Scrum Maturity Model

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Abstract

Within the agile development methodologies context, the topic of client relationship management is sturdily focused on mainly due to the importance of collaboration between the development team and its clients. Most clients avoid or are unable to develop a close cooperation with vendor organizations, since it requires high motivation and close participation among key stakeholders in the development processes as well as the correct usage of the adopted agile software development methodology. Hence, many software development projects fail and become unsuccessful because of this lack of communication.

In order to increase the rate of successful projects, this document will present the results from the validation process for the proposed roadmap to lead and aid software vendor organizations, improve their development processes, concentrating mainly on the client’s role throughout the process and specially in level three of the suggested roadmap.

This proposal is called Scrum Maturity Model: Therefore, the main goal was to validate this proposal in organizations that use Scrum, a popular and widely adopted agile methodology, as their main development process. Scrum Maturity Model, as we shall see, turns out to be an applicable, useful and viable approach to reduce the failed development projects rate within the evaluation set of organizations.

Keywords: Agile methodologies, Scrum development methodology, Maturity model
Resumo

No contexto de metodologias de desenvolvimento ágil, o tema da gestão da relação com o cliente é muito focado e investigado, principalmente devido à importância da colaboração entre a equipa de desenvolvimento e os seus clientes. A maioria dos clientes são incapazes ou evitam o desenvolvimento de uma cooperação próxima com as organizações fornecedoras, uma vez que tal exige elevada motivação e participação activa entre as partes interessadas nos processos de desenvolvimento, assim como o uso correcto da metodologia adoptada para o desenvolvimento de software. Por isso, muitos projectos de desenvolvimento de software falham, tornando-se mal sucedidos devido a esta falta de comunicação.

A fim de aumentar a taxa de projectos bem-sucedidos, esta investigação apresentará os resultados do processo de validação da proposta que tem como objectivo ajudar organizações que desenvolvem software a melhorar os seus processos de desenvolvimento, concentrando-se, sobretudo, no papel do cliente durante todo o processo, particularmente no nível três da proposta.

A proposta tem o nome Scrum Maturity Model e, como tal, o objectivo passou por validá-la em organizações que usam o Scrum, uma metodologia ágil muito adoptada e popular, como principal processo de desenvolvimento. Em conclusão, é possível afirmar que a proposta de solução é uma abordagem aplicável, útil e viável para reduzir a taxa de projectos de desenvolvimento falhados nas organizações que participaram no processo de avaliação e validação da proposta.

Keywords: Metodologias ágeis, Metodologia de desenvolvimento Scrum, Modelo de maturidade
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Acronyms

ATD  Actor Transaction Diagram
BPMN  Business Process Modeling Notation
CA  Certification Authority
CBSE  Component-based Software Engineering
COFF  Compliance Office
CMMI-SVC  Capability Maturity Model Integration for Services
DEMO  Design & Engineering Methodology for Organizations
DSRM  Design Science Research Methodology
EE  External Entity
EO  Enterprise Ontology
GSDP  Generic System Development Process
HR  Human Resources
INCB  Institute for Nature Conservation and Biodiversity
IT  Information Technology
ITD  IT Division
ITIL  Information Technology Infrastructure Library
ITSM  IT Service Management
OS  Object System
SOA  Service Oriented Architecture
SPM    Service Portfolio Management
SPOCS  Simple Procedures Online for Cross-Border Services
ToP    Tourism of Portugal
TAR    Tourist Animator Registry
TEC    Tourist Entertainment Company
TTAR   Travel and Tourism Agencies Registry
US     Using System
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Chapter 1

Introduction

This section provides a context overview of the area and theme of this dissertation. The main scientific contributions from this research are introduced, followed by the description of the adopted research method.

1.1 Area of Research

Ever since computers were invented and mass distributed, software solutions became a core instrument for personal entertainment and a professional’s tool to attain competitive advantage (Russell & Stafford, 2002). Enterprises usually achieve innovation through creative software development, despite the associated risk within the very abstract process of software development (Laudon & Laudon, 2009).

Given the abstractness of this industry, rather than the basic technical development skills communication, teamwork and business alignment skill are the core competences to succeed, rather than the basic technical development skills (Leonard-Barton, 1992). According to a CHAOS Report, about 70 % of IT development projects fail to deliver functional software, mostly due to poor communication between stakeholders who play key roles in the development process (Standish Group, 2009). IT software industry has been in crisis as time and cost overruns are mostly caused by human factors in software development collaboration (Kraut & Streeter, 1995).
1.2 Theme of Research

Given this chaotic situation regarding the pressure with schedules and budget issues, agile methodologies emerged in order to offer a different approach against traditional waterfall development process. Agile methodologies provide a time boxed, flexible, and business aligned development process (Schwaber & Beedle, 2001) (Highsmith & Cockburn, 2001).

The Agile Manifesto values, which are the foundations for a successful agile oriented development, stress the communication between all parties involved in the software development project (Beck et al., 2001). However, according to the CHAOS Report (Standish Group, 2009), the fact that most clients spend an extremely small amount of time and effort working closely with the software vendor organization, that develops the solution, goes against the Agile Manifesto, jeopardizing the success rate of IT projects (Cockburn & Highsmith, 2001).

The failure of IT projects, mainly caused by problematic software requirements engineering and other human/client collaboration factors mentioned above, is a highly researched theme among professionals and scholars (Leffingwell & Widrig, 2000) (Charette, 2005) (Reel, 1999) (Wilson, 1998) (Cockburn & Highsmith, 2001). This dissertation intents to provide a different insight on the current issues concerning this topic throughout the proposal.

The area of this dissertation focuses on software development processes, and the theme centers itself on agile methodologies in a quest to attempt to solve the problem of IT projects failures due to communications gaps.

1.3 Research Problem

The main concern that induced this research was precisely the problem mentioned above:

*The lack of cooperation among stakeholders involved in a software development project, in particular the type of communication between the development team and the client.*

The problems in communication can result from various factors, namely:

- Human factors and resistance to changes;
- Distance that separates both vendors and clients; or
- Inexistence of a commitment that follows the definition of a contract of collaboration.
Generally, both clients and software development organization teams may fear and avoid the adoption of new methods of collaboration in order to achieve homogeneous communication channels (Wilson, 1998) (Burke et al., 2001) (Charette, 2005). This harms the partnership between the two, thus resulting in inadequate requirements engineering emphasized by agile methodologies, which will, eventually, lead to an unsuccessful project (Cockburn & Highsmith, 2001).

Concerning human behavior, the distance that separates the vendor organization and the client challenges the accomplishment of a fluent and successful cooperation (Batra, 2009) (Holmström et al., 2006) (Cherry & Robillard, 2004). Apart from this exact physical distance, which hardens the communication and occasionally blocks the possibility of face-to-face meetings, a cultural distance must also be considered, since this aspect may bring negative impacts, from cultural clashes to collaboration performance and, hence, influence the project as a whole (Herbsleb & Moitra, 2001).

Another cause of this problem is the inexistence of highlighted goals, such as market competition, which will motivate all stakeholders to improve their processes and maximize the outputs. According to a Gartner survey (Norton, 2008), agile methodologies could use a specific maturity model as a roadmap and market differential, so software development organizations might explore their processes and reach higher levels of maturity. Moreover, a paper from the Software Engineering Institute (SEI) reveals that, despite the disadvantages of CMMI while applied onto agile methodologies, Capability Maturity Model Integration (CMMI) can coexist with agile methodologies and enhance these software development organizations (Glazer et al., 2008).

To summarize, this dissertation’s main motivation is the large numbers of failed IT projects caused by insufficient communication among involved parties, namely between development teams and business clients to assure business alignment (Standish Group, 2009) (Kraut & Streeter, 1995).

### 1.4 Research Goals

In order to answer the identified problems in this research, this dissertation aims to review the related work and present a proposal for the identified problem as well as to evaluate it.

According to Chapters 2 and 3, it is possible to claim that the introduction of a maturity model into Agile methodologies represents an interesting complement to tackle the problem, therefore this research will evaluate whether this is a valid approach to the problem.

Given the extensive span of agile methodologies, this dissertation will focus solely on one particular methodology to assemble the maturity model. Scrum, which is a popular and widely adopted agile methodology, was chosen as the target of the proposed maturity model.
Thus, the goal of this thesis is to evaluate if the introduction of a maturity model for Scrum process improvement will stimulate more customer cooperation.

1.5 Scientific Contributions

This dissertation details the accomplished research, from the elaboration of the initial proposal, experimentation, and evaluation to the continuous improvement to unravel the problem: lack of collaboration between vendor organizations and clients.

A roadmap is proposed for comparing the software development process between various organizations in order to enable enhanced benchmarking, stimulate customer collaboration from benchmarking results and self-improved development processes in organizations so as to enable further successful IT projects.

This topic of maturity models and other IT governance frameworks on agile methodologies is highly polemic among the agile community. Nevertheless, IT governance mechanisms are necessary and welcomed in organizations which are underproductive, and, thus, hold the major slice of failed projects (Glazer et al., 2008).

Note that the present research resulted into a paper accepted at The Sixth International Conference on Software Engineering Advances (ICSEA 2011) which is available to the scientific community’s further research and analysis; also available in Appendix I.

1.6 Research Method

The chosen research method for validating the proposal was Action Research (AR) due to its success in various academic investigations in the Information Systems (IS) area and its singularity in allowing the researcher to interfere and observe introduced modifications on the studied environment. Action Research is comprised by a cycle of five stages (Baskerville, 1999), as illustrated in Figure 1.1:

1. **Diagnosis**: problem identification;

2. **Action Planning**: research phase to prepare the experiment and alternative actions;

3. **Action**: implementation of planned actions, introduction of changes and analysis of the outputs on the environment;
4. **Evaluation**: determined if the outcomes are expected or against odds and assures that introduced actions are the only reason for success; and

5. **Specifying Learning**: Identify general findings.

Action Research is carried out by individuals who are interested parties in the research. This fact has led to criticisms to the validity of the research, with accusations of inevitable researcher bias in data gathering and analysis. The justification for AR counters this by suggesting that it is impossible to access practice without involving the practitioner. Practice is action informed by values and aims that are not fully accessible from the outside. The practitioner may not even be wholly aware of the meaning of his or her values until he or she tries to embody them in their actions.

The limitations of this research method are, thus, the following: the unfamiliarity with research methods and representations of the process of action research, which may confuse rather than enlighten. These limitations affect the credibility of this research method negatively. However, it still presents positive characteristics that make its adoption for this research worthwhile.

### 1.7 Structure of Document

The review of the state of the art and related work are detailed in Chapters 2 and 3. Chapter 4 describes the first Action Research cycle applied in this research. As explained in the previous Section 1.6, the AR cycle is comprised of five stages, and each of them will be detailed in the first iteration for the initial version of the proposal. Then, in Chapter 5, the second iteration of the AR cycle will be described. This section provides facts about the experiences and the learning
from the planned action and from the improved version of the proposal. In Chapter 6, the third and last iteration will describe the final actions and the learning that validates both the research and the presented proposal. Chapter 7 details the final proposal obtained from the continuous improvement throughout the three cycles of Action Research. To conclude and end this research, Chapter 8 will present the final words regarding this thesis and consider possible future work.
Chapter 2

Related Work

This Chapter makes a critical analysis of the related work in the field of agile development study, which is related to the area and theme of this dissertation.

Section 2.1, presents agile development methodologies and the Agile Manifesto. Then in Section 2.2, Scrum, a popular and widely adopted agile methodology (Larman, 2004), is detailed and analyzed. In Section 2.3, Modified Agile is shown focusing on the communication issues within agile methodology performed at adistance.

These research efforts will be detailed by how they attempt to solve the recurrent issue of having a large number of failed IT projects and commutation difficulties, along with understanding of why they are not totally successful.

2.1 Agile Methodologies

The origins of agile methodologies are deeply connected with the concepts of iterative and incremental development. Traditional development methodologies, such as waterfall, will be surpassed through the partition of plan, execution and revision phases into smaller iterative cycles, endorsing practical and measurable outputs at the end of each iterative cycle (Larman & Basili, 2003).

There were several ideas concerning the agile concept, hence an Agile Manifesto (Beck et al., 2001) established the following values (Fowler & Highsmith, 2001):

- Individuals and interactions over processes and tools;
- Working software over comprehensive documentation;
• Customer collaboration over contract negotiation; and
• Responding to change over following a plan.

Regarding the first statement from the manifesto, its founders did not intend to eliminate processes and tools to replace them for individuals and interactions. Rather, the prioritizations of interaction between individuals are stressed over well-defined processes and tools. These prioritizations are equally applied to the other three statements in the Agile Manifesto.

The set of values and inherent principles listed on this manifesto stress the importance of the clients’ presence and interaction in order to obtain a better collaboration outcome, working software and agility when facing a sudden change in requirements (Layman et al., 2006) (Chow & Cao, 2008).

Since this approach requires a high level of cooperation between the client and the development team, mainly through face-to-face meetings, it has the drawback of being partially superseded in the current market, in which an ascending number of projects are developed at a distance (Cockburn, 2005).

2.2 Scrum

Scrum is an agile methodology to manage development projects through an iterative and incremental method (Schwaber & Beedle, 2001).

Scrum introduces the concept of sprint that represents an iteration of a time-boxed development cycle with a duration of two weeks to one month. In fact, the core of Scrum is comprised by a set of sprints that delivers working software at the end of each sprint. In addition, it defines three roles, four artifacts to enhance communication and five meetings to increase collaboration (Schwaber & Sutherland, 2010).

This development methodology is divided into three main roles:

• **Scrum Master**: individual who is responsible for the Scrum process and its correct usage maximizing its benefits. The role of Scrum Master is usually misunderstood as the traditional role of project manager, but the Scrum Master is the facilitator, removing barriers and impediments, rather than providing a work plan and monitoring, as the Team should be self-organized;

• **Product Owner**: individual who is accountable for the alignment of the development and business goals definition. Generally, this role is assigned to a client's representative or
the development side project manager, given the business model knowledge. Therefore, the main responsibility of the Product Owner is to steer the Team to develop successful IT projects.; and

- **Team**: in charge of delivering the product. A team comprises five to nine members with cross-functional skills, who are self-organized and self-led. They perform under the Product Owner’s guidance, defining requirements for the end product, and are supported by the Scrum Master.

The relationship and collaboration among these three roles are crucial and must follow the values defined in the Agile Manifesto. However, these values are hardly complied in enterprises, thus partially represent the motivation for this research (Cockburn & Highsmith, 2001).

Moreover, Scrum also identifies four objects that are operated by the Scrum team throughout the development cycle:

- **Product Backlog**: a prioritized list of everything necessary to conclude the product. This backlog is similar to the concept of requirements contract used in traditional development methodologies such as waterfall;

- **Sprint Backlog**: a list of tasks to be performed during a sprint (i.e., development iteration) to translate parts of the Product Backlog into working software. This object assists Team members to focus on short-term goals in order to maximize their quality and product delivery time;

- **Release Burndown Charts**: charts which show the progress of the project over time, allowing the Scrum team to have a global vision of the development project; and

- **Sprint Burndown Charts**: charts that display the progress of the sprint over time, for the development team to track their sprint’s progress.

The interaction of the roles using these objects led to various types of Scrum meetings, which are as follows:

- **Release Planning Meeting**: kick-off meeting to define the initial items of the Product Backlog as well as the analysis of schedule and budget for the development project by the Scrum team. In this meeting, the formal roles of Scrum are assigned to project performers. Generally, it is brief, consuming only about twenty per cent of a traditional kick-off planning meeting;
• **Sprint Planning Meeting**: development team and client closely discuss matters and define the goals for the next upcoming sprint. In this meeting the Sprint backlog is filled and a plan for development cycle is defined. The maximum duration of this meeting should not surpass two hours for a sprint of two weeks;

• **Daily Scrum**: a brief and relaxed meeting of fifteen minutes for developers to identify personal issues, actual performance and possible improvements within the usage of the methodology;

• **Sprint Review**: demonstration of the working software to the client and stakeholders. This meeting ought to have the same duration as a Sprint Planning Meeting and is particularly relevant, as it collects important feedback from final users and executive managers that finance and exercise the developed solution; and

• **Sprint Retrospective**: team performs a self-examination regarding the last sprint in order to seek improvements on their use of Scrum Methodology and collaboration in general. Issues and performance metrics shall be detailed, analyzed and used to obtain information regarding the actual process and opportunities for future improvements.

In Figure 2.2, Scrum is shown as an iterative and incremental development methodology. The phase for planning and system architecture takes place in Release Planning Meeting, while the sprints are comprised by Sprint Planning Meetings, Daily Scrum, Sprint Review and Sprint Retrospective. The closure phase delivers the end product to the customer.

![Figure 2.2: Scrum Methodology (Schwaber & Beedle, 2001).](image)

Although Scrum defines a set of simple yet important concepts that allows agile software development, the implementation of Scrum theoretical model cannot guarantee the success of IT
projects by itself, since culture shift is required, as well as adoption of agile values (Beedle et al., 1999). The adoption of Scrum concepts is difficulted in a distributed Scrum team or distant clients, since close collaboration between development teams and their clients are emphasized. Thus, supplementary solutions to complement this imperfection are needed.

Furthermore, Scrum does not consider any method for process measurement and improvement, which strengthens the need for complementary solution such as maturity models (Glazer et al., 2008).

### 2.3 Modified Agile

Modified Agile is an agile development methodology that results from the analysis of the flaws in the Agile Manifesto (Beck et al., 2001) in a distant outsourcing environment (Batra, 2009).

As shown in Figure 2.3, the Agile Manifesto’s flaws are identified within a distant outsourcing environment by classifying Agile values feasibility in this context.

![Figure 2.3: Support for Current Agile Values in Outsourcing Environment (Batra, 2009)](image)

As shown, the value “Individuals and interactions vs. processes and tools” from the Agile Manifesto is considered an advantage to this distant outsourcing context through the enhancement of the quality of communication among key stakeholders. However, this value entails several difficulties from physical and cultural distance to complex communication factors.

On the other hand, the value “Working software vs. comprehensive documentation” is clearly an advantage to this distant outsourcing context due to its goal to deliver shippable products rapidly. On the other hand, formal documentation is essential in this context, since it eliminates ambiguity
derived from the lack of tacit knowledge.

The value "Customer collaboration vs. contract negotiation" is hardly valid in this context, since customers tend to work far away from the development site, which makes close collaboration among key stakeholders much more difficult. Moreover, as previously mentioned, this context usually requires formal documentation and contract negotiation to ensure effective collaboration.

Finally, the value "Responding to change vs. following a plan" enables the increase of available resources for development. However, it is hard to be applied due to formal contracts that difficult the flexible negotiations, except in rare cases of additional compensations.

The main problems identified in a distant outsourcing context were the poor communication among participants of the IT projects and the exhaustive documentation needed for contract negotiation. All other values and principles mentioned in the Agile Manifesto remain feasible.

The recommended solution is a communication model and team composition structure that will enhance the communication between clients and developers to reduce the negative effects derived from the distance factor that leads to a loss of knowledge.

In Figure 2.4, the introduction of two specific roles reduces communication barriers by establishing clear communication channels for formal and technical topics.

![Figure 2.4: Modified Agile communication model proposal (Batra, 2009)](image)

Regarding the business layer of this collaboration, the agile methodology details these two roles to ensure a clear and effective collaboration among key stakeholders:

- **Coordinator**: an individual from the client-side, who ensures the maximization of development outputs by assigning the most important business goals to be developed as a priority,
- **Ambassador**: worker from the development team-side who makes sure that the developed product is aligned according to the customer’s requirements.
These two roles must work closely as a formal communication channel, while team members from both development and the client-side might communicate among themselves through an informal channel.

While most of them very similar to Modified Agile, distributed agile methodologies are broadly used, their success being validated by several case studies. However, there are also many failed IT development projects due to human factors and inadequate collaboration between clients and vendor organizations, which shows that distribute agile cannot solve this communication problem by itself. Hence, supplementary solutions to complement this imperfection are (Braithwaite & Joyce, 2005) (Kircher et al., 2001) (Sutherland et al., 2007).

Like Scrum, this methodology does not consider any method for process measurement and improvement, which strengthens the need for complementary solutions such as maturity models (Glazer et al., 2008).

