagram (PDD) in Figure 3 shows the research approach that this research will follow. The PDD is modeled by the method of Weerd and Brinkkemper (2008).

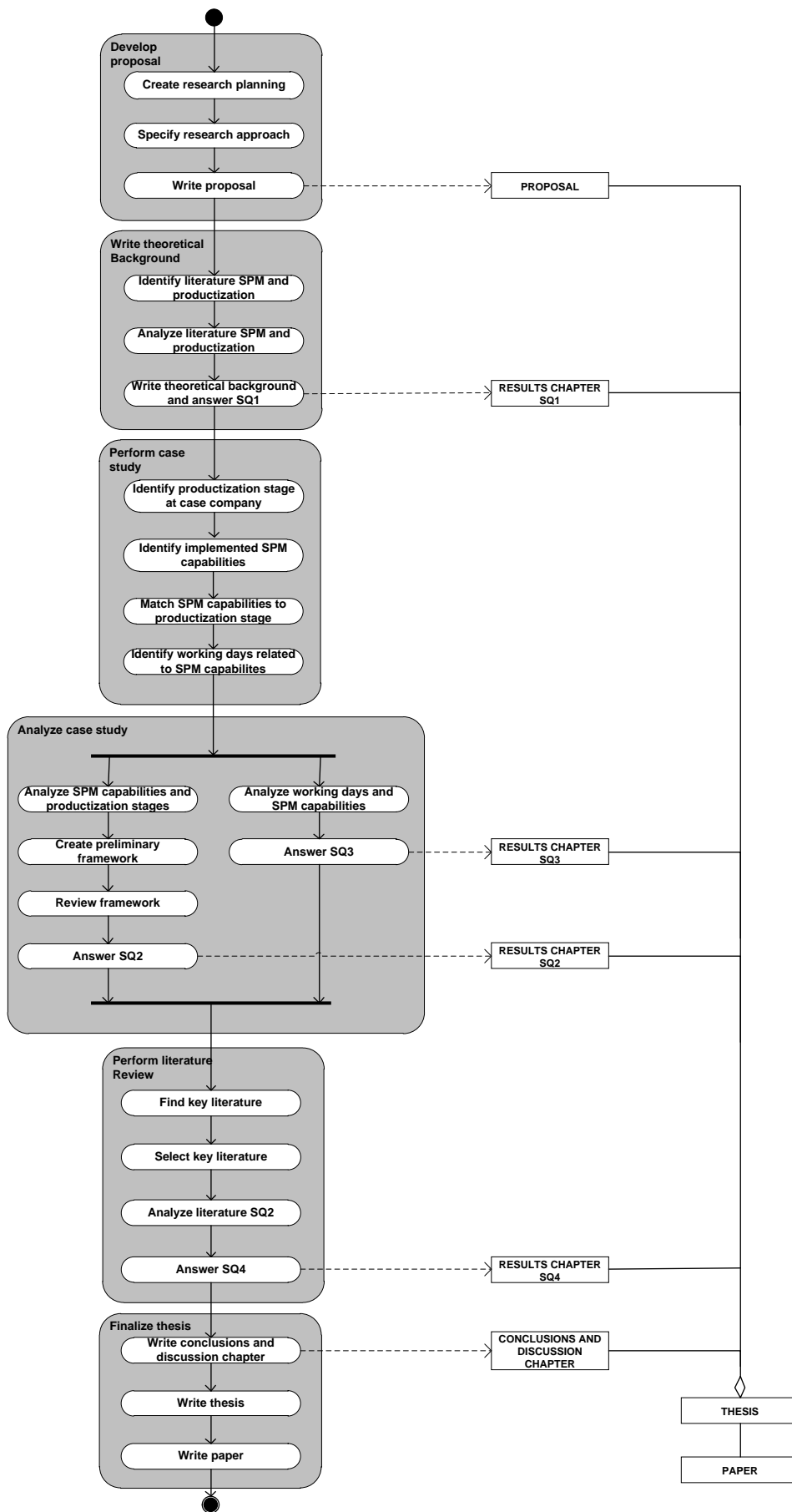


Figure 3: PDD of the research approach

## **2.3 Scientific and practical contribution**

The scientific contribution in this research lies in specifying what SPM capabilities need to be implemented in a productization stage to move to the next stage in the productization process. Furthermore the research will provide an overview of what investments in terms of working days is, related to a specific SPM capability. Change aspects are identified that should be considered for the implementation of SPM during the productization process. Furthermore this research will also provide a further validation for the productization process (Artz, Weerd, Brinkkemper & Fieggen, 2010) and the SPM competence model (Bekkers, Weerd, Spruit & Brinkkemper, 2010).

The practical contribution of this research lies in providing software vendors with a guideline of which SPM capabilities need to be implemented in their current stage of productization to move to the next stage in the productization process. Furthermore it provides software vendors with an overview of what kind of investments in terms of working days can be expected to implement a SPM capability.

## **3 Theoretical background**

This section will answer the first sub question: What is Software Product Management and productization? This is done by looking at the existing literature of software product management (Bekkers, Weerd, Spruit & Brinkkemper, 2010), productization (Artz, Weerd, Brinkkemper & Fieggen, 2010) and software process improvement in general. The theoretical background is part of the suggestion phase the design science research.

### **3.1 Software Product Management**

Software product management (SPM) is used to govern a software product during its lifetime. Ebert (2009) describes SPM as “the discipline and business process governing a product from its inception to the market or customer delivery and service in order to generate the largest possible value to a business”. Weerd, Brinkkemper, Nieuwenhuis, Versendaal and Bijlsma (2006) created a reference framework for SPM. This reference framework for SPM is further developed into the software product management competence model (Bekkers, Weerd, Spruit & Brinkkemper, 2010). The SPM competence model gives an overview of the areas that are important in the field of SPM. The SPM competence model is shown in Figure 4.

The SPM competence model consists of four main business functions, namely: portfolio management, product planning, release planning and requirements management.

Portfolio management oversees the products in the portfolio by gathering strategic information and making decisions across the product portfolio. Portfolio management has three focus areas. (1) Market analysis gathers information about the market to support the decision making of the product portfolio. (2) Product life cycle management gathers information about the life of a product and product changes. (3) Partnering & contracting concerns establishing partnerships, pricing and distribution aspects.

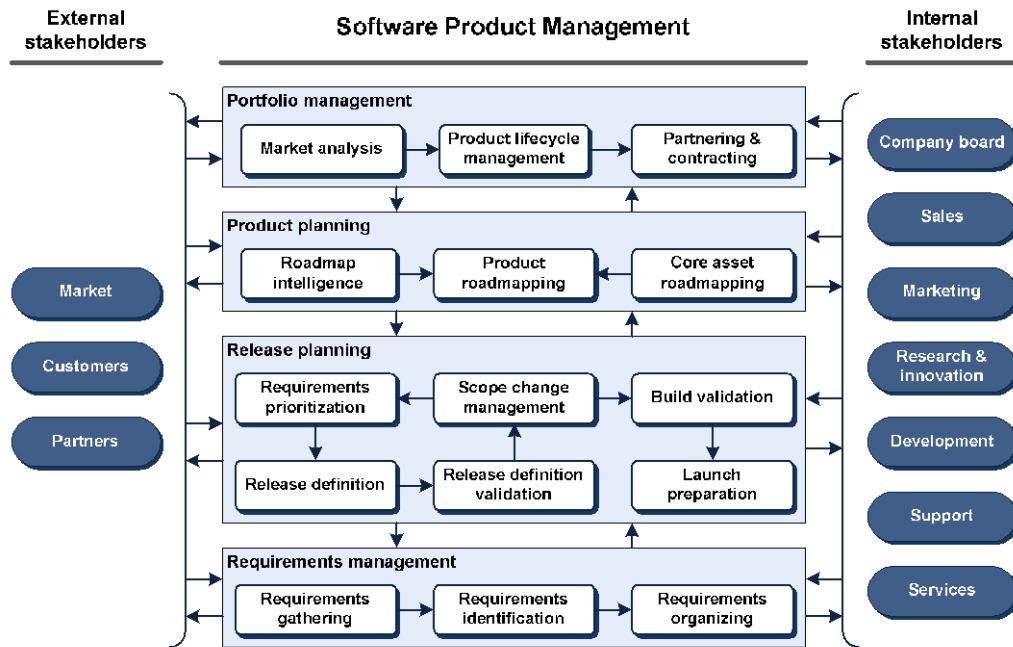


Figure 4: The Software Product Management competence model by Bekkers, Weerd, Spruit & Brinkkemper (2010).

Product planning oversees the different releases a product, it gathers information for creating a product (line) roadmap and its core assets. Product planning has three focus areas. (1) Roadmap intelligence gathers the information needed to create a roadmap, its focuses upon markets, competitors and technologies. (2) Product roadmapping uses the data gathered in roadmap intelligence to create a roadmap. (3) Core asset roadmapping oversees the planning of the development of the core assets.

Release planning oversees the requirements for each release. Release planning has six focus areas. (1) Requirements prioritization determinates which the requirements for the next release by prioritizing them. (2) Release definition selects the requirements that will be in the next release. (3) Release definition validation concerns the approval of the release definition. (4) Scope change management handles possible scope changes that might occur during the development of the release. (5) Build validation handles the validation of the build before it is launched, the build is checked internally and if needed also externally. (6) Launch preparation oversees the preparation of the internal and external stakeholders for the new release.

Requirements management oversees the content and administrative data of individual requirements. Requirement management has three focus areas. (1) Requirements gathering concerns the collection of requirements from internal and external stakeholders. (2) Requirements identification rewrites the requirements to product requirements and connects similar requirements. (3) Requirements organizing structures requirements throughout their lifecycle and shared aspects and describes dependencies between product requirements.

Stakeholders influence the SPM competence model; the stakeholders can be internal or external. The internal stakeholders are the company board, sales, marketing, research & innovation, development, support and services. The external stakeholders are market, customers and partners.

### 3.2 SPM maturity matrix

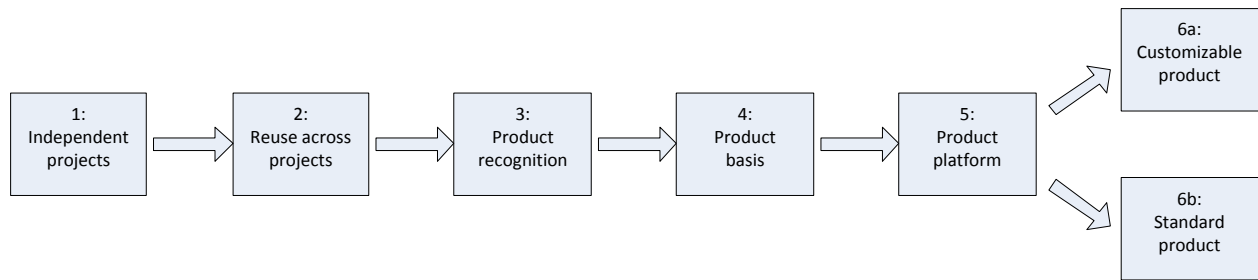
The SPM maturity matrix provides software vendors with the ability to measure their SPM maturity and identifies areas that can be improved (Bekkers & Spruit, 2010; Bekkers, Weerd, Spruit & Brinkkemper, 2010). The SPM maturity matrix consists of 68 capabilities divided over the focus areas. Bekkers and Spruit (2010) define capabilities as “a predefined goal that needs to be achieved to reach the maturity level with which it is associated”. The SPM maturity matrix is shown in Figure 5. The numbers 0 to 10 indicate the SPM maturity levels; whereas 0 is the lowest maturity level and 10 the highest maturity level. The letters A - F each represent a SPM capability in a focus area. An overview of the SPM capabilities by Bekkers and Spruit, (2010); Bekkers, Weerd, Spruit and Brinkkemper (2010) ordered by focus area can be found in Appendix A. The dependencies between the SPM capabilities can also be found in appendix A. The maturity level is determined by selecting the maturity level up to the lowest ranking capability that is not implemented in the business function.

Maturity	0	1	2	3	4	5	6	7	8	9	10
<i>Requirements management</i>											
Requirements gathering		A		B	C		D	E	F		
Requirements identification			A			B		C			D
Requirements organizing				A		B		C			
<i>Release planning</i>											
Requirements prioritization			A		B	C	D			E	
Release definition			A	B	C				D		E
Release definition validation					A			B		C	
Scope change management				A		B		C		D	
Build validation					A			B		C	
Launch preparation		A		B		C	D		E		F
<i>Product planning</i>											
Roadmap intelligence				A		B	C		D	E	
Core asset roadmapping					A		B		C		D
Product roadmapping			A	B			C	D		E	
<i>Portfolio management</i>											
Market analysis					A		B	C	D		E
Partnering & contracting						A	B		C	D	E
Product lifecycle management					A	B			C	D	E

Figure 5: SPM maturity matrix.

### 3.3 Productization

Artz, Weerd, Brinkkemper and Fieggen (2010) introduced the productization process. The process describes the change from developing customer specific software to a standard software product. The productization process consists of six stages ranging from independent projects to a customizable/standard product. The productization process is depicted in Figure 6.



**Figure 6: The productization process by Artz, Weerd, Brinkkemper and Fieggen (2010).**

The different stages of the productization process by Artz, Weerd, Brinkkemper and Fieggen (2010) can be described as follows:

- Stage 1 consists of independent projects that are executed independently. These projects have little to none standard/common functions or features and differ in technology, functionality and budget. The projects are mainly customer driven in this stage.
- Stage 2 reuses features of previous projects across different projects. The new projects are developed with parts used in previous projects. Using parts from previous projects has the advantage of an increased reliability and quality since the parts have been tested before in past projects. During this stage the number of custom feature is larger than the number of standard features.
- Stage 3 consists of projects where the larger part is based upon standard features. Projects with the majority of standard parts will results in recognition of a product. Features are shared between projects, the number of standard features is larger than the number of custom features and the maintenance at this stage is customer specific.
- Stage 4 consists of a generic product platform, which is a set of features that form a common structure. This can be used for multiple products that can effectively be customized. The customer requirements during this stage are being handled as market requirements. The maintenance at this stage is still customer specific.
- Stage 5 consists of the focus on a standardizing generic product platform, which has an increasing number of features that are a common structure in comparison with the previous stage. From this platform products can efficiently customized, developed and produced. The requirements gathering during this stage is based upon market trends. The releases during this stage are event based customized release per customer.
- Stage 6a consists of a customizable software product. The releases for each of the customers are the same; in addition to the standard product release there is a customer specific layer, which is needed for the release to be used in specific situations that a customer requires. The releases during this stage are structured.
- Stage 6b consists of one standard software product that is built for specific market; the focus in this stage is moved from the customer to the market. The software product is completely customizable and has structured releases.

### 3.4 Software process improvement

Software process improvement intends to improve the quality of a software product, increasing its productivity and reducing the development cycle of the software product (Stelzer and Mellis, 1998; Paulk, Curtis, Chrissis & Weber, 1993). Whereas Allison and Merali (2007) state that: *“software process improvement facilitates the identification and application of changes to the development and management activities in order to improve the product”*. A software process can be defined as: *“a set of activities, methods, practices, and transformations that people use to develop and maintain software and the associated products (e.g., project plans, design documents, code, test cases, and user manuals)”* (Stelzer and Mellis, 1998 & Paulk, Curtis, Chrissis & Weber, 1993).

Mathiassen, Ngwenyama and Aaen (2005) describe four elements of change related to software process improvement. The first element is changing the processes, which include the definitions of the software process, the technologies that support them and practices that merge the process definitions with the process technologies. The second element is changing structures, which include the grouping of units, coordination and authority structures. The third element is changing the people, which include change in the responsibilities of roles to support the new software processes, the identification of the implied need for skills and knowledge. And career paths that support the new processes as well the education and training of people to align to new processes. The last element is the management, which includes the planning and control, incentive schemes and culture. Resulting from these elements of change Mathiassen, Ngwenyama and Aaen (2005) identified the following five change management tactics.

- Creating a vision; creating a shared vision, adapting the vision to the change conditions and communication and sharing this vision.
- Managing the commitment by establishing commitment on all levels; balance the commitment with customer demands and supporting commitment with incentive schemes.
- Planning initiative by transforming the vision into specific projects; ensure there are sufficient resources and the adjustment of the plans as a reflection of the change and learning.
- Staying agile by sensing and responding to change; the coordination of software process improvement with other initiatives and the prioritization and managing of the software process improvement project portfolio.
- Monitoring the improvement; this includes making the changes sustainable, monitoring the specific software process improvement projects and measuring the long-term effects.

Hansen, Rose and Tjornehoj (2004) categorizes software process improvement into three categories, these are prescriptive, descriptive and reflective. Prescriptive software process management is focused upon how strategies should be formulated; it specifies how software processes should be improved. Prescriptive software process management can be norm driven or problem driven. The norm driven approach focuses upon software development processes at organizational, project, team or individual level. Beside that it also focuses upon standardizing and improving the processes. The problem driven approach focuses upon on ways to identify and solve specific problems in the organization. Descriptive software process management is focused upon describing the strategies do and get made. Reflective

software process improvement focuses upon reviewing or categorizing prescriptions and descriptions against a theoretical background.

Stelzer and Mellis (1998) describe a model for changing software processes; this model is based upon a generic model for change management by Backhard and Harris (1987). The adjusted model by Stelzer and Mellis (1998) consists of two phases. The first phase is analyzing the process, which results into an envisioned process and the second phase is changing the process, which results into an improved version of the current process. The analyzing the process phase consists of two steps; firstly the identification the process issues which reveals the strengths and weaknesses of the current processes and secondly the exploration of improvement options which aims at developing recommendations, setting priorities and establishing a plan for improvement. The “changing the process” phase concerns the recommendations on how to deploy improvements to the software process. The two phases follow each other in a cycle, which results in a continuous improvement of the software processes. During the phases a software process assessment like for example CMM can be used.

A generic software process improvement model by ESSI (1994) (Villalon, Gilabert, Seco Sanchez & Cota, 2002) consists of a cycle of four stages. The first stage is commitment to improvement. This stage focuses upon obtaining support from the senior management for the execution of the improvement project. The second stage is software process assessment. This stage is to identify the strength and weaknesses of the processes, and then selects processes for improvement. And assessment method like CMM can be used in this stage. The third stage is infrastructure and action plan. In this stage the needed infrastructure to carry out the improvement in the selected processes is provided, and a plan is created to define and implement the improvement in the selected processes. The fourth stage is the software process improvement implementation. In this stage the selected processes are newly defined and implemented in pilot projects, in the end the improvement will be implemented.

A software process improvement program model is the IDEAL model (McFeeley, 1996); which consists of five phases. The first phase is the initiating phase, where a SPI plan is created. It consists of setting the initial improvement structure, defining the roles and responsibilities, and assigning the initial resources. The second phase is the diagnosing phase. During this phase the SPI plan is initiated in to comply too the organizations strategic business plan, vision, the lessons learned by previous improvements, key business issues and long range goals. The results of this phase are included in the SPI plan. The third phase is the establishing phase. In this phase the issues that are identified to be improved are prioritized and strategies the create solutions are developed. The results of this phase are added to the SPI plan. The fourth phase is the acting phase. In this phase the earlier established solutions are created, piloted and deployed within the organization. The fifth phase is the leveraging phase. In this phase the lessons learned, performance and goal achievements are collected into the process database; so that this information can for next run through the IDEAL model.

### **3.5 Software process improvement assessments methods**

Besides SPM there are other software improvement methods. El-Emam, Goldenson, McCurley and Herbsleb (2001) state that software process assessments are important tools to initiate and sustain



software process improvement. An assessment method for software process improvement is capability maturity model (CMM) (Paulk, Curtis, Chrissis, & Weber, 1993). The CMM grades the maturity of an organization on the scale of one to five. The first level is initial; at this level the success of an organization depends on the individual skill and efforts of the developers and not on a managed process. The second level is repeatable; at this level there are policies and procedures in place to carry out projects. The policies and procedures are monitored by a quality assurance function. The third level is defined, at this level there is a standard software process defined. The software process defines project management and the software engineering processes. The fourth level is managed; at this level the process and product quality is measured. With this measurement causes of exceptional events can be corrected. The fifth level is optimizing; at this level the process is continuously improved on the basis of quantitative feedback from previous instantiations of the process. The process is improved by the introduction of new method and technologies. Level two to five have key process areas; these are shown in Table 1.

**Table 1: CMM (SoftWare) (Paulk, 1996)**

<b>Level</b>	<b>Focus</b>	<b>Key Process Areas</b>
5 Optimizing	Continuous process improvement	Defect Prevention Technology Change Management Process Change Management
4 Managed	Product and process quality	Quantitative Process Management Software Quality Management
3 Defined	Engineering processes and organizational support	Organization Process Focus Organization Process Definition Training Program Integrated Software Management Software Product Engineering Intergroup Coordination Peer Reviews
2 Repeatable	Project management processes	Requirements Management Software Project Planning Software Project Tracking & Oversight Software Subcontract Management Software Quality Assurance Software Configuration Management
1 Initial	Competent people and heroics	

An extension of CMM is the Capability Maturity Model Integration (CMMI) (Ahern, Clouse & Turner, 2004) (Harmon, 2004). CMM has different versions for software development, software engineering and product development; CMMI integrated these versions. CMMI has four process areas each containing capabilities related to these areas. The process areas are process management, project management, engineering and support. Table 2 shows the CMMI levels and CMMI process areas.

**Table 2: CMMI (Harmon, 2004)**

Process Areas That Support CMMI Maturity Levels	Four Process Areas Defined by CMMI			
	Process Management	Project Management	Engineering	Support
Level 5. Optimizing (Focus on process improvement)	5. Organizational Innovation & Deployment			6. Causal Analysis & Resolution
Level 4. Managed (Process measured and controlled)	4. Organizational Process Performance	8. Quantitative Project Management		
Level 3. Defined (Process characterized for the organization and is proactive.)	3. Organizational Training  2. Organizational Process Focus  1. Organizational Process Definition	7. Integrated Supplier Management  6. Integrated Teaming  5. Risk Management  4. Integrated Project Management for IPPD	6. Validation  5. Verification  4. Product Integration  3. Technical Solution  2. Requirements Development	5. Organizational Environment for Integration  4. Decision Analysis & Resolution
Level 2. Repeatable (Process characterized for projects and is often reactive)		3. Supplier Agreement Management  2. Project Monitoring & Control  1 Project Planning	1. Requirements Management	3. Measurement & Analysis  2. Process & Product Quality Assurance  1. Configuration Management
Level 1. Initial (Processes unpredictable, poorly controlled, and reactive)				

Spice (Software Process Improvement and Capability dEtermination) is an SPI assessment method. The capability maturity has six levels and has a range of zero to five (Dorling, 1993). Level zero is ad hoc; at this level there do not exist any software process artifacts. Level one is performed; at this level a software process is performed but it is unplanned and untracked, the performance depends on the individual's knowledge and effort. Level two is Repeatable; at this level each project is planned,

managed and verifies the performance of the activities. Level three is defined; at this level the software process is documented, standardized and integrated into a standard process. The projects use a tailored version of the organizations standard software process. Furthermore the feedback of customers is monitored. Level four is managed; at this level the performance of the process is detailed measured, collected and analyzed. Level five is optimizing; at this level the process is continuously improved by quantitative feedback from performing the process and testing new ideas and technologies.

