Pós-Graduação em Ciência da Computação

C2M - A COMMUNICATION MATURITY MODEL FOR DISTRIBUTED SOFTWARE DEVELOPMENT

BY

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RESUMO

É comum hoje em dia que equipes de projeto estejam organizadas de forma distribuída, ou seja, seus integrantes estão em diferentes cidades, estados ou países. Essa configuração deu origem, na área de desenvolvimento de software, a estratégia de negócio chamada Desenvolvimento Distribuído de Software (DDS). Atualmente, pode-se perceber que o número de empresas que estão aderindo ao DDS é bem mais significativo quando comparado há alguns anos atrás. As empresas visam ganhos de qualidade, produtividade e diminuição de custos. Por tais motivos, o DDS vem despertando um grande interesse de pesquisadores nos últimos anos. A distribuição geográfica das equipes tem criado diversos desafios ao processo de desenvolvimento de software e à gestão dos seus projetos. Dentre esses desafios, destaca-se a comunicação pois é necessária a toda e qualquer atividade do ciclo de desenvolvimento. A comunicação torna-se crítica à medida que os recursos tradicionais de comunicação em projetos (e.g. reuniões face a face, comunicação não verbal, visualização do trabalho *in loco*, entre outros) passam a ser limitados e/ou substituídos por meios tecnológicos (e.g. videoconferências, *e-mails*, mensagens instantâneas, entre outros). Diante desse contexto, esta tese teve como objetivo conceber um modelo de maturidade para comunicação em projetos DDS. Para propor esse modelo de maturidade optou-se por um estudo *ad-hoc* da literatura, bem como duas revisões sistemáticas da literatura em conjunto com um estudo de campo qualitativo. Em seguida, propor-se uma versão inicial do modelo e realizou-se dois grupos focais para avaliá-lo de forma preliminar. Os resultados obtidos com esses dois grupos focais, foram utilizados para gerar uma nova versão do modelo. Em seguida, realizou-se uma *survey* através de entrevistas semi-estruturadas para avaliar a nova versão do modelo com especialistas. Neste sentido, a principal contribuição desta pesquisa de doutorado é o modelo de maturidade para a comunicação que visa estabelecer boas práticas de comunicação em DDS para maximizar o sucesso dos projetos. Por conseguinte, este trabalho também contribui com o ainda incipiente corpo de conhecimento da área projetos e em especial projetos DDS. Este entendimento é útil não apenas para estudos futuros na academia, mas também para empresas de software iniciando suas operações em DDS. Elas podem se beneficiar do conhecimento consolidado e utilizá-lo para guiar a definição de seus processos de comunicação em tais ambientes distribuídos.

Palavras-chave: DDS. Comunicação. Projeto. Modelo de maturidade. Desenvolvimento de software.

ABSTRACT

Nowadays, software teams are often organized in a distributed way, that is, team members are located in different places, with the distance varying from the level of cities, states or countries. This distributed configuration promoted the creation of a business strategy called Distributed Software Development (DSD). Nowadays, the number of companies adhering to the DSD strategy is much more significant when compared to few years ago. Companies aim for quality and productivity gains and the redution of development costs. For those reasons, DSD has increased interest of Software Engineering researchers over the last years. The geographic distribution of the teams has created several challenges to the development process and to the management of software projects. Among these challenges, communication can be highlighted as one of the most critical since it is necessary to support all and every activity during the development life cycle. Communication becomes critical as the traditional communication channels (e.g., face-to-face meetings, unplanned discussions, and non-verbal communication) become limited and substituted by technologic media (e.g., videoconferences, e-mails, and instant messengers). Given this context, this thesis aimed to develop a model to software teams to improve the maturity in of communication processes distributed projects. To propose this maturity model, I conducted an *ad-hoc* review of literature followed by two systematic reviews of literature and a qualitative study. I then proposed an initial version of the model and next conducted two focus groups (qualitative study) to preliminarily evaluate the model. Insights from this study were used to generate a new version of the model. Next, I conducted semi-structured interviews to evaluate the new version of the model with experts. Therefore, the main contribution of this research is a maturity model for communication that aims to establish good communication practices in DSD to maximize the success of a DSD project. My work contributes also to the still incipient body of knowledge about communication in the DSD area. This understanding is useful not only to further studies in the academy but also to software companies that are starting DSD operations. They can benefit from the knowledge consolidated in the model and use it to guide the definition of their communication processes in such distributed settings.

Keywords: DSD. Communication. Project. Maturity model. Software development.

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LIST OF ACRONYMS

C2M	Communication Maturity Model
CMM	Capability Maturity Model
CMMI	Capability Maturity Model Integration
CSCW	Conference on Computer Supported Cooperative Work
DSD	Distributed Software Development
ESCM	eSourcing Capability Model
GSD	Global Software Development
ICGSE	International Conference Global Software Engenniering
MPS.BR	Melhoria de Processos do Software Brasileiro
OMM	Offsourcing Maturity Model
OSM	Offshore Stage Model
PCMM	People capabiliti maturity model
PMBOK	Project Management Body of Knowledge
PMF	Process Maturity Framework
SE	Software Engineering
SEI	Software Engineering Institute
SITO	Source of IT Work Offshore
SLR	Systematic Review Literature
TQM	Total Quality Management
WDDS	Workshop de Desenvolvimento Distribuído de Software

SUMÁRIO

1. INTRODUCTION

This chapter aims to present the motivation, the goal and the research methodology of this thesis. It also introduces the structure of the thesis.

1.1. MOTIVATION

Over the recent years, the software engineering community and the industry have observed a huge change influenced by the globalization. In the globalization era and especially during the past decade, the Distributed Software Development (DSD) strategy became a needed solution for software organizations which aim to accelerate their processes and reduce their costs development. Issues like limited budgets, lack of resources, cost and time had motivated many companies to search for partners in other countries outside their operational zone (BASS *et al.*, 2009), (HERBSLEB *et al.*, 2005), (HOLMSTROM *et al.*, 2006), (SMITE *et al.*, 2008). Therefore, we had a large increase in the number of organizations adopting DSD in their software projects (ASPRAY; MAYADAS; VARDI, 2006), (BOEHM, 2006) and, as a consequence, the term DSD has spread out in the software industry (HERBSLEB, 2007), (RAMASUBBU; BALAN, 2007). This scenario has restructured the national and international software market despite whether companies are only developing software products or redefining their business models.

Consequently, research on DSD has grown on the last fifteen years (e.g., (BIRD *et al.*, 2009), (CARMEL; TJIA, 2005), (CARMEL, 1999), (CATALDO; NAMBIAR, 2009), (DAMIAN; MOITRA, 2006), (DAMIAN; ZOWGHI, 2002), (HERBSLEB; MOITRA, 2001), (KAROLAK, 1998), (PRIKLADNICKI; AUDY; EVARISTO, 2003a), (ROBINSON; KALAKOTA, 2004), (SANGWAN et al., 2007), (SENGUPTA; CHANDRA; SINHA, 2006), (SMITE *et al.*, 2008), (FARIAS JUNIOR *et al.*, 2009)). To Prikladnicki (2009), DSD has led organizations to seek for external solutions in different countries, aiming to obtain greater advantages in the global market. DSD becomes then a common trend in global scale. Global Software Development (GSD) is a type of DSD. It is referred as offshore sourcing or offshoring in the literature (PRIKLADNICKI, 2009). In GSD, the main business models are either offshore outsourcing—the contracting a third-party company located in another country; or internal

offshoring—the contracting or creation of a unit of the company outside its original country.

Software companies are distributing their processes and operations to offshore/outsourcing in order to obtain benefits such as low costs, high productivity, access to skilled workforce and access to the international market, (COTTMEYER, 2008), (GOPAL *et al.*, 2002), (LEE; POWELL, 2006), (NISAR; HAMEED, 2004), (PILATTI; AUDY; PRIKLADNICKI, 2006). For instance, many Asian countries, like China, India, Pakistan, Malaysia, Singapore, Philippines, Thailand, and Vietnam are involved in activities of offshore development (KUBLANOV *et al.*, 2004), where their software companies work as low cost providers mainly for companies located in European countries and in the USA. These countries can quickly provide a great volume of skilled professionals. However, this new way of developing software also presents challenges, due to temporal, geographic and sociocultural distances and the lack of communication between the now dispersed teams (HOLMSTROM *et al.*, 2006), (FARIAS JUNIOR *et al.*, 2009), (CONCHUIR et al., 2006), (HOFNER; MANI; TAPER, 2007), (KORKALA; ABRAHAMSSON, 2007), (LAYMAN *et al.*, 2006), (SAUER, 2006), (LEAL; DA SILVA; HUZITA; TAIT, 2010). Nisar and Hameed (2004) found that seven out of ten software projects fail due to different global scale challenges. Some of the most cited problems are: lack of face-to-face interactions, lack of experience in distributed projects, difficulty in managing the cooperation among the stakeholders, limited technological infrastructure, cultural differences, time zone differences, among others.

Some researchers (e.g., (BASS *et al.*, 2009), (HERBSLEB, 2007), (HERBSLEB *et al.*, 2001), (HERBSLEB *et al.*, 2005)) argue that communication, coordination and collaboration are the main reasons to distributed software projects' failure. Herbsleb (2007) posed that distributed projects have more chances to face issues than the collocated projects due to the impact of communication issues and coordination challenges. Therefore, communication in DSD projects is reported as less effective since those involved in the development cycle communicate less with their team's remote members when compared to co-located projects. Evidently, communication is less frequent, and, consequently it is not as effective. These communication issues promote side effects such as the lack of information about the team members, which may

cause misunderstandings and rework. These side effects may harm the progress of the project if, for example, team members do not know who is the responsible for a certain activity. Thus, there is a need to identify the critical factors of communication which cause these challenges as well as to map the effects inherent to these critical factors.

Communication is one of the greatest problems in DSD projects, especially in the offshore outsourcing and internal offshore development, due to the temporal distance, and cultural and language differences (CARMEL, 1999), (HERBSLEB *et al.*, 2005), (HUANG; TRAUTH, 2007), (MOE; ŠMITE, 2008). In the distributed environment, the communication frequency is low when compared to the traditional or collocated development (BASS, 2006), and there is a lack of face-to-face communication (MOE; ŠMITE, 2008). Therefore, the geographic distance becomes a critical factor to the success of the project since it considerably decreases the personal or face-to-face meetings, and reduces opportunities for informal communication (HERBSLEB, J.D.; MOITRA, 2001). Damian and Moitra (2006) and Herbsleb *et* al., (2005) claim that members of distributed teams must interchange with other disperse teams to increase trust and to know the context of the other distributed teams.

The videoconference tools are being used to reduce the impact of the lack of face-to-face meetings and to increase the informal communication in a way to do not impact the project in a negative way (CARMEL, 1999).

Temporal distance introduces the limitation of synchronous communication due to the time zone, that is, lack of time overlaps between the members of the distributed teams (MASSEY *et al.*, 2003). In the sake of this limitation, the team members are obligated to use and trust asynchronous communication (MASSEY *et al.*, 2003), which can cause delay in the response or even generate some social conflict. According to Smite *et al.* (2008), most of the studies in the DSD area discuss different challenges. Some authors, to minimize these negative impacts in projects with dispersed teams, highlight in their research the importance of the communication in DSD projects (FARIAS JUNIOR *et al.*, 2009), (GOPAL *et al.*, 2002), (HERBSLEB *et al.*, 2001), (KORKALA; ABRAHAMSSON, 2007), (LAYMAN *et al.*, 2006), (DA SILVA *et al.*, 2010), (FARIAS JUNIOR *et al.*, 2012), (HUZITA et. al., 2008) and propose solutions based in case studies, qualitative researches and other empirical works.

However, there are only a few articles which illustrate recommendations or techniques to mitigate these challenges.

One can see that as the geographic dispersion increases, the challenges also increase, and consequently the communication becomes scarcer, losing all its richness of knowledge and clear project status transmission, and trust development between the teams. So, the lack of a framework or model of good practices or of a well-defined communication process minimally standardized for DSD projects become a critical aspect for the success of the fews kind of project.

For this reason, is necessary to improve communication processes and practices. When a project has a poorly planned communication, there is a possibility of it adding challenges in the project, which can lead to failure.

In this context, this study sought to answer the following research question: **What should a maturity model consist of to support communication in DSD?**

1.2. RESEARCH GOAL

The **main goal** of this research was to propose a maturity model to support communication in DSD projects. To achieve the main goal the following objectives were defined:

- To carry out an exploratory or *ad hoc* review and a systematic literature review about critical factors in communication in DSD as well as the effects of these critical factors;
- To identify good practices mentioned in literature as being practiced by industry to mitigate communication challenges in DSD projects;
- To develop a maturity model to support communication in DSD projects;
- To evaluate the proposed maturity model with DSD experts.

1.3. METHODOLOGY

For a researcher, knowledge is “public” in the sense that it is communicable and transmitted in some form to others; it is “objective” because it is founded in facts; it is “verifiable” because it is obtained through methods that are known by

the scientific community and it is “relational” because it seeks to identify the casual relationships between events (SANTOS, 1992) generated through observation and description and oriented by theoretical references. The systematized effort to obtain new knowledge about a specific subject is part of the researcher routine, in the attempt to reach the understanding about the unknown object.

A scientific research has the purpose of providing answers to proposed questions. The aim of this research is not the accumulation of facts (data) but the development of an understanding about the collected facts related to the posed research question (CRUZ & RIBEIRO, 2004). Any scientific research aims the creation of scientific knowledge and, to reach valid results, the researcher has at its disposal a set of methods, such as: experimental and non-experimental or descriptive plans and qualitative, quantitative, mixed/specific plans (COUTINHO, 2005). In this circumstance, the present doctoral thesis is guided by one basic principle: guided by the research question that is in Section 1.1. After defining the problem, by formulating the research question, proceeded to the definition of the respective context of this study as instructed Varela (2011). To answer the posed research question, I defined a research methodology inspired in the methodological process proposed by Dias-Neto, Spínola, Travassos (2010). Their research strategy combines primary and secondary studies as a mechanism to obtain scientific evidences in a domain (Figure 1).

Dias-Neto, Spínola, and Travassos (2010) illustrate the activities that compose the methodology, the adopted study types, and the expected results of each individual study. Furthermore, the research strategy has been used in other investigations performed by the Experimental SE Group (ESE) at COPPE/UFRJ, e.g., an investigation in the context of the (i) Software Defect Causal Analysis (MAFRA, BARCELOS, TRAVASSOS, 2006); (ii) agility in processes of Software Testing (CONTE et al., 2007); and (iii) requirements engineering in ubiquity (CONTE et al., 2007), demonstrating its fit for this kind of study.

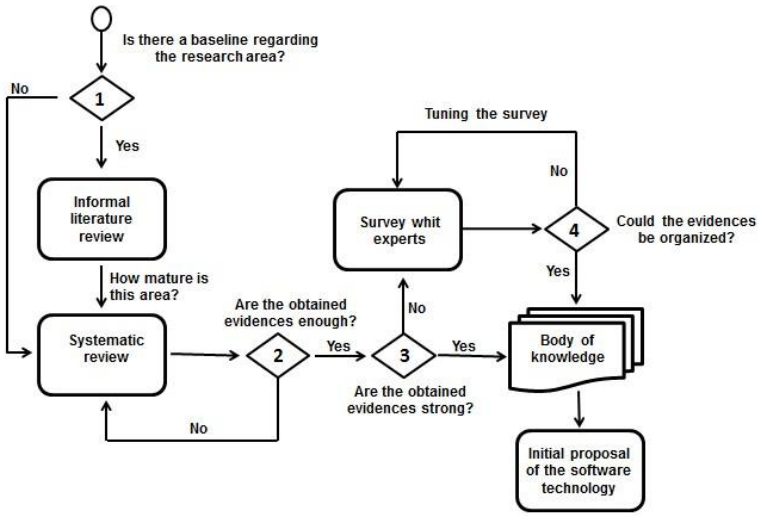

Figure 1 - Research strategy. Source: Dias-Neto, Spínola and Travassos (2010).

In order to develop the proposed communication maturity model for DSD projects, a research methodology was planned in four phases (Figure 2) inspired on Dias-Neto, Spínola, Travassos (2010) is research strategy:

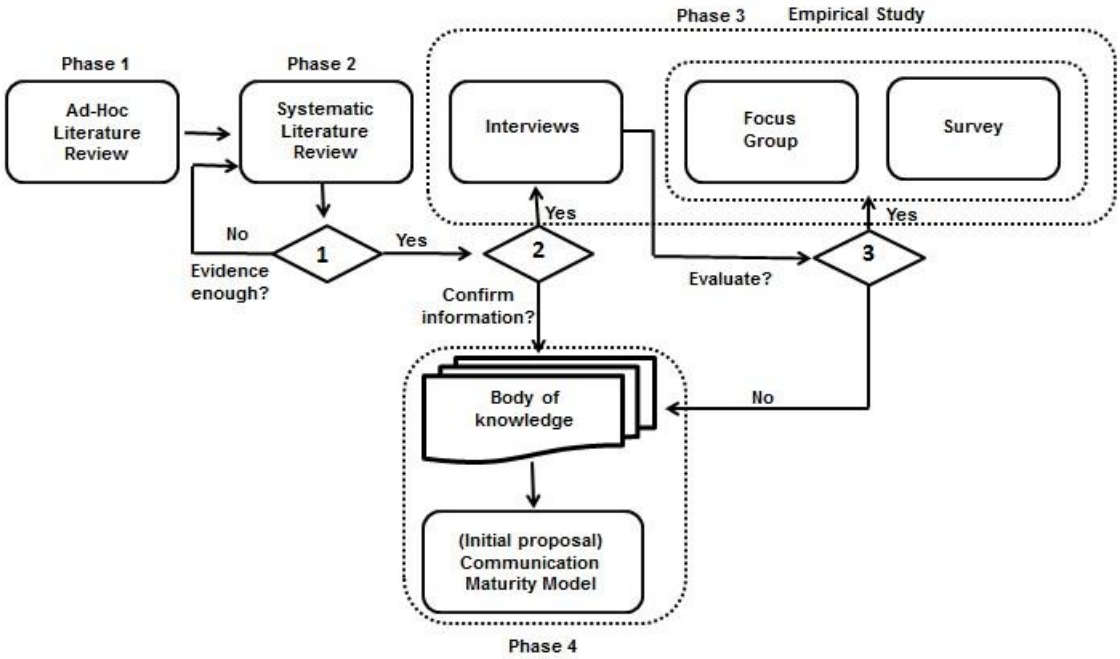

Figure 2 - Scientific methodology steps, inspired by the *research strategy* proposed by Dias-Neto, Spínola, Travassos (2010).

1.3.1 PHASE I: AD-HOC LITERATURE REVIEW

Every research area, independent of its classification (either based in their objectives, technical procedures or information sources), demands a previous bibliographic research (Cruz and Ribeiro, 2004). Gressler (2004) demonstrates

the truth of the affirmative, by arguing that “to an investigation be well succeeded, is supposed that the researcher already has a previous knowledge about the subject. The aim of the review is, then, the update and integration of this knowledge. It must include both the authors whose support the study and those who contradict its hypothetical affirmations”.

Phase 1 included an ad-hoc literature review that aimed to obtain the main concepts of the area – it corresponds to the Informal Literature Review step in Dias-Neto, Spínola, and Travassos (2010). Phase 1 was important as it formed the initial background for the continuity of this research. Furthermore, the review of some theoretical basis allowed me to prepare a protocol to formally investigate the state-of-the-art of communication in DSD.

1.3.2 PHASE 2: SYSTEMATIC LITERATURE REVIEW

Systematic Literature Reviews (SLR) are part of the paradigm of evidence based practices, which evaluates the evidences in a systematic and transparent way. SLRs aims to establish a formal process to conduct a literature review, avoiding to introduce eventual biases, allowing identifying, evaluating and interpreting all available and relevant work about a research question (MAFRA; BARCELOS; TRAVASSOS, 2006).

In a traditional literature review, the research strategy and criteria for the evaluation of the results are not transparent to the reader, meaning that the review can be performed in a non-structured way and the evidences may not sustain the hypothesis or investigation questions. However, in a systematic literature review, the research strategy and the evaluation criteria are explicit, and all the relevant evidences are included in the evaluation (KITCHENHAM; CHARTERS, 2007) (OATES; CAPPER, 2009).

A SLR “is a way to evaluate and interpret all the available research, concerning to a particular research question, thematic area or phenomenon of interest” define KITCHENHAM and CHARTERS (2007). Travassos e Biolchini (2007) say that systematic reviews “provide means to execute comprehensive and unbiased reviews in the literature, making their results have scientific value”. In addition, systematic reviews have as aim to present a fair assessment of an investigation topic, using a reliable, rigorous and auditable methodology (KITCHENHAM; CHARTERS, 2007). Two sytematic literature reviews (SLR1 and SLR2) were performed in this work. Phase 2 of this research work

corresponds to the “Systematic Review” step in Dias-Neto, Spínola, and Travassos (2010).

The following itens describes the performed systematic literature reviews:

- **SRL 1.** This first systematic literature review with secundary studies was performed between September 2010 and April 2011 and aimed to identify factors and effects of communication processes and practices in the DSD context. I identified 29 factors and 25 effects extracted from the SLR which was selected from established criteria. The results of this study are described details in Section 4.1. The results were published in (SANTOS, FARIAS JUNIOR, MOURA, MARCZAK, 2012).

- **SRL 2.** The second systematic review was performed in the period of August 2013 to May 2014 and aimed to identify communication practices adopted in DSD projects seeking to solve and minimize the impacts suffered by the factors identified in the first RSL. The results of this systematic review were extracted from 185 publications selected by established criteria. From these publications (studies) was possible to extract communication practices in DSD. The results of this study are presented in Section 4.3. The results were published in research work of Master's (RODRIGUES, 2014), a master thesis work.

1.3.3 PHASE 3: EMPIRICAL STUDY

In the empirical study, I aimed to understand the context of a situation and, creatively, to interpret and describe the complexity of a concrete case, through a deep and exhaustive dive in a delimited object (MARTINS, 2008), (MILES; HUBERMAN, 1994).

The researcher investigates the object of study in depth using a variety of data collection techniques to produce evidences which conduct to the understanding to answer the research question(s).

Coutinho (2005) says that one way of performing an empirical study is the case study method (YIN, 2009), which is based in a inductive reasoning method (MERRIAM, 1998) a case study depends heavily on the fieldwork (PUNCH, 1998), that is non-experimental (PONTE, 1994) and based in multiple

and varied data sources (YIN, 2009), constituting on the perspective of this last author, the suitable approach to the research. Coutinho (2005) clarifies that the aim of this kind of research is always holistic (systemic, wide, integrated). To this, the researcher seeks to extract the information in the real context, in depth, by questionnaires, interviews, observations, documents and written records, notes and field diaries, photos, audiovisual registers, testimonials, internet searches, among other methods.

The influence of the qualitative methods in the investigation of the DSD projects has been grow up since the publication of the first paper (refer to Section 2.3). From this on, many researchers, mainly from the Software Engineering (SE) area, began to manifest a proactive attitude in the use of the investigation strategies contemplating the qualitative approach, either on academic level or in the level of the conduction of the investigation in the software industry. On the other hand, some of them perform "fieldwork by observing the" in the participants and in in-depth interviews, spending time on site (Bogdan and Biklen, 1994). I aimed to understand specific situation to dynamically describe what is happening, to explain the mutual influences of the components and factors of a situation, to see the causes and consequences of certain interventions, to study a certain aspect of the problem in a comprehensive and deeper way (DENDALUCE, 1988). This Phase 3 corresponds to the step of Survey with Experts in (DIAS-NETO; SPÍNOLA; TRAVASSOS, 2010).

1.3.3.1 Interviews with DSD Professionals

Data were collected via semi-structured interviews. The goal was to confirm the factors identified in the SLR1 and to identify those that are most important for software industry in DSD context as well as the main problems and good practices in DSD projects that are related to communication. Thirty-one professionals from 12 organizations were interviewed; out of these 31 professionals, two are located outside Brazil (United States and Canada) and the access to both was facilitated by the collaboration with SOFTEX Recife. The other organizations were located in Paraíba, Pernambuco, Rio Grande do Sul and São Paulo. Based on this step, some elements of the C2M model were presented in (FARIAS JUNIOR *et* al, 2013). In a second moment, I consulted the respondents again and asked them to make the distribution of the factors

and practices in the maturity levels proposed by the C2M model. This time, through the interviews, I got inputs to the conception of a still incipient version of the C2M model.

1.3.3.2 Focus Group

To Caplan (1990), a focal group is a group of people reunited to evaluate concepts and/or evidenced problems. Vaughn et al. (1996), argues that a focal group is a qualitative technique which can be used alone or together with other qualitative or quantitative techniques to further the knowledge about the needs of the participants about a topic. The main aim of a focal group is to identify feelings of the participants about a certain matter, product or activity. Its specific objectives vary according to the approach of the research. In an exploratory research, its purpose is to generate new ideas or hypothesis and stimulate the researcher's thinking, while in phenomenological or orientation research, it is to learn how the participants interpret the reality, its knowledge and experiences.

I conducted focus group sessions aiming to evaluate the preliminary version of the C2M maturity model. This preliminary evaluation had as result feedbacks for the evolution of the model. It served also as imput to the design of a survey to a final evaluation through the opinion of DSD experts.

1.3.3.3 Survey

A survey consists in organizing a set of respondents, normally representative of a population, and a series of questions relative to the social, professional or familiar situation, their opinions, their attitude about human and social options or questions, their expectative, their knowledge or conscience level about an event or problem, or even about any other point that interest to the researcher (QUIVY; CAMPENHOUDT, 2003). The method is one of the most used information recovery techniques used in scientific research, once it allows the quantitative and qualitative treatment of the findings, presenting a strong capacity to capture the countable aspects of the investigated phenomenon (AIDA MARIA, 2007).

There are three types of questions to be used in a survey: open, closed and mixed. The open questions allow the respondent to build their answers with their own words, permitting the freedom of expression (AMARO; PÓVOA;

MACEDO, 2005). The closed questions are those in which the respondent chose the option (among the presented) which better fits her opinion, and in the mixed questions open and close question are used the same survey.

My work, the (open and closed questions) of the survey were based in the work of Garcia (2010). In this way, after adaptations, I validated the contents with three specialists. This survey (Appendix A) was performed in July/August 2014 with experts in DSD aiming to evaluate the model proposed in this doctoral thesis. I obtained as result of this survey the adherence level of the C2M to its application in real projects based in the opinion of the experts. The evaluation runs through the structure levels, the distribution of the factors on the levels, the logical and natural sequence of the factors to the maturity evolution, the objectives of each maturity level, the objectives of the factors, as well as the evaluation of the practices contained in every factor.

1.3.4 PHASE 4: BODY OF KNOWLEDGE

The body of knowledge is characterized by the following: i) the first systematic review that describes that the factors of communication in DSD, ii) the empirical study that corroborates the factors of the first systematic review and highlightes some practices to enhance communication in DSD projects, iii) the second systematic review showed that practices communication practices for DSD complementing the practices found in the empirical study, and finally, the two focus groups and the survey that evaluates the proposed maturity model. Phase 4 corresponds to the “Body of Knowledge” step (DIAS-NETO; SPÍNOLA; TRAVASSOS, 2010).

1.3.5 INITIAL THESIS PROPOSAL

At this stage the definition of the C2M Model proposal is consolidated through the body of knowledge gained from the primary and secondary studies. The definition of the proposed thesis was performed in the period 2013-2014 and aimed to build a maturity model for communication in DSD. The results of this study will be presented in Chapter 5 of this work. This Phase 4 corresponds to the “Initial Proposal of the Software Thechnology” step in (DIAS-NETO; SPÍNOLA; TRAVASSOS, 2010).

1.4. STRUCTURE OF THIS THESIS

This thesis is organized in five chapters as follows. Chapter 2 presents background concepts related to the three main topics of this work: communication, Software Engineering Maturity Models, and Distributed Software Development. Chapter 3 discusses the related works. Chapter 4 describes the studies performed to reach the research objectives and their respective results. Chapter 5 describes the proposed C2M maturity model for communication in Distributed Software Development. Chapter 6 presents the evaluation of the model with specialists in DSD. Chapter 6 concludes with final remarks about this research, its main contributions, and future work.

2. THEORETICAL BACKGROUND

In this chapter will be presented the definitions of communication, maturity model and DSD, which are the three main areas approached in this work.

2.1. COMMUNICATION

The emergence of new sociability forms promoted new directions to the technological development, changing, redirecting and creating unusual relations between the man and the information and communication technologies, theorizes Lemos (2004). This happened in the transition from the 20th to the 21th century, with the development of revolutionary electronic devices for network communication. Consequence of the globalization and technological expansion, the multiculturalism prescribed a new social structure composed by people and companies from several segments, guided by interactions, collaborations and knowledge exchange in the recently adult "virtual universe". Under this empirical-descriptive perspective, we will raise, in this chapter, conceptual questions inherent to the communicative process, the evolution of the communication media as mediating interfaces for the communication, and the media convergence to the virtual universe, considering, yet, the transformations in the mass media culture.

From 1972 to 1974, the movements "Computers for the People" and "Community Memory" [1] emerged, respectively, in Berkeley and San Francisco (California). The last had as aim create a network of shared information, like an electronic newsletter without a central control, where anyone could insert information (beginnings of the wiki) or read them in any way he likes (TORRES, 2011). To this, it was used a network of terminals spread on the North American states of the Pacific, composed by Alaska, California, Hawaii, Oregon and Washington. The project represented the construction of an alternative media which could be used by the community in the production of information related to its needs and common interests, i.e. an attempt to use the communication power of the computer at the service of the society (ibidem). Therefore, it served as model for network communities around the world, usually formed to ease the free exchange of information, since libraries to philanthropic entities, between

[1]Created in San Francisco by Efrem Lipkin, Szpakowski Mark and Lee Felsenstein, in 1973, in the Project One.

the e-mail exchanges, debates in discussion forums and elaboration of textual documents (collective authorship), highlight Barbosa and Canesso (2004).

In the late 80's and early 90s, a new sociocultural movement originated by the young professionals from great American metropolis and Universities conquered a global dimension, and without any instance conditioning this process, the different computer networks formed in the 70's joined themselves, while the number of people and computers connected to a network grew exponentially (VANASSI, 2007). There was thirty years of continuous growth of the society virtualization and collective intelligence which resulted in the millennial generation (or generation Y), parting from the operating system ENQUIRE, by Timothy John Berners-Lee, following the principles of the Xanadu and the Hypertext of Ted Nelson, leading to the World Wide Web, in 1989. Sequentially, the Web evolved from a static model (1.0) to the collaborative (2.0) and from this to the portability of contents, connectivity of the information and integration of programming languages (3.0). There is already talking about the Artificial Intelligence Web (4.0) as previse Anandarajan and Anandarajan (2010). In parallel, are developed several interactive resources for the Internet and digitalization of the Mass Media.

Over the years, the mass media was reformulated and redefined, and the new information and communication technologies had become used in all the knowledge fields. It is within this context that establishes a plurality of convergences – from the human communication to the networked communication.

2.1.1. MAIN THEORIES OF COMMUNICATION

In the last years, the communication has been studied by several researchers from the industry and the academy, and this occurs mainly where divergences between the sent and received information exist, in the communicative process. From this, surged currents and theories, as: hypodermic, persuasion, functionalist, mathematic, critic, semiotic approach, scheduling among others which helped evolve and improve the contemporaneous communicative process. These theories are described below:

The hypodermic theory, which is based in the concept of stimulus-response and investigates the effects that the propagation of the communication media has on the individuals, is strongly linked to the behaviorism, that focuses in the

observation of the changes in the behavior of the people parting from the interaction between stimulus and response (WOLF, 2002). Once the hypodermic theory hit its target, i.e. successfully reach the desired public, the content of the message sent from the sender to the receiver public could induce the public to adopt certain conduct which would not occur if they were not influenced by the message (VIEIRA, 2013).

The functionalist theory studies the relations between the people, the society and the communication media, i.e. differently of the hypodermic theory, it does not study over the individuals (MATTELART; MATTELART, 2006); in this sense, Araujo (1994) claims that the main contributions of the functionalist theory for the consolidation of the Mass Communication Research was the attempt to formalize the communicative process. Still according the same author, this is a model that problematizes and solves the question pointing that a convenient way to describe a communication act consists in answer the following questions: Who? Says what? In what channel? For who? With what effect? This model had a great influence in every American research, serving as paradigm for the distinct research tendencies and remaining for many years as a true communication theory.

The functionalist theory is a sociologic study in the field of communication, mainly about the “Mass Media”. It studies the harmony between individuals and all their knowledge transmission environment. The main functionalist researchers who conceived models for the communicative process were: Wright, Lasswell and Lazarfeld-Merton.

The mathematical theory of communication (MTC), also known as Shannon’s Communication Theory, systematizes the knowledge until the understanding in the communicative process (MARTINO, 2010). The scientific fundaments were established in 1948, in the book of the American mathematician and engineer Claude Elwood Shannon, called “The Mathematical Theory of Communication”. It is worth noting that some authors, like Salichtchev, Robinson and Petchenik, did not consider the theory acceptable. The MTC presented a theoretical basis of what is now known as Information Theory. “The Information Theory encouraged the Digital Revolution, where the information is sent in discrete fragments instead of the wavelike forms of analogical signals, because the Error Correction Code of Shannon function naturally on the digital” (WOLF, 2002).

Parallel to the appearance of the previous studies, in Europe, researchers influenced by Marxist theories made appear other communicational theory called Critical Theory, which fundaments some elements of the psychoanalysis influenced by Freud, with focus in the effects of the communication over the audience (WOLF, 2002). This theory is a social analysis method that appeared from the search of the "Critical Theory" thinkers to the sociological, aesthetical, economical, psychological and philosophical interpretations, while validation systems for the mistakes made by the modern society, to give answers for the paradoxes, methods and objectives defended by the society. Advocates of the Critical Theory affirm that our physical, intellectual and social emancipation will only be achieved with a real life quality reached with transformations of the social and economic conditions that structure our society (MATTELART; MATTELART, 2006).

Later, in France, according to (MATTELART; MATTELART, 2006) the same theme was approached by the Frankfurt school under the perspective of the mass culture, discreetly generating critics to the explicative power of the communication contained in the classical focus, which is formed in a process that excludes the human factor and the social context (WOLF, 2002). In light of this context, appears the contribution of the English people from the Birmingham School, led by Stuart Hall, that see all the social practices and inter-relations in the communicative process (WOLF, 2002). We can add to this current the studies of the American School, led by Blumer (WOLF, 2002), which see society, individual and mind as three indivisible entities, characterized as symbolical interactionism, that is, the people behave according to the meanings that the world offers to them. These meanings appear from the social interaction with other people and are influenced and/or manipulated by an interpretative process of interrelated people.

Subsequently, appears the semiotic theoretical approach. The semiotic is a philosophical science created by Charles Pierce, "that researches the modes as we learn anything that appears in our mind" (SANTANELLA; NÖTH, 2004), is also known as the Theory of Signs.

In general, the communicational theories preach that is necessary that the symbols have common meaning to the individuals inserted in the process, i.e.,

the sender and the receiver, whose comprehension will depend of the uniformity of the meanings.

Penteado (1993) affirms that the communication is the exchange of meanings through every message, so, it must pass something common to the emitter and the receiver. Considering this condition, any and every communication becomes an intelligent act, which depends on the intensity of the message interpretation, by sender and receiver.

The theory of scheduling, or Agenda-Setting was developed in the 1960s, in the United States and became widely divulged in Brazil with the classic work “Etica na comunicação”, of Clóvis de Barros Filho in 1995 (MARTINO, 2010). The first studies were developed by Maxwell McCombs and Donald Shaw, of the Austin University, in Texas. They were inspired by the interest in evidencing a long term effect of the communication media, the capacity to define the conversation themes. In this theory, the dynamic dimension of the communication, and its creation aimed to explain the relations between the macro level of mass communication and the micro level of the social relations (MARTINO, 2010).

Inside the concept of Agenda-Setting, “Agenda definition” brings the idea that the matters discussed by the people are defined by the communication media, where the “Agenda” refers to the themes discussed in certain time and place. Thus, the “media agenda” defines the “public agenda”, that is, the media determines the themes and topics which the people will discuss in their conversations. In other words, the Agenda-Setting previses that the themes focused by the media will be consequently discussed between the people (MATTELART; MATTELART, 2006).

Finally, the persuasion theory was the first field of study to promote the overcoming of the hypodermical model. The hypodermic theory does not consider the social particularities and the subjective and individual psychological factors, but, in turn, the persuasion theory highlights that they interfere in the receiving mode of the messages and vary according to the context in which such messages are emitted, observing that the persuasion in advertising campaigns (specially) can be effective or not. The same theory says that the message of the media is not quickly assimilated by the individual, being submitted to many psychological filters. Therefore, the media effects would not be of manipulation, but of persuasion. The communicative model of this theory

is very similar to the behaviorist, but increased of psychological processes which determine the response. Such psychological processes are relative to the audience and the message. For example, the persuasion theory affirms that to obtain the expected effect in a campaign or promotion of certain product on the different type of media, the form and organization of the message must be adjusted to the personal factors which surrounds the interlocutor to interpret it. Nevertheless, this effect does not surpass the limit of the possible (MARTINO, 2010).

2.1.2. MAIN COMMUNICATION MODELS

In this section are shown some models or paradigms in chronological order (Figure 3), but without depth, once exist several models to the communication processes, many of them being complementary and others being opposed.

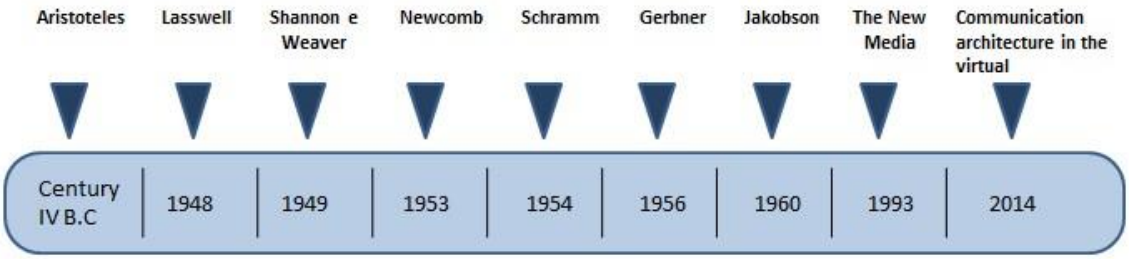

Figure 3 - Timeline of the main communication models. Source: author.

We adopted to show the first models which appeared on the history of the communicational research, since, anyway, they had defined great part of the components of the later models (SOUZA, 2006).

2.1.3. THE RHETORICAL METHOD OF ARISTOTLE (CENTURY IV B.C)

A historical and inaugural mark of the communication theory is the Aristotle work “The Art of Rhetoric”, which exposes the first model of the communication process according to Bonini (2001) and supported by Souza (2006). By aiming to explain his argumentation theory, Aristotle postulates three fundamental components to the occurrence of the process: the speaker, the speech and the listener (Figure 4). “The art of rhetoric” shows itself as a first try to systematize the study field of argumentation. In principle, it was not interested in compose

an explanation of the communication process. However, it was the basis from where appeared, in the last century, a series of models trying to explain the communication theory, as well as to generate a common concept to the communication (BONINI, 2001).

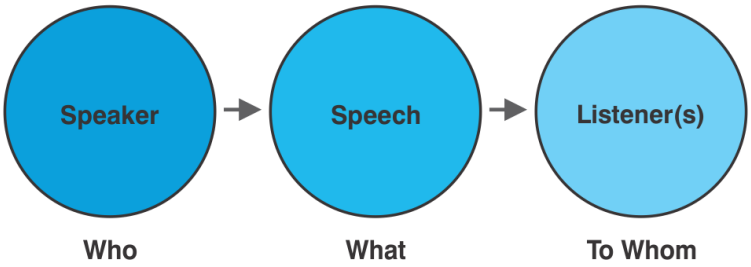

Figure 4 – Rhetorical model of Aristotle. Source: (BONINI, 2001).

2.1.4. LASSWELL'S MODEL (OR PARADIGM) (1948)

Harold Lasswell presented, in 1948, a model which could be the transition phase between the first (not scientific) theories about the social communication, in concrete the hypodermic theory, and the first scientific studies about the effects of communication, like the Psychodynamic model of Cantril (apud SOUZA, 2006, p.78) or the functionalist theories of the communication flow in two steps or multiple steps. Lasswell sustained that a form to describe a communication act is answer to five questions (Figure 5).

Figure 5 - The Lasswell's model (or paradigm). Source: Adaptado (SOUZA, 2006)

Souza (2006) affirms that, although the Lasswell's model is useful to describe any communicative act, it was originally thought for the description of the communication mediated through the mass media, also designated by diffusion media or social communication media. Someway, it is a model that proposes the idea that the initiative of a communication act always come from the sender and the effects only occur in the receiver, when, in fact, a communicative act has not

a well-defined beginning. Further, senders and receivers are mutually influenced. According to Lasswell, the study of the communication tends to focus in the questions which are part of its model (ibidem). So, the study of the communication can be systematized in many fields:

- Who? Studies about the sender and the emission of the messages.
- Says what? Analysis of the speech.
- Through what channel? Media analysis.
- To who? Analysis of the audience and studies about the receiver and the reception of the messages.
- With what effects? Analysis of the effects of the messages and the communication.

According to some researchers (WOLF, 2002), (BONINI, 2001), (SOUZA, 2006), the Lasswell's model is clearly functionalist, because it atomizes and articulates the communication phenomenon in many functional segments, proposing, consequently, several fields of study. Thus, the model deserved many critics, mainly from the theoreticians whose does not fit in the functionalist position. They say, for example, that the Lasswell's model is:

- linear, however when the communication process is complex, admitts several forms which transcend this apparent linearity:
- a reduced model, because it does not cover several variables, like the feedback;
- a compartmentalized model, because it segments in many elements what, in fact, is a whole: the communication process;
- a model which assumes that the effect constitutes an observable or measurable change registered in the receiver, when this not necessarily occurs;
- finally, it does not cover the context of the communication process, namely the history and the circumstances of its elements.

2.1.5. THE SHANNON AND WEAVER'S MODEL (1949)

The third model for the communication process was presented in 1949, by the mathematician Claude Shannon and the engineer Warren Weaver. In that moment was born a model for the study of electronic communication. However, the model can be applied to the study of other communication forms (SOUSA, 2006), (BONINI, 2001).

The scheme (Figure 6) proposed by the North Americans Claude Elwood Shannon and Warren Weaver (known as mother of all models) became the scope of the epistemological investigation in the field of the Social Sciences:

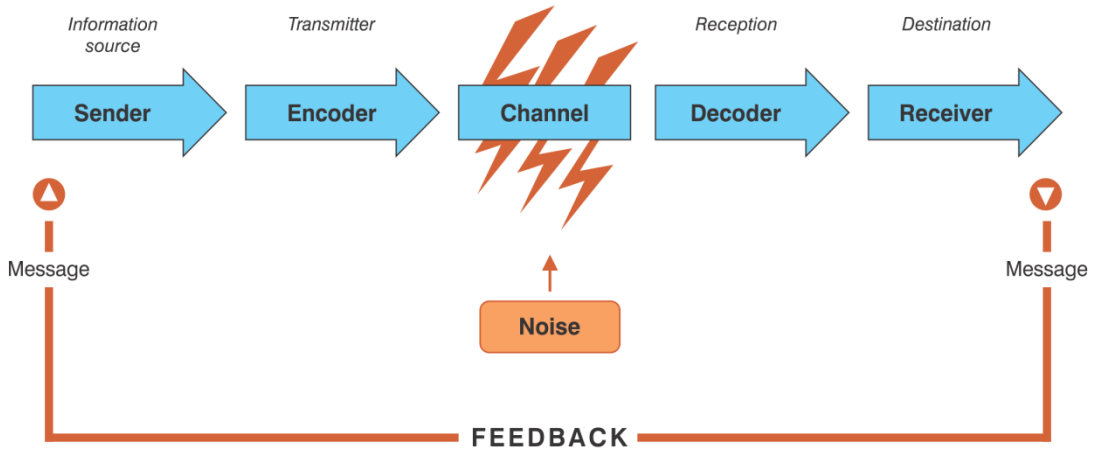

Figure 6 - The Shannon and Weaver's Model. Source: author.

The communication channel refers to the media where the message is transmitted (from the sender to the receiver) and is characterized in three aspects: Visual – Auditory – Kinesthetic. In this sense, the communication process derives from the following structure: the code is a system of meanings which are common to the members of a culture or subculture. The result of this communication is the message, verbal or non-verbal, where any event, behavior or object can be perceived, and that can be sent and/or interpreted independently of the will. The language encompasses the different body signals and, when talking about the "non-verbal" system, it points to the following channels: Facial Expression – the look – gestures and postural movements – body contact – spatial behavior – and physical aspects. The code is formed by a set of signals of distinct nature between the sender and the receiver of the message (CUNHA *et al.*, 2006).

According to their model, Shannon and Weaver identified three orders of problems at the study of the communication (SOUZA, 2006):

- Technical Problems, related to the transmission of signals;
- Semantic Problems, related to the precision of the meaning intended for a message;
- Effectiveness Problems, related to the form which the meaning influences the behavior of the receiver.

2.1.6. THE NEWCOMB'S MODEL (1953)

The Newcomb's model, presented in 1953, presents a triangular shape, introducing, for the first time, the role of the communication in a society, group or social relation (SOUZA, 2006). The model evidences that many of the social behavior phenomena, which can be classified as "interactions" are, in fact, communicative acts (Figure 7).

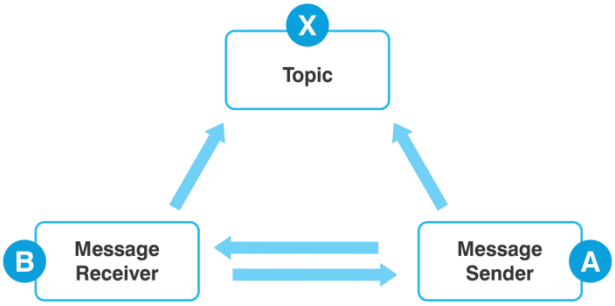

Figure 7 - The Newcomb's model. Source: http://communicationtheory.org/the-newcomb%E2%80%99s-model/.

To Newcomb, the role of the communication in a society is to maintain the equilibrium inside the social system. The model works as follows: A and B are the communicator and the receiver; they can be individuals, the government or the people. X is part of their social environment. ABX is a system, meaning that its internal relations are independent: If A changes, B and X will change, too, or, if A changes its relation with X, B will need to change its relation with X or with A. The system only will be in equilibrium when A and B have the same attitude in relation to X; else, the communication between A and B will be under pressure until they agree about X. This agreement is fundamental, particularly when changes occur in X: We must have detailed information about our social environment to know how to react and to identify in our relation factors which we can share with the partners of our group, subculture or culture (TEIXEIRA, 2012).

2.1.7. THE SCHRAMM'S MODEL (1954)

According to some researchers (SOUZA, 2006), (BONINI, 2001), (MARTINO, 2010), Schramm presented two communication models. In the first one, Schramm presents a linear relation between source and destiny, but considers that the encoding/decoding process depends on the experiences of the encoder and the decoder:

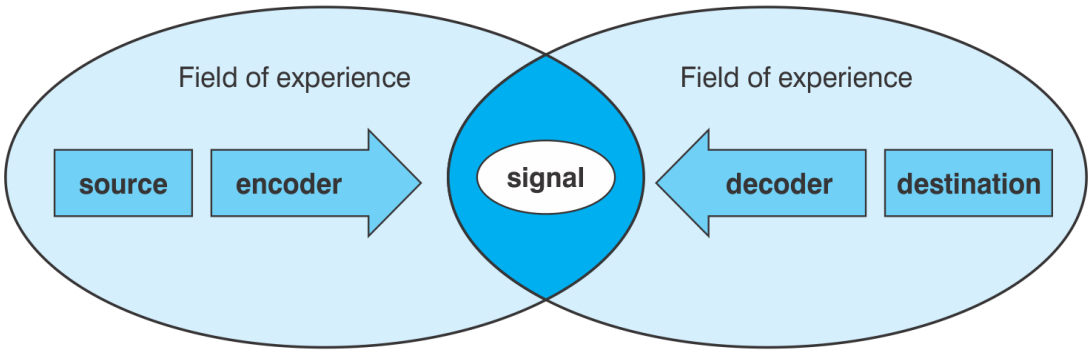

Figure 8 - Schramm's Model of Communication. Source: http://commtheories.wikispaces.com/Wilbur+Schramm.

In this first model (Figure 8), Schramm matches to the source an encoding function, and to the destiny a decoding function. The knowledge, or experience field, of the source and the destiny interpenetrate themselves, allowing the intercommunication. If the surface common to the two experience fields is wide, the communication will be easy; if the surface common to them is small, will be hard to communicate with the other person. For example, a physician will communicate better about physics with other physician than with a non-expert. In the sequence of his first method, Wilbur Schramm presented, in 1954, a model of the communication process that introduces, for the first time, the concept of feedback (SOUZA, 2006). It is the first circular model for the communication process. Therefore, in this model Schramm continues to explore the issues of the meaning, anticipated, in the first model, by the notion of "experience field". The second Schramm's model (Figure 9) can be graphically translated as follows:

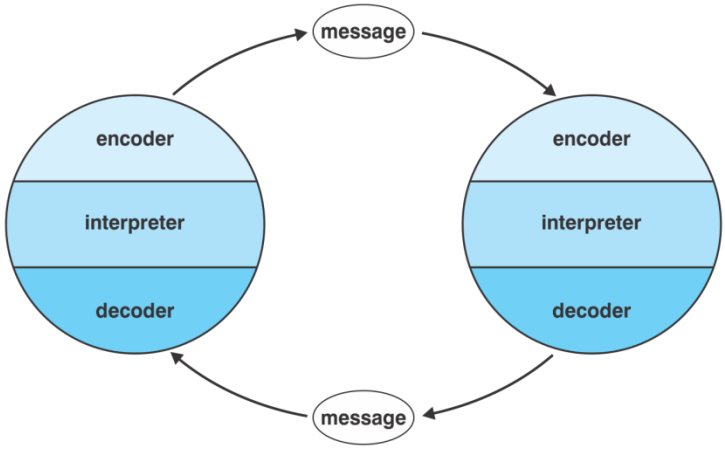

Figure 9 - The Osgood and Schramm Circular Model. Source: http://commtheories.wikispaces.com/Wilbur+Schramm.

In short, the Schramm proposes that each sender may also work as receiver in the same communicative act (due the feedback). Each sender/receiver has the ability to decode and interpret the received messages and to encode the messages to send. Although the model does not translate it, Schramm highlighted that when a message is emitted, in fact many messages are emitted. For example, in the interpersonal or televised communication, it doesn't count only what is said, but also how is said, the posture, the clothing, etc. Raymond Nixon added to the Lasswell's model the objectives of the sender and the reception conditions, what, with the idea of feedback proposed by Schramm, complements more satisfactorily the Lasswell's Paradigm (SOUZA, 2006) (TEIXEIRA, 2012).