### 2.4 Summary

This section briefly presented the related work in the area of software development, namely in agile development. Agile Manifesto values provides the backbone for all agile methodologies. Methodologies like Scrum intend to supply a defined method for enhanced communication and work planning.

Relating to the difficulties identified in Section 1.3., this related work approaches the IT project failure rate problem and attempts to increase communication’s effectiveness. Nevertheless, complementary solutions are needed, since IT projects continue to fail and communication barriers still exist, especially in distributed teams and distant clients (Cockburn & Highsmith, 2001) (Herbsleb & Moitra, 2001).
Chapter 3

Maturity Models

The maturity models for software development processes enable the classification of the performance of organizations that have a development process. Maturity models guide and encourage organizations to continuously improve their processes through a staged method, also known as maturity.

These maturity models are an interesting approach to solving the problem described in Section 1.3., since the presence of a maturity classification provides a roadmap for process improvement (namely those related to customer collaboration issues) and allows the comparison between organizations in order to encourage competition and differentiation.

For this purpose, Section 3.1 analyzes the well-known Capability Maturity Model Integration (CMMI), regarding the benefits of maturity mode within agile methodologies, namely Scrum. Then, in Section 3.2, we describes the Agile Maturity Model that aims to deliver support and guidance for future research. This maturity model is highly aligned with CMMI and combines several practices from different agile methodologies.

In Section 3.3 we presents Agile Maturity, a concept similar to maturity model for agile methodologies that was conceived in a form of roadmap for agile process improvement. Finally, Section 3.4 analyzes the vastly discussed Agile Process Maturity Model from Scott Ambler (sponsored by IBM) and which later evolved into the Agile Scaling Model.

3.1 Capability Maturity Model Integration

CMMI was introduced in 2002 and ever since it has focused on process improvement approaches that assist organizations in adopting the best type of practice from each process area and make
processes performance evolve (Chrissis et al., 2003) (Menezes, 2002).

CMMI has two representations: continuous representation and staged representation, as illustrated in Figure 3.5. Continuous representation is designed to focus on the specific processes that are considered important for the organization’s immediate business objectives, or those to which the organization assigns a higher degree of risk. Staged representation is designed to provide a standard sequence of improvements, and can serve as a foundation for comparing the maturity of different projects and organizations.

A level of maturity is characterized by a set of predefined process areas, evaluated by the accomplishment of specific and generic goals applicable to the various areas. Each of them is comprised by a set of practices that reflect specific and generic goals (TheStandishGroup, 2010). This type of approach is highly successful worldwide amongst enterprises that wish to demonstrate the use of best practices.

In the staged representation, the Initial Level of maturity (level 1) is described as an unstable definition of processes, which are usually ad-hoc. The success in organizations classified in this level depends mostly upon individuals competences and heroic acts, rather than following well defined business processes. Organizations may produce effective outputs, however, most of the times they exceed in both schedule and budget. Moreover, organizations in this level generally abandon defined processes in moments of crisis.

The Level Managed (level 2) characterizes organizations that accomplished all generic and specific goals assigned to this level. More specifically, project requirements are managed, processes are planned, executed, assessed and controlled. Rigor and discipline are maintained in times of crisis, so while the defined practices prevail, projects are executed and managed according to plan and documentation. The goal of this level is to have manageable and traceable requirements, process, products and services.

The Level Defined (level 3), characterizes organizations that accomplish all generic and specific
goals assigned to this level. The main difference between levels 2 and 3 is the scope of the norms, description of processes and procedures. In the previous level, these norms description of processes and procedures can differ at each instance of the process or project, while in this level they are unified for the whole organization, apart from allowed exceptions described in documentation. Another difference centers on the detail and rigor of the description and evaluation of the processes. In this level, processes are managed proactively with knowledge from the interrelation of activities, products and services.

The Level Quantitatively Managed (level 4) characterizes organizations that accomplish all generic and specific goals assigned to it. In this level, selected sub-processes increase processes performance through the usage of statistical and other quantitative techniques as process management criteria for performance. Quality and performance are understood in statistical terms and managed throughout the process lifecycle. Variation of process performance is identified and corrected to prevent future occurrences. Quality metrics for process performance are stored in a repository of metrics to support future decisions based on actual facts. The main difference between level 3 and level 4 is the predictability of the performance of processes, in a quantitative form, as in level 3 only qualitative data is available.

The Level Optimizing (level 5) characterizes organizations that accomplish all assigned generic and specific goals. In this level, processes are continuously improved based on the quantitative understanding of common causes of process variation. The focus of this level centers in continuous improvement through incremental enhancements and technological innovation. These improvements are measured with quantitative goals and they are continuously reviewed in order to adapt to changes in business. Both defined and normalized processes improve in a measurable way while the optimization of flexible and innovative ones depends highly on the participation and alignment of workers who were empowered with business value and organizational goals. Therefore, the capability to change due to threats and opportunities reinforces the search of methods to accelerate and share knowledge among all workers.

The critical difference from level 4 to level 5 is centered on the type of variation addressed to in the processes. In level 4, the focus is concentrated on particular variation of processes, so the statistical predictability of results is possible. However, even though process produces predictable results, they might not be enough to achieve established goals. Nevertheless, in level 5, the main focus centers on the common causes of the process variation to improve its performance, while maintaining statistical outcome predictability to achieve quantitative goals for process improvement.

As previously referred to in the beginning of this chapter, maturity models are an interesting approach to solve the problem inherent to the present research, since they motivate the clients
to become involved and seek continuous processes improvement, in particular practices related to customer relationship.

CMMI provides a good process improvement roadmap, however, given its broad scope coverage, it cannot adequately aid organizations that apply agile development processes, due to non-focus on agile software development processes from CMMI.

Moreover, CMMI does not present a set of suggested metrics to monitor and evaluate the performance of practices listed in each level of CMMI.

### 3.2 Agile Maturity Model

AMM (Patel & Ramachandran, 2009) was purposed in order to provide future researchers a more in-depth agile maturity model as a basis for their studies. This model is shown in Figure 3.6, and was inspired by CMMI, each level with a set of goals for their practices inspired from several agile methodologies:

![Figure 3.6](image)

Figure 3.6: Agile Maturity Model staged representation (Patel & Ramachandran, 2009)

Level Initial (level 1) characterizes organizations not that do have a clearly defined process for agile development. Success depends solely on the competence of individuals, since the processes are unstable regarding the development environment. The main issues at organizations in this
level center on the failure to comply with planned schedule, budget and quality goals. Organizations in this level operate on their own approach without a clear definition of process improvement goals.

The Level Explored (level 2) presents more structured and complete development practices than the previous one, therefore, organizations in this level have less problems throughout the development process. However, some of the major problems are communication issues and software code integration. Level 2 gives particular focus to project planning and requirements engineering for organizations. The usage of game planning and story cards practices is stressed in order to achieve the established goals. In addition, this level of maturity aims to help developers and clients to identify problems regarding project planning and software requirements engineering through learning from previous projects. This is achieved through the verification of actual processes and the identification of weaknesses to elaborate a global vision of the process state and address problem associated to any particular project.

The Level Defined (level 3) mainly stresses the enhancement of practices related to customer relationship, frequent delivery, pair programming communication, codification norms, tests and software quality. Customer relationship is maintained through high levels of effectiveness in this level by assuring the correct and in depth comprehension of these concepts. However, overtime issues may prevail over a sustainable development velocity management and, thus, project management cannot be assured. Risk assessment mechanisms usually do not exist in this level. Moreover, practices for software code optimization are missing therefore, this level only aims at solving technical problems and issues with technical communication among participants, maintaining organizational issues unsolved.

The Level Improved, (level 4) focus on goals such as the sustainable velocity of development, project management and self-organized teams. These organizations may measure the performance of their development process and the quality of the end product. Both practices and products are understood quantitatively through detailed metrics. The main goals of this level are project management, work schedule, self-organized teams, risk assessment, and major focus on development team rather than work product that cannot be easily perceived by the client. Hence, this level focuses on programmers and managers to identify problems and impediments to sustained development velocity and on a self-organized team.

The Level Sustained (level 5) underlines the need for the management of projects' performance, thus continuously improving processes. This is achieved through the attainment of quantitative feedback from processes and technological innovation, after which effective metrics are defined in order to manage them. This level of maturity addresses problems related with satisfaction levels from both clients and internal development team, hence it improves the projects' performance
and prevents defects.

The AMM provides a first approach to classifying the maturity of agile development processes, which comprises practices from various agile methodologies. AMM leads researchers to a continuous investigation, since this model's set of practices crosses too many agile methodologies that most organizations do not apply, causing increased levels of entropy. Since this is a first approach to classifying agile processes, the description of the levels is not very detailed and it is a bit ambiguous.

Additionally, this maturity model lacks measurement goals to monitor and evaluate the performance of the practices listed in each level as well as a set of suggested metrics to aid the organizations that wish to monitor its processes.

### 3.3 Agile Maturity

There is a paper about case study from the British Telecom while developing an IT project (Benefield, 2010). According to the said case study, big organizations had increased the barrier for a successful agile adoption, so an agile maturity roadmap was presented. The Agile Maturity evaluates the agile performance in seven dimensions within five levels of maturity:

- **Level 1**: represents the appearance of software engineering best-practices. The goal of this level centers on breaking the incoherence of work and tools’ approach. Investments are needed to normalize people's technical knowledge, processes and whole organizations. Therefore, software engineering best practices such as unit tests and code review as configuration management are introduced and adopted;

- **Level 2**: represents continuous practices at the component level, i.e. best-practices are continuous and improved within small development teams, known as components. While the previous level intended to end the chaotic situation of organizations, this one aims to brew a repetitive work rhythm in this component team. The reusable automation enables the usage of scripts to installments, tests and configuration to hasten some processes;

- **Level 3**: represents the continuous practices among components, which means there is a continuous integration within local component teams. This level focuses on organizations as a whole, through intensive and regular tests of components interface and boundaries' coherence;

- **Level 4**: represents continuous integration among journeys, i.e. there is an incessant integration within global journey teams, similar to what happens in distributed development.
Occasionally, multiple products and services require a unison collaboration to be delivered to the final client. As so, this level aims to implement the concept of development team from Extreme Programming (XP), including practices such as code refactoring on a daily basis. In this level, tests are even more sophisticated, tools proliferate and scalability and performance extend to all components and journeys. Specialized continuous improvement teams exist and seek possible and unreported issues.; and epresents an o

• **Level 5**: represents an on-demand development maturity in which a development team presents high levels of productivity and is capable of effectively sharing knowledge among components and journeys. Service Oriented Architecture (SOA) is adopted throughout risk assessment and project planning to provide decoupled products. This level can be extremely difficult to achieve at great scale organizations, however, market differentiation benefits are so persuasive that it is attractive even to smaller scaled organizations.

For each of these five levels, they shall be evaluated by each one of the seven dimension present next:

1. **Automation of regression tests**: regression tests can guarantee software coherence with previous functionality after software code change with a pre-defined test suite. The automation of these tests makes the test process more efficient and less intrusive;

2. **Code quality metrics**: establishment of norms concerning the code writing conventions and organizational culture regarding design patterns, architectures and code review. These practices enables better software code management;

3. **Automation of deployment**: since it is important to assure the uniformity and coherence of behavior within development, test and production environment. The automation of this process aims to eliminate incoherence and improve its efficiency;

4. **Automation of configurations and best-practices management**: an efficient configuration management strategy enables the mechanization of various configurations and effectively manages software code. This configuration management strategy is comprised by norms and software code version controls;

5. **Interface integration tests**: are a pre-requisite for transparent deliveries that cross components within development, by identifying crossing points that needed to be checked. This saves the development team time while performing integration of different components, promoting functionality alignment;
6. **Test driven development**: guarantees a high level of confidence upon the development software code, since it must be submitted to pre-defined tests and succeed. Hence, defined functionality and clients expectation can be met by using this technique.; and

7. **Performance scalability tests**: guarantees the existence of scalability and performance attributes within tested components and products. It encourages critical analysis and identification of underdeveloped skills, as well as a potential gauge to evaluate the ratio of cost over benefits.

The combination of these five maturity levels and the seven dimensions allowed British Telecom to incrementally perform a better agile development process. However, this research effort approach is generic and too focused on technical issues. Moreover, the description of these levels and their practices are not very detailed, which leads to one’s need to seek other solution for the problem stated in Section 1.3.

Furthermore, this Agile Maturity is a roadmap designed within the context of British Telecom, which does not provide enough validation.

### 3.4 Agile Scaling Model

Agile scaling model is related to the application of maturity models onto agile processes and was introduced by Scott Ambler from IBM and labeled as Agile Process Maturity Model (APMM) (Ambler, Agile Scaling Factors, 2009). Its main goal is to offer a framework that provides context for the plethora of existing agile methodologies (Ambler, 2009a) (Ambler, 2008).

Agile Process Maturity Model, has three levels:

1. **Core Agile Software Development**: Scrum, XP, Agile Modeling, and Agile Data are placed in this level;

2. **Disciplined Agile Software Development**: Includes hybrid processes such as Scrum combined with XP, as well as Rational Unified Process (RUP), Open Unified Process (OpenUP), and Dynamic System Development Method (DSDM);; and

3. **Agility at Scale**: No examples are given here, but this level is about "explicitly addressing the complexities which disciplined agile delivery teams face in the real world" (Level 3 is Level 2 with one or more scaling factors).

Similarly, three levels are proposed for the managerial process maturity:
1. **Initial**: Characterized by the absence of particular practices;

2. **Organized**: Project management practices are established;

3. **Disciplined**: Intra-project practices support management decisions with numerical data.

As the present APMM research failed, the author evolved the previous research into the Agile Scaling Model (ASM) (Ambler, 2009b) which defines a roadmap for effective adoption and tailoring of agile strategies to meet the unique challenges faced by a system delivery team.

The ASM is a contextual framework for effective adoption and tailoring of agile practices to meet the unique challenges faced by a system delivery team of any size. Below, we present how the ASM distinguishes between three scaling categories, including each of these three scaling categories with practices and goals for each method:

1. **Core agile development**: Core agile methods, such as Scrum and Agile Modeling, are self-governing, have a value-driven system development lifecycle (SDLC), and address a portion of the development lifecycle. These methods and their practices - such as daily stand-up meetings and requirements envisioning - are optimized for small, co-located teams developing fairly straightforward systems;

2. **Disciplined agile delivery**: Disciplined agile delivery processes, which include DSDM and OpenUP, go further by covering the full software development lifecycle from project inception to transitioning the system into production. Disciplined agile delivery processes are: self-organizing, within an appropriate governance framework, and take both a risk and value driven approach to the lifecycle. Like the core agile development category, this one is also focused on small, co-located teams delivering fairly straightforward systems. To address the full delivery lifecycle, one needs to combine practices from several core methods (or adopt a method which has already done so) and adopt a few "traditional" practices, such as doing a bit of up-front requirements and architecture modeling, which have been tailored to reflect agile philosophies to round out your overall software process; and

3. **Agility at scale**: This category focuses on disciplined agile delivery where one or more scaling factors are applicable. The eight scaling factors are team size, geographical distribution, regulatory compliance, organizational complexity, technical complexity, organizational distribution, and enterprise discipline. All of these scaling factors are ranges, but not all of them are likely to be applied to any given project, so one needs to be flexible when scaling agile approaches to meet the needs of an unique situation. To address these scaling factors one will need to tailor disciplined agile delivery practices and, in some situations, adopt a handful of new practices to address the additional risks that one face at this scale.
As referred above, this proposal was highly debated among agile community. Even with intensive support from IBM, this model failed to achieve the expected recognition, remaining only an interesting related work as roadmap for agile scaling.

Since this work focus on agile scaling with various agile methodologies, rather than focusing the improvements on a single development process, this proposal fails to strengthen and enhance the quality of adoption of an agile methodology. Moreover, this Agile Scaling Model does not provide measurement goals nor does it suggest metrics to monitor and evaluate the performance of the processes.

3.5 Summary

In this chapter we analyzed four maturity models for software development processes. CMMI was first presented for its popularity and relevance, since it is considered a prestigious certification. Moreover, this model inspired and motivated various researchers to study different approaches in this area.

A fundamental and theoretical proposal was Agile Maturity Model, that aligned CMMI maturity levels with various practices from popular agile methodologies. However, CMMI and other maturity models are classified as generic and difficulties to apply it on organizations with single agile methodology adopted.

Then, a case study from British Telecom was presented along with a roadmap for agile adoption, labeled Agile Maturity. This roadmap presents interesting findings, but lacks more validation, since it only worked for one major organization.

Lastly, we showed the controversial Agile Process Maturity Model, that failed at the first instance, and a maturity model, which evolved into a remarkable related work for agile scaling. However, this proposal lacks the focus that was set for this research (improve the quality of development process) since APMM focuses on agile methodologies integration rather than single methodology improvement.

By analyzing their characteristics, advantages and drawbacks, all maturity models presented above provided an insight to produce an initial version of the proposal that will be put forward in the next chapter.
Chapter 4

Action Research - Iteration 1

Following the research method proposal, this chapter details the five stages of a complete research cycle. In this first attempt, we present the initial proposal, as well as the applied action and evaluation methods to experiment and validate the proposal.

4.1 Diagnosis

The Diagnosis phase was presented in the Chapters 1, 2 and 3, in which the problem and motivation for this thesis was highlighted as well as the related work in this area of research. As a result, from this analysis and diagnosis, an initial version of the proposal was designed and is exhibited below.

4.1.1 Initial Proposal

The initial proposal was a maturity model to classify the maturity of the software development process using Scrum methodology, in order to aid organizations achieve their goals of process improvement and quality assurance. Figure 4.7 illustrates the initial maturity model (with five levels of maturity) that was inspired on previous related work, namely the Agile Maturity Model and CMMI.

At level 1, the organizations are capable of developing functional software without any formal definition of Scrum development methodology. An organization classified at this level does not generally accomplish the schedule and budget plans agreed to in the initial project plan due to a lack of method and accuracy, since there are mostly ad-hoc process and they are highly
dependent on individuals acts and competences to achieve success.

Level 2 represents an initial adoption towards the Scrum methodology, specifically the implementation of the team structure and main meetings. An organization classified at this level has a clear assignments definition for the role each of its workers has in Scrum, it is able to keep the Scrum objects updated and visible, and accomplish the defined meetings. This level aims to achieve correct software requirements engineering, so that the final product lives to client's expectations.

In level 3, the organization accomplished all goals and objectives from level 2 and is yet capable of assuring customer relationship management. Moreover, these organizations have better management of the project schedules and customer acceptance.

At level 4, the organization accomplishes all goals and objectives from level 2 and 3, and also has the standardized project management in all these projects.

Finally, in level 5, organizations accomplish all previous levels and proactively seek new ways of process improvement. The practices of Sprint Retrospective Meeting and Daily Scrum are highly productive, enabling specific improvements to be introduced, so both internal team and clients can perceive the enhancements.
4.2 Action Planning

In order to validate the initial proposal introduced in the previous section, the action and evaluation methods were applied uniformly in the next iterations of this research.

As the first cycle of Action Research, a CMMI and an agile development expert were interviewed in order to evaluate the proposal. Additionally, the proposal was applied to an organization that develops software solutions using the Scrum methodology.

4.2.1 Action Method

In order to evaluate and validate the usefulness and effectiveness of this proposal, we made three cycles of AR that included interviews with Scrum, Agile and CMMI experts to validate the concepts and details of the proposal. In addition, appraisals and audits of Scrum maturity were performed in various organizations to evaluate usefulness, efficiency and impact. Moreover, scientific papers were written and submitted in order to receive feedback from the scientific community.

The appraisal to assess the Scrum maturity of organizations produced two outputs: the results from the assessment and collected feedback from pre and post-appraisal questionnaires, that were used for validation of the proposal. However, the results from Scrum maturity appraisal solely provide statistical outputs without influencing the evaluation of the model itself. All other forms of results detailed next are used for validation and evaluation purposes.

Afterwards, we present the methodology adopted for the various cycle of actions, including interviews, Scrum maturity assessments, and submission of scientific papers.

4.2.1.1 Interviews With Experts In This Area Of Study

In order to obtain validation of this proposal (maturity model for agile Scrum development methodology) a number of experts were interviewed throughout the research. In each interview, singular interview goals and consequent questions were setup.