Bootstrap is an assessment method that consists of two perspectives (Thomson & Mayhew, 1997), the software producing unit assessment and the project assessments. The software producing unit assessment looks at how things are supposed to be done while project assessment looks at what is actually done on a project basis. The assessments are threaded individually, each providing a results profile and an action plan. Figure 7 gives an overview of the inputs and outputs of the bootstrap assessment.

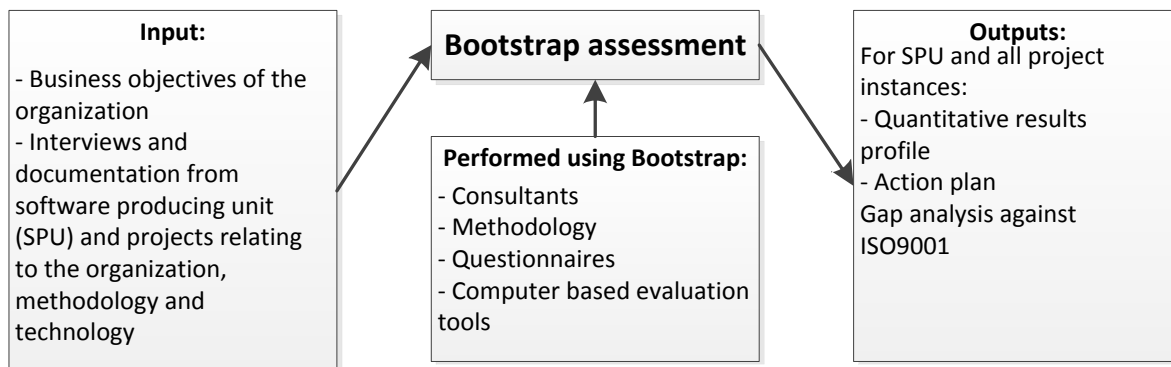


Figure 7: The bootstrap methodology as described by Thomson and Mayhew (1997)

## 4 Case study approach

This section will describe the approach that will be used for the case study and the case company. The data collected by the case study will be used to help answer the second and third sub questions. Section 4.1 describes the guidelines that the case study, section 4.2 the validity of the case study and section 4.3 describes the case company where the case study will be performed.

### 4.1 Case study

The case study will follow the guidelines of Yin (2003) for performing a case study. The case study will be exploratory and will be using an embedded single-case design. The case study is single case since it will be performed at a single software vendor, the description of the case company can be found in section 4.2. The case study is embedded since there is a single unit of analysis. The following five components of Yin (2003) will be used as guideline for the case study.

**1. The study questions:** The questions answered in the case study will be the sub questions two and three, namely: Which SPM capability can be linked to which productization stage? And what are the

investments associated with these SPM capabilities in terms of working days? These sub questions were defined in the research approach section.

**2. The proposition:** for the case study in this research there are no propositions, therefore the purpose will be stated. The first purpose is identification of the current productization stage of the case company and the identification of the time span when the previous productization stages occurred. The second purpose is identifying which SPM capabilities are implemented during each of the productization and determine the SPM maturity during the productization stage. The third purpose is identifying what investments in terms of working days are allocated to each SPM capability that is implemented.

**3. The unit(s) of analysis:** The unit of analysis in the case study will be the case company described in section 4.4. The unit of analysis will be studied with purpose stated above; namely the identification of the productization stages at the unit of analysis, the implemented SPM capabilities at the unit of analysis and the investments allocated to the SPM capabilities at the unit of analysis. The unit will be analyzed by performing an open-ended interview and a document study which are described in section 4.3.

**4. The logic linking of the data to the propositions and 5. The criteria for interpreting the finding:** Yin (2003) states that the current state of art does not provide detailed guidance for these two components. In this research the found data will be linked to the stated purposes stated in the second component. In these two components the data will be analyzed and used to answer the sub question stated in the first component.

## 4.2 Validity

For the quality of the case study Yin (2003) defines four quality criteria. The case study in this research will use these quality criteria as follows:

- **Construct validity:** This research uses where possible multiple sources of data collection, document study, archival records and interviews, where possible multiple persons are used as source for the interviews, furthermore the chain of evidence is recorded.
- **Internal validity:** Is not used for an exploratory study and is therefore not considered in this case study.
- **External validity:** The case study uses a single case and the research is explorative. Therefore it is not possible in this research to test the external validity with theory.
- **Reliability:** In the earlier mentioned components above the research questions and data collection procedures and case study database are describe such that other research will be able to reproduce the results in the same case study.

## 4.3 Approach

The case study is conducted by open-ended interviews and a document study. The case study will research three aspects of the case company. The first aspect is the identification of productization stages at the case company. The productization stages will be identified with open-ended interviews with the two managers of the case company. The second aspect is the identification of which SPM

capabilities are implemented during each productization phase. First the implemented capabilities are identified with the situational assessment method for SPM (Bekkers & Spruit, 2010; Bekkers, Weerd, Spruit & Brinkkemper, 2010) that will be performed with the managers of the case company. The case company participated in a previous research by Leenen, Vlaanderen, Weerd and Brinkkemper (2012) where also the implemented capabilities at a point of time were identified. This data will be used as verification for the results of the interview. In addition to the assessment method the capabilities in progress to be implemented are also identified. The second part consists of determining when the capabilities are implemented and assigning them to a productization stage. This will be done with open-ended interviews with the two managers of the case company. The identification of the productization stages and SPM capabilities will be used to answer the second sub question in the research.

The third aspect is identification of the investments in terms of working days related to the use of an implemented capability. First a document study and study of archival records will be performed on the hour registration and the meeting reports of the case company to get a general overview of the time related to each of the implemented capabilities. This will be verified and the gaps will be filled by open-ended interviews with managers of the case company. Furthermore these results will be discussed with the employees involved with the capabilities. The identification of the investments will be used to answer the third sub question.

The data of the SPM capabilities implemented and their investments will be recorded in an excel file. For each capability will be recorded if it is implemented. When a capability is implemented the following data is described for each capability:

- The year the capability was implemented
- The productization stage the capability is implemented
- The stakeholders involved with the capability
- The hours related to running capability in a year and possible remarks to it
- The hours related to setting up a capability (if any) and possible remarks to it

The data gathered during the case study can be found in appendix B.

#### **4.4 Case company**

The research will be performed at Relyon located in Nootdorp, the Netherlands and was founded in late 2001. Relyon is a software vendor that provides complete web solutions that enable the internal staff and the mobile field organization to work together. The strength of Relyon is their standardized, modular web applications that are focused upon the processes, management, users and clients. Relyon uses web-based software components that are used as building blocks and makes it possible to customize standard software.

The software, Relyon Service management (RSM) has five main modules which can be enabled separately. These modules are: service center, planning, mobile, admin and reports. Service center provides and extensive CRM functionality and complete back office functionality. Planning provides a

digital planning board with a map, planning function, service staff and overview of maintenance and malfunctions; furthermore it provides track and tracing. The mobile module runs on a smartphone, tablet or PDA and provides the service staff with their daily planning, navigation to customers, processing of digital work orders, registration of used parts and time registration. The admin module processes electronic work orders and can be integrated with a financial system. The reports module provides reports about the performance of the service organization. Furthermore the following additional functionalities are possible Customer satisfaction research, portal, self-service and machine to machine. The customers have the choice the combine modules for their specific situation.

Relyon currently has four product lines, one product line that is standard software and three product lines tailored to a large customer. The different product lines and modules they use are shown in Table 3. The management of Relyon has knowledge of SPM and has undergone the process of moving from customer specific software to a standard product.

**Table 3: Product lines and modules in the case company**

Module:	RSM standard	Large Customer 1	Large Customer 2	Large Customer 3
Service center (Back office)	Standard	Custom	Custom	Custom
Planning	Standard	Not in use	Standard	Standard
Mobile	Standard	Standard	Standard	Standard
Admin	Standard	Not in use	Custom	Custom
Reports	Standard	Standard	Not in use	Custom
Customer satisfaction research	Standard	Standard (with custom look and feel)	Not in use	Not in use
Portal	Standard	Standard with custom parts	Not in use	Not in use
Self-service	Standard	Standard with custom parts	Not in use	Not in use
Machine to machine	Standard	Not in use	Not in use	Not in use

## 5 Productization stages and SPM capabilities implemented

This chapter consists of the analysis of the case study performed according to the case study approach described in chapter 4 and the construction of a preliminary framework. Furthermore the preliminary framework is evaluated by an expert. The case study analysis is part of the suggestion phase of design science research; the framework construction is the development stage of the design science research and the expert review is the evaluation phase of the design science research. This chapter answers the second sub question: which SPM capability can be linked to which productization stage? Firstly the implementation of the SPM capabilities during the productization stages is studied at the case company. Secondly the results from the case study and the theory of the SPM competence model and the productization process are combined into a preliminary framework and evaluated by an expert review.

## 5.1 Productization stages

To be able to determine in which productization stage a SPM capability is implemented the current productization stage of the company must be determined and the time span of the previous productization stages need to be determined. This is done by open-ended interviews with the managers of the case company as described in section 4.3. Both managers are involved with the case company since it was founded in late 2001. The interviews identified that the case company is currently in the fifth stage of the productization process. Therefore the stages one till five of the productization process can be studied in this research. The case company has the goal to reach stage 6a of the productization process where it will produce a customizable product. Table 4 shows the time span of the productization stages that are identified within the case company.

Table 4: Productization stages in the case company

Productization Stage	Stage time span (years)
Stage 1	2001 – 2004
Stage 2	2005 – 2006
Stage 3	2006 – 2007
Stage 4	2007 – 2009
Stage 5	2010 – current
Stage 6a	Not reached yet

The first productization stage started when the company was founded in late 2001, the case company remained in the first stage of the productization process until the end of 2004. In this stage of the productization process the case company was producing customer specific software in specific projects for each customer. The software build ranged from service management, risk assessment, collection agencies, and credit management. The requirements for each project were customer driven. In the projects different platforms and programming languages were used to develop software. At the end of this stage the cases company realized that it would be more efficient not to have to rewrite similar software components for each project.

The second stage of productization process at the case company started in early 2005 and ended mid 2006. During this stage the case company started the development Web Application Building Blocks that consist of standard components of earlier projects that could be used for future projects. The standard components were used in customer specific software. The number of custom components used in the software projects is larger than the standard components.

The third stage of the productization process starts mid 2006 and ended at the mid of 2007. In this stage the Web Application Building Blocks are put to full use. The Web Application Building Blocks are used as a basis to develop software of customers. Customers still have their own code base that is maintained separately. During the end of the third stage the case company realized that it wanted to focus on one type of software.

The fourth stage of the productization process starts mid 2007 and ended at the end of 2009. During beginning of this stage the case company decided that it would only focus upon service management software and sold of the other software packages to external parties. During this stage the code bases from different customers were merged into four different modules: back office, planning, mobile and administrative. These four modules form the product platform. Upon the product platform customer specific features were build.

The fifth stage of the productization process starts early 2010 and it still the stage that the case company currently is in. In this stage the case company identifies four product lines: a standard product and three different versions of the product specifically build for large customers. The three versions for large customers exist because the case company is small and still is depended on these large customers. Upon the standard software customers still have the option of a customized layer. The releases of the standard software all consist of the same version of the four modules. Although the releases of the standard product are the same for each customer they are not available for each customer at the same time.

The case company currently has not reached the sixth stage of the productization process but has as goal the reach stage 6a where a customizable software product is developed. To allocate the implemented SPM capabilities to productization stages the time span of the stages in this section will be used.

## **5.2 SPM maturity**

The implemented capabilities are identified with the situational assessment method for SPM (Bekkers & Spruit, 2010; Bekkers, Weerd, Spruit & Brinkkemper, 2010), which also determines the current SPM maturity of the case company. The result of the situational assessment method is the maturity matrix shown in Figure 8.

The letters A – F each represent a SPM capability in a focus area. A green colored capability indicate that the capability is implemented, a red colored capability is not implemented and grey a capability is not implemented due to situational factors. The implemented capabilities, colored green, are shown in Figure 8. The full list of the SPM capabilities and their descriptions can be found in appendix A.

In Figure 8 two capabilities are shown as disabled, this is due to situational factors. Both are disabled due to size of the case company since the board is already directly involved. The capability that is disabled in the focus area release definition validation is formal approval (B) and the capability disabled in the focus area launch preparation is formal approval (B).

Table 5 shows the maturity levels that resulted from the situational assessment method. The maturity level is determined by selecting the maturity level up to the lowest ranking capability that is not implemented in the business function. The highest SPM maturity in the case company can be found in the product planning business function with a SPM maturity of 6. The second highest maturity in the case company is in the portfolio management business function. Both requirements management and release planning have a SPM maturity of 2, which results in an overall maturity of 2.



Table 5: SPM maturity

Business function	Maturity level
Requirements management	2
Release planning	2
Product planning	6
Portfolio management	3
Overall	2



Figure 8: Current SPM maturity of the case company

### 5.3 SPM capabilities implemented during productization stages

The situational assessment method identified implemented capabilities in the previous section. To identify in which productization stage each capability is implemented open-ended interviews with the managers are held. In these interviews it is determined when the capability was implemented and which stakeholders within the case company are involved. In this section the capabilities are classified by the production stage they are implemented. This will give an overview on how the SPM capabilities in case company evolved during the productization stages. In comparison with a previous research by Leenen, Vlaanderen, Weerd and Brinkkemper (2012) that the case company participated in the number of capabilities implemented had increased from 38 to 43.

### **Stage 1**

In the first stage of the productization process in the case company two capabilities were implemented, these can be found in Table 6. The SPM maturity matrix for the first productization stage can be found in appendix C; the maturity matrices use the same guidelines as described earlier with the exception that light green indicates a capability implemented in the previous stage and a dark green capability indicates a capability implemented in the current stage. Both implemented capabilities in the first productization stage are from requirement management business function. The first stage of the productization process for the case company only requires basic requirements gathering and identifications; since all the products in the case company differ from each other and are custom made for specific customers. During the first stage of the productization process an A and a B capability are implemented.

The overall SPM maturity in the first stage of the productization process is the initial 0. This also counts for the business functions release planning, product planning and portfolio management, their initial maturity levels are respectively 0, 1 and 3. The maturity level for the business function requirements management in this stage is 1.

**Table 6: Capabilities implemented during the first stage of the productization process.**

<b>Capability</b>	<b>Capability Description ( By Bekkers, Weerd, Spruit &amp; Brinkkemper, 2010)</b>	<b>Stakeholders involved</b>
<b>Requirements management</b>		
<b>Requirements gathering</b>		
A- Basic registration	Requirements are being gathered and registered.	R&D, support, sales
<b>Requirements identification</b>		
B- Requirements validation	The correctness (“Is the definition correct?”), completeness (“Does the requirement describe all relevant aspects?”), and unambiguousness (“Can the requirement only be interpreted in one way?”) of the requirement is validated.	R&D, board

### **Stage 2**

In the second stage of the productization process at the case company five capabilities were implemented. The implemented capabilities can be found in Table 7 and the SPM maturity matrix can be found in appendix C. Two capabilities were implemented in the release planning business function. These capabilities concern the validation of the build software by the internal stakeholders and by the external parties. The case company had setup an internal test environment and test acceptance environment at customers. In the Product planning business function there were also implemented two capabilities. These two capabilities concern the roadmapping of standard core assets. This is in line with the second stage of the productization process were components a reused in new projects and the goal of the case company to start reusing components for earlier projects in future projects. The case company started to setup a central location to store reusable components. The last capability implemented during this stage is in the portfolio management area and concerns service level agreements with the customers, in this case the case company had setup a standard service level

agreement. From this stage can be concluded that the case company is getting aware of the fact that component from previous projects can be reused in future projects. During the second stage of the productization process only A and B capabilities are implemented.

In the second stage of the productization process in the case company the overall maturity is still 0. The individual maturity levels for each business function are still on the same level as in the first stage of the productization process.

**Table 7: Capabilities implemented during the second stage of the productization process.**

Capability	Capability Description ( By Bekkers, Weerd, Spruit & Brinkkemper, 2010)	Stakeholders involved
<b>Release planning</b>		
<b>Release build validation</b>		
A- Internal validation	Internal stakeholders perform a functional validation of the build release to verify that it meets the expected outcome.	R&D
B- External validation	The build is validated by external parties (customers, partners) to verify the builds quality (e.g. by settings up a pilot).	Customers
<b>Product planning</b>		
<b>Core asset roadmapping</b>		
A- Centralized registration	All core assets are registered in a standardized manner, and are stored in a central location.	R&D
B- Core asset identification	Core assets are systematically identified among the organization's products and deliverables surrounding the product.	R&D
<b>Portfolio management</b>		
<b>Partnering &amp; contracting</b>		
A - Service level agreements	(Standard) service level agreements (SLA's) are set up for customers.	Sales

### **Stage 3**

In the third stage of the productization process a total of thirteen capabilities were implemented. In each business function capabilities were implemented. The implemented capabilities can be found in Table 8 and the SPM maturity matrix of this stage can be found in appendix C. In the business function requirements management two capabilities were implemented which concern the involvement of the internal stakeholders with the requirements gathering process and that market requirements are rewritten to product requirements. In this stage the case company has setup a standard template for requirements. The market requirements indicate a change from custom software to more standard software that the case company is developing. In the business function release planning six capabilities were implemented. These capabilities concern the involvement of the internal stakeholders with the requirements prioritization, the creation of a release definition and the validation of the release definition and the launch preparation by involving all internal stakeholders. All the internal stakeholders are automatically involved at the case company due to the small size of the case company. Furthermore the case company setup online documentation and help for training of the external parties. In the

product planning business function two capabilities are implemented that support the creation of roadmaps and gathering the intelligence about what competing products are doing. In this stage the case company started creating roadmaps and getting more aware of what competitors are doing. In the business function portfolio management three capabilities are implemented relating to market analysis. This indicates that the case company is getting more aware of the market wherein they are active and looking to make their products more fit more to the marketed demands. The capabilities that are implemented at this stage of the productization process range from A to D.

The overall SPM maturity in stage three of the productization process increases from 0 two 1. The maturity of the requirements management business function increases to 2, release planning increases to 2 while product planning and portfolio management stay at the same SPM maturity level as the previous productization stage.

**Table 8: Capabilities implemented during the third stage of the productization process.**

<b>Capability</b>	<b>Capability Description ( By Bekkers, Weerd, Spruit &amp; Brinkemper, 2010)</b>	<b>Stakeholders involved</b>
<b>Requirements management</b>		
<b>Requirements gathering</b>		
D - Internal stakeholder involvement	Requirements are gathered from all relevant internal stakeholders: support, services, development, sales & marketing, research & development (parties not present in your organization can be ignored).	All
<b>Requirements identification</b>		
A - Uniformity	Market Requirements are rewritten to Product Requirements using a pre-defined template if the Market Requirement is applicable to a product.	Consultants
<b>Release planning</b>		
<b>Requirements prioritization</b>		
A - Internal stakeholder involvement	All relevant internal stakeholders are involved in prioritizing the requirements that should be incorporated in future releases.	All
<b>Release definition</b>		
A - Basic requirements selection	During requirements selection for the next release, constraints concerning engineering capacity are taken into account.	Board
C - Internal communication	The release definition is communicated to the internal stakeholders.	Board
<b>Release definition validation</b>		
A - Internal validation	The release definition is checked by internal stakeholders, before the software is realized.	Board
<b>Launch preparation</b>		
A - Internal communication	Information about the upcoming new release is communicated to the internal stakeholders. This information contains a description of the most important changed and added features, the estimated release date, possible costs involved, information about how the new release can be obtained, possible training dates, etc.	All

D - Training	Trainings are organized and documentation is updated for both internal parties) and external parties to help educate them in the new release.	Support, consultants
<b>Product planning</b>		
<b>Roadmap intelligence</b>		
D - Competition trends	An overview is created showing what competing products are doing in terms of their product development in the coming years. The general developments trends among your competitors are shown, and the developments of the most important competing	(Board)
<b>Product roadmapping</b>		
C - Internal consultation	Product roadmaps are created in consultation with all relevant internal stakeholders.	R&D, board
<b>Portfolio management</b>		
<b>Market analysis</b>		
A - Market trend identification	There is an active search for market opportunities to either expand existing products to, or create new products for. This search exists of doing market research in markets related to or similar to your organizations markets, visiting conferences, listening to customers, etc. All search findings are documented.	Board, Sales, Partners
B - Market strategy	A plan is created showing which markets will be pursued and products for each segment can be developed. E.g., in year one, a company might plan to enter the automotive market by partnering with another company, or it may want to enter the pharmaceutical market in year two by building products in-house or acquiring products.	Sales, board (marketing)
D - Competitor analysis	A competitor analysis is performed on an organizational level to analyze what competitors offer, what their strengths are and are going to offer compared to your organizations.	Board, sales

#### **Stage 4**

In the fourth stage of the productization process a total of ten capabilities were implemented. In each business function capabilities were implemented. The implemented capabilities can be found in Table 9 and the SPM maturity matrix for the stage can be found in appendix C. In the business function requirements management two capabilities were implemented which concern the organizing of the requirements. The capabilities organize similar requirements and log them for further use. The case company started using a requirements managing tool in this stage to support this process. In the release planning business function there are also two capabilities implemented. These concern the involvement of customers with the requirements that indicates that the case company is starting to focus more upon the market. Furthermore a standard template for the release definition is being used by the case company, which indicates more frequent and standardized releases. In the product planning business function three capabilities were implemented during this productization stage. Two capabilities concern the product analysis and the society trends for the roadmap intelligence. Furthermore a more detailed roadmap is being created which describe the short-term plans of the case company. In the portfolio management business function three capabilities were implemented during this stage. The intellectual property management capability is implemented; this is mainly caused by that the old software projects

that are not related to current product are sold in this stage. But it also offers the management of the intellectual property for the current software product. The capabilities implemented for product life cycle management focuses upon if current trends need to be incorporated in the current product of the case company. Furthermore portfolio scope analysis looks at the four modules within the case company to identify possible overlap of gaps between the modules. The capabilities that are implemented at this stage of the productization process range from A to D.

In comparison to the previous productization stage the overall SPM maturity increases from 1 to 2. The maturity of the business function product planning also increases to 2. The other business functions stay at the same maturity level as the previous productization stage.

