# Development of a Continuous Improvement Maturity Model Assessment Instrument

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**Maturity models are increasing in popularity in order to gain and retain competitive advantage. The Continuous Improvement Maturity Model is one of these maturity models. It provides best practice methods and techniques as well as the mindset, skill set and tool set of process improvement. However, it does not indicate the current maturity status of an organization. Knowledge on the maturity status and progress made is needed to consolidate and further improve the maturity of an organization. The developed Continuous Improvement Maturity Model Assessment is a research-based instrument which helps users to make an objective assessment of their organization's maturity. It is designed to be used by any manufacturing organization. The instrument followed a series of iterations and was moderated and validated based on multiple case studies and semi-structured interviews with experts.**

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**Keywords**
Maturity models, Process Improvement, Continuous Improvement Maturity Model, Assessment instrument, Design science research.



*5th IBA Bachelor Thesis Conference*, July 2nd, 2015, Enschede, The Netherlands.

# 1. INTRODUCTION

Over the past decades firms are experiencing a growing pressure to gain and retain competitive advantage. Thus improving quality, cutting costs, reducing time to market, and so on are increasingly important (De Bruin, Freeze, Kaulkarni, & Rosemann, 2005). Hence, organizations need to improve processes continuously. Organization undergo changes and refinements in order to increase their ability to deal with the requirements and expectations of their market and stakeholders (Lepmets, McBride, & Ras, 2012). Maturity models are an increasingly popular and important tool as they support organizations in this endeavor.

Although there is no scarcity of maturity models, there is no set definition (Bititci, Garengo, Ates, & Nudurupati, 2014). However, it is clear that the models are used as an evaluative and comparative basis for improvement (Fisher, 2004; Harmon, 2004; Lee, Lee, & Kang, 2007) and provide an informed approach to improve capabilities within an organization (Ahern, Clouse, & Turner, 2004; Lee et al., 2007). Process maturity models provide organizations with a framework and various best practice methods and techniques in order to reach different maturity levels. These levels represent thresholds, indicating a more capable, mature organization (Lockamy III & McCormack, 2004).

Since the Capability Maturity Model (CMM), developed by the Software Engineering Institute at Carnegie Mellon University, started its legacy (Bititci et al., 2014; Paulk, Curtis, Chrissis, & Weber, 1993) maturity as a measure to evaluate the capabilities in regard to a certain domain became popular (De Bruin & Rosemann, 2005; Paulk et al., 1993). Numerous maturity models emerged in multiple management research fields like business process management, performance management, information technology, knowledge management and project management (Bititci et al., 2014; De Bruin et al., 2005). All claiming to guide the organization through the process of building levels of maturity that lead to competitive advantage (McCormack et al., 2009).

As mentioned, maturity models are high in numbers and broad in application. Some models, like the Continuous Improvement Maturity Model (CIMM), aim to provide a holistic approach. CIMM is a relatively new model and is an open standard, developed and maintained by the Lean Six Sigma Academy (LSSA). The model incorporates not only the best practices methods and techniques of process improvement, quality management and new product development, but also the mindset, skill set and tool set for process improvement. This framework is therefore valuable as it guides organizations through the maturity levels of structured, managed, predictable, and capable to eventually become a world class organization (Theisens, 2014). It is argued that CIMM provides a comprehensive process improvement framework, of which each maturity level is outlined by Theisens (2014). However, there is little theoretical understanding on how the various maturity levels could be assessed.

Knowledge on maturity models and their assessment instruments is scattered. Various research concerning maturity models has been done. Röglinger, Pöppelbuß, and Becker (2012), Harmon (2009), and Rosemann and vom Brocke (2015) for instance compared various business process management maturity models. However, limited research has been done focusing on comparing the assessment instruments of maturity models. It is very likely that various studies can be used as a basis for a comprehending CIMM assessment. Presently there is a gap between the desired and actual theoretical base and thus utility of CIMM. This is especially important since Bititci et al. (2014) demonstrated that maturity models can enable efficient and effective assessment of the performance management practices. Assessment is thus valuable as it forms the basis of the utility of maturity models in supporting organizations to attain competitive advantage.

Therefore the goal of this paper is to answer the following research question: What is a valid Continuous Improvement Maturity Model assessment instrument?

Based on the given research problem several sub questions are derived: (1) Which assessment instruments do various maturity models use? (2) What are the key elements of the Continuous Improvement Maturity Model? (3) What should a CIMM assessment look like?

During the literature review studies specifically concerning various maturity model assessments and the applicability of these assessments for CIMM have been identified. Instruments used range from an informal approach by using a checklist (Harmon, 2004), a simple but useful matrix (Fisher, 2004), to an elaborate appraisal over the time span of a multiple months (SCAMPI, 2011). This paper aims to contribute to existing literature and knowledge by providing comparisons of existing maturity models, with a focus on their assessment instruments. With this literature base a design science research method is used to develop a valid CIMM assessment instrument; enabling a useful maturity model for both theoretical and practical applications.

In order to answer the research question this paper first provides an overview of maturity models with a focus on their assessment instruments. Furthermore this part elaborates on CIMM and the key elements it encompasses. The second part will elaborate on the methodology used for the design and evaluation of the assessment instrument. Next the results of the interviews are outlined in the Analysis. This is followed by the main findings and implications in the conclusion. Lastly, the paper outlines the limitations of the study and future research.

# 2. THEORETICAL FRAMEWORK

In this section, underlying theories and existing scientific knowledge is explained and evaluated. It will provide necessary information that contributes to answering the research question. First, a critical review on existing literature concerning various assessment instruments of maturity models is presented. The last part will elaborate on CIMM.

## 2.1 Maturity Models Assessment Instruments

The literature sample was focused around maturity models which addressed processes, as this is the focus of CIMM. Various studies provided a basis of maturity models for consideration. For instance, Rosemann and vom Brocke (2015) compiled a list of nine maturity models from the Business Process Management field. Röglinger et al. (2012) build on this research and compared ten maturity models. The sample only considered maturity models that had been published in English language, did not refer to a specific process type, and for which a reasonable amount of documentation on the assessment instrument was freely available. Some maturity models are not publicly accessible in their complete version (e.g. including detailed assessment criteria and guidelines). This is especially the case for maturity models that are considered as intellectual property by consulting companies and research institutes who sell the service of maturity assessments to organizations (Willaert, Van den Bergh, Willems, & Deschoolmeester, 2007). The models of the sample differ i.a. regarding their maturity

levels, structure, and also representation. Some adopt a one-dimensional linear presented maturity, while others adopt a stage gate presentation (De Bruin et al., 2005).