Generally, these interviews are informal meetings to analyze the research done so far and present available results in order to obtain feedback from experts and professionals in the area of Agile development and CMMI. These interviews have an average duration of two hours, involving two experts within four interviews.

The collected feedback from these interviews is important and inspiring for future improvements
and for validating the current research.

4.2.1.2 Scrum Maturity Assessment and Post-Appraisal Questionnaires

Another way to validate this proposal’s work is to apply the model to organizations with strong contact with real business problems and extract their feedback. Therefore, the following process was adopted to assess the Scrum maturity of an organization and collect feedback:

1. **Pre-appraisal questionnaire**: First, a brief presentation of Scrum Maturity Model concept and its goals for each level take places. Then, we asked the organization to fill in the pre-appraisal evaluation form, which unfolds its beliefs about the level in which the organization should and will be classified;

2. **Appraisal**: Later on, if there was never an appraisal before, the appraisal for level 2 of Scrum maturity will begin. If they had obtained successful appraisals before, then the next level of Scrum maturity is appraised. This process consists in assessing the organizations’ practices against the checklist of the Scrum ones, which must be accomplished in order to obtain the intended level of Scrum maturity; and

3. **Post-appraisal questionnaire**: After the appraisal, the assessed organization receives a post-appraisal questionnaire to evaluate the proposal. This phase aims to extract all feedback, both positive and negative, about the proposal and the satisfaction level with the appraisal results, compared to the initial expectations.

The main learning that can be extracted from each Scrum maturity assessment comes from comparing between expected Scrum maturity, from the pre-appraisal questionnaire, and the actual maturity level resulted from the appraisal. Moreover, important feedback is provided during the post-appraisal questionnaire for evaluation purposes.

This process was applied to four organizations and seven different project managers, that represent a total of eight Scrum maturity assessment audits. The initial version of the appraisal questionnaire is available online and included in Appendixes A, B, C and D. After the first changes to the proposal, in the second cycle of AR these appraisal questionnaires became obsolete. Hence, the following appraisals assess Scrum maturity using the Scrum Maturity Model manually, i.e., they check if practices are accomplished against the theoretical model in Appendixes E, F, G and H.
4.2.1.3 Submission of Scientific Papers

In order to collect more validation for this research, three scientific papers were submitted to international conferences related to software engineering. These conferences are ranked as level C by the Excellence in Research for Australia (ERA) conference ranking of 2010. The acceptance of a paper validates the scientific value of this research and represents an addition to the scientific communication knowledge base.

Moreover, feedback from reviewers provides different insight and occasionally unexplored flaws that need to be perfected.

4.2.2 Evaluation Method

The evaluation method consists in analyzing the obtained results from along research cycles and present the main critic comments and general findings regarding the proposal.

The major part focuses on qualitative evaluation, which is comprised by constructive comments provided by individual experts and conference reviewers in this area of research, and by the feedback collected from professionals who work for the organizations audited by the proposal.

The quantitative evaluation takes into consideration the actual improvements made into audited organizations and the differences between expected outcome from the audit process and the actual results.

4.3 Action

This section describes the action taken within the first iteration of Action Research methodology in a single IT development organization while auditing the maturity of their development process using Scrum. Before this assessment, a CMMI and agile expert were interview for validation and feedback purposes.

4.3.1 First Interview with Expert Ana Paula Pereira

Expert Ana Paula Pereira (APP), an international CMMI, Agile and Scrum expert and also partner of an Agile coaching company, granted us two interviews to present our previous proposal and discuss its viability, usefulness and value.
At that moment the proposal was not validated yet, it was still purely a creation from the researcher with a slight foundation from related work and maturity models. This first version was mostly inspired from Agile Maturity Model described in Section 3.3., but adapted to this Scrum development methodology. This initial version is presented in Section 4.1.1 and further described in the Scrum Maturity Appraisal questionnaires in Appendixes A, B, C and D.

At first, APP found this model an interesting proposal with potential and research value. The identified problem of customer and development team collaboration is a serious problem among the professional community, and the proposed Scrum Maturity Model offers a way to improve their development process using Scrum, by stressing customer collaboration practices. However, there was an apparent inaccuracy by assigning the practice of Daily Scrum only to level 5. APP stated that Daily Scrum is one of the most relevant and beneficial practices from Scrum, so its implementation should not be delayed.

As for the Scrum maturity assessment, APP suggested the usage of a questionnaire and guidelines similar to appraisals made with CMMI, labeled as Standard CMMI Appraisal Method for Process Improvement (SCAMPI). Additionally, she pointed out the need to not only concentrate efforts to audit the quality of the process, but also the compliance with assigned practices to each level of Scrum maturity.

Overall, APP stated that this model represents a good start to tackle this customer collaboration problem. The proposed roadmap stresses this collaboration in level 3, which may decrease these problems and reduce the rate of IT projects failure. APP also suggested an experimental evaluation through the assessment of the maturity of a real organization. Therefore, we decided to follow the evaluation with the following Scrum maturity assessment.

4.3.2 Scrum Maturity Assessment on Organization ALPHA

Before evaluating this model by assessing an enterprise, the planned action for appraisal and consequential evaluation were all validated by an Agile and CMMI consultant, who provided important feedback and suggestions that were a posteriori applied.

Before evaluating this model by assessing an enterprise, the planned action for appraisal and consequent evaluation were all validated by an Agile and CMMI consultant, who provided important feedback and suggestions that were applied a posteriori.
4.3.2.1 Organization ALPHA

In the final quarter of 2010, a Portuguese enterprise, ALPHA, accepted to be assessed by the Scrum Maturity Model, in order to evaluate their maturity of Scrum development process.

Organization ALPHA is a Portuguese enterprise, derived from a technology research institute that provides IT solutions remotely to any place in the world using agile methodologies. That organization claims to have a young and advanced agile development team and that the enterprise is one of those that has the most potential in Portugal to follow Scrum development methodology seriously and successfully.

4.3.2.2 First Appraisal

We met a co-worker from the organization, who performs the role of Scrum Coach within most of the projects still being developed or recently finished.

Pre-Appraisal Questionnaire

First, we asked her to fill in the pre-appraisal evaluation form, which would, after a brief explanation of Scrum Maturity Model and its goals for each level, unfold her beliefs about the level in which the organization should be classified in. She picked level 3 of Scrum maturity.

Appraisal

Later on, the appraisal for level 2 of Scrum maturity began, and she started filling in the online form with a checklist of Scrum practices that must be fulfilled to obtain level 2. After she completed the form, we analyzed if all practices were performed in the organization and then checked if these practices were really performed. However, before continuing to prove the truthfulness of the answer, we realized that three practices were not accomplished. In fact, after the audit on the organization, that goal was not satisfied and we declared the appraisal as negative, assigning it level 1 of Scrum maturity.

As illustrated in Figure 4.8, in this appraisal organization ALPHA accomplished 36 out of 39 (about 92%) of the practices assigned to level 1 of the Scrum Maturity Model.

In order to achieve level, the following practices must also be accomplished:

- "Exists the artifact Release Burndown?":
• "Release Burndown is update according the reported progresses", and;
• "Exists the meeting Sprint Retrospective Meeting?".

Post-Appraisal Questionnaire

After the appraisal, we gave her the post-appraisal questionnaire for evaluation purposes. Although she was frustrated with the results, she answered that she understood the key failure of the organization, since they ignored the Scrum Retrospective Meeting. At the end, she praised the proposal for identifying the main flaws on the organization’s processes and we encouraged them to implement the remaining goal and reach the next level.

As she was visibly disappointed, we let her simulate the appraisal for level 3 in Scrum Maturity Model, since technically an organization is not allowed to undertake the appraisal for level 3 without bypassing level 2 first. The same process occurred:

1. **Pre-appraisal questionnaire**: she maintained her beliefs, though accepting the fact that, according to the model, the organization only deserved level 1;

2. **Appraisal**: she filled the form, comprised by a checklist of practices to accomplish for level 3 of Scrum maturity, until she realized that the organization would fail another goal and its practices. Indeed, the organization failed to have a Definition of Done for finished tasks, sprints and products, which, according to the proposal, is essential to succeed and obtain level 3 of Scrum maturity. If they were audited now, they would accomplish only 86% of the assigned practices for level 2 by failing three practices;
3. **Post-appraisal questionnaire**: we gave her, again, the post-questionnaire and she admitted humbly that her expectations were incorrect and she was pleased with the proposal, since it really helps organizations look further into their software development processes as a set of goals and use a staged representation of maturity to encourage process improvements.

The simulation of appraisal for level 3 ended and she went back to the office to plan the implementation of the missing goals and their practices so they can achieve level 2 and level 3.

4.3.3 **Paper Submitted to ICGSE 2011**

At the end of the first action research cycle, the lessons learned and actual state of the research were formalized and submitted to the 6th International Conference on Global Software Engineering (ICGSE), to be held in Helsinki, Finland.

On the 27th of April 2011 the conference sent back the feedback from its reviewers, providing important feedback that was analyzed in detail. According to them, the designed Scrum Maturity Model represents a roadmap for establishing the Scrum in projects, respecting the distance to the client and step-by-step implementation of the Scrum principles, practices and objects. The suggested model represents a good possibility of how to implement Scrum in projects by stages. However, they said the slash over maturity stages, despite being good, is not the optimal way, due to the loss of Scrum integrity.

This criticism can be disputed, since Scrum Maturity Model requires the implementation of all Scrum meetings, roles and objects in the first level, and only focuses on the quality of different practices in further levels.

Moreover, according to the reviewers, some Scrum principles were sometimes misunderstood, namely the role of a Scrum Master, the role of a Team, and the goal of a Retrospective. The online Product Owner managing the Product Backlog is a crucial point for Scrum and Agile.

The Scrum principles that were misunderstood, according to reviewer, were corrected in the end of this first iteration of AR, however the need for an online Product Owner is implicit, since the presence of a Product Owner is stressed throughout the proposed model.

At the end, the reviewers stated that basic Scrum principles/practices (as time-boxing, Sprint Backlog, Daily Scrum, Retrospective) are in the suggested model "postponed" to the higher maturity level. According to their experience, they should be practiced from the beginning.

This comment can be debated upon by the same arguments as the first comment, which stresses
the entire Scrum structure in the initial level, while the next levels focus on the quality of these practices, which will differentiate the correct Scrum practitioners from the incorrect ones.

Aware of the existing flaws in this initial stage, corrections were made. A set for a second iteration of AR to validate both the correctness (by presenting reasonable level description and its practices definition) and the usefulness (by presenting progress onto an applied organization of the maturity model) was created.

4.3.4 Main Results

From the first experimentation and validation of the proposal, important feedback was obtained from three sources: expert, Scrum coach and representative from organization ALPHA, and the reviewers from ICGSE 2011.

Although the proposal presents some flaws, corrective actions were already being planned and in progress. As so, changes were introduced afterwards, displaying a renewed Scrum Maturity Model with some changes regarding the practices assigned to each level and the definition of some other levels.

For instance, the main change was the goal “Successful Daily Scrum Meeting” being moved from level 5 to level 3, which according to most feedback was an important goal that should not be delayed. Since this change was valid and made sense, it was introduced to the model and prepared for the next iteration of action and consequent evaluation.

Moreover, the need for suggested metrics to monitor and improve the quality of the development process was identified from the APP Scrum coach’s feedback from organization ALPHA. Therefore, efforts were gathered in order to investigate this topic. In the end of the AR cycle, we produced an initial list of suggested metrics to motivate a better use and quality assurance for the practices.

4.4 Evaluating

The main goal for this phase of Action Research is to verify if the predicted impact and outcomes from this first application of the presented maturity model onto organizations and experts are observed. Moreover, the quality of the proposed solution is assessed in confrontation with the problem identified within this dissertation to reduce the rate of failed IT projects using agile methodologies. This can be done by addressing and stressing human collaboration factor among key stakeholders.
4.4.1 Interview

According to the results from the interview with APP, the expert affirms that this proposal may enhance customer collaboration by establishing a roadmap for process improvement and process classification that interests both parties. Although the proposal looked very immature, it seemed to be a good initial approach, that can be entirely enhanced in short term.

4.4.2 Scrum Maturity Assessment

The assessment of Scrum maturity in organization ALPHA provided an experimental action which resulted in level 1. According to the appraised organization, the outcome is unexpected, since they anticipated level 3 to be the result. The organization explains that the proposal offers a solution to identify practices from Scrum that are usually misunderstood or underrated. Moreover, it provides a focus on customer collaboration that is greatly stressed by agile methodologies, and a key factor for success.

Organization ALPHA identifies Scrum Maturity Model as a roadmap for process improvement with goals and focus on solving problems in customer relationship, even when they work at a distance. Through this assessment of Scrum maturity, it is possible to motivate them to implement the missing practice of Scrum Sprint Retrospective Meeting.

4.4.3 International Conference

The scientific paper submitted to ICGSE 2011 obtained a weak acceptance for the conference. Since this paper presented the initial proposal and the first cycle of evaluation, the initial phase of this investigation was validated by professional reviewers from the conference, by providing both positive feedback and suggestions for future improvement.

4.5 Specifying Learning

While analyzing this assessment, we learned the following situations:

- The proposal has successfully completed its goal as a roadmap for organizations that wish to know how are they are performing, according to the Scrum methodology practices;
- The goals for each level are adequate and well identified;
• There is some ambiguity within the post-evaluation questionnaire, resulting in misunderstandings for the participants;

• Some questions from the maturity appraisal were not objective and lacked some evidence;

• The initial proposal could be more complete and have a broader coverage of Scrum practices; and

• In general, it was a positive experiment.

4.5.1 Summary

As a newly assigned level 3 Scrum maturity organization must be evaluated, it was not possible to conclude whether this proposition can be the solution to our problem. Nevertheless, through this experiment it was possible to verify that level 2 of Scrum maturity is essential and well defined, something agreed upon by all interviewees in the post-appraisal evaluation process.

Through this assessment, it was possible to conclude that the proposal provides a roadmap for organizations. Even though the changes introduced by level 3 of maturity and its consequent improvements in the collaboration with clients could not be evaluated, a partial success was achieved as the applicability of the proposition as a solution to guide organizations adopting Scrum methodology was verified.

In order to validate the success (or failure) of this methodology, another iteration of Action Research must be completed through the appraisal of another organization that acquires level 3 of maturity and by reasoning of the verified changes, or while studying again organization ALPHA after their implementation of the goals suggested by Scrum Maturity Model for level 2 and then level 3.
Chapter 5

Action Research - Iteration 2

Following the first cycle of the Action Research, a second cycle took place and it described next according to the five stages of AR.

5.1 Diagnosis

After collecting all feedback from the previous iteration, changes were introduced into the Scrum Maturity Model, namely some minor improvements in practices description and some goals shift to other levels. Additionally, considering APP’s advice regarding the metrics to complement maturity models, a set of suggested metrics to monitor the performance of the practices listed in Scrum Maturity Model were introduced and evaluated in order to find out whether it was a viable complement for the proposal. The set of suggested metrics, the improved and final version, are presented in Appendixes E, F, G and H, along with the description of the goals, objectives and practices for each level of Scrum maturity.

5.2 Action Planning

The goal for this second AR cycle was to verify if the Scrum Maturity Model encouraged and steered process improvement in organization ALPHA and if the main goals of this proposal were accomplished: to improve software development with Scrum and reduce communication barriers. The goal also includes the validation of introduced improvements to the proposal and to the suggested metrics.
The improved version of the proposal, along with a set of suggested metrics to monitor the quality of the performed practices, was designed and re-experimented in organization ALPHA as well as checked with expert APP. It will be described in the next section.

5.3 Action

5.3.1 Scrum Maturity Assessment on Organization ALPHA

5.3.1.1 Organization ALPHA

Organization ALPHA was described previously in Section 4.3.2.1.

5.3.1.2 Second Appraisal on Organization ALPHA

A month after the first appraisal, the same organization ALPHA took another assessment in order to attempt a higher Scrum maturity level. For that, organization ALPHA placed immense effort to correct and implement the missing practices and unachieved goals identified in the previous Scrum maturity assessment.

Pre-Appraisal Questionnaire

As before, a pre-appraisal questionnaire for evaluation of the proposal first took place. Since they knew the overview of the Scrum Maturity Model, they aimed for level 2 of the Scrum maturity, because they were not able to implement the objective “Definition of done’ exists” at level 3 of Scrum Maturity Model.

Appraisal

During the appraisal phase, the organization successfully obtained level 2 of Scrum maturity, upgrading from previous level 1. As expected, organization ALPHA failed level 3 of Scrum maturity with the same three failed practices.

As illustrated in Figure 5.9, organization ALPHA failed 3 out of 21 (about 14%) of total assigned practices.

In order to achieve level 3, the following practices must also be accomplished:
• "Estimates for ongoing tasks are updated daily";
• "Definition of done’ achievable within each iteration"; and
• "Team respects 'Definition of done"."

Post-Appraisal Questionnaire

Later, during the post-appraisal questionnaire meeting, organization ALPHA provided important feedback, stating that this solution successfully improved their Scrum process, giving more emphasis to the people factor, both internal staff and the client. This emphasis is transformed into motivation in both producing better projects and more client satisfaction.

5.3.2 Second Interview with Expert Ana Paula Pereira

In the second meeting with expert Ana Paula Pereira (APP), the results from the previous iteration were presented and discussed.

The suggested metrics were shown to APP and she affirmed that they are an excellent complement to the Scrum Maturity Model, since even CMMI does not include a set of suggested metrics to monitor and measure processes listed in each level of CMMI. Additionally, APP referred Control Objectives for Information and related Technology (COBIT) as a best-practice that holds this concept of measurement and quality monitoring.

An important outcome from this interview was the identification of some misalignment with CMMI,
specifically at level 4 and 5, so objectives such as Performance Management and Causal Analysis Resolution were introduced.

### 5.3.3 Paper Submitted to ICSSEA 2011

Similarly to the previous iteration of AR, this version of the proposal and the lessons learned were formalized and submitted to another international software engineering conference: the 23rd International Conference on Software & Systems and their Applications (ICSSEA) to be held in Paris.

As the previous submission was rejected, this improved version included the learning from this iteration of AR and the accompanying of organization ALPHA.

On the 15th of June, the feedback from the conference’s reviewers arrived. According to them, the paper was a partial case study of implementation to present a model based on a flawed foundation.

They based their answer on the fact that the proposal attempts to impose rigid practices on what is, by definition, a methodology that focuses on flexibility and adaptability in the processes used to produce a software product. The real purpose of the model is to give organizations a way to measure how well they are doing Scrum - not to provide improvement of the product's quality, customer satisfaction or to ease eliciting requirements, etc. The world does not need a tool for measuring "agility". Measuring agility and attempting to improve it by developing a standard process, does that not destroy the very goal of being agile?

This comment can be answered by references mentioned in Chapter 1, namely in Section 1.3, on which various authors declare the benefits of a maturity model in agile development methodologies (Glazer et al., 2008). Throughout the present document, and especially in Chapter 3, the advantages of maturity models onto agile development methodologies for benchmarking and process improvements purposes are explained. By assessing the compliance of Scrum principles and practices, it is possible to ensure the correct application of the methodology in order to achieve the goals and outcomes, that are flexibility, customer communication and satisfaction. Therefore, agile practitioners would not freely develop software on their own way, but following important agile values and Scrum practices that are a solid development methodology (Braithwaite & Joyce, 2005) (Sutherland et al., 2007) (Kircher et al., 2001).

Even though improvements were made from the previous version of the paper, still some flaws were identified, namely the need for more and better experimental validation and more theoretical foundation for the need of a maturity model onto agile methodologies.
5.3.4 Main Results

The main changes to this version of Scrum Maturity Model were the following:

- According to the last evaluation of the proposal, level 2 of Scrum maturity showed solid goals, objectives, practices and suggested metrics. For this reason, level 2 presented minor changes in the text of the practices, remaining the majority of this level intact;

- Again, previous work evaluated level 3 as fairly solid, and only minor changes within the description of the practices were introduced;

- It was also possible to identify the ambiguity within level 4 for many organizations. In order to clarify it, the demand for “Standardized Projects Management” is only now applied to all agile Scrum projects within the organization, and not to all projects, since in an organization both waterfall development methodologies and agile, in different projects and clients, can coexist;

- The main result from this research cycle is that the top levels of this Scrum Maturity Model were slightly incomplete and ambiguous. Therefore, the objective “Causal Analysis and Resolution” was included to be used with Daily Scrum and Scrum Retrospective Meeting as to analyze the occurred impediments, differentiate them from incidents and problems, make causal analysis retrospective, and then take corrective actions against them.