**Table 9: Capabilities implemented during the fourth stage of the productization process.**

<b>Capability</b>	<b>Capability Description ( By Bekkers, Weerd, Spruit &amp; Brinkkemper, 2010)</b>	<b>Stakeholders involved</b>
<b>Requirements management</b>		
<b>Requirements organizing</b>		
A - Requirement organization	Product requirements are organized based on shared aspects (e.g. type, function, or core asset).	R&D
B - Requirement lifecycle management	A requirement's history is logged by recording the submitter, submission date, change log, original description, current status (e.g. new, rewritten, validated, organized, scheduled for release X, tested, released in release X), etc. A requirement remains in the database after it has been built, so that it can be reused in a new or related product.	R&D
<b>Release planning</b>		
<b>Requirements prioritization</b>		
C - Customer involvement	Customers and prospects (or representatives thereof) indicate the requirements that should be incorporated in future releases by assigning priorities to the requirements from their point of view. Customers can also be represented in a delegation, select group of customers, or in other more manageable forms.	Customers, (board)
<b>Release definition</b>		
B - Standardization	A standard template is used to write the release definition. The release definition contains aspects such as an overview of the requirements that will be implemented, a time path, and the needed capacity.	R&D
<b>Product planning</b>		
<b>Roadmap intelligence</b>		
A - Product analysis	A plan is created showing which markets you will be going after and how you plan to develop the products for each segment. Eg., in year one you may plan to enter the automotive market by partnering with another company, or you may want to enter the pharmaceutical market in year two by building products in-house or acquiring products.	Sales, board (marketing)

B - Society trends	An overview is created showing the big picture of important trends in society in the coming years. This picture contains a general view and a view specific for your products industry.	All
<b>Product roadmapping</b>		
A - Short-term roadmap	A roadmap is developed detailing the short-term plans. The plans span more than one release.is developed detailing the short-term plans.	Sales, marketing
<b>Portfolio management</b>		
<b>Partnering &amp; contracting</b>		
B - Intellectual property management	Measures are in place to protect the intellectual property of the own organization, and to manage the used intellectual property from other organizations.	- (externally)
<b>Product lifecycle management</b>		
B - Portfolio innovation	A decision process is in place to decide whether or not to incorporate trends in one of the current products or in newly to be developed products.	Board, sales, consultancy, partners
C - Portfolio scope analysis	A product scope analysis is performed to identify overlaps and gaps between the products in the organizations product portfolio.	R&D

### **Stage 5**

In the fifth stage of the productization process a total of thirteen capabilities are implemented. In each business function capabilities were implemented. The capabilities implemented during this stage can be found in Table 10 and the SPM maturity matrix for the stage can be found in appendix C. In the business function requirements management one capability is implemented which concerns the customer's involvement in the requirements gathering process of the case company; that indicates that requirements are being gathered from the market. In the release planning business function six capabilities are implemented. For requirements prioritization a structured technique by Wiegers (1999) is being used by the case company which also takes the cost revenue in consideration. The key dates for the product delivery are being monitored for the releases by the case company. Furthermore for the launch preparation the case company has setup external communication to the external stakeholders is; the needed time to implement a new release for each customer is determined and all the external expressions of the product are updated to the new release version. In the product planning business function three capabilities are implemented. These capabilities concern following technologies trends for the roadmap intelligence and for product roadmapping it concerns an identification of a release theme and less detailed versions of the roadmap are created for external parties. In the portfolio management business function three capabilities are implemented during this stage of the productization process. These include the gathering of external market trend information by the case company that is supplied by external parties. Furthermore the case company has a process is in place that looks at the current distribution channels and looks at possible alternative ones. In this stage four product lines are defined, a standard product and the products focused upon three large customers. During this stage the capabilities implemented range from A to F.

Compared to the previous productization stage the overall SPM maturity remains at 2. The maturity of the product planning function increases to 6. The other three business functions remain at the same maturity levels as the previous stage.

**Table 10: Capabilities implemented during the fifth stage of the productization process.**

<b>Capability</b>	<b>Capability Description ( By Bekkers, Weerd, Spruit &amp; Brinkkemper, 2010)</b>	<b>Stakeholders involved</b>
<b>Requirements management</b>		
<b>Requirements gathering</b>		
E - Customer involvement	Customer's and prospect's requirements are being gathered and registered, and the customer or prospect is informed of the status of their requirements.	Sales, consultants
<b>Release planning</b>		
<b>Requirements prioritization</b>		
B - Prioritization methodology	A structured prioritization technique is used (e.g. MOSCOW, Wieggers).	All
D - Cost revenue consideration	Information about the costs and revenues of each (group of) requirement(s) is taken into account during the requirements prioritization (costs can be expressed in other means than money).	All
<b>Scope change management</b>		
B - Milestone monitoring	Key dates and checkpoints are monitored in the product delivery.	R&D
<b>Launch preparation</b>		
C - External communication	Information about the upcoming new release is communicated to the external stakeholders. This information contains a description of the most important changed and added features, the estimated release date, possible costs involved, information about how the new release can be obtained, possible training dates, etc.	Sales, marketing
E - Launch impact analysis	The time needed to implement the new release at the individual customers is determined, and what type of experts are needed to perform the implementation (e.g. database experts).	Consultants
F - Sales & marketing support	A checklist of all external expressions of the product (e.g. fact sheets, demo's, presentations) that may need to be updated by changes made in latest release of the product is created. The items are checked, and possibly updated before they are made available to external parties (e.g. customers, partners).	Sales, marketing
<b>Product planning</b>		
<b>Roadmap intelligence</b>		
C - Technology trends	An overview is created showing the big picture of important developments in terms of technology in the coming years. This picture contains a general view and a view specific for your products industry.	All (R&D)
<b>Product roadmapping</b>		
B - Theme identification	Release themes are identified and maintained. Themes are decided on together with the internal stakeholders. Identification of the themes results in a list of release themes	Board (All)



	that are stored centrally, so that requirements, core assets, market trends etc. can be linked to it.	
E - External variants	Less detailed variants of the internal roadmap are created for specific external parties (e.g. customers, partners, investors).	Sales, marketing
<b>Portfolio management</b>		
<b>Market analysis</b>		
E - Custom market trend identification	External market research parties are used to perform a market analysis specifically for the organization's product portfolio.	External parties (sales, marketing)
<b>Partnering &amp; contracting</b>		
C - Investigate distribution channels	A process is in place to periodically verify the current distribution channels, and identify alternative distribution channels.	Sales, marketing
<b>Product lifecycle management</b>		
E - Product lines	Product lines are developed. The architecture of the product line is documented, and its goal is clearly defined. A software product line is defined as a set of software intensive systems sharing a common, managed set of features that satisfy the specific needs of a particular market segment or mission and that are developed from a common set of core assets in a prescribed way.	Board

**Capabilities in progress to be implemented**

The case company is currently in stage 5 of the productization process and has as goal to reach stage 6a of the productization process. The case company currently has a total of six capabilities in progress to be implemented. The capabilities in progress to be implemented can be found in Table 11 and Figure 9. Two of these capabilities are in the release planning business function. These capabilities concern the involvement of partners in the prioritization of the requirements; this is due to the acquirement of new partners by the case company. The advanced requirements selection is in progress to be implemented with the Wiegers prioritization method (Wiegers, 1999) that is currently in use within the case company. In the product planning business function there are two capabilities in progress to be implemented. These capabilities concern the creation of a roadmap of what partners are involved in during the coming period and the roadmapping of the core assets within the case company. In the business function portfolio management there are also two capabilities in progress to be implemented. These capabilities concern market analysis about why customer decided to buy or not to buy the organizations products. Furthermore they analysis of the life cycle of the products its modules is going to be done on a regular basis at least once each year.

When the capabilities in progress are fully implemented the overall SPM maturity will still remain the same. The maturity in the portfolio management business function increases from 3 to 8. The maturity in the other business functions remains the same.

Table 11: Capabilities currently in progress to be implemented.

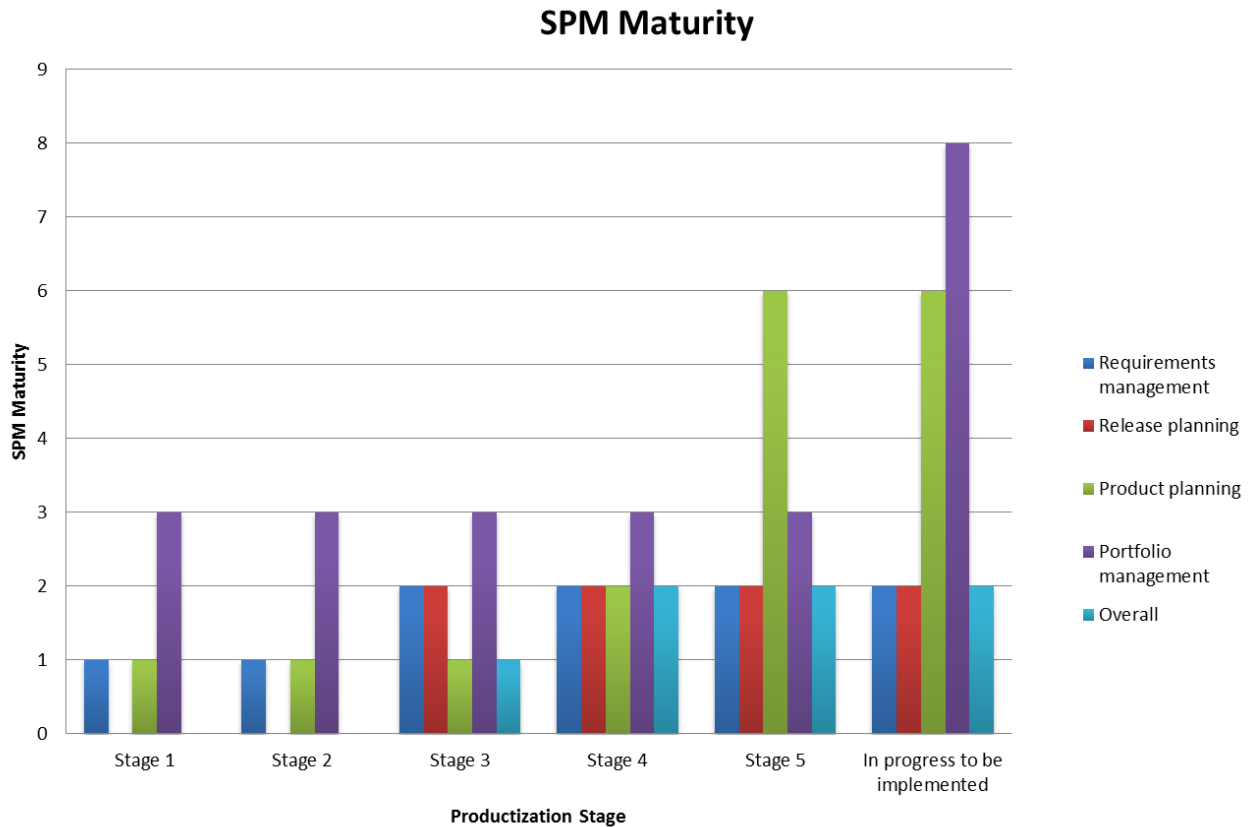
Capability	Capability Description ( By Bekkers, Weerd, Spruit & Brinkkemper, 2010)
<b>Release planning</b>	
<b>Requirements prioritization</b>	
E - Partner involvement	Partner companies indicate the requirements that should be incorporated in future releases by assigning priorities to the requirements from their point of view.
<b>Release definition</b>	
D - Advanced requirements selection	The optimal release is automatically calculated based upon the constraints of the requirements. At minimum the engineering capacity, priorities, cost, requirement dependencies are all taken into account.
<b>Product planning</b>	
<b>Roadmap intelligence</b>	
E - Partner roadmap	An overview is created showing what your partners will be developing the coming period. Examples of partner products are operating systems, development environments, database, etc. The overview shows what will be happening with the core platform software as well as what the partner organization will be delivering in terms of their own products and development tools that your organization can or will need to use to support the partner products/components.
<b>Core asset roadmapping</b>	
D - Core asset roadmap construction	A roadmap is created for the core assets, this roadmap shows how the core assets are sustained, upgraded, and enhanced. This roadmap contains both existing core assets, and core assets that are in development.
<b>Portfolio management</b>	
<b>Market analysis</b>	
C - Customer win/loss analysis	A win/loss analysis is performed to research why customers chose or did not choose to buy your organizations products. This capability looks further than just the product features, e.g. the sales process is reviewed.
<b>Product lifecycle management</b>	
A - Product life cycle analysis	The current life phase is determined, at least once per year, for each product in the organizations portfolio. This analysis is based on both financial and technical aspects. Information is thus gathered from all relevant internal stakeholders (e.g. company board, sales, development).



**Figure 9: SPM maturity matrix for the capabilities currently in progress to be implemented.**

### 5.4 Evolution of SPM during the productization process

This section gives an overview of how SPM evolved during the productization stages within the case company. Figure 10 gives an overview of the SPM maturity within each business function and the overall maturity during each stage of the productization process. From this figure can be concluded that the case company did not follow the exact order of the maturity of the capabilities during the productization process. This is in contrast with that the case company was expected to follow the maturity order of the SPM capabilities more strictly. From this can be concluded that the case company did not had to follow the exact maturity order of the SPM capabilities in order to advance through the productization stages. As result of this the SPM maturity level of the case company slightly increased during the productization process. The only exception is that the maturity of the product planning business function increased from one to six. When the capabilities in progress to be implemented are considered the portfolio management business function also showed a notable increase in maturity from three to eight.



**Figure 10: Development of the SPM maturity in the case company.**

Table 12 gives an overview of the capabilities implemented during each stage of the productization process for each business function and the overall capabilities implemented. The numbers from stage 1 to stage 5 are cumulative. The last column in the table shows the total capabilities present in the business function. In the business function release planning there is a total of 26 capabilities, in the case company two capabilities in the area are disabled, therefore a total of 24 capabilities in the release planning business function are used. The same applies to the total number of capabilities instead of 68 the number of capabilities used will be 66. From the table can be concluded that the case company implemented the most capabilities during the stages 3 to 5 of the productization process. Stage 3 of the productization process is also the first point where the number of standard features is larger than the number of custom features.

In Table 13 the percentage of total capabilities in each business function during the stage of the productization process are shown. The disabled capabilities mentioned earlier are excluded here as well. The percentages are cumulative. The case company is currently in stage 5 where it has total of 65% of the capabilities implemented. The business function requirements management has 54% of the capabilities implemented and is a bit lacking compared to the other business functions. The case company expects that it is not necessary to implement all the capabilities to be competitive in stage 6a.

As expected the number of SPM capabilities implemented started to increase rapidly in the higher productization stages; stage 3 and higher. This indicates that for the case company the need to implement SPM started in stage 3 of the productization process; where more standard feature than custom feature were used and the focus of the case company started to switch from customer specific software to a standard software product.

Overall the order of implementation of the SPM capabilities did not match the expected order of implementation as it was expected to follow the SPM maturity level order within the focus areas more closely. This might suggest that SPM maturity level order does not precisely have to be followed during the productization process. On the other hand the number of SPM capabilities implemented during each productization stage did match the expectations. Since it was expected to be low in the first two stages where the different projects did not have much in common and increases more rapidly from stage 3 and onwards where the number of standard features is larger than the number of custom features.

**Table 12: Number of SPM capabilities implemented.**

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Total capabilities in business function
<b>Requirements management</b>	2	2	4	6	7	13
<b>Release planning</b>	0	2	8	10	16	24 (26)*
<b>Product planning</b>	0	2	4	7	10	14
<b>Portfolio management</b>	0	1	4	7	10	15
<b>Total</b>	2	7	20	30	43	66 (68)**

\* 2 out of the 26 capabilities in this business function are disabled due too company context  
 \*\* 2 out of the total of 68 capabilities are disabled due too company context

**Table 13: Percentage of SPM capabilities implemented.**

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
<b>Requirements management</b>	15%	15%	31%	46%	54%
<b>Release planning</b>	0%	8%	33%	42%	67%
<b>Product planning</b>	0%	14%	29%	50%	71%
<b>Portfolio management</b>	0%	7%	27%	47%	67%
<b>Total (Overall)</b>	3%	11%	30%	45%	65%

## 5.5 Preliminary framework

In this section the possibilities for a preliminary framework are explored. The development of the preliminary framework is part of the development phase of the design science research. The preliminary framework will be based upon:

- The results of the case study at the case company
- The SPM competence model and SPM maturity matrix by: Bekkers, Weerd, Spruit and Brinkkemper (2010); Bekkers and Spruit, (2010).
- The productization process by: Artz, Weerd, Brinkkemper and Fieggen (2010).

For the preliminary framework the productization stages as defined by Artz, Weerd, Brinkkemper and Fieggen (2010) will be used. For the construction of the preliminary framework there will be assumed that a company should follow all the stages of the productization process and does not skip one or more stages. Therefore the stages in the framework will range from stage 1 to stage 6a/b.

From the SPM competence model and the SPM maturity matrix the SPM capabilities will be used: a total of 68 SPM capabilities. The capabilities will be divided over the same focus areas and business functions as in the SPM competence model. Furthermore the order of the maturity of the capabilities will be assumed to be the right order to be implemented. The less mature capabilities are followed by increasing mature capabilities in the focus area. Furthermore the dependencies between capabilities in the SPM competence model will be followed. The dependences can be found the appendix A.

The results of the case study at the case company will be used as guideline at which stage of the productization process a SPM capability should be implemented. The results of the case company will be only be used as guideline since the case company did not reach the final stage of the productization process yet, implemented 43 out of the 68 capabilities and did not follow the maturity level order for some capabilities. The results of the case company indicate that lower maturity capabilities are implemented during the first four stages of the productization process and the higher maturity capabilities where implemented during stage five of the productization process.

For the construction of the preliminary framework the SPM maturity matrix by Bekkers, Weerd, Spruit and Brinkkemper (2010); Bekkers and Spruit, (2010) will be used as basis. The preliminary framework will consists of the following aspects:

- Productization stage 1 to stage 6a/b
- The 4 business functions of the SPM competence model
- The 15 focus areas of the SPM competence model
- The 68 capabilities that can be found in Appendix A

This results in the preliminary framework that can be found in table 14. In section 5.5.1 the capabilities that are placed in each stage of the preliminary framework are discussed.

Table 14: Preliminary Framework

Productization	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6 a/b
<b>SPM focus area</b>						
<b>Requirements management</b>						
Requirements gathering	A		B	C, D	E	F
Requirements identification			A, B		C	D
Requirements organizing				A, B	C	
<b>Release planning</b>						
Requirements prioritization			A	B, C	D, E	
Release definition			A	B, C	D	E
Release definition validation			A, B			C
Scope change management					A, B, C	D
Release Build validation		A, B				C
Launch preparation			A	B, C, D	E, F	
<b>Product planning</b>						
Roadmap intelligence				A, B	C, D	E
Core asset roadmapping		A, B				C, D
Product roadmapping				A, B, C	D, E	
<b>Portfolio management</b>						
Market analysis			A, B	C, D	E	
Partnering & contracting		A		B	C	D, E
Product lifecycle management				A, B, C	D, E	

### 5.5.1 Capabilities and stages

In this section the SPM capabilities that are matched to the productization stages are describe; based upon the SPM competence model, SPM maturity matrix, productization process and the case study results.

#### Stage 1

Table 15 gives an overview of the capabilities that are matched to the first stage of the productization process. A total of 1 capability is assigned to stage 1.

Table 15: Capabilities assigned to stage 1.

Capability	Focus area
A – Basic registration	Requirements gathering

*A – Basic Registration:* Is the first capability in the requirements gathering business function and is the capability with the lowest maturity in the SPM maturity matrix. In the first stage of the productization process Artz, Weerd and Brinkkemper (2010) state that in order to satisfy the customer all requirements must be obtained. Furthermore the results of the case study show that basic registration is implemented during the first stage of the productization process. Basic registration is the only capability implemented in stage 1 because stage only consist out of independent projects which have nothing in common with each other and therefore only require basic registration of the requirements of the individual projects.

## Stage 2

Table 16 gives an overview of the capabilities that are matched to the second stage of the productization process. A total of 5 capabilities are assigned to stage 2.

Table 16: Capabilities assigned to stage 2.

Capability	Focus area
A - Internal validation	Release build validation
B - External validation	Release build validation
A - Centralized registration	Core asset roadmapping
B - Core asset identification	Core asset roadmapping
A - Service level agreements	Partnering & contracting

*A - Internal validation and B - External validation:* are the first and second capabilities in the release build validation focus area. The case company implemented these capabilities during the second stage of the productization process. In the description of stage 1 in the productization process Artz, Weerd and Brinkkemper (2010) states that after the software is developed it should be validated together with the customer. This validation is only at the end of each project and updates for a project are seen as new projects. This validation will be different for each project, and therefore is chosen to place these capabilities in stage 2 based upon the results of the case study.

*A - Centralized registration and B - Core asset identification:* are the first and second capabilities in the core asset roadmapping focus area. In the second stage of the productization process the focus is upon the reuse of standard software components between different projects. Central registration and core asset identification both support the process of reusing standard software components. Furthermore the case company implemented centralized registration and core asset identification in stage 2. Based on this these two capabilities are placed in the second stage of the productization process.

*A – Service level agreements:* Is the first capability of the partnering & contracting focus area. Service level agreements are setup to manage the customer’s expectations, which support the overall management of the projects. Artz, Weerd and Brinkkemper (2010) state proper management of the project portfolio is important for the second and future stages of the productization process. The case company implemented the service level agreements capabilities in stage 2. Based upon this the capabilities is placed in the second stage of the productization process.

## Stage 3

Table 17 gives an overview of the capabilities that are matched to the third stage of the productization process. A total of 10 capabilities are assigned to stage 3.



**Table 17: Capabilities assigned to stage 3.**

<b>Capability</b>	<b>Focus area</b>
B - Centralized registration	Requirements gathering
A – Uniformity	Requirements identification
B - Requirements validation	Requirements identification
A - Internal stakeholder involvement	Requirements prioritization
A - Basic requirements selection	Release definition
A - Internal validation	Release definition validation
B - Formal approval	Release definition validation
A - Internal communication	Launch preparation
A - Market trend identification	Market analysis
B - Market strategy	Market analysis

*B - Centralized registration:* Is the second, capability in the requirements gathering focus of the SPM maturity matrix. All the requirements gathered are stored in a central location. Currently the case company has not fully implemented this capability. During stage 3 of the productization process the number of standard software components is larger than the number of custom components. Artz, Weerd and Brinkkemper (2010) state that in the third stage of the productization process requirements should be stored in a central place. Based upon this the centralized registration capability is placed in the third stage of the productization process.

*A - Uniformity and B - Requirements validation:* are the first second capabilities in the requirements identification focus area. These concern rewriting of market requirements to product requirements and validating these requirements. During stage 3 of the productization process a company should be able to identify similar customer wishes, which are supported by these two capabilities. The case company implemented the requirements validation in stage 1 and uniformity in stage 3. In order to follow the order of the capabilities in the SPM maturity matrix both capabilities are placed in stage 3 to be implemented.