### *2.1.1 One-dimensional linear presented maturity models*

Most maturity models represent maturity as a series of one-dimensional linear stages. This concept formed the basis of assessment in many existing tools and is widely accepted (De Bruin et al., 2005). In this approach maturity is assessed as an 'average' maturity level instead of having detailed layers for each maturity level in addition to an overall assessment, as is the case with a 'stage-gate' representation (De Bruin et al., 2005). A widely adopted and recognized model is the Capability Maturity Model Integration (CMMI) (Ahern et al., 2004). In this model higher levels build on lower levels of maturity. Organizations can assess their CMMI process maturity by undergoing an 'appraisal' - which is done according to the Standard CMMI Appraisal Method for Process Improvement (SCAMPI). There are three classes of SCAMPI appraisal: A, B, and C. Of which SCAMPI A is the most rigorous method and the only class that provides the organization with a maturity level ranking. The first phase of class A appraisal consists of various months of planning and preparing. During this phase requirements are established, the appraisal plan is developed, the appraisal team assembled and prepared, and initial objectives are defined. During the second phase the appraisal will be conducted. Finally, during the last phase the results of the appraisal are reported (SCAMPI, 2011). Class B encompasses a less comprehensive appraisal. It is an initial and partial self-assessment. Lastly, class C provides just a quick look, it checks for specific risk areas (Ahern et al., 2004).

Although CMMI is software-oriented Paulk et al. (1993) concluded that higher maturity led to increased process capability of the organization. However, CMMI is not suitable as a Business Process Management Maturity (BPMM) because of the differences between the context of software and business process. However, CMMI does form a useful base of a majority of Business Process Maturity Models. For instance, Harmon (2004) developed a model based on CMMI, the Process Maturity Ladder (PML) – in which maturity levels range from initial, repeatable, defined, and managed to optimizing. Here the maturity assessment is done in an informal and brief manner. It includes a quick assessment based on just a few checklists and a worksheet. The primary purpose of this assessment is not to be as rigorous as CMMI, but for people within the organization to starting thinking about the processes.

Likewise Weber, Curtis, and Gardiner (2008) describe the Business Process Maturity Model for the Object Management Group (BPMM-OMG) with roots in CMM and CMMI. The model guides organizations in moving from immature, inconsistent processes to mature, disciplined processes. It provides best practices to grow through the maturity levels initial, managed, standardized, predictable, and innovating. For each maturity level, except the first one, process areas are described. Goals are set for the various process areas and their achievements form the measurement of the maturity levels. To achieve a maturity level, the process areas for that maturity level must be satisfied (or be not applicable) and the processes must be institutionalized. Measurement is performed at all levels of the organization - at the individual, workgroup, project, work unit, unit, organization, and organizational levels and is done using an organizational specific adoption of the provided Process Area Templates.

### *2.1.2 Stage gate presented maturity models*

Although one-dimensional models provide relatively simple means to compare maturities it does not always provide an organization with the guidance to improve the current situation, especially since organizations deal with various complex domains. An alternative representation of a model is the so called 'stage-gate' approach. This enables the organization to differentiate maturity assessments within complex domains and provides assessment reports tailored to the needs of a varied audience (De Bruin et al., 2005).

Fisher (2004) for instance uses a multidimensional, non-linear model. Although based on CMMI his BPMM model (for further referencing this model will be indicated with BPMM-Fisher) combines the 'five levers of change' with five stages of maturity. His model is, in comparison with other models, more about alignment. Assessment of this model is done in a matrix, presenting the core characteristics of each Lever of Change, (i.e. strategy, controls, people, technology, and process) in the context of each maturity state (i.e. siloed, tactically integrated, process driven, optimized enterprise, and intelligent operating network). The maturity state thus encompasses the extent to which the five levers of change are aligned. Organizations can quickly assess where they stand and find some details to identify specific opportunities for growth-oriented actions. This assessment has an advantage in that it is comprehensible and quick. However it does not provide a very rigorous assessment.

Another example of a stage gate model is the BPMMM of Rosemann and De Bruin (2005) (BPMMM). Their model has the advantage of being supported by surveys and case studies they completed. It measures the business process management maturity of the organization and includes quantitative measures of 'coverage' and 'proficiency', which are similar to effectiveness and efficiency. For both quantitative measures three criteria are determined and assessed using five-point scale questions. Furthermore five factors were determined, i.e. IT/IS, culture, accountability, methodology, and performance. These are specific, measurable and independent elements which reflect fundamental and distinct characteristics of BPM. The basis for these factors was found in literature on critical success factors or barriers to the successful implementation of BPM. The five maturity levels of the model are: initial, defined, repeatable, managed, and optimized. These levels are determined for each of these factors, one based on the criteria for coverage and one based on the criteria of proficiency. Although these maturity levels are quite similar to those of CMMI they are more comprehending in order to reflect the specific requirements of BPMM. The assessment is presented as a cube, with the maturity levels and factors forming a matrix and an extra dimension including the scope (organizational entity and time). Assessment is done by a self-assessment survey and a third party. This approach is similar to the continuous representation of the CMMI model (Ahern et al., 2004). Benefits of the assessment of this comprehensive model of Rosemann and De Bruin (2005) include the quantitative measures as it enables organizations to better understand their maturity, target improvement strategies, reduces individual interpretation and enables consistent application. However, because of the complex three dimension structure the model could be perceived as confusing.

Another model is the excellence model created by the European Foundation for Quality Management (EFQM) (Bou-Llusar, Escrig-Tena, Roca-Puig, & Beltrán-Martín, 2009). This model has the advantage of being applicable to any organization and is widely acknowledged and applied. Although the model does not encompass different specific maturity levels it supports

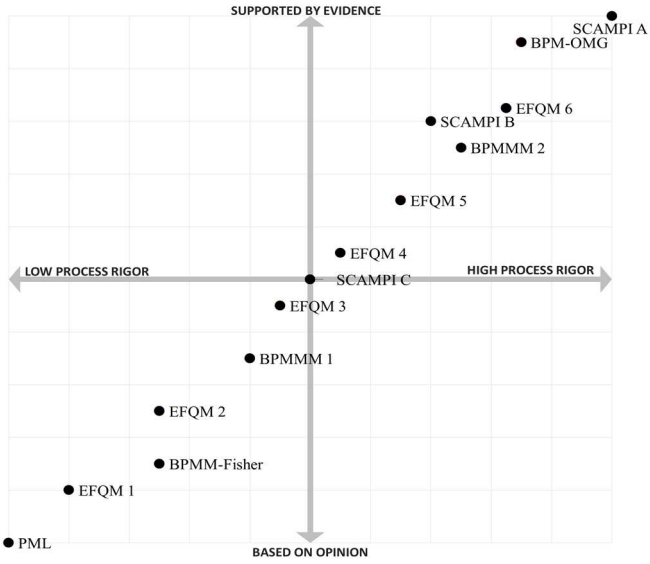
organizations to reach excellence, which can be seen as becoming mature. The EFQM Excellence Model consists of nine fundamental concepts, grouped under five enabler criteria (leadership, people, strategy, partnerships and resources, and processes, products and services) and four result criteria (people results, customer results, society results, business results) (EFQM, 2013). Various self-assessment tools are provided. Based on knowledge, time and resources available and the detail of outcome desired an organization can decide on which tool(s) to apply. Options consist of a simple self-assessment, various questionnaires, EFQM quick check, EFQM business excellence matrix, EFQM excellence matrix, and site visit simulation. The later tools encompass more process rigor and are more supported by evidence. For example, more evidence based instruments include information about results of the organization while less evidence based instruments are very subjective frameworks which are completed by just one person. Besides the self-assessment options an independent EFQM validator can complete interviews and review the organization.