Apart from changes in the Scrum Maturity Model, the suggested metrics also suffered alterations. The list of suggested metrics were trimmed by eliminating some metrics that are impossible to monitor or do not offer added value. For instance, in the second version of the proposal with an initial version suggesting metrics, the metrics for goal “Software Requirements Engineering” from level 2: "# of priorities defined" and "# of changed priorities" were classified as unfeasible, since they are difficult to track.

Additionally, it was observed that process improvement occurred in organization ALPHA by the assessment of their Scrum development maturity aided by their desire to attain higher classification within Scrum Maturity Model.

The feedback from ICSSEA 2011 disclosed the need for more validation of the proposal. Hence, the actual model was diagnosed and the next steps of action were planned.
5.4 Evaluating

The main goal for this phase of Action Research is to verify if the predicted impact from the previous experimentation of the second version of Scrum Maturity Model onto organization ALPHA is observed.

This is achieved by re-assessing the Scrum maturity of organization ALPHA (ALPHA failed previous appraisal to achieve the level 2 of Scrum maturity), and verify whether improvements have been accomplished from previous appraisal. ALPHA’s Scrum maturity increased by the guidance provided for process improvement to achieve level 2.

Hence, the benefits of the proposal can be evaluated from the action performed in this second cycle of Action Research.

5.4.1 Interview

While evaluating the improved Scrum Maturity Model and the suggested practices, APP stated that the improved model is more solid and she was pleased with the introduction of suggested metrics as an complement for this proposal.

The set of suggested metrics enables a more accurate quality assessment for Scrum practices, highlighting the customer collaboration practices that involve the presence and participation of the customer with the development team. These metrics also aid quality differentiation from various organization, providing another benchmarking method beside the Scrum Maturity Model.

5.4.2 Scrum Maturity Assessment

The second Scrum maturity assessment in organization ALPHA provided a successful validation for this proposal because it successfully lead this organization to improve their Scrum development process by implementing missing practices that are fundamental to Scrum ideology.

According to the feedback from organization ALPHA, it is their intention to achieve a higher level of Scrum maturity by implementing the missing practices from previous failed assessment for level 3.
5.4.3 International Conference

An improved version of the previous paper submitted to ICGSE was sent to ICSSEA in order to share findings from this investigation and obtain feedback from professional reviewers. This submission resulted in a rejection, mainly due to lack of evaluation. This fact was analyzed, and it means that the validation phase does not provide enough strength and reliability to this proposal. Therefore, it was decided that the next evaluation cycle would involve more and different organizations in order to better validate the proposal.

5.5 Specifying Learning

By analysis from this assessment and interviews with experts, it was possible to identify the following situations and lessons learned:

- Although maturity models within agile context are highly polemic (as the reviewer from the conference shows), the proposal had successfully completed its goal as a roadmap for organizations that wish to know how they are performing according to the Scrum methodology practices;

- This proposal promotes motivation for internal staff and external clients to improve and seek higher maturity levels;

- The goals, objectives, practices and suggested metrics at each level are adequate and well-identified;

- The existence of suggested metrics is totally relevant and, although missing in CMMI, it exists in COBIT; and

- There is some ambiguity within the post-evaluation questionnaire, resulting in participants’ misunderstanding.

In general, it was another positive experiment with few experimental results.

5.5.1 Summary

As organization ALPHA failed level 3 Scrum maturity appraisals, organization ALPHA will make further efforts to implement required practices and continue self-improving in order to bring about
better results without forgetting agile principles. It was possible to prove through this experi-
ment that level 2 of Scrum maturity is essential and well-defined, a conclusion agreed on by all
interviewees in the post-appraisal evaluation process.

Through this assessment, it was also possible to conclude that the proposal provides a roadmap
for organizations. By evaluating improvements and increasing Scrum maturity, organization AL-
PHA will successfully implement the missing practices for level 2 and will gather efforts to achieve
level 3 of Scrum maturity. Hence, the applicability of the proposal to guide organizations adopting
Scrum methodology was verified.

In order to validate the complete success (or failure) of this methodology, more iterations of Action
Research must be completed through the appraisal of other organizations that acquire various
levels of maturity as well as reasoning the verified changes, or by studying again organization
ALPHA after their implementation of the goals suggested by Scrum Maturity Model for level 3, 4
and maybe 5 of maturity.

In the next subsection the final evaluation phase is presented, which comprises larger and a more
complete experimental set of experts and audited organizations.
Chapter 6

Action Research - Iteration 3

Following the two previous cycles of Action Research, a final cycle occurred in order to validate the proposal for the Scrum Maturity Model.

6.1 Diagnosis

According to the previous cycle of research, the present model needed minor changes within the description of the practices and set of suggested metrics were corrected in this iteration. The main drawback of the previous proposal was the lack of validation, since it was only evaluated by one expert and organization.

So, this third and last cycle was planned in order to attain more validation for this proposal.

6.2 Action Planning

It was planned to assess more organizations in order to collect more feedback about of the usefulness and effectiveness of this proposal. The proposal was validated by two experts in agile development methodology and three different enterprises with six Scrum maturity assessments.
6.3 Action

6.3.1 Scrum Maturity Assessment on Organization BETA

6.3.1.1 Organization BETA

Organization BETA is focused on cutting waste in software delivery through the practice of lean and agile concepts they have been implementing for a year now.

They have seven developers in Ukraine (who assume the Scrum role “Team”) and three project managers in Portugal (that take on the role of “Scrum Master”) involved in two or three projects. BETA is an excellent example of distributed Scrum, that intends to manage the resources wisely without creating waste and still fulfill the needs of the client, considering the cooperation and distance problems.

6.3.1.2 First Appraisal on Organization BETA

Pre-Appraisal Questionnaire

Within the pre-appraisal questionnaire, the organization predicted the possible outcome from the audit as level 2 or 3 of Scrum maturity, since they were aware of the lack of mechanisms to measure and monitor process metrics and formal processes for continuous improvement.

Appraisal

As the assessment occurred, the organization was confronted with the checklist of the practices which had to be fulfilled in order to achieve level 2 of Scrum maturity. According to the appraisal, they failed the “Basic Scrum Management” goal by missing the objective “Scrum meetings occur and are participated in”. Actually, they ignored the need for a Scrum Retrospective Meeting and neglected the importance of a formal Daily Scrum Meeting and Scrum Review Meeting.

As illustrated in Figure 6.10, organization BETA accomplishes about 9 out of 43 (about 80%) practices assigned to level 2 of Scrum maturity.

In order to achieve level 2, the following practices must also be accomplished in the next assessment:

- “Daily Scrum Meeting occurs exactly once per workday”;

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Figure 6.10: Result from first Scrum maturity appraisal for level 2 at organization BETA

- “Daily Scrum Meeting is, at least, attended by Scrum Master and Team”;
- “Sprint Review Meeting occurs exactly once per Sprint”;
- “Sprint Review Meeting is attended by Stakeholders, Scrum Master, Product Owner and Team”;
- “Sprint Retrospective Meeting occurs exactly once per Sprint”;
- “Sprint Retrospective Meeting is, at least, attended by Scrum Master and Team. Optionally, the Product Owner can attended the meeting”;
- “Daily Scrum Meeting happens every Sprint-day”;
- “Sprint Review Meeting occurs after the development work ended”, and
- “Sprint ends with Sprint Retrospective Meeting”.

Post-Appraisal Questionnaire

During the post-appraisal questionnaire, the organization did not show any sight of disappointment but instead was very excited about the results, displaying motivation and constructive analysis toward the results and opportunities for future improvement for a better development process. First, they argued that it is very difficult to communicate with clients. In particular it was hard to request their active collaboration by, for instance, being present at the end of each sprint, which caused them to fail practices such as “Sprint Review Meeting occurs exactly once per Sprint” and “Sprint Review Meeting is attended by Stakeholders, Scrum Master, Product Owner and Team”.

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They also claimed against the failed “Daily Scrum occurs exactly once per workday” practice, since the organization affirms there are “Casing Meetings” from Lean development principles. However, the nature of these meetings is different.

Nevertheless, the organization agreed to rethink these failed practices, and the interviewed project manager planned to immediately launch the implementation of the Scrum Retrospective Meeting, since it has great potential benefits that had not yet been considered.

When the interview ended, the manager gave the following feedback regarding the Scrum Maturity Model: “This proposal provides a good roadmap for IT organizations by offering goals and objectives per level to evolve and gradually improve, tackling one goal at a time.”; “For higher levels of maturity, it is required much more stability to see the improvements and, although the existence of suggested metrics is brilliant, it lacks information on how to implement the monitoring mechanism.”. As a final word, a Scrum Master from the organization stated: “Many organizations nowadays declare themselves as agile, but how agile can they be when there are no definitions or rules? The existence of this proposal can surely differentiate the successful agile practitioners from the others.”

6.3.2 Scrum Maturity Assessment on Organization GAMMA

6.3.2.1 Organization GAMMA

Organization GAMMA, an agile IT consulting company, also accepted to be a part of this assessed by providing three of their four project managers to be audited through the Scrum Maturity Model.

They have around forty employees, with about thirty in the headquarters and ten distributed in two other branches. Currently, they employ four project managers and the CEO arranged three meetings with three of them in order to receive feedback.

6.3.2.2 First Appraisal on Organization GAMMA with Project Manager GAMMA1

Project Manager GAMMA1 had been recently promoted to perform the more technical oriented role of project manager. He has background in the business intelligence field, and now focuses more on the leadership and management of the team of developers in consulting projects.

Pre-Appraisal Questionnaire
During the pre-appraisal questionnaire phase, while analyzing the goals required for each level, he determined levels 1 or 2 as a possible result, because he was fully aware that the organization is on the early stage of agile implementation and several goals might not be fulfilled.

**Appraisal**

As the appraisal for level 2 of Scrum maturity occurred, the missing practices were immediately identified. They missed the "Sprint Retrospective Meeting occurs exactly once per Sprint" practice. Unfortunately, this missing feature made this organization fail level 2, although most other practices were accomplished.

As illustrated in Figure 6.11, in a project managed by GAMMA1, organization GAMMA, accomplishes 40 out of 43 (about 93%) practices assigned to level 2 of Scrum maturity.

![Figure 6.11: Result from first Scrum maturity appraisal for level 2 at organization GAMMA with Project Manager GAMMA1](image)

The failed practices are related with the Scrum Retrospective Meetings:

- "Daily Scrum Meeting occurs exactly once per workday";
- "Daily Scrum Meeting is, at least, attended by Scrum Master and Team";
- "Sprint Review Meeting occurs exactly once per Sprint";
- "Sprint Review Meeting is attended by Stakeholders, Scrum Master, Product Owner and Team";
- "Sprint Retrospective Meeting occurs exactly once per Sprint"
• “Sprint Retrospective Meeting is, at least, attended by Scrum Master and Team. Optionally, the Product Owner can attend the meeting”;

• “Daily Scrum Meeting happens every Sprint-day”;

• “Sprint Review Meeting occurs after the development work ended”, and;

• “Sprint ends with Sprint Retrospective Meeting”.

Post-Appraisal Questionnaire

The project manager agreed with the results, although he was slightly disappointed with the obtained level. The ground for this result, he said, was that many unachieved practices were not given the importance they should have and they wanted to focus more on current client needs without having to worry about overworking their employees. Another explanation was that, given the dimension of his team, so much formality in the development process was not really necessary, as long as the results show up and the clients are satisfied.

For evaluation purposes, we allowed the project manager to inspect the next level, which turned out to be another failed appraisal, but this time for level 3 the organization failed the “Sprint Backlog Items are split into tasks” practice when all other practices were accomplished. The project manager was relieved with this result as he believed that they could achieve up to level 3 of Scrum maturity with a relative ease, even though it required immense work in employees’ culture to implement them.

He agreed that the Scrum Maturity Model has potential to grown into a certification, that will provide more market differentiation. Another interesting point is that it might not be very expensive to concentrate efforts and obtain an acceptable level 3 of Scrum maturity.

6.3.2.3 First Appraisal on Organization GAMMA with Project Manager GAMMA2

Project Manager GAMMA2 is in charge of four development projects, each of them with only one or two developers located in Viana do Castelo focusing on the development of applications for smart phones. The main challenges for him are how to coordinate and perform the role of middle man between the client’s needs and developers’ performance using Scrum, since he has less than a year experience with this development methodology.

Pre-Appraisal Questionnaire
Project Manager GAMMA2 did not have high expectations and pointed out level 2 as a possible outcome.

**Appraisal**

During the appraisal, they failed many practices such as: "Release Burndown Chart exists", "Sprint Burndown Chart exists" and "Sprint Retrospective Meeting occurs exactly once per Sprint". As illustrated in Figure 6.12, organization GAMMA, in a project managed by GAMMA2 accomplishes 35 out of 43 (about 81%) practices assigned to level 2 of Scrum maturity.

![Figure 6.12: Result from first Scrum maturity appraisal for level 2 at organization GAMMA with Project Manager GAMMA2](image)

The eight failed practices are the following:

- "Release Burndown Chart exists";
- "Release Burndown Chart is updated according to reported progress";
- "Sprint Burndown Chart exists";
- "Sprint Burndown Chart is updated according to reported progress";
- "Sprint Retrospective Meeting occurs exactly once per Sprint";
- "Sprint Retrospective Meeting is, at least, attended by Scrum Master and Team. Optionally, the Product Owner can attended the meeting";
- "Sprint Review Meeting occurs after the development work ended", and;
- "Sprint ends with Sprint Retrospective Meeting".

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Post-Appraisal Questionnaire

In the post-appraisal questionnaire phase, the project manager explained that due to the unawareness of the technical capabilities of the project management tools, it was not possible to maintain updated and correct burn down charts that caused them to fail this level 2 of Scrum maturity. Concerning the missing practice of Scrum Retrospective Meeting, he stated that it is very difficult to have formal meetings with the distributed team, which seriously affected the performance of this communication.

For evaluation purposes, we allowed the project manager to inspect the fully detailed Scrum Maturity Model. They did not accomplish practices like: "Definition of one' is achieved in each iteration" and "During Sprint Review Meeting Product Owner and other stakeholders provide feedback".

In the end, the project manager was satisfied to learn more about Scrum and which practices he should improve in further projects. He stated that this maturity model might be an important tool to measure their current performance and guide them to continuous improvement.

6.3.2.4 First Appraisal on Organization GAMMA with Project Manager GAMMA3

Project Manager GAMMA3, a very experienced and enthusiastic Scrum practitioner with a Scrum Master Certification, is leading the company to implement the backbone for Scrum adoption. It has been almost a year since they started trying to reach this objective, and, at the moment, they are in the final stage.

For him, continuous improvement is the core strategy to achieve a competitive advantage. In order to achieve this goal, he leads the implementation and integration of several support systems to aid the development process. He was in charge of a development project with three developers and a three-month time period.

Pre-Appraisal Questionnaire

The pre-appraisal questionnaire revealed that he had high expectations and confidence in their maturity, choosing level 4 or 5 as the expected result from the appraisal.

Appraisal
When the appraisal began, they succeeded to fulfill level 2 practices, and then level 3. Surprisingly, level 4 was also achieved, because all his previous projects were managed with a standard method and he had a data mining module that defined, monitored and measure their development process and metrics.

In the final appraisal for level 5, they failed the practices: “Successful Retrospective Meetings result in concrete improvement proposals” and “Successful Retrospective Meetings’ lessons learned are recorded to a knowledge base”.

As illustrated in Figure 6.13, organization GAMMA failed to achieve level 5 of Scrum maturity by failing 3 out of 12 (about 25%) assigned practices for this level 5.

![Figure 6.13: Result from first Scrum maturity appraisal for level 5 at organization GAMMA with Project Manager GAMMA3](image)

The three failed practices are the following:

- “Results in specific improvement proposals”;
- “Some proposals are implemented”; and
- “Lessons learned are recorded”.

**Post-Appraisal Questionnaire**

The project manager was satisfied with the results, seeing his efforts recognized by external parties and was not disappointed with the obtained level 4 of Scrum maturity, since they were working on the quality of retrospective meetings.

His final feedback for this proposal was the following: “This proposal is an excellent tool for deeper insight, to rethink agile path. Moreover, this proposal motivates the adoption of Scrum by
separating several objectives in levels. Agile is easy to learn, however very hard to master, thus, it is very important for proposals like these to exist in order to aid organizations to correctly adopt Scrum.

6.3.3 Scrum Maturity Assessment on Organization DELTA

6.3.3.1 Organization DELTA

Organization DELTA is a large international company that provides technology solutions and services around the world. In their office in Portugal, they employ around four hundred professionals, delivering both consulting services and software solutions. Their development projects are usually large, involving more than forty people and a twelve-month period.

6.3.3.2 First Appraisal on Organization BETA with Project Manager DELTA1

Project Manager DELTA1 is the senior software architect and performs team coaching regularly. He worked for a leading company using agile methodologies, where he learned a lot about agile best practices.

Currently, the project he is working on involves forty people, three scrum teams, a one year time period, and they are using Scrum with this client for the first time. At the moment, the project is on the production and deployment phase.

Pre-Appraisal Questionnaire

Project Manager DELTA1 suggested level 3 as the result, since he was aware that the company missed the goals “Measurement and Analysis Management” and “Performance Management”.

Appraisal

During the appraisal for level 2 of Scrum maturity, Project Manager DELTA1’s project succeeded in accomplishing all practices except “Sprint Burndown Chart exists” practice.

As illustrated in Figure 6.14, organization DELTA accomplishes 41 out of 43 (about 95%) assigned practices for level 2.

In order to achieve level, the following practices must also be accomplished:
• “Sprint Burndown Chart exists”; and

• “Sprint Burndown Chart is updated according to reported progress”.

Post-Appraisal Questionnaire

Project Manager DELTA1 intensely argued against the need for a sprint burndown chart that is only used to manage small two weeks sprints and creates waste by manually building such a chart (note that the organization uses manual means to follow Scrum.).

By analyzing the next levels, Manager DELTA1 felt frustrated again because he would fail level 3 due to the inexistence of the sprint burndown chart stressed in the goal "Iteration Management”, having two failed practices in a total of twenty-six assigned to level 3 of Scrum maturity. However, to achieve levels 4 and 5, he agreed that more efforts were needed and that they intended to move further in their continuous improvement.

As final words, he said: "What I see here is a very interesting approach in agile methodologies research. The roadmap is very good for new enterprises to adopt Scrum and a nice differentiation model for companies in the development industry.”

6.3.3.3 First Appraisal on Organization BETA with Project Manager DELTA2

Project Manager DELTA2 is also an experienced Scrum practitioner, and is currently managing a project for more than four years already that involves three Scrum teams. The client does not collaborate as closely as the company would wish, so Scrum was only applied as internal
communication and work methodology.

**Pre-Appraisal Questionnaire**

After the overview of the maturity model, he selected level 2 as the most likely result of the assessment.

**Appraisal**

As the assessment started, "Sprint Burndown Chart exists" practice was found to be missing just like in the previous project manager. Moreover, they did not have "Sprint Review Meeting occurs exactly once per Sprint" practice formally implemented, only some demonstrations once or twice a year. Another missing practice was "Sprint Retrospective Meeting occurs exactly once per Sprint" as, according to company's culture, it only happens right after the Scrum Review Meeting. As illustrated in Figure 6.15, they accomplished 32 out of 43 (about 75%) assigned practices for level 2.

[Figure 6.15: Result from first Scrum maturity appraisal for level 2 at organization DELTA with Project Manager DELTA2]

They failed the following practices:

- "Sprint Burndown Chart exists";
- "Sprint Burndown Chart is update according to reported progresses";
- "Sprint Review Meeting occurs exactly once per Sprint";
• “Sprint Review Meeting is attended by Stakeholders, Scrum Master, Product Owner and Team”;

• “Sprint Retrospective Meeting occurs exactly once per Sprint”;

• “Sprint Retrospective Meeting is, at least, attended by Scrum Master and Team. Optionally, the Product Owner can attend the meeting”;

• “Sprint Review Meeting occurs after the development work ended”;

• “Sprint ends with Sprint Retrospective Meeting”;

• “Product Owner has the knowledge to define priorities”;

• “Product Owner has product’s vision”, and;

• “Product Backlog items are in sync with Product Owner’s product vision”.