2.1.8. THE GERBNER'S MODEL (1956)

A new model for the communication process appeared in 1956, being proposed by Gerbner (SOUZA, 2006) (WOLF, 2002). In comparison with the previous, it has as advantage the relation of the message to the reality, allowing us to approach simultaneously the questions of perception and signification. This model can be translated as follows (Figure 10):

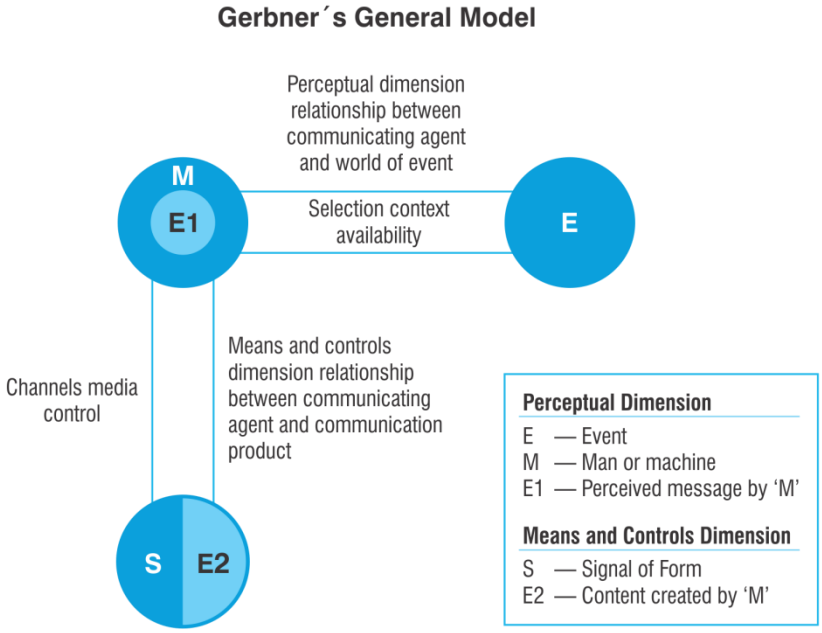

Figure 10 - The Gerbner's Model. Source: http://mlis4ugcnet.wordpress.com/tag/gerbner-model-of-communication.

According to Souza (2006), Wolf (2002) and Teixeira (2012), the model intends to show the communication as message transmission. An event, something that is noted in the reality, is perceived by an agent, which can be either a person or a machine. The perception is selective. If the agent is a machine, the selection is determined by the mechanisms owned by the machine. A photographic camera does not "capture" all the reality. If the agent is a person, the selection is determined by the adaptation of the message to his cognitive system, which, as seen, is interfered by the values, the life experiences, among others. Anyway, the message has the reality by reference. The meaning emerges from the framing of the message on the cognitive system. The framing of the message is an externally conditional upon the culture, once the cognitions vary in function of the culture. People from different cultures perceive and know the reality in different ways (SOUZA, 2006) (BONINI, 2001).

The agent can send a message to other agent, as a follow-up to the process. The message has a form, and determined contents. The same content can be communicated in different ways (for example, a written message can be also distributed orally). The agent can choose a media between those which he has access and are available to pass the message. Whether made available to the

second agent, the message will be submitted again to a dynamic and interactive process of perception, selection and interpretation (SOUZA, 2006).

2.1.9. THE ROMAN JAKOBSON'S MODEL (1960)

Roman Jakobson presented a model directed to the study of the communication under the linguistic prism (Figure 11). Someway, it is also a model that makes the bridge between the procedural and the semiotic. Graphically, the model can be illustrated as follows:

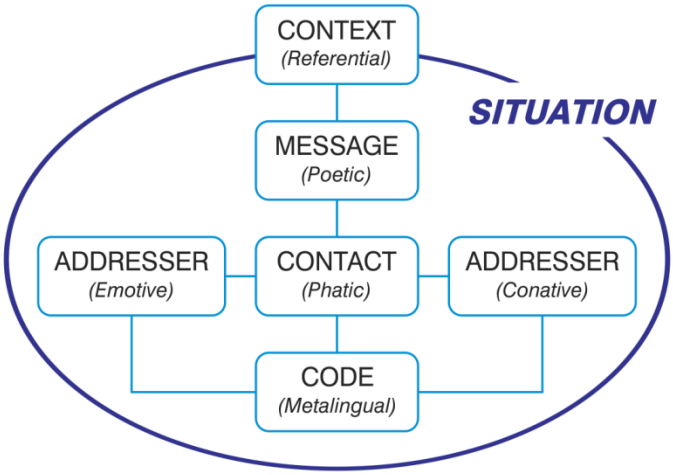

Figure 11 - The Roman Jakobson's Model. Source: author.

The model, with linear basis, relates the emitter (called sender) of a message and its receiver. However, the model shows that the message must have a context, that is, it needs to refer to something external to the own message. The model adds, yet, the contact, which represents, simultaneously, the physical channel where the message is diffused and the psychological links between sender/emitter and receiver. They only perceive the message because they dominate the same code. To each one of the constitutive factors of the Jakobson's Model, there is one correspondent function of the language. According to Souza (2006) with support of Martino (2010), in a communicative act, the functions appear hierarchically organized, always having one which is dominant:

- Referential function
- Emotive Function – Poetical Function – Conative Function
- Phatic Function
- Metalinguistic Function

The emotive or expressive function refers to the relation of the message with the sender. The emotive function presents the “state of the soul” of the sender. In a love letter, in a political inflammatory speech, this function is emphasized among the others.

The conative function refers to the effect of the message in the receiver. This function is particularly relevant in the orders and in the advertisements.

The referential function, based on the context, often is the dominant function of the communicative acts. It refers to the orientation of the message to the reality, to the denotation. It is the main function in the journalistic speech, the analytic and scientific texts, etc.

Following, the phatic function is related to the establishment and maintaining of the contact between emitter and receiver. When the interlocutor is greeted, when is confirmed that the communication is happening through questions and gestures, this function is evidenced.

And finally, the poetical function concerns the relation of the message with itself, being particularly noted in the aesthetic communication, namely in the literature, as well, for example, on the advertising slogans.

The metalinguistic function refers to the code and is done when the language is used to talk about the language. When a Portuguese teacher clarifies the grammatical mechanisms of the language to a student, the metalinguistic function is put in evidence.

2.1.10.THE NEW MEDIA

The concept of “New Media” arises from the convergence among contemporary cultural forms (multimedia interfaces, hypertext, online databases), representing a globalized cybercultural transformation, as the audience is encouraged to search new information and make connections between disperse media contents (FIORELLI, 2010). In 1993, inspired by the technological advances, Mary Cullinan affirmed that the advantages of the electronic communication are inarguable and go beyond the simple communicative act, considering, inclusive, that the use of electronic devices as improvement interfaces for the communicational process does not change the basic precepts of the communication. Otherwise, it permits a fast transmission of the information and the simultaneous sharing of the same information by different people, independently of the place where they are. The same thought is

shared in contemporary literary works about the media communication, like in Biagi (2011); Jenkins (2008); Straubhaar, Larose and Davenport (2011); Wimmer and Dominick (2011) and many others. Dennis Macquail, notorious by his "McQuails's Mass Communication Theory"[2], says that the most important aspect provided by the Information and Communication Technologies is the digitalization, where all the texts (symbolical meanings in all their encoded and registered forms) can be reduced to a binary code, sharing the same process of production, distribution and storage. Consequently, the convergence will be present in all the existent media forms in terms of its organizing, distribution, reception and regulation, justifies the theoretical.

Under this media perspective, the media which survived the convergence process were transformed in new information and communication technologies, incorporating interactive resources and multiple communication channels (the radio, is no longer restricted to the sound; the journal, to the text; the telephone, to the voice; the television, to the audio and video, etc.), providing a new type of consumer – the Prosumer (producer and consumer of information and services)[3]. To Cardoso (2009), the traditional media can, now, be digitalized and offered to the consumers through a great variety of channels, on which are included a great variety of communication media. The researcher considers that one of the greater challenges to the actual mass media is their capacity of response to the convergence between themselves and the new forms of communication supported by virtual environments, as the relationship between producers of contents and the audience was resized; the traditional generalist operators; the operators based in new technologies (oriented to a specific niche) and, finally, between the traditional programming and the collaborative. The present scenario, conceptualized by Fidler (1997) as "Mediamorphosis", reflects the "Information Age" designed by Castells (2010), which confirms the theory of Macluhan and Powers (1992) about the "Global Village"[4]. Participating in the socio-cultural production of the mass media and developing independent networks of horizontal communication, the citizens of

[2]It's a compilation of communication theories through the view of the English academic Dennis Macquail.

[3]Term originated from the english language that comes from the junction of the words producer + consumer or professional + consumer (SURHONE; TIMPLEDON; MARSEKEN, 2010).

[4]The Global Village (original work), suggests that the technological advances condense the world to the same situation of a village, where everybody know and discuss about the life of the other people

the digital age are capable to create new programs to their lives, idealizes Castells (2009). Macquail (2003) agrees that the digitalization and the technological convergence have revolutionary and unpredictable consequences, but does not necessarily decree the end of the traditional communication media, working more like an addition to the mediated communication than as a substitution of the existent ways.

From the mass media to the network communication, we know, from Cardoso (2009), that our societies had witnessed the raise of a new communicational model: the first corresponds to the interpersonal communication, characterizing the bidirectional exchange between two or more people inside a group; the second establishes as “one to many”, when an individual send a single message to a limited group of people; the third is the model of mass communication, on which, thanks to the use of specific mediation technologies, a single message is delivered to a mass of people; and the fourth is the communicational model of the contemporary society, molded by the capacity of the worldwide communicational globalization processes, together with the network between the mass media and the interpersonal media.

The relation of the communicational models with the public resulted in a new type of audience, moved by the immediate communicational exchanges (in real time), allied to the hybridization of media languages according to the technological development. The technologies, the equipment and the languages that run on them, provide a new cultural logic, allow the choice and consume of the messages in a more personal and individual way, opposing to the massive consume (SANTANELLA, 2007). “Are precisely these processes which constitute the mass media. So, this culture constitutes a period of passing, of transition, working like a bridge between the mass culture and the cyberculture” (p.125). Nicolau (2011) reminds that are conceptions corroborated by Henry Jenkins from his idea of “Convergence Culture”, set in the content stream by multiple media supports in full cooperation, associated with the migratory behavior of the audience of the communication media, capable to go almost everywhere in search of the desired information. Living in a consume society, we legitimate the Culture of Convergence by the common sense, in the endless search for individuality, autonomy, social recognition, nationality, sexuality and

social interaction, before curtailed by the depersonalization and unidimensionality of the traditional communication media.

As mentioned before, “the fundamental dimension which these media proposes is the mobility”, declares Silva (1998, p. 163). Within reach of the “fingertips” of the “homo communicans”, opens up a world of information coming from distant and, by tradition, closed places, like the great files, at the same time when it permits you to be in many places, without move physically. This way, the multidimensionality of the communicative universe joins the ubiquitous nature of the individual (ibidem). The contemporary view of Bento Silva reflects in the actual society, what Santaella (2008) calls the “Mobility Culture”. Since the rise of the mass culture, the passing of a natural cycle to other has accelerated so much that the expression “Mobility Culture” is putting the use of the past, and still recent expression, “Cyberculture”, in second place (ibidem). He also relates that, although the mobility culture is a result of the digital revolution, it is a cultural virtualization of the human reality, fruit of the migration from the physical space to the virtual (mediated by the ICTs), ruled by codes, signs and proper social relations. Forward, appear instantaneous forms of communication, interaction and possibility of fast access to the information, in which we are not mere emitters, but producers, reproducers, collaborators and distributors. The new technologies also had served to “connect” people from different culture outside the virtual space, something unimaginable fifty years ago. In this gigantic web of relationships, we absorb, reciprocally, beliefs, customs, values, laws, habits, one from each other, cultural heritage eternized by a physical-visual dynamic in permanent metamorphosis.

2.1.11.THE COMMUNICATION ARCHITECTURE IN THE VIRTUAL ENVIRONMENT

Emitters, receivers, channels, signals and the messages, which can be verbal or non-verbal, symmetric or asymmetric, convergent or not, are part of the human communication. Thus, models and theories are created and reformulated along the history. “Comparing to the other sciences relative to the study of the society, the studies centered in the communication are considered recent”, affirms Vieira and Freitas (2013, p.1). The concern with the communicative activity of the man is perceived since the Ancient Times, having by example the studies of the Greeks about the rhetoric. Nevertheless a specific theory about the

communication started to develop only in the 20th Century, with the emergence of a new communicative practice, based on electronic resources that raised considerably the range of the messages, inaugurating what has become called mass communication. Since this, the communication studies occupied an important place in the social theories, creating controversy many times, until delimit its study object and, with this, contribute to the knowledge field of other investigation areas (ibidem).

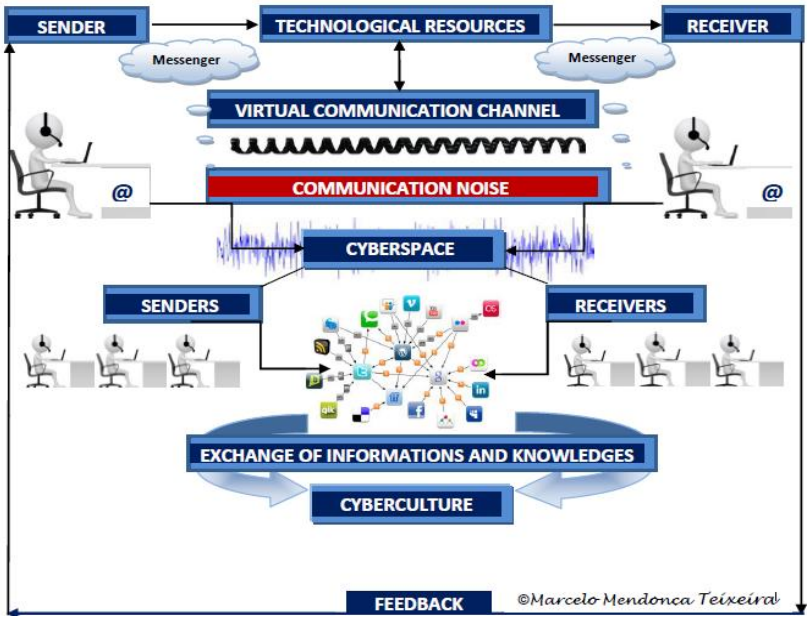

Figure 12 - Communication Architecture on the Virtual Environment. Source: Teixeira, Ferreira and Farias Junor (2014).

The "Communication Architecture on the Virtual Environment" evidences the contemporary communicative process, mediated by information technologies and cyberspace communication, with many emitters and many receivers in a multipolarity environment for the exchange of written messages, sounds, videos, images and interchange of information and knowledge, synchronously or asynchronously (see Figure 12). Therefore, as we highlighted on the figure 12, does not exist a linear horizontality in the transmission of messages between the polo(s) of emission/reception, that is, the emitter is the mirror of the receiver, and vice-versa. Is in this sense, occurs an exchange from the information society to the knowledge society and from this to the network society, connected and free from the corporeal presentiality. The cyberculture is the product of these exchanges and makes itself present in the established relations between the

“residents” of the virtual universe, the social networks, blogs, discussion forums, online games and learning communities.

In short, differently of the "Mother of All Models", of Shannon and Weaver (apud SOUZA, 2006), the “Virtual Universe Model of Communication” uses the technological resources to do the process of the human communication, which functionally goes from emitter(s) to receiver(s) through multimedia messages on the internet, suffering or not “noises” (interruption on the network access, for example), making difficult or impeding the communication between the involved polos. The perceiving of the message is the digital feedback. It is allowed to agree that from gestures to the virtual interaction, the communicative process is in permanent evolution and, to adapt to this reality, is necessary to know the new identities of the human being. Notorious are the contributions brought by Manuel Castells (2009), Pierre Lévy (2010), Dennis Mcquail (2003), Lúcia Santaella (2008), Paul Virilio (1993) to the digital communication, together with the models and theories which appeared through the decades, to which we attribute direct and indirectly influences for the conception and justifications to the proposed model (see figure 10), in the passage from the tacit to the explicit knowledge grounded here.

2.2. MATURITY MODELS

This section presents a general view about the maturity and capacity models, showing the historical evolution, types and properties of these models, as well as the requirements to the conception of a model of this nature. Furthermore, are described also the models (CMMI, MPS.BR, PCMM, ESCM, WAVE) which inspired the conception of the model proposed in this thesis.

2.2.1. MATURITY AND CAPABILITY MODELS OVERVIEW

Maturity model is a guide to the organization, in such way it can find where and how it is, "reflecting" on it to, then, perform a plan to reach a point better than the actual, in the seek for excellence (MundoPM, 2014). The maturity level is defined as a well-defined evolutionary plateau toward achieving a mature software process (Paulk et al, 1994). Maturity models focus in different areas which the organizations must prioritize to continuously improve their processes and consequently enhance their businesses. According to (MAGDALENO *et al.*, 2011), these maturity models have proliferated, on the academy and industry,

through a multiplicity of domains since the concept of maturity measurement was introduced and popularized by the SEI (Software Engineering Institute) with the development of the CMM (Capability Maturity Model) (PAULK *et al.*, 1994), which evolved to the Capability Maturity Model Integration (CMMI) (CHRISSIS et al., 2006). According to Mettler (2009), the development of maturity models should not decrease, since they support the top management in the decision making, among other things.

Facing this scenario, the maturity models represent, basically, the theories about how the organizational capabilities evolve, along a desired way of logical maturation (PÖPPELBUß; RÖGLINGER, 2011). The maturity models were projected to assess the maturity (competence, capacity, sophistication level) on a certain domain with basis on a set of criteria (DE BRUIN *et al.*, 2005). Furthermore, it consists on a sequence of maturity levels for organizations or processes. It represents an estimated, desired or typical way of evolution in the form of discrete stages (BECKER; KNACKSTEDT; PÖPPELBUß, 2009).

A maturity model describes, for a specific area of interest, a certain number of sophistication levels where the activities in this area can be performed (ALONSO *et al.*, 2010). Essentially, a maturity model can be used: (i) to assess and understand the actual situation of the organization, identifying opportunities of optimization; (ii) to establish objectives and recommend enhancement actions to improve the capacity of a specific area of the organization; (iii) as a control instrument to track the success of the actions taken (BECKER; KNACKSTEDT; PÖPPELBUß, 2009) (HAIN; BACK, 2011) (HAIN, 2010).

As exposed, in general, maturity can be defined as “the state of being complete, perfect or prepared” (METTLER, 2009). Maturity implies in an evolutionary progress in the performing of an objective from an initial stage to a desired ending. In the literature, the term maturity is reflected in an one-dimensional way, focusing: (i) on the maturity of the process, that is, to what extent a specific process is explicitly defined, managed, measured, controlled and effective (PAULK *et al.*, 1994); (ii) on the maturity of the object, that is, to what extent a certain object, like a software product, a company report or similar reaches a predefined sophistication level; (iii) capability of people, that is, in what extent the workforce allows the creation of knowledge and improves the proficiency.

According to Magdaleno (2006), these three maturity factors are commonly used as a basis for the maturity models, but it is necessary to realize that there is a mutual influence between them.

2.2.2. ORIGIN OF THE MATURITY AND CAPABILITY MODELS

In the 1930's, Walter Shewhart had started a study about the enhancement of the process with their principles of statistical quality control, which were refined by W. Edwards Deming, Phillip Crosby, and Joseph Juran (SILVEIRA, 2009). Next, Watts Humphrey, Ron Radice and others extended even more these principles and started to apply them on the software development (SEI, 2010). The Humphrey's book, "Managing the Software Process", provides a description of the principles and basic concepts for which the capacity maturity models are based in.

In this context, the Capability Maturity Model (CMM) was developed. Nowadays, we observe that the academy and the industry have demanded many maturity models to several knowledge domains. The basis for most of these maturity models was the CMM (PAULK *et al.*, 1994). The CMM was developed to assess the maturity or capability of the processes of software development or maintenancee. This model was originally created by the SEI (Software Engineering Institute) in 1991. Its basic premise is that the quality of the software product is strongly determined by the quality of the development and maintaining processes used to build it (FUGGETTA, 2000) (PAULK, 2009). CMM is a reference model to determine the maturity of the software of an organization and has gained considerable acceptance around the world. It was considered by many professionals and researchers as the industrial standard for the definition of the software quality process (HERBSLEB *et al.*, 1997). One of the main contributions of the CMM was to establish a common terminology inside the software industry (PAULK, 2009).

CMM works as a framework that organizes a set of basic software engineering practices to guide the efforts of process improvement. These practices must be applied systematically to reach a determined quality pattern in the products and services (PAULK *et al.*, 1994). The staged structure adopted by the model is based in the principles of the TQM (Total Quality Management) (PAULK, 2009). For the definition of the maturity levels, the observation of the

challenges and common problems faced by projects of software development were took in consideration. In order to address consistently the common problems, it was considered an effective way to build the organizational capacity (PAULK, 2009).

This way, five maturity levels (initial, repeatable, defined, managing, optimized) were defined for the CMM. The maturity levels clearly define the priorities for the improvement of the processes, because they offer orientations to select those improvement activities which will be more useful if immediately implemented. Many organizations had committed the error of identify several and necessary improvements and after do not act over them, due to the size and complexity of the necessity. Thus, the model helps on the identification of the vital points in every maturity level that must be addressed as a matter of priority (PAULK, 2009). After this, the CMM evolved to the CMMI, which established a unique model to the process of corporative improvement, integrating different models and disciplines focusing in meet the needs of the organizations in different areas of interest.

2.2.3. TYPES OF MATURITY AND CAPABILITY MODELS

A maturity model can be descriptive, prescriptive or comparative (DE BRUIN *et al.*, 2005) (PÖPPELBUß; RÖGLINGER, 2011). If a model is purely descriptive, the model's application does not offer any provision to enhance the maturity. This type of model is useful to assess the actual situation, where the actual resources of the investigated organization are assessed in relation to a certain criterion. That is, in this case the model is used as a diagnostic tool (MAGDALENO, 2006). A prescriptive model indicates a guide to the improvement of the maturity, that is, indicates how to identify the desirable maturity level and gives orientations about improvement actions (BECKER; KNACKSTEDT; PÖPPELBUß, 2009). In this case, specific and well detailed actions are suggested. In turn, a comparative model permits the benchmarking between industries and regions, because it allows comparing similar practices in different organizations. Therefore, is necessary the existence of sufficient historical data of a great number of participants, and evaluations of similar business units to allow the organizations to be compared (MAGDALENO, 2011).

Despite been seen as distinct kinds of model, on practice they represent evolutionary stages of a life cycle of models. In the beginning, the model can be descriptive or prescriptive and, finally, evolve to be applied on a wide range of organizations aiming to obtain sufficient data to allow the comparison (DE BRUIN *et al.*, 2005). Actually, C2M is a prescriptive model.

2.2.4. PROPERTIES OF MATURITY AND CAPABILITY MODELS

Traditionally, the maturity models have the following characteristics (BECKER; KNACKSTEDT; PÖPPELBUß, 2009)(DE BRUIN et al., 2005)(TEAH; PEE; KRANKANHALLI, 2006):

(i)The development of a single domain is simplified and described through a limited number of maturity levels;

(ii)The levels are characterized by requirements that define what must be reached in every level;

(iii)The levels are cumulative, and the higher levels are built over the requirements of the lower ones;

(iv)The number of levels can vary, but the levels are distinct, well defined and sequentially ordered, going from an initial characterized by low capacity to an final level where the perfection is achieved;

(v) There is a logical progression along the maturity levels, and no level should be skipped;

(vi) The levels must be named with short labels, that give a clear indication of the purpose of the level;

(vii)The definition of the level must be developed to expand the name of the level and provide a resume of its main requirements and measures, especially concerning those aspects that are new and were not covered by the lower levels.

These common design principles of a maturity model came from the CMM and seem to have a large practical acceptance. In the Section 4.5, we explore whether C2M satisfies all these properties.

Despite the main characteristics of the maturity levels be known, there are few directions about how to develop a maturity model (HAIN, 2010). Therefore, to

fill this gap, C2M maturity model was conceived from a rigorous scientific research methodology presented in the Section 1.3.

2.2.5. APPROACHES TO THE DEVELOPMENT OF MATURITY AND CAPABILITY MODELS

Although maturity models are high in number and have a wide application, there is little documentation about how to develop a maturity model theoretically based, rigorously tested and widely accepted (DE BRUIN *et al.*, 2005).

Becker, Knackstedt and Pöppelbuß (2009) established a set of requirements (Rq) to the Development of maturity models:

Rq1 – Comparison with existing maturity models: The need for a maturity model must be supported by a comparison with existing models. The new model can be the result of the absence of models to a certain domain or the improvement of an already existing model.

Rq2 – Iterative Development: The maturity models must be developed on an iterative way;

Rq3 – Evaluation: All the principles and premises to the development of a maturity model, like the quality, the usefulness and the effectiveness must be iteratively evaluated;

Rq4 – Multi-methodological Development: The Development of maturity models must employ a variety of research methods, which use must be well founded;

Rq5 – Identification of the problem's relevance : The relevance of the solution of the problem proposed by the maturity model for researchers and/or professionals must be demonstrated.

Rq6 – Definition of the Problem: The application domain of the maturity model, as well as the conditions of its application and the expected benefits, must be determined before its conception;

Rq7 – Objective Presentation of Results: The presentation of the maturity model must be oriented by the conditions of its application and the needs of their users;

Rq8 – Scientific Documentation: The conception process of the maturity model must be documented in details, considering every stage of the process, the involved parts, the methods applied and the results.

Next, from these requirements, the authors (BECKER; KNACKSTEDT; PÖPPELBUß, 2009) propose a procedure to the development of maturity models. The main contribution of this procedure is to show that these requirements must be adopted in a logical sequence: Rq5 – Rq6 – Rq1 – Rq2 – Rq4 – Rq7 – Rq3.

2.2.6. CMMI

The CMMI-DEV is a model of maturity and capability of software processes, created by SEI (Software Engineering Institute) to meet the DoD's24 demands regarding the evaluation of risks related to the hiring of Software Suppliers (SEI, 2010). The model consists of good practices of Software Engineering directed to the development and maintenance of products and services and offers a structure and key elements for a software process, comprehending the production cycle as a whole, from the conception to the delivery and maintenance of the software, yet representing an evolutionary path to the organization towards a mature and orderly process. The CMMI-DEV has two types of representation: Continuous and Staged (SEI, 2010) (SEBRAE, 2013).

In the Continuous Representation, the process areas are organized in categories and the implementation of the improvement occurs by capability levels, while in the Staged Representation the process areas are organized in maturity levels.

In the continuous representation, the process areas can be individually evaluated, according to the strategy and business goals of the organization. But, in the Staged Representation, the evaluation is made in all the process areas that together form the maturity level selected by the organization. The types of representation differ in the selection and organization of its model's compounds, but use the same group of process and practices (SEI, 2010) (SEBRAE, 2013).

Even though both possibilities of evaluation are available, the market did not recognize any value whatsoever in the continuous representation and, as a consequence, most CMMI evaluations performed to this day followed the Representation by Stages. The levels indicate a logic sequence to the evolution

of the process areas, as long as they satisfy the model's demands. While a capability level is related to a process area, the maturity levels are related to a group of process areas (SEBRAE, 2013).

The maturity levels and the capability defined in the CMMI-DEV are listed in the Table 1:

Table 1 - Capability and maturity levels of the CMMI-DEV.

Level	Continuous Representation: Capability Levels	Staged Representation: Maturity Levels
Level 0	Not Performed	N/A
Level 1	Performed	Performed
Level 2	Managed	Managed
Level 3	Defined	Defined
Level 4	Quantitatively Managed	Quantitatively Managed
Level 5	Optimizing	Optimizing

Source: SEI (2010).

Regarding its structure, the CMMI-DEV is formed by components arranged into three categories: required components, expected components and informative components. They help in the understanding of the model, as shown in the Figure 13:

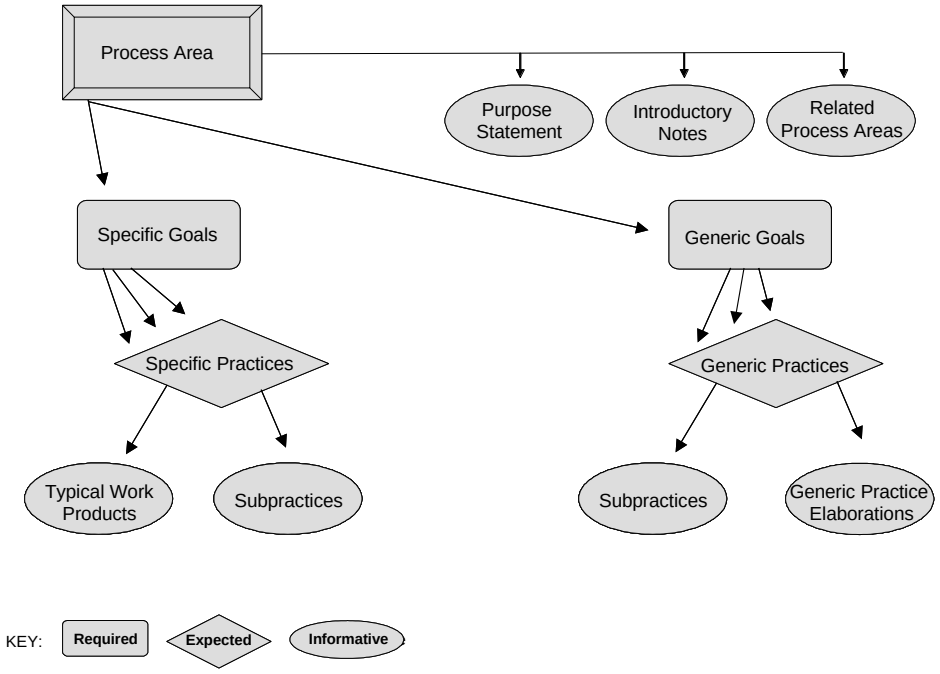

Figure 13 - CMMI structure. Source: (SEI, 2010).

Each process area is a group of related practices which, implemented together, satisfy the objectives considered important to constitute the improvement of the process and, consequently, of the organization. The CMMI-DEV is composed of twenty-two process areas, which can be observed at the Table 2 with their respective maturity levels and categories.

Table 2 - Process Areas of CMMI-DEV.

Maturity Levels	Process Areas	Category
2	Project Monitoring and Control (PMC)	Project Management
2	Project Planning (PP)	Project Management
2	Requirements Management (REQM)	Project Management
2	Measurement and Analysis (MA)	Support
2	Process and Product Quality Assurance (PPQA)	Support
2	Configuration Management (CM)	Support
3	Supplier Agreement Management (SAM)	Project Management
3	Integrated Project Management (IPM)	Project Management
3	Risk Management (RSKM)	Project Management
3	Organizational Process Definition (OPD)	Project Management
3	Organizational Process Focus (OPF)	Project Management
3	Organizational Training (OT)	Project Management
3	Requirements Development (RD)	Engineering
3	Product Integration (PI)	Engineering
3	Technical Solution (TS)	Engineering
3	Validation (VAL)	Engineering
3	Verification (VER)	Engineering
3	Decision Analysis and Resolution (DAR)	Support/Base
4	Quantitative Project Management (QPM)	Project Management
4	Organizational Process Performance (OPP)	Project Management
5	Organizational Performance Management (OPM)	Project Management

5	Causal Analysis and Resolution (CAR)	Support

Source: SEI (2010).

The function of the specific objectives is to define the unique characteristics which should be present to satisfy a determined process area. Meanwhile, the generic objectives are associated to more than one process area and define the characteristics that should be present to institutionalize the processes which implement the process area. The specific objectives hold a group of specific practices which are descriptions of activities, considered important for the accomplishment of the specific goal. Similarly, a generic practice is the description of an activity that is considered important for the satisfaction of a generic goal.

The communication management is a knowledge area that, through its processes, assures a correct communication between the interested parts, that is, the Stakeholders (PMI, 2013). The CMMI model evaluates the organizational maturity, as well as the capacities of the processes used in each organization (SEI, 2010).

The CMMI displays some communication practices that are not explicit in the model, but that we can interpret and utilize to establish this process. It's is known that e-mails and reports do not guarantee the effective communication, as such, it is important that there is a formal and well-defined process from both interested parts. Furthermore, it is necessary to know how and when this communication may be established. Particularly, the ways in which CMMI can help to obtain an effective communication are presentend as follows:

Planning the Process: This generic CMMI practice asks to make the "planning of the plan". In the planning the following requirements are included: attribution of time, resources and abilities for the attainment of the processes, together with the description of what will or will not be attained. The communications in several moments have the attribution of multitasks, and sometimes one single message may trigger several responses and message exchanges. Whether the message flow is not expected by the sender or manager, this event may create a great hassle for the Project.

Identifying and involving the important stakeholders: This practice is necessary to the selection of stakeholders that are relevant to the Project

(Project managers, functional managers, suppliers, clients, among others who can affect or be affected by the Project). This way, the CMMI can establish activities that need a correct communication like: establish estimations, solve questions about risks in the Project, and establish plans of other projects among other. Furthermore, once the most important stakeholders are selected, we can delimit who is responsible for such activity and who is going to receive the proper information without generating a broadcast of messages inside the Project. In order to obtain a good selection of the project's stakeholders is necessary to know which ones of the elected are specialized to execute the activity. Is important to mention that a plan of involvement with the stakeholders must contain: reasons for their involvement; roles and responsibilities related to the Project; relationship among the stakeholders; importance and optimism related to the success of the Project; necessary resources to assure the interaction of the stakeholders (training, time, finances, material).

Distribution of information: This process of distribution comprehends important information related to the Project; which are totally available to the interested parts in the right moment, i.e. the correct information made available in the correct way, to the correct people. This process is located in the Project execution level, where the distribution of this information starts to validate what was foreseen in the communication management. Nevertheless, given that the CMMI promotes a structure for the management of processes and better practices for the Software Engineering, the term "communication" appears throughout the text of the model, but there is nothing explicit to the execution of the process of informationdistribution . The model elements that relate more clearly with the communication components are the generic practices, which we will not be seeing more deeply in this research. Before this context, in the CMMI model we can find some elements of information distribution process along several practices of different process areas, amongst which we highlight:

Institutionalize a managed process – This practice involves reviewing the activities, status and results of the process with the highest management levels, aiming to solve difficulties.

Monitoring the plan before the Project – This practice seeks reviewing the process periodically, its performance and issues of the Project to maintain

the stakeholders always informed, i.e. communicate frequently the status of the attributed activities and products of work. This CMMI practice establishes that such reviews can be informal and should not be explicitly specified in the project plans.

Supply Results of Measurements – This practice establishes that the results of the activities of measurements and analysis should be communicated to the important stakeholders in an adequate way and at the appropriate moment.

In this context, this communication model can support the definition of a better planning, through communication techniques and strategies, which the quality models do not show explicitly. Therefore, the PMBOK Guide (PMI, 2013) can be an alternative to be used to attend the communication area together with the quality models (e.g.: CMMI).

2.2.7. MPS.BR

The MPS-BR – Melhoria do Processo de Software Brasileiro (Brazilian Software Process Improvement) – was created in 2003 as a mobilizer program, of long-term, under the coordination of the Sociedade Brasileira para Promoção da Exportação de Software (Brazilian Society for the Promotion of the Software Exporting) – SOFTEX, having as a goal the definition and bettering of an model for improvement and evaluation of software processes, aiming preferably the micro, small and medium business, in a way that meet its business necessities. The MPS model was defined as a basis in the norms of ISO/IEC 15504 (ISO/IEC15504, 2003) and ISO/IEC 12207 (ISO/IEC12207, 2008) and in conformity with the CMMI-DEV and its structure is divided in three components: Reference Model (MR-MPS), Assessment Method (MA-MPS) and Negotiation Model (MN-MPS). Each component is described through sections and/or documents of the MPS model (SOFTEX, 2012).

The MPS Reference Model for Software describes the requirements for the company's processes to be in conformity with the MR MPS-SW20. It contains the definition of the maturity levels, the processes and the attributes of the process related to each level of maturity.

The MR-MPS-SW defines seven levels of maturity (Figure 14), sequential and cumulative, described as follows:

- Level G (Partially Managed)
- Level F (Managed)
- Level E (Partially Defined)
- Level D (Largely Defined)
- Level C (Defined)
- Level B (Quantitatively Managed)
- Level A (Being Optimized)

ML	Processes	Process Attributes
A	(no new process are added)	1.1, 2.1, 2.2, 3.1, 3.2, 4.1*, 4.2*, 5,1*, 5.2*
B	Project Management (new out comes)	1.1, 2.1, 2.2, 3.1, 3.2, 4.1*, 4.2*
C	Decision Management, Risk Management and Development for Reuse	1.1, 2.1, 2.2, 3.1, 3.2
D	Requirements Development, Product Design and Construction, Product Integration, Verification, and Validation	1.1, 2.1, 2.2, 3.1, 3.2
E	Human Resources Management, Process Establishment, Process Assessment and Improvement, Project Management (new outcomes) and Reuse Management	1.1, 2.1, 2.2, 3.1, 3.2
F	Measurement, Configuration Management, Acquisition, Quality Assurance, and Project Portfolio Management	1.1, 2.1, 2.2
G	Requirements Management and Project Management	1.1, 2.1

** Theses process attributes (PAs) are applicable only on selected processes. The others PAs must be applied on all processes.*

Figure 14 - MPS.BR Model. Source: (Softex, 2012)

The maturity scale starts on the level G and evolves up to the level A, when the organization reaches a high level of maturity. When compared to the CMMI-DEV, the model holds three extra evaluation levels. The creation of this division in a larger number of levels had the purpose of attend better the small and medium companies, which can reach their improvement goals in intermediate steps.

Each maturity level is a combination of the processes and of the capability of the processes. The processes are described according to the purpose and the expected results. The purpose describes a goal to be achieved with the execution

of the process and the expected results establish the goals that should be achieved with the effective implementation of the process. Nevertheless, the process capability is represented by a group of attributes that are described in terms of expected results.

The progress and the reach of a determined level of maturity of the MR-MPS-SW is obtained when the expected results of the processes and the attributes of established processes for that level are attained. The Attributes of the Process (AP) are a measurable characteristic of process capability. The attendance to the attributes of the process (AP), by the attendance to the expected results of the attributes of the process (RAP), is required for all the processes in the level corresponding to the maturity level, even though they are not detailed inside the process (SEBRAE, 2013).

The communication management in the MPS.BR is not much different from the CMMI model. For both models the PMBOK Guide (PMI, 2013) is a very important partner, since it stimulates the effective improvement of the communication process. In the MPS.BR the process Projects Management establishes the communication having as benefit information about the status of the project for the decision making and actions about it.

Next we will show a wide view of communication management that pervades by some levels like G, E, and D of the MPS.BR.

The more relevant data of Project are identified and planned accordingly to the ways of gathering, storing and distribution. For the MPS.BR the project data provides several forms of documentation that work as entries for the communication, for example: reports; informal data; studies and analysis; meeting assignments; lessons that were learnt; generated artifacts; action items and indicators. The communication of this data can come in any format, like: printed or drawn in several materials; photographs; electronic means; among other formats. This data can be made available to all of the relevant stakeholders of the project so there can be a good communication about the important information of the project. MPS.BR Project Plan is reviewed with all the stakeholders. Achieving the compromise requires a communication among all of the the relevant stakeholders of the project, either internal or external. The meeting in the beginning of the project can be used to define roles and solve

conflicts, as well as to obtain the commitment of the team that is involved in the project. The communication with the stakeholders is treated as a fundamental factor to the project regarding the planned resources, to achieve the defined goals, like the success itself. The evolution of the project is monitored and accompanied with relation to what was established in the project plan and the way the results of this monitoring are effectively documented.

The involvement of the stakeholders in the project is managed. At this moment, the most important stakeholders should be identified, where and how they will be involved. However, we notice that the communication among the interested parts includes several questions that are related to terms, costs, resources and also requirements, since they have an impact in the other variables. A well-defined and institutionalized communication management plan, following what is showed in the (PMI, 2013), can cover the expected results. When we speak about the expected results, we should remember that it is adherent to the level G, where Requirements Management is mentioned. In relation to the communication, is necessary for the better understanding of the requirements to come together with the interested parts (the stakeholders) to ease the understanding of the real needs of the project. Besides, it is primordial to verify whether the contracts made by the stakeholders are being kept (or negotiated), to identify the ones that were not satisfied or that hold a high risk of not being satisfied. By knowing this information, a few adjustments will be made necessary for the contracts to be effectively kept.

The survey of requirements is done through the requirement providers. The correct and effective communication with the requirement providers is extremely important to assure a clear understanding of the client's needs and of the project requirements, as described above. The requirement providers must be identified from some predefined criteria; the communications must be registered into minutes, emails, communication tools, being required evidence that the stakeholders totally have agreed with the recorded contents.

The level E concerns to standardize the organization processes, by their definition, being instantiated through the processes and the existing best practices of the organization, thus resulting in a search for continuous improvement. The purpose of the Project Management process, in what concerns to the communication, is to provide information about the project

status and progress, in addition to establish and maintain plans that define the project activities, resources and responsibilities.

In the Level D the requirements are validated. This expected result aims to assure the validation of the requirements, since the early stages of the life cycle, through an efficient communication, improving the confidence that the elicited and defined requirements are capable of guide and assure the good software development.

A quality model successfully implanted is not only a set of politics, processes and procedures. Organizations seeking to adopt some quality model must concentrate efforts in the communication principles, to promote an effective improvement of their processes. The best processes involve people and knowledge. The documentation must not be the purpose of the improvement of the process; the purpose must be the communication improvement. Documents are a way to communicate, but not the only one.

Many organizations aim only to achieve the quality seal, and don't analyze how this implantation can improve their organizational structure. Thus, they lose the opportunity to increase the synergy of their operations through the continuous improvement of their processes.

In every quality model, is visible the great need for efficient communication, so that the processes come to flow in a positive way. Is possible to note that the communication pervades the whole project, from the beginning to the end. Therefore, the project manager or deployment leader concerns about the qualitative benefits to everyone; that is, with clients reaching the best understanding and high quality service, with the financial gains comes also the productivity improvement.

Finally, can be observed that the companies are even more concerned with the adoption of quality models, they are concerned with the certification of their processes to provide greater quality in their products and/or services. However, in front of this new challenge of the software engineering in have to develop software with geographically separated teams, these models say not how to do, but what to do. Facing this problem, it was worth to study how the communication works in some quality models, and becames clear that most of them treat the communication over the entire model, that is, the

communication pervades all the maturity levels on quality models, having not a document or section which covers the communication specifically.

If is complicated to manage the communication in centralized or collocated projects, in distributed projects this challenge becomes even harder to manage.

2.2.8. PEOPLE CAPABILITY MATURITY MODEL – P-CMM

The People Capability Maturity Model (P-CMM) is a model oriented to the strategies of people management, guiding the organizations into the establishment of practices of human resources aligned to the business objectives (CURTIS; HEFLEY; MILLER, 2009). This model aims to help the organizations to choose activities to improve their practices, based in the existing maturity. It focuses in the implantation of a set of practices and techniques that allow the companies to significantly improve the level of their talents, and to get gains in their performance.

This model presents a scheme in five maturity levels (Figure 15), where the organization modifies its culture on every level crossing, facilitating the practices of improvement, motivation and retaining people(CURTIS; HEFLEY; MILLER, 2009), (SILVEIRA, 2009), (CHEN; HSIEH; WU, 2012).

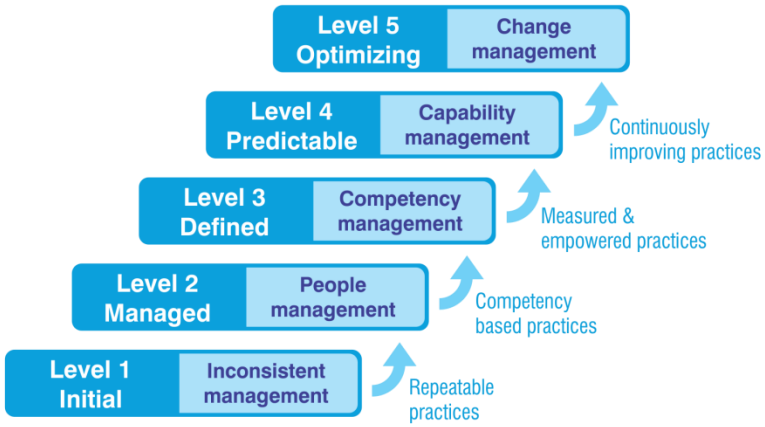

Figure 15 - The five maturity levels of the P-CMM. Source: Curtis, Hefley and Miller (2009).

The P-CMM has in the second maturity level a process area dedicated to the communication and coordination. This area aims to establish communications in a timely manner through the organization, and ensure that the workforce has the skills to share information and coordinate efficiently the activities (SILVEIRA, 2009), (CHEN; HSIEH; WU, 2012).

The area of communication and coordination establishes an initial basis to develop and train teams. This process area establishes a culture to openly share the information through the organizational levels and laterally between dependent units. In order to increase the information flow, it provides basis for a participative culture and strengthened teams. A critical attribute of this culture is that individuals can feel confident in raising questions to the management without fear of retaliation (PRIKLADNICKI, 2009), (SILVEIRA, 2009).

To obtain the gains of defined processes, people that work together must have the skills needed to coordinate their activities and manage shared dependencies. In higher maturity levels, the definition of competence based on processes removes some of the responsibilities of individuals by managing dependencies through the coordination of the interactions required in defined roles and tasks. Before the availability of defined processes, the interpersonal communication and coordination abilities must be developed to provide a basis for the structured development of workgroups in higher levels (CURTIS; HEFLEY; MILLER, 2009), (SILVEIRA, 2009).

The establishment of efficient communication starts by the communication of the values, politics, practices and other information of the organization to the task force. In addition to this top-down information, the bottom-up communication is stimulated by seeking the opinion of the individuals in their working conditions. The lateral communication between the units starts giving special attention to the communication needed to complete the work (CHEN; HSIEH; WU, 2012)

To reinforce the importance of the open communication, the organization establishes formal procedures to find and solve problems. Once elicited, these problems must be accompanied by the administration to enhance their respect by the knowledge and experience of where these problems emerge. To eliminate the fear of retaliations, the respect to individuals as an important component of the culture must be established. The interpersonal communication abilities needed to maintain efficient work relationships are developed (CURTIS; HEFLEY; MILLER, 2009)

To maintain efficient workgroups, interpersonal problems are quickly approached and office meetings are managed to assure that the teamwork time is used in a more effective way. Individuals identify dependences in the works assigned to them and establish arrangements to align their activities. Individuals monitor the progress in front of these dependencies to ensure the coordination with their workgroup (PRIKLADNICKI, 2009).

2.2.9. ESCM (ESOURCING CAPABILITY MODEL)

The eSCM model, proposed by Hyder *et al.* (2006), was developed by a consortium of companies and universities, coordinated by the Carnegie Mellon University (CMU), through the ITSQC (Information Technology Service Quality Center). The latest version was published in 2006 (ITSQC, 2014). The model is divided in two parts: clients (eSCM-CL) and service providers (eSCM – SP), the version to service providers had its development started in 2001, and already is officially available. The most recent client version dates of 2004, and still is in beta version. The main goal of the model is to be a reference to the IT supported service provision activities, focused in critical questions of the management of the sourcing processes (Figure 16).

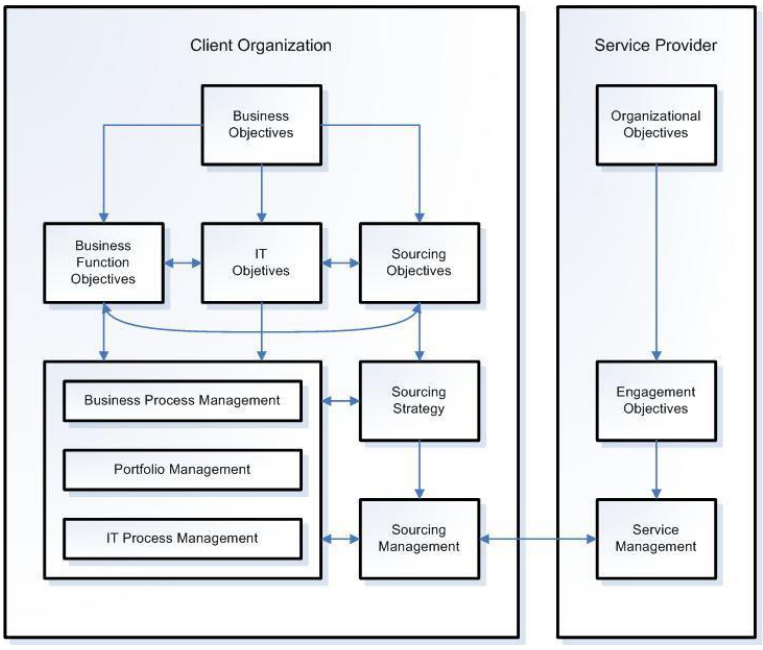

Figure 16 - The relation between cliente and supplier in the eSCM model.

Source: (PRIKLADNICKI, 2009).

In the eSCM-SP model, the aim is to determine the potentialities of the IT service providers. Furthermore, the model is used to improve the organization and recognize its delivery capability. It involves the whole sourcing process,

ensuring the understanding of critical success factors. In the eSCM-CL, the clients use the model as a way to compare service providers in their selection process. There exists a wondering with the relationship process that exists between the buyer and the provider of the IT supported process. Finally, it provides a set of information to the client to evaluate the risk of certain service providers. The sourcing lifecycle is divided in: Ongoing, Initiation, Delivery, and Completion. The Capability Areas are divided in Knowledge Management, People Management, Relationship Management, Technology management, Threat Management, Contracting, Service Design & Deployment, Service Delivery, and Service Transfer Hyder *et al.* (2006).

The Capability Levels are divided in five levels, namely: Level 1 – Providing Services, Level 2 – Consistently Meeting Requirements, Level 3 – Managing Organizational Performance, Level 4 – Proactively enhancing Value, and Level 5 – Sustaining Excelence (Figure 17) (ITSQC, 2014):

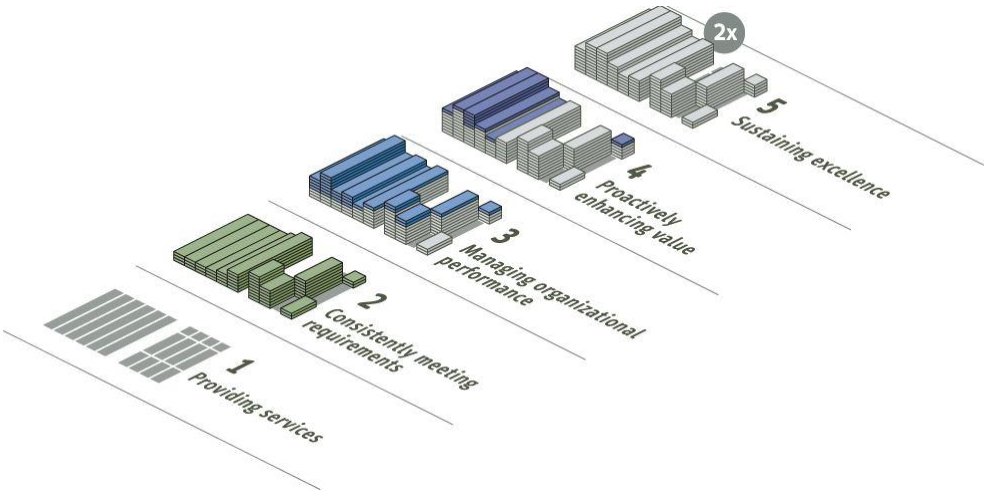

Figure 17 - General Structure of the eSCM (ITSQC, 2007).