### *2.1.3 Overview of the described maturity model assessment instruments*

An overview of the maturity models sample including each maturity model's assessment instrument(s), as well as short descriptions of these assessment instruments and the findings of these instruments is presented in appendix A. The maturity assessment findings serve as a good indicator of what the main goal of the assessment is. This brief overview of maturity model assessments in the area of process improvement has shown that some models focus on an extensive and precise assessment (e.g. SCAMPI A, the third party assessment of BPMMM, and some instruments of the EFQM), while other maturity models use a more general assessment focusing on awareness and/or discussion within the organization. All assessments however start with a less rigorous assessment and then do or do not extent their precision with a more in-depth analysis.

The instruments used differ in the extent to which they are supported by evidence and their rigor – as can be seen in graph 1. This framework is an adoption of the presentation of the various EFQM (2013) instruments. It gives a subjective but clear comparison of the instruments of the various maturity models. There is a distinct linear consideration between process rigor and evidence support. Some instruments have a focus on a general, first indication of the maturity level of an organization (e.g. PML, EFQM 1, BPMM-Fisher). Other instruments are very time consuming and precise and therefore result in a high rigorous assessment based on evidence within the organization (e.g. SCAMPI A, BPM-OMG, EFQM 6). These instruments are more elaborate, often include large assessment teams, are time consuming, and include an internal as well as an external assessment. Furthermore there is a large amount of instruments which is situated between these two distinctions (e.g. BPMMM 1, EFQM 4, and SCAMPI C). It can be noticed that the chosen representation of the maturity model (i.e. a one-dimensional linear or a stage gate representation) does not influence the process rigor or evidence bases of the assessment instrument. Decisions made, on the extent of the process rigor and the evidence base, seem to fully depend on the purpose of the assessment instrument. For instance, while the PML checklists aim to start awareness and a thinking process about maturity within the organization the SCAMPI A assessment is meant to be used as a benchmark maturity score. Confirming the statement of De Bruin et al. (2005) that in order to meet audience needs, appropriate balances have to be made. The next section will describe CIMM which underpins the usefulness of a dedicated CIMM assessment instrument.

**Graph 1. Maturity model assessment instrument framework (Adaption of EFQM (2013))**




## 2.2 The Continuous Improvement Maturity Model (CIMM)

### *2.2.1 The model*

Theisens (2014) clarifies that the basis of process improvement are the interlinked areas of People, Process, and Product. People and Product are respectively supported by leadership and competences, innovation and quality. These four different components support the organization to improve its processes in order to fulfil its strategy. Processes are therefore the focus of CIMM. The model includes best practices from TQM, Kaizen, TPM, Lean, Six Sigma and Design for Six Sigma. Choosing the right focus area for improvement depends on the actual maturity level of the organization. CIMM guides organizations in this endeavor towards a more mature organization. The model deviates from other models in that the maturity levels are slightly different and CIMM includes and structures the best practices methods and techniques as well as the mindset, skill set and tool set for process improvement.

### *2.2.2 Maturity levels*

CIMM is a one-dimensional linear presented maturity model. It consists, as most maturity models, of five maturity levels and proposes an 'evolutionary staged approach' (Theisens, 2014). This means that higher levels of maturity build on lower levels and that each level should be sustained while moving on to the next one. The maturity levels are: structured, managed, predictable, capable, and world class – as shown in figure 1.

The first maturity level aims for a proper and organized working environment, reliable equipment and standardized work. This level builds a solid foundation for further improvements. The next level—managed—is about creating a continuous improvement culture. This culture should include proactive problem solving, following the philosophy of Imai (1997) and focusses on the organization of the workplace. The importance of making constant small improvements steps is highlighted and continuous improvement projects are carried out to improve for instance the standards developed in the first maturity level. Once the organization reached this level it can move on to the next maturity level, "predictable". This third level creates stable and efficient processes with a predictable outcome in order to be reliable. Optimizing logistics is the main activity as this avoids incidents, stress, downtime, quality spills,

mistakes etc. An organization can then predict what will happen and knows what can be promised to the customer. The fourth maturity level is "capable", here capable processes are created. Reducing variation of the processes is at the core of this level by executing large quality breakthrough improvement projects. The fifth and last maturity level is labelled "world class". Here the focus from improving the current situation shifts to a proactive approach, where products are developed which meet the expectations of clients and no production problems occur. Overall, the model with its various levels guides the organization in defining the most appropriate improvement plan for the situation of the organization. (Theisens, 2014)

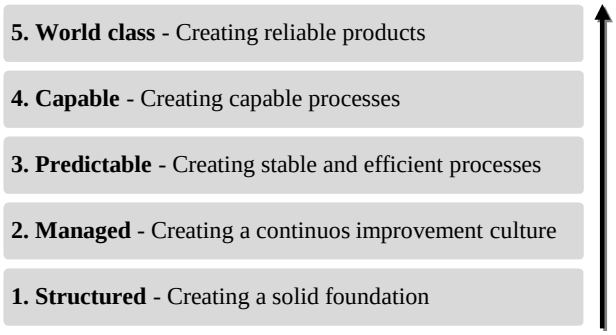



**Figure 1. CIMM Maturity levels (adapted from Theisens (2014, p. 35))**

### *2.2.3 Identification and operationalization of the CIMM key elements*

The CIMM levels are non-related, for the exception that they build on each other. Each level is determined by different key elements instead of improving various key elements throughout the five levels. This means that each maturity level encompasses different key elements which, when fully implemented within the organization, indicate the fulfilment of that specific CIMM maturity level.

The list of tools, techniques, and theories which are and could be included in the model and the instrument is almost endless. Therefore decisions had to be made. Key elements were chosen on the basis of their relative contribution to the ultimate goal of the specific CIMM levels according to Theisens (2014) and other literature, and the extent to which these elements and their terms are widely known. The key elements of each maturity level are shown in figure 2.