Post-Appraisal Questionnaire

During the post-appraisal questionnaire, he commented the following: "Agile methodologies stress communication a lot. Its qualities are not shown in tiny projects, but in large scale projects in which real problems occur. In these big projects, flexible and constant communication is needed to maximize and optimize the work performed. This proposal presents a staged maturity model to guide Scrum’s implementation, performance and usage to differentiate enterprises, which is a magnificent idea.”

6.3.4 Third Interview with Expert Ana Paula Pereira

According to expert Ana Paula Pereira (APP), the first three levels of Scrum maturity have sufficient detail and they make a robust proposal. Nevertheless, level 4 and 5 required some more detail, more specifically practices to enhance the quality of Scrum Retrospective Meeting are lacking. For instance, practices such as "Question five W's", "Identify problems and incidents" and "Build cause-effect diagram to identify problems" would enhance the quality of the inner inspection from retrospective meetings to seek continuous improvement.

Nevertheless, APP also stated that the improved version of the suggested metrics for level 4 of Scrum maturity presents an excellent feature, since not even CMMI has recommended metrics. These suggestions allow one to monitor the current state of the process and to discover presents suggested metrics. These suggested metrics allow the monitoring of the current state of the
process and discover where to put efforts for improvement, apart from analyzing quantitative statistics from the development process.

About the concept as a whole, APP accepts that scattering Scrum by levels and stages results in integrity loss, however she also agrees that Scrum Maturity Model is not intended to split Scrum into five levels and areas, but rather to provide more emphasis on different areas in each level. Furthermore, it was assured that if this proposal does not become a standard worldwide, it will at least be an extraordinary tool to be used in Scrum Retrospective Meetings as self appraisal and assessment of own maturity.

6.3.5 First Interview with Expert Tiago Andrade e Silva

Expert Tiago Andrade e Silva (TAS), also an international Agile and Scrum expert as well as a Scrum coach, works for a top international IT company, and granted us an interview to present to him the proposal and discuss about its viability, usefulness and added value. He was pleased with the concept that involves the evaluation of the maturity of the Scrum process, and provided precious feedback and validation for the definition of the practices of each level and within each goal.

Most of the original proposal was validated and accepted and while some minor description practices were changed, all goals and objectives remained intact.

Additionally, the results and validation achieved so far were presented to him, and he was glad with the amount of assessments accomplished. Overall, TAS found this proposal very interesting, offering a roadmap for organizations to implement and improve their Scrum development process, as well as a benchmark tool to compare the Scrum maturity of different organizations, motivating the organization and its clients to self-improve in order to achieve competitive advantage.

6.3.6 Paper Accepted at ICSEA 2011

The acceptance of the proposal provided acknowledgement from our peers within the scientific community.

Aside from the positive feedback about the proposed solution, some problems regarding the presentation of the research were identified. Initially, the present research was based mostly on the credibility of the CHAOS report but, according to the reviewers, more references were needed in order to base the research problem and motivation.

It was also mentioned that the presented results are not broad enough, since this limitation rises
doubt for evaluation process’ strength. Another issue concerned the lack of description for the research method, since the limitations of Action Research were not included in the paper.

These constructive comments were analyzed and the paper corrected, which resulted into the final submission to the conference for publication in the proceedings. The paper is also available in the Appendix I.

### 6.3.7 Main Results

After the interview and assessments made with various professionals in this area of agile development process, a major validation was obtained along with the positive feedback from the interviewees.

Most of the assessed organizations planned to implement and adopt the missing practices within two months, which is in accordance with the goal for this research: a roadmap for Scrum development process improvement.

Regarding the proposal, in this iteration some semantic enhancements were introduced to the practices description.

### 6.4 Evaluating

The qualitative evaluation provided from both experts and professionals from various evaluated organization verified the usefulness of the proposal for process improvement assessed, in particular for processes focusing on customer collaboration. The main goal set for this phase was to verify the proposal in more organizations and experts.

#### 6.4.1 Interview

We concluded that the first three levels were well structured, while top levels were considered fairly difficult to achieve due to their requirement for standard management and causal analysis resolution. Moreover, it was stated by professionals that the present proposal is a very good approach for Scrum adoption, self-inspection and continuous improvement.
6.4.2 Scrum Maturity Assessment

This third iteration of the research considered the six performed assessments in three organizations in Portugal, represented by a small, a medium and a large-size company. Although the average level of maturity is not very high, many of the assessed organizations were able to reach level 3 by focusing efforts to implement the missing goals, objectives and practices.

Most of the assessed organizations were pleased with the proposal, since the Scrum Maturity Model allowed them to rethink their current practices and envision a path defined by each level of Scrum maturity. Therefore, the Scrum Maturity Model presents an excellent roadmap for organizations that seek Scrum methodology adoption using process improvement.

They also agreed that level 3 presents good focus on customer and development team’s collaboration, providing increased motivation to enhance this issue.

6.4.3 International Conference

The acceptance of the research paper that summarizes this proposal acknowledges it as a scientific contribution of merit. This fact validates the value of this research and the proposed model as a partial solution for the problem identified in Section 1.3.

6.5 Specifying Learning

The major finding is that although many organizations define themselves as Scrum followers, several of the basics were not taken into account, and only core and easier values and principles were implemented.

The most common missing practices for the first level of Scrum Maturity (level 2), were “Sprint Review Meeting occurs exactly once per Sprint” and “Sprint Retrospective Meeting occurs exactly once per Sprint”. In level 3, “Definition of done’ is achieved in each iteration” is the most commonly failed practice.

Top levels were scarcely achievable due to their requirements for mechanisms and concepts for measurement, analysis of process metrics, causal analysis, resolution of problems and identified impediments, which were not popular among IT development organizations.
6.5.1 Summary

After this iteration, we conclude that the proposal provides a good roadmap for organizations that want to implement Scrum, align their position for benchmarking purposes or for improving their Scrum practices. All feedback collected from interviews with experts and professionals gave us a great deal of confidence and insight to continue our research, improve the proposal even more and possibly scale its usage and define it as a certification. The acceptance of the paper: “Scrum Maturity Model” acknowledged of our scientific contribution to this research area and provided even more feedback from reviewers.
Chapter 7

Final Proposal

Throughout the three cycles of validation of Action Research, this thesis proposes a roadmap for organizations to manage IT projects with Scrum, i.e., more focused on client role, and providing motivation toward self-improvement.

As mentioned in Chapter 3, maturity models such as CMMI can classify an organization's process performance and encourage process improvement and excellence in service and products. They provide a roadmap to guide organizations to adopt best-practices in an incremental approach.

Most approaches have an ample and broad scope, that allow them to be widely accepted and implemented. However, this one is followed by highly generic goals and practices that cannot be easily understood and applied. Therefore, the present proposal classifies maturity in a focused scope of Scrum development methodology processes.

7.1 Overview

The Scrum Maturity Model's main purpose is to aid and guide organizations that develop IT projects and encourage self-improvement, by taking a special approach to the client's role. Furthermore, this proposal helps organizations that are not familiar with Scrum, but want to adopt it using an assess incremental approach.

As illustrated in Figure 7.16, the final version of this proposal introduces five levels for Scrum development methodology with respective goals, objectives, specific and suggested practices. The number of levels is standard, thus making it easier to compare with other maturity models.

A Scrum maturity assessment requires a form, which answers if the organization performs the
As a complement to this proposal, every level includes a set of suggested metrics to monitor and assure the quality of the various practices and goals assigned to each level of Scrum maturity.

We now present an overview of the proposal, while the full details are included in Appendixes E, F, G and H. The proposal contains a complete set of goals, objectives, practices and metrics for each level of Scrum maturity.

### 7.2 Level 1 - Initial

This first and lowest level of maturity can be assigned to any organization that uses Scrum; it represents the absence of goals for process definition or improvement. The explicit definition of agile development with Scrum methodology does not exist within organizations classified as belonging to this level.

The main issues of organizations at this level are over-time and over-budget projects, poor communication among stakeholders, and unsatisfactory quality of the final product. These organizations operate on their own and their success is highly dependent on competent and skilled individuals, rather than on standardized and capable teams.

Organizations that do not comply with the goals defined for level 2 are classified as level 1.
7.3 Level 2 - Managed

In level 2 of Scrum maturity, software development practices appear more structured and complete than in level 1, especially due to the fulfillment of two of the main goals set for this level of maturity

- **Basic Scrum Management**: this goal dictates practices that organizations in level 2 must accomplish to ensure the minimum acceptable usage of Scrum methodology. Although all Scrum roles, objects and meetings must exist in organizations at level 2, they might not be used correctly nor effectively.; and

- **Software Requirement Engineering**: this goal comprises a set of practices that organizations at this level must comply with in order to achieve satisfaction from the quality of the final product created by the vendor organization.

As can be realize in Figure 7.17, the first goal of Basic Scrum Management has four objectives, and each of these objectives has some specific practices that organizations must accomplish.

![Figure 7.17: Goals and objectives for level 2 of Scrum Maturity](image)

For instance, a defined objective "Scrum artifacts exist" means that the "Existence and update of Release Burndown according to reported progress" is accomplished, nonetheless this practice does not include the performance of daily and coherent report of actual development progress.

As illustrated in Figure 7.18, the goal "Software Requirements Engineering" stresses the clear definition of a Product Owner to steer the development team and the correct application of Scrum concepts regarding the Product Backlog Management and Successful Sprint Planning Meetings.
In order for an objective to be attained, the listed practices must be also accomplished. For instance, the objective “Clear Definition of a Product Owner” is associated with five practices that must be met. Additionally, we purpose metrics to measure the quality of the implementation of these practices.

![Figure 7.18: Details for goal "Software Requirements Engineering" in level 2 of Scrum Maturity](image)

All other objectives and practices from this goal have the purpose of promoting basic concepts, the usage of Scrum methodology and to provide the foundation for further improvements, even if according to agile development practitioners, they are not fully correct.

The full set of practices and suggested metrics for level 2 is presented in Appendix E.

### 7.4 Level 3 - Managed

Level 3 of this maturity model has its major focus on the relationship with clients and on timely deliveries, including two chief goals:

- **Customer Relationship Management**: this goal emphasizes the importance of the client and the efforts required to maximize the collaboration with the customer side, even considering the difficulties mentioned in Chapter 1. A set of practices that must be satisfied in order to solve the core problem of this research are defined; and
• **Iteration Management**: this goal is linked to the previous one, since both contribute to raise customer satisfaction levels. In order to achieve it, a set of practices must be fulfilled and implemented so the organizations always deliver their projects and sprints on time and according to their budgets.

Figure 7.19 shows the objectives for each goal of this level of Scrum maturity:

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objective</th>
<th>Practice</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Relationship Management</td>
<td>Definition of “Done” exists</td>
<td>(...)</td>
<td>(...)</td>
</tr>
<tr>
<td></td>
<td>Product Owner available</td>
<td>(...)</td>
<td>(...)</td>
</tr>
<tr>
<td></td>
<td>Successful Sprint Review Meetings</td>
<td>(...)</td>
<td>(...)</td>
</tr>
<tr>
<td>Iteration Management</td>
<td>Sprint Backlog Management</td>
<td>(...)</td>
<td>(...)</td>
</tr>
<tr>
<td></td>
<td>Planned Iterations</td>
<td>(...)</td>
<td>(...)</td>
</tr>
<tr>
<td></td>
<td>Measured Velocity</td>
<td>(...)</td>
<td>(...)</td>
</tr>
<tr>
<td></td>
<td>Successful Daily Scrum</td>
<td>(...)</td>
<td>(...)</td>
</tr>
</tbody>
</table>

The first goal of “Customer Relation Management” has three objectives that will guide the organizations to have a better communication and understanding with the client. For instance, a specific practice is “Definition of Done is achieved at each iteration” that will aid organizations to have a mutual understanding of the short term goals.

Other stressed practices are: “Product Owner is available when team is estimating” and “Feedback is given by client stakeholders during Sprint Review meeting” as they are intended to draw the two sides of the project closer. This cooperation is not easy for clients and development organization are separated by physical and cultural distances, therefore these practices represent the core of this maturity model and help mitigate the negative effects caused by distance.

The second main goal of level 3 has four objectives focusing on efficiency to provide greater customer satisfaction upon the development side. Thus, some specific practices considered within objective “Sprint Backlog Management” are:

- “Highly visible”;
- “Whole team estimate”; and
- “Estimates for sprint tasks are updated daily”.

75
The objective “Planned iterations” includes the following practices:

• "Sprints end on schedule";
• "Iterations doomed to fail are terminated immediately"; and
• "Team is not disturbed by foreigners".

Other practices such as "Product Owner uses velocity to plan releases", "Highly visible Sprint Burndown Chart" and "Sprint Burndown Chart is daily updated" guide organizations to develop and deliver timely software solutions since level 2 of Scrum maturity already focuses on solution’s acceptance by the client.

In Figure 7.20, we present the second goal of this level of Scrum maturity in detail. The practices and suggested metrics are related to their objectives, and those objectives are defined within goals. For instance, the objective “Definition of done’ Exists” is comprised by three practices, such as: “Team respects Definition of done”. In order to measure the quality of this objective, the implementation and monitoring of the metric “% of consensus of ‘Definition of done’” is suggested, which will provide more information regarding the organization’s culture and consensus while achieving the “Definition of done”.

With the implementation of level 3 of maturity, an organization can succeed in several projects, however, this success is only partial due to the lack of standardized management that guarantees the same quality and performance in all development processes.
The full set of practices and suggested metrics for this level are presented in Appendix F.

7.5 Level 4 - Quantitatively Managed

At level 4 of Scrum maturity, an organization offers standardized and regular software development processes aided by the management of process performance through measurement and practices analysis. In this level of maturity, there are two main fields:

- **Standardized Project Management**: this goal leads organizations to use the same development process for all projects. In order to achieve it, an organization must complete process standardization.; and

- **Process Performance Management**: it demands the monitoring of all suggested practices up to level 4 of Scrum maturity. These metrics aim to provide enough feedback about actual process and manage performance.

Although level 4 seems very simple in Figure 7.21, we actually found out that it is extremely hard to implement the management and monitoring of all projects within an organization to fulfill all specific practices and maintain the process standardized. The suggested metrics should be customized to each enterprise culture and best practices.

![Figure 7.21: Goals and objectives for level 4 of Scrum Maturity](image)

Figure 7.22 illustrates in detail of the goal “Measurement and Analysis” composed by its objectives, practices and suggested metrics for each practice.

![Figure 7.22: Details for goal “Measurement and Analysis” in level 4 of Scrum Maturity](image)
Organizations in this level are adopting Scrum development processes and the majority of their projects result in a successful achievement. The only and last improvement left is optimization of the current processes.

The full set of practices and suggested metrics for level 4 are presented in Appendix G.

7.6 Level 5 - Optimizing

Organizations at level 5 of the Scrum Maturity Model are top class software developers using Scrum methodology. They focus on continuous self-improvement to excel competition and bring higher levels of satisfaction from client, development team and all stakeholders. The only goal for this level is:

- **Performance Management**: it allows organizations to measure and analyze their own actions and processes in order to self-improve.

Figure 7.23 illustrates the three objectives for the main goal of this Scrum maturity, while Figure 7.24 shows the full details of the level. Like in the previous levels, each objective is associated to a set of specific practices that must be accomplished in order to achieve this level of Scrum maturity.

<table>
<thead>
<tr>
<th>Goal</th>
<th>Objective</th>
<th>Practice</th>
<th>Suggested Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Management</td>
<td>Successful Sprint Retrospective</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td></td>
<td>Goal Analysis and Resolution</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td></td>
<td>Positive Indicators</td>
<td>(-)</td>
<td>(-)</td>
</tr>
</tbody>
</table>

Figure 7.23: Goals and objectives for level 5 of Scrum Maturity

Level 5 intends to provide success to Daily Scrum Meeting by implementing the following practices:

- "Whole team participates";
- "Problems and impediments are identified"; and
- "Everyone knows what tasks the other colleagues are performing".

Whereas the success in Sprint Retrospective Meeting can be achieved by adopting the following practices:
Figure 7.24: Details for goal “Performance Management” in level 5 of Scrum Maturity

• “Results in specific process improvements proposals”; and
• “Some proposals are actually implemented”.

An organization at this level of Scrum maturity presents some positive gauges such as “High level of energy and satisfaction”, “Rare overtime working and only happens voluntarily” and “Discussion, constructive criticism and experimentation with present processes” that are also specific for this level so as to encourage continuous self-improvement.

Organizations in level 5 have achieved the maximum level and must not discard previous accomplishments and goals by negligence, which will block continuous process improvement. The full set of practices and suggested metrics for this level are presented in Appendix G.

The full set of practices and suggested metrics for this level are presented in Appendix G.

7.7 Summary

Similarly to other maturity models for agile development processes described in Chapter 3, this Scrum Maturity Model was inspired in CMMI process areas and, when possible, the mapping between them and Scrum practices.

The concept of suggested practices provides supplementary assurance for process quality while assessing an organization’s Scrum development process maturity. Additionally, it provides a set of suggested metrics to monitor the quality of Scrum practices assigned to each level, which should be customized to each organization.

The full details of the final version of this Scrum Maturity Model including Levels, Goals, Objectives, Practices and Suggested Metrics) are in Appendixes E, F, G and H.
Similar to other maturity models for agile development processes described in Chapter 3, this Scrum Maturity Model was inspired in CMMI process areas and, when possible, the mapping between them and Scrum practices.

The concept of suggested practices provides supplementary assurance for process quality while assessing one organization's Scrum development process maturity. Additionally, it is provided a set of suggested metrics to monitor the quality of Scrum practices assigned to each level that should be customized to each organization.

The full detail of the final version of this Scrum Maturity Model including Levels, Goals, Objectives, Practices and Suggested Metrics) is in the Appendix E, F, G and H.
Chapter 8

Conclusion

The present dissertation intended to research a current problem within agile software development reality: generally, there is lack of collaboration and communication among vendor organizations and their clients. The fact that various bibliographic references present the problem as a consequence of human nature, which is usually uncomfortable, avoids the adoption of agile software development to new cultures, procedures or people.

This issue is a widely researched topic among IT experts, due to its vital importance in the success of IT software development projects and in creating value to client (Standish Group, 2009) (Leffingwell & Widrig, 2000) (Charette, 2005) (Reel, 1999) (Cockburn & Highsmith, 2001).

By analyzing related work, comprised by Agile Methodologies, Scrum and Modified Agile, it was possible to present the advantages and disadvantages of each methodology through a critical analysis. Namely, the major problems of communication within Agile development were identified when performed at a distance, i.e., when the vendor organization is both physically and culturally distanced from its client.

Then, maturity models for software development processes, comprised by CMMMI, Agile Maturity Model, Agile Maturity and Agile Scaling Model, were detailed and analyzed. In general, all lacked the focus to classify the maturity of Scrum development process and missed the ability to measure the quality of this process through a set of defined practices.

Inspired by the related work and maturity, the Scrum Maturity Model, which offers a roadmap for them to implement Scrum incrementally and can compare the performance of software development processes among various organizations, was proposed. Additionally, a set of suggested metrics to monitor and assess the quality of the practices in each level of Scrum maturity is provided.
In order to validate the proposal as a solution for the problem identified in Section 1.3, the three iterations of Action Research took place. These iterations included validation from various experts in this area of research, professionals from organizations that use Scrum as a development process and feedback from international conferences’ reviewers. Throughout the three cycles of Action Research, the proposal evolved and was incrementally validated at each iteration cycle.

In the last iteration of Action Research, major results and validation were achieved by interviewing two experts in the Agile Methodology and Maturity Model areas, assessing three organizations within five agile software development projects and acceptance of a research paper in an international conference.

According to the interviewed experts, the proposed Scrum Maturity Model is well-structured as a roadmap and as a maturity model to both classify current Scrum practitioner organizations and guide the adoption of Scrum for organizations new to it. The levels contained correct goals and objectives to focus early on the structure of Scrum and then on the quality of each objective on further levels. Moreover, they praised the set of suggested metrics to measure, monitor and assess the quality of each Scrum practice.