Level 1 – Providing services: according to the authors, the capacities of this level can vary in a significant way. Some service providers could have some of the practices implemented, while others could have many, including practices of the levels 3 and 4. But once they didn't implement all the practices of the level 2, they still have risk of failure in some areas.

Level 2 – Consistently meeting requirements: The service providers have formal procedures to document requirements and to deliver the services in line with the compromise assumed with the stakeholders. Furthermore, the infrastructure is configured to the work to be executed.

Level 3 – Managing Organizational Performance: The service providers can deliver the services according with the defined requirements, even if the requirements differ a little from the experience of the service provider. On this level, is possible to manage the performance in the organization, understanding the objectives of the market, and identify and manage risks in the engagements. Furthermore, there exists a formal process to measure and reward the collaborators, as well as to monitor and control the technological infrastructure. The improvements are measurable according to the organizational objectives.

Level 4 – Proactively enhancing value: In this level, the service providers are able to continuously innovate, adding practical and statistical value to the services they provide to the clients. The strategy can be personalized, and it is possible to better understand the perception of the clients, considering inclusively historical data. This level also provides the possibility to create plans and control improvements according to the benchmarking of other service providers.

Level 5 – Sustaining excellence: In this level, the service providers show the capability to measure, control and constantly improve the performance, while they implement the practices of the levels 2, 3 and 4 for two or more consecutive assessments in a period not longer than two years. Additional practices in this level do not exist.

Since it is a recent model, its use still has been limited to the great companies that have a complex sourcing process. In Brazil, the program of Production Engineering of the COPPE/UFRJ, by the group of Integrated Production, participated of the conception, definition and assessment of the model. In addition, there are already companies working with specific consultancies in the practices of the eSCM. Even with little use in the country, the perspective is that the practices start to be gradually implanted to the extent that the model be more used and known (PRIKLADNICKI, 2009).

2.2.10.WAVE CAPABILITY MODEL

The WAVE capability model has as objective to help the organization units to increase their capability to develop projects with globally distributed teams. The WAVE model was the first capability model created with focus in companies that act in the context of offshore insourcing, but can be used also by companies

that work with offshore outsourcing (PRIKLADNICKI, 2009), (GLANZNER; PRIKLADNICKI; AUDY, 2010).

WAVE is structured in “Capability Levels”, “Capability Areas”, “Capability Attributes”, “Objectives” and “Practices”. The model is divided in four big capability areas: “People”, “Projects”, “Portfolio” and “Unit”. Every capability area groups together capability attributes with common nature. The capability attributes are points which must be monitored when working in the GSD context. To cite an example, the “People” area has a series of capability attributes related to people, like: “Cultural Differences”, “Knowledge Management”, “Training in Distributed Software Development”, among others.

Each of these capability attributes has an objective, which describes the benefits brought by this attribute to the company, whenever well implemented. Moreover, capability attributes addresses a series of practices and, while they are being implemented, a greater capability in deal with this attribute is reached. Table 3 shows the composition of the capability attribute “GSD Training” (PRIKLADNICKI, 2009), (GLANZNER; PRIKLADNICKI; AUDY, 2010).

Table 3 - Training in Distributed Software Development (DSD).

Attribute	Distributed Software Development Training (TRAI)		
Objective	Understand the training needs in the many units, to improve the training politics to the distributed teams and projects.		
Level	2	Practice 1	The trainings are technical and non-technical, on demand.
	2	Practice 2	These exist a program for technical and non-technical trainings in the units.
	3	Practice 3	There is a global program for technical and non-technical trainings.

Source: Prikladnicki (2009).

In the WAVE model the capability level of a unit can be defined in three scales: by attributes, by capability area, or general. Whenever a company implements practices of an attribute, it increases its capability on this attribute. Depending on the capability attribute and desired level, more or less practices must be implemented. Revisiting the example in Table 2, two practices are needed to

reach the level two of the “DSD training” capability attribute and only one to reach the level three (PRIKLADNICKI, 2009).

The WAVE model has a scale of four capability levels: ad-hoc (level one), capability (level two), preparation (level three) and integration (level four). These levels were based on the eSCM model.

In the first level, ad-hoc, stands out those units in the initial level on the use of GSD, implementing few practices and normally without any basis or improvement plan.

Units in the second level, capacitation, are those which already implemented basic practices and which an easier projects execution on the GSD context. The improvement initiatives are normally oriented to entire projects and rarely to the whole unit. These efforts are still done on demand, hardly being previously planned by the organization. The capability attributes, more required in this level, are the people ones, because is decisive that the involved teams are trained to this paradigm exchange (PRIKLADNICKI, 2009).

When an organization and the units acquire more experience in globally distributed projects, the initiatives of the level two of the WAVE are expanded. Improvements previously applied only to a single project, when in the preparation level start to be applied in a project group, on the unit or even in all the units. The projects count with distributed teams; poorly integrated and normally managed on an individual way (PRIKLADNICKI, 2009), (GLANZNER; PRIKLADNICKI; AUDY, 2010).

Finally, the units in the level of integration capability can have projects with dependences between more than one unit, in more complex sceneries, and, furthermore, patterns to the work in the DSD context are created in an organizational level (PRIKLADNICKI, 2009).

2.3. DISTRIBUTED SOFTWARE DEVELOPMENT

On the last decade, large investments were done to promote the expansion and conversion of national markets into global markets. Consequently, new categories of competition and collaboration amongst the countries have appeared (EVARISTO, 2005). In the last years there has a great advance in direction to the business globalization. According to Prikladnicki (2009), “In the

Software Development Area this is not different." The software, and the technologies as a whole, had become a strategic asset for the organizations in their many business areas.

In face of these changes driven many times by the globalization, the cost to develop software in the same physical space had progressively increased leading to a decline of the competitiveness in the local, national and even global markets. In this sense, the growing economy, the evolution of the communication media and the exigency for cost-reduction have motivated additional investment in the Distributed Software Development (DSD).

In this scenario, the DSD had been an alternative for different companies over the last years. Nowadays, such software companies are adopting the DSD, distributing their software projects, at local, national and even global level, aiming to reduce the costs, be close to the customers and markets, access qualified workforce, fiscal incentives and competitive advantages. It is worth to note that a significant number of researches in the area of Software Engineering, focusing particularly in DSD, has appeared (BOEHM, 2006) (CARMEL; TJIA, 2005) (CARMEL, 1999) (DAMIAN; HADWIN; AL-ANI, 2006) (HERBSLEB; MOITRA, 2001) (KAROLAK, 1998) (PRIKLADNICKI, *et al.*, 2006) (PRIKLADNICKI; AUDY; EVARISTO, 2003). The crescent evolution of the research in DSD is showed in Figure 18.

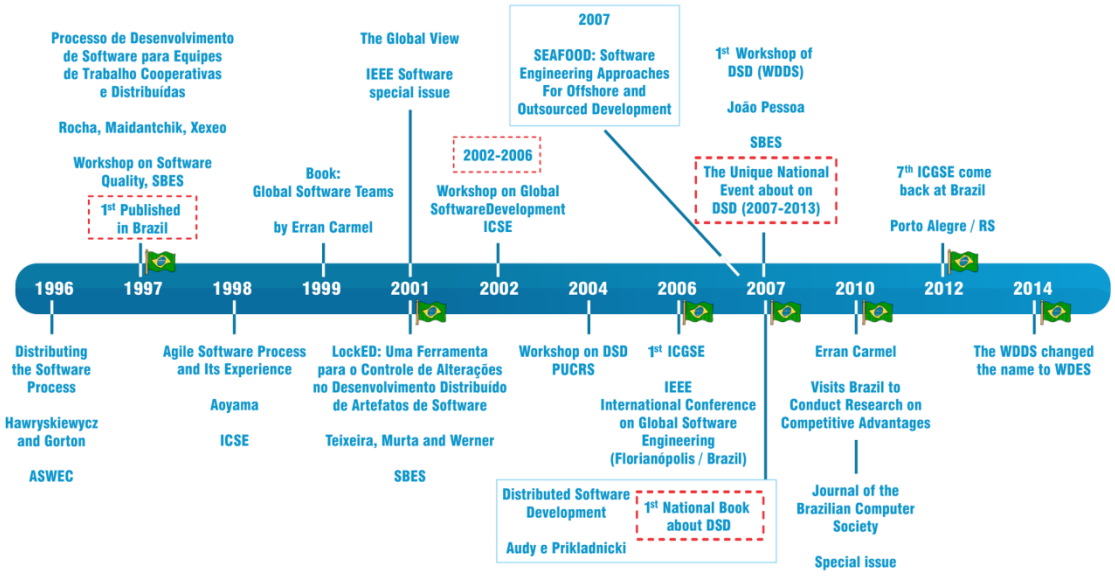

Figure 18 - DSD Timeline. Source: the author.

According to Prikladnicki *et al.* (2006), it is possible to find registers of DSD projects since the 90s. For example, the article of Hawryszkiewycz and Gorton (1996), published in the Australian *Software Engineering Conference* in 1996, which was one of the first works directly related to the distributed software development. The authors had discussed about how to manage, as well as coordinate geographically distributed teams using groupware.

In 1998, some works related to the DSD instance, regarding the global scale development became public; in addition, the first books about DSD (CARMEL, 1999) (KAROLAK, 1998) were published. The book published by Karolak (1998), particularly, gathered contents regarding the motivation and challenges related to DSD.

Still in 1998 surged the first publication about DSD in a conference of world visibility. The theme started to spread and draw attention of the main Software Engineering event, the International Conference on Software Engineering (ICSE). Aoyama (1998) presented a discussion about the tendency based in the need of the organizations to evolve the way to develop software, like to seek methodologies, manners and forms to proactively help the distributed teams.

Although these first publications had been of great importance, was the work of Carmel named *"Global Software Teams"* (CARMEL, 1999) that really marked the beginning of the researches in the DSD area on the world. According to Prikladnicki, Marczak and Conte (2011), this can be proved by the citations found on the Google Scholar base, where the work appears on the ACM portal and in the Prentice Hall publisher as the publication most cited nowadays (more than 800 citations since its publication).

In 2001 the first specific edition about DSD in a journal was edited and published in the IEEE Software (HERBSLEB; MOITRA, 2001). From the most cited publications until now, four are related to this special edition and two to the first two books published. From this special edition on, the main researchers of the area decided to propose a specific workshop about the theme on the ICSE.

In 2002, the first edition of the *Workshop on Global Software Development* on the ICSE was held in Orlando, on the United States,. The event counted with the presentation of researchers from Canada, United States,

Australia, Finland, Germany, Nederland, Holland, Italy and Brazil (MAIDANTCHIK; ROCHA, 2002) (DE SOUZA; BASAVESWARA; REDMILES, 2002). This workshop happened again in the years of 2002, 2003, 2004, 2005 and finally in 2006 with the realization of the last edition on the ICSE, where were presented 16 papers, one of them made by Brazilian researchers. It should be stressed that for every edition, Brazilian researchers always contribute with remarkable works (PRIKLADNICKI; MARCZAK; CONTE, 2011).

At this year, the ICGSE (*International Conference on Global Software Engineering* - http://www.icgse.org) takes place and it is until now the main international event on the area. The first edition was organized on Brazil, in Florianopolis.

In the Brazilian scenario, the first publication about DSD was presented in 1997, on the workshop of Software Quality in the Brazilian Symposium of Software Engineering – SBES, held in Rio de Janeiro (ROCHA; MAIDANTCHIK; XEXEO, 1997). The paper presented partial results of a doctoral research of the COPPE /UFRJ (MAIDANTCHIK, 1999). In this paper, the author presented a process of software development for distributed teams, aligned with quality models like the *Capability Maturity Model* - CMM. The same authors had published results of this work in the journal Computer Physics Communications (MAIDANTCHIK; ROCHA; XEXEO, 1998).

In 2004 the first event about DSD on Brazil was organized. Despite being a regional event, organized by the PUCRS in Porto Alegre, the event brought together the participation of over 150 people and the presence of the Professor Daniela Damian (University of Victoria on Canada), one of those who idealized the DSD workshop on the ICSE. On this same year was published a paper about DSD on the main track of the SBES. In 2006, on the same event, occurred other publication about DSD (PRIKLADNICKI; AUDY, 2006) (PRIKLADNICKI; AUDY, 2004).

In 2007 the first (and only) Brazilian event focused in DSD, WDDS - the Brazilian Workshop in DSD, was organized as a satellite event into the SBES. This event had as aim to create a forum for debate of experiences of researchers and practitioners about the subject, and had received on its first edition 27 submissions, with 12 papers published. It counted with the participation of

more than 40 people of several Brazilian States, from both the academy and the industry. In these seven editions that occurred until today, the workshop has been attracting even more interest from the students, researchers and companies with operations in DSD on Brazil. This can be observed through the several collaborations generated between the researchers of Brazilian (ALLEN, 1977), (HERBSLEB, 2001) (BOUTELLIER, 1998) (ALLEN; HENN, 2007) (SCHWEIGER; ATAMER; CALORI, 2003) and international (LANUBILE, 2010) (COSTA; CATALDO; DE SOUZA, 2011) universities/industries. Still in 2007, the first book about DSD in Portuguese was published, on the series "Livros didáticos Campus-SBC (Campus-SBC Didatical Books)".

In 2010, the author Erran Carmel (the most cited in the area of DSD on the world) came to Brazil to research about the competitive differentials on the global software development. This study was published as a technical report and disclosed by Brasscom (Associação Brasileira de Empresas de Tecnologia da Informação e Comunicação, or Brazilian Association of Information and Communication Technology) as the first study conducted on the country in this sense (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1647305). Still in 2010 was published the first special edition about DSD on a journal edited on Brazil, the JBCS – Journal of the Brazilian Computer Society (PRIKLADNICKI; CARMEL; AUDY, 2010) with global visibility.

Due to the relevance of the participation and contributions of Brazilians on the Academic community and Industry at global level, in 2012, Brazil organized and held again the ICGSE, considered the bigger and better event on the DSD area. The event occurred on the PUCRS in Porto Alegre – RS. That year Brazil completed 15 years of its first publication about the theme and in commemoration to this historical mark, the WDDS was co-located as a satellite event on the ICGSE with international visibility and indexed by the IEEE.

Finally, in 2014, aiming to unite skills and research cover three other related areas, the Workshop on Distributed Software Development (WDDS), in its 8th edition enlarges its scope, giving rise to the Workshop on Distributed Software Development Ecosystems Software and Systems Systems (WDES).

Through this journey of maturing and consolidation of relevance of the thematic, the distributed software development is defined as an activity of

software development performed by a geographically distributed team, whose distribution may be established in different dispersion levels (between offices, companies, cities, states, countries, etc.). According to Prikladnicki, Audy and Evaristo (2003), the collaboration and cooperation between the parts of the team are presented as the main characteristic, that is, the creation of developer groups that work together. Figure 19 outlines the distribution of a DSD team. The responsibilities about the different tasks are distributed among a group of members allocated geographically distant from each other (ŠTEINBERGA; DARJA, 2011).

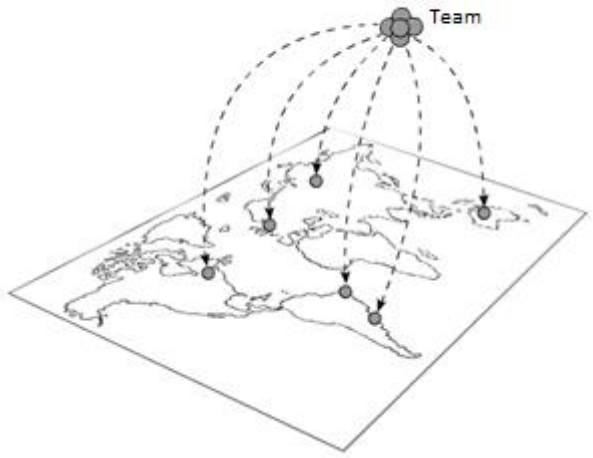

Figure 19 - Distribution of DSD Teams. Source: Šteinberga and DARJA (2011).

This is a practice that is increasingly present in companies and organizations around the world (AUDY; PRIKLADNICKI, 2007).The evolution in the adoption of DSD strategies stimulates the generation of knowledge in the area, because to increased research ain the area, and the practical experience on the use of DSD itself.

According to Carmel and Agarwal (2002), particularities of certain projects could create the need of development distribution, among companies, or affiliates, situated on different localities. Such particularities vary and require competitive advances (potentially provided by the adoption of the DSD strategy) like, for example, the use of cheaper or more specialized workforce, and the understanding of local markets (SIQUEIRA; SILVA, 2004). In the section 2.3.3

some of the main motivations and advantages associated to DSD will be discussed.

Other point that stimulates the DSD practice is that the software, in particular, presents some characteristics that can be considered advantageous to the distributed development. Software can be replicated, divided in versions, fixed, adapted, and transmitted by long distances with minimal costs (ROCHA; MORAES; MEIRA, 2009).

Although DSD could be an activity that presents many advantages, it adds to the project challenges that may lead the project to failure (SIQUEIRA; SILVA, 2004) (CARMEL, 2006). The traditional software development presents already an elevated degree of complexity, which will be increased by the DSD, adding challenges like the physical distance, temporal lag and cultural differences (AUDY; PRIKLADNICKI, 2007). These particularities will be exposed in the section 2.3.2.

2.3.1. BUSINESS MODELS

A DSD environment may be set as a simple distribution in a single country or a distribution in different countries or continents. The literature in the area recognizes several terms to characterize the distribution of the development team and some of these terms are related to the organization(s) business model(s) involved in the project. Audy and Prikladnicki (2007) present a classification based on the business model (Figure 20):

- ***Onshore Insourcing*:** In this model, there is a department inside the company or a company subsidiary on the same country (onshore) that provides services of software development through internal projects (insourcing);
- ***Offshore Insourcing*:** There is also a department or company subsidiary to provide software development services, but in a different country from the one of the company's headquarters or hiring company (offshore);
- ***Onshore Outsourcing* or *Outsourcing*:** The hiring of an outsourcing company is located on the same country of the contractor company. In this model, both the involved (contractor and outsourcing company) can be found in the same country (onshore);

- ***Offshore Outsourcing* or *Offshoring*:** The hiring of an outsourcing company located in a different contractor country (offshore).

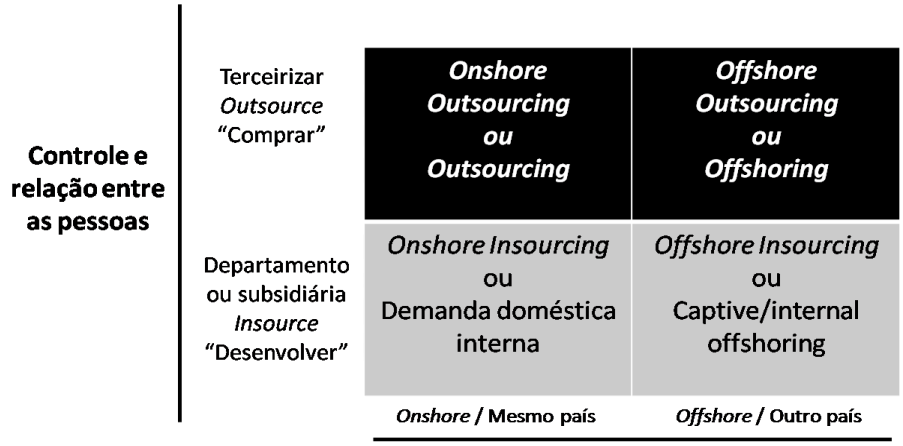

Figure 20 - DSD Business Models. Source: Adapted from Audy and Prikladnicki (2007).

It is important to observe, in addition to other forms of relationship between companies, other kinds of geographical distribution could emerge, resulting in other types of business models.

2.3.2. CHALLENGES OF DSD

DSD brings up a range of challenges inherent to its nature. Management and coordination activities have their complexities increased, creating difficulties that may impact the project, leading, consequently, to the failure (LIVIERO, 2007).

Next, some potential challenges and/or particularities in DSD projects are listed.

2.3.2.1.PHYSICAL DISTANCE

Allen (1977) presented an important study, which shows the relation between the increase of the distance and the decline in the communication frequency between members of a distributed team. The author shows that the communication frequency between parts of a team declines logarithmically as the distance between these parts increases (Figure 21). In such way, the frequency varies more intensely for distances between 10 and 30 meters, and for longer distances, the frequency variations decreases considerably (HERBSLEB, 2001) (LIVIERO, 2007). This critical range of distance can be interpreted as the transition from teams in a same office to distributed teams.

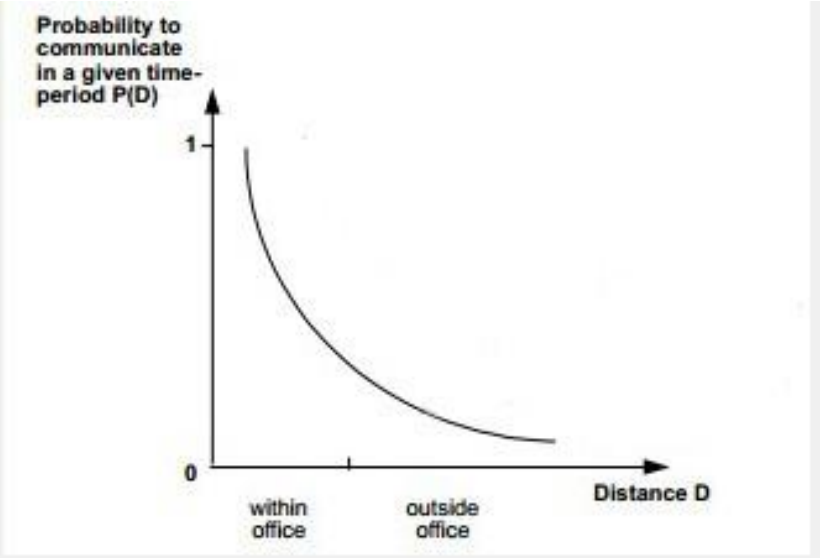

Figure 21 - Allen Curve. Source: Adapted from Boutellier *et al.* (1998).

However, the technological evolution since 1977 modifies the Allen's proposal (LIVIERO, 2007), because nowadays it is possible to communicate with people around the world quickly and with low costs, using tools like e-mail, chats and videoconferences.

Therefore, Allen and Henn (2007) reaffirm the tendency of reduction in the frequency communication with the increase of the distance between the team parts, despite the availability of the technological facilities. Their researches showed that with with the increasing of the distance not only the face-to-face meetings frequency decays, but the frequency of use of the communication media. An important fragment of the work that resumes some conclusions about the observed results is: "The greater the frequency with which we see somebody, greater the probability of made a call to this people or to communicate by another way."(ALLEN; HENN, 2007, p. 58).

Considering the change of scenario created by the advances in the communication technologies, but maintaining the general tendency presented by Allen, Boutellier *et al.* (1998) proposes a modification on the Allen curve (Figure 22), so that the impact of the distance increase is reducted, but its behavior is kept.

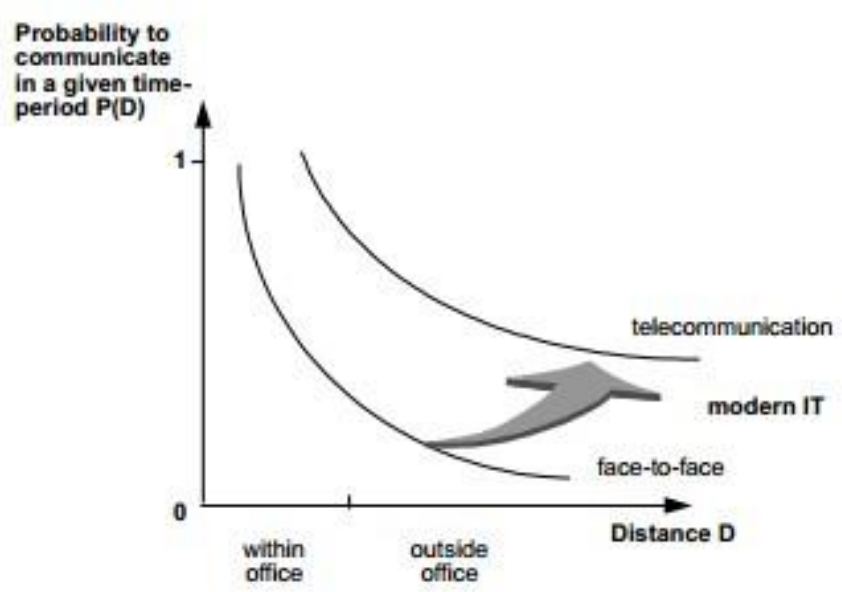

Figure 22 - Allen curve changed by the telecommunications. Source: Adapted from Boutellier *et al.* (1998).

Besides the aspects directly related to the communication frequency between the distributed parts of a team, projects obliged to use certain communication technologies because of specific needs can present difficulties. The conflict resolution is one of these challenges (SIQUEIRA; SILVA, 2004). This occurs due to the incapacity of the communication media to simulate all the details involved in a face-to-face meeting. According to Schweiger, Atamer e Calori (2003), even that a virtual meeting uses sound and video, many details, related to the corporal language, for example, are not easily perceived.

When there are face-to-face interactions or contact, one can use many resources to express the message that you want to pass. Facial expressions, gestures, among others, aid the communication. This way, the communication media used, depending on the interaction level it allows, can affect the communication quality and, consequently, can affect the whole DSD project (FARIAS JUNIOR et al., 2009).

It is known that the communication technologies emerge as alternatives, many times essential to the project implementation; however, face-to-face meetings between team members can be of extreme importance in particular moments (SIQUEIRA; SILVA, 2004). Nevertheless these face-to-face encounters must be applied very carefully, because they can reflect, in additional, costs to the projects (airplane tickets, hosting, etc.).

Another drawback presented by the technological solutions is the incapacity to simulate the daily interaction. When a team shares a same office, dividing also the difficulties, besides the overcoming of challenges and experiences, are created relations based on friendship, confidence and cooperation feelings (LIVIERO, 2007). Feelings like these are positive to the progress of the project, however, are hardly created without a frequent sharing of the everyday issues.

In a different but complementary line, Audy and Prikladnicki (2007) highlight the need of categorization of the possible distances in a DSD team, allowing the identification of patterns and their possible palliative actions. They propose four levels. The first level is the level of same physical location, i.e., all the team members work on the same place. The second level is the level of national distance, when the team is distributed over the same country. The third level is the level of continental distance. And the fourth is the level of global distance. The Figure 23 shows the last three distance levels. From each one of these levels, emerge other challenges detailed on the following subsections (MARQUARDT, 2001).

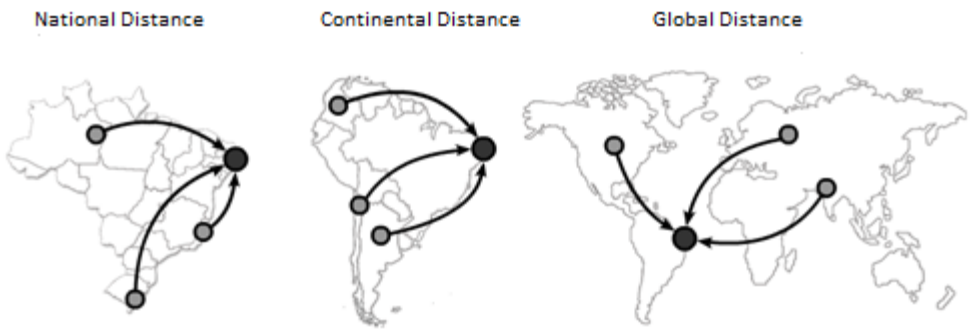

Figure 23 - National, continental and global distance levels. Source: Audy and Prikladnicki (2007).

2.3.2.2.TIME DISTANCE

Depending from the level of physical separation involved in a DSD team, a time lag can be created, reducing the number of working hours when all the team parts are working simultaneously (SIQUEIRA; SILVA, 2004). Great separations can transpose time zones, for example, a team located part in Recife (Brazil) and

part in Hamburg (Germany) depending on the time of the year could be separated by four or five hours.

On the time before the fax, the time lag did not represent a great barrier to distributed projects. The time to send artifacts could be very larger than any time zone difference, which make it irrelevant. Today, the e-mail facilities modified this scenery. The exchange of artifacts and the communication started to occur with delays tending to zero (CARMEL, 2006).

The great problem of deal with teams with asynchronous fuses is the incompatibility of the working hours, because they generally follow certain patterns, for example, a workday of eight hours, preferably concentrated throughout the day. It would be almost impossible to do teams separated by more than eight time zones maintain, frequently, synchronous contact, that is, through chats or videoconferences (CARMEL, 2006). However, even in less extreme cases, those with minimal time zone differences, is also possible to observe the occurrence of problems on the execution of the activities. Even if a daily contact is possible, via videoconference, for example, could exist a need for an immediate contact with a part that already ended it working day. This contact only will be able to occur on the following day.

In front of the impossibility of immediate contact, tools like e-mail could look like the better solution, but this is not always the truth. The clarification of certain activities can require more than written words. Furthermore, in several cases, the first clarification can be insufficient, needing more interactions and resulting in the sum of several delays (CARMEL, 2006) (CARMEL; ABBOTT, 2007).

One can see that the time lag cannot be solved or amortized trivially with the use of technologies that reduce the impact of physical distances. Indeed, as mention Carmel and Abbott (2007), on the last decades the problems caused by the time lag had increased and this behavior is contrary to the problems caused by the physical distance.

2.3.2.3.CULTURAL DIFFERENCES

Cultural differences represent a dense barrier on DSD practice. The cultural differences in a team can generate disagreements, difficulties, intolerance and conflicts (SCHWEIGER; ATAMER; CALORI, 2003). These differences must be

identified, analyzed and managed in a way that minimizes their negative impacts.

In a study regarding the impacts of cultural differences, Hofstede Hofstede and Minkov (1991) expose the idea that every individual has his personality reflected in the way they feel, think and act; which is the result of the learning accumulated along of his live. The author compares the human being to a computer, regarding the form that they are programmed. They suggest that the patterns of each individual are programmed by the *stimuli* they have been receiving through their life, initially by the family, next by the neighborhood, on the school, by the friends, workplaces and finally, from every part of his community.

The variables responsible for cultural divergences are the most diverse, however, is possible to perceive the deep influence of the locality, because all the cited stimuli have sources belonging to their local community.

Culture can be understood as the patterns that exist in the stimuli of any arbitrary society. Cultural differences may change completely the programming of the individual's behavior pattern. This might even change their values. What is considered a correct attitude to an individual may represent an abuse for other, what is considered gentleness for someone can represent disrespect for other people, besides other divergence possibilities (GOODALL; ROBERTS, 2003).

Nevertheless, Hofstede, Hofstede and Minkov (1991) highlights also that the personality inherent to each individual and to the human nature represents, also, important rules on the definition of his behavior pattern (Figure 24).

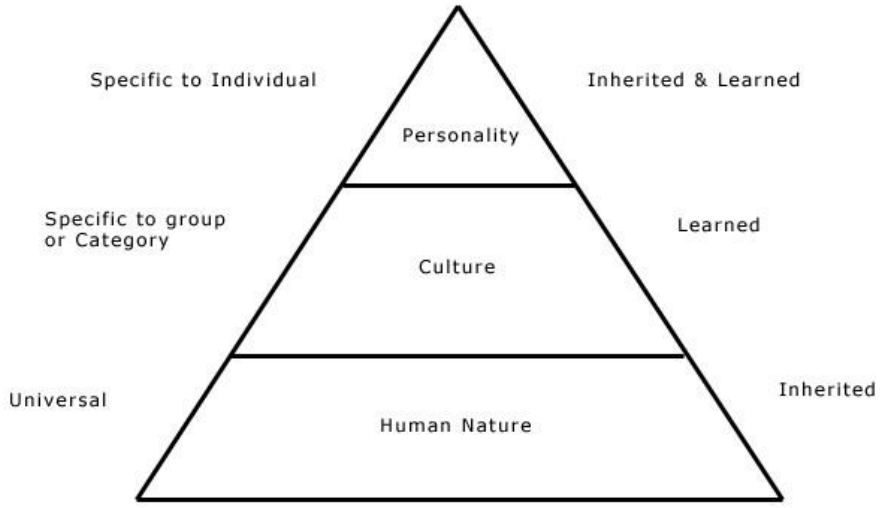

Figure 24 - Three unicity levels on mind programming. Source: Hofsted; Hofstede; Minkov (1991).

Many studies were done seeking to elaborate a way to classify differences; Liviero (LIVIERO, 2007) cites different authors whose classify cultural differences using multidimensional levels. One of the most referenced is the four dimensions model of Hofstede, Hofstede and Minkov (1991). In this work, the author analyzes the cultural differences on the dimensions, measuring each one of them by an index:

Power Distance Index (PDI) – represents the level of power inequality involved among individuals from the same social system. Power is the potential to determine or influence in a direct way the behavior of other individuals (MULDER, 1977, apud HOFSTEDE, 1984). The larger is the index, the higher the power inequality. The Table 4 summarizes some of the main cultural characteristics presented in societies with high and low power distance index.

Table 4 - Cultural characteristics of societies with low and high PDI.

Low PDI	High PDI
The hierarchy on the organizations means a difference of functions established by convenience.	The hierarchy on the organizations reflects an existential inequality between power levels.
Decentralization.	Centralization.
Low wage differentiation between the higher and lower levels of the organizations.	Significant wage differences between the higher and lower organizational levels.
The subordinates expect to be asked.	The subordinates expect to be said what to do.
The status and privilege symbols are not incentivized.	The privileges and status sign of the managers are expected.
The ideal boss is a democrat.	The ideal boss is a “benevolent autocrat”.

Source: Liviero (2007).

Uncertainty Aversion Index (UAI) – represents the level of discomfort in respect to an uncertain future. A high index means that the community in question feels worried about uncertainties, so this community requires practices of uncertainty reduction, like frequent status reports, risk analysis, meticulous planning, like others (MENDEZ, 2003). The Table 5 shows some of the main cultural characteristics in societies of low and high uncertainty aversion index.

Table 5 - Cultural characteristics of societies with low and high UAI.

Low UAI	High UAI
Emotions and aggressions must not be set out.	Emotions and aggressions must be set out in proper occasions.
Comfortable in front of ambiguous situations and unknown risks.	Acceptation of known risks, fear of ambiguous and unfamiliar situations.
There should be more rules than the strictly necessary.	Emotional need for rules, even that they never come to be used.
Comfortable feeling where resting; hardworking only when necessary.	Emotional need on bein occupied, even without an effective result.
Precision must be learned.	Precision is a natural thing.
Motivation by the sensation of achievement.	Motivation by the sensation of security.

Source: Liviero (2007).

Individualism Index (IDV) – represents the level of appreciation of individual elements by a community. A high level is reflected from a community that values the individualism, on the other hand low values reflect communities that value team notions (HOFSTEDE, 1984). The Table 6 shows some of the main cultural characteristics presented in societies with high and low individualism levels.

Table 6 - Cultural characteristics of societies with high and low IDV.

Low IDV	High IDV
The people belong to groups which protect them in exchange for loyalty.	The people are educated to take care of themselves or of their near familiars.
The identity is based on the social network where the individual is inserted.	The identity is based on the individual.
The boss-employee relation is seen in moral terms as a familiar link.	The boss-employee relation is a contract supposedly with mutual advantages.
Contratations and promotions consider the grupal links of the individual.	Emotional need to be busy, even without an actual result.
Management is to manage groups.	Management is to manage individuals.

The relations prevail over the activities.	The activities prevail over the relations.

Source: Liviero (2007).

Masculinity index (MAS) – reflects the level of competition and aggressiveness or passivity on the relations among individuals, in the defense of their own opinion and on the approach of subjects on a direct way. High values reflect aggressive societies, low values, more careful societies (HOFSTEDE, 1984). The Table 7 exhibits some of the main cultural characteristics presented in societies with low and high masculinity index.

Table 7 - Cultural Characteristics of societies with low and high MAS.

Low MAS	High MAS
The dominant values of the society are the care about the others and the preservation.	The dominant values of the society are the material success and the progress.
Everyone is expected to be modest.	Is expected that the men would be more assertive, ambitious and "strong".
Work to live.	Live to work.
The managers use intuition and seek consensus.	Is expected that the managers decide and be assertive.
Focus on the equality, solidariety and life quality on the work.	Focus on the competition between colleagues and on the "performance".
Resolution of conflicts by commitment and negotiation.	Resolution of conflicts by the force.

Source: Liviero (2007).

Furthermore, the language is a critical barrier when dealing with communication among distributed teams with cultural differences. Whenever a team is distributed at continental or global levels, is expected that it contains members with different native languages. This barrier is considered critic, because apparently is impossible to develop a product using a collaborative work between parts of a team that cannot communicate satisfactorily (SIQUEIRA; SILVA, 2004).

Communicating efficiently without the existence of a language dominated by all the parts involved in the process turns into a non-trivial (and perhaps, impossible) task. Usually, companies with distributed teams adopt a default language. The mass diffusion in the globalized scenario has listed the English natural language as the most widespread one However, some particular contexts which surrounds these involved companies, sometimes, enable the adoption of other languages as default.

Even worse, people involved with DSD Multilanguage teams can not understand the company default language. Interpretation problems are, in general, the result of the misalignment of the language proficiency levels among the team members (LIVIERO, 2007).

Similarly to the time lag barrier, the language barrier also had its impacts highlighted with the advances on the communication media. The increase of the dynamism made necessary the proficiency of the default language adopted by the distributed parts of the team. Until recently, the need of knowledge of a default language by most of the team members was limited to the reading of sent documents (LIVIERO, 2007). Today is common that all the team members need to exchange e-mails and talk based on the default language.

As quoted by Siqueira and Silva (2004), in DSD activities, the existence of the default language and the team proficiency is still more important. Beyond the need of communication in meetings and dialogues in general, exists also all the documentation involved in the course of a software project. Schweiger, Atamer and Calori (2003) also said that creative activities, as the development of new products (for example, software) are still more problematic. For these activities, is required an intense and high level communication, where each detail of the language can have great importance for the comprehension of everybody on what is the product about. Thus, interpretation divergences can be highly adverse.

2.3.3. MOTIVATION FOR DSD PROJECTS

In front of the challenges presented by activities involving distributed teams, it might look like an error the option for a distributed development strategy. However, in many cases, projects and companies see themselves pressured by a highly competitive context, where certain adaptations are essential to the survival on the market (ALLOUCHE; HUAUT, 1998 apud MENDEZ, 2003). Thus, even with the existence of intrinsic barriers to the distributed teams, the advantages arising from this strategy can be decisive.

The scenario of software development is not very different. In relation to the expansion of the activity, a wide competition market was made up, where the slightest of the details can be the difference between a successful project and a great failure. On the other hand, software presents a series of peculiar

characteristics that make them more proper to distributed activities when compared to other sectors. Software can be replicated, divided in versions, corrected, adapted, and transmitted over great distances with minimal costs (ROCHA; MORAES; MEIRA, 2009).

The sum of needs and peculiar characteristics of the software market boosted the expansion of distributed development strategies. Next will be exposed and briefly analyzed the main advantages that can be reached with the DSD.

2.3.3.1.COST REDUCTION

The cost reduction in a project is the most trivial advantage caused by the adoption of the DSD. Avagliano (2003) says that most of the executives of the great companies spread over the world consider the cost reduction as the main motivation for the distribution of a project development.

Regarding a series of factors like cost of living, legislation and valorization of the activity, the average wage for an activity in an arbitrary country can be sharply different, when compared to other countries. In many cases this difference is accentuated inside the same country (CIFRAS INE, 2011).

The team services contracting in a region where the average wage is low can represent a great advantage. For example, in relation to a team of software developers, the costs related to the payment of the team wages can be reduced in more than 60% if a team from India is contracted, instead of a team from the United States (LEGASPI, 2009).

In this context, the great potential for cost reduction, and also the facilities presented by the software development activities in relation to the distributed development, motivate an increasing number of software development companies to start to create offices, partnerships, affiliates, among others, in places spread over the world (KRISHNA; SAHAY; WALSHAM, 2004).

2.3.3.2.LEGAL AND FISCAL ASPECTS

On the planning of the politic adopted by some governments, can be interesting that certain companies have, on their territory, an affiliate, a partner, an office or even a headquarter. The justifications involved in this question can be

extremely complex, so they are studied by an area known as National Competitiveness, which is beyond the scope of this work.

It is sufficient to understand that in this context exists an exchange of interests. The implantation of the company can represent a form to increase the work opportunities, technological development, market stimulus, exportations, among others. On the other hand are offered to the company tax incentives, like for example reduced taxes (PORTER, 1999).

Furthermore, legal aspects can also influence the distribution of a project. Different locals are subject to different laws. Some particularities represent attractive, as the low minimum salaries. On the other hand some legislation can represent impositions too, like the prohibition of importations (CIBOTTO, 2009).

2.3.3.3.SPECIALIZED LABOUR

Many projects require the participation of individuals or organizations with specialized knowledge in certain areas. To these individuals or organizations present satisfactory results, many times is needed their expansion to other locations (SIQUEIRA; SILVA, 2004). The reasons for this to take place are rather varied, for example, the required specialty can be a technique very new on certain site, where do not exist many skilled professionals. Can be also a practice that fell into disuse, or be something that traditionally does not make part of certain culture, among others.

In addition to the need for searching professionals in distant locals, the range of the professional search will permit a wider selection, increasing the chances to hire the better professional for the required function (KERBER; BUONO, 2004).

2.3.3.4.CREATIVE CULTURAL DIVERSITY

The cultural diversity was, later, treated like a challenge faced by distributed projects. However, it provides also advantages that can be explored by the team.

Individuals from distinct cultural contexts present different patterns on thinking, feeling and acting (HOFSTEDE; HOFSTEDE; MINKOV, 1991). So, a culturally eclectic team share diverse ideas, that when combined stimulate the creativity (JORDÃO, 2004). Schweiger, Atamer and Calori (2003) add that on

the Project for the development of new products the creativity becomes more important. They reinforce also the idea that the team heterogeneity improves its creativity.

2.3.3.5.PROXIMITY TO THE LOCAL MARKETS

In a dynamic market, with strong competitiveness, like the software development one, the speed with which a company realizes and reacts to the changes can be a determinant factor in relation to the success of the project.

To understand particularities of the local market, like acceptation, aversion or preference patterns, can represent agility on the reactions to the changes of the market. A centralized company hardly will realize and react to challenges resulting from the dynamics of different markets (BOUTELLIER *et al.*, 1998).

So, many companies are stimulated to distribute their teams in such a way that their parts can react quickly to the changes of local markets. In an attempt to be more agile than the concurrency and, with this, conquer a competitive advantage.

2.3.3.6.KNOWLEDGE OF THE LOCAL CLIENT

To understand the local client can be seen like a subset of the to understanding of the local market. However, the client assumes such importance in a commercial relationship that it deserves to be analyzed apart and in several projects is very important that certain steps of the development be made close to the clients (ROCHA; MORAES; MEIRA, 2009), allowing, this way, a strong interaction.

The clients must be understood in their particularities, in order to be surprised by the product or service provided to them. A client whose expectative is met will buy again and make good publicity.

This way, the different local particularities of the group of clients must be understood. As said before, the local culture influences some behavior patterns (HOFSTEDE; HOFSTEDE; MINKOV, 1991). So, the distribution of a development team in such a way that their parts stand next to the client, will allow an easier understanding of its culture, preferences and tendencies, allowing also an stronger interaction between the development team and the

client, practice considered very important to the software development (COCKBURN, 2006).

2.3.4. DISTRIBUTED SOFTWARE TEAMS

Teams are defined, traditionally, as a group of people focused on reach a common objective and that, for this, acts on a collaborative way on the achievement of complementary tasks (LIPNACK; STAMPS, 2011). Salas *et al.* (1993) added to the characterization of teams the common values, the intense communication between the members, and the definition of the functions of each one of the parts.

In a scenery of strong competitiveness is essential the formation of teams. This fact explains one quality searched on the candidates for most of the job offers: teamwork. A team will not only aggregate more labor to the project; even if the knowledge of all the members is similar, the sum of the individual creativities can represent an important factor on the performing of the project activities. So, a team is more than a group of individuals. Within this setting, we can realize that the created synergy made that all the team become more intelligent than their members in an isolated context (SILVA, 2007).

To reach the synergy and make the team more effective is necessary to create a comfortable environment where the team spirit can be easily perceived. Characteristics like generalized participation of the members, open communication, controlled divergences, well-defined individual roles, frequent analysis of good and bad practices, among others; must be guaranteed (SILVA, 2007).

Moreover, come out the figure of the leader. He has the ability to direct the actions of the team in an adequate manner to guarantee the cited characteristics, creating the team spirit. The leader represents the central facilitation figure, in a way that his actions are always focused on the involvement of the team members, for this, he must be properly trained. Also, is important that the leadership function can be shared by the whole team, meaning that the figure of leader can be diluted between different team members, according to the circumstantial needs of the project and the qualifications of each member (SILVA, 2007).

Traditional software development teams have they members located on the same region, or physically next. This permits a great exchange of information, questionings and ideas (COCKBURN, 2006). When it comes to DSD project teams, some characteristics are added. As the own name says, DSD teams are disposed in a distributed way. This distribution can occur in different levels, from offices to continents (SIQUEIRA; SILVA, 2004). The main difference is that the DSD teams present low frequency of face-to-face interactions, and interact mainly by digital communication media (GOULD, 2011).

The distribution of a team reflects in an increase of the complexity involved on the activities of leadership and coordination of projects. Come out a series of challenges, like the physical distance, the time lag, and the cultural and language diversity inside the team. These challenges were approached on the section 2.3.2.

On the other hand, the technology is a strong facilitation element to the functioning of projects of distributed teams. Its evolution, mainly on the communications area, reflected on the diminution of the negative impact caused by the distribution of the elements of a team on the progress of its projects (COSSULIN, 2007). With facilities like email, chats, videoconferences and the internet as a whole; is possible to strength the relationship of the team members separated by geographic barriers (FISHER; FISHER, 2011).

Despite the technology represents an essential element on DSD sceneries, is important to realize that organizations are driven by people (FISHER; FISHER, 2011). Because of this, is primarily important either the formation of a team with convenient qualities for the profile of DSD projects, and an efficient management of this team, considering the specific needs and challenges involved in a distributed project.

2.3.4.1.MOTIVATION OF DSD TEAMS

As previously discussed, DSD projects involve a series of challenges, some of these impacting directly the motivation of the team. From the survey done by Beecham *et al.* (2007) some of the motivational factors for software development teams can be minimized, or even nullified, because of the team distribution. The intense contact with other team members and the

participation on the decision making are some examples of these motivational factors.

To minimize the negative impacts that the distribution of a team can exert on its motivation, actions must be done to valorize the motivational factors which can be enhanced or even created from the team distribution.

However, the efficiency of certain factors on the motivation of a team can differ according to cultural factors (OLSON; OLSON, 2004). To perceive the differences and to act considering the peculiarities of each culture is responsibility of the team leaders, on their different levels (CASTRO; MARIA, 1999). Moreover, as Cossulin (FISHER; FISHER, 2011) says, the efficiency of the motivating factors can vary from person to person, and even from situation to situation. This way, is important the existence of leaders aware not only of the cultural details, but also, of the particularities of their followers, to, through motivation, enhance their strengths (CASTRO; MARIA, 1999).

Schweiger, Atamer and Calori (2003), cite that a team can be composed by a series of sub teams, and that any one of these must have a key member, whose exerts the role of leader and integrator of the sub team to the main team. The existence of key members permits that they know more deeply the followers and the cultural context where they are inserted, permitting to use more specific motivational techniques and reach a higher efficiency. The Figure 25 schematizes the idea of sub teams.

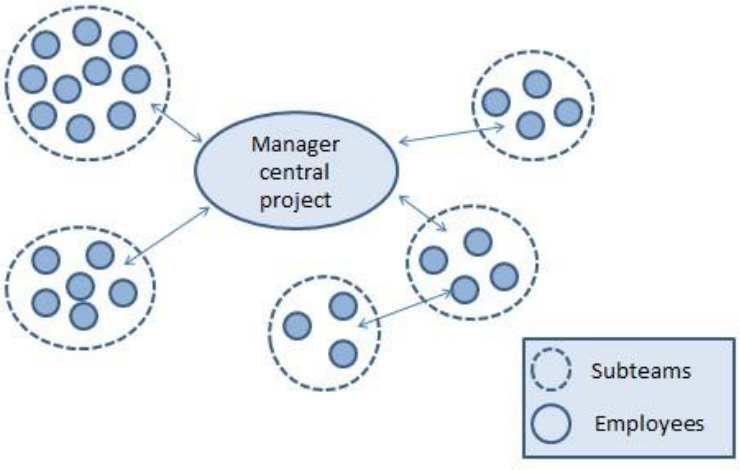

Figure 25 - DSD Project team divided in sub teams. Source: Adapted from Schweiger; Atamer and Calo.

2.4. COMMUNICATION IN DSD PROJECTS

The communication management in projects is a process that is as important as any other process in companies. Recognizing the communication as a process, knowing its elements, and the forms of communication and the involved parts, is the first step to the implementation of an efficient management system. A project can produce knowledge in the company if the produced information and data are treated in an efficient and professional way. The produced knowledge can come as a diferential in the Market, when it becomes an active it can be reused by the company in the management of other projects.

The communication of the Project has always been and will always be an important ingredient in the formula for its success. The PMBOK Guide (PMI, 2013) considers the area of knowledge “communication” vital for the project and its success. As such, the management of the communication is considered one of the most important areas in the management of the projects, even though it’s very frequently neglected (CHAVES, 2006).

To put the communication management in projects to work, be them distributed or centralized, is necessary to obtain the adequate processes to assure an appropriate and opportune production, the gathering, the distribution, the storage and the basic control of the information of the project. The stakeholders must be conscious and accultured to send and receive coomunication in the “language” of the Project and they must also understand how communication affects the Project as a whole (MAYER, 1998).

With the great growing of DSD, teams have been confronting partners of different technical, social and cultural levels (HERBSLEB; MOITRA, 2001). The resolution of these differences locally is already very significative and complex, especially when there is a face-to-face communication due to the the differences of technical terms and jargons (DAMIAN; ZOWGHI, 2002). In a distributed development environment this problem is even greater since the means of communication such as e-mail, chats and phone calls are not as rich and complete as face-to-face communication (HERBSLEB; MOITRA, 2001).

As a new distributed software project starts, frequent communication is required to establish the definitions of the project (PERRY; STAYDEBNATER; VOTTA, 1994). In this context there are two complementary ways of

communication: formal and the informal. From the moment the communication is effectively present among the memebers and that the collaborative tools can provide synched informal communication, there will be an improvement in the perception of the virtual team, and this will start to create importante relationships of mutual trust in the remote communication (HERBSLEB; MOITRA, 2001).

The choice of a mean of communication for the accomplishment of certain tasks requires carefulness. For example, a manager must, regularly, transmit the view of the team for all the groups, in a way to contextualize the teams regarding the progress of the project. The chosen mean of communication must provide the highes levels of motivation and emotion (CARMEL, 2001). There are cases in which the synched communication can be less appropriate than the unsynched communication. For example, a certain member of the team arranges something with a colleague by telefone and later does not remember exactly what this arrangement was about, this way there is no history to confront the arrangement made by them. But if the whole process had been arranged via e-mail there would be a history to prove the arrangement that they made. In DSD, the communication is the basis to define how the information will be passed on to the *stakeholders* involved in the project.