The aim of the first key element of the maturity level "structured" (Theisens, 2014, P. 95-104) is to enable an organized work environment. The theory behind this is that a tidy workplace leads to quality and that quality is the starting point of every improvement. This key element builds on the concept of 5S. The 5S framework was originally developed by Osada in the early 1980s. Although diverse translations of the Japanese words are used, they all come down to the following steps: sort, set in order, shine, standardize, and sustain (Chapman, 2005; Gapp, Fisher, & Kobayashi, 2008). While an additional S for safety is sometimes added to the model, implementation of 5S already includes significant decreases in industry accidents (Gapp et al., 2008). Therefore it is argued that safety is an unnecessary addition. The second key element, standardized work, has overlapping elements with 5S. However, this key element specifically focusses on processes within the organization instead of focusing on the environment of the workplace. Standardization is defined as the degree to which task activities are specified in detail and the extent to which Standard Operating Procedures (SOPs) are defined, followed, and improved (Van de Ven, 1976). The last key element of this maturity level is quality control and quality assurance. This key element assures that customers are satisfied by meeting their demands and legal requirements (Theisens, 2014). However, this does not mean that every product produced has to fulfill a high quality standard, it means that the organization has to make sure that only good quality products are delivered to the customers.

The second maturity level (Theisens, 2014, p. 107-125) is built around Kaizen, the Japanese word for improvement. This philosophy of Imai (1997) is a bottom-up approach aiming to establish many small improvements and is often defined as being a key element in Japanese manufacturing success (Paul Brunet & New, 2003). It is structured around the five key principles of Kaizen: creating commitment for all, following standards, good work morale, following the Plan, Do, Check, Act (PDCA) improvement cycles, and being receptive to new ideas and suggestions for improvement (Imai, 1997). An important element to achieve this is the visual workplace. It helps operations to reduce waste and to maintain improvements over a long time (Theisens, 2014). This element encompasses "a self-ordering, self-explaining, self-regulating, and a self-improving work environment where what is supposed to happen happens on time, every time, because of visual devices" (Galsworth, 2004, p. 44). The visual workplace manifests itself through many attributes. These may include work instructions, labels colors, signs, lighting, and presentation of tools through shadow boxing (Kattman, Corbin, Moore, & Walsh, 2012). Another key element is Short Interval Management (SIM). This element corresponds with the basic idea of many small improvements of the Kaizen philosophy. It is a shop floor process that engages individuals to assess whether they are still on track to meet the targets established for the day (Theisens, 2014). Stand-up meetings can be used to review performance of the previous interval and to discuss the targets of the next interval. Key Performance Indicators (KPIs) are essential to monitor the performances. The last key element of this level is Work in Process (WIP) control. This element increases the proportion of value-added time, and thereby reducing Lead time, costs etc. (Arnheiter & Maleyeff, 2005).

The core principle of the third maturity level is that management should be based on facts. Therefore the first key element is Lean management. Nowadays Lean management is one of the most popular programs (Arnheiter & Maleyeff, 2005). Various Lean performance measures exists, e.g. takt time, cycle time, lead time, process time, and Work In Process. All measurements relate to time and/or quantities. These metrics need to be measured over time and relate to KPI's in order to classify the performance against a maximum or a certain goal (Theisens, 2014). To create stable and efficient processes an organization needs to map its processes. Process mapping is a proven analytical and communication tool (Hunt, 1996) which supports the understanding of organization's processes. It makes it easier to determine where and how to improve the processes (Soliman, 1998). Process mapping encompasses the following steps (1) Defining, mapping and prioritizing the processes (2) Transforming the data of the processes into visual representation in order to identify bottlenecks, wasted activities, delays and duplication of efforts (3) Defining and operationalizing process-specific objectives (4) Continuous communication of the objectives (Hunt, 1996; Soliman, 1998). Process mapping often precedes one of the key technique of Lean management, which is Value Stream Mapping (VSM). VSM aims to identify and eliminate waist and does so by analyzing the series of activities to manufacture a product in a focused manner (Hines et al., 1998; Rother & Shook, 2003). Various tools are available for VSM, but all

come down to mapping the various activities, identifying the wastes to be reduced, and identifying and executing improvements to reach the desired future value stream (Hines et al., 1998). With other words, it supports the key element: eliminating waste and creating flow. This level thus encompasses Lean projects to improve the processes within an organization. Projects of this kind regularly follow the Define, Measure, Analyze, Improve, and Control (DMAIC) roadmap as it helps eliminating unproductive steps. Another key element to create stable and efficient processes is to focus on the effective and efficient use of equipment by employing Total Productive Maintenance (TPM). This is a unique Japanese philosophy and was first introduced by M/s Nippon Denso Co. Ltd. of Japan, a supplier of M/s Toyota Motor Company. Total Productive Maintenance is an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns and promotes autonomous maintenance by operators through day-to-day activities involving total workforce (Bhadury, 2000). Although various TPM frameworks exist, the main accepted one consists of eight best practices. These are: autonomous-, focused-, planned-, and quality maintenance, education and training, safety health and environment, office TPM and lastly, development management (Ahuja & Khamba, 2008).

The fourth maturity level (Theisens, 2014, p. 192-280), "capable", includes the key elements: reducing variation, statistical analysis, and applying the organized and systematic project-driven Six Sigma approach. The Six Sigma approach is gaining wide acceptance in industries (Linderman, Schroeder, Zaheer, & Choo, 2003). The fundamental purpose of Six Sigma is strategic process improvement and relies on statistical methods and scientific methods to make dramatic reduction in customer defined defect rates. (Antony, Escamilla, & Caine, 2003; Kwak & Anbari, 2006; Linderman et al., 2003). Also Six Sigma projects usually use the DMAIC process which eliminates unproductive steps and aims for continuous improvement (Kwak & Anbari, 2006). This process is therefore suitable for CIMM and enables the structuring of the key elements of the fourth maturity level. An important element in any Six Sigma improvement effort is determining exactly what the customer requirements are and then defining defects in terms of their Critical To Quality (CTQ) parameters (Linderman et al., 2003). CTQs parameters are the key measurable characteristics of a product or process of which the performance specifications meet the customer requirements. Therefore customer requirements have to be defined and understood. The CTQs must interpret these qualitative statements to a manageable quantitative business specifications (He, Tang, & Chang, 2010). After the defining phase the next important step is to measure and analyze the project. The goal of this phase is to measure the process to satisfy the customer needs, collect and analyze required data, determine and analyze variations within the process and define opportunites for improvement (Kwak & Anbari, 2006). This can be done using various Six Sigma performance metrics and Measurement System Analysis (MSA), which assures valid and reliable data (Theisens, 2014). Lastly, in the Improve and Control phase the variations have to be eliminated or reduced and a strategy and system has to be in place to minotor and control the improved process (Kwak & Anbari, 2006). Six Sigma tools and techniques used in this phase are for instance Design of Experiments (DOE), which considers variables simultaniously, and Statisical Process Control (SPC), which establishes the detection of variation.