*A - Internal stakeholder involvement:* is the first capability in the requirements prioritization focus area. The internal stakeholders are involved in the requirements prioritization process; stakeholder involvement and product quality is improved. This is needed to support the requirements for the increasing number of standard software components. The case company implemented this capability in stage 3 of the productization process. Based upon this the capability is placed in stage 3 in the framework.

*A - Basic requirements selection:* is the first capability of the release definition focus area. Although the software that is created in stage 3 is still custom software Artz, Weerd and Brinkkemper (2010) indicate that this stage is the initial point of becoming market orientation and the recognition of a specific

product. The basic requirements selection function supports the requirements selection for the standard software components. The case company implemented this capability in stage 3 of the productization process. Based upon this basic requirements selection capability is placed in stage 3 in the framework.

*A - Internal validation and B - Formal approval:* are the first and second capabilities in the Release definition validation focus area. The internal validation of the release definition helps support increasing the quality of the release and increases awareness among the internal stakeholders. The case company has implemented the internal validation capability in stage 3 and has the formal approval disabled due to its size. Larger companies may require formal approval if the board is not directly involved in the process. Based upon this these two requirements are placed in stage 3 in the framework.

*A - Internal communication:* is the first capability in the launch preparation focus area. The upcoming release is communicated to the internal stakeholders that contains the most important changes and updates for the upcoming release. In the previous two stages changes to projects were seen as new projects, which is still the fact during this stage, but due to the increase of standard software components and an increased focus upon the market there is need for the internal communication with the internal stakeholders. The case company implemented this capability at stage 3 of the productization process. Based upon the internal communication capability is placed in stage 3 in the framework.

*A - Market trend identification and B - Market strategy:* are the first and the second capabilities in the market analysis focus area. These two capabilities concern the searching for market opportunities and identifying which markets will be targeted. These two capabilities can help a company identifying possible products that can be used as a product basis in the next stage. In later stages it will help to find new markets and identifying that markets that will be targeted. The case company implemented both capabilities in stage 3 of the productization process. Based upon the above these two capabilities are placed in stage 3 of the framework.

#### **Stage 4**

Table 18 gives an overview of the capabilities that are matched to the fourth stage of the productization process. A total of 22 capabilities are assigned to stage 4.

**Table 18: Capabilities assigned to stage 4.**

<b>Capability</b>	<b>Focus area</b>
C - Automation	Requirements gathering
D - Internal stakeholder involvement	Requirements gathering
A - Requirement organization	Requirements organizing
B - Requirement lifecycle management	Requirements organizing
B - Prioritization methodology	Requirements prioritization
C - Customer involvement	Requirements prioritization
B - Standardization	Release definition
C - Internal communication	Release definition

B - Formal approval	Launch preparation
C - External communication	Launch preparation
D - Training	Launch preparation
A - Product analysis	Roadmap intelligence
B - Society trends	Roadmap intelligence
A - Short-term roadmap	Product roadmapping
B - Theme identification	Product roadmapping
C - Internal consultation	Product roadmapping
C - Customer win/loss analysis	Market analysis
D - Competitor analysis	Market analysis
B - Intellectual property management	Partnering & contracting
A - Product life cycle analysis	Product lifecycle management
B - Portfolio innovation	Product lifecycle management
C - Portfolio scope analysis	Product lifecycle management

*C - Automation and D - Internal stakeholder involvement:* are the third and the fourth capabilities in the requirements gathering focus area. In stage 4 there is a product basis that requires a company to be market focused. The requirements gathering in this stage should be focusing upon gathering market requirements. To support the efficiency of the requirements gathering the process should be automated. Furthermore the internal stakeholders should be involved to increase their involvement and increase the product quality. Artz, Weerd and Brinkkemper (2010) state that in stage 4 of the productization process the involvement of the internal stakeholders should increase. The case company has not implemented automation capability and implemented internal stakeholder capability in stage 3. Due to that automation supports an efficient way of gathering market requirements it was placed in stage 4 in the framework. In order to follow the order of the capabilities of the SPM maturity matrix the internal stakeholder involvement capability was also placed in stage 4.

*A - Requirement organization and B - Requirement lifecycle management:* are the first and the second capability of the requirements organization focus area. Due to the gathering of market requirements there rises a need to organize requirements on shared aspects and the requirements lifecycle management makes the reusable in future new or related products. The case company implemented both capabilities in stage 4 of the productization process. Based upon the above both capabilities are placed in stage 4 of the productization process.

*B - Prioritization methodology and C - Customer involvement:* are the second and the third capabilities of the requirements prioritization focus area. Due to that market requirements are being used in stage 4 of the productization process of the standard product basis, there needs to be a more solid way of prioritizing requirements this can be done with a prioritizing methodology. The customer involvement capability helps to incorporate customer's needs and wishes and based upon the gathered market requirements. The case company implemented the prioritization methodology capability in stage 5 and customer involvement capability in stage 4. To follow the SPM maturity matrix order of capabilities

there is chose to place the prioritization methodology and customer involvement capabilities in stage 4 of the framework.

*B - Standardization and C - Internal communication:* are the second and third capabilities in the release definition focus area. In stage 4 of the productization process there is a generic product platform that shares the same features across different customers. During the development of this generic product platform the different customers projects become more alike and a standard release definition template can create clarity and provide the ability compare different version easier. Furthermore a standard release definition will already be in place for the next productization stage where the standard software features are large enough to be called a release. The internal communication causes the release definition to be communicated to the internal stakeholders. This supports the increase of internal stakeholder involvement in stage 4 of the productization process. The case company implemented the standardization capability in stage 4 and the internal communication capability in stage 3. To follow the order of capabilities in the SPM maturity matrix both the standardization and internal communication capabilities are placed in stage 4 of the framework.

*B - Formal approval, C - External communication and D – Training:* are the second, third and fourth capability in the launch preparation focus area. Depending on the size of a company formal approval can improve the quality of releases. External communication and training prepare and train the customers for the new release. The case company had the formal approval capability disabled due to its size. The external communication capability was implemented at the case company in stage 5 and the training capability in stage 3. To follow the order of the capabilities in the SPM maturity matrix all three capabilities are placed in stage 4 of the framework.

*A - Product analysis and B - Society trends:* are the first and the second capabilities of the roadmap intelligence focus area. Both of these capabilities gather decision supporting information to create roadmap for the product(s). The main focus in stage 4 should be on the product planning (Artz, Weerd & Brinkkemper, 2010). The case company implemented the product analysis and the society trends capability in stage 4 of the productization process. Based upon the above both capabilities are placed in stage 4 in the framework.

*A - Short-term roadmap, B - Theme identification and C - Internal consultation:* are the three capabilities in the product roadmapping focus area. These three capabilities support the creation of roadmaps and themes for the roadmaps; and increase the internal stakeholder involvement as described by Artz, Weerd and Brinkkemper (2010). The case company implemented the short-term roadmap capability in stage 4, the theme identification capability in stage 5 and the internal consultation in stage 3. Based upon the above both capabilities are placed in stage 4 of the framework.

*C - Customer win/loss analysis and D - Competitor analysis:* are the third and the fourth capabilities in the market analysis focus area. These capabilities concern why a customer did or did not buy the company's product and learning from what competitors are doing. The case company has not implemented the customer win/loss analysis capability and implemented the competitor analysis

capability in stage 3. These two capabilities are an extension of the first two capabilities of the market analysis focus that were placed in stage 3 of the framework. To follow this customer win/loss analysis and competitor analysis are placed in stage 4 of the framework.

*B - Intellectual property management:* is the second capability in the partnering & contracting focus area. This capability concerns the protection of the intellectual property within the company and the ones used from other companies. Furthermore it helps protect the product platform that is being developed during this stage 4. The case company implemented the intellectual property management capability in stage 4. Based upon the above the intellectual property management is placed in stage 4 of the framework.

*A - Product life cycle analysis, B - Portfolio innovation and C - Portfolio scope analysis:* are the first three capabilities of the product lifecycle management focus area. These capabilities support determining the life phase of the product(s), if trends should be incorporated, identify gaps and overlaps between products or part of a product. In stage 4 of the productization process the project portfolio transforms in the product portfolio. The case company has not implemented the product life cycle analysis capability and implemented portfolio innovation and portfolio scope analysis in stage 4 of the productization process. Based upon the above there is chosen to implement product life cycle analysis, portfolio innovation and portfolio scope analysis in stage 4 of the framework.

### **Stage 5**

Table 19 gives an overview of the capabilities that are matched to the fifth stage of the productization process. A total of 18 capabilities are assigned to stage 5.

**Table 19: Capabilities assigned to stage 5.**

<b>Capability</b>	<b>Focus area</b>
E - Customer involvement	Requirements gathering
C - Connect similar requirements	Requirements identification
C -Requirement dependency linking	Requirements organizing
D - Cost revenue consideration	Requirements prioritization
E - Partner involvement	Requirements prioritization
D - Advanced requirements selection	Release definition
A - Event notification	Scope change management
B - Milestone monitoring	Scope change management
C - Impact analysis	Scope change management
E - Launch impact analysis	Launch preparation
F - Sales & marketing support	Launch preparation
C - Technology trends	Roadmap intelligence
D - Competition trends	Roadmap intelligence
D - Long-term roadmap	Product roadmapping
E - External variants	Product roadmapping
E - Custom market trend identification	Market analysis
C - Investigate distribution channels	Partnering & contracting

D - Business case	Product lifecycle management
E - Product lines	Product lifecycle management

*E - Customer involvement:* is the fifth capability in the requirement gathering focus area. This capability concerns the gathering and registering the requirements of customers and keeping them informed about the developments concerning their requirements. In stage 5 of the productization process a company starts to change from a customer-orientation to a market orientation. The customer requests in this stage should be handled as market requirements. The case company implemented this capability in stage 5 of the productization process. Based upon the above customer involvement capability is placed in stage 5 of the framework.

*C - Connect similar requirements:* is the third capability in the requirements identification focus area. This capability concerns the linking of similar market and product requirements to prevent double requirements. In stage 5 customer requirements are handled as market requirements. The case company has not implemented this capability yet. The connect similar requirements capability is placed in stage 5 of the framework.

*C-Requirement dependency linking:* is the last capability in the requirements organizing focus area. This capability concerns the determining and registering dependencies between requirements. This capability is required for the advanced requirements selection capability of the release definition focus area. The case company has not implemented the requirement dependency linking capability.

*D - Cost revenue consideration and E - Partner involvement:* are the last two capabilities in the requirements prioritization focus area. These capabilities concern that information about cost and revenue of a requirement is taken into account while prioritizing and partners can assign priorities to requirements that should be incorporated in a future release. Artz, Weerd and Brinkkemper (2010) state that in stage 5 of the productization process that when selecting requirements for a release the added value of specific features should be considered. The case company implemented cost revenue consideration in stage 5 of the productization process and is considering to implemented partner involvement in the near future. Based upon the above cost revenue consideration and partner involvement are placed in stage 5 of the framework.

*D - Advanced requirements selection:* is the fourth capability in the release definition focus area. This capability concerns calculating the optimal release automatically based upon the constraints of the requirements. The case company currently has not implemented the advanced requirements selection capability but is planning to do so in the near future. The advanced requirements selection capability is placed in stage 5 in the framework.

*A - Event notification, B - Milestone monitoring and C - Impact analysis:* are the first three capabilities in the scope change management focus area. These capabilities concern a formal scope change management process that informs all involved internal stakeholders, monitoring key dates and checkpoints, determining the effects of the scope change with an impact analysis. The life cycle of a

product becomes long and may require scope changes between releases. The case company has implemented the milestone monitoring capability in stage 5 and has not implemented the other two capabilities. The capabilities event notification, milestone monitoring and impact analysis are placed in stage 5 of the framework.

*E - Launch impact analysis and F - Sales & marketing support:* are the last two capabilities in the launch preparation focus area. These capabilities concern identifying what is needed to implement a release at a customer and the checking and updating of the external expressions of the product to the latest version of the release. Although the releases in this stage are event based, it still requires the external outings of the product to be up to date to the latest version for the customer. The case company implemented the launch impact analysis and sales & marketing support capabilities in stage 5 of the productization process. Based upon the above these capabilities are placed in stage 5 of the framework.

*C - Technology trends and D - Competition trends:* are the third and fourth capabilities in the roadmap intelligence focus area. These capabilities concern creating an overview important technology developments in the coming years and creating an overview of what competing products are doing in the coming years. These two capabilities support the change of focus from specific customers to a market focus. The case company implemented the capability competition trends in stage 3 and plans to implement the technology trends capability in the near future. Based upon the above technology trends and competition trends are placed in stage 5 of the framework.

*D - Long-term roadmap and E - External variants:* are the last two capabilities in the product roadmapping focus area. These capabilities concern creating a long term road map and creating external variants of the roadmap that are less detailed for external parties. This becomes necessary due to the shifting focus from customer specific to a focus upon the market. The case company has implemented the external variants capability in stage 5 and has not implemented the long-term roadmap capability. These capabilities are placed in stage 5 of the framework.

*E - Custom market trend identification:* is the last capability in the market analysis focus area. This capability concerns gaining market analysis from external parties. With the focus change for customer specific to market focus the information about the market becomes valuable. The case company implemented this capability in stage 5 of the productization process. Custom market trend identification is placed in stage 5 of the framework.

*C - Investigate distribution channels:* is the third capability in the partnering & contracting focus area. This capability looks at current distribution channels and looks for possible new distribution channels. This becomes necessary due to the focus upon the market. The case company implemented the investigate distribution channels capability during stage 5 of the productization process. In the framework this capability is placed in stage 5.

*D - Business case and E - Product lines:* are the last two capabilities in the product lifecycle management focus area. These capabilities concern performing a business case before a major product revision and defining and developing product lines. In stage 5 of the productization process a company should decide

on its product lines. The case company implemented the products lines capability in stage 5 of the productization process and has not implemented the business case capability. In the framework business case and product lines are placed in stage 5.

### **Stage 6**

Table 20 gives an overview of the capabilities that are matched to the sixth stage of the productization process. A total of 12 capabilities are assigned to stage 6. This stage consists out of the left over capabilities that were not placed in earlier stages of the framework.

**Table 20: Capabilities assigned to stage 6.**

<b>Capability</b>	<b>Focus area</b>
F - Partner involvement	Requirements gathering
D - Automatically connect similar requirements	Requirements identification
E - Multiple releases	Release definition
C - Business case	Release definition validation
D - Scope change handling	Scope change management
C – Certification	Release build validation
E - Partner roadmap	Roadmap intelligence
C - Make or buy decision	Core asset roadmapping
D - Core asset roadmap construction	Core asset roadmapping
D - Establish and evaluate pricing model	Partnering & contracting
E - Monitored partner network	Partnering & contracting

*F - Partner involvement:* is the last capability in the requirements gathering focus area. This capability concerns the systematically gathering of requirements from partners. The case company has not implemented the partner involvement capability

*D - Automatically connect similar requirements:* is the last capability in the requirements identification focus area. The capability concerns the automatically linking of similar requirements. The case company has not implemented the automatically connect similar requirements capability.

*E - Multiple releases:* is the last capability in the release definition focus area. This capability concerns including multiple releases in the requirements selection process. The case company has not implemented the multiple releases capability.

*C - Business case:* is the last capability in the release definition validation focus area. This capability concerns the writing of a business case before realizing the product. The case company has not implemented the business case capability.

*D - Scope change handling:* is the last capability in the scope change management focus area. This capability concerns that there is a process in place to develop alternative plans with the relevant internal stakeholders to react to scope changes. The case company has not implemented the scope change handling capability.



*C – Certification*: is the last capability in the release build validation focus area. This capability concerns that there is done a certification by an external independent party for the release. . The case company has not implemented the certification capability.

*E - Partner roadmap*: is the last capability in the roadmap intelligence focus area. This capability concerns creating an overview of what partners will be developing in the coming period. The case company has not implemented the partner roadmap capability, but plans to implement it in the near future.

*C - Make or buy decision and D - Core asset roadmap construction*: are the last two capabilities in the core asset roadmapping focus area. These two capabilities concern investigating make or buy decisions for external sources and creating a roadmap for the core assets of existing core assets and core assets that are in development. The case company has not implemented the make or buy decision capability and plans to implement the core asset roadmap construction capability in the near future.

*D - Establish and evaluate pricing model and E - Monitored partner network*: are the last two capabilities in the partnering & contracting focus area. These capabilities concern that there is a process in place to establish a pricing model which is periodically verified if it still fits the market and setting up a partner network. The case company has not implemented both capabilities.

### 5.5.2 Expert review

The preliminary framework is validated with an expert review. This is the evaluation phase of the design science research. The expert who participated in the review is I. van de Weerd; who currently is assistant professor at the VU University Amsterdam and is an author of *A framework for process improvement in software product management* (Bekkers, W., Weerd, I. van de, Spruit, M., & Brinkkemper, S., 2010) and *Productization: The process of transforming from customer-specific software development to product software development* (Artz, P., Weerd, I. van de, & Brinkkemper, S., 2010).

For the first part of the review the expert was asked to assign the capabilities for the requirements management business function before seeing the preliminary framework. Table 21 shows how the expert assigned the capabilities in the requirements management business function and Table 22 how the capabilities are assigned in the preliminary framework.

**Table 21: Requirement management capabilities as assigned by the expert.**

SPM focus area	Productization	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6 a/b
<b>Requirements management</b>							
Requirements gathering		A	B	C	D	E	F
Requirements identification			A	B		C	D
Requirements organizing			A		B	C	

**Table 22: Requirement management capabilities as assigned in the preliminary framework.**

Productization	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6 a/b
<b>SPM focus area</b>						
<b>Requirements management</b>						
Requirements gathering	A		B	C, D	E	F
Requirements identification			A, B		C	D
Requirements organizing				A, B	C	

The expert assigned four capabilities to a different productization stage. The capabilities assigned by the expert are more spread out and only one capability of a focus area is implemented during a productization stage. From this can be concluded that 9 out of the 13 capabilities match with the expert's view. This is an indication that some of the capabilities might not have been appointed to the correct productization stage and might have to be adjusted to another productization stage.

For the second part of the expert review the expert was asked if the SPM capabilities are in the right order of implementation for each of the focus areas. The expert indicated that the maturity level and implementation stage are linked and that they therefore should follow their SPM maturity order through the productization stages. Furthermore the expert was asked if the SPM capabilities were assigned to the right productization stage. This resulted in the suggestion the following capabilities should be moved.

- Centralized registration (requirements gathering B) from stage 3 to stage 2; if requirements are reused they should be centrally stored and start with it early
- Automation (requirements gathering C) from stage 4 to stage 3
- Uniformity (requirements identification A) from stage 3 to stage 2; should be done at the same moment that requirements are stored on a central database
- Make or buy decision and Core asset roadmap construction (core asset roadmapping C and D) should be placed earlier to manage this change from customer specific software to a standard software product.
- The market analysis and partnering & contracting capabilities should be placed earlier because when changing from projects to standard software product these should be considered in the early stages; looking at the market and competitors.

Table 23 shows the preliminary framework after the suggestions of the expert. The capabilities that were moved to another stage are underlined.

Table 23: Preliminary framework with suggestions of expert.

Productization	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6 a/b
<b>SPM focus area</b>						
<b>Requirements management</b>						
Requirements gathering	A	<u>B</u>	<u>C</u>	D	E	F
Requirements identification		<u>A</u>	B		C	D
Requirements organizing		<u>A</u>		B	C	
<b>Release planning</b>						
Requirements prioritization			A	B, C	D, E	
Release definition			A	B, C	D	E
Release definition validation			A, B			C
Scope change management					A, B, C	D
Release Build validation		A, B				C
Launch preparation			A	B, C, D	E, F	
<b>Product planning</b>						
Roadmap intelligence				A, B	C, D	E
Core asset roadmapping		A, B		<u>C, D</u>		
Product roadmapping				A, B, C	D, E	
<b>Portfolio management</b>						
Market analysis			A, B, <u>C</u>	D, <u>E</u>		
Partnering & contracting		A		B	C	D, E
Product lifecycle management			<u>A, B, C</u>	<u>D</u>	E	

## 6 Investments in capabilities

This chapter will consist of the analysis of the second part of the case study and has as goal to provide insight into how investments are divided over the SPM capabilities within the case company and identify which areas require the most investments in terms of working days. The question that this chapter will answer is the third sub question: What are the investments associated with these SPM capabilities in terms of resources? The working days were determined by a document study and open ended interviews with the managers of the case company. The case study approach and the company are described in chapter 4. The time span of productization stages was determined by the second sub question in section 5.1. This chapter identifies the investments in terms of working days spend on running the SPM capabilities. In this research the number of working days is shown per year and a working day consists of 8 hours this is based upon the situation at the case company. Additional information for the case company can be found in Appendix D.

### 6.1 Working days related to SPM capabilities and focus areas

Table 24 shows the data found in the case study. The implemented capabilities were determined during the second sub question. In Table 24 for each individual capability the working days are shown that are related to that capability. The full data of all capabilities implemented per stage of the productization process and the working days related to those capabilities can be found in appendix B.

Table 24: Days related to the implemented capabilities

Capability	Days	Capability	Days
<b>Requirements management</b>		<b>Product planning</b>	
<b>Requirements gathering</b>		<b>Roadmap intelligence</b>	
A - Basic registration	62,5	A - Product analysis	2,5
D - Internal stakeholder involvement	43,75	B - Society trends	1,25
E - Customer involvement	6,25	C - Technology trends	2,5
<b>Requirements identification</b>		D - Competition trends	2,5
A - Uniformity	25	<b>Core asset roadmapping</b>	
B - Requirements validation	6,25	A - Centralized registration	1,25
<b>Requirements organizing</b>		B - Core asset identification	0,5
A - Requirement organization	37,5	<b>Product roadmapping</b>	
B - Requirement lifecycle management	0	A - Short-term roadmap	1
<b>Release planning</b>		B - Theme identification	0
<b>Requirements prioritization</b>		C - Internal consultation	0
A - Internal stakeholder involvement	5	E - External variants	0,5
B - Prioritization methodology	0	<b>Portfolio management</b>	
C - Customer involvement	10	<b>Market analysis</b>	
D - Cost revenue consideration	0	A - Market trend identification	2
<b>Release definition</b>		B - Market strategy	1
A - Basic requirements selection	0	D - Competitor analysis	4
B - Standardization	4	E - Custom market trend identification	0
C - Internal communication	0	<b>Partnering &amp; contracting</b>	
<b>Release definition validation</b>		A - Service level agreements	0
A - Internal validation	1	B - Intellectual property management	0,25
<b>Scope change management</b>		C - Investigate distribution channels	0
B - Milestone monitoring	2	<b>Product lifecycle management</b>	
<b>Release build validation</b>		B - Portfolio innovation	0,5
A - Internal validation	2,5	C - Portfolio scope analysis	0,5
B - External validation	5	E - Product lines	1
<b>Launch preparation</b>		<b>Total:</b>	
A - Internal communication	5	267	
C - External communication	5		
D - Training	10		
E - Launch impact analysis	10		
F - Sales & marketing support	5		

To get a better overview of investments in terms of working days the capabilities are grouped by focus area. Figure 11 till Figure 14 show how the working days within each business function are divided over the different focus areas. Within the requirements management business function almost two third of the working days (62%) are used for the requirements gathering. Whereas the working days used

requirements identification and requirements organizing are almost evenly divided, respectively 17% and 21%. In the case company the requirements gathering takes up the largest amount of time, the requirements are mainly gathered by the sales, support and R&D stakeholders. Every stakeholder keeps its own list of gathered requirements; about 70% of the incoming requirements are being directly stored in a central database/software package (informup). The other requirements are being discussed with meeting and later added to the central database if seemed necessary. The time related to requirements gathering can be reduced by automating the process. The requirements in the case company are identified by rewriting the market requirements to product requirements with the help of a standard template, furthermore the completeness and correctness of the requirement is validated. The requirements in the case company are organized and their history is logged within the same software package as there requirements are stored in.