According to the organizations that were assessed by the Scrum Maturity Model, most agreed that this proposal has a great potential to bring value to organizations to self-evaluate themselves and perform benchmarking activities. Although the validation process of the proposal involved many different project managers, some with distinct ideologies regarding agile development, most considered the proposal an excellent roadmap for enterprises to deliver better Scrum development, focusing on customer communication and collaboration. The evaluation of the suggested metrics is based on the qualitative evaluation from the experts and professionals from the assessed organizations. Few organizations have their own metrics to measure the quality of their Scrum development process, therefore the suggested set of metrics deliver increased value to organizations, offering an initial version of metrics to calculate the quality of their Scrum process.

As additional validation, the proposal resulted in the acceptance of a research paper in ICSEA 2011, an international conference ranked as level C by the Excellence in Research for Australia (ERA) conference ranking of 2010. This paper summarizes this final version of the proposal, as well as the evaluation made in the third cycle of Action Research.

### 8.1 Future Work

Since our proposal evolved incrementally, this research can be continued with more organizations in order to obtain more validation and feedback from a business perspective. Additionally, this
proposal can be presented to more experts from both Agile community and CMMI experts for further validation and self-evaluation.

Further research on human factors and change management areas might benefit and enhance the performance of this maturity model, since human mindset greatly affects the success and goals from every solution and proposal.

The proposal of a maturity model is highly controversial within the agile community, and the present dissertation verified that Scrum can benefit from a maturity model. It was verified that Scrum Maturity Model succeeds as the roadmap for small-medium organizations that seek self-improvement and guidance, a self-evaluation model to rethink actual Scrum adoption for specific organizations, and a model to classify and compare the maturity of organizations for benchmarking purposes.
Bibliography


THESTANDISHGROUP (2010). Cmmi product development team, cmmi for development version 1.3.

Appendix A

Scrum Assessment Questionnaire for Level 2

This Appendix presents the Scrum maturity assessment questionnaire for level 2 that was used in the first iteration of Action Research, as mentioned in Chapter 5.

The following questionnaire is also available at:

- **Part 1**: https://spreadsheets.google.com/spreadsheet/viewform?hl=en_US&formkey=dERNejhnYjNoWVltVDFrCXBWE5V3c6MQ#gid=0
- **Part 2**: https://spreadsheets.google.com/spreadsheet/viewform?hl=en_US&formkey=dGN1UXo1cV8ybGNLTVdTWFaERYT0E6MQ#gid=0
### SCRUM MATURITY ASSESSMENT – LEVEL 2 (PART 1/2)

The following form as the main goal to appraise the maturity of an organization that develops software using Scrum methodology. The current form is under continuous improvement in order to assign the proper level of maturity to the organizations. This appraisal is performed to all members in Scrum team and stakeholders involved on the projects under evaluation. (to remove)**Projects evaluated in this appraisal must correspond to about 70% of the projects using Scrum.*** Please respond truthfully... evidences... == Goal: Basic usage of Scrum Methodology Sub-goals:  - Scrum roles exists (Q1~3)  - Scrum artifacts exists (Q4~12)  - Scrum meetings exists (Q13~17)  - Scrum Sprints are correct (Q18~19)  - Standardization (Q20)

* Required

**Identification**

Please enter your organization's name

Organization's name? * 

**Scrum roles exists**

Question 1: Exists an individual nominated by client to assume the role of Product Owner? * Exists a person in the client's organization that assumes the role of Product Owner defined by Scrum methodology within some project in execution or accomplished in the past 6 months?

- [ ] Yes
- [ ] No

Question 2: Exists an individual nominated by vendor organization to assume the role of Scrum Master? * Exists a person in vendor's organization that assumes the role of Scrum Master defined by Scrum methodology within some project in execution or accomplished in the past 6 months?

- [ ] Yes
- [ ] No

Question 3: Exists a team nominated by vendor organization to assume the role of Team? * Exists a team in vendor's organization that assumes the role of Team defined by Scrum methodology within some project in execution or accomplished in the past 6 months?

- [ ] Yes
- [ ] No

Question 4: Exists the artifact Product Backlog? * Exists the artifact Product Backlog defined by Scrum methodology within some project in execution or accomplished in the past 6 months?
<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scrum artifacts exists</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question 5: Product Backlog is update by the client-side?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Question 6: Exists the artifact Sprint Backlog?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Question 7: Sprint Backlog is update by the Team?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Question 8: Sprint Backlog is update under client-side knowing?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Question 9: Exists the artifact Release Burndown?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Question 10: Release Burndown is update according the reported progresses?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

*Product Backlog is update by client or Product Owner within some project in execution or accomplished in the past 6 months?*

*Exists the artifact Sprint Backlog defined by Scrum methodology within some project in execution or accomplished in the past 6 months?*

*Sprint Backlog is update by Team, Scrum role, within some project in execution or accomplished in the past 6 months?*

*Sprint Backlog is update under client-side knowing within some project in execution or accomplished in the past 6 months?*

*Exists the artifact Release Burndown defined by Scrum methodology within some project in execution or accomplished in the past 6 months?*

*Release Burndown is update according the reported progresses by Team? Note that Team might not hand out daily progress reports.*
**Question 11:** Exists the artifact Sprint Burndown? *Exists the artifact Sprint Burndown defined by Scrum methodology within some project in execution or accomplished in the past 6 months?*

- Yes
- No

**Question 12:** Sprint Burndown is update according the reported progresses? *Sprint Burndown is update according the reported progresses by Team? Note that Team might not hand out daily progress reports.*

- Yes
- No

### Scrum meetings exists

**Question 13:** Exists the meeting Release Planning Meeting? *Exists the meeting Release Planning Meeting defined by Scrum methodology within some project in execution or accomplished in the past 6 months?*

- Yes
- No

**Question 14:** Exists the meeting Sprint Planning Meeting? *Exists the meeting Sprint Planning Meeting defined by Scrum methodology within some project in execution or accomplished in the past 6 months?*

- Yes
- No

**Question 15:** Exists the meeting Daily Scrum? *Exists the meeting Daily Scrum defined by Scrum methodology within some project in execution or accomplished in the past 6 months?*

- Yes
- No

**Question 16:** Exists the meeting Sprint Review? *Exists the meeting Sprint Review defined by Scrum methodology within some project in execution or accomplished in the past 6 months?*

- Yes
- No

**Question 17:** Exists the meeting Sprint Retrospective? *Exists the meeting Sprint Retrospective defined by Scrum methodology within some project in execution or accomplished in the past 6 months?*

- Yes
<table>
<thead>
<tr>
<th>No</th>
</tr>
</thead>
</table>

**Scrum Sprints are correct**

Question 18: Does the usage of Sprint exist? *Exists the usage of Sprint defined by Scrum methodology within some project in execution or accomplished in the past 6 months?*

- Yes
- No

Question 19: Does Sprint's iteration have a maximum length of 4 weeks? *Sprints within some project in execution or accomplished in the past 6 months have a maximum length of 4 weeks?*

- Yes
- No

**Standardization**

Question 20: Do all projects using Scrum development methodology in execution or accomplished in the past 6 months answer positively to all previous questions?*

- Yes
- No

**End Part 1**

Thank you. Please continue with part 2.
The following form as the main goal to appraise the maturity of an organization that develops software using Scrum methodology. The current form is under continuous improvement in order to assign the proper level of maturity to the organizations. This appraisal is performed to all members in Scrum team and stakeholders involved on the projects under evaluation. (to remove)***Projects evaluated in this appraisal must correspond to about 70% of the projects using Scrum.***

= Goal: Requirement Management Sub-goals: - Clearly defined Product Owner (Q1-4) - Product Owner has a Product Backlog (Q5-10) - Have successful Sprint Planning Meetings (Q11-16)

* Required

Identification

Please enter your organization’s name

Organization’s name? *

Clearly defined Product Owner

Question 1: Product Owner is empowered to prioritize? *

☐ Yes
☐ No

Question 2: Product Owner has knowledge to prioritize? *

☐ Yes
☐ No

Question 3: Product Owner has direct contact with Team? *

☐ Yes
☐ No

Question 4: Product Owner has direct contact with Stakeholders? *

☐ Yes
☐ No

Product Owner has a Product Backlog

Question 5: Product Owner has product vision that is in sync with Product Backlog? *

☐ Yes
<table>
<thead>
<tr>
<th>Question 6: Top items are prioritized by business value?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ No</td>
</tr>
<tr>
<td>☑ Yes</td>
</tr>
<tr>
<td>☐ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 7: Top items are estimated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Yes</td>
</tr>
<tr>
<td>☐ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 8: Estimates written by the Team?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Yes</td>
</tr>
<tr>
<td>☐ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 9: Top items in Product Backlog small enough to fit in a Sprint?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Yes</td>
</tr>
<tr>
<td>☐ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 10: Product Owner understands purpose of all Product Backlog items?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Yes</td>
</tr>
<tr>
<td>☐ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Have successful Sprint Planning Meetings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 11: Product Owner participates?</td>
</tr>
<tr>
<td>☐ Yes</td>
</tr>
<tr>
<td>☐ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 12: Product Owner brings up-to-date Product Backlog?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Yes</td>
</tr>
<tr>
<td>☐ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 13: Whole Team participates?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Yes</td>
</tr>
<tr>
<td>☐ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 14: Results in a Sprint plan?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Yes</td>
</tr>
<tr>
<td>☐ No</td>
</tr>
</tbody>
</table>
Question 15: Whole Team believes plan is achievable? *
☐ Yes
☐ No

Question 16: Product Owner satisfied with priorities? *
☐ Yes
☐ No

End

Thank You. After analyzing all responses, will be published the results for your organization.
Appendix B

Scrum Assessment Questionnaire for Level 3

This Appendix presents the Scrum maturity assessment questionnaire for level 3 that was used in the first iteration of Action Research, as mentioned in Chapter 5.

The following questionnaire is also available at:

- **Part 1**: [https://spreadsheets.google.com/spreadsheet/viewform?hl=en_US&formkey=dGNGQTNGcXBObHNsYmhWbkRvNkY0Q3c6MQ#gid=0](https://spreadsheets.google.com/spreadsheet/viewform?hl=en_US&formkey=dGNGQTNGcXBObHNsYmhWbkRvNkY0Q3c6MQ#gid=0)
- **Part 2**: [https://spreadsheets.google.com/spreadsheet/viewform?hl=en_US&formkey=dEZmZXNsdVlWS0xXOVpVV92RFy22c6MQ#gid=0](https://spreadsheets.google.com/spreadsheet/viewform?hl=en_US&formkey=dEZmZXNsdVlWS0xXOVpVV92RFy22c6MQ#gid=0)
The following form as the main goal to appraise the maturity of an organization that develops software using Scrum methodology. The current form is under continuous improvement in order to assign the proper level of maturity to the organizations. This appraisal is performed to all members in Scrum team and stakeholders involved on the projects under evaluation. (to remove)****Projects evaluated in this appraisal must correspond to about 70% of the projects using Scrum.*** 2 parts... Please respond truthfully... evidences... — Goal: Customer Relationship Management Sub-goals: - Have Definition of Done (Q1-2) - Product Owner Available (Q3) - Demo happens after every Sprint (Q4~)

* Required

**Identification**

Please enter your organization's name

Organization's name? *

**Have Definition of Done**

Question 1: Definition of Done achievable within each iteration? *

- [ ] Yes
- [ ] No

Question 2: Team respects Definition of Done? *

- [ ] Yes
- [ ] No

**Product Owner available**

Question 3: Product Owner available when team is estimating? *

- [ ] Yes
- [ ] No

**Demo happens after every Sprint**

Question 4: Shows working, tested software? *

- [ ] Yes
- [ ] No

Question 5: Feedback received from stakeholders & Product Owner? *
Question 5: Feedback received from stakeholders & Product Owner? *

☐ Yes
☐ No

End Part 1

Thank you. Please continue with part 2

Submit

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The following form as the main goal to appraise the maturity of an organization that develops software using Scrum methodology. The current form is under continuous improvement in order to assign the proper level of maturity to the organizations. This appraisal is performed to all members in Scrum team and stakeholders involved on the projects under evaluation. (to remove) Projects evaluated in this appraisal must correspond to about 70% of the projects using Scrum. 2 parts... Please respond truthfully... evidences... Goal: Project Management

---

<table>
<thead>
<tr>
<th>Sub-goals:</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team has a sprint backlog (Q1-7)</td>
<td>Timeboxed iterations (Q8-11)</td>
</tr>
</tbody>
</table>

* Required

**Identification**

Please enter your organization's name

Organization's name? * __________

**Team has a sprint backlog**

<table>
<thead>
<tr>
<th>Question 1: Highly visible? *</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Yes</td>
</tr>
<tr>
<td>□ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 2: Updated daily? *</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Yes</td>
</tr>
<tr>
<td>□ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 3: Owned exclusively by the team? *</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Yes</td>
</tr>
<tr>
<td>□ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 4: Everyone on the team participates in estimating? *</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Yes</td>
</tr>
<tr>
<td>□ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 5: Product Backlog items are broken into tasks within a Sprint? *</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Yes</td>
</tr>
<tr>
<td>□ No</td>
</tr>
</tbody>
</table>
### Question 6: Sprint tasks are estimated? *
- [ ] Yes
- [x] No

### Question 7: Estimates for ongoing tasks are updated daily? *
- [ ] Yes
- [x] No

#### Timeboxed iterations

### Question 8: Always end on time? *
- [ ] Yes
- [x] No

### Question 9: Iterations that are doomed to fail are terminated early? *
- [ ] Yes
- [x] No

### Question 10: Team not disrupted or controlled by outsiders? *
- [ ] Yes
- [x] No

### Question 11: Team usually delivers what they committed to? *
- [ ] Yes
- [x] No

#### Velocity is measured

### Question 12: All items in Sprint plan have an estimate? *
- [ ] Yes
- [x] No

### Question 13: Product Owner uses velocity for release planning? *
- [ ] Yes
- [x] No

### Question 14: Velocity only includes items that are Done? *
- [ ] Yes
- [x] No
Team has an effective Sprint Burndown Chart

Question 15: Highly visible?
- Yes
- No

Question 16: Updated daily?
- Yes
- No

End

Thank You. After analyzing all responses, will be published the results for your organization.
Appendix C

Scrum Assessment Questionnaire
for Level 4

This Appendix presents the Scrum maturity assessment questionnaire for level 4 that was used in the first iteration of Action Research, as mentioned in Chapter 5.

The following questionnaire is also available at:

- **Part 1**: https://spreadsheets.google.com/spreadsheet/viewform?hl=en_US&formkey=dEQxcW1SOEVQZ2p4VURVc0tcXo1M3c6MQ#gid=0
SCRUM MATURITY ASSESSMENT – LEVEL 4

The following form as the main goal to appraise the maturity of an organization that develops software using Scrum methodology. The current form is under continuous improvement in order to assign the proper level of maturity to the organizations. This appraisal is performed to all members in Scrum team and stakeholders involved on the projects under evaluation. (to remove)****Projects evaluated in this appraisal must correspond to about 70% of the projects using Scrum.*** Please respond truthfully... evidences... == Goal: Standardized Project Management

Required

Identification

Please enter your organization's name

Organization's name? *

Standartized Project Management

Question 1: All projects have level 3 of Scrum Maturity? *

☐ Yes
☐ No

End

Thank You. After analyzing all responses, will be published the results for your organization.

Submit

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Appendix D

Scrum Assessment Questionnaire for Level 5

This Appendix presents the Scrum maturity assessment questionnaire for level 5 that was used in the first iteration of Action Research, as mentioned in Chapter 5.

The following questionnaire is also available at:

- **Part 1**: https://spreadsheets0.google.com/spreadsheet/viewform?hl=en-US&formkey=dFBqZjJabjJyUXNhSGNITktBeGxxc1E6MQ#gid=0
SCRUM MATURITY ASSESSMENT – LEVEL 5

The following form as the main goal to appraise the maturity of an organization that develops software using Scrum methodology. The current form is under continuous improvement in order to assign the proper level of maturity to the organizations. This appraisal is performed to all members in Scrum team and stakeholders involved on the projects under evaluation. (to remove)****Projects evaluated in this appraisal must correspond to about 70% of the projects using Scrum.*** Please respond truthfully... evidences... == Goal: Project Performance
Management Sub-goals: - Daily Scrum happens with success - Successful Retrospective happens after every sprint - Positive indicators

* Required

Identification

Please enter your organization's name

Organization's name? *

Daily Scrum happens with success

Question 1: Whole Team participates? *

☐ Yes
☐ No

Question 2: Problems and impediments are surfaced? *

☐ Yes
☐ No

Question 3: Daily Scrum is every day, same time and place? *

☐ Yes
☐ No

Question 4: Product Owner participates at least a few times per week? *

☐ Yes
☐ No

Question 5: Max 15 minutes? *

☐ Yes
☐ No

Question 6: Each Team member knows what the others are doing? *

☐ Yes
☐ No
## Successful Retrospective happens after every sprint

**Question 7:** Results in concrete improvement proposals? *
- [ ] Yes
- [ ] No

**Question 8:** Some proposals actually get implemented? *
- [ ] Yes
- [ ] No

**Question 9:** Whole Team participates? *
- [ ] Yes
- [ ] No

## Positive indicators

**Question 10:** Having fun, high energy level? *
- [ ] Yes
- [ ] No

**Question 11:** Overtime work is rare and happens voluntarily? *
- [ ] Yes
- [ ] No

**Question 12:** Discussing, criticizing, and experimenting with the process? *
- [ ] Yes
- [ ] No

## End

Thank You. After analyzing all responses, will be published the results for your organization.
Appendix E

Level 2 of Scrum Maturity Model

This Appendix presents the Level 2 of Scrum Maturity Model, that was designed throughout the three cycles of Action Research and presented briefly in Chapter 7.