The last maturity level, "world class", (Theisens, 2014, p.283 – 302) aims to develop products that will meet customer expectations. A key element of this level is Product Lifecycle Management (PLM). This is a business solution which streamlines the flow of all available data throughout the product's lifecycle – i.e. development, growth, maturity, and decline. It states that the right information should be available to everyone within the organization, in the right context and at the right time, as this will result in a successful introduction of the products in the market (Ameri & Dutta, 2005; Sudarsan, Fenves, Sriram, & Wang, 2005; Theisens, 2014). A closely related method, as both methods reduce failures during product launch, is Design for Six Sigma (DfSS). DfSS has been used and proven successful at for example Dow Chemical (Buss & Ivey, 2001), Delphi Automotive (Treichler, Carmichael, Kusmanoff, Lewis, & Berthiez, 2002), and General Electrics (Weiner, 2004). This powerful approach aims to involve "the utilization of powerful and useful statistical tools to predict and improve quality before building prototypes" (Shahin, 2008). The goal of DfSS is to achieve minimum defect rates, a six sigma level, and maximize positive impact during the development stage of the products (Kwak & Anbari, 2006). DfSS has no one standard methodology that organization follows. However, often the Define, Measure, Analyze, Design, and Verify (DMADV), or the Identify, Design, Optimize and Validate (IDOV) approach (Antony & Coronado, 2002) is followed. Critical Parameter Management (CPM) is at the core of DfSS and this maturity level. CPM is the disciplined and focused attention to the design's function, parameters, and responses that are critical to the fulfillment of the customers needs (Creveling, Slutsky, & Antis, 2002). This level furthermore includes the key element: reliability engineering. This element focuses on examining and optimizing the reliablity of a product or system so that it is capable of fulfilling its desired functions. Various techniques and methods are avalailable for this, e.g. Failure Mode and Effects Analysis and maintenance management. A key element which is not incorporated in the model but important and described and by Theisens (2014) is risk management. As many tools regarding this element have already been used in lower maturity levels (e.g. MSA and process flow diagrams) the focus in this level is on Design Failure Mode and Effect Analysis (Design FMEA). This tool extends the risk prioritization beyond the conventional risk priority number (RPN) method, it aims to maximize design quality, reliability, minimize costs, and maintainability (Stamatis, 2003).

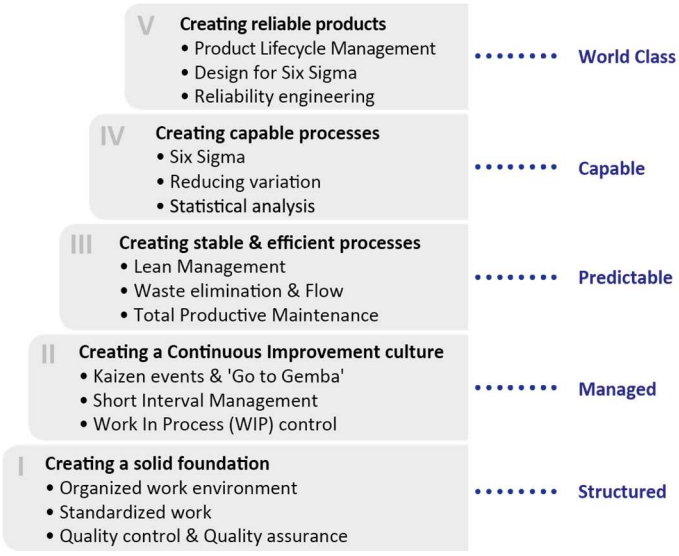



**Figure 2. Continuous Improvement Maturity Model (Theisens, 2014, p. 35)**

# 3. METHODOLOGY

Chapter 1 identified several research issues and the introduction to the methodology; this chapter describes the methodology used to provide data to investigate them, aims to build on that introduction, and to provide assurance that appropriate procedures were followed.

## 3.1 Design Science Research

In order to answer the research questions posed and due to the exploratory and constructing nature of enquiry, a design science research was adopted. According to March and Smith (1995) the design and evaluation are the two main activities of design science. These activities were therefore used as steps to develop and continuously improve the CIMM assessment instrument.

The development of the CIMM assessment instrument followed a deductive approach. This was especially appropriate since De Bruin et al. (2005) argue that a review of existing literature can result in a comprehensive list of questions for the assessment of a maturity model. Additionally Hevner (2007) uses literature as a knowledge base in order to design an artefact. The assessment was afterwards evaluated and improved based on multiple case studies and qualitative research. This research was done in collaboration with Symbol BV as various consultants of this organization provided input and feedback for the development of CIMM and this organization is actively aiding various organizations with the implementation of the model.

### *3.1.1 Design*

The design of the assessment instrument was affected by three main requirements. First, the assessment had to be appropriate for any organization within the manufacturing industry as this industry is more actively establishing process improvement at this moment and differs to a great extent from the service sector. Hence, this instrument is specifically aimed at this industry, and not tested in other industries. Therefore the external validity is limited. While the general census of this instrument is generally applicable, some specific measures will need to be varied across industries to accommodate differences, e.g. the TPM key element is not fully applicable in the service sector as there is no production. Second, the instrument had to indicate the progress status of the organization at each maturity level as well as provide an overall maturity indication. Lastly, the instrument aimed to be an initial, fairly evidence based assessment with a minimal process rigor (i.e. it had to be in the right upper quadrant of graph 1).

It was decided to develop an excel-based questionnaire as assessment instrument for the CIMM. This is especially appropriate since this method is used by multiple, different, but comparable maturity models (Ahern et al., 2004; EFQM, 2013; Rosemann & De Bruin, 2005) with comparable assessment goals. Furthermore, questionnaires can function as quantitative, descriptive research (Korzilius, 2000) which suits the purpose of the instrument, i.e. to assess the current maturity level of an organization. The instrument takes the form of three excel sheets. The first sheet includes a short explanation on how to complete the assessment. The second sheet encompasses the questionnaire and the last sheet presents the results of the questionnaire in a table and visualizes it in a graph.