The release planning business function has the largest number of focus areas. The largest focus areas is the launch preparation; which takes up more than half the working days (54%) spent in the release planning business function. The second working days intensive focus area is requirements prioritization with 23%, followed by release build validation with 12%. The focus areas: release definition, release definition validation and scope change management all have a small amount of working days devoted to them, respectively 6%, 2% and 3%. For the requirements prioritization the case company uses the requirements prioritization method by Wiegers (1999). The case company has a standard prioritization sheet that is used every time the requirements need to be prioritized. Due to the size of the case company the release definition is created with all relevant internal stakeholders, the release definition is written with the use of a standard template. Due to the involvement of all relevant internal stakeholder of the case company in the creation of the release definition, the internal stakeholders are also involved in the validation of the release definition as part of the process. The case company has not many capabilities implemented for scope change management, currently is only monitors key dates and checkpoints for the product delivery. The release build is validated by the internal stakeholders of the case company with the help of a test environment and is validated by customers with the use of a test acceptance environment for the customer. For the launch preparation the case company informs internal and external stakeholders about the upcoming release. Trainings are provided for customers and the documentation and online helps is updated for the upcoming release. With the help of a checklist the time needed to implement a new release at an individual customer is determined.

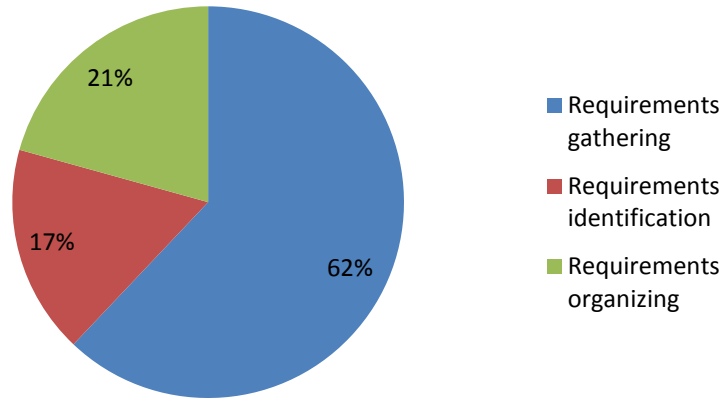
In the product planning business function most of the working days are used in the roadmap intelligence focus area, 72%. The focus areas core asset roadmapping and product roadmapping are about evenly divided with respectively 15% and 12%. For roadmap intelligence the case company does product analysis by looking at possible markets to go after. Furthermore society, technology and competition trends are followed. The case company systematically identifies and registers the core assets in a central location. The core assets of the case company are stored within self-developed platform which is used a basis to build all their software products. The case company creates short-term roadmaps and identifies release themes with the relevant internal stakeholders. Besides an internal version of the roadmap an external less detailed version of the roadmap is created for external parties.

In the portfolio management business function most of the working days are used in the market analysis focus area, 76%, followed by product life cycle management with 21%. Only 3% of the hours in the portfolio management business function are used for partnering and contracting. In the marketing analysis focus area the case company looks for market opportunities to expand their product, furthermore it creates a plan of which markets to peruse. Competitor analysis is done by for example visiting websites of competitors or visiting conventions. Partners often supply external market research to the case company. In the partnering and contracting area the case company has create a standard service level agreement for customers and the intellectual property of the case company is stored at a separate external company. In the product lifecycle management area the case company looks at if there is need to incorporate trends within their product; this occurs during the planning for each new version. Furthermore the case company performs product scope analysis to identify overlap and gaps between the different modules of the product. The case company has four product lines to be managed, one standard version and three versions for three lagers customers, the product lines can be found in section 4.4.

Figure 15 shows how the total number of working days related to SPM is divided over the four business functions. The most working days related to SPM, 68%, are related to requirements management business function. The second most time related to SPM is spent in the release planning business function, namely 24%. The least time is spent on product planning and portfolio management, respectively 5% and 3%. The least time is related to portfolio management this is mainly due to the fact that the case company only has one product that requires a low amount of product life cycle management and marketing analysis, furthermore the small size of the company also plays a role in this. The time spent in the product planning business function is 5% due to that the case company only has one product that has a release beat of 90 days. Release planning almost takes up a quarter of the time related to SPM capabilities in the case company and consists mainly of launch preparation and requirement prioritization related activities. Currently the requirement management business function takes up the largest amount of time in the case company. This is mainly cause by the current way the case company is gathering requirements, which is not centralized and automated. The case company has the intention to improve this in the future.

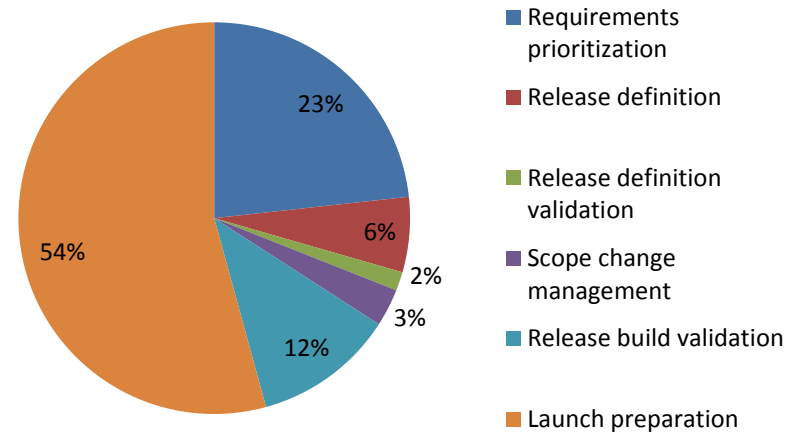
This section gave an overview of how the investments in terms of working days are within the case company. It has shown that the main investments are in the requirements management and release planning business functions. This can provide companies that are implementing SPM an indication of what investments in terms of working days to expect. It is currently not generalizable due to the fact that it is based upon a single case study.

**Requirements management**



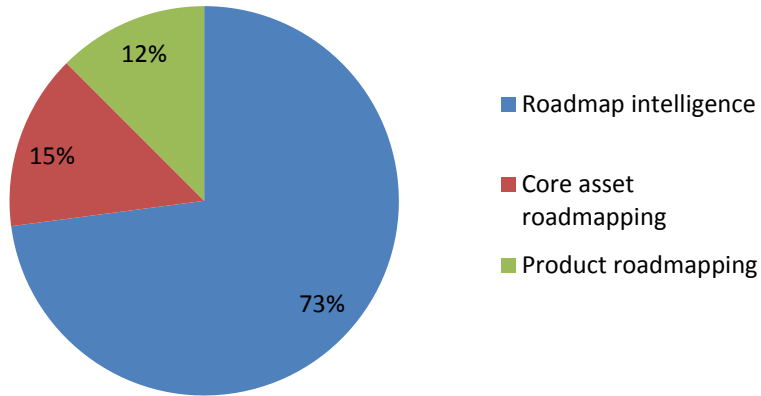
**Figure 11: Distribution of days within requirements management.**

**Release planning**



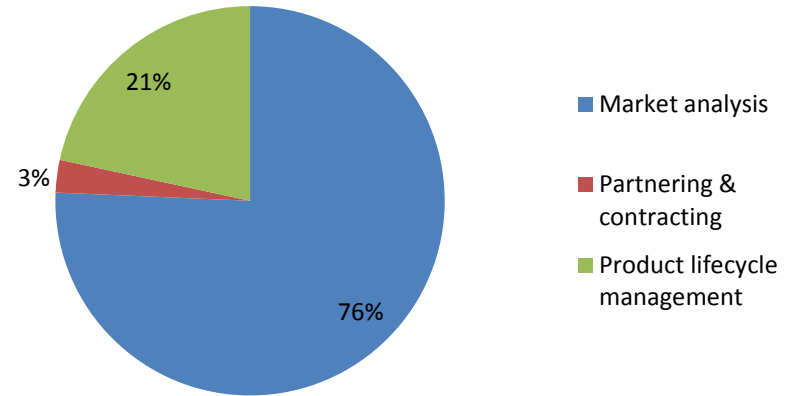
**Figure 12: Distribution of days within release planning.**

**Product planning**

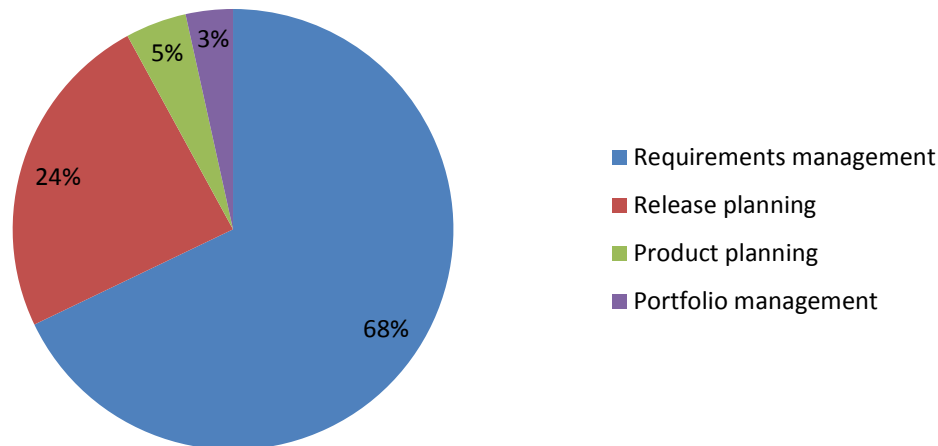


**Figure 13: Distribution of days within product planning.**

**Portfolio management**



**Figure 14: Distribution of days within portfolio management.**



**Figure 15: Percentage of total SPM days spend in each business function.**

## **6.2 Working days related to SPM during each stage of productization process**

This section will provide insight on how the investments in terms of working days evolve during the productization at the case company. It will show the working day during each of the production stage based upon the capabilities that were implemented during that productization stage

Table 25 summarizes the total working days spend on running the SPM capabilities during each stage. Furthermore it shows the working days spend in each of the business functions. The working days for each stage are bases upon the current amount of working days the case company spends on a capability. In the case company the largest amount of the working days related to SPM is spend in the requirements management business function. The second largest amount of working days is spent in the release planning business function, which is about one third of the days compared to requirements management. The least working days are spent in the product planning and portfolio management business functions. The working days spent on SPM rapidly increase between stage 2 and 3 of the productization process. The working days grow about evenly between stage 3 and 4 and stage 4 and 5.

Table 26 summarizes the total working days spend on running the SPM capabilities during each stage on average for each FTE. The total amount of working days related to SPM per FTE is about the same for stage 1 and stage 2 of the productization process; both are around 16 days per FTE. Between stage 2 and stage 3 of the productization process there is an increase of day per FTE to 27. This falls together with the change from projects to product recognition, and the increase of the number of capabilities implemented that increase from 7 to 20. From stage 3 to stage 5 the average working days per FTE remain at the same level of around 27 days. This indicates that case company grows at the same speed as that it is increasing its productization.



Table 25: Total days related to SPM during each stage.

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
<b>Requirements management</b>	68,75	68,75	137,5	175	181,25
<b>Release planning</b>	0	7,5	28,5	42,5	64,5
<b>Product planning</b>	0	1,75	4,25	9	12
<b>Portfolio management</b>	0	0	7	8,25	9,25
<b>Total days related to SPM</b>	68,75	78	177,25	234,75	267

Table 26: Days related to SPM on average per FTE.

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
<b>Requirements management</b>	15,87	14,34	21,30	20,22	18,57
<b>Release planning</b>	0,00	1,56	4,42	4,91	6,61
<b>Product planning</b>	0,00	0,36	0,66	1,04	1,23
<b>Portfolio management</b>	0,00	0,00	1,08	0,95	0,95
<b>Total days related to SPM</b>	15,87	16,27	27,46	27,12	27,36

Table 27 shows the SPM related working days, FTEs and total available working days a year during the productization process. Furthermore it shows the development of working hours spent on SPM relative to the total number working days during the productization process. In the first two stages of the productization process the working days spent on SPM are about 7% of the total working days in the case company. In stage 3 and 4 this increases to around 12%. In stage 5 of the productization process 14% of the total working days are related to SPM. In the current situation it decreases to around 12%, this is due to the increase of FTEs.

Table 27: SPM days and total working hours

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Current
<b>SPM Related working days</b>	68,75	78	177,25	234,75	267	267
<b>FTE</b>	4,3	4,8	6,5	8,7	9,8	10,9
<b>Total working days a year</b>	953,33	1054,90	1420,10	1904,47	2147,20	2395,80
<b>Percentage related hours to SPM</b>	7,2%	7,4%	12,5%	12,3%	12,4%	11,1%

From this section can be concluded that the SPM related working days increased the most between stage 3 and stage 5, this is in line with that the most capabilities were implemented in stage 3 to stage 5. When taking the size of the case company into account the major change percentage hours related to SPM can be found between stage 2 and stage 3. The finding can provide other companies insights of what to expect while moving through the productization stages. It is currently not generalizable due to the fact that it is based upon a single case study.

## 7 Change aspects

This chapter will answer the fourth sub question: which aspects of process change should be considered for the introduction of SPM? This sub question will result in change aspects that should be considered for the implementation of SPM during the productization process. The question will be answered by performing a literature research. Section 7.1 describes the literature review approach and section 7.2 is the result of the literature review.

### 7.1 Literature review approach

To answer the fourth sub question a systematic literature review will be performed. The systematic literature review described by Okoli and Schabram (2010) will be used as a guideline to create the literature review approach. They define the following eight steps: (1) purpose of the literature review, (2) protocol and training, (3) searching for literature, (4) practical screen, (5) quality appraisal, (6) data extraction, (7) synthesis of studies and (8) writing the review.

The following literature review approach will be used:

**1. Purpose of the literature review:** In this step the purpose and the goal of the literature review is clearly defined. In this research the purpose of the literature review is finding an answer to the following questions: which aspects of process change and which success factors should be considered for the introduction of SPM? The fourth sub research questions will be answered in section 4.2.

**2. Searching for literature:** During this step the search for literature is performed to answer the research questions. Parameters used during the literature search are the search locations/ engines.

The search locations/engines that are used during the literature research are:

- Google scholar
- ScienceDirect
- CiteSeer
- Scirus

Keywords used during the literature research to answer SQ4:

- Business process change
- Business process change management
- Business process redesign
- Business process reengineering
- Change management
- Organizational process change / organisational process change
- Organizational change / organisational change
- Software process change
- Software process improvement
- Business process change success factors

- Business process redesign success factors
- Business process reengineering success factors
- Change management success factors
- Organizational change / organisational change success factors
- Software process improvement success factors

The keywords were searched with a combination of all (AND) the keywords. The keywords may occur in the whole article.

The found articles are saved and their metadata is stored. The following metadata of the article is stored:

- Title
- Author(s)
- Publication year
- Type of publication
- Journal or conference
- Search engine used
- Keywords used
- Date retrieved

This initial search for literature resulted in 339 articles that were found.

**3. Literature screening:** In the previous step a large amount of literature is found. Since not all literature found is applicable to the research a selection needs to be made. During this step the abstracts of the literature found in the previous step is read to determine if it is applicable to the research and should be studied further. In this research the found articles will be categorized relevant and non-relevant. Relevant articles will be studied further and non-relevant articles will not be used in the research anymore. For literature to be relevant it should describe aspects and success factors related to change management, business process change or software process improvement. Furthermore the article will be judged on quantity based upon the extensiveness of the literature. To assure the quality the literature should be published in a journal, book or be part of a conference. And at last the authors of the literature are considered. After the literature screen there were 114 articles left.

**4. Data extraction and synthesis:** After the practical screen the remaining literature will be used in the data extraction. The information found in each study is systematically gathered from the study. The following data is extracted for each article: the research goal, the research method and the key findings. After the data extraction the found data is aggregated, organized and compared based upon concepts.

**5. Writing the review:** In this step the findings are reported by writing the literature review, which exists from an introduction, body and conclusion.

## **7.2 Process change aspects and success factors during the implementation of SPM**

First this section will describe the aspects of change management and organizational change in general. Later it looks at the change aspects caused by business process change and software process improvement. Software process improvement is already discussed in section 3. This will result in important aspects of change that need to be considered for the implementation of SPM during the productization process. This is followed by identifying success factors that are of importance during the implementation of SPM.

### **7.2.1 Change management and organizational change**

In order to change from customer specific software to a standard software product, while implementing the SPM competence model, an organization needs to continuously adapt to these changes. To support these changes we will look at organizational change and change management. Change management can be defined as: *'the process of continually renewing an organization's direction, structure, and capabilities to serve the ever-changing needs of external and internal customers'* (Moran & Brightman, 2001).

Organizations change due to changes in the business environment, advancing technology and changing expectations of employees are some of the possible causes that can force continuing change within an organization (Kearns, 2004). Change in an organization is always present, on operational level and strategic level (Burnes, 2004). Barnett and Carroll (1995) state that change is a transformation between two points in time within an organization; the key point is the comparison between before and after the transformation.

Organizational change can cause change in the following components within an organization (Bryson, 1997). In order of significance these components are: (1) management structure and processes, (2) organizational culture, (3) people, (4) organizational performance, (5) tasks and activities, (6) image of the organization, (7) set up of organization and (8) technology used.

Change in an organization can be internal or external driven. Internal change can be referred as push; it is initiated by the development of a new process or technology used to gain a competitive advantage. External change is referred as pull; it is initiated by customer demands or by new regulations by the government (Kearns, 2004). In the case of productization and SPM the change is mainly internal driven, since the organization want to gain a competitive advantage by implementing SPM and broaden their market by creating a standard software product.

#### ***Stages of change***

Change is a process is a continuous cycle; Moran and Brightman (2001) define four phases in the change management cycle. The first phase is getting an understanding of the current situation. The second phase consists of a determination of the desired state and the creation of a change plan. The third phase concerns the enlisting of others and the development of a critical mass. The last phase is the tracking and the stabilization of the results. The four stages change process model goes through a cycle of four stages of change (Kearns, 2004) & (ITIL, 1999), these stages are: diagnosis, plan, implement and review. These stages are generally the same as the phases of Moran and Brightman (2001).

Organizational change follows three stages, each with different activities and communication needs (Klein, 1996). The first stage is unfreezing which concerns the preparing of the organization for the change. The second stage is changing; in this stage the process of change is started. Refreezing is the last stage; where the change is reinforced. Weick and Quinn (1999) define these stages as unfreezing, transition and refreeze.

### ***Types of change***

In a literature study Todnem (2005) presents an overview that identifies different types of change characteristics. Firstly discontinuous change concerns rapid changes in strategy, structure and culture (Grundy 1993). Secondly Burnes (2004) incremental change as *'when individual parts of an organization deal increasingly and separately with one problem and one objective at a time. Advocates of this view argue that change is best implemented through successive, limited, and negotiated shifts'*. Incremental change can be divided in bumpy and smooth incremental change (Grundy, 1993). And thirdly continuous change, which Burnes (2004) defines as *'the ability to change continuously in a fundamental manner to keep up with the fast-moving pace of change'*. The continuous change can occur bumpy.

The change characteristics can occur in different ways; according to Todnem (2005) planned and emergent are the most common ways. The planned approach focuses upon the different states an organization needs to go through to move from an unsatisfied state to a desired state. The emergent approach focuses upon that change is an open-ended continuous process of adaptation to changing circumstances and conditions. Lesser common the change can occur found in literature according to Todnem (2005) are contingency and choice.

Le Jean (2011) differentiates between discontinuous and continuous change. Whereby discontinuous change is based upon a revolutionary approach and continuous change is based upon an evolutionary approach. Revolutionary change does not build on a current situation in an organization but overthrows it, where evolutionary changes build on the current situation in an organization and changes it in a constant stream of moderate changes (De Wit and Meyer, 2004).

Weick and Quinn (1999) define two types of change: episodic change and continuous change. Episodic change is used for changes in an organization that are infrequent, discontinuous, and intentional. The episodic change is created by intention and generally follows the same change stages as by Klein (1996). Weick and Quinn (1999) define the stages as unfreezing, transition and refreeze. Continuous change is used for changes in an organization that are ongoing, evolving, and cumulative. Continuous change tends to be emergent and is a redirection of a change that is already underway. In contrast with episodic change the first stage of continuous change is freezing and is followed by rebalancing and unfreezing.

The different types of changes are summarized in Table 28. These type of changes show great similarities; this result into two types of change found in literature. The first type of change makes large changes in a short amount of time and therefore can be called revolutionary. While the second type of change makes small changes over a longer period of time and is in general an ongoing process and therefore can be called evolutionary.

**Table 28: Types of change**

	<b>Large changes at once (revolutionary)</b>	<b>Small changes over time (evolutionary)</b>
Grundy (1993) & Burnes (2004)	Discontinues change	Incremental change & continuous change
Todnem (2005)	Discontinuous change	Continuous change
Le Jean (2011)	Revolutionary change	Evolutionary change
Le Jean (2011)	Planned change	Emergent change
Weick and Quinn (1999)	Episodic change	Continuous change

***Change models***

Todnem (2005) identified three different models for emergent change from literature. The ten commandments for executing change by Kanter, Stein and Jick (1992). The eight stage process for successful organizational transformation by Kotter (1996). And thirdly the seven steps by Luecke (2003). These models can be found in Table 29. Other models are the models of implementing change by Galpin (1996), Judson (1991) and two models by Armenakis, Harris and Feild (1999). These models can also be found in Table 29. The two models of Armenakis focus more on the readiness and desire to change than the whole change process.

The change models in Table 29 have a number of elements in common. An element that occurs in multiple change models is shown in bold in Table 29. These elements are: determining the need for change; analyzing the current state of the organization; create a vision and strategy; define and empower the leadership for the change; communicate the change; institutionalize the change and refine the change.