There is not a rule for managing a distributed Project, however there are good practices that are relevant and help the projects reaching their goals. The communication follows the same model, i.e. good practices can auxiliate in the maturity of the project and support the development of the Project as a whole.

2.4.1 PROBLEMS RELATED TO COMMUNICATION IN DSD PROJECTS

With the great growing of the DSD, engineers, managers and businessmen have been having conflicts with partners of different technical, social and cultural levels (PRIKLADNICKI, 2009). The resolution of these differences locally is already very significative and complex, especially when there is face-to-face communication due to the diferent technical terms and jargons. In a software development distributed environment this problem is even greater, since the means of communication such as email, chats and phone calls are not as rich

and complete as face-to-face communication (FARIAS JUNIOR, 2009) (HERBSLEB; MOITRA, 2001) (DAMIAN; ZOWGHI, 2002).

As a new distributed software project starts, frequent communication is required to establish the definitions of the project (PERRY; STAYDEBNATER; VOTTA, 1994). In this context there are two complementary ways of communication: formal and the informal. From the moment the communication is effectively present among the members and that the collaborative tools can provide synched informal communication, there will be an improvement in the perception of the virtual team, and this will start to create importante relationships of mutual trust in the remote communication (HERBSLEB; MOITRA, 2001).

The choice of a communication media for the accomplishment of certain tasks requires caution. For example, a manager must, regularly, transmit the view of the team for all the groups, in a way to contextualize the teams regarding the progress of the project. The chosen communication media must provide high levels of motivation and emotion (CARMEL, 2001). There are cases in which the synched communication can be less appropriate than the unsynched communication. For example: a certain member of the team arranges something with a colleague by telefone and later does not remember exactly what this arrangement was about. This way there is no history to confront the arrangement made by them. But if the whole process had been arranged via e-mail there would be a history to prove the arrangement that they made. In DSD, the communication is the basis to define how the informatil will be passed on to the *stakeholders* that are involved in the project.

In distributed projects, the communication is the basis to define how the information will be passed on to the stakeholders involved in the project.

There isn't a rule for managing a distributed Project, however there are good practices that are relevant and help the projects reaching their fundamental goals: concluding it on the given time, within the costs and with quality.

Evaristo (2005) says that communication processes must be adapted to the characteristcs of each organization and can change in each step of the Project, as they can start including teams with different cultures. An effective

communication in distributed projects builds the trust among the collaborators of the teams.

2.5. CONSIDERATIONS OF THE CHAPTER

In this chapter, were presented the main concepts of the theoretical basis of this thesis.

About the Section 2.1, which approaches the communication, we can say that face to the new characteristics and functionalities of the communication media in the contemporary era, we perceived the need to support the concept of communication in cyberspace through an virtual communication model, guided by the literature of Claude Shannon and Warren Weaver “The Mathematical Theory of Communication” published in 1949. To this, we invested on a literature review about the human communicative process, including the main communication theories, the historical evolution of the main communication models and the technological convergence. In this sense, this literature review about communication, which sometimes reflects in a mediatic culture globally emergente, with proper identity and characteristics, but lacking of discussion in the academic scenery. Plus, the purpose of this section was to present a model for the virtual communication, contributing to the foundation of an eminent communicational theory for the cyberspace, to improve the distributed or strongly technology supported communication. Also, we highlight that the present study was published in a communication specialized magazine called Revista Ibero-americana de Ciências da Comunicação (TEIXEIRA, FERREIRA and FARIAS JUNIOR, 2014).

About the Section 2.3 we presented a general view about maturity and capacity models, highlighting types, properties and requirements to the conception of a new maturity and capacity model. In this section we perceived that, despite the existence of guides, books and norms which generate information to support the creation of a certain model, still exists a significative amount of models from the academy and industry that do not take these informations in account. In this sense, the model generated in this thesis aimed to follow the best practices suggested by the literature, as well as used of methodological rigour to the conceive of the same.

About the Section 2.4, we evidenced the main concepts and challenges about the DSD context. Some of these challenges are well known in the area of software engineering. However, these challenges are potentialized when inserted in this context (Examples: Requirement engineering, Project management, etc.) In front of this scenery, DSD had unchained other challenges, considered non-technicals (examples: cultural differences, time and geographic dispersion, etc.). So, adopt DSD can bring some benefits, like cost reduction, proximity to local markets or improve the time to market, among others.

Despite having 20 years, is still visible the immaturity of the DSD, because many areas or dimensions are still considered great challenges, even with the evolution of the communicational technologies. They are: geographical and time distance and cultural diversity. Still in this context, we cannot forget the already existent challenges of the software engineering which are enhanced in DSD, like: Development Process, Requirements, Communication Management, etc.

We believe this chapter contributes to the explicitation of the knowledge to support, guide, and serve as reference to other researchers which want to study some of these pillars of the research in question.

3. RELATED WORK

In this chapter, related works that address communication in distributed software development are presented and discussed. The related models serve also as inputs for the conception of the maturity model proposed in this thesis. Each related work was carefully studied aiming to understand the contributions of these models to the C2M model.

3.1 OSM (OFFSHORE STAGE MODEL)

Carmel & Agarwal (2002) proposed a maturity model called SITO (Source of IT Work Offshore) for IT organizations acting in offshore sourcing environments. The model is composed by four stages on which the organizations could be contextualized. In 2005, this model was updated, and from then on called OSM (Offshore Stage Model). The OSM model is composed by the following maturity levels: Offshore bystander, Experimental, Cost strategy, and Leveraging offshore (Figure 26). These levels are described below:

Level 1 – Offshore bystander: In this level, there are no offshore sourcing activities. Every type of IT demand is accomplished by the own organization.

Level 2 – Offshore experimenter: In this level, the organizations start to adopt (experience) the offshore development strategy. However, they still do not have a systematic control of what they are doing.

Level 3 – Cost strategy: the passage from the level two to the level three is labeled by a proactive behavior. This level consolidates the vision of using the offshore development as a channel for minimizing operational costs in a short term.

Level 4 – Leveraging offshore: In this level, the organizations adopt the offshore development as a business strategy. The authors of the OSM model affirm that the organizations in the level four almost have an huge experience in offshore sourcing, and therefore they choose in establish their own software development centers.

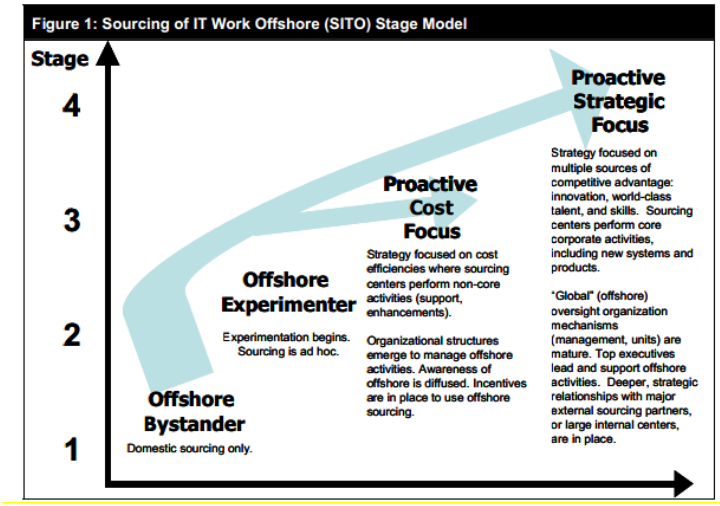

Figure 26 - The OSM model (CARMEL and AGARWAL, 2002).

The OSM model does not explore questions like the set of practices or software development processes that a company must have to figure in a certain level. Furthermore, there is no relationship between the levels proposed in the model and the way the organization works. So, the main question that arises is if exists the chance to reach highest degrees of offshore work, without having methodologies guiding the most operational activities behind every level. This way, the organization loses in terms of evolution of the organizational maturity.

3.2 OMM (OFFSOURCING MATURITY MODEL)

The model proposed by Morstead & Blount (2003) has as objective position the organizations on the maturity level of their processes, metrics, people, technology, and relationship. The main difference of this model is the relation on the investment cost in every maturity level. Furthermore, it is a model to manage the risks to redesign IT services and activities, with low cost and high quality. The model has five maturity levels: Staff augmentation, Turnkey, Integrated, Managed and Optimized.

Level 1 – Staff Augmentation: In this level the organization starts the contact of the organizations with the offshore business strategy in a very incipient way, with the only objective of increasing the number of people involved in the activities, but without increasing the costs.

This is achieved when there is the possibility to employ human resources of other countries. They are simply aggregated to the project, increasing the

chance of execution of the activities. There is almost none training for the people, because the organization understands that they are almost qualified to perform the designed function.

Level 2 – Turnkey: In this level, the organization develops offshore projects as an exercise to involve and start the work with the distributed teams. The infrastructure tends to be limited and there is little benefit in the short term. The main benefit is the development of the human capital for leadership positions in offshore environments.

Level 3 – Integrated: In this level, the head office start granting development , modeling and analysis activities. The offshore organizations are aligned with the business strategies of the head office. During this alignment, is normal that exist also initiatives to [aproximar] and integrate the geographically distributed teams.

Level 4 – Managed: In this level, many aspects of the Development capacity are moved for the offshore organizations, and the data collected for analysis purposes are considered as parameters for improvement of their processes. In this level, the focus is in the quality and speed of the developed product, as well as the quality of the used processes.

Level 5 – Optimized: In this level is assumed that the offshore organization is the most important part of the businesses in the head office. In addition, the head office starts to have more profitability, the human resources work without cultural, trust or coordination barriers. The author explains that the model is limited and imperfect, once it does not details or specifies objectives of activities in daily situations.

However, the OMM model aims to support the organization during the learning curve in relation to the offshore development. It focuses in the ability to distribute operations to work efficiently as part of the same organization or through a partner.

3.3 PMF (PROCESS MATURITY FRAMEWORK)

The maturity model proposed by Ramasubbu et al (2005) presents a set of 24 process areas with focus in the management of distributed software development projects. The authors believe that a company must evaluate the

investment in distributed software development not only in terms of cost reduction, but also in relation to the improvement of the final product as well as productivity targets. In addition to this, the same authors say that the models (CMMI or ISO 9001) do not consider processes needed to develop or assess distributed projects. For this reason, an organization must identify best practices to evaluate the adoption of DSD projects. Still according to the authors, the conceived model took as basis their practice experiences in the area and four concepts: collaboration readiness, mutual knowledge, coupling in work and technology readiness. The Figure 27 presents 24 process areas mapped in 3 maturity levels and in 4 presented concepts.

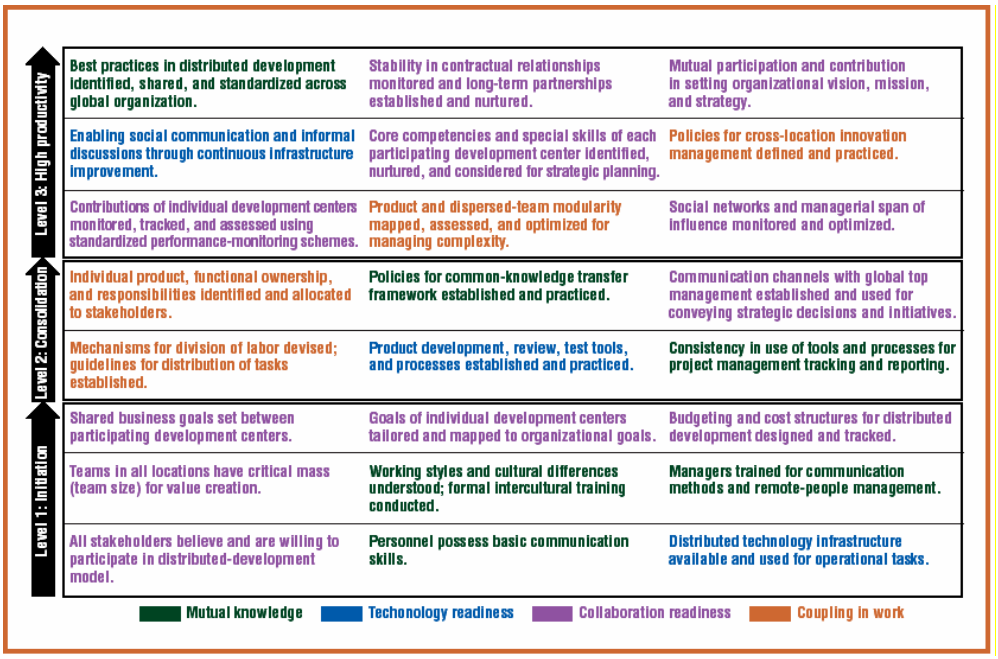

Figure 27 - Process areas of the Ramasubbu et. al. Model (2005).

Before the model is put in practice, interviews were performed having as objective the evaluation together with the execution of a focal group to make a review with a committee of specialists. This committee was composed by 34 executives randomly selected. In the evaluation, three process areas stayed below the minimum of 75% acceptable, generating a round of discussion with the selected committee, generating the final model. The model was implemented in some global software development teams of SAP, a multinational headquartered in Germany, with more than 28 thousand collaborators in more than 54 countries.

Table 8 brings a synthesis of the related work. The comparing criteria were selected from Pilatti (2006) work. The analyzed models bring significant results to the DSD projects, but there are still gaps to be treated. The present work defines a maturity model for communication in DSD (C2M) as a form of filling some of these gaps not attended by the models presented in this section. The C2M has its differential in the use of practices for the communication, seeking to improve the communicative process of the organization, clear identification of the needs for a more effective communication to support the success of the project.

Table 8 - Analysis Criteria for the Models

ID	Criterion	Description of the Criterion
1	Governance	This item verifies if the maturity model has support or indicative of governance over IT. Mainly in what concerns to DSD;
2	Process Maturity	This criterion identifies if the models describe the evolution of their processes. That is, if exists the need for maturation in the use of the processes;
3	Implementation and deployment	Identifies whether the model provides information for its correct implementation and deployment;
4	Alignment with other models	Verifies if the maturity model is aligned, or can be aligned, with other reference or maturity models.
5	Focus in the social aspect of the communication	This criterion aims to characterize if the analyzed model emphasizes the communication conceiving, for example, practices with their respective objectives described in DSD situations.

Source: Adapted from Pilatti (2006)

According to Pilattis (2006) structure analysis criteria is hard and give margin to many questions that can extrapolate the scope of any research. The same author still affirms that the aim is not to limit or restrict the researched models and compared to this set of analysis criteria. However, this preliminary formulation can serve as basis for future studies.

Aiming a better presentation of the data analysis, Table 9 was elaborated. In the header, it has the numeration of the respective criteria used in the critical analysis of the models. Based in Table 8, were used the numbers from 1 to 5 to represent the analyzed criteria. When the model contemplates the criterion, a symbol (√) is introduced in the relation model and criterion. When the model

partially contemplates the criterion, a symbol (±) is introduced in the relation model and criterion. When the symbol is not present, the model does not contemplate the analyzed criterion.

Table 9 - Comparative Analysis of the Maturity Models

Maturity Models	Analysis Criteria				
	1	2	3	4	5
OSM		√			
OMM	√	√		√	
PMF		√			±

Source: the Author

3.4 CONSIDERATIONS OF THE CHAPTER

The described models present gaps in what concerns implementation and deployment, so as in the social aspect of communication.

The OMM model has a significant relationship with the CMM. However, it is not shown where the dependences are. It demonstrated to be highly dependent on the CMM, being not possible to perform an evaluation only in relation to the maturity of the organization in what concerns to the offshore insourcing services. The OSM model does not specializes the relations in every maturity level with dimensions or process key areas that would exist in the organization. This way, is not possible to identify if the model attends the organization needs.

The PMF model presents a process area called Enabling Social Communication and informal discussions through continuous infrastructure improvement. However, it is still considered very incipient to treat a so complex area as is the communication.

In light of the above, the main differential of this research is the conception of a maturity model for the DSD communication. The model has as main focus the social aspect of communication.

4. STUDIES' RESULTS

This chapter describes the preliminary results of this thesis proposal. The results are related to SRL1, SRL2, Interview of Experts and focus groups (see Figure 2 in Section 1.3).

4.1 FACTORS AND EFFECTS OF COMMUNICATION IN DSD: A SYSTEMATIC REVIEW LITERATURE (SRL 1)

This study (Phase 2 of our methodological approach - presented in Section 1.3) aims at moving towards a consolidated knowledge about communication in distributed projects by developing a better understanding of which factors influence communication processes and which are the reported effects of this influence in DSD projects. For this thesis, the factors are like points that deserve attention and management to increase the chances to communicate satisfactorily (effectiveness and efficiency). To attend our goal, we conducted a systematic tertiary literature review (KITCHENHAM; CHARTERS, 2007) of communication in distributed projects. The review was guided by the following three research questions:

- RQ.1 What factors influence communication in Distributed Software Development projects?
- RQ.2 What are the effects of these factors in communication in Distributed Software Development projects?
- RQ.3 What factors identified in RQ.1 are related to the effects identified in RQ.2 in Distributed Software Development projects?

This consolidated knowledge can be a useful resource for researchers and practitioners looking for improving communication processes in such distributed settings.

4.1.2 REVIEW PROTOCOL

In this study we followed a tertiary review research methodology (KITCHENHAM; CHARTERS, 2007), which consists of conducting a systematic review of secondary studies. We present our methodology in details in this section.

The review protocol was developed based on the guidelines and procedures of a traditional Systematic Literature Review (KITCHENHAM; CHARTERS, 2007). This protocol specifies the basis for the study research questions, search strategy, selection criteria, and data extraction and synthesis. The protocol was mainly developed by one of the researchers and reviewed by two of the senior researchers aiming to mitigate any source of bias.

4.1.3 SEARCH TERMS

An extensive search process was conducted in order to identify papers and articles published between 2006 and 2010. This search combined an automatic search for the period of 2006 to 2010, and a manual search from the period of 2008 to 2010 in order to ensure the automatic search was covering all possible publications that attended our selection criteria. A manual search is relevant because it increases coverage by articles that were not identified in the automatic search did not identify. The manual search considered relevant conferences in the field as presented in Table I. To select candidate publications, we read the paper title and abstract of all returned papers of our manual search.

For the automatic search, the definition of the search terms to investigate the research questions was developed in three steps. First, keywords were identified based in the posed research questions. Second, synonyms for the keywords were defined. Third, the unique search string was built from the combination of keywords and synonyms (Communication, Systematic Literature Review and Distributed software development) in which the operators OR and AND were interchangeably used. The resulting search string is shown as follows:

> *"(Communication OR Communication Management) AND (Distributed software development OR Global software development OR Collaborative software development OR Global software engineering OR Globally distributed work OR Collaborative software engineering OR Distributed development OR Distributed teams OR Global software teams OR Globally distributed development OR Geographically distributed software development OR Offshore software development OR Offshoring OR Offshore OR Offshore outsourcing OR Dispersed teams) AND (Systematic Literature Review OR Systematic Review OR Systematic Mapping Study OR Systematic Mapping)".*

4.1.4 SEARCHED DATABASES

A broad search process was performed looking for peer-reviewed articles published between 2006 and 2010, combining the automatic search with manual search. Manual search was carried out at conferences and relevant sources (Table 10). Researchers analyzed the title of all articles published in each source used for the manual search. The criteria for selection of databases were: (1) search engines that use keywords, (2) the importance and relevance of research sources, and (3) availability of the sources to the authors. Therefore, the automatic search was conducted in the following databases: ACM Digital Library, IEEEXplore Digital Library, Elsevier ScienceDirect, El Compendex, and Scopus. To select a paper from the returning results of the automatic search, we read the paper title, keywords, abstract and conclusions or final considerations. We read the entire paper when necessary to better understand its content.

Table 10 - Manual search sources.

Agile Conference 2009 e 2010;
GSW 2009, 2010, 2011 – Global Sourcing Workshop;
ICGSE 2009 e 2010 – 4th e 5th International Conference on Global Software Engineering;
EASE 2010 - 14th International Conference on Evaluation and Assessment in Software Engineering;
SEAFOOD 2010 - Software Engineering Approaches for Offshore Software Development;
ESELAW 2008, 2009, 2010 - VII Experimental Software Engineering Latin American Workshop;
WDDS 2008, 2009, 2010 - IV Workshop de Desenvolvimento Distribuído de software;

Source: the author

4.1.5 INCLUSION AND EXCLUSION CRITERIA

Studies were selected for inclusion according to the inclusion and exclusion criteria presented in Table 11.

Table 11 - Inclusion and exclusion criteria.

Inclusion Criteria (all must apply)
Studies that described a systematic Literature Review about topics related to DSD; and
Studies that primarily or secondarily focus on the Communication in DSD; and

Studies which are available for access through the online library service.

Exclusion Criteria (any that applies)
Irrelevant studies which do not answer the research questions; or
Repeated studies: same article found in different sources; or
Duplicate case studies: same study published in different; or
Studies presenting in progress research or incomplete.

Source: the author

When a study had been published in more than one journal or conference, both versions of the study were reviewed for purposes of data extraction, and the first publication was used in all time-based analyses.

4.1.6 SELECTION PROCESS FOR SECUNDARY STUDIES

According to Kitchenham and Charters (2007), Travassos e Biolchini (2007), the initial searches show a large number of studies that are often not relevant as they usually do not answer the questions nor they have a relation to the topic at hand. Therefore, irrelevant studies are completely put aside at first. The complete study selection process was developed in four steps as presented Figure 28.

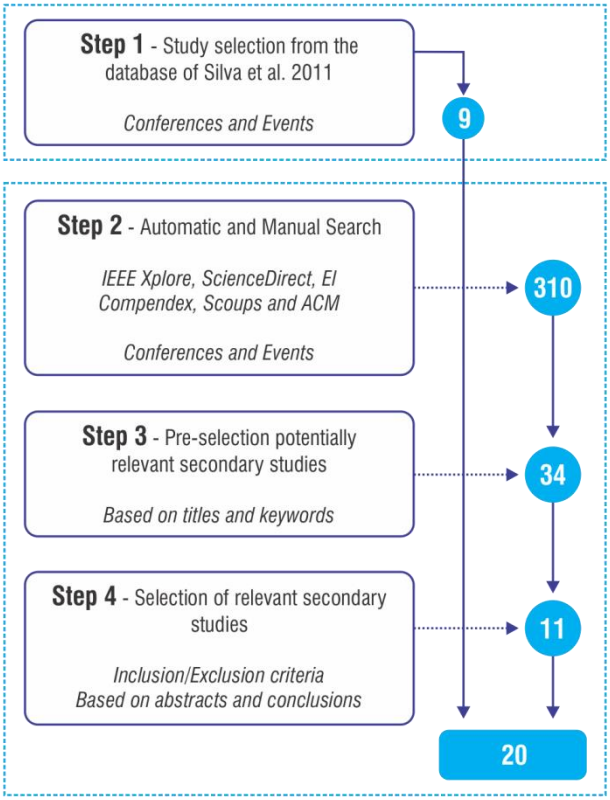

Figure 28 - Selection Process for Secondary Studies. Source: the author

As a result of our investigation, we selected 11 secondary studies. Nine additional papers from the DA SILVA, PRIKLADNICKI, FRANCA, MONTEIRO, COSTA, ROCHA(2011) pre-selection were added (step 1) totaling 20 studies. A unique identifier (SE1 to SE20) was assigned to each study. The list of studies is presented in Appendix B.

4.1.7 QUALITY ASSESSMENT OF THE SELECTED STUDIES

The 20 studies were independently assessed by two of the researchers using the same version of the criteria set by the Centre for Reviews and Dissemination (CDR) and Database of Abstracts of Reviews of Effects (DARE) from York University (AOYAMA, 1998). This version of the DARE criteria is based on four questions (refer to Table 12), which use the following levels of agreement or disagreement: 0 (not included), 0.5 (partly included), and 1 (totally included). The final quality index is calculated by the total sum of the four criteria scores (Appendix C). This index is also commonly used to display the strength of evidence for extraction and data synthesis.

Table 12 - Quality criteria.

1. Are the Inclusion/Exclusion criteria well described and appropriate?
2. Did the literature research potentially include all the relevant studies?
3. Did the included studies have their quality/validity assessed?
4. The studies were adequately describe or written?

Source: the author

In our research, each study was assessed independently by two researchers according to the four quality criteria. Each researcher provided scores for each criterion, so the final quality score was obtained by summing up the scores assigned to all four criteria. However, if there was a disagreement between the two researchers in a certain criterion, a third researcher was consulted. The complete results of quality assessment are presented in Appendix D.

The table 13 presents the results of the automatic and the manual searches. The significant manual search number results shows that the combination of automatic and manual search strategies is essential to ensure coverage on systematic reviews and mapping studies, as can be seen in (PRIKLADNICKI; MARCZAK; CONTE, 2011).

Table 13 – Search strategies, sources and number of secundary studies.

Search Strategy	Source	Search Results (a)	Potentially Relevant (b)	No Access	Not Relevant	Repeated	Incomplete	Relevant Studies (c)
Automatic	IEEEXplore	83	7	0	2	0	3	2
	ScienceDirect	100	5	0	0	4	0	1
	EI Compendex	7	5	1	1	1	0	2
	Scopus	15	6	1	2	3	0	0
	ACM	5	3	2	0	1	0	0
Manual	Conferences and Events	100	8	0	2	0	0	6
	Total	**310**	**34**	**4**	**7**	**9**	**0**	**11**

Source: the author

The Table 14 summarizes the quality assessment according to the four quality criteria.

Table 14 - Summary of quality assessment of secundary studies.

Study Ref	Quality Score	Mininum Score	Maximum Score
SE_05, SE_11, SE_14, SE_18, SE_20	4 3,5	3,5	4
SE_07, SE_08, SE_10, SE_13, SE_15, SE_19 SE_02, SE_12,	3 2,5	2,5	3
SE_04, SE_06, SE_16, SE_17 SE_03	2 1,5	1,5	2
SE_01, SE_09	1	0,5	1

Source: the author

4.1.8 DATA EXTRACTION

To back up and register data and to conduct the subsequent analysis of extracted data, we used the Mendeley tool. Mendeley is a Web-based reference manager. The following information was extracted from each article: publication year, authors, and the country where the research was conducted.

4.1.9 DATA SYNTHESIS

The data synthesis process was based on the constant coding and comparison methods (DE SOUZA; BASAVESWARA; REDMILES, 2002), where the studies transcriptions have a code for a given factor/effect and make up a specific category. As the data were identified, they were removed and given a unique identifier (Category – C1...Cn/ Factor – F1...Fn / Effect – E1...En/ Secondary Study – SE/ Articles – A1...An).

The method of data analysis and synthesis through constant coding and comparison and Grounded Theory (GT) (PRIKLADNICKI; AUDY, 2006), where the studies transcriptions have a code for a given factor/effect and make up a specific category. This process began by marking key points of each secondary study transcription, being assigned a code to each key point. A code is represented by the secondary study reference, factor or corresponding effect, study page and paragraph in which the transcription was identified (E.g. 01).

The data analysis process for the factor F9, Lack of face-to-face interaction, is exemplified in Figure 29. This factor refers to the lack of presencial meetings between teams within a project. The Figure 29a illustrates how the evidence F9 arose from the underlying concepts and the Figure 29b shows the data abstraction levels used as reference.

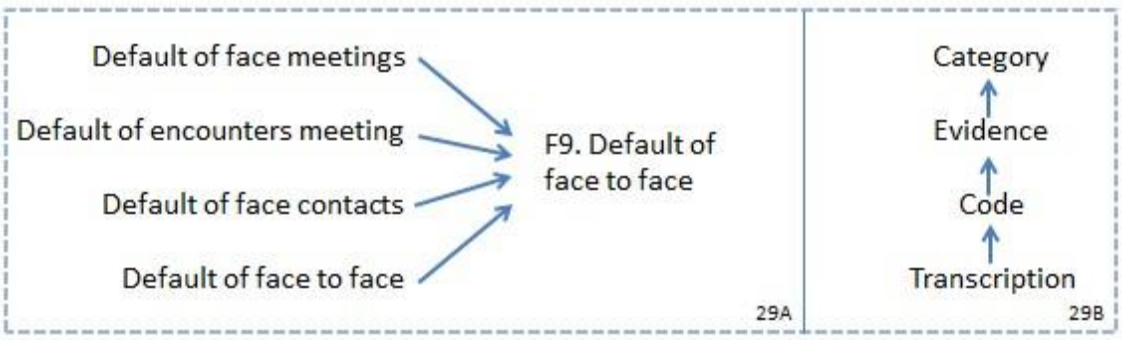

Figure 29 - (A) Emergence of the evidence from the concepts / (B) Levels of abstraction. Source: the author

The synthesis of the results was organized in tables, which show the occurrence frequency of the evidence.

4.1.10 VALIDITY THREATS

The most common systematic literature review limitations are: the possible biases introduced in the selection process and the data extraction inaccuracies. These are also the possible main limitations of this study. The developed research protocol is the measure taken to avoid the studies selection bias. The combination between automatic search on multiple search sources and manual search improves the exposure of the selection process, reducing a possible bias. In all the stages, The processes of Research and selection were performed by at least two researchers, and the conflicts in the selection process have been solved either by a third party or by consensus meetings.

The data extraction is also considered a challenge due to the great diversity in form, style and content of the analyzed secondary studies. There was little structure and content standardization, what led to the possible inaccuracy in the data extracted from secondary studies. In several studies, important data were not explicitly presented, forcing the information reading, thus making possible the inaccuracy in the data extracted from the secondary studies. To minimize the effects of the lacking of standardization of the data extracted, the researchers conducting this process adopted a coding scheme that allowed them to comment of the data extracted for future alignment of discrepancies. A senior researcher also extracted a small sample of data and contrasted his analysis to the other two researchers. Discrepancies were discussed in during several alignment meetings improving the understanding of the researchers on the limited data available.

4.1.11 FINDINGS

A total of 29 factors that influence communication in distributed software development were found in literature. Similarly, a total of 25 effects caused by these factors were found. The identified effects were mapped to the possible factors and are also discussed here in details.

4.1.12 RQ.1 FACTORS THAT INFLUENCE COMMUNICATION

We identified 29 factors that influence communication in distributed projects. These factors were grouped according to the following categories: human factors (38%, 11/29), Location and infrastructure (17%, 5/29), and Processes and technology (45%, 13/29). The identified factors, which answer RQ.1, are

listed in Table 15. The first column identifies the category, the second column lists the factor itself, and the third column identifies the total of studies that refer to the factor. It is important to note that each occurrence of a certain factor was given the same weight, thus the number presented merely reflects how many times a given factor was mentioned. The number does not imply how important the factor might be.

Table 15 - Factors of process communication in DSD projects.

Categories	Factors (F1- F29)	Number of studies (%)
C1. Human Factors	F1. Cultural Differences	8/20 (40%)
	F3. Language / Linguistic Barriers	7/20 (35%)
	F5. Coordination	6/20 (30%)
	F6. Visibility / Perceiving	6/20 (30%)
	F7. Informal Communication limited	6/20 (30%)
	F17. Awareness Team	2/20 (10%)
	F18. Communication skills	2/20 (10%)
	F19. Reduced Contact Networks	2/20 (10%)
	F20. Definition of roles and responsibilities	2/20 (10%)
	F27. Size of Personal Networks	1/20 (5%)
	F29. Social Relations weak	1/20 (5%)
C2. Location and Infrastructure	F2. Geographic dispersion	7/20 (35%)
	F4. Temporal distance	6/20 (30%)
	F8. Infrastructure	5/20 (25%)
	F9. Lack of face-to-face	5/20 (25%)
	F21. Synchronization of Work Schedules	1/20 (5%)
C3. Processes and Technology	F10. Definition of Media Communication (synchronous and asynchronous)	5/20 (25%)
	F11. Application of Agile Approaches	4/20 (20%)
	F12. Selection of Communication Technologies	4/20 (20%)
	F13. Distribution of tasks	4/20 (20%)
	F14. Collaboration Tools	4/20 (20%)
	F15. High-Bandwidth	2/20 (10%)
	F16. Communication Standards	2/20 (10%)
	F22. Number of Distributed Teams	1/20 (5%)
	F23. Communication Policy	1/20 (5%)

F24. Different Communication Styles	1/20 (5%)
F25. Collaboration Models	1/20 (5%)
F26. Multiple Communication Channels	1/20 (5%)
F28. Translation Process and Coding	1/20 (5%)

Source: the author

4.1.13 RQ.2 EFFECTS OF THE IDENTIFIED FACTORS IN COMMUNICATION PROCESSES

A total of 25 effects were identified in our literature review. These effects were also grouped according to the categories defined for the factors categorization. The results are as follows: 6 out of the 25 effects belong to the Human factors category (24%), 4 belong to the Location and infrastructure category (16%), and 15 belong to the Processes and technology category (60%).

These effects were further classified according to their impact to the communication process. This classification is defined as negative effects, which are associated with non-effective communication (NEC) and positive effects, associated with Effective Communication (EC). Table 16 shows our findings for RQ.2.

Table 16 - Effects of process communication in DSD projects.

Categories	Classification	Effects	Number of studies (%)
C1. Human Factors	EC. Effective Communication	E8. Personal Relationships	3/20 (15%)
		E25. Ripening Team	1/20 (5%)
	NEC. Non-Effective Communication	E1. Uncertainties, misunderstandings and misconceptions	7/20 (35%)
		E3. Lack of Confidence	5/20 (25%)
		E21. Lack of team cohesion	1/20 (5%)
		E23. Low creativity	1/20 (5%)
C2. Location and Infrastructure	EC. Effective Communication	E14. Collaboration of the teams	2/20 (10%)
	NEC. Non-Effective Communication	E16. Absence of Synchronous Communication	2/20 (10%)
		E18. High Number of Failures	2/20 (10%)
		E22. Low performance	1/20 (5%)
C3. Processes and Technology	EC. Effective Communication	E4. Quality of Communication	4/20 (20%)
		E6. Survey Process Requirements	3/20 (15%)
		E7. Sharing knowledge	3/20 (15%)

	E10. Distributed Project Management	2/20 (10%)
	E17. Project Success	2/20 (10%)
	E19. Feedback using Scrum	2/20 (10%)
NEC. Non-Effective Communication	E2. Limited Information Sharing	6/20 (30%)
	E5. Delay of Responses	4/20 (20%)
	E9. Ambiguity of Information	3/20 (15%)
	E11. Reduced Productivity	2/20 (10%)
	E12. Software Defects	2/20 (10%)
	E13. Reduced Frequency of Communication	2/20 (10%)
	E15. Loss of Information	2/20 (10%)
	E20. Restriction of Communication	1/20 (5%)
	E24. Low Quality of Decision	1/20 (5%)

Source: the author

It is important to highlight that most of effects are categorized either as a "Human Factors" or a "Processes and Technology" factor. Of the 25 identified factors, 21 are related to these two categories. In addition, 16 (out of the 25) effects (64%) are classified as negative, i.e., they contribute to non-effective communication (NEC).

4.1.14 RQ.3 THE RELATIONSHIP BETWEEN THE FACTORS AND THE EFFECTS

This question sought to relate the main factors that cause the effects identified in the communication process in DSD projects. Out of the 29 identified factors, 25 were associated with 23 (out of the 25) of the identified effects.

More than one effect can relate to the same factor in the relationship between factors and effects, as well as more than one study can relate to the same effect to a given factor. In other words, based on the studies were identified secondary factors that are related to the effects. This relationship has been mapped from the citations identified by the studies side, which references are some factors that cause some effects as can be seen in Figure 33.

The Table 17 presents the relationship between factors and effects.

Table 17 - Relationship between factors and effects.

Factor	Effect	References – ES: Secondary	Number of Studies

		Studies	(Reviews) (%)
F1. Cultural Differences	E1. Uncertainties, misunderstandings and misconceptions E2. Limited Shared Information E3. Lack of Confidence E16. Absence of Synchronous Communication	SE_02; SE_04; SE_05; SE_11.	4/20 (20%)
F2. Geographic Dispersion	E1. Uncertainties, misunderstandings and misconceptions E2. Limited Shared Information E3. Lack of Confidence E5. Delay of Responses E13. Reduced Communication Frequency E15. Loss of Information	SE_03; SE _04; SE _05; SE _15; SE _18; SE _19	6/20 (30%)
F3. Language/ Linguistic Barriers	E1. Uncertainties, misunderstandings and misconceptions E2. Shared Limited Information E3. Lack of Confidence E13. Reduced Communication Frequency	SE _04; SE _05; SE _18	3/20 (15%)
F4. Temporal Dispersion	E5. Delay of Responses E13. Reduced Communication Frequency E20. Restriction of Communication	SE_05; SE _06; SE_15; SE _18	4/20 (20%)
F5. Coordination	E2. Limited Shared Information E5. Delay of Responses E7. Shared Knowledge E14. Team Cooperation E18. High Number of Failures E22. Low Performance	SE_02; SE_05; SE_18	3/20 (15%)
F6. Visibility / Perception	E2. Limited Shared Information E6. Requirements Acquisition E7. Shared Knowledge E10. Distributed Projects Management E13. Communication Frequency Reduced	SE_02; SE_03; SE_12; SE_17; SE_18	5/20 (25%)
F7. Informal Communication Limited	E3. Lack of Confidence E6. Acquisition of Requirements E8. Personal Relationship E10. Distributed Projects Management	SE_02; SE_03; SE_05; SE_15; SE_18	5/20 (25%)

	E23. Low Creativity E24. Low Quality of Decision		
F8. Infrastructure	E2. Limited Shared Information E4. Quality of Communication E11. Productivity Reduced E13. Communication Frequency Reduced E15. Loss of Information E20. Restriction of Communication	SE_02; SE_05; SE_06; SE_15	4/20 (20%)
F9. No *face-a-face* Interaction	E1. Uncertainties, misunderstandings and misconceptions E2. Limited Shared Information E3. Lack of Confidence E8. Personal Relationship	SE_04; SE_05; SE_15; SE_18; SE_20	5/20 (25%)
F10. Definition of Media Communication (synchronous or asynchronous)	E4. Quality of Communication E6. Requirements Acquisition E9. Ambiguity of Information E10. Distributed Projects Management	SE_03; SE_05; SE_08; SE_17; SE_18.	5/20 (25%)
F11. Application of Agile Approaches	E3. Lack of Confidence E6. Requirements Acquisition E19. Regular Feed-back regular using Scrum	SE_07; SE_18	2/20 (10%)
F12. Communication Technologies Selection	E2. Limited Shared Information E4. Quality of Communication E7. Shared Knowledge E8. Personal Relationship E10. Distributed Projects Management E14. Team Collaboration E15. Loss of Information E17. Project Success E25. Ripening Team	SE_02; SE_04; SE_05; SE_08; SE_13; SE_15; SE_19	7/20 (35%)
F13. Tasks Division	E1. Uncertainties, misunderstandings and misconceptions E7. Shared Knowledge E17. Project Success E8. Personal Relationship	SE_05; SE_18	2/20 (10%).
F14. Collaboration tools	E4. Quality of Communication	SE_02; SE_06;	3/20 (15%)

	E7. Shared Knowledge E8. Personal Relationship E10. Distributed Projects Management E17. Project Success E19. Regular Feedback using Scrum	SE_18	
F15. High-Bandwidth	E4. Quality of Communication E10. Distributed Projects Management	SE_05; SE_06	2/20 (10%)
F16. Communication Patterns	E1. Uncertainties, misunderstandings and misconceptions E2. Limited Shared Information E5. Delay of Responses	SE_02; SE_05	2/20 (10%)
F17. Awareness Team	E2. Shared Information Limited E12. Software Defects	SE_02; SE_05	2/20 (10%)
F18. Communication Skills	E2. Limited Shared Information E4. Quality of Communication	SE_02; SE_18	2/20 (10%)
F19. Contact Networks	E11. Productivity Reduced E13. Communication Frequency Reduced	SE_02; SE_17	2/20 (10%)
F22. Number of Distributed teams	E3. Lack of Confidence	SE_01	1/20 (5%)
F23. Communication Policy	E19. Regular Feedback using Scrum	SE_06	1/20 (5%)
F24. Different Communication Styles	E1. Uncertainties, misunderstandings and misconceptions	SE_03	1/20 (5%)
F26. Multiple Communication Channels	E4. Quality of Communication	SE_06	1/20 (5%)
F27. Size of Personal Networks	E11. Productivity Reduced E13. Communication Frequency Reduced	SE_02	1/20 (5%)
F29. Weak Social Relations	E3. Lack of Confidence	SE_05	1/20 (5%)

Source: the author

4.1.15 SUMMARY OF THE MAIN FINDINGS

RQ.1 sought to identify the main factors that influence communication in distributed projects. Based on the 20 secondary studies analyzed, we identified 29 factors grouped into three categories (Human Factors, Location and Infrastructure, Processes and Technology).

RQ.2 sought to identify the main effects. These effects were classified in the same categories as in the factors. In addition, they were also categorized as their

impact in the effectiveness of communication (uncertainties / misconceptions , sharing of information limited , lack of confidence, quality of communication and delay of answers). Finally the RQ.3 sought to relate the main factors that cause the effects identified in the communication process of DSD projects. From the studies examined side of the 29 factors identified, 25 were related to 23 of 25 effects identified in our study. Figure 30 represents graphically the relationship between the factors and their identified effects according to the quality index of each study. The quartiles divide the dataset into four equal groups, each representing a fourth of the population being sampled. The relationship between factors and effects, highlighting the factors that are related to specific effects, according to the evidence identified in their respective secondary studies. The quality index is indicated in the circle center.

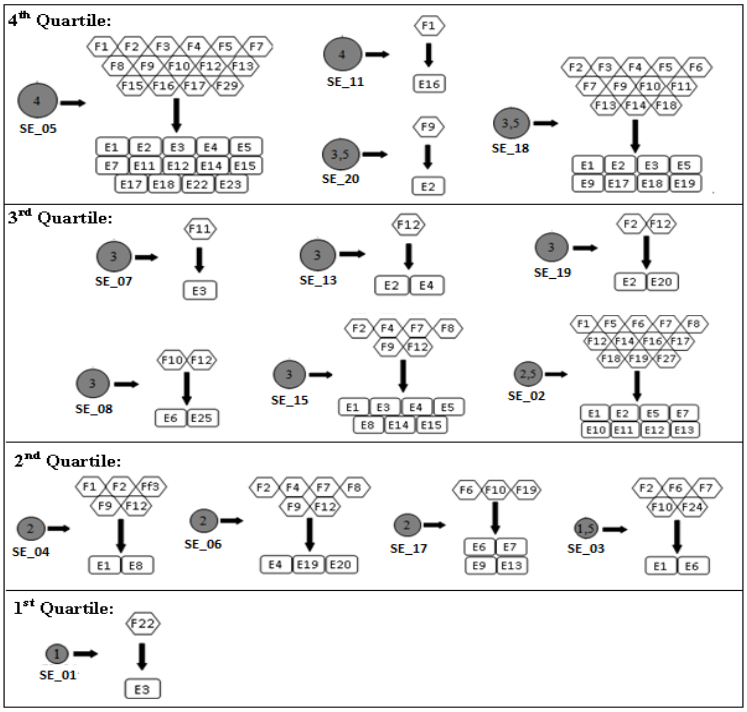

Figure 30 - Mapping the relationship between factors and effects by category. Source: the author

As seen in Table 14, the main challenges for the communication process in DSD projects are Cultural Differences, Geographic dispersion, Language / Linguistic Barriers, Temporal distance and Coordination. Therefore, these five Challenges are strong candidates to receive attention from researchers and practitioners in DSD.

The effects are the results of the communication effective or ineffective, such as: Uncertainties, misunderstandings and misconceptions, Limited Information Sharing and Lack of Confidence related to Non-Effective Communication;

Personal Relationships and Communication Quality related to Effective Communication, where 64% (16/25) of the effects are classified as Non Effective Communication, due to the difficulties presented in the communication process in distributed environments.

Consistently, the vast majority of evidence 86% (25/29) of the factors are related to 92% (23/25) of the effects identified in 20 studies, showing that other researchers should emphasize the evidence identified in order to overcome the problems related to the communication process.

4.2 INTERVIEWS WITH DSD PROFESSIONALS

The empirical research is centered (Phase 3 of our methodological approach - see Section 1 - Figure 2) in the choice of aspects of the relation between subjects. It aims the process of interaction and face-to-face, that is, the researcher cannot elaborate the research “in laboratory” or in a library isolated with only books around him. In this modality of the knowledge elaboration, the researcher must “go to the field”.

The empirical study with 31 professionals was developed in twelve units of software development companies. The objective of this study was to understand the challenges of the communication, identify the factors with more priority, as well as the communication practices adopted in the DSD context. The research participants were geographically distributed as follows: One professional was located in Canada, five in the United States, and Twenty-five in Brazil, in the following states: Paraíba, Pernambuco, Rio Grande do Sul e São Paulo. An effort was made to understand the relevance order of the factors, as well as to classify them in maturity levels to the conception of the first version of the C2M model.

4.2.1 SELECTION OF THE ORGANIZATIONS AND UNITIES OF ANALYSIS

The unit of analysis of the study was defined as being professionals of organizations involved in DSD projects.

Professionals of twelve organizations were selected (C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11 e C12), and they all provided their professionals with unrestricted access to the questioned information. Some organizations only liberated the professionals to the interview after the signature of a

confidentiality agreement. In the Section 4 the results found in the empirical research in this step are detailed.

4.2.2 DATA SOURCE AND SELECTION OF THE PARTICIPANTS

The data collection was conducted by primary sources. The primary sources were constituted by interviews. 12 semi-structured in-depht interviews were performed. They started with a basic script with questions formulated for the interviewed and adjusted according to its conduction. The table 18 shows the time spent with the data collection in every company.

Table 18 - Data collection time.

Company	Interview Time	Number of interviewed people	Language
C1	1h 15 min	1	Portuguese
C2	1h 05 min	1	
C3	1h 30 min	1	
C4	1h 05 min	1	
C5	1h 15 min	1	
C6	1h 25 min	1	
C7	3h	2	
C8	1h	1	
C9	1h	1	
C10	2h 35 min	2	
C11	9h 30 min	10	
C12	8h 20min	9	
Total	**33h**	**31**	

Source: the author

In the beginning of the study, every professional was invited and the agreement of the organizations they work to the participation in the research was asked. Every professional in accordance with the organization answered the invite with the acceptance to make part of the research. However, some companies demanded a confidentiality term to liberate the professional to the interviews. All the interviews were recorded and transcript with the authorization of the professionals

The initial criterion to the definition of the respondents was centered mainly in the objectives of the study. In this sense, the population direct or indirectly involved was constituted mainly of collaborators in two levels: management and operational. In the management level, was sought the vision of managers with knowledge sufficient to respond questions about the project management in the DSD context and the interaction between unities and/or subsidiaries (if they exist). In the operational level, was sought the vision of the

technical leaders and software developers, with enough knowledge to answer questions about the several projects developed in the company they work.

4.2.3 DATA COLLECTION TOOLS

The data collection tools consisted of a script to semi-structured interviews (Appendix E), with open and non-inductive questions. The interviews were organized to identify challenges, main communication factors of the technical and non-technical parts.

4.2.4 DATA ANALYSIS

In relation to the data analysis, all the interviews were recorded, transcript and after analyzed, through content analysis according to Coutinho (2005). At first, the data was prepared; after the transcriptions, a careful reading was performed, seeking the familiarization of the researcher with the data before starting the codification of the categories. Next, the texts were codified, following two steps.

The first step involved the classification of a subset of the texts in one of the following categories: maturity factors of the communication and good practices in DSD communication (Figure 31).

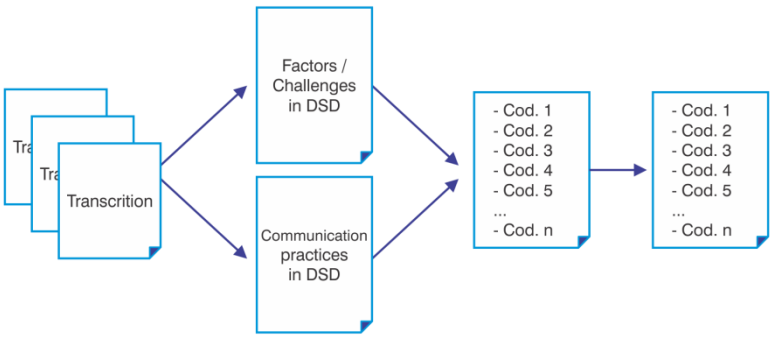

Figure 31 - Data analysis. Source: the author

Microsoft Excel and the Weft QDA (http://www.pressure.to/qda/) were used as data analysis tools.

4.2.5 CONDUCTION OF THE STUDY

The research performed with the thirty-one respondents of the twelve organizations allowed to develop the proposed study as planned. It involved the contacts, aiming to develop the in-depth interviews, and the organizations, which made available the physical space conditions and the support to the

research. The linking of this research with the GP2 group, of the Federal University of Pernambuco – UFPE helped this process.

In the organizations, the contact occurred between the researcher and the collaborators of the organizations. After this initial contact, was performed a meeting to present the study protocol and obtain the approval to perform it. With the approval obtained, was possible to begin the research and perform the interviews.

The research tool (semi-structured script) was developed based on an initial script of questions, parting from the theory studied and represented in the research protocol developed for the study. Successive refinements were performed until the partial version of the script. Then, the validation of face and content was performed by two senior researchers (doctors), one in Rio Grande do Sul and other in Pernambuco.

The next activity was the execution of the pilot interviews, also known as pre-test. Two interviews were performed; one with a project manager directly involved in DSD projects with national dispersion level and other with a software developer with global dispersion level. With the application of the pilot, was possible to discover the weaknesses and eliminate ambiguities, choosing also the formulation of the questions most coherent to the research objective. Before the interviews, adjusts in the script were done and, next, the final version of it was defined to carry on the study. After the adjust on the instrument based in the pre-test, the interview phase started.

Interviews with thirty-one professionals were defined, selected by convenience. All the interviews were previously scheduled and transcribed after they occurred. Aiming to ensure the quality of the data, six respondents were contacted again to clarify some points where the researcher had doubts.

With the transcriptions in hands, was performed the qualitative analysis of the data. At first, was performed an analysis of the content, where were defined the preliminary categories. This process was developed by the researcher and after consolidated with the Adviser and co-Adviser, defining a set of categories to be considered.

4.2.6 RESULTS OF THE STUDY

The participants were managers, leaders and software developers acting in DSD projects. In the beginning of the interviews, were obtained information about the academic formation, experience in DSD projects, among other information. The participants were selected in function of their roles in the project.

The respondents have, in average, 6 years of experience in DSD. The average age was 36 years, being the minimal age 27 years, and the maximum age 54 years. Most of the respondents have between 30 and 40 years. The interviews lasted an average of 1h 04 minutes and counted with total availability and attention of the participants. About the dispersion level of the projects, 52% were classified as Global, and 48% as National (Figure 32).

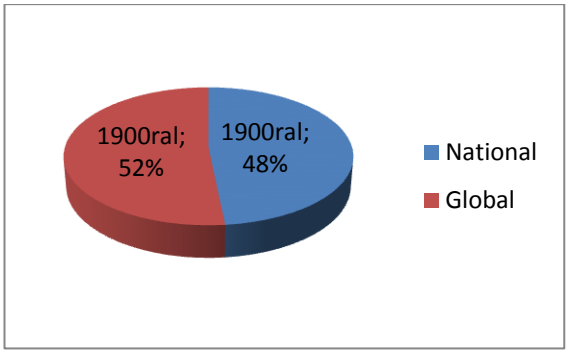

Figure 32 - Types of dispersion of the projects. Source: the author.