The CIMM assessment instrument consists of various statements providing the respondent with the option to assess the extent to which these statements are reflected within the organization on a five-point Likert scale (1- this statement is not reflected within my organization, 5- this statement fully reflects the situation within my organization). A number of reasons account for the use of these scales. First, these scales communicate interval properties to the respondents, and can therefore be assumed to be an interval scale (Schertzer & Kernan, 1985). Furthermore, this scale is widely used and increasing the precision of measurement does not result in more reliable or valid results (Matell & Jacoby, 1971). Also, these scales are used in a variety of other maturity model assessment instruments, e.g. the assessment on continuous improvement by Caffyn (1999). The statements of the assessment were based on the in-depth literature review of the various CIMM key elements. This provided knowledge on theories, tools, techniques, and steps used to eventually reach the key elements and therefore the goals of the maturity levels. For each key element the eventual aim was determined and translated into statements representing the specific key steps or elements needed. The assessment instrument is structured along the five maturity levels as this best fits the structure of CIMM. This however potentially causes subject bias due to possible prior ideas or knowledge on their organization's maturity level. However, as the statements are clearly and specifically linked to key elements and the subjects have no personal interest in the assessment result it is argued that this bias is minimal. The structure therefore suits the purpose of this assessment.

### *3.1.2 Evaluation*

After the instrument had been designed and followed a series of iterations by advice of an expert practitioner it was evaluated to further mitigate construct validity issues. A multiple case studies approach was used because the concept of the different levels under study are abstract and their boundaries are still unclear (Rowley, 2002). Furthermore semi-structured interviews were held with an additional purposive sample, including two consultants of Symbol BV.

#### *3.1.2.1 Data collection*

**Organizations**

Two organizations, both clients of Symbol BV, were chosen in order to evaluate the designed assessment instrument. Of each organization a manager was interviewed in order to explore and understand their opinions on the assessment instrument. Additionally, after suggested adjustments had been made, managers were asked to complete the questionnaire after which their maturity result was confirmed by the responsible consultant of Symbol BV.

**Table 1. Sample information**

| Organization | Function | Client since |
|---|---|---|
| Fresenius Hemocare Nederland | Organizational Change and Continuous Improvement Manager | January 2013 |
| Sealed Air Diversey Netherlands Production B.V. | Production Manager | January 2015 |
| **Organization** | **Function** | **Employee since** |
| Symbol BV | Consultant | September 2008 |
| Symbol BV | Consultant | March 2013 |

The semi-structured interviews were conducted at the manager's office between May and June 2015, and lasted between one to two hours. It is argued that the selected managers have a comprehensive understanding of the maturity within the organization. As their prior involvement with the model enables well informed interview results, as sufficient knowledge and experience lead to informed responses (Saunders, Lewis, & Thornhill, 2011). The interviews started by explaining the aim of the assessment after which each level was read and commented on by the interviewee. The interview further explored: ideas on possible use of the instrument; comparisons with other assessment instruments used; overall impressions of the assessment. Additional specific questions were frequently asked in order to fully understand the opinions and ideas of the interviewee. To prevent bias from data collection the required information was obtained by semi-structured, in-depth interviews with the manager of the selected organization, the author, and with an expert practitioner of Symbol BV. Paired interviews were chosen as they can generate in-depth individual data about the subject with participants being less inhibited in discussing material as they know and trust the other. Furthermore this generates more natural conversations than individual interviews and allows greater insights, for example, into social meanings. The decision also allowed in-depth discussions during the interviews as both the expert practitioner of Symbol BV and the interviewed managers are experts when it comes to continuous improvement.

After the interviews had been carried out their suggestions were evaluated by comparing it to the literature review. Improvements were made and the assessment instrument was send by e-mail to the interviewed managers. This was done since it allowed the measurement of the organization's maturity score. Second, it enabled corrections of possible bias due to misinterpretations, misunderstanding etc. and therefore provided useful subject feedback. The organizations' maturity scores were afterward verified in an e-mail conversation with the concerning consultant of Symbol BV.

**Experts**

In addition to the case studies of the two organizations, two consultants working for Symbol BV were interviewed. The two contribute as a critical case sample due to their specific experience with CIMM (Marshall, 1996). Another consultant was approached but due to illness this interview was cancelled.

A qualitative research design was adopted. This method was specifically appropriate since the aim of the study was to explore and understand the opinions of the experts on the assessment instrument (Saunders et al., 2011). The two consultants of Symbol BV were interviewed one-to-one at the office of Symbol BV. Main reason for this was to prevent subject bias due to the urge to confirm the opinion of their boss (Saunders et al., 2011). The interviews lasted around 45 minutes and explored: overall impressions of the assessment; ideas on possible use of the instrument; possible suggestion. Additional specific questions were frequently asked in order to fully understand the opinions and ideas of the interviewee.

### *3.1.2.2 Data processing*

The interviews were recorded and fully transcribed in order to structure the data analysis. Key emergent themes were inductively generated. Inductive content analysis is particularly appropriate due to the exploratory nature of inquiry and the interactive nature of data collection and analysis (Saunders et al., 2011). The adjustments made to the instrument were reviewed by an expert practitioner in order to further diminish bias due to misinterpretations or misunderstanding. Quotations in the next analysis chapter are used to illustrate some key emergent themes around the CIMM assessment instrument.

# 4. ANALYSIS

As this research was an in-depth investigation of a complex instrument and because of the requirements of trustworthiness in qualitative quotations, this chapter had to be quite detailed in some parts. Each interview let to the further developments of the assessment instrument before another interview took place. As each interview evaluated and improved the assessment instrument main information given on the CIMM assessment is shortly and separately outlined. Additionally, a cross case analysis is performed to specifically asses the CIMM assessment instrument. Lastly, the assessment instrument is outlined.

## 4.1 Interview Results

### *Fresenius Hemocare Nederland*

The first interview was performed with the organizational change and continuous improvement manager at Fresenius. Their current maturity assessment is done using an assessment including fourteen questions with descriptions for each ranking option. Middle managers sit together and discuss the current maturity state of the organization using this assessment.

The main part of the total suggested instrument improvements for the CIMM assessment were focused around the formulation of the statements. For instance, the statement 'quality is a way of life for everyone' was too general and should be formulated more concrete. Another example is the suggestion to replace 'tangible and measurable objectives' with 'SMART objectives' in order to be more precise and relate to this widely accepted concept. Most moderations were suggested for level three. Especially the structure of the key elements was perceived as being illogical. *"I think this chapter is still a bit inconsistent"*. He explained that it was essential to first have an overview of the process, after which you can identify wastes and only then process optimization can be done using TPM. Furthermore it was found that some statements were unclear. Terms like "preparations" and "high level" should be explained in more detail. Important was also the definition of TPM, as he stated that various people have different perceptions of this term. *"I suggest you ask questions related to the parameters of TPM instead of the term"*. When it comes to the completeness of assessment he suggested including some additional elements, like Gemba, Hoskin Kanri, Process FMEA, supply chain integration, and DOE. Especially level four and five were perceived as incomplete.