Axelrod (2000), Nilikant and Ramnarayan (2006) describe four approaches for change by different ways of communicating and engagement of staff. The leader-driven approach; whereby the change is led by one leader or CEO from within the organization. With this approach the leader has the power and the needed knowledge for the change. Secondly the process-driven approach, experts or outside consultants identify the areas for change and give their recommendations. With this approach the experts or consultants have the needed specialized knowledge and the leader plays a supportive role. Thirdly the team driven approach, whereby the change is identified and recommended by a team of employees from within the organization. With this approach the involved employees in the change have all the knowledge; there is no single person who has all the knowledge. Lastly the change management approach, which is a combination of the process driven and the team driven approach. In this approach experts or consultants recommend and initiate change with the input of the employees from the organization. With this approach the employees have the knowledge to provide the experts or consultants with input; no single person has all the knowledge with this approach.

Table 29: Change models

Ten commandments for executing change (Kanter et al., 1992)	Eight stage process for successful organizational transformation (Kotter, 1996)	Seven steps (Luecke, 2003)	Galpin (1996)
<ol style="list-style-type: none"> <li>1. <b>Analyze the organization and its need for change</b></li> <li>2. <b>Create a vision and a common direction</b></li> <li>3. Separate from the past</li> <li>4. Create a sense of urgency</li> <li>5. <b>Support a strong leader role</b></li> <li>6. Line up political sponsorship</li> <li>7. Craft an implementation plan</li> <li>8. Develop enabling structures</li> <li>9. <b>Communicate, involve people and be honest</b></li> <li>10. <b>Reinforce and institutionalize change</b></li> </ol>	<ol style="list-style-type: none"> <li>1. Establishing a sense of urgency</li> <li>2. Creating a guiding coalition</li> <li>3. <b>Developing a vision and strategy</b></li> <li>4. <b>Communicating the change vision</b></li> <li>5. <b>Empowering broad-based action</b></li> <li>6. Generating short-term wins</li> <li>7. Consolidating gains and producing more change</li> <li>8. Anchoring new approaches in the culture</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Mobilize energy and commitment through joint identification of business problems and their solutions</b></li> <li>2. <b>Develop a shared vision of how to organize and manage for competitiveness</b></li> <li>3. <b>Identify the leadership</b></li> <li>4. Focus on results, not on activities</li> <li>5. Start change at the periphery, then let it spread to other units without pushing it from the top</li> <li>6. <b>Institutionalize success through formal policies, systems, and structures</b></li> <li>7. Monitor and adjust strategies in response to problems in the change process</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Establishing the need to change</b></li> <li>2. <b>Developing and disseminating a vision of a planned change</b></li> <li>3. <b>Diagnosing and analyzing the current situation</b></li> <li>4. Generating recommendations</li> <li>5. Detailing the recommendations;</li> <li>6. Pilot testing the recommendations;</li> <li>7. Preparing the recommendations for rollout;</li> <li>8. Rolling out the recommendations; and</li> <li>9. <b>Measuring, reinforcing, and refining the change</b></li> </ol>
<p><b>Judson (1991)</b></p>	<p><b>Armenakis et al. (1999) Readiness for change</b></p>	<p><b>Armenakis et al. (1999) adoption of desired change</b></p>	
<ol style="list-style-type: none"> <li>1. <b>Analyzing and planning the change</b></li> <li>2. <b>Communicating the change</b></li> <li>3. Gaining acceptance of new behaviors</li> <li>4. Changing from the status quo to a desired state</li> <li>5. <b>Consolidating and institutionalizing the new state</b></li> </ol>	<ol style="list-style-type: none"> <li>1. Discrepancy (we need to change)</li> <li>2. Self-efficacy (we have the capability to successfully change)</li> <li>3. Personal valence (it is in our best interest to change);</li> <li>4. Principal support (those affected are behind the change)</li> <li>5. Appropriateness</li> </ol>	<ol style="list-style-type: none"> <li>1. Persuasive communication (speeches by change agents and articles in employee newsletters)</li> <li>2. Active participation by those affected (vicarious learning, enactive mastery, and participative decision making)</li> <li>3. Human resource management practices (selection, performance appraisal, compensation, and training and development programs)</li> <li>4. Symbolic activities (rites and ceremonies)</li> <li>5. Diffusion practices (best practice programs and transition teams)</li> <li>6. Management of internal and external information; and</li> <li>7. Formal activities that demonstrate support for change initiatives (new organizational structures and revised job descriptions)</li> </ol>	

### ***Resistance, commitment and change***

During the change process employees of an organization can show resistance to the change process where instead commitment of the employees is needed for the change. This section looks at resistance and commitment to change.

Trader-Leigh (2002) (Kearns, 2004) identify six resistance forces that can exist during organizational change. These six resistance forces are: self-interest, psychological impact, tyranny of custom, redistributive effects, destabilization effects and culture compatibility.

Sørensen, Hasle and Pejtersen (2011) state that change in an organization occurs when structures and processes change and uncertainty develops. Uncertainty and transformational change within an organization in most cases threatens the trust between the employees and the management. Low trust under employees causes difficulties for transformational change. Involvement of the employees in the change process causes the employees to assume co-ownership and provides the management of better understanding of the employees.

Kotter and Schlesinger (2008) describe five methods to manage the resistance against change. Firstly education; where the desired changes and reasons are communicated. Secondly there is participation, where the possible resisters to the change are actively involved in the change process. The third method is facilitation, where skill training and support is provided. The fourth method is negotiation, where incentives are offered for adjusting to the change. The last method is coercion; resisters are threatened with loss of job or promotion opportunity.

A model for 'the development of commitment to change' was created by Conner and Patterson (1982) (Abrahamsson, 2001). The model consists of three phases: preparation, acceptance and commitment. And the model goes through eight stages that are dependent on the phases and time. The model is shown in Figure 16.



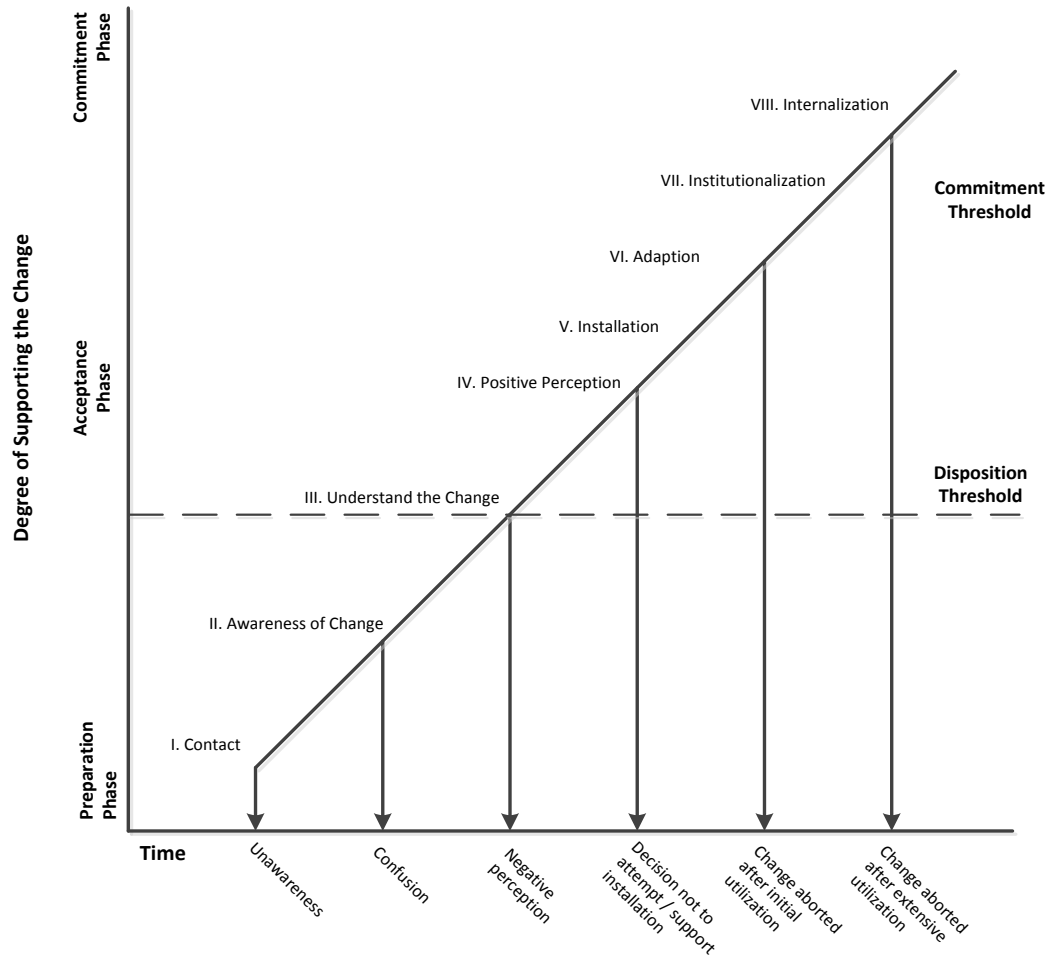


Figure 16: Model: Development of change by Conner and Patterson (1984) from (Abrahamsson, 2001).

### 7.2.2 Business process change, reengineering and redesign

The change from customer specific software to a standard software product changes the way a software company works and results in a need to change processes within the company. Business process change, reengineering and redesign describe how to change this. Hammer and Champy (1993) define business process reengineering as: *'the fundamental rethinking and radical redesign of business processes to achieve improvements in critical, contemporary measures of performance such as cost, quality, service and speed'*. Hammer (1990) states reengineering should be done with the power of modern information technology that should be used to radically redesign business processes. Kettinger, Teng and Guha (1997) describe business process reengineering as *'a form of organizational change characterized by strategic transformation of interrelated organizational subsystems producing varied levels of impact'*. Compared to other forms of organizational change the business process reengineering approach primary focuses upon the business process. Hickman (1993) defines a business process as: *'a logical series of dependent activities which use the resources of the organization to create, or result in, an observable or measurable outcome, such as a product or service'*. Whereas Earl (1994) defines a business process as *'a lateral or horizontal organizational form, that encapsulates the interdependence of tasks, roles, people,*

*departments and functions required to provide a customer with a product or service* '. Important characteristics of business processes are that they have internal and external customers and that they cross the boundaries of the organization.

Besides business process reengineering another term often used is business process redesign. Davenport and Short (1990) define business process redesign as '*analysis and design of work flows and processes within and between organizations*' and business process as '*a set of logically related tasks performed to achieve a defined business outcome*'. Earl (1994) defines six elements of Business process redesign: transformation, process, information technology, business change, change management and systems analysis. Mansar and Reijers (2007) describe the difference between business process reengineering and business process redesign as follows: business process redesign concerns how a process relates to interdependent tasks and resources while business process reengineering can refer to all aspects related to the restructuring of the processes of an organization. A reengineering project is likely to include multiple processes that will be redesigned. Reengineering often focuses upon drastic changes where redesign is more neutral in this area.

Hammer (1990) describes seven principles of reengineering:

- Organize around outcomes, not tasks
- Have those who use the output of the process perform the process
- Subsume information processing work into the real work that produces information
- Treat geographically dispersed resources as though they are centralized
- Link parallel activities instead of integrating their results
- Put the decision point where the work is performed, and build control into the process
- Capture information once and at the source

Grover and Malhotra (1997) state four elements about business process reengineering. These elements are radical or significant change; the business process is the unit of analysis; it is focused upon dramatic performance improvements or the achievement of major goals; IT is a critical enabler to undergo the change. Business process reengineering uses the different views of quality, IT, organizational change, innovation and work redesign to in the reengineering process.

Al-Mashari, Irani and Zairi (2001) identify six dimensions of change related to business process reengineering. These dimensions of change are: (1) roles and responsibilities, (2) organizational structure, (3) management systems, (4) skill requirements, (5) shared values and beliefs, (6) reward and recognition systems.

Childe, Maull and Bennett (1994) identify three approaches for business process reengineering. Top-down restructuring: horizontal workflows are imposed upon a functionally oriented organization. Green-field site: a new process-oriented organization is created at a new site while the current functional orientated organization is reduced. Bottom-up restructuring: process improvement teams based upon quality improvement programs are used.

Kettinger, Teng and Guha (1997) propose the stage-activity framework for business process reengineering. This framework consists of the following six stages. The first stage is envision, where the business process that needs to be improved is selected. The second stage is initiate, where a reengineering team is assigned and the goals and project planning are set. The third stage is diagnose, where the current process is documented. The fourth stage is redesign, where the new process is designed. The fifth stage is reconstruct, where change management techniques are used for the migration to the new process. The last stage is evaluate, where the new process is monitored to determine if the set goals are met.

Important tools to establish business process reengineering are change management, TQM and benchmarking Al-Mashari, Irani and Zairi (2001). Change management is used to adopt new designed business processes into the current environment. TQM manages the reengineering efforts and benchmarking provides strategic directions for the reengineering efforts. Tools and techniques that can be used for business process reengineering according to O'Neill and Sohal (1999) are: process visualization, process mapping, change management, benchmarking and process and customer focus. Whereas Zairi and Sinclair (1995) identify the following tools and techniques: process visualization, operational research/method study, information technology, change management, benchmarking, industrial engineering and process and customer focus.

Teng, Grover and Fiedler (1996) identified elements of organizational change associated with business process redesign. The elements are ordered in five stages these are (1) sources for organizational impulses that lead to business process redesign, (2) initiating the process change, (3) selecting the change enablers, (4) managing the change implementation and (5) directions of organizational change as result from the redesign process. Element one and five are the input and the output of the process while phase two till four are actions to manage the process change.

Jarvenpaa and Stoddard (1998) argue that business process redesign can follow different theories of organizational change, namely evolutionary change and revolutionary change. With evolutionary change the change consists of a recursive interaction between hard and soft system changes. The change is managed by the current leader and employees within the organization; they must design and implement the change. Evolutionary change has the best results when it is performed with small increments. Revolutionary change focuses upon radical change with changes deep in the structure of an organization. Revolutionary change is controlled by the CEO of the organization and by external parties. The risk of failure with evolutionary change is lower compared to revolutionary change, on the other side evolutionary change takes a long time to accomplish compared to revolutionary change. In Table 30 a comparison between evolutionary change and revolutionary change elements is given (Jarvenpaa & Stoddard, 1998). The revolutionary and evolutionary change match the general change types identified in section 7.1.2.

**Table 30: Jarvenpaa and Stoddard (1998)**

<b>Element</b>	<b>Revolutionary change</b>	<b>Evolutionary Change</b>
Leadership	Outsiders	Insiders
Outside resources	Consultants led initiative	Few, if any, consultants
Physical separation	Yes	No, part-time team members
Financial crisis	Poor performance	None
Rigid milestones	Firm milestones	Flexible milestones
New reward/compensation	New scheme	No change
Simultaneous IT/process change	Simultaneous process and IT	Process first

Childe, Maull and Bennett (1994), Smith (1982) identifies two types of change that can occur during a business process redesign process. Incremental: is based upon sustained effort and is seen as low risk, easy to manage and less disruptive. The second type is radical: which see incremental change as non-change, with radical change the organization is disrupted for periods of time during the change. Incremental change matches the evolutionary change and radical change matches revolutionary change of Jarvenpaa and Stoddard (1998).

### **7.2.3 Success factors**

This section discusses the success factors for change management and software process improvement that can be related to SPM.

Stelzer and Mellis (1998) identified ten success factors of organizational change in software process improvement. Dyba (2000, 2003) identified six key factors of success in software process improvement. Rainer and Hall (2002) identified nine factors that have a major impact on of software process improvement. Niazi, Wilson and Zowghi (2006) compared critical success factors for software process improvement from literature and interviews. This resulted in a list of ten common critical success factors.

Goldenson and Herbsleb (1995) (El-Emam, Goldenson, McCurley & Herbsleb, 2001) found the following thirteen factors that relate to the success of software process improvement. These factors are summarized in Table 31.

Success factors for organizational change in general by Gill (2002) and Zink, Steimle and Schröder (2008) can be found in Table 32. Besides the success factors Gill (2002) states that change requires good management and effective leadership. The following elements are of importance for effective leadership during change: vision, values, strategy, empowerment and motivation and inspiration.

The different lists of success factors identified from the literature have some overlap. The most common found success factors are relating to organizational change and software process improvement are: support of management; clear leadership and communication during the change; employee involvement and employees with experience; management of the change process, employees and resources; training and mentoring; review and measuring the change. These success factors can be help during the implementation of SPM in an organization.

**Table 31: Success factors software process improvement**

<b>Stelzer &amp; Mellis (1998)</b>	<b>Dyba (2000,2003)</b>	<b>Rainer &amp; Hall (2002)</b>
<ol style="list-style-type: none"> <li>1. Management commitment and support</li> <li>2. Staff involvement</li> <li>3. Providing enhanced understanding</li> <li>4. Tailoring improvement initiatives</li> <li>5. Managing the improvement project</li> <li>6. Change agents and opinion leaders</li> <li>7. Stabilizing changed processes</li> <li>8. Encouraging communication and collaboration</li> <li>9. Setting relevant and realistic objectives</li> <li>10. Unfreezing the organization</li> </ol>	<ol style="list-style-type: none"> <li>1. Business orientation</li> <li>2. Leadership involvement</li> <li>3. Employee participation</li> <li>4. Concern for measurement</li> <li>5. Exploitation of existing knowledge</li> <li>6. Exploitation of new knowledge</li> </ol>	<ol style="list-style-type: none"> <li>1. Training &amp; mentoring</li> <li>2. Reviews</li> <li>3. Standards &amp; procedures</li> <li>4. Experienced staff</li> <li>5. Inspections</li> <li>6. Internal process ownership</li> <li>7. Internal leadership</li> <li>8. Executive support</li> <li>9. Metrics</li> </ol>
<b>Niazi, Wilson &amp; Zowghi (2006)</b>	<b>Goldenson &amp; Herbsleb (1995) and El-Emam, Goldenson, McCurley &amp; Herbsleb (2001)</b>	
<ol style="list-style-type: none"> <li>1. Creating process action team/external agents</li> <li>2. Encouraging communication and collaboration</li> <li>3. Experienced staff</li> <li>4. Managing the SPI project</li> <li>5. Reviews</li> <li>6. Senior management commitment</li> <li>7. Staff involvement</li> <li>8. Staff time and resources</li> <li>9. Tailoring improvement initiatives</li> <li>10. Training and mentoring</li> </ol>	<ol style="list-style-type: none"> <li>1. Senior management monitoring of SPI</li> <li>2. Compensated SPI responsibilities</li> <li>3. SPI goals well understood</li> <li>4. Technical staff involved in SPI</li> <li>5. SPI people well respected</li> <li>6. Staff time/resources dedicated to process improvement</li> <li>7. Discouragement about SPI prospects</li> <li>8. SPI gets in the way of “real” work</li> <li>9. “Turf guarding” inhibits SPI</li> <li>10. Existence of organizational politics</li> <li>11. Assessment recommendation too ambitious</li> <li>12. Need guidance about how to improve</li> <li>13. Need more mentoring and assistance</li> </ol>	

**Table 32: succes factors organizational change**

<b>Gill (2002)</b>	<b>Zink, Steimle &amp; Schröder (2008)</b>
<ol style="list-style-type: none"> <li>1. Leadership</li> <li>2. Corporate values</li> <li>3. Communication</li> <li>4. Teambuilding</li> <li>5. Education and training</li> </ol>	<ol style="list-style-type: none"> <li>1. The deployment of a long-term strategy and the ability to make the needed resources available with the organization</li> <li>2. Participation of the people affected by the changes that are going to be made.</li> <li>3. The consideration of the influence of the change on the organizational culture.</li> <li>4. The coherence between different change projects within the organization.</li> <li>5. Structure and behavior relating to the interdependencies between the different change projects</li> <li>6. Change should be seen as an evolutionary process and should not be limited by a predefined time limit</li> </ol>

### **7.2.4 SPM and change management**

This section looks at what aspects discussed in the previous sections should be considered for the implementation SPM during the productization process. In section 7.2.1 two general types of change were identified from literature, namely revolutionary and evolutionary. When considering these types of changes for SPM, the evolutionary change would be a better fit. Since SPM consists of 68 capabilities which are not suitable to be implemented all at once. Furthermore when considering the productization process as well, which is an evolutionary process itself where an organization gradually moves from customer specific software to a standard software product.

When implementing a SPM capability the four stages of Kearns (2004), ITIL (1999), Moran and Brightman (2001) should be considered. The four stages are: diagnosis, plan, implement and review.

For an organization to change to SPM the following elements of change models that were recurring in literature should be considered:

- Determining the need for change (Kanter, 1992; Galpin, 1996; Luecke, 2003)
- Analyzing the current state of the organization (Kanter, 1992; Judson, 1991; Galpin, 1996)
- Create a vision and strategy (Kanter, 1992; Galpin 1996; Kotter, 1996; Luecke, 2003)
- Define and empower the leadership for the change (Kanter, 1992; Kotter 1996, Luecke, 2003)
- Communicate the change (Judson, 1991; Kanter, 1992; Kotter, 1996)
- Institutionalize the change (Judson, 1991; Kanter 1992; Luecke, 2003)
- Refine the change (Kanter, 1992; Galpin, 1996)

These elements can be matched to the earlier mentioned four stages of change. This matching can be found in Table 33. Furthermore these elements also largely match with the five change management tactics for software process improvement of Mathiassen, Ngwenyama and Aaen (2005) described in section 7.2.3.

**Table 33: The stages of changes and the elements of change.**

<b>Diagnosis</b>	<b>Plan</b>	<b>Implement</b>	<b>Review</b>
<ul style="list-style-type: none"> <li>• Determining the need for change.</li> <li>• Analyzing the current state of the organization.</li> </ul>	<ul style="list-style-type: none"> <li>• Create a vision and strategy.</li> <li>• Define and empower the leadership for the change.</li> </ul>	<ul style="list-style-type: none"> <li>• Communicate the change.</li> <li>• Institutionalize the change.</li> </ul>	<ul style="list-style-type: none"> <li>• Refine the change.</li> </ul>

The methods for leading and communication change within an organization by Axelrod (2000); Nilikant and Ramnarayan (2006) do not describe one best method that should be used with SPM. The method to be used depends on the knowledge that an organization has about SPM, the change should be led by somebody who has the knowledge of SPM; this can be internal or external person. It is important to involve the employees influenced by the implementation of SPM in the change process.

Section 7.2.4 looked at the success factors that are related to change management and the software improvement process. This resulted in the following seven most common success factors found.

- Management support for the change (Stelzer & Mellis, 1998; Rainer & Hall, 2002; Niazi, Wilson & Zowghi, 2006)
- Clear leadership and communication during the change (Stelzer & Mellis, 1998; Gill, 2002; Rainer & Hall, 2002; Dyba, 2000, 2003; Niazi, Wilson & Zowghi, 2006)
- Employees should be involved during the change (Goldsenson & Herbsleb, 1995; Stelzer & Mellis, 1998; Dyba, 2000, 2003; Niazi, Wilson & Zowghi, 2006)
- Employees should be experienced (Rainer & Hall, 2002; Niazi, Wilson & Zowghi, 2006)
- Availability of employees and resources for the change (Goldsenson & Herbsleb, 1995; Niazi, Wilson & Zowghi, 2006)
- Training and mentoring to support the change (Gill, 2002; ; Rainer & Hall, 2002; Niazi, Wilson & Zowghi, 2006)
- Reviewing and measuring of the change (Goldsenson & Herbsleb, 1995; Rainer & Hall, 2002; Dyba, 2000, 2003; Niazi, Wilson & Zowghi, 2006)

What can be seen from these success factors is that they all can be related to one of the identified elements of change. Furthermore the methods to manage resistance against change by Kotter and Schlesinger (2008) are of importance to manage resistance and make the change a success.