The information was provided always respecting the privacity and confidentiality policies of the project they were involved. In relation to the formation level, all the interviewed are from the computing area, and post-graduated. On the table 19, more details are presented.

Table 19 - profile and distribution of the respondents.

Company(C)	Respondents (R)	Area of Work	Experiência em DSD	Nível de Dispersão
C1	R1	Software Developer	9 years	National
C2	R2	Software Developer	8 years	National
C3	R3	Project Manager	4 years	National
C4	R4	Project Manager	3 years	National
C5	R5	Project Manager	6 years	National
C6	R6	Technical Leader	8 years	National
C7	R7	Project Manager	10 years	Global
	R8	Software Developer	5 years	Global
C8	R9	Software Developer	3 years	Global

C9	R10	Project Manager	3 years	Global
C10	R11	Project Manager	4 years	Global
	R12	Software Developer	3 years	Global
C11	R14	Project Manager	7 years	National
	R15	Project Manager	5 years	National
	R16	Project Manager	7 years	National
	R17	Test Analyst	5 years	National
	R18	Test Analyst	4 years	National
	R19	Software Developer	9 years	National
	R20	Software Developer	6 years	National
	R21	Software Developer	4 years	National
	R22	Software Developer	3 years	National
C12	R23	Technical Leader	8 years	Global
	R24	Technical Leader	8 years	Global
	R25	Technical Leader	6 years	Global
	R26	Project Manager	7 years	Global
	R27	Project Manager	7 years	Global
	R28	Project Manager	3 years	Global
	R29	Test Analyst	9 years	Global
	R30	Test Analyst	8 years	Global
	R31	Test Analyst	8 years	Global

Source: the author

4.2.7 TOOLS USED IN DSD PROJETCS

The graph represented by the Figure 33 shows the intensity of use of the communication tools in the DSD projects. The question whose answers resulted in this graph permitted the participants to cite the tools used in communication on the DSD projects they participated. In the figure 36, is possible to realize that e-mail and telephone still are the most used communication tools in DSD projects.

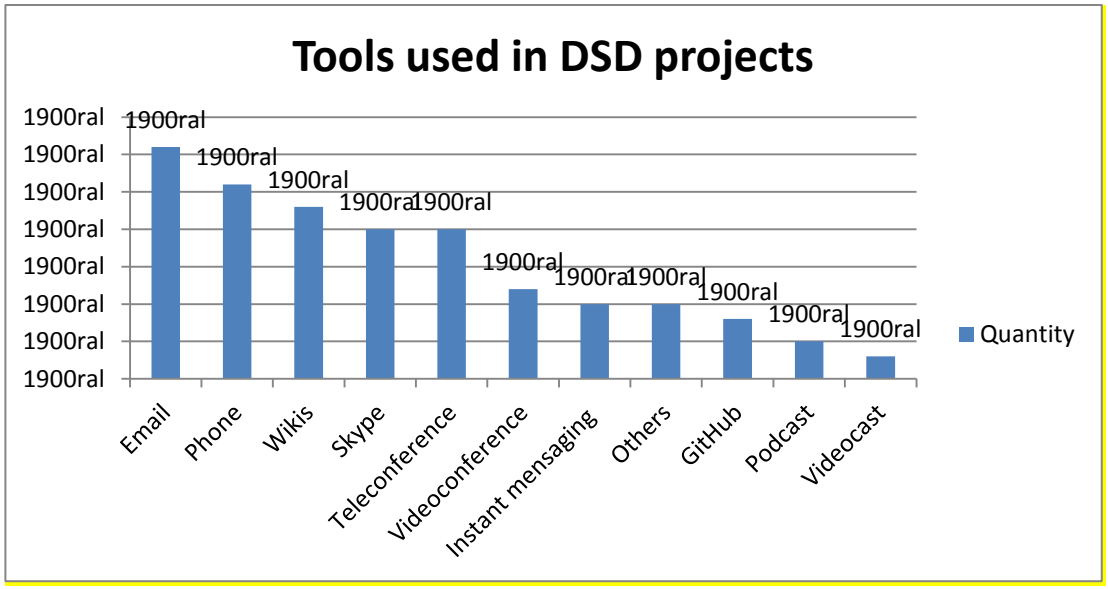

Figure 33 - Tools used in DSD Projects. Source: the author

The participants of this study affirmed that most of the tools used in their projects are proprietary. 22 respondents said that the DSD projects where they work used mainly paid tools, because of their maturituy for the professional use. Furthermore, the participants said that in the companies where they worked or work with DSD the used tools were often mature (with more than 3 years of market).

4.2.8 FACTORS WHICH AFFECT THE COMMUNICATION IN DSD PROJECTS

According to the analysis of the collected data, can be said that the factors (considered challenges) of the DSD communication, according to the 31 respondents of the 12 companies, are centered in the absence of the understanding of the activities, absence of mechanisms (guides, processes, models) to the planning of the communication in projects, lack of standardization of the activities between the distributed teams and the absence of a well-defined process reflecting in the requirement engineering activities. Plus, also were verified factors in relation to language barriers, cultural differences, among other (Table 20).

Table 20 - Factors identified in the empirical study.

Communication Factors	Respondents (R)
Provide project results to the high management	R1, R2, R4, R5, R6, R9, R10, R11, R12,R13,R20,R22,R30
Requirement Elicitation and Specification	R1, R2, R3, R4, R5, R8, R10,R20,R31
Frequent Videoconference Meetings	R1, R2, R4, R5, R6, R7,R14,R16,R22,R27
Trust Building	R1,R2, R3, R4, R8, R9, R11,R15,R16,R18,R19,R20,R21,R22,R23,R24,R25,26
Communication Planning	R1, R2, R4, R5, R6,R12,R19,R20,R24,R25,R27,R30
Management of Cultural Differences	R3, R4, R8, R9, R18,R19,R20,R22,R31
Interpersonal Relations	R3,R4, R8, R9, R9,R15, R16,R22,R25,R26,R28,R30R,31
Create focal points (ambassadors) in every remote team.	R2, R3, R5, R7, R8, R10, R14, R21, R25, R27, R28, R29
Continuous Communication Improvement	R2, R3, R8, R12
Communication Policies and Practices	R2, R5, R11, R20,R23,R27,R29
Definition of communication support tools.	R1, R2, R3,R4,R7,R10,R14,R29
Understanding of the provided information	R2, R8,R13,R20,R25,R29,R31
Synchronous communication	R6,R7,R12,R13,R14,R15,R16,R17,R18R20,R25,R26,R27,R28
Definition of a default language	R1,R3,R4,R5,R10,R11,R12,R15,R28,R29,R30,R31
Knowledge Management	R6, R8, R10, R19, R21
Communication Infrastructure	R1,R3,R5,R6,R7,R12,R15,R16,R17,R18R20,R21,R25,R26,R27,R28
Information and Task Distribution	R2,R5,R11,R12,R21,R20,R21,R23,R25,R30,R31
Asynchronous Communication	R1,R3,R5,R6,R7,R12,R13,R14,R15,R16,R17,R18R20,R21,R25,R26,R27, R28
Human Resource Alocation Planning in Projects	R13,R14,R15,17,R18
Training to develop communication abilities	R1,,R6,R7,R12,R13,R14,R15,R16,R17,R18R20,R21,R25,R26,R27,R28
Standardization of the terminologies/vocabular used in the Project	R10,R12,R20,R22,R29
Configuration management	R10,R12,R20,R22,R29
Face-to-face Interaction	R3, R4, R8,R9,R15, R16,R22,R25,R26,R28,R30R,31
Determine the communication channel	R3, R4, R8, R9,R15, R16,R22,R25,R26,R28
Manage the stakeholders	R3, R4, R8, R9, R18,R19,R20,R22,R31
Interchange between team members	R1,R2,R3,R10,,R19,R20,R21,R22,R23,R24,R25
Conflict management	R12,R13,R16,R18,R20
Temporal Distance Management (Time zone)	R5, R6, R9, R10, R11, R12,R13,R14,R15,R19,R20,R21
Synchronization of the work schedules	R1,R2,R3,R10,R13,R16,R19,R20,R21,R22,R23,R24,R25,R26,28
Leadership Style	R1,R2,R3,R10,,R19,R20,R21,R22,R23,R24,R25
Activities Standardization	R1, R2, R4, R5, R6, R7,R14,R16,R22,R27
Cordiality between the stakeholders	R3, R7, R8, R9, R12, R15,R29,R30
Management of the meeting schedule	R5, R6, R9, R10, R11, R12,R13,R14,R15,R19,R20,R22,R30

Source: The author.

The identification of the communication factors is directly linked to the work method of a certain organization. Different factors can exist to the same activity, each one, linked to the adopted strategy. Aiming to consolidate the results were explicited the most relevant ones in the view of the respondent (Table 21).

Table 21 - Communication Factors in relevance order.

Communication Factors	Is the fator Relevant?	(%)
	Yes	
To provide results of the project to the high management	31	100%
Requirement Elicitation and Specification	31	100%
Frequent Communication	31	100%
Trust Acquisition	31	100%
Communication Planning	31	100%
Management of Cultural Differences	31	100%
Interpersonal Relationship	31	100%
Continuous Improvement of the Management	30	97%
Communication Policies and Patterns	29	94%
Definition of communication support tools	29	94%
Understanding of the provided information	29	94%
Ability to elicitate and negotiate requirements with the cliente	28	90%
Synchronous Communication	27	87%
Definition of a default Language	27	87%
Knowledge management	27	87%
Communication Infrastructure	26	84%
Information and task distribution	26	84%
Asynchronous Communication	26	84%
Planning of the human resource alocation in projects	26	84%
Training to develop communication abilities	26	84%
Standardization of the terminologies/vocabulary used in the Project	25	81%
Configuration Management	25	81%
Face-to-face Interaction	25	81%
Determine the communication channel	22	71%
Manage the stakeholders	22	71%
Interchange between team members	22	71%
Conflict management	22	71%
Temporal Distance Management (Time Zone)	20	65%
Synchronization of the Work schedules	20	65%
Leadership Style	19	61%
Activity Standardization	19	61%

Source: the author

From the exposed on Table 19, we can realize that, of the 31 factors that were found, 11 vary between 94% and 100% of relevance according to the opinion of the respondents. These factors are considered of major impact for DSD projects from the point of view of those who deal daily with distributed software projects. Aiming to corroborate with this affirmation, some passages extracted from the interviews with the referred answerers are shown above:

- **Supply the High Management with results of the project:** For the respondent 22 *"the high management is represented by the project manager."* However, the respondent 28 said *"that the information of the project have to be passed on and presented to the high management periodically so the high management can be aware of everything that occurs in the project. Still to this respondent, this type of monitoring can be done in the points of control ("Project marks") planned on the schedule of the projects."*
- **Elicitation and Specification of the requirements:** For the respondent 6 the *"specification and elicitation of the requirements is a highly communicative activity, which means it is necessary for the professional that will perform this activity to be a good speaker, a skilled writer and know the subject in the technical aspect."* The respondent 6 also said "*that this type of professional is hard to find in the market."* But respondent 19 said "*that this activity requires a lot of attention in traditional projects. When this same activity is performed in DSD projects, it is necessary to double the attention to minimize or avoid errors that can generate rework.*
- **Frequent communication:** The respondents 4 and 5 said that with the adoption of agile practices is simple to solve this (for example, daily meetings, reviews, retrospectives and etc). The answerer 27 says *"is necessary to create means of communication in many levels. For example: forums for discussion among teams, meetings to present the results with the high administration of the organization, meetings to resolution of technical problems and etc."*
- **Acquisition of trust:** The respondent 11 says *"that trust comes from the good relationship with everyone in the Project, as well as from a good workplace."* However, respondent 5 says *"that an effective*

communication generates trust among the collaborators." Then respondent 9 says "*it is necessary to create moments of integration to break the barrier among the members of the teams and then the trust building among them happens naturally. "*

- **Managing cultural differences:** The respondent 15 was very emphatic to say *"that this is a vital point to be managed in distributed projects."* However, the answerer 23 says *"that culture is difficult to be managed when people are in the same state or country. When the teams are globally distributed, it gets much more complicated."* The respondent 3 corroborates *"the relevance of the culture when he says that cultural problems that occur in traditional projects are even more serious in DSD projects, since they cause a diminution of the face to face interaction."*
- **Communication planning:** The respondent 13 *says "that this practice must be mandatory in any type of project."* But the respondent 22 says *"that it is necessary to create an organizational culture to indoctrinate the collaborators to plan the communication in their projects systematically."* At last, the respondent 13 says "*that the communication is one of the areas that lead projects to failure. And as such it is necessary to manage the communication from the start to the end of the project so the level of communication can be evaluated and good practices can be replicated in other projects."*
- **Continuous improvement of the communication:** The respondent 30 emphasizes that *"the communication is the backbone of any organization or project."* To support this affirmation, the respondent 23 says that *"people who communicate better are able to transcend effectively when problems arise. He also says that we need to review the policy and planning of communication, seeking its continuous improvement."* But respondent 29 says that *"there is no formula to deal with communication. Is necessary that we have a system to reflect upon the communication in each and every project continuously."*
- **Interpersonal relationship:** The respondent 11 says that *"a good interpersonal relationship brings more trust to the teams."* But the respondent 25 goes *"deeper on the matter and paraphrases a Chinese*

proverb that says the following: if you want 1 year of prosperity, grow grain. If you want 10 years of prosperity, grow trees. If you want 100 years of prosperity, grow people."

- **Policies and patterns of communication:** The respondent 1 says that *"it is necessary to create policies and patterns to reach the excellence."* Then respondent 10 says that *"organizational policy is something necessary, however, when the organization does not have a well-defined culture it is necessary to be careful so that it won't end up getting in the way of the management/operationalization of the project instead of helping."*
- **Definition of tools that support the communication:** Respondent 22 says that *"there is no successful project without planning. And in the context of projects with distributed teams, such planning must contemplate the definition of the tools that are used for communication. In case that does not happen, huge problems may occur during the project. "*
- **Understanding of the provided information:** Respondent 5: Often, *"the teams do not have the same understanding of what is being developed as a whole, what causes many misunderstandings about the concept of the project."* Supporting this affirmation, the respondent 6 says that *"in every project there will be misunderstood information, however, it is necessary to create mechanisms to minimize and sometimes even avoid that this come to happen in the projects. There are enterprises that establish goals and errors that come from wrong information."*

In this sense, it was identified through the reported information by the answerer the area where the communication efforts in DSD projects are more concentrated (Figure 34).

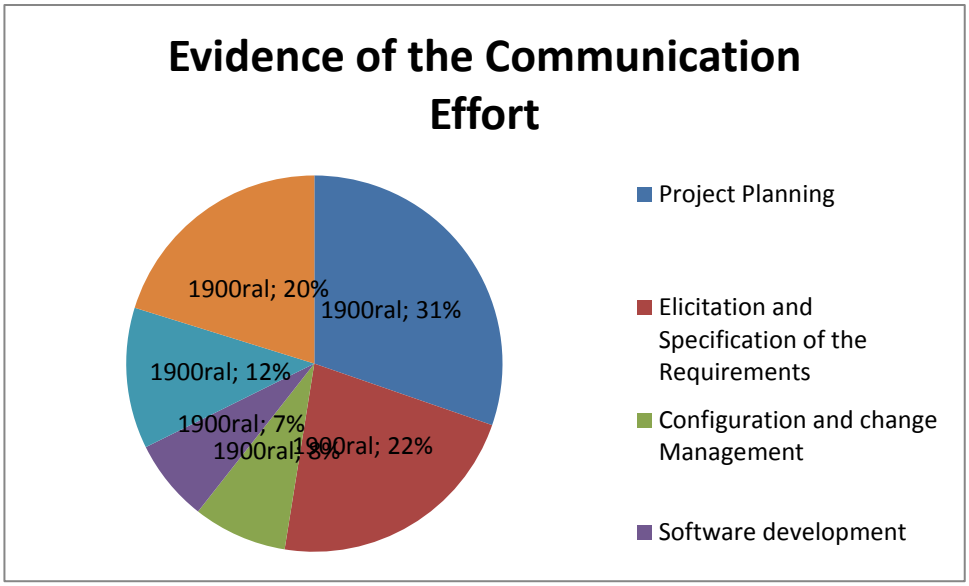

Figure 34 - Communication effort in DSD per phase. Source: the author.

4.2.9 PRACTICES TO POTENTIALIZE COMMUNICATION IN DSD PROJECTS: A SYSTEMATIC REVIEW LITERATURE (SRL 2)

Even though there are several initiatives of applicable solutions seeking to minimize the problems in the DSD context, there are still no guides, models or effective practices in the planning and management of the communication in DSD projects. In the sample of answerers of the study, the practices that were identified are concentrated mainly in the need of defining tools for communication, meetings, daily meetings, adoption of collaboration tools and work patterns (Table 22).

Table 22 - Relation of communication practices identified by the professionals in the study.

Id	Practices that were implemented by the professional (answerers)	Respondents (R)
P1	Defining communication ambassadors (focal points or speakers)	R1, R2, R4,R13,R14,R15,R20,21,R25,R26,R27,R 28,R29
P2	Daily meetings	R1, R5, R8, R11, R12,R13,R14,R15,R16,R25,R27,R29,R2 R9,R30,R31
P3	Adoption of synchronous and asynchronous tools	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12,
P4	Definition of communication training programs	R3, R4, R26,R27, R30,R31
P5	Exchanging of members among dispersed teams	R3, R4, R5, R8, R20,R22,R24,R26,R27

P6	Adoption of collaboration tools	R2, R3, R5, R6, R11, R22,R30
P7	Making of technical workshops about technologies used in the project.	R4, R13, R30,R31
P8	Create mechanisms to confirm the understanding of the activities	R2, R8,R25,R29,R31
P9	Periodical face to face meetings	R5, R7, R8, R10, R14, R21, R25, R27, R28, R29
P10	Institutionalize the cultural context of each team that belongs in the project	R9,R15, R16,R22,R25,R26,R28,R30R,31
P11	Use good practices to plan the communication of the project	R2, R10,R11,R12,R13,R15,R17,R18
P12	Define and institutionalize the vocabulary of the project to the teams	R10, R15,R16,R22,R30,R31
P13	Standardize the activities and reports to the distribution of information to the interested parts	R4, R6, R10, R11, R25,R27,R28,R29,R30,R31
P14	Keep a nice and harmonious work environment	R3, R7, R8, R9, R12, R15,R29,R30
P15	Discuss the improvement of the communication on the SEPG	R4, R6, R10, R11, R22,R23,R29,R31
P16	Define roles and responsibilities	R1, R5, R8, R11, R12,R13,R14,R15,R16,R20,R21,R22,R25,R28,R30
P17	Discussion forums	R2,R10,R11,R12,R15,R16,R27,R30
P18	Establish communication policies	R10,R13,R14,R18,R19, R29, R30, R31
P19	Establish a communication plan	R1,R2,R3,R4,R5,R6,R7,R8,R9R10,R13, R14,R18,R19,R21,R22,R23,R24,R25,R2 R26,R28,R31
P20	Continuous feedback of the status of the project	R13,R15,R16,R17,R18,R19,R31
P21	Obtain understanding of the requirements	R1,R2,R5,R10,R11,R20,R21,R24,R26
P22	Keep the ability to track the requirements	R2,R10,R11,R30
P23	Publish periodically a report of the performance of the Project	R8,R10,R12,R16,R17,R21
P24	Carry out a closing meeting of the Project	R13,R14,R19,R29,R30,R31
P25	Communicate the lessons that were learnt	R3,R20,R21,R25,R26,R27,R28
P26	Plan and manage meetings	R13,R14,R15,R16,R19,R20,R31
P27	Define communication infrastructure for the Projects taking into account the level of	R1,R3,R4,R10,R12,R14,R29,R30,R31

	dispersion	
P28	Commitment of the stakeholders with the communication plan	R1, R2, R3,R5,R7,R11,R13,R14,R15,R16,17,R18
P29	Define a communication strategy	R15,R16,R17,R18,R19,R22,R23,R24,R25
P30	Distribute information to the stakeholders	R2,R5,R11,R12,R21,R25,R30,R31

Source: the author.

4.3 COMMUNICATION PRACTICES IN DSD PROJECTS: A SYSTEMATIC REVIEW LITERATURE (SRL 2)

This study (Phase 2 of our methodological approach - see Section 1 - Figure 2) aims at moving towards a knowledge about communication in distributed projects by developing a better understanding identification of factors and communication practices used in the software industry to increase the chances of success of DSD projects.

The protocol was established based on the guideline proposed by Kitchenham and Charters (2007). The first step was to specify a clear group of research questions that should be answered by the RSL. Then, aiming to investigate the communication in DSD projects, two main questions were formulated.

Next, the development of the researching strategy was made. For the construction of the search string, synonyms were selected for the terms “Distributed Software Development” and “communication”. Six sources were selected for the automatic search and fifteen sources for the manual search. In regard to the sources for the automatic RSL search, most of them (four sources) are indicated in the guideline (Kitchenham and Charters, 2007) as review sources with relevance for Software Engineering Area.

Furthermore, eight exclusion criteria and two inclusion criteria were defined. As to the team, three more researchers were invited to participle in the RSL, because, according to Kitchenham and Charters (2007), the involvement of more researchers lowers the bias of interpretation that the study is really relevant to answer the research questions.

Finally, a strategy of extraction was defined. A text type template of the document was elaborated, with sections to map the relative data of each

primary study. At last, was defined that the data synthesis would be based on the method of Thematic Analysis (Merriam, 2009) generating codes and categories;

The protocol of this RSL was evaluated by seven researchers. The evaluation result was positive, and indicated the possibility of executing the RSL. But, before that, few adjusts suggested by the evaluators were made in the protocol (Appendix F)

The whole team that executed the Systematic Review of Literature was composed by four researchers. While the search and selection were made, three of those researchers participated. To the extraction, there was the participation of one more researcher. Nevertheless, the analysis and synthesis step was executed by two researchers.

During the manual and automatic searches, 1338 primary studies were obtained. After the selection there were 245 left. During the manual and automatic searches, 1338 primary studies were obtained. After the selection there were 245 left. During the extraction some repeated studies and studies that did not answer the questions of the search were excluded. So, for the analysis step there were 184 studies left.

4.3.2 REVIEW PROTOCOL

To a better solving of the search question, two central search questions were defined (PP1 and PP2):

- **PP1: What are the communication factors in DSD projects?** The scope of this question is examining the factors which are related to the communication in DSD projects. To approach these factors means to manage the occurrence of communication in DSD projects.
- **PP2: What are the practices utilized to maximize the communication in DSD projects?** This question investigates the practical support to deal with the communication in DSD projects. A general and resumed description of the utilized practices to improve the communication in the DSD projects is to be made available.

Next, the questions were classified according to the categories defined by Easterbrook *et al.* (2008).

Search Questions:

P1	What are the communication factors in DSD projects?	Relationship – Causality *'What causes X?'*
P2	What practices are utilized to improve the communication in DSD projects?	Relationship – Causality *'What causes X?'*

According to this classification, we can call this research a Systematic Review of Literature, instead of Systematic Mapping. The systematic mapping enables a wide view of the primary studies, making it dependent of the making of mappings to reveal the evidences of the search (KITCHENHAM; CHARTERS, 2007). But the Systematic Review of Literature seeks to identify, evaluate and interpret all the relevant searches available to a question of a specific search, or thematic area, or phenomenon of interest (KITCHENHAM; CHARTERS, 2007).

4.3.3 SEARCH STRATEGY

The main part of the strategy search is the elaboration of a search *string*. Kitchenham and Charters (2007) says that, to fulfill this activity, it is essential to consider the questions and the search as a whole. The construction of the *string* happened according to the following steps:

1. The main terms are identified according to the search questions;
2. These terms are translated to English, the mostly used language in the Computer Science Literature;
3. Synonyms of the terms are identified;
4. The search string is generated from the combination of these main terms and synonyms. Are used the operators OR between the identified synonyms, and between the terms the operator AND.

Table 23 shows the main terms and the identified synonyms:

Table 23 - Main terms and synonyms.

Terms	Synonyms
Distributed Software Development	Distributed software development, Distributed development, Distributed teams, Global software development, Global software engineering, Global software teams, Globally distributed development, Globally distributed work, Geographically distributed software development, Collaborative software development, Collaborative software engineering, Cooperative software development, Cooperative software engineering, Offshore software development, Offshoring, Offshore, Offshore outsourcing
Communication	Communication, Communicate, Communication management, Information sharing, Information transfer

Source: the author

Based on the discussed steps, the following *string* was built:

("Communication" OR "Communicate" OR "Communication Management" OR "Information sharing" OR "Information transfer") AND ("Distributed software development" OR "Distributed development" OR "Distributed teams" OR "Global software development" OR "Global software engineering" OR "Global software teams" OR "Globally distributed development" OR "Globally distributed work" OR "Geographically distributed software development" OR "Collaborative software development" OR "Collaborative software engineering" OR "Cooperative software development" OR "Cooperative software engineering" OR "Offshore software development" OR "Offshoring" OR "Offshore" OR "Offshore outsourcing").

The search is divided in two steps: automatic and manual searches (in magazines, newspapers, conferences). The following criteria were used to select the sources of the studies:

- The source must be available for the consultation of articles through the web;
- The source must have search mechanisms that work through key-words;

- Sources for automatic searchers already used by experts in ESBE (For example, Kitchenham and Charters (2007)); Sources for the automatic and manual searches that were already used in other Reviews of Literature about DSD or DSD communication (For example, Santos (2012), Trindade et al. (2008) and Da Silva et al. (2011)).

Table 24, 25 and 26 presents the list of sources for automatic and manual search:

Table 24 - Sources for automatic search (Electronic Bases).

ID	Source	URL
1	ACM Digital Library	http://portal.acm.org
2	El Compendex	www.engineeringvillage2.org
3	Elsevier ScienceDirect	http://www.sciencedirect.com
4	IEEEXplore Digital Library	http://www.ieeexplore.ieee.org/Xplore
5	Scopus	http://www.scopus.com
6	Wiley InterScience	http://onlinelibrary.wiley.com/

Source: the author

Table 25 - Sources for manual search (Magazines and Newspapers).

ID	Source	Electronic Idexing Basis
1	Communications of the ACM	ACM Scopus
2	Transactions on Software Engineering	IEEE Scopus
3	IEEE Software	IEEE Scopus
4	Information and Software Technology	ScienceDirect
5	Journal of Systems and Software	ScienceDirect
6	Empirical Software Engineering	Scopus
7	Annals of Software Engineering	Scopus
8	Software Practice and Experience	Scopus Wiley InterScience
9	Journal of Global Information Management	Scopus
10	Journal of Global Information Technology Management	Scopus
11	Information Systems Journal	Wiley InterScience
12	Journal of Computer-Mediated Communication	Wiley InterScience
13	Journal of Software: Evolution and Process	Wiley InterScience

Source: the author

Table 26 - Sources for manual search (conferences).

ID	Source	Electronic Idexing Basis
1	Conference on Computer Supported Cooperative Work	ACM
2	International Conference on Software Engineering	ACM
3	International Symposium on Empirical Software Engineering and Measurement	ACM
4	International Conference on Supporting Group Work	ACM
5	International Conference on Intercultural Collaboration	ACM
6	IET Software	Scopus
7	International Conference on Collaborative Computing: Networking, Applications and Worksharing	IEEE
8	International Conference on Collaboration Technologies and Systems	IEEE
9	Symposium on Advanced Management of Information for Globalized Enterprises	IEEE
10	International Conference on Computer Supported Cooperative Work in Design	IEEE
11	International Conference on Cooperation and Promotion of Information Resources in Science and Technology	IEEE
12	International Conference on Global Software Engineering	IEEE
13	International Conference Professional Communication	IEEE
14	Collaboration and Intercultural Issues on Requirements: Communication, Understanding and Softskills	IEEE
15	Workshop on Wikis for Software Engineering	IEEE
16	Workshop de Desenvolvimento Distribuído de Software	WDDS

Source: the author

The addresses of the conferences, journals and Magazines can be found on the Appendix J. The searches took in account the date of the publishing of the article, which is from 1999 up (year when an important publication about the DSD team occurred: the work Global Software Teams – Collaborating across Borders and Time-Zones, which was written by the researcher Carmel (1999)).

A preliminary automatic search (gauging of the search string) was made in 05/26/2013 to verify the returned articles. For the gauging and real search of the studies, it was decided that the searches would be made in the Abstract field, in order to search studies that deal directly with communication in DSD projects, as well as minimizing the initial quantity of returned articles. For the experience with the reading of articles in the field, a considerable part of the DSD literature mentions aspects of the communication even though it's not the focus of the article. This happens because the communication is interfered by most of the distribution characteristics of the groups.

4.3.4 STRATEGY OF SELECTION

To Kitchenham and Charters (2007) the strategy of selection must offer a group of selection criteria (of inclusion and exclusion) for primary studies, as well as the definition of a procedure to apply such criteria.

The configuration of the criteria of this RSL makes possible the selection of a great variety of studies; another way, with a rigid group of rules, the review could be at risk of containing an insignificant and/or an unreal number of studies. The criteria of inclusion and exclusion defined for this study is of the "Restriction" type. There are no criteria of the "quality" type, since the evaluation of quality is part of another step in the search. This classification of criteria is originally proposed by Rabiser *et al.* (2010).

Exclusion Criteria

Will be excluded:

- (Restriction 1) The articles that are not written in English;
- (Restriction 2) The articles that are completely irrelevant, that do not answer any of the questions of the search;
- (Restriction 3) The articles that are not available for recuperation through the web;
- (Restriction 4) If two articles publish the same results of a study, the least detailed will be excluded;
- (Restriction 5) If two equal articles are found in more than one source, one of them will be excluded;
- (Restriction 6) The articles that are not from the field of Computer Science (for example, Business, etc).
- (Restriction 7) The articles which were published before 1999;
- (Restriction 8) The articles that contemplate the execution of theoretical studies involving the communication in DSD projects.

Inclusion Criteria

Will be included:

- (Restriction 9) The articles that contemplate an execution of the empirical studies involving the communication in DSD projects and that answer at least one of the questions of the search;

- (Restriction 10) If two articles publish different results for the same study, both will be included.

Selection Process

The Figure 35 represents the selection process of the primary studies. Hereinafter, each step is briefly described:

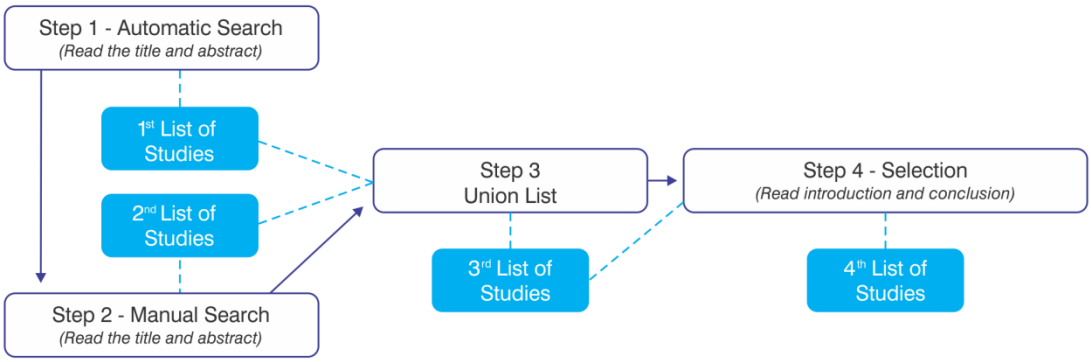

Figure 35 - Selection Process. Source: the author

For the making of the RSL a team of four researchers was formed. For the fourth step, the team will be divided in two pairs, so that each primary study is evaluated by two people.

Step 1 – Automatic Search: Each one of the four researchers will be responsible for determined searching sources. The researcher conducts searches according to the search strategy described in the previous sections to identify the potential studies. From the reading of the title, abstract and keywords of the studies, exclude works using the criteria of exclusion Restriction 1,2,3,6,7 and 8. Case there are doubts that the article does not attend to the exclusion criteria, the same should be included in order to be evaluated in the next step. A list of the potential articles of automatic sources is maintained in the Dropbox Sharing Management System (https://www.dropbox.com/).

Step 2 – Manual Search: Each one of the four researchers will be responsible for determined searching sources. For the magazines and newspapers, the researcher makes the searches through the list of published article in the volumes and editions of the volume. For the checkings, the researcher makes the searches through a list of articles accepted for publishing. From the reading of the title, abstract and key-words of the study, they exclude Works using the criteria of exclusion Restriction 1,2,3,6,7 and 8. Case there are doubts that the

article does not attend to the exclusion criteria, the same should be included in order to be evaluated in the next step. A list of the potential articles of automatic sources is maintained in the Dropbox's sharing management system (https://www.dropbox.com/).

According to Kitchenham and Charters (2007), the initial searches return a great quantity of studies which are not relevant, not answering the search questions or even not being related to the topic in question. Therefore, studies that are completely irrelevant will be discarded in the beginning and will not be maintained in any list of the excluded studies.

Step 3 – Union of the lists of potential articles: The researchers unite the lists of potential articles of the automatic sources and manual acquiring. Then, a list of potential primary studies is created, using the criteria of exclusion Restriction 5. The list will be maintained in the Dropbox's sharing management system (https://www.dropbox.com/). Mendeley (http://www.mendeley.com/) will also be used as a database of the studies. This tool also extracts the data of each primary study automatically. The automatically extracted data from the Mendeley will be exported to a Microsoft Excel spreadsheet with the following columns:

- Study ID;
- Title;
- Author (s);
- Year;
- Country;
- Source.

Step 4 – Selection: Each study from the list of potential studies will be evaluated by at least two researchers, subject to the Reading of the Introduction and Conclusion. In case there is doubt if the article has an answer or not to any of the questions of the search, other sections of the article must be read. In this step they utilize the criteria of exclusion 2,4,6 and 8 and criteria of inclusion Restriction 9 and 10 to get to a final list of the primary studies, which probably answer the search questions. If any disagreement appears in the inclusion of exclusion of a study, a third researcher will solve the conflict; The selection will be documented as a whole in a Microsoft Excel Spreadsheet, maintaining even

the criteria that defined the exclusion of the articles. The spreadsheet contains the following columns:

- Study ID;
- Title;
- Author (s);
- Year;
- Country;
- Source;
- Search Questions;
- Criteria of Exclusion Researcher 1;
- Criteria of Exclusion Researcher 2;
- Criteria of Tiebreaking/Decision.

4.3.5 EXTRACTION STRATEGY

To Kitchenham and Charters (2007), the goal of this step is to create instruments for the extraction of data from the primary studies. The instruments will be projected to collect the necessary information to answer the search questions.

With the objective of answering the search questions **PP1 and PP2**, a Microsoft Excel spreadsheet was used with the following columns:

- Study ID;
- Title;
- Author (s);
- Year;
- Country;
- Source;
- Communication Factor;
- Name of the practice/Description of the practice.

An initial list of possible methods of research was created from Easterbrook et al. (2008) and Merriam (2009). However, other types of methods can be found.

4.3.6 SYNTESIS STRATEGY

The synthesis of data was based on the method of Thematic Analysis, using constant comparisons and the inductive jumps (Glaser e Strauss, 1967). The

group of codes and categories is a product of the analysis and was obtained with the help of the quantitative data analysis software Weft QDA.[5]

4.3.7 EXTERNAL PROTOCOL EVALUATION

The protocol is a critical element of any systematic review of literature and, as such, the researchers must develop a procedure to evaluate it. As suggested by Kitchenham and Charters (2007), a group of independent evaluators (search counselor and other researchers with experience in Management of Software Projects and/or DSD and Systematic Reviews of Literature) will be invited to determine how adequate the protocol is.

The checklist used for this evaluation of the protocol contains questions suggested by:

- Kitchenham and Charters (2007), for the protocol evaluation;
- Kitchenham and Charters (2007) apud Centre for Reviews and Dissemination (CRD) and Database of Abstracts of Reviews of Effects (DARE), for the SLR evaluation;
- Donald and Greenhalgh (2000) for the SLR Evaluation.

The evaluation questions of the RSL were adapted for the evaluation of the protocol. The evaluation form will be available in the tool Survey Monkey.

The Likert scale -5 will be used in the evaluation. It allows gradual answers through the opinion of the evaluators. The following levels of agreement or disagreement should be considered:

- **Agree completely (Burden/Weigh 4):** it should concede in case the protocol attends completely to the criteria of the question;
- **Agree partially (Burden/Weigh 3):** it should concede in case the protocol attends partially to the criteria of the question;
- **Neutral (Burden/Weigh 2):** it should concede in case the protocol doesn't make it clear if it attends or not to the question;
- **Disagree partially (Burden/Weigh 1):** it should concede in case the protocol does not attend the criteria contained in the question;

[5] http://www.pressure.to/qda/

- **Disagree completely (Burden/Weigh 0):** it should concede in case the protocol does not attend the evaluation criteria at all, which means, there is nothing in the protocol that attends to the criteria of the question.

The evaluation form of the protocol was between the days 05/10/2013 and 05/25/2013. Seven answers were obtained and the collected data are available in the Appendix G.

Regarding the profile of the respondents, 2 of them are Doctors in Computer Science and the other 5 are masters and are pursuing doctorate in Computer Science, as in the table in Figure 36.

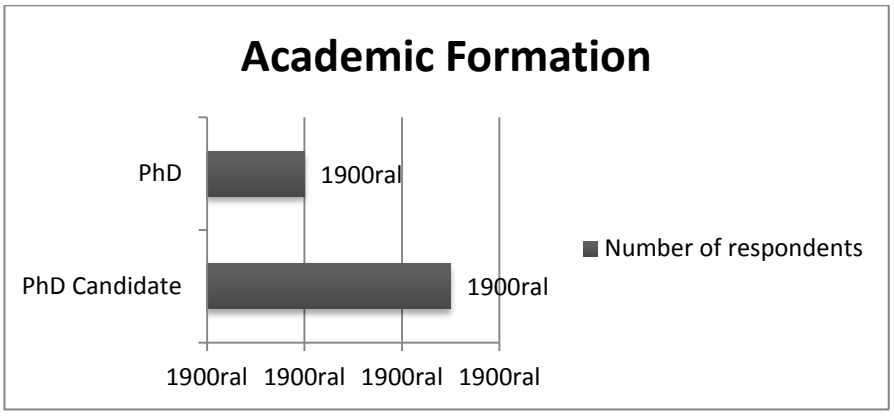

Figure 36 - Academic education of the respondents. Source: the author

The average evaluation of each one of the seven questions was calculated and is plotted in the graph of the Figure 37. These average evaluations are all superior to the value 2,5, and as such it can be said that the protocol was positively accepted and that it is apt to pass to the next phase. Values above 2,5, are closer to the degree of agreement Agree Partially (3) in relation to the inferior agreement degree Neutral (2).

This minimum acceptable value (>2,5) was already reached in the first evaluation of the protocol, and as such it will not be necessary to redefine and expose it to a new evaluation. But, facing the improvement suggestions made supplied by the evaluators, a few weaknesses in the protocol were repaired.

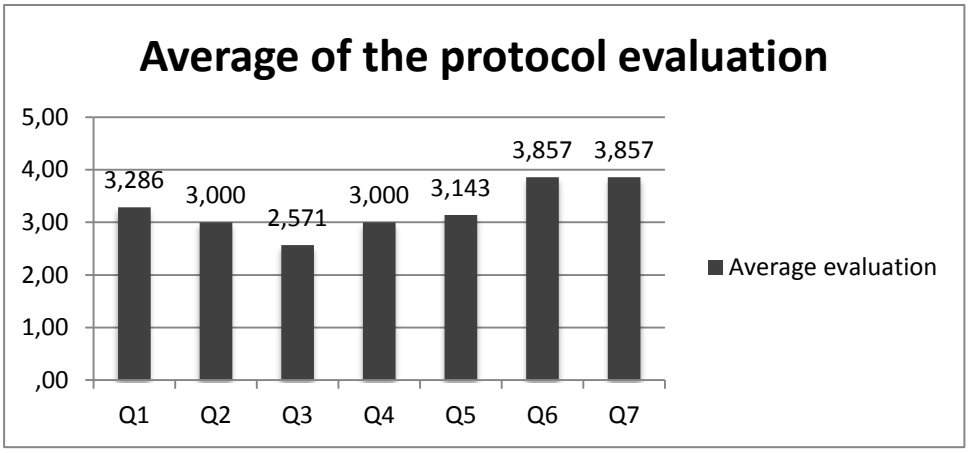

Figure 37 - Average protocol evaluation. Source: the author

This new version of the protocol implemented improvements in aspects such as:

- Grammar (related from Q1 to Q7): Correction of spelling errors and improvement in the writing of sections of the text clearer.
- Search Questions (related to Q2): Reorganization, fusion and elimination of search questions.
- Search Strategy (related to Q3): In regard to the type of manual search, the Snowballing technique was added. In regard to the search sources. In regard to the search sources, the Springer Link was eliminated and the Wiley InterScience was added. The reason of the elimination is that the articles Springer Link are not made available for free on the Internet accessed through the Center of Informatics.

4.3.8 RESULTS OF THE SELECTION

This RSL had a selection process composed by four steps, as described in Figure 35. This procedure was performed starting on June of 2013; because of this, only the studies that were published until the first semester of the previously mentioned year were considered.

Step 1 – Automatic Search

In this step, the studies were automatically obtained from the following sources: ACM Digital Library, El Compendex, Elsevier ScienceDirect, IEEEXplore Digital Library, Scopus and Wiley InterScience. The electronic bases were configured to examine only the abstracts of the studies and, when possible, to apply the

criteria of exclusion CE1, CE 6 and CE7 automatically. The automatic search returned a total of 2,712 studies, as shown in details in Table 27:

Table 27 - Results of the automatic search.

Electronic Basis	Returned Studies
El Compendex	1.021
Scopus	866
IEEEXplore Digital Library	338
Wiley InterScience	308
ACM Digital Library	148
Elsevier ScienceDirect	31
Total	2.712

Source: the author

At this point, the title, the abstract and the keywords of the studies were read and excluded according to the criteria of exclusion CE1 to CE8. After the execution of these steps, a proportion of 31,01% (841) of the total of the studies was selected, according to the detailed in table 26. These retained studies form the first List of Studies potentially relevant (Step 1 – Figure 35). They were downloaded in the PDF format, and stored in the Dropbox file sharing system to participate in the next steps

Table 28 - First selection in the automatic search.

Electronic Basis	Returned Studies	Selected Studies	Percentage (%)
Scopus	866	332	38,34
El Compendex	1.021	351	34,18
ACM Digital Library	148	48	32,43
Elsevier ScienceDirect	31	8	25,81
IEEEXplore Digital Library	338	82	23,96
Wiley InterScience	308	24	7,47
Total	2.712	845	31,15

Source: the author

During the automatic search they observed that the synonyms of DSD ‘Offshoring’ and ‘Offshore’ constantly returned articles related to the topic ‘oil and gas’. Therefore, it is believed that these terms could have been discarded from the string without bigger losses to the result of this RSL. It is believed as well, that applying the search in the abstract of the studies has been an efficient way of finding the studies, taking into consideration that there was a retention tax that ranged from 30% to 38% just as occurred in the bases of Scopus, El Compendex and ACM Digital Library.

At this point, all of the 845 selected studies were imported to the Mendeley reference managing system. The Mendeley is capable of extracting equal studies obeying, this way, the criteria of exclusion CE5. --, 518 unique studies were obtained, as shown in Table 28.

At this point, all the 845 selected studies were imported to the reference management system Mendeley. Mendeley is able to subtract the equal studies, obeying the exclusion criteria 5. This way, were obtained 518 unique studies, as detailed in the Table 29.

Table 29 - Repeated studies – automatic search.

Studies selected in the automatic search	Repeated studies	Unique studies
845	323	**518**

Source: the author

The great number of repeated studies evidences the fact that different electronic bases index the studies from the same magazines and newspapers. The fact reveals as well a uniform function of the search mechanisms, once different bases return the same studies through the same terms and synonyms.

Step 2 – Manual Search

In this step, the studies were obtained from 32 sources that ranged from journals, to magazines and conferences (Table 30 and Table 31). The search for the studies was made in a way similar to the automatic search: Reading of the title, abstract and keywords, and the studies were excluded according to the criteria of exclusion CE1 to CE8. These retained studies compose the Second List of potentially relevant Studies (Step 2 – Figure 35). The studies were downloaded in PDF and were also stored in the Dropbox file sharing system in order to participate in the next steps.

Table 30 - Results of the manual search (newspapers and magazines).

Magazines and newspapers	Selected Studies
Communications of the ACM	49
IEEE Software	26
Information and Software Technology	20
Information Systems Journal	14
Journal of Software: Evolution and Process	9
Transactions on Software Engineering	6
Journal of Systems and Software	6
Empirical Software Engineering	5

Annals of Software Engineering	4
Software Practice and Experience	4
Journal of Global Information Management	4
Journal of Global Information Technology Management	3
Journal of Computer-Mediated Communication	3
Total	153

Source: the author

Table 31 - Results of the manual search (conferences).

Conferences	**Selected Studies**
International Conference on Global Software Engineering	134
International Conference on Computer Supported Cooperative Work in Design	62
International Conference on Software Engineering	45
International Conference on Collaboration Technologies and Systems	34
International Conference on Collaborative Computing: Networking, Applications and Worksharing	17
Conference on Computer Supported Cooperative Work	15
International Symposium on Empirical Software Engineering and Measurement	12
International Conference on Supporting Group Work	9
IET Software	7
Workshop on Wikis for Software Engineering	6
Symposium on Advanced Management of Information for Globalized Enterprises	5
Workshop de Desenvolvimento Distribuído de Software	5
International Conference Professional Communication	3
Collaboration and Intercultural Issues on Requirements: Communication, Understanding and Softskills	3
International Conference on Intercultural Collaboration	2
International Conference on Cooperation and Promotion of Information Resources in Science and Technology	2
Total	361

Source: the author

At this point, the selected studies from all of the sources were also imported to the Mendeley, which subtracted the equal studies obeying the exclusion criteria CE5. From the total of 514 studies coming from newspapers, magazines and conferences, a list with 511 unique studies was obtained, as shown in table 32.

Table 32 - Repeated studies - manual search.

Studies selected through manual search (newspapers, magazines and conferences)	**Repeated studies**	**Unique studies**
514	3	**511**

Source: the author

Step 3 – Union of the Lists

Using Mendeley, both the potentially relevant studies list were united (Figure 35 – Step 3), excluding the repeated studies as well. This union of the 518 articles obtained through automatic search and 511 studies obtained through manual search originated a third list with 923 potentially relevant studies. The absence of 106 items was due to overlapping in the entering lists, as detailed in Table 33.

Table 33 - Union of the results of automatic and manual searches.

Studies selected through automatic search	Studies selected through manual search	Repeated studies	Unique studies
518	511	106	**923**

Source: the author

In this point, the benefit of search both ways is observed, once different studies were found in manual searches and automatic searches. At last, the Third List of potentially relevant studies was exported from an Excel spreadsheet, with information of the 'Title', 'Author (s)', 'Local' and 'Year of Publication' and four more columns were added 'ID, 'Situation', 'Exclusion Criteria', 'Untie', 'Observation' to make the next analysis of the studies possible, as described below.

Step 4 – Selection of Studies

All of the 923 potentially relevant studies from the Third List (Step 4 – Figure 35) were evaluated by at least two researchers, through the reading of the introduction and conclusion. But when there was doubt if the study obeyed or not the criteria of inclusion or exclusion, other sections of the article were read. The column 'Situation' was filled with the values 'Included' or 'Excluded', and the column 'Criteria of Exclusion' was filled with the adopted criteria of exclusion. The criteria of exclusion CE1 to CE8 and the criteria of inclusion CI1 and CI2 were used.

When there was any disagreement regarding the inclusion or exclusion of a study, a meeting is done to untie amongst the researchers. And if the doubt persisted a third researcher would solve the conflict, filling the column "Untie". After this process, a parcel of 26.54% (245) of the total number of the studies was selected, as shown in details in Table 34.

Table 34 - Results of the selection.

Unique studies	Excluded studies	Selected Studies	Percentage (%)
923	678	**245**	26,54

Source: the author

The origin of primary studies is detailed in Figure 38.

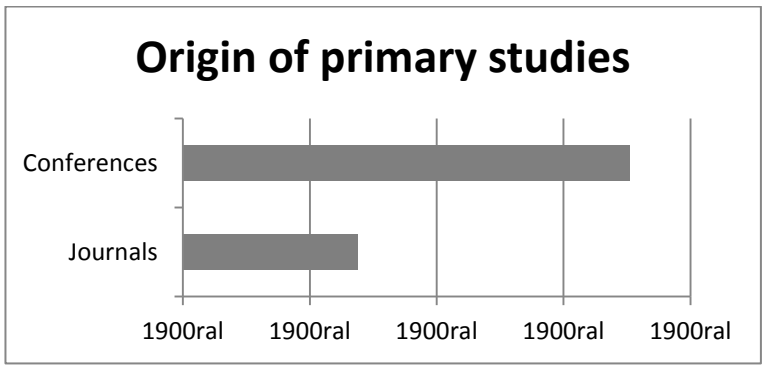

Figure 38 - Origin of primary studies. Source: the author

In regard to the criteria of exclusion, at most, the studies of this RSL were excluded by the criteria 'CE2: The irrelevant studies should be excluded, the ones that don't answer any of the questions of the search' and the 'CE 5: If two equal articles are captured from more than one source, one of them will be excluded' as shown in Figure 39.

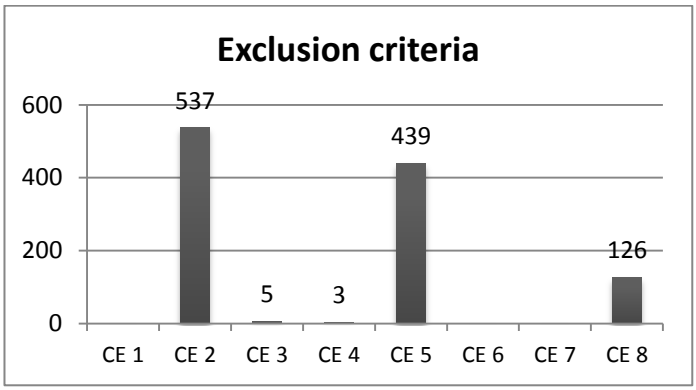

Figure 39 - Criteria of exclusion adopted in the selection. Source: the author

Studies about collaboration in co-localized teams, thesis proposals and papers without any results to the moment, descriptions of workshops, studies of communication in virtual teams from different areas of Software Engineering, studies about DSD projects that did not focus on the communication activity, among others, were classified in the CE2, for example. Meanwhile, studies that mention the communication in DSD projects but were not empirical, among

them many reviews of ad-hoc and systematic reviews of literature were classified in the CE 8.

Not all of the repeated studies were automatically excluded by Mendeley, being seven of them excluded manually (CE 5). As stated previously, most of these duplicates came from the automatic search, since the several electronic bases index the same newspapers and magazines. Unfortunately, an analysis of the intersection of the magazines, newspapers and conferences that were indexed by the electronic bases is not known. There were, also, incomplete PDFs i.e. its complete text was not available to download (CE 3), and articles with different titles but with the same results published were found (CE 4). Remembering the criteria C1, C6 and C7 were utilized in the automatic search as filters available in the sources, and the manual search through the conscience of the researcher.