E.1 Goal: Basic Scrum Management

E.1.1 Objective: Scrum Roles Exist

Practices:

1. An individual from client side organization assumes the role of Product Owner
2. An individual from provider side organization assumes the role of Scrum Master
3. A team from provider side organization assumes the role of Team

Metrics:

1. # of changes of role Product Owner during a project
2. # of changes of role Scrum Master during a project
3. # of changes of role Team during a project
4. # of changes of Team members during a project
5. # of members for each role (team dimension) per Scrum team
E.1.2 Objective: Scrum Artifacts Exist

Practices:

1. Product Backlog exists
2. Product Backlog is updated under Product Owner’s authorization
3. Sprint Backlog exists
4. Sprint Backlog is updated by Team
5. Sprint Backlog is updated under Team’s acknowledgment
6. Release Burndown Chart exists
7. Release Burndown Chart is updated according to reported progresses
8. Sprint Burndown Chart exists
9. Sprint Burndown Chart is updated according to reported progresses

Metrics:

1. # of accesses to Product Backlog
2. # of updates to Product Backlog
3. # of accesses to Sprint Backlog
4. # of updates to Sprint Backlog
5. # of accesses to Release Burndown Chart
6. # of updates to Release Burndown Chart
7. # of accesses to Sprint Burndown Chart
8. # of updates to Sprint Burndown Chart

E.1.3 Objective: Scrum Meetings Occur and are Participated

Practices:

1. Release Planning Meeting occurs exactly once, or none at all
2. Release Planning Meeting is, at least, attended by Scrum Master and Product Owner

3. Sprint Planning Meeting occurs exactly once per Sprint

4. Sprint Planning Meeting is attended by Scrum Master, Product Owner and Team

5. Daily Scrum Meeting occurs exactly once per workday

6. Daily Scrum Meeting is, at least, attended by Scrum Master and Team

7. Sprint Review Meeting occurs exactly once per Sprint

8. Sprint Review Meeting is attended by Decision Makers, Stakeholders, Scrum Master, Product Owner and Team

9. Sprint Retrospective Meeting occurs exactly once per Sprint

10. Sprint Retrospective Meeting is, at least, attended by Scrum Master and Team. Optionally, the Product Owner can attended the meeting

**Metrics:**

1. % of occurred against planned Release Planning Meetings

2. % of actual attendees against planned attendees of Release Planning Meetings

3. Mean duration of Release Planning Meetings

4. % of occurred against planned Sprint Planning Meetings

5. % of actual attendees against planned attendees of Release Planning Meetings

6. Mean duration of Sprint Planning Meetings

7. % of occurred against planned Daily Scrum Meetings

8. % of actual attendees against planned attendees of Daily Scrum Meetings

9. Mean duration of Daily Scrum

10. % of occurred against planned Sprint Review Meetings

11. % of actual attendees against planned attendees of Sprint Review Meetings

12. Mean duration of Sprint Review Meeting

13. % of occurred against planned Sprint Retrospective Meetings

14. % of actual attendees against planned attendees of Sprint Retrospective Meetings

15. Mean duration of Sprint Retrospective Meeting
E.1.4  Objective: Scrum Process Flow is Respected

Practices:

1. Software development project starts with Release Planning Meeting, optionally

2. Cycle of Sprints of development occurs
   - Sprints has maximum length of four weeks
   - Sprint starts with Sprint Planning Meeting
   - Daily Scrum Meeting happens every Sprint-day
   - Sprint Review Meeting occurs after the development ended
   - Sprint ends with Sprint Retrospective Meeting

Metrics:

1. Mean length of Sprints

E.2  Goal: Software Requirements Engineering

E.2.1  Objective: Clear Definition of Product Owner

Practices:

1. Product Owner has direct contact with Scrum Team

2. Product Owner has direct contact with client side stakeholders

3. Product Owner is responsible to define priorities

4. Product Owner has the knowledge to define priorities

5. Product Owner has product’s vision

Metrics:

1. % of unattended or canceled meetings with Scrum team
E.2.2 Objective: Product Backlog Management

Practices:

1. Product Backlog items are sync with Product Owner’s product vision
2. Product Backlog items are prioritized by Product Owner
3. Product Backlog top items are defined according to business value

Metrics:

1. % of defined priorities in Product Backlog

E.2.3 Objective: Successful Sprint Planning Meetings

Practices:

1. Product Owner presents updated Product Backlog
2. Product Owner collaborates actively
3. All Team collaborates actively
4. Results on agreed sprint plan
5. Product Owner satisfied with priorities agreed
6. All Team believes that the plan is achievable

Metrics:

1. % of consensus for sprint plan
2. # of changes in Sprint Backlog’s priorities after Sprint Planning Meeting
3. % of consensus in the belief that plan is achievable
Appendix F

Level 3 of Scrum Maturity Model

This Appendix presents the Level 3 of Scrum Maturity Model, that was designed throughout the three cycles of Action Research and presented briefly in Chapter 7.

F.1 Goal: Customer Relationship Management

F.1.1 Objective: Definition of ”Done” exists

Practices:

1. Definition of ”Done” is agreed by whole Scrum team
2. Definition of ”Done” is achieved in each iteration
3. Team respects the Definition of ”Done”

Metrics:

1. % of consensus for Definition of ”Done”
2. % of reject items by failing the Definition of ”Done”

F.1.2 Objective: Product Owner available

Practices:

1. Product Owner available for Team
2. Product Owner is reachable

**Metrics:**

1. % of failed attempts reaching the Product Owner

**F.1.3 Objective: Successful Sprint Review Meetings**

**Practices:**

1. Demonstrates working software
2. Demonstrates tested software
3. Product Owner and other stakeholders provide feedback
4. Product Owner and other stakeholders accept delivered software

**Metrics:**

1. % of failed acceptance tests
2. % of accepted functionalities
3. Mean client's satisfaction level

**F.2 Goal: Iteration Management**

**F.2.1 Objective: Sprint Backlog Management**

**Practices:**

1. Sprint Backlog is highly visible
2. Sprint Backlog is updated daily
3. Sprint Backlog Belongs only to Team
4. Sprint Backlog items are split into tasks
5. All Team estimates
6. All Sprint Backlog items are estimated
7. All tasks are estimated
8. Remaining effort for each task's estimative are updated daily

Metrics:

1. # visits to sprint backlog
2. # updates to sprint backlog
3. Mean estimate time for each user story
4. Mean estimate time for each task

F.2.2 Objective: Planned iterations

Practices:

1. Sprint ends as planned on schedule
2. Daily Scrum happens every workday
3. Within Daily Scrum is identified problems and impediments
4. Sprints that will not accomplish the plan shall be terminated immediately
5. Team is not disturbed by outsiders
6. Team delivers promised results

Metrics:

1. Mean duration of daily scrum
2. # of problems and impediments identified in daily scrum
3. # of terminated sprints
4. Mean duration of sprints

F.2.3 Objective: Successful Daily Scrum

Practices:

1. Limit of 15 minutes' meeting
2. Each Team member knows what the other are working on

Metrics:

1. % of canceled Daily Meetings

F.2.4 Objective: Measured Velocity

Practices:

1. Sprint Burndown Chart is highly visible
2. Sprint Burndown Chart is updated daily
3. Scrum Master does regular analysis of sprint's progress

Metrics:

1. Mean velocity
2. % of sprint goal achieved
Appendix G

Level 4 of Scrum Maturity Model

This Appendix presents the Level 4 of Scrum Maturity Model, that was designed throughout
the three cycles of Action Research and presented briefly in Chapter 7.

G.1 Goal: Unified Project Management

G.1.1 Objective: Unified Project Management

Practices:

1. All projects are managed with compliance to all goals, objectives and practices from level 2
   and 3 of Scrum maturity.

Metrics:

1. # of occurrence of non unified project management incidents

G.2 Goal: Measurement and Analysis Management

G.2.1 Objective: Measurement and Analysis Management

Practices:

1. All metrics from level 2 to level 4 are monitored and managed for all projects. This is
   suggested but optional.
2. Project measures are systematized via metrics. They are monitored and managed constantly.

Metrics:

1. # of findings for suboptimal processes with off range metrics
Appendix H

Level 5 of Scrum Maturity Model

This Appendix presents the Level 5 of Scrum Maturity Model, that was designed throughout the three cycles of Action Research and presented briefly in Chapter 7.

H.1 Goal: Performance Management

H.1.1 Objective: Successful Sprint Retrospective

Practices:

1. Up to 3 hours’ meeting

2. Results in concrete improvement proposals

3. Some proposals are implemented

4. Lessons learned are recorded

Metrics:

1. # of concrete corrective action generated

2. # of concrete corrective action implemented

3. # of lessons learned
H.1.2 Objective: Positive Indicators

Practices:

1. High level of energy from whole Scrum team
2. High level of satisfaction from whole Scrum team
3. High level of satisfaction from stakeholders
4. Rare extra working hours; if it happens, it must be voluntarily
5. Discussion, constructive criticism
6. Experimentation and Scrum process improvement

Metrics:

1. Satisfaction level from questionnaires
2. # of extra working hours
Appendix I

Accepted Paper at ICSEA 2011

This Appendix presents accepted paper at ISCEA 2011 conference that is referenced in Chapter 6, within the results from the third cycle of Action Research.
Scrum Maturity Model
Validation for IT organizations’ roadmap to develop software centered on the client role

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Soraia Figueiredo; Miguel Mira da Silva
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Abstract—Within the agile development methodologies context, the topic of client relationship management is strongly focused, mainly due to the importance of collaboration between the development team and its clients. Most clients avoid or are unable to develop a close cooperation with vendor organizations, since it requires a motivation and close participation among key stakeholders in the development processes within and correct usage of the adopted software development methodology. Hence, software development projects fail and become unsuccessful because of this lack of communication. In order to increase the rate of successful projects, this paper will present the journey of the validation process for this roadmap to lead and aid software vendor organizations improve their development processes, concentrating mainly on the client’s role throughout the process. This concept is called Scrum Maturity Model; therefore, our main goal is to validate this concept with organizations that use Scrum agile methodology as their main development process, which turns out to be an viable approach to reduce the rate failed development projects.

Keywords—development methodologies; agile methodologies; scrum development methodology; maturity model; action research

I. INTRODUCTION

According to a CHAOS Report [1], about 70% of IT development projects fail to deliver functional software, mostly due to a poor communication between stakeholders, who play key roles in the development process. This problem of human factors in software development collaboration is also highlighted in these three following papers [2][3][4][5].

The fact that most clients spend an extremely small amount of time and effort working closely with the software vendor organization, that develops the solution, goes against the Agile Manifesto values [6], which are the foundations for a successful agile oriented development.

The failure of Information Technology (IT) projects caused by mediocre software requirements engineering and other human/client factors is a highly researched theme among professionals and scholars. Therefore, this paper intends to provide a different insight about the current issues concerning this topic [7][8][9][10].

The main concern that induced this research was precisely the dilemma mentioned above: lack of cooperation among stakeholders involved in an IT development project, focusing on the type of communication between the development team and the client. This problem in communication can result from: (1) Human factors and resistance to changes; (2) Distance that separates both vendors and clients or; (3) Inexistence of a commitment that follows the definition of a contract of collaboration.

Generally, both clients and software development organization teams may fear and avoid the adoption of new methods of collaboration with a new team [10]. This harms the partnership between the two, thus resulting in inadequate requirements engineering emphasized by agile methodologies, which will, eventually, lead to an unsuccessful project.

Concerning human behavior, the distance that separates the vendor organization and the client challenges the accomplishment of a fluent and successful cooperation [11]. Apart from this exact physical distance, that hardens the communication and occasionally blocks the possibility of face-to-face meetings, a cultural distance must also be considered, since this aspect may bring a negative impact, such as cultural clashes, to the performance of the collaboration and influence the project as a whole [10].

Another cause of this problem is the inexistence of highlighted goals, such as market competition, which will motivate all stakeholders to improve their processes and maximize the outputs. According to a survey made by Gartner [13], agile methodologies could use a maturity model as a roadmap and market differential, so software development organizations might explore their processes and reach higher levels of maturity. Moreover, a paper from Software Engineering Institute (SEI) [14] reveals that Capability Maturity Model Integration (CMMI) can coexist with agile methodologies and enhance these software development organizations [15].

This paper will focus on the changes from the previous proposal [16] and recent evaluation processes of the solution for this lack of collaboration, usually, between vendor organizations and clients. Moreover, it will conceive a roadmap for improvement in order to create successful IT development projects. Since Scrum development methodology emphasizes such collaboration, the solution shall be molded as a roadmap in the form of a maturity model so as to achieve the goal of this paper.
Note that this topic of maturity models and other IT governance frameworks on agile methodologies a highly polemic among the agile community. Nevertheless, IT governance mechanisms are necessary and welcomed in organizations which are underproductive, and, thus, hold the major slice of failed projects [14].

The chosen research method was Action Research (AR) due to its success in various academic investigations in the Information Systems area and for allowing the researcher to interfere and observe introduced modifications on the studied environment. AR is comprised by a five stages cycle [17]: (1) Diagnosis – problem identification; (2) Action Planning – planning and research phase to prepare the experiment and alternative actions; (3) Action – implementation of planned actions, introduction of changes and analysis of the outputs on the environment; (4) Evaluation – it is determined if the outcomes are expected or against odds and assures that introduced actions are the only reason for the obtained success; (5) Specifying Learning – Identify general findings.

Note that AR is carried out by individuals who are interested parties in the research. This fact has led to criticisms of the validity of the research process, with accusations of inevitable researcher bias in data gathering and analysis. The justification for AR counters this criticism by suggesting that it is impossible to access practice without involving the practitioner. Practice is action informed by values and aims which are not fully accessible from the outside. The practitioner may not even be wholly aware of the meaning of his or her values until he or she tries to embody them in his action. Nevertheless, there are some limitations with this research methodology, namely: the unfamiliarity with research methods and the representations of the process of action research may confuse, rather than enlighten.

As stated, this paper continues our previous research, hence, the first two cycles of action research were already previously applied. This paper will mainly focus on the changes to the proposal, based on past learning, and iterate more cycles of action research in order to achieve stronger validation of the proposal.

Before the presentation of the improved proposition, a brief introduction and review of the related work in this area of research shall be developed in Sections II and III. After, the changes in the proposition are detailed in Section VI, in the next section (Section V) the results of newer and various practical experimentation of the proposition will be presented. Afterwards, in Section VI, the main lessons learned shall be analyzed. Finally, Section VII will conclude with the summary of this investigation, relating all mentioned topics as a whole. In this section, some future works and approaches are given to continue the research.

II. RELATED WORK

This section intends to make a brief review of the related work in the field of agile development study.

A. Agile Methodologies

The origins of Agile methodologies are deeply connected with the concepts of iterative and incremental development. There were several ideas concerning the agile concept, hence an Agile Manifesto [6] was established.

The set of values and inherent principles listed on this Manifesto stress the importance of the clients’ presence in order to obtain a better collaboration outcome, working software as the main goal and agility when facing a sudden change in requirements [18][19].

Since this approach requires a high cooperation level between the client and the development team, mainly through face-to-face meetings, it has the drawback of being partially obsolete in the current market, in which an ascending number of projects are developed at a distance [20][24][25].

B. Scrum

Scrum is an agile methodology to manage development projects through an iterative and incremental method [23][24][25]. It is divided into three main key roles: (1) Scrum Master – individual who is responsible for the Scrum process and its correct usage maximizing its benefits; also known as the facilitator of Scrum team; (2) Product Owner – individual who is accountable for the alignment of the development and business goals definition, and; (3) Team – team that is in charge of delivering the product. A team comprises 5 to 9 members with cross-functional skills, who are self-organized and self-led.

This methodology identifies four objects that are operated by the Scrum team throughout the development cycle: (1) Product Backlog – a prioritized list of everything necessary to conclude the product; (2) Sprint Backlog – a list of tasks to perform during a sprint, i.e., an up to four weeks development iteration to introduce parts of the Product Backlog into working software; (3) Release Burndown Charts – charts that show the progress of the project over time; and, (4) Sprint Burndown Charts – charts that show the progress of the sprint over time.

The interaction of the roles maneuvering these objects is set for the following meeting: (1) Release Planning Meeting – Scrum team gathers and fills in the Product Backlog; (2) Sprint Planning Meeting – development team and client closely discuss matters and define the goals for the next sprint; (3) Daily Scrum – a brief meeting for developers to identify personal issues and possible improvements in methodology usage; (4) Sprint Review – demonstration of the working software to the client and stakeholders; (5) Sprint Retrospective – team performs a self-examination regarding the last sprint in order to seek improvements on their use of Scrum Methodology and collaboration in general.

Scrum methodology is an iterative and incremental development methodology. The phase for planning and system architecture takes place in Release Planning Meeting, while the sprints are comprised by Sprint Planning Meetings, Daily Scrum, Sprint Review and Sprint Retrospective.

Although Scrum has a wide definition of concepts, that, when applied, may allow agile software development, it cannot guarantee the success of IT projects. This methodology
emphasizes close collaboration between development teams and their clients; still, most of the time this does not happen and, thus, a supplementary solution to complement this imperfection is needed.

C. Modified Agile


The main problems identified concerning this matter were the poor communication among participants of the IT projects and the exhaustive documentation needed for contract negotiation. All other values and principles mentioned in Agile Manifesto remain feasible in a distant outsourcing context.

![Modified Agile communication model proposal](image)

Figure 1. Modified Agile communication model proposal [11].

The solution recommended by the author of this paper is an authentic communication model and team composition structure, which will enhance the communication between clients and developers and reduce the negative effects derived from the distance factor that leads to a loss of knowledge.

In Figure 1, the introduction of two specific roles is emphasized: (1) Coordination – an individual from the client-side, who ensures the maximization of development outputs by assigning the most important business goals to be developed as a priority; (2) Ambassador – individual from the development team-side who makes sure that the product developed is aligned according to the customer’s needs and wills. These two roles must work closely as a formal communication channel, while team members from both development and the client-side might communicate among themselves through an informal channel.

Although this distributed agile concept is broadly used with several case studies proving its success, there are also many failed IT projects due to human factors and inadequate collaboration between clients and vendor organizations [26][27].

III. MATURITY MODELS

The maturity models from software development processes enable the classification of the performance of the actual ones and guide organizations to encourage process improvement through a staged method, also known as maturity. These maturity models are an interesting approach to solving the problem described in Section I, since the presence of a maturity classification can allow the comparison between competitor organizations.

A. Capability Maturity Model Integration

Capability Maturity Model Integration (CMMI) was introduced in 2002 and ever since, it has focused on process improvement approaches, which assist organizations in adopting the best type of practices from each process area and make the processes performance evolve [28][29].

In the staged representation, CMMI presents different levels that vary from one to five. One level of maturity is characterized by a set of predefined process areas, evaluated by the accomplishment of specific and generic goals applicable to the various areas. Each of these is attached to a set of practices, which reflect specific and generic goals [30]. This type of approach is highly successful worldwide amongst enterprises that wish to surpass competitors by providing improved and better products and services.

Given its broad scope coverage, CMMI does not solve the issue due to its non-focus on agile software development processes, which are the area of the current study.

B. Agile Maturity Model

Agile Maturity Model (AMM) was introduced by two researchers in an IT University in Leeds, and it was conceived in order to provide future researchers a more in-depth agile maturity model as a basis for their investigations [31].

This model is shown in Figure 2, and it is somehow inspired by CMMI, since it also has 5 levels, each with a set of goals for their practices: (1) Level 1: Initial – organizations belonging to this level of agile maturity do not have a clearly defined process for agile development and eminent success depends solely on the competence of individuals; (2) Level 2: Explored – it gives particular focus to project planning and requirements engineering for organizations; (3) Level 3: Defined – it stresses the importance of frequent deliveries, pair programming and customer relationship enhancement; (4)
Level 4: Improved – it focus on project management, sustainable velocity of development and self-organizing teams; (5) Level 5: Sustained – underlines the need for the management of projects’ performance, thus continuously improving processes.

The AMM provides a first approach to classifying the maturity of agile development processes, which comprises practices from various agile methodologies. Therefore, it leads us to a continuous research, since this model’s set of practices crosses too many agile methodologies that most organizations do not apply, causing increased levels of entropy.

C. Agile Maturity

Agile Maturity paper appeared as a study case from the British Telecom while developing an IT project [32]. Since it was said that big organizations had increased the barrier for a successful agile adoption, an agile maturity roadmap was presented.

The agile maturity evaluates the agile performance in seven dimensions within five levels of maturity: (1) Level 1 – represents the appearance of software engineering best-practices; (2) Level 2 – best-practices are continuous and improve within small development teams; (3) Level 3 – there is continuous integration within local component teams; (4) Level 4 – there is an incessant integration within global journey teams, i.e., distributed teams, and, (5) Level 5 – on-demand development maturity.

For each of these levels there shall be an evaluation of each the seven existing dimension: (1) Automation of regression tests; (2) Code quality metrics; (3) Automation of deployment; (4) Automation of configuration and best-practices management; (5) Interface integration tests; (6) Test driven development, and, (7) Performance scalability tests.

The combination of these five maturity levels and the seven dimensions allowed British Telecom to incrementally perform a better agile development process. However, this approach is generic and non-focused on the description of these levels and their practices, which leads to one’s need to seek another solution for the major problem stated in Section I.

IV. PROPOSAL

Following the problem focused throughout the last investigation and its various related work, the proposal of a potential solution was introduced in the previous work. Therefore, this section will present the improvements made, the results from the previous proposal through the last two cycles of action research, and propose an optimized roadmap for IT organizations, with renewed validation, so as to develop software with better quality, i.e., more focused on the client role and motivated to self-improvement and market competition.

The Scrum Maturity Model’s main purpose is to aid and guide IT software development organizations and encourage self-improvement, giving special attention to the client’s role, which is mandatory on this fast moving, global and competitive worldwide market. Furthermore, this proposal intends to help organizations that are not familiar with Scrum and wish to implement and adopt it on a staged and incremental approach.

This proposition introduces five levels for Scrum development methodology with its respective goals, objectives, specific and suggested practices. The number of levels is a standard of maturity models, thus making it easier to be measured up with other maturity models for comparison and evaluation purposes.

Next, the main improvements made from the original proposal will be presented. Note that the full details of the proposition contain the complete goals, objectives, practices and suggested metrics for each level of Scrum maturity.

A. Level 1 – Initial

This first and lowest level of maturity, which can be assigned to an organization that uses Scrum, represents the absence of goals for process improvement. The explicit definition of agile development with Scrum methodology does not exist within organizations classified as belonging to this level.