## 8 Conclusions and discussion

This chapter will give an overview of the answered research question and discusses the limitations of the research and possible future research.

### 8.1 Conclusions

The exploratory research resulted in a preliminary framework, an indication of investments in terms of working days that are related to SPM capabilities and an overview of change aspects that should be considered for the implementation SPM during the productization process. The main question of this research was: *How can software product management capabilities be implemented during each stage of the productization process?*

The main research question is answered by the four individual sub questions. The first sub question was: *What is Software Product Management and productization?* This sub question defined that SPM is used to govern a software product during its lifetime and productization as the process describes the change from developing customer specific software to a standard software product. The full description can be found in chapter 3.

The second sub question was: *Which SPM capability can be linked to which productization stage?* The case study identified the SPM capabilities implemented during each stage of the productization process at the case company; this can be found in section 5.3. The case company had 43 out of the 68 SPM capabilities implemented; most of the capabilities were implemented during stage 3 till stage 5 of the productization process. Based on the case study, the SPM competence model, SPM maturity matrix and the productization process the preliminary framework was created. The preliminary framework can be found in section 5.5. The preliminary framework indicates the ideal stage of the productization process to implement a specific SPM capability. The preliminary framework can provide a basis guideline for software vendors of what SPM capabilities to implement while going through the productization process, although future research is still needed as will be discussed in section 8.2. Furthermore the results of the case study provide that case company with an overview how they went through the productization process and their current status in it, and in which areas they still can improve.

The third sub question was: *What are the investments associated with these SPM capabilities in terms of working days?* This sub question identified the working days related to the implemented capabilities at the case company; this can be found in chapter 6. The most time related to SPM at the case company is in the requirements management business function, more than two third of the time related to SPM. The business function release planning follows with almost a quarter of the total time related to SPM. Therefore the business functions product planning and portfolio management don't require much time in the case company. Currently in the case company the SPM related working days account for 11.1% of the total working days. The case study gives the case company an overview of the investments in terms of working days and costs for the different focus areas and business functions. For other software vendors that go through the productization it will provide an indication of what amount of working days need to be invested for the business functions and focus areas.



The fourth sub question was: *Which aspects of process change and which success factors should be considered for the introduction of SPM during the productization process?* This sub question identified by a literature research the change aspects that should be considered for the implementation of SPM during the productization process; the literature research can be found in chapter 7. The literature identified the evolutionary change as a suitable type change. Four stages of change and seven elements of change were identified. Furthermore seven success factors for change were identified. The stage, elements and success factors can be used to support the implementation of SPM during the productization process.

## **8.2 Discussion**

Due to the nature of an exploratory research and time restrictions there are limitations to this research and there is need for future research.

In this research the case study identified the implemented SPM capabilities and the related working days to those capabilities at a single software vendor. This raises the limitations of a single case where there are no other cases to compare too. There was chosen for a single case due to time restrictions. A second limitation to the case study is that the case company in the case study reached stage 5 of the productization process and not the stage 6a/b of the productization process. For future research there is suggested to perform this case study at multiple software vendors and compare the results.

This single case study has also effect on the creation of the framework; therefore the framework presented in this research is preliminary. It is currently based on a single case and the existing literature of SPM and productization. Another limitation of the research is that the evaluation of the preliminary framework is done by a single expert review. For future research there is suggested to adapt the preliminary framework based upon the results of case study at other software vendors that went through the productization process.

## References

- Abrahamsson, P. (2001). Commitment development in software process improvement: critical misconceptions. *Proceedings of the 23rd International Conference on Software Engineering, ICSE '01* (pp. 71–80). Washington, DC, USA: IEEE Computer Society.
- Ahern, D., Clouse, A., & Turner, R. (2008). *Cmmi distilled: a practical introduction to integrated process improvement*. Addison-Wesley Professional.
- Al-Mashari, M., & Zairi, M. (2000). Revisiting BPR: a holistic review of practice and development. *Business Process Management Journal*, 6(1), 10–42.
- Al-Mashari, M., Irani, Z., & Zairi, M. (2001). Business process reengineering: a survey of international experience. *Business Process Management Journal*, 7(5), 437–455.
- Allison, I., & Merali, Y. (2007). Software process improvement as emergent change: A structural analysis. *Information and Software Technology*, 49(6), 668–681.
- Armenakis, A., Harris, S., & Feild, H. 1999. Paradigms in organizational change: Change agent and change target perspectives. In R. Golembiewski (Ed.), *Handbook of organizational behavior*. New York: Marcel Dekker.
- Artz, P., Weerd, I. van de, & Brinkkemper, S. (2010). Productization: The process of transforming from customer-specific software development to product software development. *SciencesNew York*, (January).
- Artz, P., Weerd, I. van de, Brinkkemper, S., & Fiegen, j. (2010). Productization: transforming from developing customer-specific software to product software. *Proceedings of the 1<sup>st</sup> International Conference on Software Business (ICSOB 2010)*, LNBIP 51, 90–102.
- Axelrod, R.H. (2000), *Terms of Engagement: Changing the way we change organisations*. San Fransico: Berrett – Koehler Publishers.
- Barnett, W.P. and Carroll, G.R. (1995) Modeling internal organizational change, *Annual Review of Sociology*, Vol. 21
- Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, 17(1), 99–120.
- Beckhard, R., Harris, R. T. (1987). *Organizational Transitions. Managing Complex Change* (2nd ed.). Addison-Wesley, Reading, Mass.
- Bekkers, W., & Spruit, M. (2010). The Situational Assessment Method put to the test: Improvements based on case studies. *Software Product Management (IWSPM), 2010 Fourth International Workshop* (pp. 7–16).

- Bekkers, W., Weerd, I. van de, Spruit, M., & Brinkkemper, S. (2010). A framework for process improvement in software product management. *Proceedings of the 17th European Conference on Systems, Software and Services Process Improvement (EUROSPI)*, Grenoble, France, 1-12.
- Burnes, B. (2004) *Managing Change: A Strategic Approach to Organisational Dynamics*, 4th edn (Harlow: Prentice Hall).
- Bryson, R. J. (1997). Business service firms, service space and the management of change. *Entrepreneurship & Regional Development*, 9(2), 93–112.
- Calvo-Manzano Villalón, J. A., Cuevas Agustín, G., San Feliu Gilabert, T., De Amescua Seco, A., García Sánchez, L., & Pérez Cota, M. (2002). Experiences in the application of software process improvement in SMES. *Software Quality Journal*, 10(3), 261–273.
- Chatterjee, S., & Wernerfelt, B. (1991). The link between resources and type of diversification: theory and evidence. *Strategic management journal*, 12(1), 33–48.
- Childe, S. J., Maull, R. S., & Bennett, J. (1994). Frameworks for understanding business process re-engineering. *International Journal of Operations & Production Management*, 14(12), 22–34.
- Conner, D. R., & Patterson, R. W. (1982). Building commitment to organizational change. *Training & Development Journal*, 36(4), 18–30.
- Davenport, T.H., Short, J.E., 1990. The new industrial engineering: Information technology and business process redesign. *Sloan Management Review* 31 (4), 11–27.
- Dorling, A. (1993). SPICE: Software process improvement and capability determination. *Software Quality Journal*, 2(4), 209–224.
- Dyba, T. (2000). An instrument for measuring the key factors of success in software process improvement. *Empirical Software Engineering*, 5(4), 357–390.
- Dyba, T. (2003). Factors of software process improvement success in small and large organizations: an empirical study in the Scandinavian context. *ACM SIGSOFT Software Engineering Notes*, 28(5), 148–157.
- Earl, M. J. (1994). The new and the old of business process redesign. *The Journal of Strategic Information Systems*, 3(1), 5–22.
- Ebert, C. (2009). Software product management. *Crosstalk*, 22(1), 15–19.
- El-Emam, K., Goldenson, D., McCurley, J., & Herbsleb, J. (2001). Modelling the likelihood of software process improvement: An exploratory study. *Empirical Software Engineering*, 6(3), 207–229.
- Finkelstein, A and Fuggetta, A and Montangero, C and Derniame, JC (1999) Software process - Standards, assessments and improvement. *LECT NOTES COMPUT SC*, 1500 15 - 25.

- Galpin, T. 1996. *The human side of change: A practical guide to organization redesign*. San Francisco: Jossey-Bass.
- Gill, R. (2002): Change management--or change leadership?, *Journal of Change Management*, 3:4, 307-318
- Goldenson, D. R., & Herbsleb, J. D. (1995). *After the Appraisal: A Systematic Survey of Process Improvement, its Benefits, and Factors that Influence Success*. DTIC Document.
- Grant, R. M. (1991). The resource-based theory of competitive advantage. *Strategy: Critical Perspectives on Business and Management*, 135.
- Grover, V., & Malhotra, M. K. (1997). Business process reengineering: a tutorial on the concept, evolution, method, technology and application. *Journal of Operations Management*, 15(3), 193–213.
- Grundy, T. (1993) *Managing Strategic Change* (London: Kogan Page).
- Gunasekaran, A., & Nath, B. (1997). The role of information technology in business process reengineering. *International journal of production economics*, 50(2), 91–104.
- Hammer, M. (1990). Reengineering work: don't automate, obliterate. *Harvard business review*, 68(4), 104–112.
- Hammer, M., Champy, (1993). *Reengineering the Corporation: A Manifesto for Business Revolution*, Harper Collins, New York
- Hansen, B., Rose, J., & Tjørnehøj, G. (2004). Prescription, description, reflection: the shape of the software process improvement field. *International Journal of Information Management*, 24(6), 457–472.
- Hevner, A., March, S., Park, J. & Ram, s. (2004), "Design science in information systems research," *Mis Quarterly* Vol. 28-1: 75–105.
- Hickman, L.J. (1993) *Technology and Business Process Re-engineering: Identifying Opportunities for Competitive Advantage*, *British Computer Society CASE Seminar on Business Process Engineering*, London, 29 June 1993.
- ITIL (1999), *CCTA: IS Management Guides Managing Change*, Format Publishing Limited, ISBN 1903091012
- Jarvenpaa, S. L., & Stoddard, D. B. (1998). Business process redesign: Radical and evolutionary change. *Journal of Business Research*, 41(1), 15–27.
- Judson, A. (1991). *Changing behavior in organizations: Minimizing resistance to change*. Cambridge, MA: Basil Blackwell.
- Kanter, R. M., Stein, B. A. and Jick, T. D. (1992) *The Challenge of Organizational Change* (New York: The Free Press).

- Kearns, B. (2004), Technology and change management
- Kettinger, W. J., & Grover, V. (1995). Toward a theory of business process change management. *Journal of Management Information Systems*, 12(1), 9–30.
- Kettinger, W. J., Teng, J. T., & Guha, S. (1997). Business process change: a study of methodologies, techniques, and tools. *MIS quarterly*, 55–80.
- Kitchenham, B., & Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering. *Engineering*, 2(EBSE 2007-001).
- Klein, S. M., (1996) "A management communication strategy for change", *Journal of Organizational Change Management*, Vol. 9 Iss: 2, pp.32 – 46
- Klein, H. K., & Myers, M. D. (1999). A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly*, 23(1), 67-93.
- Kotter, J. P. (1996) *Leading Change* (Boston, MA: Harvard Business School Press).
- Kotter, J.P. and Schlesinger, L.A. (2008) *Choosing Strategies for Change*, Harvard Business Review
- Leenen, Vlaanderen, Weerd and Brinkkemper (2012) *Transforming to Product Software: the Evolution of Software Product Management Processes during the Stages of Productization. ICSOB, 2012 Boston.*
- Le Jean, P., (2011). *Change Management: Some preliminary key factors to succeed in leading people*
- Luecke, R. (2003) *Managing Change and Transition* (Boston, MA: Harvard Business School Press).
- Mansar, S. L., & Reijers, H. A. (2007). Best practices in business process redesign: use and impact. *Business Process Management Journal*, 13(2), 193–213.
- Mathiassen, L., Ngwenyama, O. K., & Aaen, I. (2005). Managing change in software process improvement. *Software, IEEE*, 22(6), 84–91.
- McFeeley, B. (1996). *IDEAL: A User's Guide for Software Process Improvement*. DTIC Document.
- Moran, J. W., Brightman, B. K., (2001) "Leading organizational change", *Career Development International*, Vol. 6 Iss: 2, pp.111 – 119
- Niazi, M., Wilson, D., & Zowghi, D. (2006). Critical success factors for software process improvement implementation: an empirical study. *Software Process: Improvement and Practice*, 11(2), 193–211.
- Nilikant, V. and Ramnarayan, S. (2006), Chapter 4. Mobilising support' in *Change Management – Altering Mindsets in a Global Context*. Response Books. New Delhi
- Okoli, C., Schabram, K. (2010). "A Guide to Conducting a Systematic Literature Review of Information Systems Research,". *Sprouts: Working Papers on Information Systems*, 10(26).

- O'Neill, P., & Sohal, A. S. (1999). Business Process Reengineering A review of recent literature. *Technovation*, 19(9), 571–581.
- Ozcelik, Y. (2010). Do business process reengineering projects payoff? Evidence from the United States. *International Journal of Project Management*, 28(1), 7–13.
- Palmer, I., Dunford, R. and Akin, G. (2006) Managing Organisational Change: A multiple perspectives approach. McGraw Hill Irwin, New York, 2006
- Paulk, M. C., Curtis, B., Chrissis, M. B., & Weber, C. V. (1993). Capability maturity model, version 1.1. *Software*, IEEE, 10(4), 18–27.
- Paulk, M. C. (1996). Effective CMM-based process improvement. *Proceedings of the 6th International Conference on Software Quality*.
- Rainer, A., & Hall, T. (2002). Key success factors for implementing software process improvement: a maturity-based analysis. *Journal of Systems and Software*, 62(2), 71–84.
- Raineri, A. B., (2011) Change management practices: Impact on perceived change results, *Journal of Business Research*, Volume 64, Issue 3, March 2011, Pages 266-272
- Regnell, B., & Brinkkemper, S. (2005). Market-driven requirements engineering for software products. In: A. Aurum and C. Wohlin (Eds.), *Engineering and Managing Software Requirements* (pp. 287-308), Springer Berlin Heidelberg.
- Sawyer, S. (2000). Packaged software: implications of the differences from custom approaches to software development. *European Journal of Information Systems*, 9(1), 47–58.
- Smith, K. K. (1982). Philosophical problems in thinking about organizational change. *Change in organizations*, 316–374.
- Sørensen, O. H., Hasle, P., Pejtersen, J. H., (2011) Trust relations in management of change, *Scandinavian Journal of Management*, Volume 27, Issue 4, December 2011, Pages 405-417
- Stelzer, D., & Mellis, W. (1998). Success factors of organizational change in software process improvement. *Software Process: Improvement and Practice*, 4(4), 227–250.
- Teng, J. T. C., Grover, V., & Fiedler, K. D. (1996). Developing strategic perspectives on business process reengineering: from process reconfiguration to organizational change. *Omega*, 24(3), 271–294.
- Thomson, H. E., & Mayhew, P. (1997). Approaches to software process improvement. *Software Process: Improvement and Practice*, 3(1), 3–17.
- Todnem By, R., (2005): Organisational change management: A critical review, *Journal of Change Management*, 5:4, 369-380

Trader-Leigh, K. E (2002), Case Study: Identifying resistance in managing change *Journal of Organizational Change Management*; Volume 15 No. 2; 2002.

Vaishnavi, V. and Kuechler, W. (2004). "Design Science Research in Information Systems" January 20, 2004, last updated September 30, 2011. URL: <http://desrist.org/desrist>

Weerd, I. van de, Brinkkemper, S., Nieuwenhuis, R., Versendaal, J., & Bijlsma, L. (2006). On the creation of a reference framework for software product management: Validation and tool support. *Proceedings of the 1st International Workshop on Product Management*, Minneapolis/St. Paul, Minnesota, USA, 3-12.

Weerd, I. van de, Brinkkemper, S. (2008). Meta-modeling for situational analysis and design methods. In M.R. Syed and S.N. Syed (Eds.), *Handbook of Research on Modern Systems Analysis and Design Technologies and Applications* (pp. 38-58). Hershey: Idea Group Publishing.

Weick, K. E., Quinn, R. E., (1999) Organizational change and development, *Annual Review of Psychology*, Vol. 50: 361-386 (Volume publication date February 1999)

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic management journal*, 5(2), 171–180.

Wieggers, K. E. (1999, September). First Things First: Prioritizing Requirements.

De Wit, B., Mayer, R., (2004), "Strategy: Process, Content, Context--An International Perspective", South-Western College Pub; 3rd edition

Xu, L., & Brinkkemper, S. (2007). Concepts of product software. *European Journal of Information Systems*, 16, 531-541.

Yin, R.K. (2003), *Case Study Research: Design and Methods*, 3rd ed., Sage, London.

Zink, K. J., Steimle, U., Schröder, D. (2008), Comprehensive change management concepts: Development of a participatory approach, *Applied Ergonomics*, Volume 39, Issue 4, July 2008, Pages 527-538

## **Appendix A**

An overview of the capabilities and their prerequisite(s) by Bekkers, Weerd, Spruit and Brinkkemper (2010) ordered by focus area.

### **Requirements management**

#### ***Requirements gathering:***

- A. Basic registration: Requirements are being gathered and registered
- B. Centralized registration: Incoming requirements are stored in a central database, accessible to stakeholders. Prerequisite: Requirements gathering A.
- C. Automation: Incoming requirements are automatically stored in a central database. Prerequisite: Requirements gathering A.
- D. Internal stakeholder involvement: Requirements are gathered from internal stakeholders.

- E. Customer involvement: Customer and prospect requirements are being gathered are registered, and the customer is informed of the status of their requirements.
- F. Partner involvement: Requirements are systematical gathered from partner companies.

### ***Requirements identification***

- A. Uniformity: Market requirements are rewritten to product requirements using a pre-defined template. Prerequisite: Requirements gathering A.
- B. Requirements validation: The correctness, completeness and unambiguousness of the requirements are validated. Prerequisite: Requirements gathering A.
- C. Connect similar requirements: Similar market requirements are grouped by linking market and product requirements together. Prerequisites: Requirements gathering A, Requirements gathering B.
- D. Automatically connect similar requirements: Similar requirements are automatically linked together. Prerequisites: Requirements gathering A, Requirements gathering B.

### ***Requirements organization***

- A. Requirement organization: Product requirements are organized based on shared aspects. Prerequisite: Requirements gathering A.
- B. Requirement lifecycle management: A requirements history is logged. Prerequisite: Requirements gathering A.
- C. Requirement dependency linking: Dependency's between market and product requirements are determined and registered. Prerequisite: Requirements gathering A.

## **Release planning**

### ***Requirements prioritization***

- A. Internal stakeholder involvement: Relevant internal stakeholders are involved in prioritizing the requirements. Prerequisite: Requirements gathering A.
- B. Prioritization methodology: A structured requirements method is used. Prerequisite: Requirements gathering A.
- C. Customer involvement: Customers and prospects indicate requirements that should be in future releases. Prerequisites: Requirements gathering A, Requirements gathering B.
- D. Cost revenue consideration: Information about the costs and revenue is taken in account when prioritizing the requirements. Prerequisite(s): Requirements gathering A.
- E. Partner involvement: Partner companies indicate requirements that should be implanted in future releases. Prerequisite: Requirements gathering A.

### ***Release definition***

- A. Basic requirements selection: During requirements selecting for the next release constraints for the next release are taken into account.
- B. Standardization: A standard template is used for writing the release definition.
- C. Internal communication: The release definition is communicated to internal stakeholders. Prerequisite: Release definition A.



- D. Advanced requirements selection: The optimal release is automatically calculated based on the constraints of the release. Prerequisites: Release definition A, Requirements organizing C
- E. Multiple releases: Multiple releases are included in the requirements selection process.

### ***Release definition validation***

- A. Internal validation: Internal stakeholders check the release definition. Prerequisite: Release definition A.
- B. Formal approval: Approval standards are determined and verified by the board. Prerequisite: Release definition A.
- C. Business case: A business case is written before the software is realized. Prerequisites: Release definition A, Requirements prioritization D.

### ***Scope change management***

- A. Event notification: A formal scope change management process is in place, in which all involved stakeholders are involved.
- B. Milestone monitoring: Key date and checkpoints are monitored for the product delivery.
- C. Impact analysis: The impact of problems is determined and stakeholders are informed of the impact.
- D. Scope change handling: A process is in place to develop alternative plans with relevant stakeholders. Prerequisite: Scope change management C.

### ***Build validation***

- A. Internal validation: Internal stakeholders verify the build.
- B. External validation: External parties validate the build.
- C. Certification: Certification by an independent external party.

### ***Launch preparation***

- A. Internal communication: Internal stakeholders are communicated information about the new release.
- B. Formal approval: A formal go must be obtained from the board.
- C. External communication: External stakeholders are communicated information about the new release.
- D. Training: Trainings are organized and updated documentation is used to educate internal and external parties of the release.
- E. Launch impact analysis: Time needed to implement the new release at individual customers is determined.
- F. Update external expressions: Checklist of external expressions that need to be updated is created.

## **Product planning**

### ***Roadmap intelligence***

- A. Product analysis: Analysis of the organizations product(s) to determine the strong and weak points of the product, functional and technical aspects.

- B. Society trends: An overview is created with the social trends for the coming years.
- C. Technology trends: An overview is created with important developments in the field of technology.
- D. Competition trends: An overview is created of developments of competing products in the coming years. Prerequisite: Roadmap intelligence A.
- E. Partner roadmap: An overview is created of what partners will develop next period.

### ***Core asset roadmapping***

- A. Centralized registration: All core assets are registered as in a standardized manner and stored in a central location.
- B. Core asset identification: Core assets are systematically identified among the organizations products and deliverables surrounding the products.
- C. Make or buy decision: A process is in place to investigate make or buy decisions.
- D. Core asset roadmap construction: A roadmap is created with existing and future core assets. Prerequisite(s): Core asset roadmapping A.

### ***Product roadmapping***

- A. Short-term roadmap: A roadmap developed for short-term plans.
- B. Internal consultation: Roadmaps are created with consultation of the internal stakeholders
- C. Theme identification: Release themes are identified with internal stakeholders.
- D. Long-term roadmap: A long-term roadmap is created (spans at least 4 year). Prerequisite: Product roadmapping A.
- E. Customer variant: A less details roadmap for external parties. Prerequisite: Product roadmapping A.