4.3.9 RESULTS OF THE EXTRACTION AND ANALYSIS OF THE EVIDENCES

During the extraction, the 245 selected studies were completely read by at least two researchers. During this process, 61 studies were excluded, because 24 of them obeyed the 'CE 2', 36 of them the 'CE 4' and 1 study obeyed the 'CE8'.

Furthermore, definitively, 184 primary studies were selected in this RSL. The temporal distribution of these studies is shown in Figure 40.

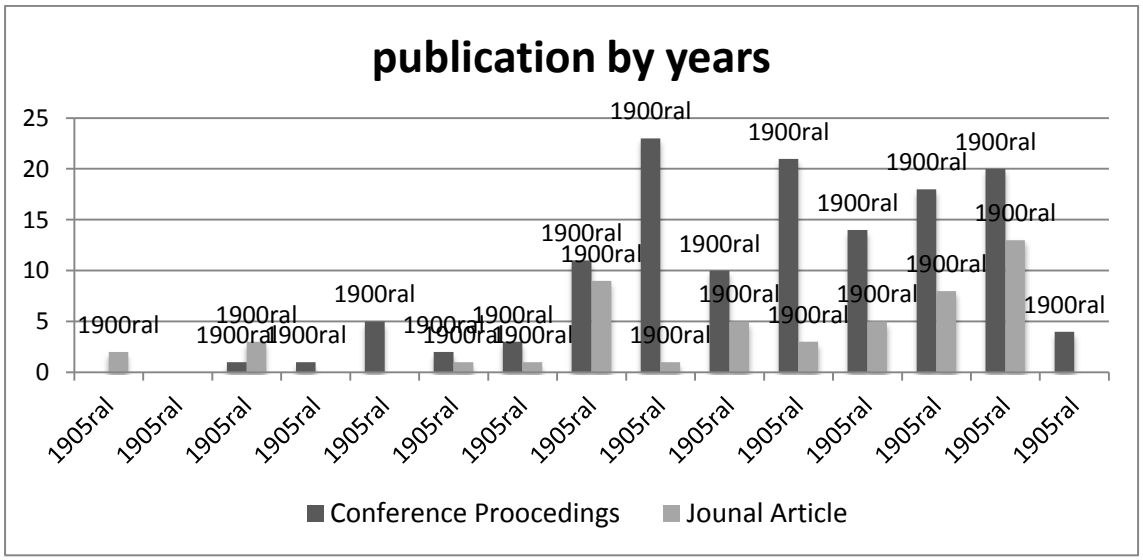

Figure 40 - Temporal distribution of the primary studies. Source: the author

The quantity of publications about communication in DSD projects was little in early 2000's, reaching a peak of 5 studies in 2003. But it has grown vertiginously to 20 studies in 2006, when the first edition of the conference ICGSE ('International Conference on Global Software Engineering') occurred. An average of 23 studies/year was kept until 2012. In 2013, the search became limited to publications of the first semester, period of time in which there had been no conferences that contributed significantly to the quantity of studies in previous years (ICGSE, CSCW and WDDS).

As for the local of the publication, 72,28% (137) of the studies were originated from conferences, and the other 27,71% (47) came from newspapers/magazines as shown in details in Tables 35 and 36. There were 30 conferences and 19 newspapers/magazines that contributed with only one study (see Appendix H), and are represented by the line 'Others'. The conferences and newspapers/magazines highlighted with bold were selected in the elaboration of the protocol.

Table 35 - Origin of the primary studies (conferences).

Conferences	Primary Studies	(%)
International Conference on Global Software Engineering	**44**	**32,12**
International Conference on Computer Supported Cooperative Work	**10**	**7,30**
International Conference on Software Engineering	**8**	**5,84**
Workshop on Collaborative Teaching of Globally Distributed Software Development	**8**	**5,84**
IET Software	**4**	**2,92**
International Symposium on Empirical Software Engineering and Measurement	**4**	**2,92**
Hawaii International Conference on System Sciences	4	2,92
International Conference on Requirements Engineering	3	2,19
International Conference on Product-Focused Software Process Improvement	3	2,19
Pacific Asia Conference on Information Systems	3	2,19
Software Engineering Approaches For Offshore and Outsourced Development	3	2,19
Agile Conference	3	2,19
Conference on Human Factors in Computing Systems	2	1,46
Conference on Computer Personnel Research	2	1,46
International Symposium on Empirical Software Engineering	2	1,46
International Conference on Collaborative Computing: Networking, Applications and Worksharing	**2**	**1,46**
European Conference on Information Systems	2	1,46
Others	30	21,90
Total	137	100

Source: the author

Table 36 - Origin of the primary studies (Newspapers and magazines).

Newspapers/magazines	Primary studies	(%)
IEEE Software	**5**	**10,64**
Communications of the ACM	**5**	**10,64**
Journal of Software: Evolution And Process	**4**	**8,51**
Expert Systems	3	6,38
Information Systems Journal	**3**	**6,38**
Software Process: Improvement and Practice	2	4,26
Information and Software Technology	**2**	**4,26**
Transactions on Professional Communication	2	4,26
Transactions on Software Engineering	**2**	**4,26**
Others	19	40,43
Total	47	100

Source: the author

Four conferences got spotlighted from the others and contributed with 44, 10, 8 and 8 studies, respectively: 'International Conference on Global Software Engineering - ICGSE', 'International Conference on Computer Supported Cooperative Work - CSCW', 'International Conference on Software Engineering - ICSE' and 'Workshop on Collaborative Teaching of Globally Distributed Software Development - CTGDSD'. The ICGSE is the main conference about DSD projects and its first edition took place in Brazil in 2006. The conference ICSE is the main conference in Software Engineering. The CSCW focuses on the study of technologies for the cooperation and collaboration in projects that are not necessarily about software. The CTGDSD focuses on DSD projects conducted through collaborative courses involving universities, i.e. it is related to teaching of DSD.

As for the newspapers/magazines, three contributed with 5,5 and 4 studies respectively: 'Communications Of The ACM', 'IEEE Software', 'Journal of Software: Evolution And Process'. The first comprehends Computer Science and the two others focus on studies about Software Engineering.

The primary studies are associated with 431 different authors. Among these, 14 authors play the most important contributors, as shown in Figure 41.

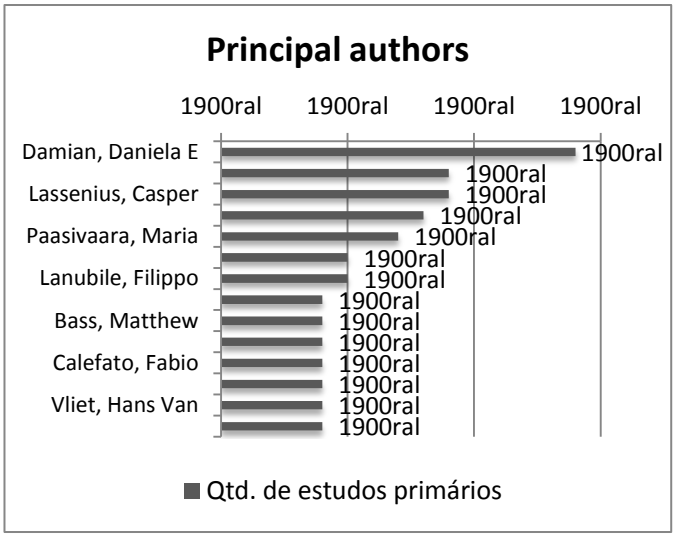

Figure 41 - Contributing authors of the primary studies. Source: the author

Regarding the scientific method utilized and expressively named in the primary studies, some stood out like 'Case Study' (40,28%), 'Experience Report' (17,36%), the 'Experiment' (13,19%), the 'Survey' (13,19%), and the 'Qualitative Study' (6,94%), as shown in Table 37.

Table 37 - Searching methods of the primary studies.

Scientific Method	Primary Studies
Case Study	58
Experience Report	25
Experiment	19
Survey	15
Qualitative Study	10
Etnography	7
Search-Action	4
Empirical Study	3
Design Science	1
Delphi Survey	1
Quantitative Study	1

Source: the author

According to Easterbook *et al.* (2008), the Software Engineering researchers have difficulty choosing the appropriate method for the empirical studies, since the benefits and challenges to utilize each method are still not well registered. In this point, it is worth to inform that 24,46% (45) of the primary studies did not indicate the utilized searching method, being inferred that the work was an empirical study by the reference to techniques of gathering and analysis of qualitative and/or quantitative data.

Regarding the techniques of data gathering, the ones that stand out are ‘interview’ (89), the ‘questionnaire’ (29) and the ‘files analysis’ (28). As shown in Table 38. In this point, it is valid to inform that 17,93% (33) of the primary studies did not clarify the data gathering technique utilized.

Table 38 - Data gathering in the primary studies.

Technique	Primary Studies
Interview	87
Files Analysis	28
Questionnaire	22
Observation	7
Survey	5
Online Survey	2
Focal Group	2
Delphi Technique	1
Panel with Experts	1
Ensobering	1
Workshop	1
Field Notes	1

Source: the author

In a similar way, the most used data analysis techniques are: ‘Fundamented Theory’ (24), ‘Coding’ (13) and ‘Quantitative Analysis’ (11) for qualitative data and ‘Statistical Analysis’ for quantitative data as shown in details in Table 39. In this point, it is valid to inform that 48,91% (90) of the primary studies did not clarify the data analysis technique that was used.

Table 39 - Data analysis in the primary studies.

Type of data	Technique	Primary Studies
Qualitative data	Fundamented Theory	24
	Coding	13
	Qualitative Analysis	11
	Content Analysis	9
	Social Network Analysis	5
	Coding	4
	Categorization	2
	Interview Analysis	1
	Analysis of the Shared Mental Model	1
	Analysis between cases	1
	Thematic Analysis	1
	Classification	1
	Data Reduction Method	1
	Narrative	1
	Abstract	1

Quantitative data	Statistics	37
	Graphic	1
	Histogram	1

Source: the author

There were failures in the indication of several aspects of the scientific methodology (absence of classification of the study in a scientific method and absence of description of the technique used for gathering analysis of data). As Marconi and Lakatos (2010) emphasize: the absence of scientific methods can reduce or eliminate the obtainment of valid and truthful knowledge in a search.

Figure 42 shows a categorization of empirical studies according with the main subject of the research. The classification forced an atribution of the study to a single subject, and was made through the reviewing of the title and objective of each study.

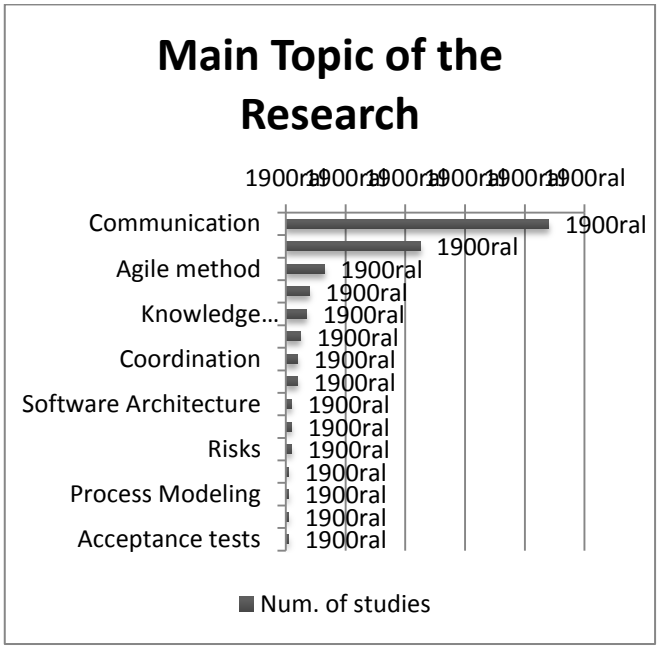

Figure 42 - Main research topics in the primary studies. Source: the author

Most of the primary studies are mainly about the communication in DSD projects (88). There is also a category of studies that show challenges/solutions in a DSD projects, detailing the communication process (45). The categories Agile Method (13), Collaboration (8) and Knowledge Management (7) also stood out.

It is also possible to obtain the total number of answers to the search questions: 64,13% (118) of the primary studies answered to the PP 1, while the PP 2 received evidences from 92,93% (171) of the studies (Figure 43).

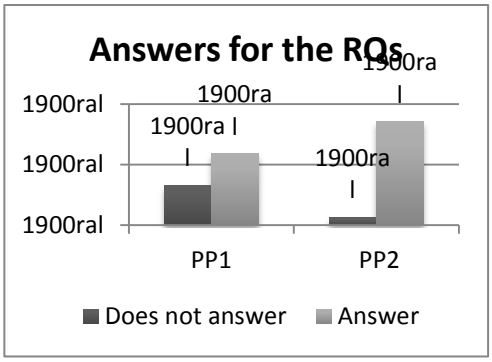

Figure 43 - Answers to the search questions. Source: the author

PP 1 – What are the factors that influence the communication in DSD projects?

The result of this search answer supplies us with a wide view of the factors that influence the communication in DSD project. In Table 40 the factors are shown with a percentage of primary studies that evidence them. All the factors are detailed above.

Table 40 - Factors that influence the communication in DSD projects.

Factors (F1-F35)	Primary Studies	Quantity of Studies (%)
F1. Cultural Difference	E007, E061, E061, E063, E089, E106, E108, E127, E137, E142, E151, E152, E158, E172, E173, E178, E192, E212, E216, E238, E248, E301, E304, E310, E329, E344, E357, E413, E469, E493, E493, E530, E533, E544, E557, E568, E581, E602, E639, E641, E646, E664, E672, E690, E695, E703, E708, E729, E736, E752, E763, E795, E825, E880, E902.	55/184 (29,35%)
F2. Temporal Difference	E007, E070, E082, E106, E137, E142, E146, E146, E172, E173, E212, E216, E237, E310, E329, E344, E376, E413, E458, E469, E495, E497, E544, E557, E558, E568, E581, E602, E664, E695, E729, E799, E827, E880.	54/184 (29,35%)
F3. Physical Difference	E080, E082, E090, E137, E152, E171, E173, E262, E276, E310, E344, E376, E458, E493, E495, E544, E602, E672, E708, E736, E799, E825, E827.	23/184 (12,50%)

F4. Infrastructure	E127, E146, E173, E178, E218, E301, E333, E375, E413, E458, E497, E544, E557, E703, E714, E880.	16/184 (8,70%)
F5. Activity of Software Engineering	E010, E080, E088, E089, E158, E197, E462, E469, E558, E568, E898.	11/184 (5,98%)
F6. Communication (constant/ informal)	E005, E070, E142, E212, E261, E331, E376, E407, E614, E666, E880.	11/184 (5,98%)
F7. Structure of the team	E007, E090, E171, E218, E219, E304, E347, E569, E646, E814, E898.	11/184 (5,98%)
F8. Adequacy of the channel	E043, E061, E142, E158, E212 E218, E238, E331, E344, E413.	10/184 (5,98%)
F9. Role and responsibility	E090, E106, E158, E197, E208, E237, E560, E695, E763, E898.	10/184 (5,43%)
F10. Software process	E005, E036, E082, E089, E156, E165, E172, E469, E672, E891.	10/184 (5,43%)
F11. Tasks distribution	E037, E061, E173, E261, E265, E558, E778, E898, E908.	9/184 (4,89%)
F12. Acquaintance with the team	E219, E276, E296, E376, E530, E543, E655, E714, E795.	9/184 (4,89%)
F13. Trust	E061, E137, E296, E310, E407, E458, E530, E572.	8/184 (4,35%)
F14. Consciousness about the team	E181, E219, E230, E252, E344, E594, E778.	7/184 (3,80%)
F15. Ability of expression	E142, E331, E344, E376, E497, E763, E795.	7/184 (3,80%)
F16. Importance of the message	E037, E061, E158, E178, E219, E321.	6/184 (3,26%)
F17. Personal preference for the channel	E158, E276, E375, E413, E462, E799.	6/184 (3,26%)
F18. Consciousness about the task	E061, E080, E146, E219, E276.	5/184 (2,72%)
F19. Cost	E127, E142, E172, E643.	4/184 (2,17%)
F20. Availability of the channel	E142, E158, E192, E375.	4/184 (2,17%)
F21. Motivation	E261, E310, E530, E666.	4/184 (2,17%)
F22. Technical capacity	E089, E347, E376, E643.	4/184 (2,17%)

F23. Knowledge management	E261, E708, E825.	3/184 (1,63%)
F24. Pressure	E321, E458, E714.	3/184 (1,63%)
F25. Interpersonal relationships	E146, E151, E458.	3/184 (1,63%)
F26. Conflicts	E639, E814.	2/184 (1,09%)
F27. Consciousness about availability	E061, E219.	2/184 (1,09%)
F28. Coordination	E212, E458.	2/184 (1,09%)
F29. Availability of the member	E276, E344.	2/184 (1,09%)
F30. Information protection	E142, E898.	2/184 (1,09%)
F31. Information overload	E146, E181.	2/184 (1,09%)
F32. Unexpected changes	E061.	1/184 (0,54%)
F33. Planning	E208.	1/184 (0,54%)
F34. Quality of the documentation	E262.	1/184 (0,54%)
F35. Extent of the project	E558.	1/184 (0,54%)

Source: the author

To summarize, the studies that were selected made evident that 34 factors that influence communication in DSD projects. The five factors that influence communication the most are F1. Cultural Difference (53/184), F2. Temporal difference (34/184), F3. Physical Difference (23/184), F4. Infrastructure (16/184), F5. Software Engineering Activities. In more details, the factors influence in a positive or negative way five characteristics of the communication: frequency, wealth, speed, efficacy and interlocutors. The frequency of the communication is the characteristic that suffered more impact due to the distribution of the teams, followed by wealth, efficacy, speed and perception about the interlocutors.

The factors influenced the frequency of the communication positively, making the interactions more constant and adequate or reducing the need of interaction without causing damage to the Project. On the other hand, when influenced negatively, a lack of necessary communication or the excessive need

for information exchange occurs. Table 41 shows which factor influenced this characteristic of the communication and the studies that make it evident.

Table 41 - Influence of the factors in the frequency of communication.

Characteristic of the communication: Frequency	
Positive influence -> Constant and adequate interaction	Negative influence -> Lack of communication
F13. Acquaintance among the teams (E219, E276, E296, E376, E655). F9. Role of the interlocutors (E106, E197, E560, E898). F5. Software Engineering Activity (E197, E265, E898). F7. Communication (constant, informal e F2F) (E376, E666). F8. Software Process (E165, E469). F15. Relevance of the message (E219, E061). F6. Structure of the team (E090). F11. Conscience about the teams (E219). F16. Personal preference for the communication channel (E276). F18. Conscience about the tasks (E080). F19. Hability of expression (E497). F34. Size of the project (E458).	F3. Physical difference (E080, E082, E090, E152, E272, E334, E493, E602, E799, E825, E827, E736). F2. Temporal difference (E142, E329, E495, E544, E581, E729). F1. Cultural difference (E106, E108, E216, E493). F7. Communication (constant, informal e F2F) (E070, E142, E880, E407). F10. Trust (E061, E407, E458). F23. Pressure (E321, E458, E714). F20. Monetary cost (E127, E643, E142). F4. Infrastructure (E158). F22. Motivation (E530). F27. Availability of the interlocutor (E276). F28. Protection of the information (E898). F29. Interpersonal relationship (E458).
Positive influence -> Little need for interaction	Negative influence -> Excessive interaction
F12. Distribution of the tasks (E908). F21. Knowledge management (E708).	F12. Distribution of the tasks (E218, E558, E898). F6. Structure of the team (E898).

Source: the author

The factors influenced positively the "Richness of communication", making the choice of communication channels more appropriate to the occasion (channels based in text, audio or video). However, when the “richness” is influenced in a negative way, there is a forced selection of narrower channels, i.e. some information that are not exchanged are missed. The Table 42 indicates which factor influenced this characteristic of the communication and the studies that make it evident.

Table 42 - Influence of the factors "Richness of communication"

Characterisct of the communication: Richness	
Positive influence -> Appropriate richness	Negative influence -> Poor communication
F5. Software Engineering activity (E061, E088, E158, E462, E469, E558, E568). F15. Relevance of the message (E037, E158, E178, E321). F16. Personal preference for the communication channel (E158, E375, E462). F1. Cultural differences (E238, E752). F9. Role of the interlocutors (E158). F17. Technical capacity (E347). F28. Protection of the information (E142).	F1. Cultural differences (E158, E212, E310, E825, E880). F4. Infrastructure (E375, E413, E703, E497). Temporal difference (E497, E880, E082). F3. Physical difference (E310). F10. Trust (E530, E310). F22. Motivation (E310). F26. Coordination (E212).

Source: the author

The factors influenced positively the efficacy of the communication, making more simple to understand the message among the interlocutors. On the other hand, when the efficacy is negatively influenced, misunderstandings may arise, turning the information exchange into a difficult process. Table 43 indicates which factor influenced this characteristic of the communication and the studies that make it evident.

Table 43 - Influence of the factors in the efficacy of the communication.

Characteristic of the communication: Efficacy	
Positive influence -> Easy comprehension of the message	Negative influence -> Misunderstandings
F8. Software process (E005, E082, E089, E156, E672, E891). F7. Communication (informal, constant and face to face) (E666, E005). F9. Role of the interlocutors (E208). F10. Trust (E572). F11. Conscience about the teams (E181). F32. Planning of the communication (E208).	F1. Cultural difference (E127, E172, E173, E192, E329, E344, E357, E469, E568, E602, E641, E703, E729, E736). F4. Infrastructure (E301, E127, E544). F14. Limitation of the communication channel (E344, E158, E331). F19. Hability of expression (E795).

Source: the author

The factors influenced positively the speed of the communication, reducing the time it took to have a satisfactory communication. However, when the speed of the communication is negatively influenced, there is a delay in the communication. Table 44 indicates which factor influenced this characteristic of the communication and the studies that make it evident.

Table 44 - Influence of the factors in the speed of communication.

Characteristic of the communication: Speed	
Positive influence -> Fast communication	Negative influence -> Delay in the communication
F11. Conscience about the teams (E594, E788) F6. Structure of the team (E171) F8. Software process (E156) F13. Acquaintance among the teams (E714) F25. Conscience about availability (E061)	F2. Temporal difference (E106, E172, E173, E212, E216, E344, E469, E799) F1. Cultural difference (E173, E413, E493, E581, E690) F3. Physical difference (E495, E544) F6. Structure of the team (E218, E898)

Source: the author

These factors influenced positively the perception about the interlocutors, making more easy to recognize disperse teams (“who they are”, “their habilities”, “their culture” “ways to get in touch”, etc). On the other hand, when it is negatively influenced, there is a poor identification of who the teams in the project are. Table 45 indicates which factor influenced this characteristic of the communication and the studies that make it evident.

Table 45 - Influence of the factors in the perception about the interlocutors.

Characteristic of the communication: Perception about the interlocutors	
Positive influence -> Adequate knowledge	Negative influence -> Low knowledge
F1. Cultural difference (E061, E089, E646). F6. Structure of the team (E219, E304).	F3. Physical difference (E544)

Source: the author

Factor F1 (Cultural Difference) stands out for it has the biggest amount of evidence found (53/184), and for influencing all the five characteristics of the communication. The following factors also stand out for having necessarily positive influence: F8 (Software Process), F9 (Role and Responsability), F11 (Conscience about the team), F13 (Acquaitance among the teams), F15 (Relevance of the message), F16 (Personal preference for the communication channel), F17 (Technical capacity), F18 (Conscience about the tasks), F21 (Knowledge Management), F25 (Conscience about availability), F32 (Planning of the communication).

While the following factors had necessarily negative influence: F2 (Temporal difference), F3 (Physical difference), F4 (Infrastructure), F14 (Limitation of the communication channel), F20 (Monetary cost), F22

(Motivation), F23 (Pressure), F26 (Coordination), F27 (Availability of the interlocutor), F29 (Interpersonal relationship).

4.3.10 COMPARISON BETWEEN FACTORS FROM SRL 2 AND SRL 1

The factors that influenced the communication in DSD projects identified in this research were compared to the factors identified in the first systematic literature review executed in this thesis, described in the Section 4.1 (Called from now on "SLR1", due to its earlier execution in this doctoral research (Table 46). Only two factors of the SLR1 ("F14. Colaboration Tools" and "F25. Colaboration Models") were not evidenced in the RSL2. However, was comprehended as a practice used to the communication (P5. Use collaboration platforms – described in the Table 39), and nineteen distinct factors surged, as shown on Table 46.

Table 46 - Comparison of the factors of the SRL1 with the SLR 2.

SRL 2 (F1-F34)	**SLR 1** (F1-F25)
F1. Cultural differences (53/184)	F1. Cultural differences (8/20) F3. Language/Linguistic barriers (7/20) F24. Different Styles of Communication (1/20) F28. Processes of Translating and Coding (1/20)
F2. Temporal differences (34/184)	F4. Temporal Distance (6/20) F21. Synching of the Working Shifts (1/20)
F3. Physical differences (23/184)	F2. Geographic Dispersion (7/20)
F4. Infrastructure (16/184)	F8. Infrastructure (5/20) F15. Extremely broad band (2/20)
F5.Software Engineering Activity (13/184)	-
F6. Structure of the team (12/184)	F19. Contact Networks (2/20) F22. Quantity of Distributed Teams (1/20) F27. Size of the Personal Networks (1/20)
F7. Communication (constant, informal e F2F) (10/184)	F7. Limited Informal Communication (6/20) F9. Abscence of Face-to-face Interaction (5/20)
F8. Software Process (10/184)	F11. Application of Agile Approaches (4/20)
F9. Role of the interlocutors (9/184)	F20. Definition of Roles and Responsibilities (2/20)
F10. Trust (8/184)	-
F11. Conscience about the teams (7/184)	-
F12. Distribution of the tasks (7/184)	F13. Distribution of Tasks (4/20)
F13. Acquaintance among the teams (7/184)	-
F14. Limitation of the communication channel (7/184)	F10. Definition of Communication Media (5/20) F12. Selection of Communication Technologies (4/20)
F15. Relevance of the message (6/184)	-

F16. Personal preference for the communication channel (5/184)	F26. Multiple Communication Channels/2)
F17. Technical capacity (4/184)	-
F18. Conscience about the tasks (4/184)	F17. Teams Conscience (2/20)
F19. Hability of expression (4/184)	F18. Communication Habilities (2/20)
F20. Monetary cost (3/184)	-
F21. Knowledge Management (3/184)	-
F22. Motivation (3/184)	-
F23. Pressure (3/184)	-
F24. Conflict (2/184)	-
F25. Conscience about availability (2/184)	-
F26. Coordination (2/184)	-
F27. Availability of the interlocutor (2/184)	-
F28. Protection of the information (2/184)	-
F29. Interpersonal relationship (2/184)	F29. Weak Social Relationships (1/20)
F30. Information overload (2/184)	-
F31. Unexpected changes (1/184)	-
F32. Planning of the communication (1/184)	F16. Communication Patterns (2/20) F23. Communication Policies (1/20)
F33. Quality of the documentation (1/184)	-
F34. Size of the project (1/184)	-
-	F14. Collaboration Tools (4/20)
-	F25. Collaboration Models (1/20)

Source: the author

PP 2 – What are the practices involved in the communication in DSD projects?

The result of this search question supplies us with a wide view of the practices that are involved in the execution of the communication in DSD projects. In Table 47, practices with a percentage of primary studies that make them evident are shown. All the practices are detailed above.

Table 47 - Practices used for communicating in projects of DSD.

Practices (P1-P29)	Primary studies	Quantity of studies (%)
P1. Have meetings/face to face encounters	E047, E061, E067, E098, E104, E106, E137, E151, E166, E172, E197, E212, E219, E224, E237, E276, E329, E331, E334, E364, E413, E429, E462, E477, E504, E533, E539, E543, E558, E568, E569, E572, E602, E614, E655,	72/184 (39,13%)

	E752, E763, E898, E902, E908, E005, E007, E043, E070, E090, E093, E117, E127, E151, E152, E165, E166, E192, E301, E333, E344, E357, E399, E457, E493, E530, E589, E591, E606, E643, E646, E708, E773, E814, E891, E898, E908.	
P2. Send 'embassador' to remote locals	E105, E142, E891, E218, E261, E457, E504, E605, E827.	9/184 (4,89%)
P3. Use unsynched communication via technological tools	E005, E037, E061, E067, E080, E082, E088, E090, E092, E093, E094, E127, E142, E146, E147, E153, E155, E156, E158, E160, E165, E171, E172, E173, E175, E177, E178, E181, E192, E208, E212, E224, E237, E252, E262, E282, E301, E310, E329, E331, E333, E334, E357, E364, E375, E376, E399, E462, E493, E504, E544, E557, E569, E581, E589, E591, E602, E605, E616, E646, E655, E666, E672, E703, E714, E736, E773, E795, E799, E825, E891, E898, E158, E218, E591.	75/184 (40,76%)
P4. Use synched communication via technologic tools	E036, E037, E045, E047, E067, E070, E080, E090, E094, E104, E127, E146, E147, E152, E153, E155, E156, E158, E165, E171, E178, E192, E197, E212, E218, E224, E237, E252, E262, E282, E301, E310, E321, E329, E331, E333, E357, E375, E387, E399, E413, E421, E425, E427, E462, E488, E493, E530, E544, E557, E558, E569, E581, E591, E602, E615, 6E16, E639, 6E46, E666, E708, E714, E773, E799, E898, E908, E005, E007, E061, E070, E080, E082, E088, E104, E106, E152, E155, E158, E172, E173, E177, E192, E212, E237, E252, E262, E301, E310, E329, E331, E333, E364, E413, E425, E462, E605, E612, E672, E736, E773, E898, E037, E156, E158, E177, E224, E237, E262, E282, E301, E344, E364, E375, E376, E399, E413, E457, E496, E533, E544, E591, E605, E616, E666, E708, E795, E827, E912, E158, E218, E591, E488, E714, E333, E376,	151/184 (82,07%)

	E002, E405, E462, E641, E037, E104, E153, E166, E197, E218, E301, E375, E413, E560, E898, E002.	
P5. Use colaboration platforms	E037, E063, E066, E067, E090, E092, E112, E147, E153, E171, E172, E181, E201, E203, E263, E301, E323, E336, E357, E408, E409, E410, E425, E434, E495, E581, E591, E695, E774, E806, E837, E855, E891, E903, E166, E175, E197, E216, E224, E227, E296, E329, E413, E495, E504, E569, E703, E714, E773, E880, E092, E127, E224, E282, E329, E570, E596, E736, E237, E252, E404, E646, E845.	63/184 (32,24%)
P6. Use fóruns to discuss topics of the Project	E127, E212, E262, E331, E591, E643, E880, E070, E106, E175, E177, E310, E357, E543, E544, E558, E708.	17/184 (9,24%)
P7. Use image gallery	E172.	1/184 (0,54%)
P8. Have frequent meetings	E047, E107, E137, E142, E160, E165, E192, E197, E218, E235, E344, E357, E376, E413, E495, E558, E572, E643, E655, E666, E690, E708, E736, E795, E891, E908.	26/184 (14,13%)
P9. Select the communication channels	E070, E086, E092, E146, E152, E153, E192, E264, E282, E329, E331, E334, E375, E413, E425, E457, E497, E591, E708, E714, E795, E013, E093, E158, E188, E216, E329, E357, E375, E429, E495, E497, E646, E714, E908	35/184 (19,02%)
P10. Name a focal point (interlocutor) of the communication in the DSD team.	E047, E061, E070, E160, E192, E197, E216, E218, E227, E254, E263, E329, E333, E457, E557, E605, E708, E729, E763, E795, E814, E061, E181, E616, E778, E300	26/184 (14,13%)
P11. Describe the communication protocol	E047, E224, E429, E497, E530, E581, E605, E643, E664, E703, E714, E752, E825, E893, E230, E695.	16/184 (8,70%)
P12. Monitor the communication	E076, E120, E201, E333, E404,	10/184 (5,43%)

	E409, E497, E558, E643, E846.	
P13. Have training	E110, E137, E261, E294, E602, E605, E646, E891, E908, E530, E581, E664, E703, E880, E893.	15/184 (8,15%)
P14. Standardize the language of the project	E061, E110, E137, E203, E329, E557, E605, E639.	8/184 (4,35%)
P15. Document artifacts of the system	E061, E070, E098, E172, E212, E218, E331, E614.	8/184 (4,35%)
P16. Share a meeting agenda	E147, E192, E364, E376, E616, E643, E646.	7/184 (3,80%)
P17. Provide communication infrastructure	E127, E142, E158, E212, E333, E602, E739.	7/184 (3,80%)
P18. Pass the results of the meeting on to the interested parts	E106, E147, E197, E301, E814, E825.	6/184 (3,26%)
P19. Use a shared schedule in meetings	E192, E364, E376, E413, E641.	5/184 (2,72%)
P20. Use a moderator in meetings	E160, E429, E493, E643, E795.	5/184 (2,72%)
P21. Keep the safety of the information of the project	E404, E457, E736, E795, E825.	5/184 (2,72%)
P22. Standardize the vocabular	E212, E304, E399, E530, E891.	5/184 (2,72%)
P23. Form subteams	E007, E166, E218.	3/184 (1,63%)
P24. Standardized communication documents	E347, E643, E752.	3/184 (1,63%)
P25. Recruit capable professional	E703, E891.	2/184 (1,09%)
P26. Test the infrastructure of the communication	E127, E646.	2/184 (1,09%)
P27. Encourage agility in the *feedback*	E171, E898.	2/184 (1,09%)
P28. Make translations	E192, E502.	2/184 (1,09%)
P29. Synch working shifts	E166, E795.	2/184 (1,09%)

Source: the author

To sumarize, the selected studies made evident 29 practices that are used for the communication in DSD projects. Can be noticed that the distributed teams make the direct communication through two direct practices: P1. Make meetings/face-to-face encounters (72/184) and P2. Send 'embassador' to remote locals (9/184).

However, in general the five practices of the communication adopted in DSD projects that stand out for the quantity of evidence that was found are: P1. Make meetings/face-to-face encounters (72/184), P3. Use unsynched communication via technologic tools (75/184), P4. Use synched communication

via technologic tools (151/184), P5. Use collaboration platforms (63/184) and at last, P9. Use collaboration platforms (35/184).

On the other hand, other practices also stood out in the evidence analysys such as: P8. Make frequent meetings, P11. Describe the communication protocol, P14. Standardize the language of the Project and, at last the P32. Share a meeting agenda.

4.3.11 COMPARISON BETWEEN THE PRACTICES FROM SRL2 AND THE EMPIRICAL STUDY

The practices that are used in the communication in DSD projects identified in this research were compared with the practices that were identified in its empirical study of this thesis and its results are described in Section 4.2. Most of the time, there was a difference in the denominations or nomenclature of the practices, because of that it was necessary a little more interpretation to make the comparison (Table 48).

Table 48– Comparison of the practices of the SRL2 with the empiral study.

Practices (P1-P29)	Practices of Empirical Study (P1-P31)
P1. Make face-to-tace encounters	P9. Periodical face to face meetings.
P2. Send 'embassador' to remote locals	P5. Exchanging of members among dispersed teams.
P3. Use unsynched communication via technologic tools	P3. Adoption of synchronous and asynchronous tools.
P4. Use synched communication via technologic tools	P3. Adoption of synchronous and asynchronous tools.
P5. Use collaboration platforms	P6. Adoption of collaboration tools.
P6. Use foruns to discuss topics of the Project	P17. Discussion forums.
P7. Use an image gallery (reduce the physical distance among the teams – create trust)	P14. Keep a nice and harmonious work environment
P8. Make frequent meetings	P2. Daily meetings ; P20. Continuous feedback of the status of the Project.
P9. Selectiont of the communication channels	-
P10. Name a focal point (interlocutor) of the communication in the DSD team.	P1. Defining communication ambassadors (focal points or speakers).
P11. Describe the communication protocol	P18. Establish communication policies; P19. Establish a communication plan.

P12. Monitor the communication	P8. Create mechanisms to confirm the understanding of the activities
P13. Have trainings	P4.Definition of communication training programs.
P14. Standardize the language of the Project	-
P15. Document artifacts of the system	-
P16. Share a meeting agenda	P26. Plan and manage meetings.
P17. Provide communication infrastructure	P27. Define communication infrastructure for the Projects taking into account the level of dispersion
P18. Pass results of the meeting on to the interested parts	P20. Continuous feedback of the status of the Project; P23. Publish periodically a report of the performance of the Project; P25. Communicate the lessons that were learnt; P30. Distribute information to the stakeholders.
P19. Use a shared scheduled in meetings	P26. Plan and manage meetings.
P20. Use a moderator in meetings	P26. Plan and manage meetings.
P21. Keep the safety of the information of the project	-
P22. Standardize the vocabulary	P12. Define and institutionalize the vocabulary of the project to the teams.
P23. Form subteams	-
P24. Standardize communication documents	P13. Standardize the activities and reports to the distribution of information to the interested parts.
P25. Recruit capable professionals	-
P26. Test the infrastructure of the communication	P27. Define communication infrastructure for the Projects taking into account the level of dispersion
P27. Encounrage agility in the feedback	P2. Daily meetings; P8. Create mechanisms to confirm the understanding of the activities; P12. Define and institutionalize the vocabulary of the project to the teams; P13. Standardize the activities and reports to the distribution of information to the

	interested parts; P17. Discussion forums; P23. Publish periodically a report of the performance of the Project.
P28. Make translations	-
P29. Sync working shifts	-

Source: the author

"After the comparison between the SLR2 and the empirical study, we found out that only eleven practices of the empirical study (Section 4.2) were not made evident/contemplated in this SLR2, which are:

- P5. Exchanging of members among dispersed teams
- P7. Making of technical workshops about technologies used in the project.
- P10. Institutionalize the cultural context of each team that belongs in the Project
- P11. Use good practices to plan the communication of the Project
- P15. Discuss the improvement of the communication on the SEPG
- P16. Define roles and responsibilities
- P21. Obtain understanding of the requirements
- P22. Keep the ability to track the requirements
- P24. Carry out a closing meeting of the Project
- P28. Commitment of the stakeholders with the communication plan
- P29. Define a communication strategy

However, in SLR2 eight new practices were identified, practices which were not indentified in the empirical study. They are:

- P3. Use unsynched communication via technologic tools
- P9. Select the communication channels
- P14. Standardized the language of the Project
- P15. Document artifacts of the system
- P21. Keep the safety of the information of the project
- P25. Recruit capable professionals
- P28. Make translations
- P29. Sync the working shifts

Then both researches compliment each other with the objective of broadening the basis of good practices regarding the communication in DSD projects.

4.4 FOCUS GROUPS

The evaluation was performed by two focus groups with experts (Phase 3 of our methodological approach - see Section 1 - Figure 2). Experts from both groups were invited to participate in the study through formal requests sent to organizations via e-mail. For the invitation, we also sent a summary of the work, as well as the prerequisites for participation in research. For the first focus group was important to have at least five years of professional experience in maturity models, and at least one year of experience in DSD projects according to the Table 49.

Table 49 – Characteristics of the participants of the first focus group.

ID	Participants (PA)	Maturity Experience	DSD Experience	Formation
01	PA1	Software Process and Quality consultant (8 years), CMMI-SW and MPS.BR implementer (5 years) and, at least, CERTICS assessor and implementer.	1 year	Ongoing Phd
02	PA2	Software Quality and Process Consultant (10 years), ISO 9001 leader assessor (8 years), CMMI-SW implementer (5 years), MPS.BR assessor and implementer (5 years) and CERTICS assessor and implementer.	2 years	Ongoing Phd
03	PA3	Software Quality and Process Consultant (10 years), MPS.BR implementer (5 years) and Project Manager (10 years).	2 years	MBA
04	PA4	Software Quality and Process Consultant (10 years), MPS.BR implementer (5 years).	2 years	Ongoing Phd
05	PA5	Software Quality and Process	1 year	Ongoing Phd

		Consultant (6 years), ISO 9001 leader Assessor (1 year), CMMI-SW implementer (5 years), MPS.BR assessor and implementer (3 years) and CERTICS assessor and implementer.		
06	PA6	Software Quality and Process Consultant (8 years), CMMI-SW implementer (5 years), CMMI-Service implementer (2 years), MPS.BR implementer (6 years)	3 years	Ongoing Phd
07	PA7	Software Quality and Process Consultant (8 years), MPS.BR implementer (2 years).	1 year	Phd

Source: the author

For the second focus group, it was important to have at least five years of experience in DSD projects and some knowledge on maturity models. We define these two criteria to make sure that both the DSD and the maturity aspects of software processes are properly covered in our model. As a result of our invitations, two organizations allowed their collaborators to participate in our study after signing a confidentiality agreement with the research team.

The first focus group was run with seven (7) experts in maturity processes for software development. They are employees of a consulting company in maturity models for software processes. All experts have either a Master or a PhD degree in Computer Science. They had an average experience in quality maturity models (e.g., ISO 9001, CMMI, and MPS.BR) of eight years. They also had an average of two years of professional experience in DSD projects. They evaluated the structure of the C2M model and the distribution of the maturity factors in their respective level of maturity, as well as the number of levels of the model.

The second focus group was run with six (6) experts with large experience in DSD projects, distributed as follows: three developers, one tester and two managers. All experts have a Master in Computer Science degree (Table 50). The experts have an average of six years of professional experience in DSD projects. They evaluated the structure of the C2M model and distribution of the

maturity factors in their respective levels of maturity. They also gave special attention to the review of the practices proposed by the C2M.

Table 50 – Characteristics of the participants of the second focal group.

ID	Participants (PA)	Experience in DSD	Function	Formation
01	PA1	6 year	Project manager	Ongoing Phd
02	PA2	5 years	Tester	master's degree
03	PA3	8 years	Developer	master's degree
04	PA4	5 years	Developer	Ongoing Phd
05	PA5	5 year	Developer	master's degree
06	PA6	6 year	Project manager	master's degree

Source: the author

The systematic definition of data collection was taken from the discussion moderated by one of the researchers involved with the goal of checking practices for each maturity factor in order to obtain a more detailed feedback.

To make the method more efficient, a presentation of the maturity model for the communication in DSD projects was made and then a form was handed (Appendix I) with the information to be evaluated (factors, levels, structure and etc.) with space for them to write any comments they would like to remember in the moment of the discussion. After the start, was solicited that the participants that whenever they were told what the discussion topic was, they should feel free to expose their opinions and if anyone had a different opnion, they could complement in a way it would aggregate more knowledge. The following sections presents in more detail the topics discussed by the two focus groups.

4.4.1 Analysis of the answers related to the C2M structure:

None of the participants totally disagreed with the effectiveness of the structure proposed by the C2M. As a suggestion, it was pointed out the possibility of creating additional categories such as “Product Engineering” to categorize factors like requirements specification, configuration management, among

others. Another suggestion made by the participants was to evaluate the possibility of following the quantitative levels of CMMI or MPS.BR, because this adjustment would facilitate the use of C2M in companies.

4.4.2 Analysis of answers related to the C2M maturity factors:

With regards to the maturity factors, none of the experts disagreed with the importance of factors in the DSD context. However, as a suggestion, was pointed out the possibility to refactor some maturity factors, i.e, modify the internal structure of C2M template so that it is improved. For example, to unifying some factors (those which are similar, e.g., Selection of Communication Technologies, Collaboration Tools and Definition of the Communication Media) and then creating others related to the product engineering previously mentioned. These suggestions have the objective of making the C2M model more dynamic, light, and easier to use. The participants of the focus group commented:

First focus group

PA1 said that *"apparently all the factors are highly relevant. However, many can be grouped or turned into practices."*

PA2 said that *"there are many factors and this can create a stereotype of complexity to the model. I advise you to review some factors with the aim of grouping them, and remove the useless ones when appropriate."*

PA3 said that *"all factors are important, but you need to check if they are really needed in the context of DSD."*

PA4 said that *"the selection of factors for a first version is great. I think that over time, the model should mature and will certainly feel the need to make some changes."*

Second focus group

PA1 said that *"all factors are relevant. I think this model will be a good tool for the project manager."*

PA2 said that *"despite the belief that the factors are important, I think there are many factors in the model. I think we need to simplify to get the*

acceptance of the organizations. However, I want to register that in my opinion they are all extremely relevant to any kind of project."

PA3 said that *"it is necessary to decrease the amount of factors and to do that, I realized that it is possible to group some factors and others may become practices. Perhaps, the model would even adopt the concept of sub-factors."*

PA6 said that *"the proposed model is relevant and the composition of the factors is also relevant. I think that there is no need to changes in the model until its appliance in a real project."*

4.4.3 Analysis of answers related to the C2M practices:

Referring to the practices of the model, two experts expressed their concerns with the large number of practices in the first level of evolution. Their opinion is that the amount of practices can hamper the use of the model in small organizations. Another important point raised by some of the experts is about the title of the practices. They believe the titles need to be self-explanatory and as such they suggest us to review how we name some practices. It was pointed out the possibility of reviewing some specific practices, aiming to rewrite them or remove others that may be unnecessary. For example, the practices i) to establish direct and fast communication channel to doubts and problem solving, ii) to maintain face to face communication and iii) to establish a committee to continuous improvement of the communication process, of the maturity factors i) Communication Planning, ii) Face to Face Interaction and iii) Continuous Improvement of Communication, was suggested to be rewritten in order improve understanding of the practices of C2M.

The participants of the focus group commented:

First focus group

PA2 said that *"the practices are very interesting, but I think there are many practices for the proposed model. I think that a small business will not be able to deploy this model."*

PA6 said that *"all practices were effectively well selected. As a suggestion, I believe it is possible to improve the names of each practice to become more understandable."*

PA7 said that *"this model can certainly be complementary to existing models such as CMMI and MPS.BR. I think that some practices are very comprehensive."*

Second focus group

PA1 said that *"the number of practices is consistent with the amount of existing factors in the model."*

PA3 said that *"I think that some practices can be grouped and others can be grained. Another important point is to review the names and descriptions of the practices in order to they be understandable by the reader."*

PA6 said that *"I think that all practices are consistent. However, I missed some other practices, for example: Managing meetings verify the effectiveness of the trainings, among other practices."*

4.4.4 Analysis of answers related to the C2M model in general:

Although the model has been developed in the academy, the experts stated that it is a welcome asset for the software industry. The main reason for the experts to deem the C2M model suitable for use in real-life projects was that it has the following characteristics:

- defined scope and established goal (communication);
- simple architecture to ease the implementation;
- the topic is relevant to real-life projects;
- the solution proposed by the maturity model is applicable for organizations of any size;
- the C2M does not override other quality models (it can be seen as supplementary model).

4.5 CONSIDERATIONS OF THE CHAPTER

This evaluation of the C2M model, executed by two focal groups, was extremely important, since we had the opportunity to review the staggering of the maturity factors, evaluate all the practices to operationalize the implementation of the C2M, and verify possible adjusts, like: group, include, exclude or change maturity factors, as well as their respective practices. Furthermore, we can capture suggestions in a general way to the proposed model. Ten respondents

(76%) pointed that the C2M model certainly will bring benefits to the communication in projects, and that they could adopt the model in their projects. However, three (24%) respondents said that the model is promising, but they believe that the model is more directed to medium and large organizations. These three respondents still declared the C2M should be put in practice (executed in real projects) to an observation of their real benefits.

5. COMMUNICATION MATURITY MODEL - C2M

In this chapter, we present the proposed maturity model with its respective characteristics. It was conceived from the execution of the phases foreseen in the research design presented in the Section 1.3 of methodology.

5.1 C2M MODEL

The maturity model C2M was developed from an opportunity identified in the master's degree research (Farias Junior, 2008) and then, corroborated with the lack of existing references in the literature about the studied theme. Furthermore, the current DSD literature does not explore deeply the communication area (explicitation of problems, solutions and their practical applications to solve or minimize the negative impact of the communication in DSD projects).

Considering the scope of this research, a maturity model for communication in DSD projects can be defined as a set of best practices that are enhanced within an organization as there are adopted in their daily software development activities aiming to improve its communication processes and, consequently, the development processes supporting its DSD projects.

Once the goal is to measure the organizational maturity in regard to the effectiveness of a domain or discipline, the use of a maturity model seems to be the most appropriate alternative or approach (ALONSO et al., 2010). As such, for the area of interest in communication the Maturity Model in Communication (C2M).

C2M was developed in a systematic way, being based in other existing models (see Table 42). The conceptual basis of the model was extracted from the literature whose research had organized the knowledge body about communication (detailed in Chapter 2).

The C2M has as objective to organize and present the main practices of communication, extracted along the methodologic process adopted in this thesis. That can be applied to any company whose objective is to improve the communicational in DSD projects. The model describes a way of progressist evolution through four levels of maturity: Casual or Ad-hoc, Partially managed, Managed and Reflective (Figure 44), described in the next sections. The

structure in levels is a way to help organizations priorize the actions to improve communication. To reach any level, it is necessary to satisfact this level itself and the inferior ones.

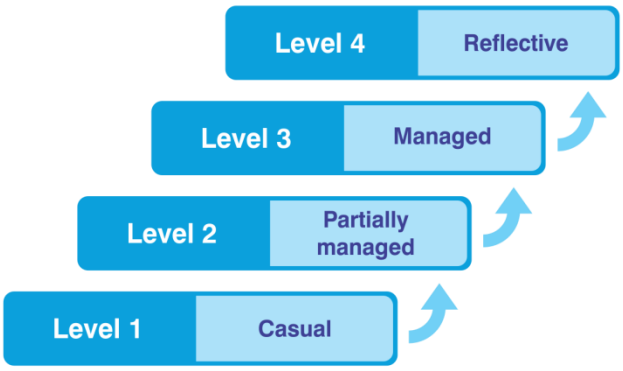

Figure 44 - C2M maturity levels. Source: the author

As a result of the research process, a maturity model for communication in DSD projects was proposed. This model had as basis the results carried out along the whole research proess, which include the related studies presented in Chapter 4 (namely, an ad-hoc vision of literature, two systematic reviews of literature, an empirical study, two focus groups and at last a survey with experts to evaluate the model C2M).

5.1.1 STRUCTURE OF THE C2M MODEL

The structure of the C2M model was defined based on the analysis of existing maturity and capability models. In practice, the C2M model was based in four consolidated maturity models in the software academia and industry: CMMI (staged representation) (CMMI, 2006), eSCM (HYDER, HESTON AND PAULK, 2006), MR-MPS (SOFTEX, 2012), and Wave (PRIKLADNICKI, 2009). Table 51 shows the origin of each element of the C2M model. Furthermore, C2M model was influenced by the "Architecture for Communication in Virtual Environment" described in Section 2, because it highlights the contemporary communicative process, mediated by information and communication technologies in cyberspace.

Table 51 - Elements of the C2M model.

Element of the model	Origin	Description
Staged Representation	CMMI-DEV and MR-MPS	Provides a well defined improvemente sequence (in levels), each one serving as a basis to the next.
Maturity Level	Wave, CMMI-DEV and P-CMM	The maturity levels are defined by the set of process areas for each the level. C2M are defined in a set of factors for each maturity level.
Maturity Area	Wave, eSCM and Author	A group of maturity factors and its practices, which is represented by a domain or knowledge area.
Maturity Factor	Santos, Farias Junior, Moura and Marczak (2012)	Describes the several communication maturity factors found in the research.
Goal	CMMI-DEV, MR-MPS and Wave	Briefly it, describes the goal to be reached by the maturity factor.
Practice	Author	Items which must be satisfied to reach an arbitrary objective.
Design	eSCM and Wave	Graphical representation of the model

Source: the author

In order to reach a level of excellence or quality in the communication of DSD projects, it is necessary that a set of maturity factors (i.e., group of related practices), when collectively implemented, meet a determined quality level. However, whether the organization is not interested in identifying its maturity level, it can decide which maturity factors are implemented according with its business/strategic objectives.