### *Sealed Air Diversey Netherlands Production B.V.*

The production manager at Sealed Air Diversey Netherlands Production B.V. was interviewed second. Their current assessment instrument is an excel-based instrument and encompasses 20-keys to operational excellence. Every key presents specific criteria of which the user can state if this is or is not achieved within the organization. These keys are not directly linked to a maturity level.

The manager stated that some statements of the assessment were not optimally formulated. Some were too broad and some too specific, unrealistic or unclear. For instance, it was suggested to add 'at the end of the day' to the statement 'every item is in its place'. *"Items are not always in their place. […] When employees use equipment and do not need it anymore you want them to bring it back immediately, but in practice this does not happen"*.

The main thing missing from the assessment according to him were one or more statements about what an organization should

do when deviations from the standard process arise. *"When someone within the organization notices a deviation that has to be addressed, how do you then deal with that? […] Who determines if it is a long term project? That a multidisciplinary team is needed or that it is a job for one person?"* Furthermore the visual workplace key element should be focused more around the visualization of Key Performance Indicators. Additionally he indicated that the restructuring of some statements within level three were needed to achieve a logical order. Level four and five were not reviewed due to time constraints.

### *Consultant at Symbol BV*

The recurring suggestions in this third interview concerned the extent to which statements where not presenting the situation as it should be to rate a '5'. *"Here it says 'value stream mapping is applied on a yearly basis for key processes' that is not exactly what VSM says. VSM says that all value streams should be mapped. The ultimate goal is to have mapped everything"*. He furthermore indicated that the statements on TPM were not complete. *"TPM encompasses way more than preventive maintenance. [...] There is way more to it: training, educating people, especially that operators perform autonomous maintenance is very important for TPM"*. Just like the manager of Sealed Air Diversey Netherlands Production B.V. the structuring the order of statements of level three were perceived as a bit illogical. Especially the distinction between the current and future value stream mapping and the gap which is could be clarified. He had little to no specific comments on level four and five. Both were perceived as good.

### *Consultant at Symbol BV*

This fourth interviewee acknowledged that not everything was present within the assessment but that these did not need to be added. *"A lot is missing. But like I said, we could make an endless list. But the main subjects are present and fit CIMM so I think that this is good."* He did have a few suggestions to make statements more generally applicable. For instance, he stated that 5S is not really necessary to have an organized work environment, and that therefore the mentioning of 5S within a statement should be prevented. Another recommendation was to use 'the workplace' instead of 'the Gemba' as this later term is not known to everyone. Furthermore additions to various statements were proposed to clarify statements based on issues he came across. *"Do you mean product or process quality?"* The structure of level three and four according to DMAIC was perceived as good. *"When I look at CIMM I think this structuring is really logical. CIMM does not fully connects to DMAIC. [...] I have no trouble with that"*. The only element which he really would like to add to the assessment was the management of change, which should preferable be put in level three or four.

## 4.2 Cross case analysis

All interviews contributed to numerous adjustments of the assessment instrument. These interviews are connected, as they build on and indirectly review each other. Different views sometimes collided. For instance the initial statement 'Every item is in its place' was made less strict by adding 'at the end of the day' as suggested in the second interview. This statement was however perceived as being too tolerant by the third interviewee. Furthermore, the logic of structuring of level three and four according to DMAIC was perceived differently. Nevertheless by restructuring the statements, appropriate adjustments could be determined. Suggestions made were constantly reviewed according to their consistency with the literature. However, there were no major deviations between the respondents' views.

The opinions on the knowledge needed to complete the assessment differed. Where the manager of Fresenius stated that the management team would be able to complete the assessment, the manager of Sealed Air Diversey Netherlands Production B.V. thought that middle-managers within the company would be able to do this, although they would encounter some unknown elements. The consultant had yet another view: *"Simply put, he/she has to be a greenbelt. Otherwise there is no use. For example SIPOC or TPM, they have no idea where you are talking about"*. Arguably top management and middle management within the organization should be able to complete the assessment, especially with the guidance of experts.

The structure of the complete assessment according to the five maturity levels is perceived as a good contribution to the clarity, and structure. Both managers were consistent in their opinion in this: *"It helps managers to get more structure and direction"*, *"It guides your direction of thought. […] which makes the understanding of the statements easier."* However, it has to be noted that multiple interviewees had concerns regarding the honesty and therefore the validity of the assessment when management had to indicate to their boss they accomplished a level using this instrument. The consultant suggested completing the assessment with a big group to get the most honest assessment and to create commitment.

All in all, even though interviewees had numerous suggestions for improvements, various positive remarks were made. *"I think you really accomplished to grasp the main idea. […] If we would not have our own assessment instrument, I would definitely use this one."* Based on the interviews the instrument followed a series of iterations resulting in a final assessment instrument which will be elaborated on next.

## 4.3 The CIMM assessment instrument

The CIMM assessment instrument aims to measure the progress on each maturity level as well as the overall maturity of an organization. It is structured around the five CIMM levels: structured, managed, predictable, capable and world class. This was presumed to be appropriate according to both literature and the interviews. Level one and two are focused around various Lean but also Six Sigma tools, respectively aiming for structure and small improvements. Level three mainly includes Lean elements while level four and five are respectively focused around Six Sigma and Design for Six Sigma.

Each CIMM level consists of three subheadings, of which each subheading encompasses five statements. The subheadings of the first three levels and level five are structured around the corresponding key elements. Level three and four however are structured according to DMAIC, as this approach is often taken at these levels. Level four has more focus on the Define and Control phase as these two included more key elements than the other DMAIC steps. The statements present the situation as it should be within the organization when it has achieved that specific level. An organization can rank its organization on a Likert scale from 1- this statement is not reflected within my organization; to 5- this statement fully reflects the situation within my organization. Furthermore, an organization can indicate their objective for each level (and subheading) in order to see progresses made towards specific goals.

The result of the CIMM assessment instrument is an overview of the percentages the organization has completed on specific levels (or subheadings). This result is, together with the set objectives, presented in a bar chart as well as a radar diagram to fully clarify the organization's maturity status.

# 5. CONCLUSION

Maturity models are increasing in popularity as a tool to guide organizations towards competitive advantage. Various maturity models exist with varying assessment instruments. It was found that there is a distinct linear consideration between process rigor and evidence support. Instruments which score high on both aspects often encompasses larger assessment teams, include both internal as well as external assessors, and these assessments are made more organization specific than instruments which score low on these two aspects. It can therefore be concluded that the aimed result of an assessment is crucial to take into account while making decisions during the development of an assessment instrument. The designed CIMM assessment had to indicate the current CIMM maturity status of an organization. Furthermore, it had to be usable by any manufacturing organization. The instrument achieves this by concentrating on general qualitative statements (only suggesting successful specific tools and methods). Additionally, the instrument aimed to be a fairly evidence based assessment with minimal process rigor. This was established by developing an excel-based questionnaire assessment instrument based on the literature review, and suggesting to include multiple (external as well as internal) assessors during the assessment. The evaluation of the assessment instrument let to various improvements regarding for example formulation, structure, and elements. Furthermore it was found that organizations and experts see the added value of an assessment and support the proposed method of the CIMM assessment instrument.