## **Portfolio management**

### ***Market analysis***

- A. Market trend identification: Search for market opportunities to expand existing products.
- B. Market strategy: A plan is created that shows which markets will be pursued and products for each segment can be developed.
- C. Customer win/loss analysis: A win/loss analysis is made to identify why customers choose or did not choose to buy the products of the organization.
- D. Competitor analysis: A competitor analysis made to analyze what competitors offer and what their strengths are.
- E. Customer market trend identification: External market research parties are used to research the organizations product portfolio.

### ***Partnering & contracting***

- A. Service level agreements: Service level agreements are setup for customers
- B. Intellectual property: There are measures to protect the Intellectual property of the organization and to use intellectual property of other organizations.

- C. Investigate distribution channels: A process to verify the current distribution channels and identify alternative ones.
- D. Establish and evaluate pricing model: A process to establish the pricing model and periodically verify whether it still fits the market.
- E. Monitored partner network: a monitored partner network is used to regulate partnering.

***Product life cycle management***

- A. Product life cycle analysis: The life phase for each product is determined at least once a year
- B. Portfolio innovation: A process to decide what trends to incorporate in current and future products.
- C. Portfolio scope analysis: portfolio scope analysis identifies gaps and overlaps between products in the organizations portfolio.
- D. Business case: A business case is performed for major product releases.
- E. Product lines: Product lines are developed.

**Appendix B**

**Interview notes summary**

Relyon was founded November 2001.

From then Relyon build custom software for different customers based upon the requirements the customers provided. At that time Relyon was developing software for collection agencies, credit management, service management and risk assessment. The employees of Relyon are working at different places often on site at customers.

This lasted till 2003/2004, were Relyon decided that different software components from different projects could be used across other/new projects.

At that time Relyon started building their web application building blocks. The web application building blocks consist of components that were used in earlier projects. These components in the web application building blocks can be used in future projects. The building of the web application building blocks was possible due to government sponsoring. (2004/2005/2006) During this time Relyon started working from its own office.

During 2006/2007 the web application building blocks was being fully operational and was used for its standard components to create customer specific software. The customer projects were still performed separately and needed different kinds of maintenance.

During this period Relyon starts to realize that its wants to focus upon a software product instead of customer specific projects. This was also suggested by a customer of the service management software of Relyon. During this period new wireless and mobile standards were emerging. Relyon decides to focus upon service management software and starts with market analysis in this area.

From around 2007 Relyon starts with producing their service management software, and the stopped with developing software for collection agencies, credit management and risk assessment. The stopped software is sold off to external parties but the intellectual property still is owned by Relyon. Before Relyon had for each customer its own code base, during this time the code bases of the service management customers were merged into one. Four different main modules were created: back office, planning, mobile and administrative, these models are the basis of the product platform. 2008-2009 Relyon provides a standard product with on top of that a possibility for standard customization.

2009-2011 Relyon fully focuses upon service management software. Relyon had developed four product lines during this time: one product line with the standard Relyon service management product and three lines for a specific version for three large customers. Several components are the same for all product lines. New releases are offered to all the current customers, whereas large customers still have a possibility of customization; the release heartbeat is 3-4 months.

Currently Relyon service management consists out of the following major and minor modules: service center (back office), planning, mobile, admin, reports, customer satisfaction research, portal, self service and M2M. For Relyon service management all these modules are standard.

Large customer 1, standard: mobile, reports, customer satisfaction research (custom look and feel), portal (with custom parts), self service (with custom parts). Custom: service center. Not in use: planning, reports, M2M

Large customer 2, standard: planning, mobile. Custom: service center, admin. Not in use: all other modules

Large customer 3, standard: planning, mobile. Custom: service center, admin, reports. Not in use: all other modules

## Document study and interview data

The data gathered from the document study and interview can be found in Table 35.

**Table 34: Description of color codes**

Description of color codes
Capability is implemented
Capability is not implemented
Capability is in progress to be implemented
Capability is not relevant due to situational factors

**Table 35: Capabilities implemented and working days invested.**

#	Cap.	Statement	Capability Implemented	Implemented Since	Productization Stage	Setup resources description	Setup Hours	Running resources description	Running Hours	Stakeholders involved
<b>Requirements gathering</b>										
1	A	Requirements are being gathered and registered.	Yes	2001-2004	1		250		500	R&D, support, sales
2	B	All incoming requirements are stored in a central database, which is accessible to all relevant stakeholders.	No				0	70% in inforumup	0	
3	C	All incoming requirements are automatically stored in a central database (e.g. by means of an online helpdesk).	No				0		0	
4	D	Requirements are gathered from all relevant internal stakeholders: support, services, development, sales & marketing, research & development (parties not present in your organization can be ignored).	Yes	2006-2007	3		350		350	All
5	E	Customer's and prospect's requirements are being gathered and registered, and the customer or prospect is informed of the status of their requirements.	Yes	2010+	5		50		50	(Consultant, sales, customer)
6	F	Requirements are systematically gathered from partner companies.	No				0		0	
<b>Requirements identifying</b>										
7	A	Market Requirements are rewritten to Product Requirements using a pre-defined template if the Market	Yes	2006-2007	3	Create standard template for requirements	40		200	Consultants

		Requirement is applicable to a product.							
8	B	The correctness (“Is the definition correct?”), completeness (“Does the requirement describe all relevant aspects?”), and unambiguousness (“Can the requirement only be interpreted in one way?”) of the requirement is validated.	Yes	2001-2004	1		40	50	R&D, board
9	C	Market Requirements that describe similar functionality are grouped together by linking Market Requirements and Product Requirements to each other.	No				0	0	
10	D	Similar requirements are automatically connected by using advanced techniques such as linguistic engineering.	No				0	0	
<b>Requirements organizing</b>									
11	A	Product requirements are organized based on shared aspects (e.g. type, function, or core asset).	Yes	excel 2005 informup 2007 (2007-2009)	4	Requirements management tool (Informup) + implementation	160	300	R&D
12	B	A requirement’s history is logged by recording the submitter, submission date, change log, original description, current status (e.g. new, rewritten, validated, organized, scheduled for release X, tested, released in release X), etc. A requirement remains in the database after it has been built, so that it can be reused in a new or related product.	Yes	2007-2009	4	Requirements management tool (requirements organizing capability A(11))	0	80	R&D
13	C	Dependencies between Market and Product Requirements are determined and registered. A dependency exists when a requirement requires a specific action of another requirement. E.g. a requirement requires that another requirement be implemented too, or that another requirement is not implemented in case of conflicting requirements. This linkage can be supported by using advanced techniques, such as linguistic engineering.	No				0	0	
<b>Requirements prioritization</b>									
14	A	All relevant internal stakeholders are involved in prioritizing the requirements that should be incorporated in future	Yes	2006-2007	3	Setup Sheet	20	40	All

		releases.								
15	B	A structured prioritization technique is used (e.g. MOSCOW, Wiegers).	Yes	2010+	5	Setup Sheet Wiegers	20	same as A	40	All
16	C	Customers and prospects (or representatives thereof) indicate the requirements that should be incorporated in future releases by assigning priorities to the requirements from their point of view. Customers can also be represented in a delegation, select group of customers, or in other more manageable forms.	Yes	2006-2007	4		0	Meetings with customers	80	Customers (board)
17	D	Information about the costs and revenues of each (group of) requirement(s) is taken into account during the requirements prioritization (costs can be expressed in other means than money).	Yes	2010+	5		0	Same as A	40	All
18	E	Partner companies indicate the requirements that should be incorporated in future releases by assigning priorities to the requirements from their point of view.	(yes)		[5]		0	Same as A	0	
<b>Release definition</b>										
19	A	During requirements selection for the next release, constraints concerning engineering capacity are taken into account.	Yes	2006-2007	3		0		0	Board
20	B	A standard template is used to write the release definition. The release definition contains aspects such as an overview of the requirements that will be implemented, a time path, and the needed capacity.	Yes	2007-2009	4	Create template	0		32	R&D
21	C	The release definition is communicated to the internal stakeholders.	Yes	2006-2007	3	Created with internal stakeholders so Automatically	0		0	Board
22	D	The optimal release is automatically calculated based upon the constraints of the requirements. At least the engineering capacity, priorities, cost, requirement dependencies are all taken into account.	(yes)		[5]	Calculated by wiegers (wiegers Functionality)	0		8	
23	E	Multiple releases are included in the requirements selection process.	No				0		0	
<b>Release definition validation</b>										
24	A	The release definition is checked by	Yes	2006-2007	3	Automatically due to	0		8	Board

		internal stakeholders, before the software is realized.				composition of the stakeholders			
25	B	Approval standards are determined and verified by the board before the software is realized (turned over to development).	No				0	0	
26	C	A business case (including the ROI) is being written before the software is realized.	No			Sometimes for a specific part or as order by a customer	0	0	
<b>Scope change management</b>									
27	A	A formal scope change management process is in place, in which all involved stakeholders are informed.	No			Composition of the stakeholders	0	0	
28	B	Key dates and checkpoints are monitored in the product delivery.	Yes	2010+	5		0	16	R&D
29	C	The impact of problems is determined, and involved stakeholders are informed of the impact.	No			Composition of the stakeholders	0	0	
30	D	A process is in place to develop alternative plans, with all relevant stakeholders, to react to the effects of the scope change.	No				0	0	
<b>Release build validation</b>									
31	A	Internal stakeholders perform a functional validation of the build release to verify that it meets the expected outcome.	Yes	2005-2006	2	Setup test environment	0	Testing 20	R&D
32	B	The build is validated by external parties (customers, partners) to verify the builds quality (e.g. by settings up a pilot).	Yes	2005-2006	2	Setup test acceptance environment for customers	0	40	Customers
33	C	Certification by an independent external party is acquired for the release.	No				0	0	
<b>Launch preparation</b>									
34	A	Information about the upcoming new release is communicated to the internal stakeholders. This information contains a description of the most important changed and added features, the estimated release date, possible costs involved, information about how the new release can be obtained, possible training dates, etc.	Yes	2006-2007	3	Still some improvement needed	20	40	All
35	B	A formal 'go', based upon standard quality rules, must be obtained from the board before the launch can begin.	No			Not formal moment due to size of the company		0	



36	C	Information about the upcoming new release is communicated to the external stakeholders. This information contains a description of the most important changed and added features, the estimated release date, possible costs involved, information about how the new release can be obtained, possible training dates, etc.	Yes	2010+	[5]	Still some improvement needed	20	40	Sales, marketing
37	D	Trainings are organized and documentation is updated for both internal parties) and external parties to help educate them in the new release.	Yes	2006-2007	3	Setup documentation and online documentation/help	0	80	Support, consultants
38	E	The time needed to implement the new release at the individual customers is determined, and what type of experts are needed to perform the implementation (e.g. database experts).	Yes		[5]	Setup checklist (40-50 steps) 20 hours (database compare, update scripts, technical support and development)	20	80	Consultants
39	F	A checklist of all external expressions of the product (e.g. fact sheets, demo's, presentations) that may need to be updated by changes made in latest release of the product is created. The items are checked, and possibly updated before they are made available to external parties (e.g. customers, partners).	Yes		[5]	Project documentation, no checklist	0	40	Sales, marketing
<b>Roadmap intelligence</b>									
40	A	A plan is created showing which markets you will be going after and how you plan to develop the products for each segment. Eg., in year one you may plan to enter the automotive market by partnering with another company, or you may want to enter the pharmaceutical market in year two by building products in-house or acquiring products.	Yes	2007-2009	4		0	20	Sales, board (marketing)
41	B	An overview is created showing the big picture of important trends in society in the coming years. This picture contains a general view and a view specific for your products industry.	Yes	2007-2009	4	Not being used frequently	0	10	All
42	C	An overview is created showing the big picture of important developments in terms of technology in the coming years. This picture contains a general view and	Yes		[5]		0	20	All (R&D)

		a view specific for your products industry.								
43	D	An overview is created showing what competing products are doing in terms of their product development in the coming years. The general developments trends among your competitors are shown, and the developments of the most important competing products are depicted with special attention.	Yes	2006-2007	3	Not being used frequently	0	20	Board	
44	E	An overview is created showing what your partners will be developing the coming period. Examples of partner products are operating systems, development environments, database, etc. The overview shows what will be happening with the core platform software as well as what the partner organization will be delivering in terms of their own products and development tools that your organization can or will need to use to support the partner products/components.	no			Will be in the future	0	0		
<b>Core asset roadmapping</b>										
45	A	All core assets are registered in a standardized manner, and are stored in a central location.	Yes	2005-2006	2	Setup central location	0	Goes along with roadmap	10	R&D
46	B	Core assets are systematically identified among the organization's products and deliverables surrounding the product.	Yes	2005-2006	2		0		4	R&D
47	C	A process is in place to actively investigate make-or-buy decisions. This also includes the decision to outsource or subcontract development.	No			Cost and benefits, resource planning/ no formal process	0		0	
48	D	A roadmap is created for the core assets, which shows how they are sustained, upgraded, and enhanced. This roadmap contains both existing core assets, and core assets that are in development.	(yes)			No distinct roadmap for core assets yet	0		0	
<b>Product roadmapping</b>										
49	A	A roadmap is developed detailing the short-term plans. The plans span more than one release.is developed detailing the short-term plans.	Yes	2007-2009	4	Yes, but no separation between functional and technical	0	4x 2 hour meeting	8	Sales, marketing
50	B	Release themes are identified and	Yes	2010+	5	Yes, but no separation	0	Same as A	8	Board (All)

		maintained. Themes are decided on together with the internal stakeholders. Identification of the themes results in a list of release themes that are stored centrally, so that requirements, core assets, market trends etc. can be linked to it.				between functional and technical				
51	C	Product roadmaps are created in consultation with all relevant internal stakeholders.	Yes	2006-2007	3		0	Same as A	8	R&D, board
52	D	The roadmap spans a time period of at least four years.	No				0			
53	E	Less detailed variants of the internal roadmap are created for specific external parties (e.g. customers, partners, investors).	Yes	2010+	5	but not specific enough for customers, partners, etc.	0		4	Sales, marketing
<b>Market analysis</b>										
54	A	There is an active search for market opportunities to either expand existing products to, or create new products for. This search exists of doing market research in markets related to or similar to your organizations markets, visiting conferences, listening to customers, etc. All search findings are documented.	Yes	2006-2007	3		0	Fairs & events, branch organizations	16	Board, Sales, Partners
55	B	A plan is created showing which markets will be pursued and products for each segment can be developed. E.g., in year one, a company might plan to enter the automotive market by partnering with another company, or it may want to enter the pharmaceutical market in year two by building products in-house or acquiring products.	Yes	2006-2007	3	Is increasing and getting more specific	0		8	Sales, board (marketing)
56	C	A win/loss analysis is performed to research why customers chose or did not choose to buy your organizations products. This capability looks further than just the product features, e.g. the sales process is reviewed.	(Yes)			Is being performed occasionally, is getting performed and improved more	0		4	
57	D	A competitor analysis is performed on an organizational level to analyze what competitors offer, what their strengths are and are going to offer compared to your organizations.	Yes	2006-2007	3		0	Own network, Fairs & events, websites	32	Board, sales
58	E	External market research parties are used to perform a market analysis	Yes	2010+	5		0	By external parties	0	External parties

		specifically for the organization's product portfolio.							(sales, marketing)	
<b>Partnering &amp; contracting</b>										
59	A	(Standard) service level agreements (SLA's) are set up for customers.	Yes	2005-2006	2	Setup Standard agreement	16	Small adjustments	0	Sales
60	B	Measures are in place to protect the intellectual property of the own organization, and to manage the used intellectual property from other organizations.	Yes	2007-2009	4	IP of the company controlled by a separate foundation. IP used from other organizations is described in the standard agreement	16		2	none (external)
61	C	A process is in place to periodically verify the current distribution channels, and identify alternative distribution channels.	yes	2010+	5	Just started by collaboration with partners	0		0	Sales, marketing
62	D	A process is in place to establish the pricing model and periodically verify whether it still fits the market.	No			Price is adjusted each year, based upon customers	0		0	
63	E	A partner network and/or partner portals are used to regulate partnering. Key performance indicators are set up to monitor the performance of partners on a regular basis.	No				0		0	
<b>Product lifecycle management</b>										
64	A	The current life phase is determined, at least once per year, for each product in the organizations portfolio. This analysis is based on both financial and technical aspects. Information is thus gathered from all relevant internal stakeholders (e.g. company board, sales, development).	(yes)				0	Is determinate for each module individually, but no set session/ not regular	4	
65	B	A decision process is in place to decide whether or not to incorporate trends in one of the current products or in newly to be developed products.	Yes	2007-2009	4		0	Regularly, at new version/roadmap, feasibility is researched at each new version and planning meetings	4	Board, sales, consultancy, partners
66	C	A product scope analysis is performed to identify overlaps and gaps between the products in the organizations product portfolio.	Yes	2007-2009	4		0	Part of the planning module and back office module overlap, these are discussed in meetings but no standard process is in place	4	R&D

67	D	A business case is performed for major product revisions (revisions spanning multiple release) or when the product strategy is changed. We use Kittlaus & Clough (2009) definition in which a business case is the “comparison of the costs associated with the product or project to the quantified economic benefits or value to be derived”.	No		0	0		
68	E	Product lines are developed. The architecture of the product line is documented, and its goal is clearly defined. A software product line is defined as a set of software intensive systems sharing a common, managed set of features that satisfy the specific needs of a particular market segment or mission and that are developed from a common set of core assets in a prescribed way (Clements & Northrop, 2002).	Yes	[5]	4 product lines: 3 large customers, RSM standard (main features are documented)	0	8	Board
					<b>Total:</b>	1022	<b>Total:</b>	2328

## Appendix C

### Maturity matrices

Figure 17 to Figure 21 show the maturity matrices of stage 1 to stage 5 of the productization process in the case company.

#### Stage 1

Process \ Maturity	0	1	2	3	4	5	6	7	8	9	10
<i>Requirements management</i>											
Requirements gathering		A		B	C		D	E	F		
Requirements identification			A			B		C			D
Requirements organizing				A		B		C			
<i>Release planning</i>											
Requirements prioritization			A		B	C	D			E	
Release definition			A	B	C				D		E
Release definition validation					A			B		C	
Scope change management				A		B		C		D	
Build validation					A			B		C	
Launch preparation		A		B		C	D		E		F
<i>Product planning</i>											
Roadmap intelligence				A		B	C		D	E	
Core asset roadmapping					A		B		C		D
Product roadmapping			A	B			C	D		E	
<i>Portfolio management</i>											
Market analysis					A		B	C	D		E
Partnering & contracting						A	B		C	D	E
Product lifecycle management					A	B			C	D	E

: Capability is implemented in this stage
  : Capability is not implemented  
 : Capability is implemented in a previous stage
  : Capability is disabled

Figure 17: SPM maturity matrix in the first stage of the productization process.

## Stage 2

Maturity \ Process	0	1	2	3	4	5	6	7	8	9	10
<i>Requirements management</i>											
Requirements gathering		A		B	C		D	E	F		
Requirements identification			A			B		C			D
Requirements organizing				A		B		C			
<i>Release planning</i>											
Requirements prioritization			A		B	C	D			E	
Release definition			A	B	C				D		E
Release definition validation					A			B		C	
Scope change management				A		B		C		D	
Build validation					A			B		C	
Launch preparation		A		B		C	D		E		F
<i>Product planning</i>											
Roadmap intelligence				A		B	C		D	E	
Core asset roadmapping					A		B		C		D
Product roadmapping			A	B			C	D		E	
<i>Portfolio management</i>											
Market analysis					A		B	C	D		E
Partnering & contracting						A	B		C	D	E
Product lifecycle management					A	B			C	D	E

A : Capability is implemented in this stage      B : Capability is not implemented  
A : Capability is implemented in a previous stage      A : Capability is disabled

Figure 18: SPM maturity matrix in the second stage of the productization process.

## Stage 3

Maturity \ Process	0	1	2	3	4	5	6	7	8	9	10
<i>Requirements management</i>											
Requirements gathering		A		B	C		D	E	F		
Requirements identification			A			B		C			D
Requirements organizing				A		B		C			
<i>Release planning</i>											
Requirements prioritization			A		B	C	D			E	
Release definition			A	B	C				D		E
Release definition validation					A			B		C	
Scope change management				A		B		C		D	
Build validation					A			B		C	
Launch preparation		A		B		C	D		E		F
<i>Product planning</i>											
Roadmap intelligence				A		B	C		D	E	
Core asset roadmapping					A		B		C		D
Product roadmapping			A	B			C	D		E	
<i>Portfolio management</i>											
Market analysis					A		B	C	D		E
Partnering & contracting						A	B		C	D	E
Product lifecycle management					A	B			C	D	E

A : Capability is implemented in this stage      B : Capability is not implemented  
A : Capability is implemented in a previous stage      A : Capability is disabled

Figure 19: SPM maturity matrix in the third stage of the productization process.

## Stage 4

Maturity \ Process	0	1	2	3	4	5	6	7	8	9	10
<i>Requirements management</i>											
Requirements gathering		A		B	C		D	E	F		
Requirements identification			A			B		C			D
Requirements organizing				A		B		C			
<i>Release planning</i>											
Requirements prioritization			A		B	C	D			E	
Release definition			A	B	C				D		E
Release definition validation					A			B		C	
Scope change management				A		B		C		D	
Build validation					A			B		C	
Launch preparation		A		B		C	D		E		F
<i>Product planning</i>											
Roadmap intelligence				A		B	C		D	E	
Core asset roadmapping					A		B		C		D
Product roadmapping			A	B			C	D		E	
<i>Portfolio management</i>											
Market analysis					A		B	C	D		E
Partnering & contracting						A	B		C	D	E
Product lifecycle management					A	B			C	D	E

A : Capability is implemented in this stage     
 B : Capability is not implemented  
C : Capability is implemented in a previous stage     
 D : Capability is disabled

Figure 20: SPM maturity matrix in the fourth stage of the productization process.

## Stage 5

Maturity \ Process	0	1	2	3	4	5	6	7	8	9	10
<i>Requirements management</i>											
Requirements gathering		A		B	C		D	E	F		
Requirements identification			A			B		C			D
Requirements organizing				A		B		C			
<i>Release planning</i>											
Requirements prioritization			A		B	C	D			E	
Release definition			A	B	C				D		E
Release definition validation					A			B		C	
Scope change management				A		B		C		D	
Build validation					A			B		C	
Launch preparation		A		B		C	D		E		F
<i>Product planning</i>											
Roadmap intelligence				A		B	C		D	E	
Core asset roadmapping					A		B		C		D
Product roadmapping			A	B			C	D		E	
<i>Portfolio management</i>											
Market analysis					A		B	C	D		E
Partnering & contracting						A	B		C	D	E
Product lifecycle management					A	B			C	D	E

A : Capability is implemented in this stage     
 B : Capability is not implemented  
C : Capability is implemented in a previous stage     
 D : Capability is disabled

Figure 21: SPM maturity matrix in the fifth stage of the productization process.



## **Appendix D (Confidential)**

<Confidential>