The main issues of the organizations in this level are the frequent over-time and over-budget projects, poor communication among stakeholders and unsatisfactory quality of the final product. These organizations operate on their own and unique way depending on their particular situation which makes their success highly reliant on competent and skilled individuals rather than on standardized and capable teams. In fact, organizations that do not comply with the goal defined for level 2 of Scrum maturity are downgraded to level 1 until further improvements are performed in order to achieve the next level.

B. Level 2 – Managed

In level 2, software development practices appear more structured and complete than in level 1, due to the fulfillment of the two main goals set for this level also shown in Figure 3:

- Basic Scrum Management – this goal dictates practices that organizations in this level must accomplish, which will ensure the minimum acceptable usage of the Scrum methodology and structure. Note that, although all Scrum roles, objects and meetings must exist in these organizations, those Scrum objects might not be correctly or effectively used, resulting on the need to have further process improvement.
Software Requirement Engineering – this goal comprises a set of practices that the organizations must comply with in order to achieve satisfaction from the final product’s quality created by the vendor organization. Organizations in level 2 usually face fewer problems in the development process than the ones in level 1. However, they still have difficulty in communicating with the client-side representatives and delivering their projects as planned, concerning schedule and budget.

According to the last evaluation of the proposal, this level showed solid goals, objectives, practices and suggested metrics. For this reason, level 2 presented minor changes in the text of the practices, remaining the majority of this level intact.

C. Level 3 – Defined

Level 3 of this maturity model has its major focus on the relationship with clients and on time deliveries. Hence, this level also has two major goals, shown in Figure 4, to guide organizations and improve their processes:

- Customer Relationship Management – this goal emphasizes the importance of the client and the efforts required to maximize the collaboration with the customer side, even considering the three main difficulties mentioned in Section I. A set of practices are defined and must be satisfied in order to solve the core problem of this investigation.

- Iteration Management – this goal is indirectly linked to the previous one, since both contribute to raise customer satisfaction levels. In order to achieve this goal, a set of practices must be fulfilled and implemented so that the organizations always deliver their projects and sprints on time, following their budgets.

With the implementation of level 3 of maturity, an organization can be successful on several projects. However, this success is only partial due to the lack of standardized management, which would guarantee the same quality and performance in all development processes.

Again, the previous work evaluated this level as fairly solid, and only minor changes within the description of the practices were introduced.

D. Level 4 – Quantitatively Managed

In level 4 of Scrum maturity, an organization can boost their achievements by offering standardized and regular software development processes aided by the management of the process performance through measurement and analysis practices. In this level of maturity, there are two main fields:

- Standardized Project Management – this goal shall lead organizations to use the same development process for all projects and deliver significantly high quality and performance levels. In order to achieve this goal, an organization must complete the standardization of the performed processes;

- Process Performance Management – this goal demands the monitoring of all suggested practices up to level 4 of Scrum maturity. These metrics aim to provide enough feedback about actual processes and manage their performance.

Although this level seems very simple in Figure 5, it is actually extremely hard to implement the management and monitor all projects within an organization so as to fulfill all specific practices and maintain the process’ consistency. Note that suggested metrics may be used and organizations are encouraged to customize them to be more appropriate for each enterprise’s culture and best practices.

Organizations in this level adopt appealing Scrum development processes and the majority of their projects are successful. The only and last improvement left is optimization of the current processes.

With the previous evaluation process for this proposal it was possible to identify the ambiguity within level 4 for many organizations. In order to clarify it, the demand for “Standardized Projects Management” is now only applied to all agile Scrum projects within the organization, and not to all projects, since in one organization both waterfall development methodologies and agile, in different projects and clients, can coexist.

E. Level 5 – Optimizing

Organizations in level 5 of the Scrum Maturity Model are top class software developers using Scrum methodology. They focus on continuous self-improvement to excel competition and bring higher levels of satisfaction from client, development team and all stakeholders. The only goal for this level is:

- Performance Management – this goal allows organizations to measure and analyze their own actions and processes to self improve.
Organizations in this level have achieved a maximum level and must not discard previous accomplishments and goals by negligence which will block continuous process improvement.

In Figure 6, the four objectives for the main goal of this Scrum maturity are illustrated, being “Causal Analysis Resolution” a newly added objective to this level of Scrum maturity.

According to Expert A, the first three levels of Scrum maturity have sufficient detail and acceptable approach. However, although level 4 and 5 have proper goals and objectives, they required some more detail, more specifically, practices to enhance the quality of Scrum Retrospective Meeting are lacking. For instance, practices such as “Question five W’s”, “Identify problems and incidents” and “Build cause-effect diagram to identify problems” would enhance the quality of the inner inspection from retrospective meeting to seek continuous improvement.

Nevertheless, in her feedback, Expert A also stated that the suggested metrics from level 4 of Scrum maturity presents an excellent feature, since not even CMMI presents suggested metrics that exists in COBIT. These suggested metrics allow the monitoring of the current state of the process and discover where to put efforts for improvement, apart from analyzing quantitative statistics from the development process.

About the concept as a whole, Expert A accepts that scattered Scrum loses integrity, however she also agrees that Scrum Maturity Model is not intended to split Scrum into five levels and areas, but rather to provide more emphasis on different areas in each level. Furthermore, it was assured that if this proposal does not become a standard worldwide, it will at least be an extraordinary tool to be used in Scrum Retrospective Meetings as self appraisal and assessment of own maturity.

Expert B, also an international Agile and Scrum expert as well as a Scrum coach, works for a top five world largest IT company, and conceded us an interview to present to him the actual proposal and discuss about its viability, usefulness and created value. He was pleased with the concept which involves the evaluation of the maturity of the Scrum process, and provided precious feedback for the definition of the practices of each level and within each goal.

Most of the original proposal remains, while merely the definition of the required practices changed, remaining the goals and objectives intact.

V. RESULTS

In order to evaluate and validate the usefulness and effectiveness of this improved proposal, a third cycle of action research was planned, which included two interviews with Scrum, agile and CMMI experts to validate the concept and details of the proposal as well as six appraisals and audits of Scrum maturity in three different enterprises so as to evaluate its usefulness, efficiency and impact made.

A. Interviews

In order to obtain validation of this concept: maturity model for agile Scrum development methodology, a few experts were interviewed.

1) Expert A

Expert A, an international CMMI, Agile and Scrum expert and also partner of an Agile coaching company, granted us two interviews to present our previous proposal and discuss it regarding its viability, usefulness and value created from it.
accomplished in order to obtain the intended level of Scrum of maturity.

- Post-appraisal questionnaire – After the appraisal, the organization receives a post-appraisal questionnaire to evaluate the proposal. This phase aims to extract all feedback, both positive and negative, about the proposal and the satisfaction level with appraisal results, comparing it to the initial expectations.

Next, we will present the action taken within three IT organizations. While auditing the maturity of their development process using Scrum, a number of organizations provided more than one project in progress for the audit process; therefore, in some, more than one project manager was interviewed.

1) Organization X

Organization X, which is focused on cutting waste in software delivery through the practice of lean and agile concepts that they have been implementing for a year now, allowed an audit of their software development process to assess their maturity of Scrum usage.

They are comprised by around seven developers abroad in Ukraine, who assume the Scrum role “Team”, and three project managers in Portugal, that take on the role of “Scrum Master” involved in two or three projects at a time. This enterprise is the excellent example of distributed Scrum, which intends to manage the resources wisely without creating waste and still fulfills the needs of the client, considering the problems from cooperation and distance.

Within the pre-appraisal questionnaire, the organization predicted the possible outcome from the audit as level 2 or 3 of Scrum maturity, since they were aware of the lack of mechanisms to measure and monitor process metrics and formal processes for continuous improvement.

As the appraisal occurred, the organization was confronted with the checklist of the practices which had to be fulfilled in order to achieve the first level of Scrum maturity – level 2. According to the audit, they failed the “Basic Scrum Management” goal by missing the objective of “Scrum meetings occur and are participated”. Actually, they ignored the need of a Scrum Retrospective Meeting and neglected the importance of a formal Daily Scrum Meeting and Scrum Review Meeting.

During the post-appraisal questionnaire, the organization did not show any sight of disappointment and, instead, appeared to be very excited with the results, displaying motivation and critic analysis toward the results and opportunities for future improvements for a better development process. First, they argued that it is very difficult to communicate with clients in this fast moving generation. It was hard to convince the collaboration and their presence at the end of each sprint, which caused them to fail practices such as “Sprint Review Meeting occurs exactly once per Sprint” and “Sprint Review Meeting is attended by Stakeholders, Scrum Master, Product Owner and Team”. They also claimed against the failed “Daily Scrum occurs exactly once per workday” practice, since the organization affirms there are caving meetings from lean development principles, for the nature of these meetings is different.

Nevertheless, at the end, the organization will rethink these failed practices, and the interviewed project manager planned to immediately launch the implementation of Scrum Retrospective Meeting, since it has great potential benefits that had not yet been considered.

When the interview ended, the interviewee gave the following feedback regarding the Scrum Maturity Model:

“This proposal provides a good road for IT organizations by offering goals and objectives per level to evolve and gradually improve, attacking one goal at a time.”. “For higher levels of maturity, it is required much more stability to see the improvements and, although the existence of suggested metrics is brilliant, it lacks how to implement the monitoring mechanism.” As a final word, the Scrum Master from the organization stated: “Many organizations nowadays declare themselves as agile, but how agile they can be when there are no definitions or rules? The existence of this proposal can surely differentiate the successful agile practitioners from the others.”

2) Organization Y

Organization Y, a fast growing IT consultant enterprise focused on satisfying the market needs through agile and flexible principles, also accepted to be a part of this investigation by providing three of their four project managers to be audited with Scrum Maturity Model.

They are around forty employees, with about thirty in headquarters and ten distributed in two other branches, being one of these branches located abroad, in Vienna. Currently, they employ four project managers and the CEO arranged three meetings with three of them in order to receive some academic research feedback within his company.

a) Project Manager Y1

Project Manager Y1 has been recently promoted to perform the more technical oriented role of project manager. He has a background in the business intelligence field, and now focuses more on the leadership and management of the team of developers for consulting projects.

During the pre-appraisal questionnaire phase, while analyzing the goals required for each level, he determined levels 1 or 2 as a possible result, for he was fully aware that the organization is on the early stage of agile implementation and several goals might not be fulfilled.

As the appraisal for level 2 of Scrum maturity occurred, soon the missing practices were identified. They missed the “Sprint Retrospective Meeting occurs exactly once per Sprint” practice. Unfortunately, this missing feature made this organization fail level 2, although many other practices were accomplished.

Then, within the post-appraisal questionnaire, the project manager agreed with the results, although slightly disappointed with the obtained level. The grounds for this result, he said, was that many unimplemented practices were not given the importance they should have and, although it is possibly very
rewarding, they wanted to focus more on the current client needs without having to worry about overworking their employees. Another explanation is that, given the dimension of his team, so much formality in the development process was not really necessary, as long as the results show up and the clients are satisfied.

For evaluation purposes, it was allowed for the project manager to inspect the next level, which turned out to be another failed appraisal, but this time for level 3, the organization failed the “Sprint Buckling Items are split into tasks” practice when all other practices were accomplished. With this result, the project manager was relieved because he believed that they could achieve up to level 3 of Scrum maturity with a relative small amount of effort, even though it required immense work in employees’ culture to implement them.

To conclude, he agreed that the concept itself has potential to grow into a certification, which will provide more market differentiation. Another interesting point is that it might not be very expensive to concentrate efforts and obtain an acceptable level 3 of Scrum maturity.

b) Project Manager Y2

Project Manager Y2 is in charge of four development projects, each of them with only one or two developers located in Vienna focusing on the improvement of applications for smartphones. The main challenges for him are how to coordinate and perform the role of middle man between the client’s needs and developers’ performance with Scrum methodology, since he has less than a year experience with this development methodology.

Within the pre-appraisal questionnaire, given Manager Y2 relative inexperience, the project manager did not have high expectations and pointed out level 2 as a possible outcome. During the appraisal, they failed many practices such as: “Release Burndown Chart exists”, “Sprint Burndown Chart exists” and “Sprint Retrospective Meeting occurs exactly once per Sprint”.

In the post-appraisal questionnaire phase, the project manager explained that due to the unawareness of the technical capabilities from the project management tools, it was not possible to maintain updated and correct burndown charts. Concerning the missing retrospective meeting, he stated that it is very difficult to have a formal meetings with the distributed team located in Vienna, seriously affecting the performance of this communication.

Again, for evaluation purposes, it was allowed for the interviewee to inspect the fully detailed Scrum Maturity Model, and advanced to the next level’s audit. They did not accomplish practices like: “Definition of ‘Done’ is achieved in each iteration” and “During Sprint Review Meeting Product Owner and other stakeholders provide feedback”.

In the end, the project manager was satisfied to learn more about agile Scrum methodologies, and where he should improve in future projects. He stated that this maturity model might be an important tool to measure their current performance and guide them to continuous improvement.

c) Project Manager Y3

Project Manager Y3, a very experienced and enthusiastic Scrum and agile practitioner, is leading the company to implement the backbone for Scrum adoption. It has been almost a year since they started trying to reach this objective, and, at the moment, they are in the final stage. For him, continuous improvement is the core strategy to achieve a competitive advantage. In order to achieve this goal, he leads the implementation and integration of several support systems to aid the development process, since he believes that no agile is solid enough without the required backbone tools. Now, he is in charge of a development project with three developers and a three month length deadline.

The pre-appraisal questionnaire phase revealed that he had high expectations and confidence in their maturity, choosing the level 4 or 5 as the expected result from the appraisal.

When the appraisal began, they succeed to fulfill level 2 practices, and then level 3. No problems were encountered so far. Surprisingly, level 4 was also achieved, because all his previous projects were managed with a standard method and he had a data mining module that defined, monitored and measure their development process and metrics. At the last appraisal for level 5, unfortunately, they failed the practices: “Successful Retrospective Meetings result in concrete improvement proposals” and “Successful Retrospective Meetings’ lessons learned are recorded to a knowledge base”.

Within the post-appraisal questionnaire, the project manager was satisfied with the results, seeing his efforts recognized by external parties and not totally disappointed with the obtained level 4 of Scrum maturity, since they were working on the quality of retrospective meetings now.

His final feedback for this proposal is the following: “This proposal is an excellent tool for deeper insight, to rethink their agile path. Moreover, this preposition motivates the adoption of Scrum by separating several objectives via levels. Agile is easy to learn, however very hard to master. Thus, it is very important for prepositions like these to exist in order to aid organizations to correctly adopt Scrum.”

3) Organization Z

Organization Z is a worldwide renowned company that provides technology solutions and services around the world. In their office located in Portugal, they employ around four hundred professionals, delivering both consulting service and software solutions. Their development projects are normally very big involving more than forty people and a twelve-month period per project.

a) Project Manager Z1

Project Manager Z1 is the senior software architect and performs team coaching regularly. He worked for a leading and pioneer company using agile methodologies, where he learned a lot about agile best practices from the elite from that generation. Currently, the project he is working with involves forty people, three scrum teams and a year of schedule, and it applies Scrum methodology with this particular client for the first time. They are on the production and deployment phase.
In the pre-appraisal questionnaire assessment, Manager Z1 suggested level 3 as the possible result, since he was aware that the company missed the goals “Measurement and Analysis Management” and “Performance Management”.

During the appraisal for level 2 of Scrum maturity, Manager Z1’s project succeeded to accomplish all practices for level 2, except “Sprint Burndown Chart exists” practice.

In the post-appraisal questionnaire phase, Manager Z1 intensely argued about the need of a sprint burndown chart, which is only used to manage small two weeks sprints and creates waste by joining efforts to manually build such a chart. Note that the organization uses manual means to follow Scrum methodology.

By analyzing the next levels, Manager Z1 felt frustrated again, because he would fail level 3 due to the inexistence of the sprint burndown chart stressed in the goal “Iteration Management”. However, to achieve levels 4 and 5, he agreed that more efforts were needed and that they intend to move further in their question of continuous improvement as a competitive advantage.

As final words, he said: “What I see here is a very interesting approach in agile methodologies study. The roadmap is very good for new enterprises to adopt Scrum and a nice differentiation model for companies in the development industry.”

b) Project Manager Z2

Project Manager Z2 is also a well experienced Scrum practitioner within the organization, and is currently managing a project with four years already, which involves three Scrum teams. This project’s particularity is that the client does not collaborate as closely as the company would wish, so Scrum was only applied as internal communication and work methodology.

In the pre-appraisal questionnaire, after the overview of the maturity mode, he selected level 2 as most likely result of the appraisal.

As the appraisal started, “Sprint Burndown Chart exists” practice was found to be missing just like in the last project manager. Moreover, they did not have “Sprint Review Meeting occurs exactly once per Sprint” practice formally implemented, only some demonstrations once or twice a year.

Yet another missing practice was “Sprint Retrospective Meeting occurs exactly once per Sprint”, as according to company’s culture, it only happens right after the Scrum Review Meeting.

During the post-appraisal questionnaire, he commented as the following: “Agile methodologies stress communication a lot. Its qualities are not shown in tiny projects, but in large scale projects in which real problems occur. In these big projects, flexible and constant communication is needed to maximize and optimize the work performed. This proposal presents a staged maturity model to guide Scrum implementation and Scrum performance and usage to differentiate enterprises, which is a magnificent idea.”

VI. EVALUATION

Given the results previously presented, in this section, a critic study for the Scrum Maturity Model will be analyzed and presented.

Regarding the interviews, it was possible for us to realize that the first three levels were well structured, while top levels needed some rework, which is already done. Moreover, it was stated by professionals that the preposition is a very good approach for Scrum adoption, self-inspection and continuous improvement.

This study considered the six performed appraisals in three sample organizations from Portugal, represented by a small, a medium and a large-sized company. Although the average level of maturity is not very high, many of the audited organizations were able to easily reach level 3 by focusing efforts to implement the missing goals, objectives and practices.

The most common missing practices for the first level of Scrum maturity, level 2, were “Sprint Review Meeting occurs exactly once per Sprint” and “Sprint Retrospective Meeting occurs exactly once per Sprint”. In level 3, “Definition of ‘Done’ is achieved in each iteration” is the most commonly failed practice. Top levels were scarcely achievable due to their requirements for mechanisms and concepts for measurement; analysis of process metrics; causal analysis; resolution of problems; and, impediments identified, which were not popular among IT development organizations.

Through this assessment, it was possible to conclude that the proposal provides a good roadmap for organizations that want to implement Scrum methodology from scratch, align their position for benchmarking purposes or for organizations that want to self-improve.

All feedback collected from both interviews with experts and professionals in the development industry gave us a great deal of confidence and insight to continue our research, refine it and possibly scale its usage and define it as a standard.

VII. CONCLUSION AND FUTURE WORK

In Section I, followed by some discussion and analysis, the main problem was a visible lack of collaboration, in most cases, between vendor organizations and clients as they tried to achieve the development of a successful IT project. This problem is a widely researched topic amongst IT experts, due to its vital importance on the success of software development projects [1][2][3][4][5][6][7][8].

Inspired by the related work and maturity models, the improved proposition, from previous research, with five levels of Scrum maturity presents a roadmap for organizations to implement Scrum methodology and compare the performance of software development process amongst competitors.

The main focus of this paper was the validation phase of the current proposal within cycles of AR, which are comprised
by two interviews with two agile and CMMI experts and six appraisals and post-appraisal assessment. The proposal was evaluated and validated by them, and it is our intention to share our findings with the scientific community. Since this proposition is continuously evolving, the current research shall be repeated until the community agrees on a final iteration and accept it as standard.

We are aware that the evaluation process has limitations, but despite credibility issues regarding this process, the experienced validation phase is worthy to be shared with the scientific community, given the interest of the process and its results.

Along with the analysis of the motivation for this research, it was pointed out that further investigation on human factors and on the change of management areas might benefit and enhance the performance of this maturity model. Another interesting research topic would be the classification of the partnership and client maturity, since, as referred to in Section 1, clients are usually the major impediment for successful IT projects.

In the end and once more stress, the proposition of maturity model is highly polemic within agile community. Nevertheless, the concept Scrum Maturity Model has proved successful as the roadmap for organizations that seek self-improvement and guidance.

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