The maturity areas in the C2M model represent a mapping of the different categories for the types of identified factors. Some models have a similar concept identified as “domains”. For each maturity area, there are maturity factors which, in turn, have goals. Each maturity factor has only one goal. Furthermore, the maturity factors have one or more practices which should be implemented to treat communication in DSD projects. Finally, by accomplishing some practices established in a set of factors, it is elegible to determine the organization’s level of maturity in the moment it was assessed.

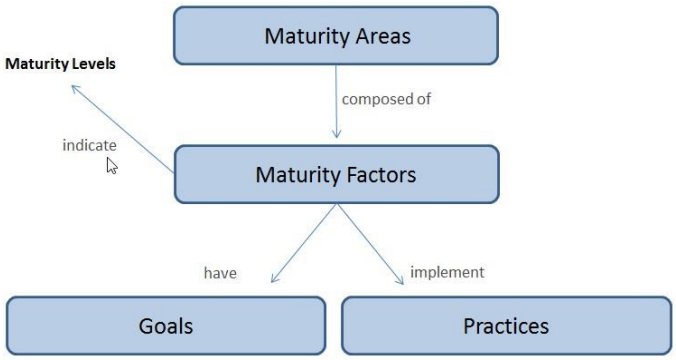

Figure 45 - Structure of the C2M model. Source: the author

Therefore, the C2M model has a structure with three dimensions: maturity areas, maturity factors and maturity levels (check Figure 45). This structure was based on the software quality literature and was experimentally built for C2M. In order to identify the maturity areas and levels, we have used data from Ad-Hoc literature review, Interviews with experts and Focus group of the adopted methodology (Section 1.3) and to identify the maturity factors, we used data from Rsl1, Rsl2 and Interviews experts. Finally, to identify the practices, we used data from Rsl2, Interviews experts and Focus group.

5.1.2 MATURITY AREAS

Maturity areas are categories that group related maturity factors. The maturity areas were initially classified from the ad-hoc literature review and the experience of the involved researchers. From the data collected, the classification was completed with the professionals' opinion about DSD. Therefore, three areas were identified; furthermore after running the focus group the fourth area was identified: i) people, ii) projects, iii) organizational and iv) engineering.

5.1.3 MATURITY FACTORS

Maturity factors group related practices that, when implemented together, reach a goal. The data collected especially from the SLR1, interviews with professionals and corroborated in the focus group contributed to identify 15 maturity factors (Figure 46). These factors and their respective levels (Tables 52a, 52b, 52c and 52d) were then analyzed in a detailed way in order to identify practices inherent to each one. The maturity factors were initially published in (SANTOS, FARIAS JUNIOR, MOURA and MARCZAK, 2012) and (FARIAS JUNIOR, MOURA and MARCZAK, 2013).

Table 52a - Maturity factors and areas of the C2M model.

Maturity Areas	Communication Maturity Factors	Maturity Levels
People	Management Cultural differences	2 and 3
	Trust acquisition	3

Source: the author

Table 53b - Maturity factors and areas of the C2M model.

Maturity Areas	Communication Maturity Factors	Maturity Levels
Project	Tools to support communication	2 and 3
	Infrastructure IT	2 anda 3
	Management geographic distance	2 and 3
	Management temporal distance	2 and 3
	Management of the stakeholders	2, 3 and 4
	Monitoring, measurement and analysis	3 and 4
	Communication Planning	2 and 3

Source: the author

Table 54c - Maturity factors and areas of the C2M model.

Maturity Areas	Communication Maturity Factors	Maturity Levels
Organzational	Continuous improviment of the communication	3 and 4
	Risk management	2 and 3
	Communication patterns and policies	2 and 3
	Communication training	3 and 4

Source: the author

Table 55d - Maturity factors and areas of the C2M model.

Maturity Areas	Communication Maturity Factors	Maturity Levels
Engineering	Configuration management	2
	Requiriments elicitation and specification	2 and 3

Source: the author

Altogether, three factors were related to the people, eight to projects, five to organization and two to engineering. However some of the factors identified

along this research were refactored, making more sense to become a model practice.

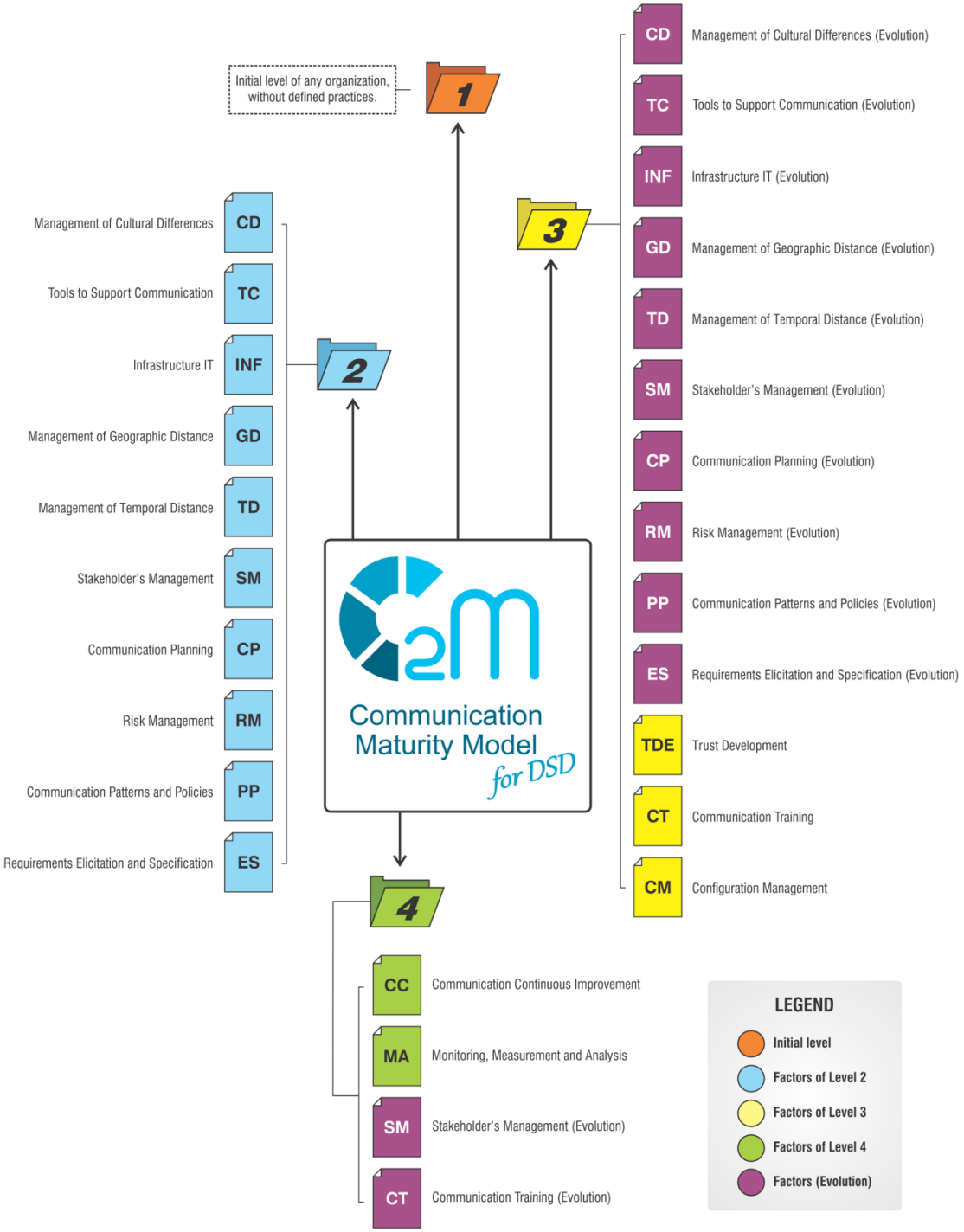

Figure 46 - Representantion of the fators in their levels of maturity. Source: the author

5.1.4 MATURITY LEVELS

Each maturity level consists in a set of maturity factors that characterize the organization maturity stage. Four maturity levels were defined for the C2M model.

The representation by maturity levels establishes a predetermined way to the improvement from the maturity level 1 in direction to the maturity level 4, which involves the satisfaction of the maturity factors objectives in each maturity level. These factors are grouped by the maturity level, indicating which factors must be implemented to reach the maturity level desired by the organization. For example, in the maturity level 2, there exists a set of factors that an organization must use to guide its process improvement, until all the objectives of these maturity factors be reached. Once the maturity level 2 was reached, the organization may focus its efforts in the maturity level 3, and so on. In the sequence, the C2M model levels are described in details.

Level 1 - Casual

C2M level 1 is assumed as the initial level of any organization, without defined practices. It means that each organization executes the communication activities in an ad-hoc way. Thus, the communication is not yet explicit in the organization process since it didn't recognize the need to encourage itself, believing that it will happen spontaneously. However, the organizations in the level 1, are not characterized by the total lack of communication. As the nature of the human behaviour is to work in a cooperative way, the communication can exist, even as an isolated, non-systematic, random and dependent practice, arising from the relationship or liking among the people.

Then, in this level the communication is still a result of individual effort and not of the maturity of the organization. In this scenario, the individuals spend a large amoung in a coordinated and unecessary effort, since most often work independent from each other. The aspects of communication are present, but they are treated under an ad-hoc manner and a non systematic perspective. In this case, it is difficult to foresee the results or learn from experience.

Level 2 - Partially Managed

C2M level 2 is defined as partially managed. The organization usually has basic capabilities that must be developed to sustain the individual abilities to deal with the communication challenges in DSD projects. Figure 47 shows the level 2 of maturity with the related practices.

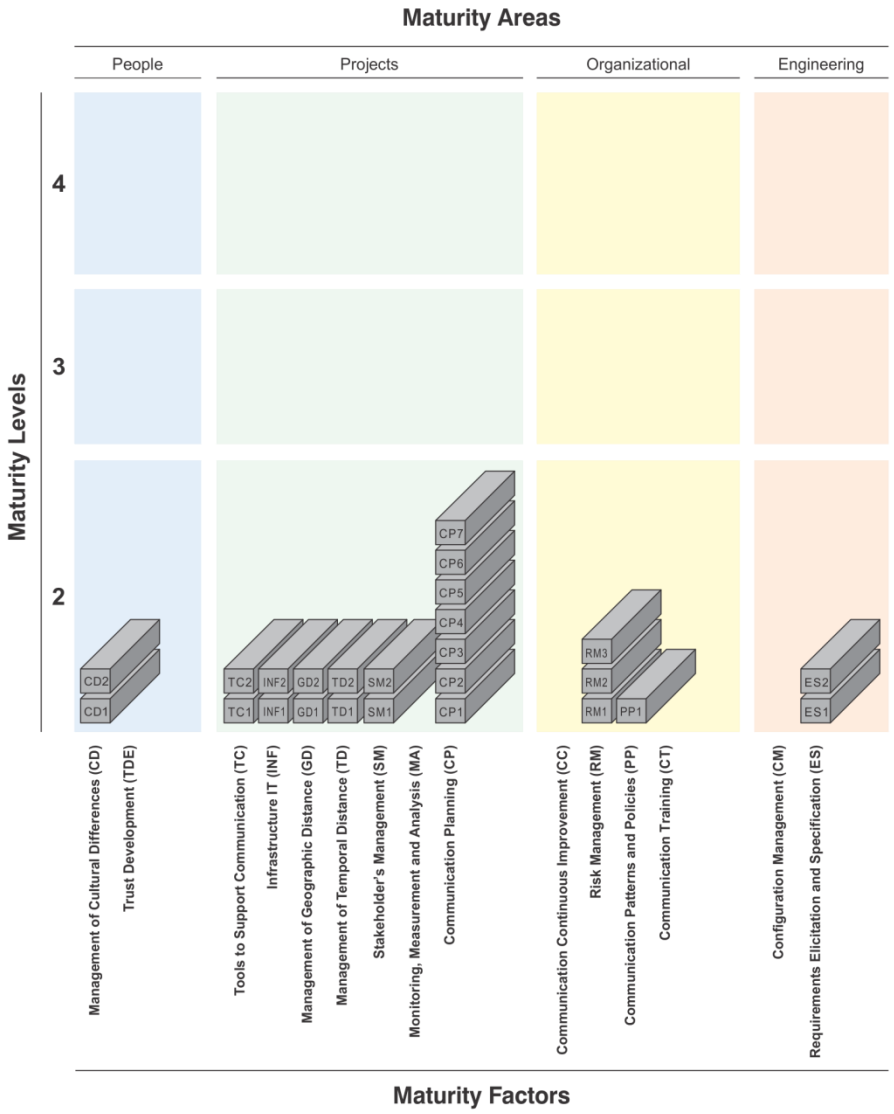

Figure 47 - Maturity level 2. Source: the author

At this level, the organization processes are systematically modified to address essential communication activities. These activities include especially the planning aspects of the communication. At this level, the communication coordination assumes a centralized view in the DSD projects. Decisions are taken to decide who will get each part of the job done and in what order. The project leader or manager encourages the commitment of the distrbuted teams

to keep on a clearly communication about their roles and responsibilities. This leader is also responsible for the planning of the work and the distribution of the tasks among the project participants. It's the leader's duty to balance the working shift of the participants at the same time he has to seek alternatives to take advantage of the habilities and specific talents of each one.

The leader also plans how the communication should happen (among the DSD Project teams and the stakeholders, besides other parts of the organization), in order to determine who needs which information, when this information is needed and through which channel it will be passed on. As a consequence, at this level the individuals realize how the components of the Project can already understand the team creation (even for two or more teams that may or may not have totally distinct cultures) and get to know their working partners of other teams. With the information obtained, about the participants, the individual can already stablish the social and cultural connections helping to create understanding, trust and commitment within the project.

Level 3 - Managed

C2M level 3 is defined as managed. At this level, the individual efforts are related to reach the teamwork (aligned teams), especially, the organizational strategy goals. The projects are executed by distributed teams which are not totally integrated and are usually managed in an independent way. Some projects aim the integration of teams, but it could not be adopted as a pattern in the organization. Figure 48 shows the level 3 of maturity with the related practices.

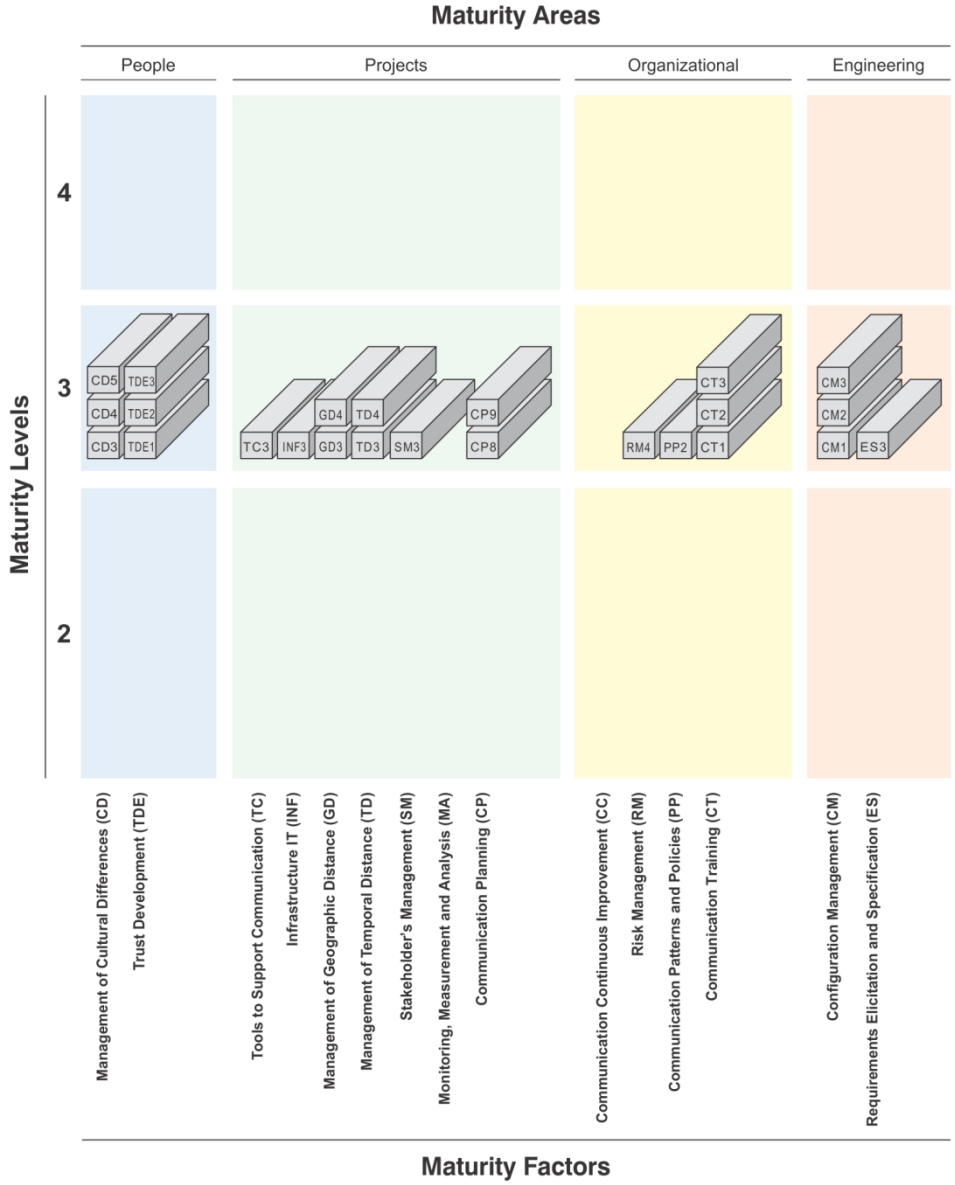

Figure 48 - Maturity level 3. Source: the author

The teams already know their responsibilities and know what activities to perform in order to allow the project reach its objectives. The team members work in a self-organized and simultaneous way. On the other hand, it must ensure to the teams the resources to access the information and understand the dependence and articulation of their previously planned activities. The aim is to be sure that the members of the distributed teams will have access to the needed information in a adequate way, respecting the current communication plan. Therefore, the distributed teams understand the work process they will perform, and their objectives. Moreover, the teams are aware of the necessary steps to

reach these objectives and have the knowledge to execute the tasks. The explicit knowledge is shared, in the form of artifacts, between the team members.

Level 4 - Reflective

Finally, the level 4 is defined as reflective. It predicts a constant motivation to improve the performance of which organization and consequentially of the team too, since the patterns (e.g., organizational processes, reports, communication media etc.) are created and institutionalized at organizational level. Moreover, it foresees practices of work integration among one or more teams, when they need to work together. Therefore, the potential of the organization as a whole (including its subsidiaries) should be identified in order to develop software in a totally global and integrated way. Figure 49 shows the level 4 of maturity with the related practices.

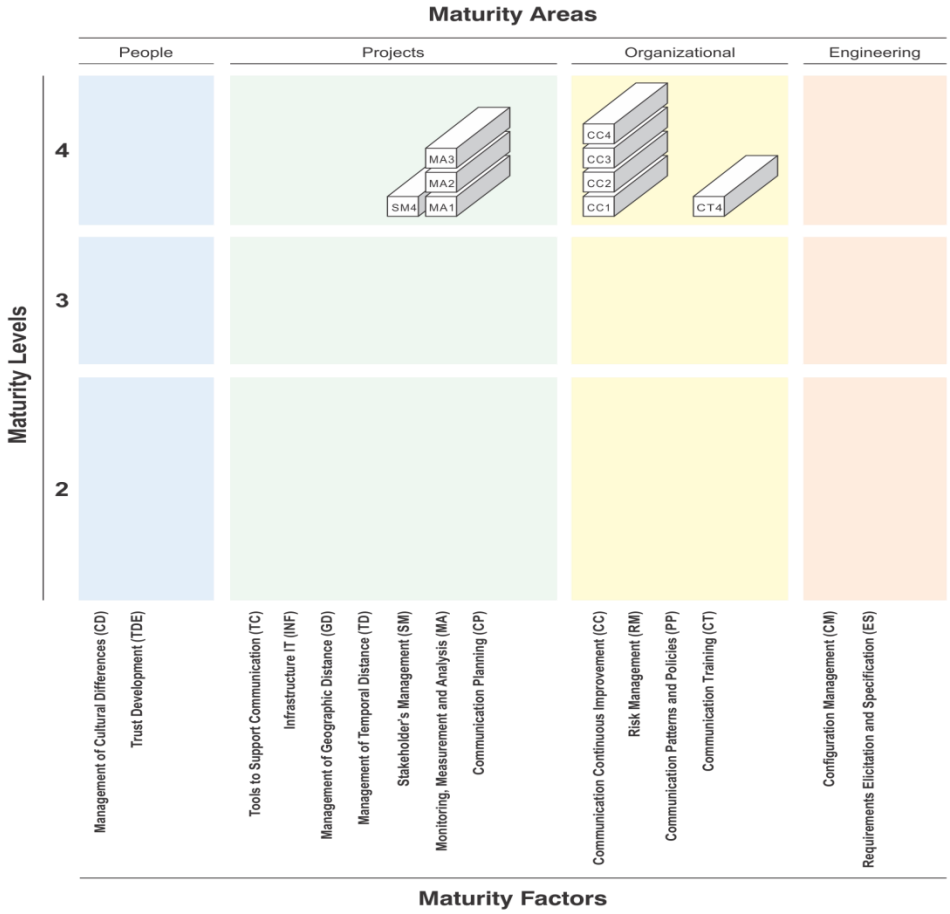

Figure 49 - Maturity level 4. Source: the author

The organizations that reach the reflexive maturity level in their processes are those which perceive the value of the knowledge that is generated in their

projects, and worry in manage and spread it inside the organization. Thus, the processes already include activities of assessment and divulgation of the results of the works developed by distributed teams. At this level, the feedback about the achievement of the objectives is important both for the analysis of the results and for the results of the project as a whole. In the results, it must be considered the quality of the generated products and the communicative process adopted. The participants must realize clearly how the communication occurs in the execution of the process, that is, how their activities interact between itselves. The team members participate of the official ending of the project, celebrating the results achieved and communicating them to the rest of the organization. This moment also can be taken to: i) capture the lessons learned; ii) analyze the forces and weaknesses of the work performed; iii) share successes and problems; and iv) extract ideas for future improvements. At least, in addition to the sharing of the explicit knowledge reached in the previous level, the tacit knowledge starts to be shared, in the form of ideas, opinions and experiences, among everybody in the project.

The full C2M model is ilustrated in Figure 50, including the instantiated maturity factors, their practices, and their respective maturity levels.

It is worth to note that the C2M model contemplate technical and non-technical aspects. Chrissis *et al* (2006) say and Prikladiniki (2009) reafirms that the technical factors refers to the use of tools, methods, data and processes needed by a process or Project, and are considered factors of the Software Engineering Area. The non-technical factors have origin in complementary areas and are related to processes which do not compose the software development activity, but affect the way the software is developed and projected. They are related to questions like: communication, coordination, self-organization, and interpersonal abilities needed to obtain exit in the social context of a project.

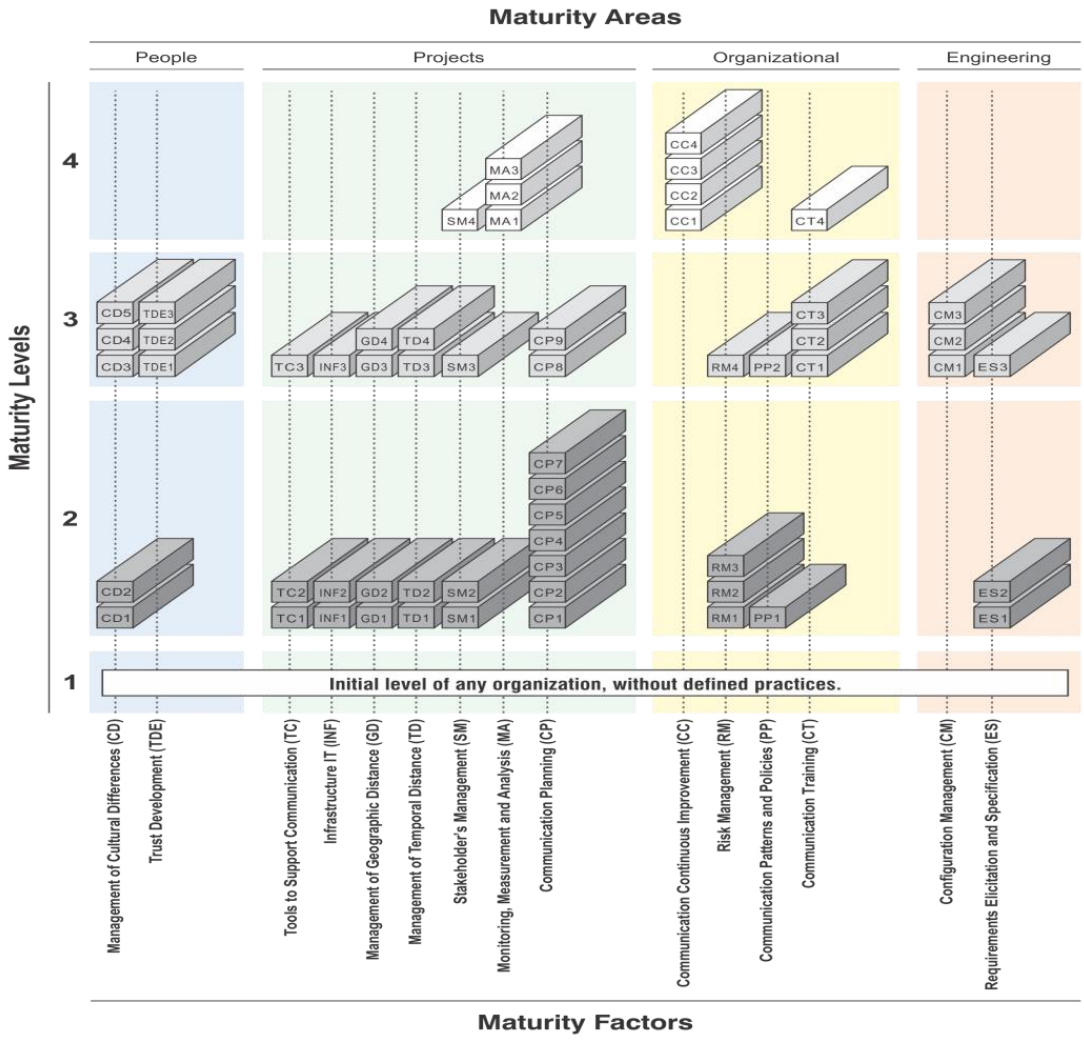

Figure 50 - C2M model. Source: the author.

5.1.5 GOALS AND PRACTICES

The data collected especially from the SLR2, interviews with professionals and corroborated in the focus group contributed to identify 58 practices to compose the C2M maturity model. For each maturity factor, a set of practices was defined. A practice is an activity that must be met and ensures that the associated factor will be gradually implemented according to the maturity aimed by the organization. The factors were documented using the pattern showed in Figure 51:

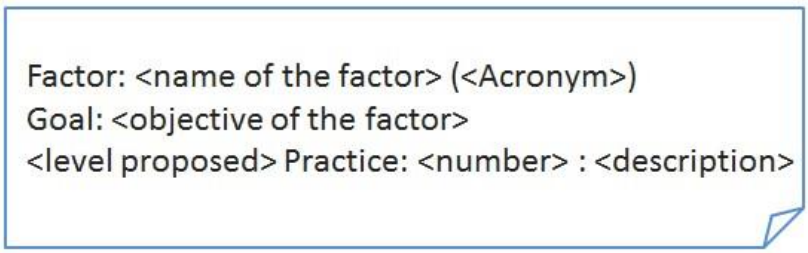

Figure 51 - Structure Factors. Source: the author.

Each factor has a name and an acronym. In addition, there is a general goal describing the objective of each factor. The practices are described for each one of the factors. We describe below the factors and their practices:

Factor:	Management of cultural differences. (CD)
Goal:	The objective of this fator is to understand the difficulties that exist due to the cultural diferences and prepare the teams to act in DSD projects knowing and respecting these diferences.
(2) CD1:	Establish policies for the recruitment and selection of new talents for the Project;
(2) CD2:	Identify and institutionalize the cultural context of each team of the project;
(3) CD3:	Establish a cultural knowledge base;
(3) CD4:	Standardize the jargon and vocabulary of the Project;
(3) CD5:	Plan initiatives to mitigate occurences caused by cultural diferences.

- **Establish policies for the recruitment and selection of new talents for the project**

This practice has as main goal the establishment of guidelines to have the recruiting and selection done taking the scenary of the project.

- **Identify and institutionalize the cultural context of each team on the Project**

This practice has as main goal to institutionalize all the information regarding the cultural diversity on each team to the stakeholders.

- **Establish a cultural knowledge base**

This practice has as its main goal establishing a knowledge management about the cultural diversity of the distributed teams.

- **Standardize jargons and vocabulary of the project**

This practice has as its main goal to standardize the jargons and vocabulary avoiding noise (misunderstandings) in the communication.

- **Plan initiatives to mitigate occurences caused by cultural differences**

This practice aims to create a mitigation plan to reduce the probability of occurence or the impact caused by cultural difference.

Factor:	Trust Development (TDE)
Goal:	The objective of this fator is to solve or minimize the difficulties derived from the absence of confidence between teams.
(3) TDE1:	Establish strategies of stakeholders integration;
(3) TDE2:	Interchange of members between the dispersed teams of the project;
(3) TDE3:	Encourage the colaboration and cooperation between the teams;

- **Establish strategies of stakeholders integration**

This practice describes the strategies used by the organization to integrate and socialize the teams (members) with each other. At this point, it is important to integrate the teams with the mission, values and objects of the organization.

- **Interchange of members between the dispersed teams of the project**

This practice address the development of the trust and a more effective communication among the members of different teams. This practice allows the member of the team to have a better informal communication with other members of the teams and it also allows them to experience the daily challenges of the host team, having to deal with a different culture among many other factors.

- **Encourage the colaboration and cooperation between the teams**

This practice has as its main goal providing a collaborative environment that has the involment of all the members of the team and supplies them with tools, processes that favor interaction, as well as sharing ideas and decision.

Factor:	Tools to support communication. (TC)
Goal:	The objective of this fator is make adequate use of the existing tools considering the scenario of distributed teams.
(2) TC1:	Adopt synchronous and/or asynchronous communication tools on demand;
(2) TC2:	Adopt collaboration tools;
(3) TC3	Adopt face-to-face communication tools;

- **Adopt synchronous and/or asynchronous communication tools on demand**

This practice focuses on define the adoption of synchronous and/or asynchronous tools based in the specific needs of the projects.

- **Adopt collaboration tools;**

This practice has as its main goal the adoption of collaboration tools seeking for a greater interaction among the teams, as well as an increment in the information sharing.

- **Adopt face-to-face communication tools**

This practice has as its main goal the adoption of a face to face communication tool to reduce the geographic distance, as well as maximize the understanding of the communicated information.

Factor:	IT infrastructure (INF).
Goal:	The objective of this fator is plan the infrastructure which will be provided to the distributed teams.
(2) INF1:	Define infrastructure taking in consideration the level of team dispersion;
(2) INF2:	Monitor the infrastructure periodically;
(3) INF3:	Maintain an infrastructure backup;

- **Define infrastructure taking in consideration the level of team dispersion**

This practice defines the IT infrastructure taking into account the dispersion level, namely, local, regional, national, continental or global. This practice provides enough infrastructures for the project to run without any impediments.

- **Monitor the infrastructure periodically**

This practice checks continuously whether the infrastructure can be maintained stable for the Project to flow without impediments.

- **Maintain an infrastructure backup**

This practice keeps a backup of the IT infrastructure, to minimize the impact of a failure.

Factor:	Management of the Geographic Distance. (GD)
Goal:	The objective of this factor is to understand and improve the levels of perception of physical distance between the teams.
(2) GD1:	Plan face-to-face meetings;
(2) GD2:	Plan and perform frequent communication
(3) GD3:	Establish a discussion forum in the project.

(3) GD4:	Plan initiatives to mitigate occurences caused by the geographic distance;

- **Plan initiatives to mitigate occurences caused by the geographic distance**

This practice produces a mitigation plan to reduce the probablity of occurence or the impact cause by the geographic distance.

- **Planning face-to-face meetings**

This practice addresses planning face to face meetings. These meetings can be face-to-face or through a communication tool.

- **Plan and perform frequent communication**

This practice plans and holds frequent communication. This communication can be addressed according to the organization plans. However, it cannot cease to exist. All the collaborators must be informed about everything that happens in the organization and in the project.

- **Establish a discussion forum in the project**

This practice establishes a communication channel that promotes debates regarding a theme, question in evidence or any problem.

Factor:	Management of the temporal distance (TD)
Goal:	The objective of this fator is to understand and improve the perception levels of time distance.
(2) TD1:	Plan and manage the synchronization of the team schedules;
(2) TD2:	Plan and execute the continuity of the tasks (handoffs);
(3) TD3:	Plan and manage the follow-the-sun strategy (almost continuous development).
(3) TD4:	Plan initiatives to mitigate ocurrences caused by time distance;

- **Plan and manage the synchronization of the team schedules**

This practice holds a shift common to all the teams that work in a distributed way (whenever possible). This also applies when the team is not physically distant, but is temporally distant, i.e. work in different shifts.

- **Plan and execute the continuity of the tasks (handoffs)**

This practice has as its main goal planning and executing in an effective way the handoffs (activities/tasks), in which when a team ends its work day, another one continue the Project.

- **Plan and manage the follow-the-sun strategy (almost continuous development)**

This practice has as its main goal establishing a strategy to adopt follow-the-sun with its focus on the reduction of the time-to-market, accelerating the construction of the final product from its conception to its distribution.

- **Plan initiatives to mitigate ocurrences caused by time distance**

This practice creates a mitigation plan to reduce the probability of occurence or the impact caused by the temporal distance.

Factor:	Stakeholders management (SM)
Goal:	The objective of this fator is to perform the planning and management of the stakeholders, considering the profile and proficiency needed to the project.
(2) SM1:	Identify the stakeholders
(2) SM2:	Define roles and responsibilities
(3) SM3:	Plan the stakeholder management
(4) SM4:	Monitor the stakeholders relationship

- **Identify the stakeholders**

This practice identifies all the people and organizations involved in the Project. Some examples of people and organizations that might be interested: i) Clients, ii) Leader or manager of the project, iii) Sponsors and iv) Users.

- **Plan the stakeholder management**

This practice plans the management of the interested parts, as well as planning, managing and controlling the engaging of these stakeholders.

- **Monitor the stakeholders relationship**

This practice monitores systematically the stakeholders and then evaluate the level of relationship among all the related to the Project. Through this monitoring and evaluation, can be possible, for example, to determine what teams/members communicate and interact more.

- **Define roles and responsibilities**

This practice defines and describes the roles and responsibilities. Is important describe them clearly and objectively.

Factor:	Monitoring, measurement and analysis (MA)
Goal:	The objective of this fator is provide inputs to develop and maintain a capacity to monitor, measure and analyse, aiming to provide information to the high management.
(4) MA1:	Establish the objective of the measurement
(4) MA2:	Establish procedures to gather, store and analyse the data
(4) MA3:	Communicate the measurement results

- **Establish the objective of the measurement**

This practice establishes the goals of communication measurement and other necessities in the like of information needs. An organization/project has a group of needs of communication information that need to be addressed. These needs for information must derive from goals.

- **Establish procedures to gather, store and analyse the data**

This practice analyses systematically the data about the preparation, conduction and execution of the communication in the project. The registered data about the communication in the project and its planning, conduction and results must be analysed to identify tendencies and improve continuously the communicative process.

- **Communicate the measurement results**

This practice ensures the measurement communication data will be passed on.

Factor:	Communication Planning (CP)
Goal:	The objective of this fator is to plan the communication from the beginning to the end of the Project.
(2) CP1:	Establish a communication strategy;
(2) CP2:	Establish mechanisms to confirm the understanding of the activities;
(2) CP3:	Establish a standard language to the project;
(2) CP4:	Establish a communication plan;
(2) CD5:	Establish commitment of the stakeholders with the communication planning;
(2) CP6:	Define a focal communication point (communication interlocutor);
(2) CP7:	Manage the data (artifacts) of the project.
(3) CP8:	Communicate periodically information about the performances of the project and of the team;
(3) CP9:	Plan and manage the meetings;

- **Establish a communication strategy**

This practice has as its main goal the method or a group of methods that were chosen for the accomplishment of the communication goal, the alignment of the communicational process with the business goals and strategies. The setting of the communication objectives is essential..

- **Establish mechanisms to confirm the undertanding of the activities**

This practice creates ways to verify whether the distributed teams (receptors) clearly understood all the activities, information and communications, seeking to be sure that the understanding is reliable to the activities transmited by the emitter.

As the activities are changed, it must be executed a new verification to reconfirm the understanding of the involved teams or responsibles by the activity.

- **Establish a standard language to the project**

This practice defines a standard communication pattern and promotes its proficiency to the members of the teams involved in the Project.

- **Establish a communication plan**

This practice has as main objective to describe all the communication needs, that is, where, when, how, and in what format the information will be distibuted/communicated to the stakeholders. Therefore, is essential to define who will be the responsible by the providing of the different communication types. The communication plan gives support to the project plan. Usually a communication plan provides some significative information, like:

- Person responsible by the information communication;
- Person responsible by authorize or liberate documents or confidential information;
- Communication methods and media to transmit some information;
- Resources alocated to the communication activity (e.g.: time and budget);
- Glossary with common terminology;
- Communication restrictions usually derived from organizational policies, laws or specific norms.

- **Communicate periodically information about the performances of the project and of the team**

This practice has as main objective provide to the stakeholders the information needed about the performance of the Project and the team as planned.

Whenever possible, it must be used indicators to assess the effectiveness of the project or teams. For example:

- Increase the productivity of the project or team;
- Redution of the turn over rate;
- Indicators of Organization Climate Surveys;
- Intensity of the communication between the teams.
- **Plan and manage the meetings**

  This practice defines clearly the meeting planning, that is, defining and disclosing the agenda, defining the facilitator, the writer, and material to be used in the meeting, time, local, objectives, expected results and at last, the information needed to the participants. We present below some types of meetings:

  - Kickoff Meeting – Start the Project engaging the stakeholders, mainly the project team;
  - Planning meetings – They serve to discuss and elaborate the plans to be developed;
  - Follow-up meeting – known as monitoring meeting. Followed by project parameters, like deadlines, costs, quality, etc.;
  - Change control meeting – allow the analysis of change requests;
  - Audit meetings – Assess products or processes
  - Continuous improvement meetings – meeting of representatives of every sector, together with the management, aiming to assess new processes, technologies and strategies to apply in the company when decided by the comitee. This meeting focuses in the continuous improvement.

- **Establish commitment of the stakeholders with the communication planning**

This practice verifies the understanding of the teams regarding all the information established in the communication plan and then, the manager requires the commitment of the team members with all that was established in the communication plan.

- **Define a focal communication point (communication interlocutor)**

This practice defines a responsible for the communication in the distributed team. This action seeks to decrease the noise in the communication and centralize the same to avoid misunderstandings among the teams.

- **Manage the data (artifacts) of the project**

This practice has as its goal to identify and plan artifacts and relevant data for the Project, as well as describe ways to storage and distribute. There must be a mechanism established to the artifacts, including privacy and safety questions.

Factor:	Communication Continuous improvement (CC)
Goal:	The objective of tis fator is to promote continuously the maintaining and improvement of the organization's communication
(4) CC1:	Perform analysis of colected data;
(4) CC2:	Provide guidance to the use of historical data (establishing of reliable estimatives);
(4) CC3:	Research, evaluate and monitor new processes, methods and tools to apply in the organization;
(4) CC4:	Establish, monitor and maintain the strategic action plan to improve the communication of the organization.

- **Perform analysis of colected data**

This practice analyses systematically the data about the preparation, conduction and execution of the communication in the Project. The registered data about the communication in the project and its planning, conduction and results must be analysed to identify tendencies and improve continuously the communicative process.

- **Provide guidance to the use of historical data (establishing of reliable estimatives)**

This practice establishes trustable estimatives about the communication and other areas that the organization should find relevant based on historical data.

- **Research, evaluate and monitor new processes, methods and tools to apply in the organization**

This practice has as its main goal researching, evaluating and monitoring new communication processes, methods and tools to apply it in the organization with the intention of discovering better ways to communicate with the

stakeholders. This is a practice that has a tendency to explore the innovation area.

- **Establish, monitor and maintain the strategic action plan to improve the communication of the organization**

This practice has as its main goal to monitore the interaction between plan and execution. As such, this practice seeks to make a continuous improvement and correction of diversions in the planning of the communication and consequently in the communicative process, according to the experience lived with the plan execution.

Factor:	Risk management (RM).
Goal:	The objective of this fator is identify, treat and monitor the risks.
(2) RM1:	Identify communication risks;
(2) RM2:	Evaluate, Categorize and Prioritize communication risks;
(2) RM3:	Identify the relevant stakeholders associated to every risk;
(3) RM4:	Elaborate plans of risk mitigation;

- **Identify communication risks**

This practice identifies, analyzes and plans answers to the communication risks, analyzing their impact, chance of occurrence and priority on the treatment.

- **Evaluate, Categorize and Prioritize communication risks**

This practice has as its main goal to identify, evaluate and categorize the risks. Furthermore, the priority of each identified risk must be determined. For the identification of the risks, some tools can be used, such as: i) Risk taxonomy, ii) Risk evaluation, iii) Checklists and iv) Brainstorming.

- **Identify the relevant stakeholders associated to every risk**

This practice identifies the relevant interested parts associated to each risk, which means all the stakeholders that are impacted by the risks, as well as the stakeholders who can manage and solve the problem in case the risk occurs.

- **Elaborate plans of risk mitigation**

This practice creates a document that lists the probability of a risk event in a Project and reduces the potential of impact whether it happens.

Factor:	Communication patterns and policies (PP)
Goal:	The objective of this fator is to establish and maintain communication policies and practices that add value to the Project.
(2) PP1:	Establish a communication policy;
(3) PP2:	Establish documentation and communication standards.

- **Estabilish a communication policy**

This practice promotes the integrated communication into the organization, aiming to maintain a good relationship between the collaborators, in an aligned, coordinated and synergic way, having as basis the guidelines of the communication strategic planning. The communication policies must communicate the expectatives of the organization about the communicative process and make all these expectations visible to those who it affects. This policy must inform what is expected in the execution of the communicative process, without specify how it must be executed.

- **Establish documentation and communication Standards**

This practice aims to standardize the writen documentation, as well as how it is communicated to the stakeholders. The main objective of the standardization is the reduction of the variability of the work processes, that is, the way the documents are elaborated and communicated. Standardizing implies meeting the expectatives of the users while not subject them to monotonous routines and tough/autocratic norms. The organization must seek a pattern for the documentation and communication that bring benefits to the project.

Factor:	Communication training program. (CT)
Goal:	The objective of this fator is to develop abilities and knowledges in communication or in áreas that support the communication to the Project members perform effectively their role.
(3) CT1:	Plan communication trainings;
(3) CT2:	Provide communication trainings;
(3) CT3:	Register communication trainings;
(4) CT4:	Assessment of the bennefits of the communication trainings.

- **Plan communication trainings**

This practice establishes an organizational training program. In this sense, the strategic objectives of the organization must be analysed to identify potential training necessities in communication or in areas that suport communication.

The training planning must fill knowledge gaps, introduction of new technologies, changes in the business area, among others.

From the identified training necessities, a strategic training program must be created, containing: Training necessities, Training topics, Training schedules, Methods used for training. This training program must be periodically revised.

- **Provide communication trainings**

This practice promotes trainings, according to the established training program. Examples of training approaches which must be used include:

- Formal training in classroom or through vídeo lesson;
- Study group;
- Mentoring;
- Workshop.

- **Register communication trainings**

This practice defines training records. These must contain a list of collaborators which participated of the training, date, name of the instructor and name of the course/training. Whether somebody who should participate of some training be prevented from participating by some reason, this must be documented, including management approvals when applicable.

- **Assessment of the bennefits of the communication trainings**

This practice performs assessments about the benefits (effectiveness) of the received trainings.

Some forms of assessment of the benefits/effectiveness of the trainings include:

- Questionnaires after the execution of the trainings;
- Satisfaction questionnaires of the managers about the applicability of the knowledge obtained through the training.

Factor:	Configuration management (CM).
Goal:	The objective of this fator is establish and maintain the integrity of the artifacts generated (work products) along the project, as well as leverage the communication regarding the code evolution and the documents revision.
(3) CM1:	Establish the control of versions and modifications;
(3) CM2:	Establish Access control to the configuration items;
(3) CM3:	Establish a configuration plan to the whole Project.

- **Establish the control of versions and modifications**

Set of activities designed to control change by identifying the work products that will be changed, establishing a relationship among them, defining mechanisms

for managing different versions of these products, controlling the changes imposed, and communicating the changes made to the stakeholders

- **Establish Access control to the configuration items**

This practice defines access levels to maintain control to the configuration items. The description of this practice is detailed in the plan of configuration management.

- **Establish a configuration plan to the whole Project**

This practice creates norms, tools and templates that allow a person to manage in a satisfactory way the configuration items of a system.

Factor:	Requirements Elicitation and Specification (ES).
Goal:	The objective of this fator is to promote a better understanding in the elicitation and specification of the requirements, to improve the spoken and writen communication of the artifacts of this activity
(2) ES1:	Obtain the confirmation of the understanding of the software requirements by the team;
(2) ES2:	Manage the changes in the software requirements;
(3) ES3:	Maintain the traceability of the software requirements.

- **Obtain the confirmation of the understanding of the software requirements by the team;**

This practice ensures that the software requirements are clearly written, without redundances or ambiguities. Some of these criteria are:

- Clarity and correction;
- Completeness;
- Traceability.

- **Manage the changes in the software requirements**

This practice manages the changes that occur in the requirements during the execution of the project. During the project, we know that the requirements change for various reasons (e.g.: change in the needs of the client, change in the law, etc.). Thus, new requirements may be included, and changes may occur in existing requirements. In this sense, it is needed to analyse the impact of the changes in an effective way. Keeping the history of all the changes in requirements is mandatory. A way to it makes the analysis of the impact of the requirement changes is using the traceability or the point of view of the

stakeholders. Finally, make available to the stakeholders of the project the data of the requirements and of the changes.

- **Maintain the traceability of the software requirements.**

This practice establishes the capacity to trace a requirement of the Project to other requirements, or even to other correlated elements. The main purpose of the traceability is to support the:

- Understanding of the conception of the requirements;
- Management of the requirements;
- Assessment of the impact of the change in a requirement inside the project.

5.2 CONSIDERATIONS OF THE CHAPTER

In this chapter the C2M model was presented with all its elements and characteristics. The model in vogue is the main contribution of this thesis, although all the results, both the literature reviews or the empirical studies explicit results that can support the managers and leaders in the management of the teams, as well as contribute to new academic researches. The proposal of the model aims to contribute for the improvement of the communication, a still challenging theme in every knowledge area, and more specifically in DSD. The model stands out by the form it was conceived, once it was defined from studies of existing maturity and capacity models, together with rigorous studies executed in this thesis (Systematic reviews and empirical studies). The 15 maturity models were organized in maturity areas (people, projects, organization and engineering) to ease their understanding. Furthermore, were defined 4 maturity levels and for each level were identified practices associated to certain maturity factors.

6. EVALUATION OF THE C2M MODEL

This chapter presents an evaluation (Phase 3 of our methodological approach - see Section 1 - Figure 2) of the C2M communication maturity model. Section 6.1 introduces the planning of the survey and the evaluation made by experts on the characteristics and elements of the proposed model and its applicability in real projects.

6.1 SURVEY BASED ON EXPERT OPINION

According to Hakim (1987), small samples can be used to develop, test and explain a certain proposition, especially in the first phases of the research. In this sense, Beechan *et. al.* (2005) affirms that the studies use small samples to obtain feedback of specialists to evaluate the development of models that support a knowledge area. For example, Dyba (2000) used 11 specialists to conduct a review process about the critical success factors in a process of software improvement, based in data collected from 120 organizations. El Eman and Madhavji (1996) interviewed 30 specialists to conceive a tool to evaluate the success in the requirement engineering.

The value of the opinion of the specialist or its knowledge also is recognized in an evaluation of the software quality that suggests methods to capture formally the opinion of the specialist (Rosqvist et. al, 2003). So, is possible to say that the software engineering community has given more importance and credibility (reliability) to the studies that use the technique of specialized opinion.

Corroborating with this affirmation, other researches had evidenced the relevance of this technique, like for example, Kitchenham et. al (2002) executed an analysis of precision of several methods of effort estimative using the opinion of specialists. This research revealed that through statistical analysis, a process of human estimative centered in the opinion of specialists can overcome substantially simple models of function point analysis. At last, the work of Beecham et. al (2005), that through its research with specialists evaluated a maturity model to the software requirement engineering aligned to the CMMI model.

For this reason, researchers and professionals that work in the area of software engineering tend to adopt the technique of opinion of specialists to evaluate their proposal, aiming to obtain a valuable feedback and an effective evaluation.

6.1.1 OPINION OF EXPERTS

The opinion of experts in certain matter can be defined as a series of scientific efforts used to interpret the data, foresee the behavior of a system, and evaluate uncertainties (Cooke, 1991). It refers to speculations, suppositions and estimates of people whose are considered specialists in a knowledge area to the extent that they serve as a process of knowledge acquisition in any decision process (Cooke, 1991, Li and Smidts, 2003).

The increasing search for the opinion of specialists, especially in academic researches, is justified by the fact that many knowledge areas and their processes of decision taking are still immature or under construction (Li and Smidts, 2003).

Our process for to gather the opinion of experts was inspired in the work of Li and Smidts (2003), and it is composed of the following steps:

- Problem Statement. The background and problem need to be clearly systematized and defined;

- Selection of Experts. A number of experts must to be identified based on a set of criteria which should include the credibility, knowledge, ability, and dependability of experts;

- Elicitation of Opinion. This step poses the right question and ensures the conditions of conduction to an elicitation process;

- Aggregation of Opinion. The idea is to reach an aggregated opinion or a consensus based on which a decision can be made;

- DecisionMaking. This last step makes the decision based on aggregated opinion.

It is worth to highlight that the software engineering has used in its researches the opinion of specialists. However, there are some controversies (Kitchenham et. al., 2007) and skepticism in the scientific community about this matter, and until the present moment, there is no consensus. Kitchenham et. al. (2007) affirms that the main problem is the dependence of informal proofs that might

be influenced by the opinion of the experts. That is, depending on the specialist, its bias (cultural, origin or self-confidence) can distort the information he pass.

Finally, according to Li and Smidts (2003), the number of specialists needed in a study, the identification of the bias, and the technique adopted to the aggregation of the opinion of the experts are questions which must be planned and clarified in the beginning of the study. This way, the adoption of the evaluation of the research based in the opinion of specialists will be more effective. In the next sections, these questions will be described in details.