## 5.1 Scientific implications

The findings of this paper contribute to the understanding of the varying assessment instruments. A clear overview of maturity assessment instruments was lacking. This paper describes existing maturity model assessment instruments and provides a framework which compares the explored assessment instruments. Furthermore a CIMM assessment instrument was developed. This instrument, with a solid scientific basis, indicates the organization's current maturity status and contributes to the utility of CIMM.

## 5.2 Practical implications

The developed CIMM assessment instrument helps management to see where their organization is in terms of their Continuous Improvement Maturity, the various elements this model encompasses, and it provides useful input to plan future developments within the organization. The instrument may also assist in developing constructive dialogue and shared insights amongst those participating in the assessment process. Inevitably with an instrument of this sort it will be used in different ways by different people, according to circumstances and individual preferences (for example, the assessment could be carried out by an individual or by a team). Even though this study explored the use of the CIMM assessment as a self-assessment instrument, the recommended approach is to include individuals from different levels within the organization with a facilitator, preferably an external expert. Before starting the assessment several decisions need to be made, including what the unit of assessment should be (e.g. the whole firm or a particular department); how the results from the assessment will be used; and who should carry out the assessment. The practical applicability and usefulness of CIMM will benefit from the CIMM assessment instrument. When used appropriately, the instrument can help organizations monitor where they are concerning their maturity, how and if they progressed over time and should provide input to determine future improvement plans as it indicates the current as well as the aimed for future maturity status.

# 6. LIMITATIONS AND FUTURE RESEARCH

A limitation of the CIMM assessment instrument is that it is only that, an instrument. Using it will not in itself lead to improved maturity of an organization. Once an assessment has been completed, the results need to be acted on; the assessment itself does not provide specific steps which should be taken. Another limitation is that the accuracy of an assessment depends very much on the honesty and judgement of the assessors. The assessment needs to be conducted with due care and attention if it is to provide a genuine reflection of the organization's maturity state. This limitation is even more fundamental since the statements are qualitative, open for interpretation and the structure of the instrument possibly guides the answers of the user. An additional limitation is that due to time constraint the study in this paper used small purposive samples. A bigger sample is necessary to find out if the conclusions can be universally applied within the manufacturing industry.

In order to overcome this limitation future research may include more intensive qualitative research. Especially since a larger sample would result in further improvements of the assessment and increase internal validity. Furthermore future research may include insights from organization's which are unrelated to Symbol BV, as their perceptions might be different. Future research may also include research concerning the possibility to include measurable KPIs to the statements. This could diminish varying interpretations and could increase the accuracy of the assessment. In addition more attention is needed to whether or not a separate or adjusted assessment instrument is needed for the service sector. This will involve research to develop a better understanding of the nature and extent of maturity and the key elements within this sector. Future research is also considered to be needed in the area of "situational maturity model assessment", in order to make the maturity model assessment capable to better fit organization-specific needs. In this regard, research on adaptation and configuration mechanisms could provide promising merits. Additionally, investigating the various different ways this instrument can be used (e.g. by a team or individuals) and their influence on the result may be useful. This paper focused on the continuous improvement of processes within organizations. However, as stated does process improvement encompasses the interlinked areas of People and Product as well. This would be an interesting area for future research.

# 7. ACKNOWLEDGMENTS

Hereby I would like to acknowledge my supervisors for providing me with helpful advice and support. Second, I would like to thank Symbol BV and especially Dick Theisens for the opportunity and support I received. I would also like to show my appreciation towards the managers and consultants I interviewed. During the interviews, they presented me with important and useful insights in their ideas on the assessment. Lastly, I would like to thank family and friends who helped me in any way in achieving the realization of this paper.

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# 9. APPENDIX

## 9.1 Appendix A. Maturity Model Assessment Synopsis

| Model | Assessment | Description | Finding |
|---|---|---|---|
| **CMMI** (SEI) | 1. SCAMPI A | Full appraisal. Including months of defining, preparing and executing. | Benchmark maturity level |
| | 2. SCAMPI B | Initial, partial self-assessment. Although less data needed than for SCAMPI A, a relatively high degree of confidence is ensured. | Identification of areas needing attention |
| | 3. SCAMPI C | Quick look | Identification of risk areas |
| **Process Maturity Ladder (PML)** (Harmon, 2004) | Checklists and Worksheet template | Informal analysis wherein managers and others within the organization complete a checklist and worksheet, linking processes with maturity levels. | Quick assessment, people start thinking about the processes |
| **BPMM-OMG** (Weber et al., 2008) | Process Area Templates | Assessment done based on the organization specific goals set, described in the process area templates. Guidelines on how to make these templates domain-specific are included. | Evidence based assessment |
| **BPMM-Fisher** (Fisher, 2004) | Self-Assessment Matrix | With the Five Levers of Change and five Maturity Levels a matrix is presented with short elaborations for every combination. | Maturity level for each lever of change |
| **BPM Maturity Model (BPMMM)** (Rosemann & De Bruin, 2005) | 1. Self-Assessment Survey | Over 300 quantitative five-point scale survey questions, clustered following 25 cubes. Which combine the five maturity levels and the five factors. | Cube representation, which shows two maturity levels, coverage and proficiency, per factor |
| | 2. Third Party Assessment | Case study by a third party within the organization, the self-assessment survey is included in this assessment. | Comprehensive assessment |
| **EFQM Excellence Model** (EFQM, 2013) | 1. Simple Self-Assessment | Rating done based on definitions of different levels of maturity for each Fundamental Concept of Excellence. | Quick maturity rating, overview of strengths and possibilities for improvement |
| | 2. Questionnaires | Assessing 44 equally weighted and balanced statements driven from the EFQM Excellence Model. | Identification of strengths and possibilities for improvement |
| | 3. EFQM Quick Check | Excel-based tool covering 20 standard approaches which determines maturity of enablers and their importance. | Ranking of 20 enablers. |
| | 4. EFQM Business Excellence Matrix | Excel-based tool that captures both information about Enablers and their Results. | Reasonably accurate score against the EFQM Excellence Model |
| | 5. EFQM Excellence Matrix | Comprehensive excel-based tool. | Results are segmented into criterion |
| | 6. Site Visit Simulation | With a team of assessors a comprehensive self-assessment is carried out. | Thorough assessment |