6.1.2 THE NUMBER OF EXPERTS

Garcia (2010) says that if a specialist is perfect (that is, he has infinite knowledge about the theme and never makes mistakes), only one specialist is needed to the elicitation process. However, there is a tendency to follow up with as many specialists as possible, justified by a perception of security in the numbers (quantity of specialists). In this sense, Li and Smidts (2003) say that the objective of the opinion of experts is "the acquisition of knowledge of the real world", the capture of the specialist's experience (challenges, lessons learned, etc.).

To this thesis, 110 potential candidates were selected, composing the group of specialists for this research. They represent a group of specialists with capacity to evaluate and contribute to the improvement of the C2M model. Despite the reduced sample, 110 specialists is considered an adequate number. As notorious in the literature, the inquired sample is satisfactory to the current study, once it is qualified by renowned specialists, with large experience in DSD and software quality process. In practice, from the selected sample, only 55 specialists participated of this study. The next session will describe the process of their selection.

6.1.3 EXPERT SELECTION IN THIS STUDY

In an ideal scenario, the specialists must be carefully chosen, taking in account some factors, like his knowledge in the research area according to NUREG-1150 (1989 apud GARCIA, 2010, p. 78). However, there is not a well-defined and known standard (Li and Smidts, 2003), for this selection or choice of specialists. In light of the above, is relevant to formulate a set of criteria which must be used

to systematize the process of selection. NUREG-1150 (1989 apud Garcia, 2010, p 78) presents a set of guidelines to this selection:

- The specialists must have experience proved by publications or services of consulting or management in the areas related to the theme of the study;
- Every specialist must be sufficiently versatile to be able to deal with very questions concerning to the studied theme, and a wide experience to know how they will be put in practice;
- The specialists must represent a great variety/diversity of experiences (e.g.: academic knowledge, consulting, laboratories, etc.);
- The specialists must be willing to participate of the research and available to pass the requested information according to the method of data gathering to be used.

It should be pointed that the specialists also are subject to some biases, particularly when forced to opine about subjects outside their knowledge domain (SLOVIC, 1987). For this reason, the specialists should be consulted only about events relative to their area of specialty; the experience and information relevant which contributed to their evaluation should be additionally required since, even the specialists have a wide knowledge, they might have difficulties to attribute probabilities (SKJONG; WENTWORTH, 2001).

We selected 110 specialists based in the previous guidelines, but only 55 participated on the research. The main requirements to participate on the study were: i) have a minimum of three years of experience (theoretical or practical) in DSD; ii) have knowledge in improvement of the software process, especially in quality models, like: CMMI, MPS and ISO. Therefore, according to the recommendations of the NUREG-1150 (. 1989 apud Garcia, 2010, p 78), were selected specialists of the industry and academy, from different companies and universities, as well as from different places.

6.1.4 EXPERT BIASES IN THIS STUDY

Tversky and Kahneman (1974) divided the experts in two classes: those with biases originated from the local where they live or work and those with biases from the excess of confidence. An additional method to decrease the biases from

the excess of confidence is to encourage the specialists to find reasons that contradict their initial opinions. However, the biases from the local or work may be corrected by the method of Bayesian aggregation (Chhibber et al, 1992), (Li and Smidts, 2003).

In this thesis, we defined the process for the elicitation of the opinion of specialists, such that the specialists provided clear and detailed explanations about the evaluation of the C2M model. Therefore, they also were contacted to clarifications about the evaluation. So, we had no evidence of bias or prejudices about the participation in the research.

6.1.5 EXPERTS OPINION AGGREGATION IN THIS STUDY

Li and Smidts (2003) say that when the aggregation methods had been used, they vary from easy-to-use methods, like the simple calculation of the arithmetic average of the specialists, to more complex techniques (Chidamber e Kemerer, 1994) and the Bayesian aggregation (Chhibber et al., 1992). Still about the aggregation of the opinion of the experts, Keeney (1992) defined a process called Value-Focused Thinking (VFT) on which is searched the identification of the values and knowledge that the researcher will use as a guide to the process. The VFT approach is a way to identify desirable decision situations and so collect the benefits of these situations to solve them.

In this doctorate research, we adopted the aggregation method based in the arithmetic average, based in the answers (analysis of the data) of the specialists. It is important to highlight that no bias was perceived during the investigation. Furthermore, all the specialists were equally weighted during the aggregation, once there was not observed a significant difference in terms of their credibility and importance.

6.2 RESEARCH APPROACH

The approach to this study was based in the recommendations from Li and Smidts (2003) and motivated by the work of Garcia (2010). It is organized in four phases. In the first phase, the objective was: define, evaluate and validate the script of the guided interview. In the second phase, the specialists were selected and contracted according to the guidelines discussed in the Section 6.1.3. In the third phase, the invitation to participate on the interview was sent to the specialists and after the acceptance the data was collected. Finally, in the

fourth phase, the data were analyzed aiming to characterize the C2M model in what concerns to its viability, based in the opinion of experts. The next sections discuss every phase in details.

6.2.1 THE SURVEY

The research was composed by an interview script developed after a wide literature review, with strong influence of works related to the DSD area (Prikladnicki et. al., 2004), (Prikladnicki et. al., 2009, Santos et. al., 2012), (Da Silva et. al., 2011)) and Opinion studies ((Beecham et. al., 2005), (Farias Junior et. al., 2012), (Li and Smidts, 2003)) among others. Furthermore, we counted with the experience of our research group (GP2 group, of the Federal University of Pernambuco – UFPE).

The first version of the research was defined in the beginning of 2014 and was reviewed for two months. The review was performed together with three researchers (one with theoretical and practical experience in software quality improvement, and the other two experienced in the DSD area). Is important to point that these researchers do not participated of the research, but made part of the pilot project that was performed to estimate the time necessary to the respondent conclude the investigation/interview, and raise other relevant aspects.

During this review process, four versions of the research were generated. The main improvement in relation to the first version was related to the order of the questions, the decrease of the script size, as well as adjusts in some clarifying points in the questions.

6.2.2 THE QUESTIONS

The main aim of our study was to evaluate the viability of the C2M model, as well as its adaptation based in the opinion of specialists. In this sense, the questions were elaborated in relation to: role of the specialist (academy or industry), the way that the maturity factors are distributed in the levels of the model; the specification, description of the main objective of every maturity level; objectives related to the maturity factors; descriptions and objectives of every practice in the model and, if is possible to an organization to perceive and obtain in the incipient levels the benefits of the effective communication, outside the highest maturity levels proposed by the C2M.

The final script was composed by 38 questions with open and closed questions and was projected to be concluded in approximately one hour. Our previous experience in similar studies and the orientations published in the literature ((Gil, 1999), (Yin, 2009), (Andrade, 2007), (Gressler, 2004) and (Li and Smidts, 2003)) were very important to its conception.

6.2.3 DATA COLLECTION AND ANALYSIS

Before the interview, the script was sent by email to all the specialists in July, 2014, and next the interviews were appointed (some face-to-face, others through Skype). In August, 2014 all the interviews were finished and collected to analysis. In some cases, we needed to contact the respondent to mitigate doubts or clarify some answers that could lead to diverse interpretations. In the study, ten specialists were contacted to clarify some questions, mainly related to the objectives and practices of the C2M model. It is worth to point that the interview script applied in this research was submitted to the Cronbach's alpha test through the SPSS software and as result was indicated an acceptable reliability to the scale of 0,70.

6.2.4 CHARACTERIZATION OF THE EXPERTS

Most of the fifty-five specialists that participated of the study are resident in Brazil, with predominance on the state of Pernambuco (Figure 52). Two participants were out of the country (USA and Germany). Still about the characterization of the participants, fourteen work exclusively in the industry, nineteen work exclusively in the academy, while twenty-two work in both (Figure 53). From the participants of the research, fifty-two have the basic formation in computing, one in administration and the other two in communication. Furthermore, there are graduated, forty have the master degree, seven are doctors and one is a post doctor in computer science. The other four are post graduated in "Lato Senso" courses in computer science. All the participants had acted actively in the last years in the DSD area.

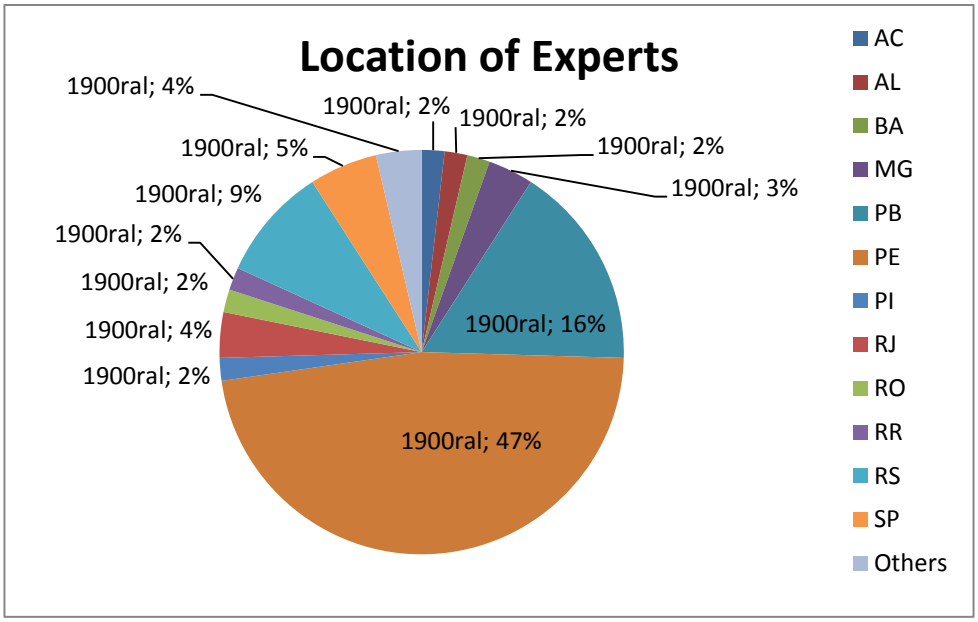

Figure 52 – Location of the respondents. the author

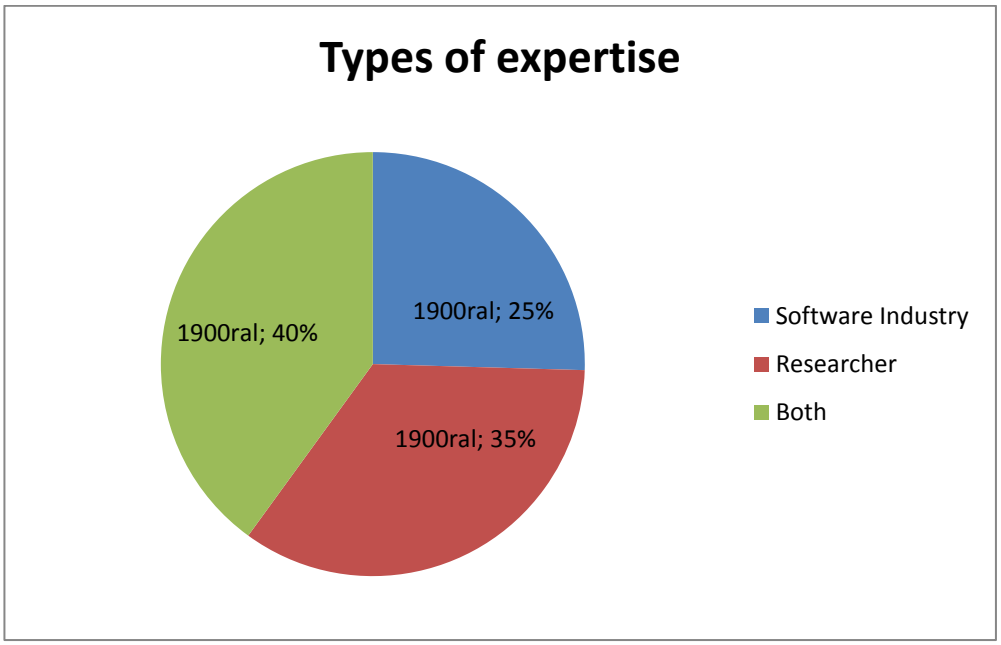

Figure 53 - Type of expertise. Source: the author

6.3 RESULTS OF THE SURVEY

This section presents the analysis of the data collected in the research, discussing in details the main questions and pointing some correlation points that must be took in consideration.

6.3.1 C2M STRUCTURE

In this question, we asked if the quantity and the organization of the levels in the C2M model are proper to evaluate the maturity of the communication. The

objective was to identify if the distribution of the levels and evolutionary paths are well-defined and understandable (Figure 54).

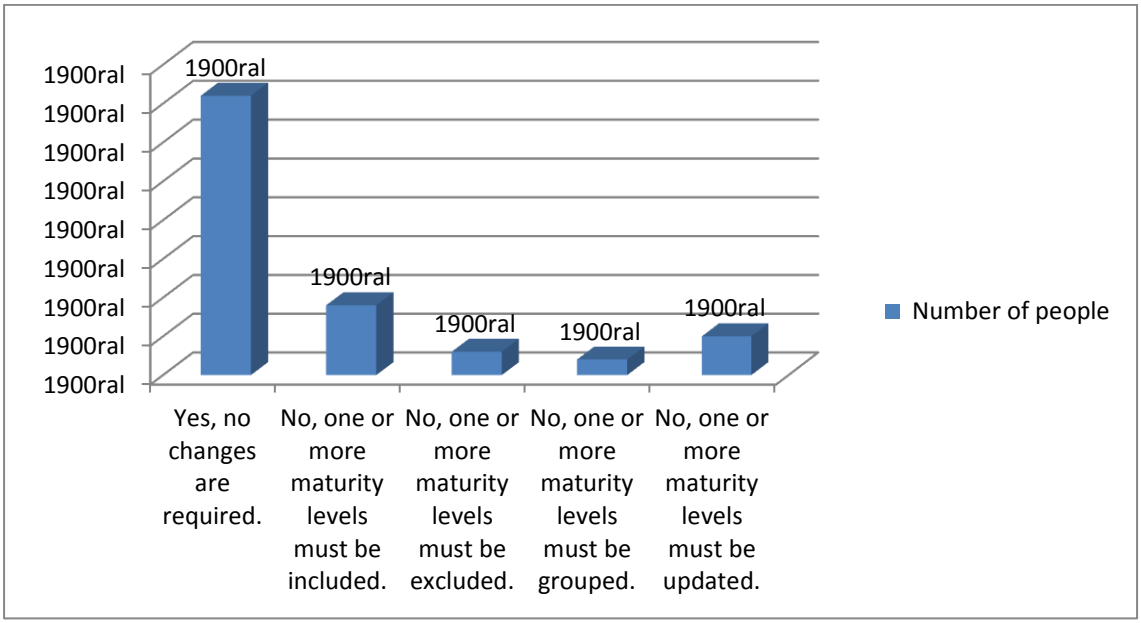

Figure 54 - C2M organization is suitable for evaluating communication maturity. Source: the author

We realize there are convergent positions about the potentialities of the C2M model to the analysis and improvement of the communication, being this an innovator model that aims the improvement of the communication in the organizations, seeking to minimize the challenges of the impersonality, absence of effective communication, in addition to the physical, geographical and cultural distances. The C2M can be used as a polyvalent tool to support the communicative process of the organization.

In this question, thirty-six respondents affirmed that the model is well organized and the number of levels is satisfactory. However, nine respondents pointed that the C2M model should have five maturity levels, in order to be in line with the CMMI. Still in their viewpoint, this change in the C2M would ease its acceptance by the organizations. Corroborating this idea, the Expert 1 affirms that “C2M would have a greater acceptance if adapted or adherent to the Carnegie-Mellon’s CMMI with 5 levels”. The Expert 4, supporting the matter in vogue, said that “is necessary to make a parallel of the C2M with the CMMI to a

company, from the CMMI implementation, know where it can treat elements of the C2M, to a greater diffusion of the model."

In minor instance, we observed some disagreeing positions in relation to its potentialities. We had three experts that disagreed with the level 1 of the C2M. In their viewpoint, if the level does not evolve, there is no reason to present it in the model. The Expert 10 affirms that "an interesting approach is the used by the MPS.BR, because since the first level the organization is already evolving". Supporting this affirmative, the Expert 5 says that "there is a tendency of the researchers and universities in following the already existent models. However, models like the CMMI may not be the best alternative. I think that a model needs to be lean to be used by the companies. It is not worth to maintain a level that does not evolve."

The other experts gave suggestions about the improvement of the nomenclature of the names of every level, as well as analyzed possible groupings in some levels.

In the other question, we asked if the C2M maturity levels represent a natural path for evolution (Figure 55).

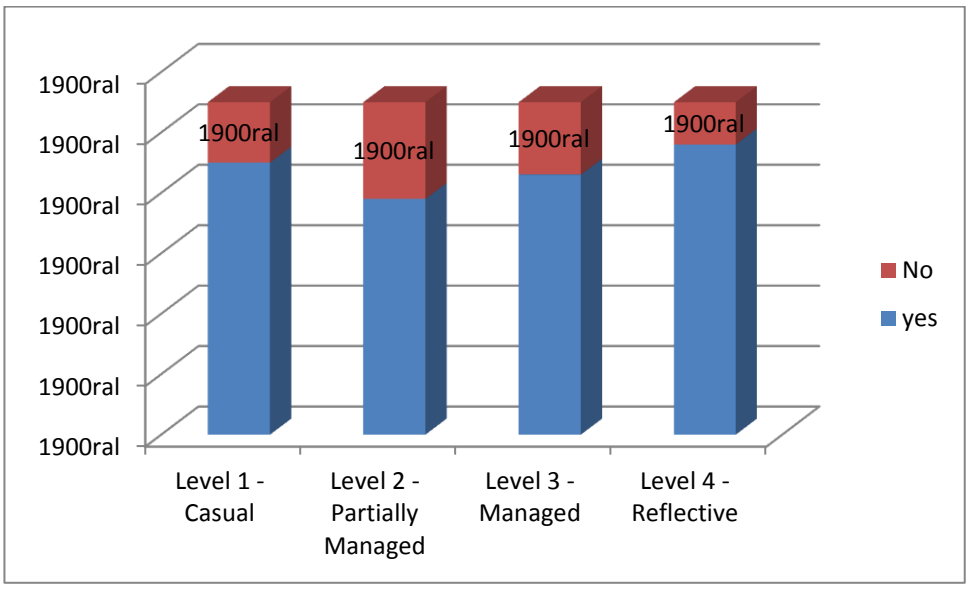

Figure 55 - C2m Model as a natural path for evolution. Source: the author

In front of the exposed in the Figure 55 above, we can note that the level 1 obtained a positive acceptance. That is, forty-five experts (82%) answered "Yes". In the level 2, thirty-nine experts (71%) answered "Yes". In the level 3, forty-

three experts (78%) answered “Yes”. And, at last, in the level 4, forty-eight (87%) answered “Yes”.

The expert 22 says that “the approach followed by the C2M is the better alternative, since it is an approach that initially considers that a company does not have maturity and evolve with things that make sense to the organization”. Still in this sense, the Expert 13 says that “It is important the initiative of conceiving a communication model, because, although being new, the C2M is well organized, showing an interesting naturality”. Finishing, the Expert 30 says that “the model have a natural and gradual path to the improvement of the communicative process of every company, being it small, medium or large.”

In the level 2, we obtained some negative answers. Sixteen experts (29%) answered “No” and next, in the level three, twelve experts (22%) answered “No”. Both levels concentrated a greater number of negative answers when comparing to the levels 1 and 4. The Expert 44 says that “Is normal the existence of rejections and acceptances when conceiving a new process, methodology or model. Over time, the model starts to maturate, reduce gaps and obtain greater acceptance of the target public.” At last, the Expert 12 says that “the C2M model still is in a little gradual sequence to micro and small companies. However, as a first version, it already has very much to contribute”

6.3.2 C2M MATURITY FACTORS AND PRACTICES

Level 1 should contain one or more maturity factors associated to it (Figure 56).

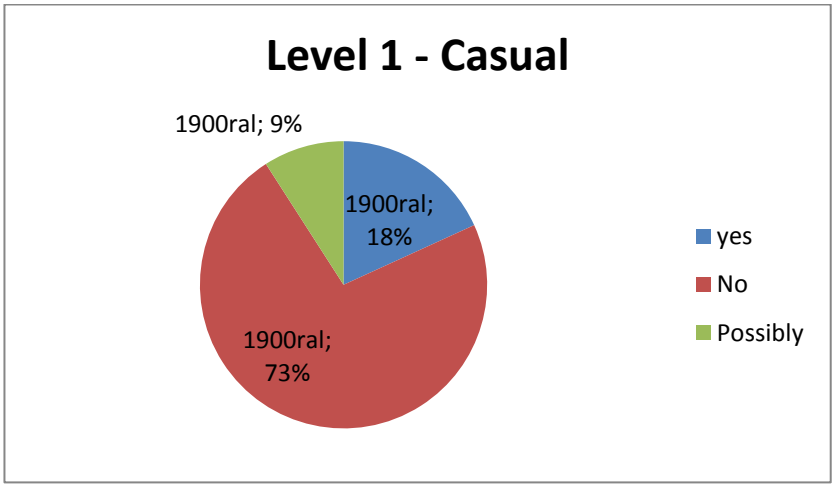

Figure 56 – Level 1. the author

According to the Figure 56, we can note that most of the experts wish that the level 1 stay without maturity factors. However, the other experts opted to insert

some factor by the following reasons: The Expert 9 said that “is necessary to include in this level elements/characteristics of the communication, even informal, inside the software processes implemented by the companies or professionals.” Next, the Expert 33 evidences that is necessary to have “tools to support the communication and the IT Infrastructure. These factors are implemented by organizations to establish the basic level, that is, level 1 of communication between teams and offshore insourcing services.” On his turn, the Expert 55 affirms that “It is worth the insertion of at least on factor in the level 1 about a “minimum” that a company treats in the area of communication in software processes.”

In sequence, we asked if the maturity factors in the Levels 2,3 and 4 are correctly organized in the C2M model (Figure 57).

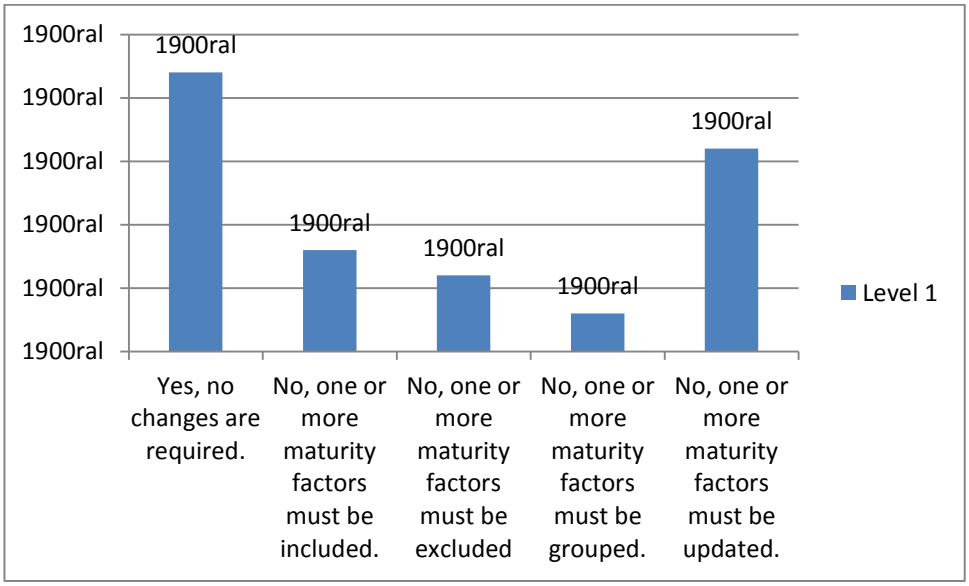

Figure 57 - maturity factors in the Levels 2,3 and 4. Source: the author

The idea was to identify gaps, mistakes and/or possibility for improvement. In light of the scenario exposed by the Figure 57, many experts gave their opinion aiming to improve the C2M. The expert 1 said that “the configuration management would be in the level two, to stay in line with other models.” Next, the Expert 21, supporting the previous affirmation, says that “the configuration management is very important in DSD projects, and, for this reason, it must be in the level 2. Another factor that should be in the level two is measurement and analysis, because there is a famous sentence that says: If you cannot measure, you cannot manage”.

The Expert 49 describes that “some practices are linked to the more generic context, as in other models, and are not specific only of communication in DSD. In my opinion, the model should focus only in what regards to the communication itself.”

The Expert 50 says that “the communication management is a very important item and it should be in the level 2. In its turn, the risk management could be in the level 3 as part of a more mature process.

The expert 52 explains that “there should be a maturity factor most associated to the called soft skills or personal attributes and competences. Please understand that the factor I am referring is different of the factor “Managing the Stakeholders.”

Next, the Figure 58 presents us the adherence of the objectives of each factor in the opinion of the experts.

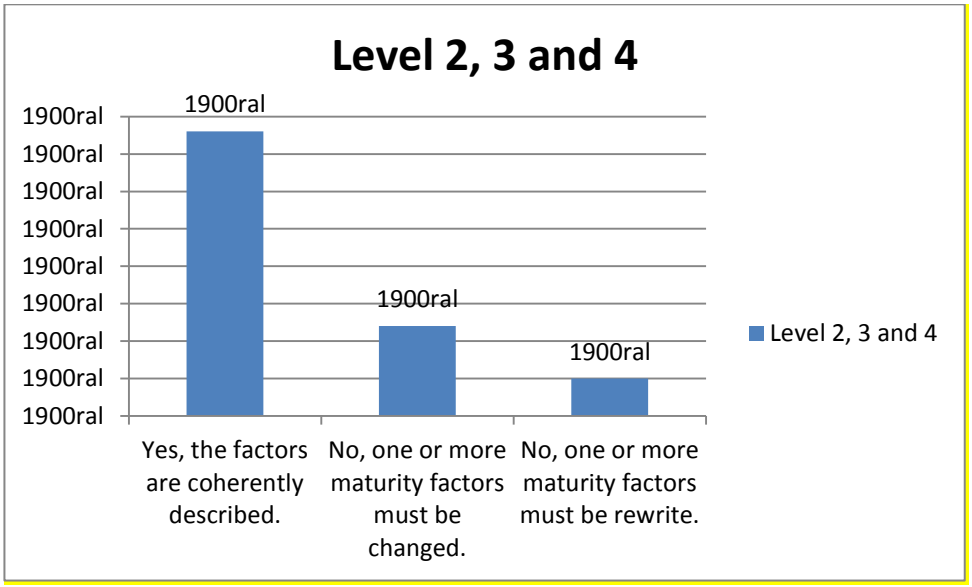

Figure 58 – About the objectives of the C2M maturity factors. Source: the author

In this question, thirty-eight experts had their opinions diversified and consensual about the description of the factors, except by twelve opinions of experts who suggested simple modifications, and five experts who suggested the complete rewrite of the objectives of some maturity factors. The dominant though that inconsciously filiates to the thought of these seventeen experts who suggested the modification or rewriting of the objectives of the maturity factors links the maturity model for the communication in DSD, in such way that the

set of ideas and arguments does not contemplate a macro vision of it use in the organizations.

However, the dominant perspective in the talks refers to the contributions the C2M can provide to the community in the sense of the professionals using the model in every project and in every dispersion level.

Between the divergent speeches, the objectives of the factors which are evolved in the C2M model were the most criticized and subject to changes and rewritings.

In this sense, the Expert 28 says that "the objectives of the factors must be refined, specifically for those which are evolved to the next levels." The expert 29 affirms that "the factors must be better described to understand the differences between the levels. For example: Requirement Elicitation and Specification."

Next, in the following question, we asked if the practices of the levels two, three and four are clearly and effectively described (Figure 59).

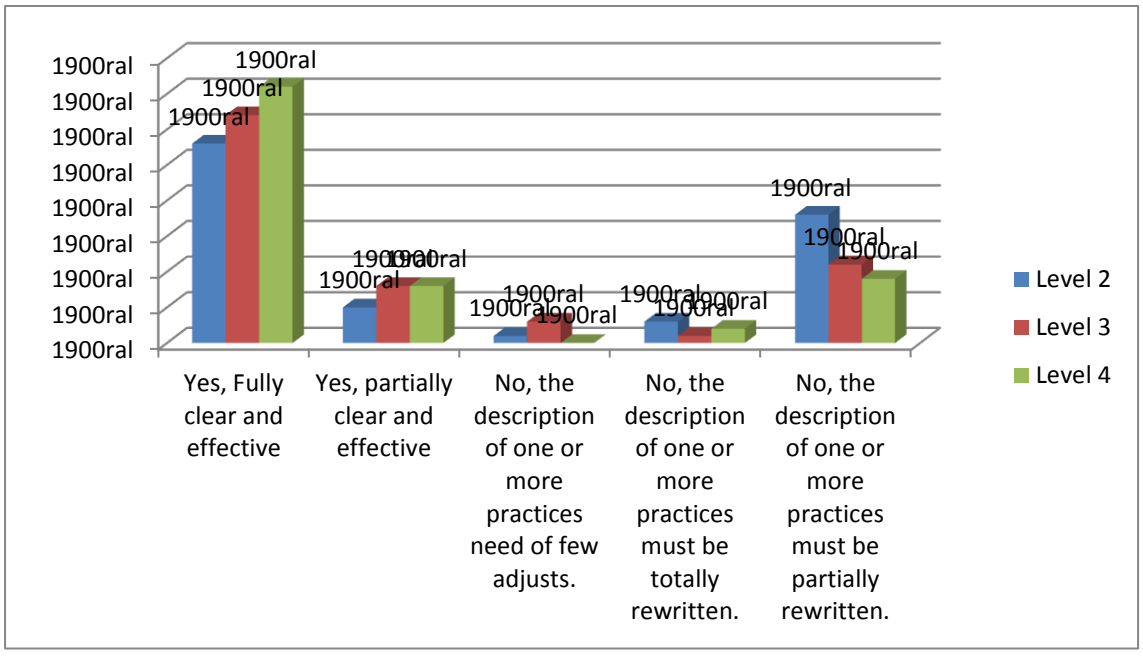

Figure 59 – About the descriptions of the practices of the levels 2, 3 and 4 of C2M. Source: the author

We are in front of antagonic opinions; however, the research had presented an interesting adherence of the proposal of the maturity model with the evaluation of the experts. Consequently, the opinions reveal an "almost" discursive

standardization (conceptual alignment) between the experts, whose are based and related under distinct aspects and perspectives in the professional scope, being it in the software industry or academy.

The Expert 3 affirms that “the factor manage the organizational culture would be established with practices that help to know and evolve the organizational culture from the level and to the level 4. It would be interesting to clarify or cite examples of how to implement a certain practice”. The Expert 38 says that “the practices are very relevant, but a calibration, redistribution and redefinition in some points will strengthen the model very much.” At last, the Expert 5 describes that “Is not enough to have the best description of the practice, but is needed that it makes sense in the organization. As I understand, the maturity model does not say how to do, it says what to do.”

6.3.3 C2M MODEL IN GENERAL

Although the model is an initiative from the academy, the specialists affirmed that the proposal is highly relevant to the industry, being it of software or not. So, this evaluation corroborates what was said by the specialists in the focus group in the Section 4.4.

From the 55 interviewed experts, ten said that the model is simple to implement. Twenty-seven affirmed that the implementation of the C2M model is regular and at last eighteen that the implementation of the model is moderately complex (Figure 60).

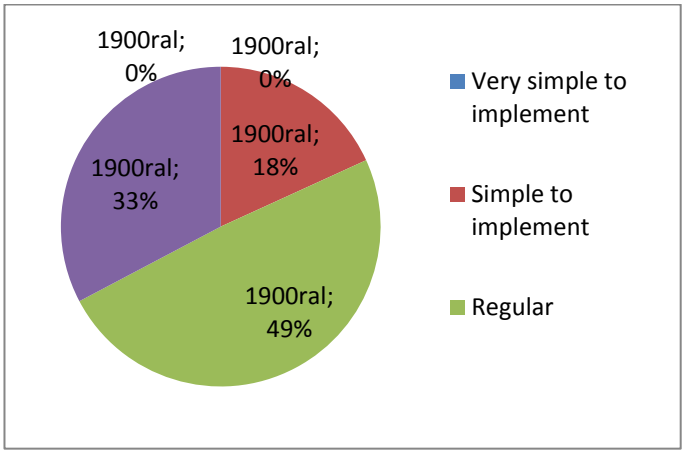

Figure 60 – Complexity level of the C2M implementation. Source: the author

Once most of the experts (49%) affirmed that the implementation of the C2M model is regular, this leads us to believe that there is an influence of this over the adoption or not of this model in a DSD project (Figure 61).

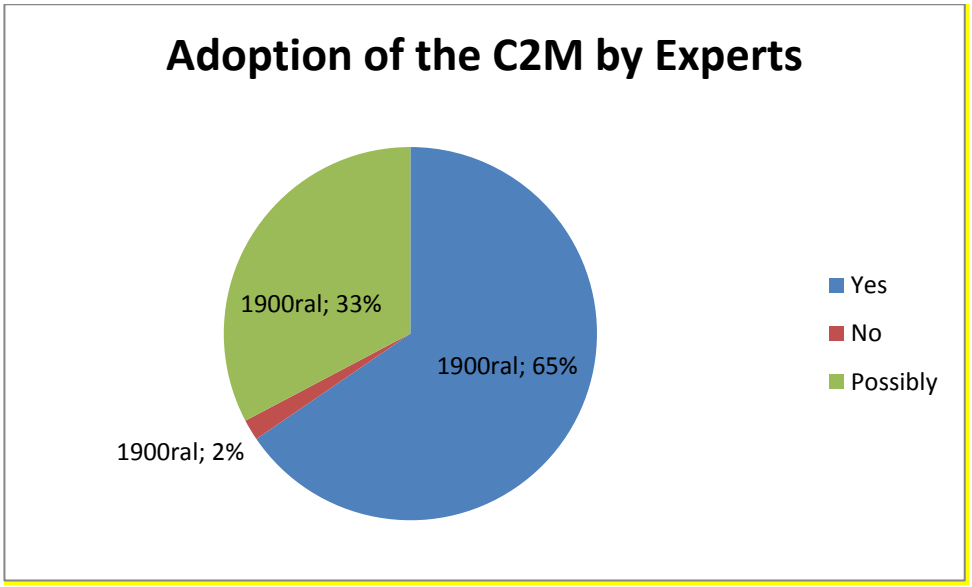

Figure 61- Experts whose would adopt the C2M in DSD projects. Source: the author

The Table 53a and 53b shows the influence of the time of experience in some questions of the interview script.

On the table 53 can be verified the significant association ($p < 0,05$) between the time of experience and the questions described in the Table. To the variables with significant association the greater perceptual differences are pointed.

Table 53a – Relationship influences the experience in DSD with some answers of Experts.

	Experience time in DSD (years)						
Variable	**3 to 4**		**5 or more**		**Total group**		**p-value**
	n	%	n	%	n	%	
TOTAL	**30**	**100,0**	**25**	**100,0**	**55**	**100,0**	
In your opinion, the maturity factors contained in the levels 2, 3 or 4 of the C2M Model are adequately distributed for the assessment of the communication maturity in DSD?							

Yes, no changes are required.	12	40,0	10	40,0	22	40,0	p (1) = 0,493*
No, one or more maturity factors must be included.	3	10,0	5	20,0	8	14,5	
No, one or more maturity factors must be excluded.	2	6,7	4	16,0	6	10,9	
No, one or more maturity factors must be grouped.	2	6,7	1	4,0	3	5,5	
No, one or more maturity factors must be updated.	11	36,7	5	20,0	16	29,1	
In your opinion, the objectives of the maturity factors which compose the levels 2, 3 and 4 of the C2M model are adequately described?							
Yes, the factors are coherently described.	18	60,0	17	68,0	35	63,6	p (1) = 0,055
Yes, partially clear and effective	1	3,3	4	16,0	5	9,1	
No, the description of one or more factors need of few adjusts.	-	-	1	4,0	1	1,8	
No, the description of one or more factors must be totally rewritten.	-	-	-	-	-	-	
No, the description of one or more factors must be partially rewritten.	11	36,7	3	12,0	14	25,5	

(*): Significative association at the level of 5,0%.

(1): Through the exact Fischer test.

Table 53b – Relationship influences the experience in DSD with some answers of Experts.

Variable	**Experience time in DSD (years)**						
	3 to 4		**5 or more**		**Total group**		**p-value**
	n	%	n	%	n	%	
TOTAL	**30**	**100,0**	**25**	**100,0**	**55**	**100,0**	
In your opinion, The practices of the factors of the level 2 – partially managed are described in an adequate way to the assessment of the communication maturity in DSD?							
Yes, the practices are coherently described.	15	50,0	13	52,0	28	50,9	p (1) = 0,653
Yes, partially clear and effective	4	13,3	1	4,0	5	9,1	
No, the description of one or more factors need of few adjusts.	-	-	1	4,0	1	1,8	
No, the description of one or more factors must be totally rewritten.	2	6,7	1	4,0	3	5,5	

No, the description of one or more factors must be partially rewritten.	9	30,0	9	36,6	18	32,7	
In your opinion, The practices of the factors of the level 3 - managed are described in an adequate way to the assessment of the communication maturity in DSD?							
Yes, the practices are coherently described.	19	63,3	13	52,0	32	58,2	p (1) = 0,204
Yes, partially clear and effective	3	10,0	5	20,0	8	14,5	
No, the description of one or more practices need of few adjusts.	-	-	3	12,0	3	5,5	
No, the description of one or more practices must be totally rewritten.	1	3,3	-	-	1	1,8	
No, the description of one or more practices must be partially rewritten.	7	23,3	4	16,6	11	20,0	
In your opinion, The practices of the factors of the level 4 - reflexive are described in an adequate way to the assessment of the communication maturity in DSD?							
Yes, the practices are coherently described.	18	60,0	18	72.0	36	65,5	p (1) = 0,099
Yes, partially clear and effective	3	10,0	5	20,0	8	14,5	
No, the description of one or more practices need of few adjusts.	-	-	-	-	-	-	
No, the description of one or more practices must be totally rewritten.	1	3,3	1	4,0	2	3,6	
No, the description of one or more practices must be partially rewritten.	8	26,7	1	4,0	9	16,4	

In the Table 54, is presented the correlation between the decisions of every type of experience (Professional of the software industry, researcher and both) in the decisions of the experts. The focus of this table is to verify if there is a significant association ($p < 0,05$) between the type of experience and the questions described in the Table. To the variables with significant associations are pointed the highest perceptual differences.

Table 54 – Relationship influences the type of experience in DSD with some answers of Experts.

Variable	Type of experience: Software industry		Research		Software industry and Research		Total Group		p-Value
	N	%	n	%	n	%	n	%	
TOTAL	**14**	**100,0**	**19**	**100,0**	**22**	**100,0**	**55**	**100,0**	
In your opinion, the maturity factors contained in the levels 2, 3 or 4 of the C2M Model are adequately distributed for the assessment of the communication maturity in DSD?									
Yes, no changes are required.	5	35,7	13	68,4	4	18,2	22	40,0	p (1) = 0,012*
No, one or more maturity factors must be included.	5	35,7	-	-	3	13,6	8	14,5	
No, one or more maturity factors must be excluded.	1	7,1	1	5,3	4	18,2	6	10,9	
No, one or more maturity factors must be grouped.	-	-	1	5,3	2	9,1	3	5,5	
No, one or more maturity factors must be updated.	3	21,4	4	21,1	9	40,9	16	29,1	
In your opinion, the objectives of the maturity factors which compose the levels 2, 3 and 4 of the C2M model are adequately described?									
Yes, the factors are coherently described.	10	71,4	14	73,7	11	35	35	63,6	p (1) = 0,010*
No, one or more maturity factors must be excluded.	3	21,4	-	-	2	9,1	5	9,1	
No, one or more maturity factors must be moved.	1	7,1	-	-	-	-	1	1,8	
No, one or more maturity factors must be grouped.	-	-	-	-	-	-	-	-	
No, one or more maturity factors must be updated.	-	-	5	26.3	9	40,9	14	25,5	
In your opinion, The practices of the factors of the level 2 – partially managed are described in an adequate way to the assessment of the communication maturity in DSD?									
Yes, the practices are coherently described.	8	57,1	13	68,4	7	31,8	28	50,9	p (1) = 0,028*
Yes, partially clear and effective	3	21,4	1	5,3	1	4,5	5	9,1	
No, the description of one or more practices need of few adjusts.	1	7,1	-	-	-	-	1	1,8	
No, the description of one or more practices must be totally rewritten.	-	-	1	5,3	2	9,1	3	5,5	
No, the description of one or more practices must be partially rewritten.	2	14,3	4	21,1	12	54,5	18	32,7	
In your opinion, The practices of the factors of the level 3 - managed are described in an adequate way to the assessment of the communication maturity in DSD?									
Yes, the practices are coherently described.	12	85,7	13	68,4	7	31,8	32	58,2	p (1) = 0,022*
Yes, partially clear and effective	1	7,1	3	15,8	4	18,2	8	14,5	

No, the description of one or more practices need of few adjusts.	1	7,1	-	-	2	9,1	3	5,5	
No, the description of one or more practices must be totally rewritten.	-	-	-	-	1	4,5	1	1,8	
No, the description of one or more practices must be partially rewritten.	-	-	3	15,8	8	36,4	11	20,0	
In your opinion, The practices of the factors of the level 4 - reflexive are described in an adequate way to the assessment of the communication maturity in DSD?									
Yes, the practices are coherently described.	10	71,4	12	63,2	14	63,6	36	65,5	$p^{(1)} = 0,864$
Yes, partially clear and effective	2	14,3	3	15,8	3	13,6	8	14,5	
No, the description of one or more practices need of few adjusts.	-	-	-	-	-	-	-	-	
No, the description of one or more practices must be totally rewritten.	1	7,1	1	5,3	-	-	2	3,6	
No, the description of one or more practices must be partially rewritten.	1	7,1	3	15,8	5	22,7	9	16,4	

6.3.4 BENEFITS OF C2M ACCORDING THE EXPERTS

After the interviews, the experts were inquired about what benefits the C2M brings to the DSD projects.

Expert 1 said that the main benefit is “the adoption of well-defined practices for the communication. A good communication makes the project have a smoother execution.” Next, Expert 2 affirms that “the model can organize and structure projects with distributed teams to better use the communicational synergy between teams, raising the productivity, reducing costs and maintaining the quality of the final product.

On his turn, expert 3 said that the greater benefit is “the communication maturity itself in a DSD project or in a company itself, where all the projects would start to be used inside that level, what highly eases all the process of software development to distributed teams”. Strengthening this idea, the Expert 4 describes that “the C2M model presents guidelines which will allow a more planned and structured communication, executing then the tasks more effectively.

Expert 5 said that “the greater benefit is to make the management reflect about the importance of several aspects (factors and practices) that often are neglected.”

Among the main benefits cited by the Experts, we point:

- The importance of the communication management;
- A systematic way to plan and better understand the problem of the communication in projects and in the organization;
- Good communication practices;
- Effective communication;
- More transparency, better results, decrease of the conflicts, understanding and follow up of the projects;
- Establish the effective management of the communication between teams;
- Minimize the impact of the lack of interpersonal contact.

6.4 CONSIDERATIONS OF THE CHAPTER

This chapter presented the definition, planning, operation, analysis and interpretation of the study based on expert opinion that evaluated the feasibility, completeness and adequacy of the C2M maturity model.

For 65% (36) of the experts said it would adopt the model and 33% (18) of the experts said they possibly adopt. Only 2% (1) expert said it would not adopt. This result motivates us to invest heavily in continuous improvement of C2M so that it can assist organizations in organizational processes effectively.

Even with the reduced number of experts (55), the analysis has shown that the C2M can be feasible.

The study also identified some directions for improvements that will be analyzed and subsequently generated a new version of the proposed model. This activity is already planned in our future works.

7. FINAL CONSIDERATIONS

Many companies that adopt distributed software development are concerned in overcoming the challenges imposed by the physical, time and cultural dispersions. In addition, they also seek to improve the quality of their products and processes. In this scenario the communication stands out, being directly impacted by the cited challenges. One of the possible solutions to handle these challenges is the adoption of improvement initiatives to the communication process aligned to the good practices of project management. However, many times, the adoption of good practices is not enough. Specific issues of the project and, in certain cases, of the organization, are not covered by the current models and norms which aim to support the implantation of an initiative for the improvement of the processes in software organizations. When I refer to specific issues of the project, I am referring mainly to the communication, which in most of the cases is the identity of a project.

Organizations, boosted by the globalization, are adhering to new ways to do businesses, develop products and, even, new forms to select new talents. Nowadays, several companies are seeking to decrease their costs, and distributed software development has brought this to organizations around the entire world, aiming productivity gains, more qualified workforce and quality improvements. In this scenario, DSD emerges as an alternative to the organizations stay closer to the market. However, DSD brings also some challenges (e.g., lack of face-to-face communication, greater technological dependency in the communication, etc.).

The main goal of this thesis, as presented in Section 1, was reached with the proposal of the C2M model, contributing in an original form to the development of the DSD area, providing a maturity model for the communication as described in Chapter 5.

From the literature review in the beginning of my degree to the present moment, this is the first maturity model for communication in DSD projects. This way, the main contribution of this thesis is the proposal of the model itself, aiming to guide the organizations in strengthening their communicational processes.

During the development of this thesis was possible to identify the main maturity models in general and also specifically in the DSD area taking in

consideration everything, from the history to mandatory characteristics to the conception of a maturity model. In this research, I identified three maturity models (OMM. OSM and PMF) in the area of DSD as related work (described in Chapter 3) and compared them one with each other using pre-established criteria defined by Pilattis (2006). In this comparison I identified that none of these models is focused on communication. Some even promote some practices to deal with communication in a more incipient form. Given this context, is clear that the model proposed by this thesis is to focus on the differential maturity of communication where the organization can improve its communication process continuously. In addition, the C2M can be implemented in conjunction with the other models. Next, I listed from a systematic review 29 factors and 25 effects of communication. Furthermore, in a second literature review, it was possible to extract a set of best practices to communication in DSD projects which composed the model proposed in this thesis. Yet, as a result, was built a knowledge body to support the communication process in organizations, containing descriptive information about the theme in vogue. This research contributed also to strengthening the importance of maintaining the methodological rigor to properly identify the elements to the conception of a maturity model.

7. 1 Theoretical and practical implications

To the academy, the proposed research contributes to the Software Engineering area, by identifying factors that impact communication in DSD environments. In addition, it contributes also to the understanding of the influence that non-technical aspects like communication have over distributed software development projects. Also noteworthy is the conception of the maturity model itself, which was based in uniquely qualitative studies. The set of best practices can be also considered a contribution, once it was extracted from the same methodological process which generated the C2M model. This thesis generated also publications in national periodicals, congresses, symposiums and national and international qualified workshops (FARIAS JUNIOR et al., 2010), (MENDES; FARIAS JUNIOR; MOURA, 2010),(FARIAS JUNIOR; MOURA; MARCZAK, 2012a), (FARIAS JUNIOR et. al., 2012b), (FARIAS JUNIOR; MOURA; MARCZAK, 2013a), (FARIAS JUNIOR; MOURA;

MARCZAK, 2013b), (OLIVEIRA; RODRIGUES; FARIAS JUNIOR; BARBOZA; MOURA, 2013c), (FARIAS JUNIOR; SANTOS; COSTA; AZEVEDO; MOURA, 2013d), (FARIAS JUNIOR; SANTOS; MARCZAK; SANTOS; WERNER; MOURA, 2013e); (BARBOSA; FARIAS JUNIOR; SANTOS.; MARCZAK; MOURA, 2014).

From the viewpoint of the software industry and the involved professionals, the proposed model aims to support the organizations in significantly improving the way they communicate. Nowadays, I am negotiating with two companies associated to the Softex Recife to gradually insert the C2M in real projects. The idea is to generate value for the two voluntary organizations and in the end calibrate the model, so that it may benefits even more organizations, being they small, medium or large sized.

To the researcher, this thesis contributed to the academic and professional maturing, through the interaction with other researchers, academic events about the subject, like WDDS and ICGSE, and the contacts with the scientific community in the area. Finally, this process contributed also to the strengthening of the DSD cell of the GP2 research group in the Informatics Center of the Federal University of Pernambuco.

7.2 Limitations

Some limitations could be observed in the study, even with all the cautions and attenuations promoted by the researchers. In relation to the used research method, the limitations are typical of qualitative studies, particularly in the generalization of the results. Additionally, in this study, with strong empirical basis, was not easy to find companies willing to participate with the desirable intensity. In relation to the systematic review, one of the greatest concerns in SLRs is selecting as many relevant studies as possible to answer the research questions, and a coverage of 100% of the sources that was possible by limitation of time and resource. Six electronic sources were chosen for the automatic search, being most of them from the list of sources relevant to Computer Sciences, according to Kitchenham and Charters (2007). Due to the limitations of the search engines, relevant articles still could not be found. To minimize this problem, was performed a manual search in the main conferences and

periodicals of the knowledge area. Furthermore, there also is the influence of the researcher in the classification of the articles found in this process of review.

In relation to the sample of the field study with DSD professionals, it counted with the participation of thirty-one professionals. This number of professionals influences in the generalization of the final results. Even if the generalization is not possible, these data have the validity of being the first results presented in this structure and can be complemented with other studies.

Finally, in relation to the utilization of the survey, it depends exclusively on the good faith and on the total capacity of the respondents, and these problems were reduced by the rigor applied during its planning and execution, as described in the Chapter 6.

7.3 Future Work

Considering the scope of the proposed model, can be identified many opportunities to the continuity of the developed studies. Next, are described some investigation points which can be worked subsequently:

- It is understood that the C2M model must be used by the organizations aiming to identify how they respond to the proposed practices. For this, is suggested the elaboration of an evaluation guide to the practices of the model, to guide the companies that seek to continuously improve their communicational processes;
- Develop a computational tool to support the proposed model, in such way that it stays accessible to every organization which wants to use it;
- Implement the C2M model in real projects and conduct evaluations eith the purpose of verify its effectiveness in relation to the communicational process;
- Constant update of the maturity factors and proposed practices, to maintain the model up-to-date with the knowledge basis existing in the moment.

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APPENDIX A - Survey Questionnaire

General View of the Research

My name is Ivaldir H. de Farias Júnior, and I am a Doctorate candidate in Computer Science in the Center of Informatics (Centro de Informática – Cin) of the Federal University of Pernambuco – (Universidade Federal de Pernambuco – UFPE), under the guidance of the PhD. Professor Hermano Perrelli de Moura and the PhD. Professor Sabrina Marczak, from the PUCRS. First of all, I would like to thank you by volunteering to answer this research. Your feedback is extremely valuable to the conclusion of this work. The following questionnaire finishes one more evaluation step of this Doctorate Work, which have as basis the elaboration of a maturity model for communication in Distributed Software Development (DSD).

The maturity model for communication in distributed software development called C2M (Communication Maturity Model) contains 4 maturity levels and 15 communication factors distributed in the referred levels. This research aims to evaluate the organization and objective of the maturity levels of the C2M model, the distribution of the factors in the maturity levels, the definition of every factor and their respective practices.

15 minutes are necessary for the reading of the documents and 35 minutes more, in average, to answer the questionnaire completely. We kindly ask you to COMPLETELY answer it. In contrary, we will need to discard it, once the incomplete questionnaires will not be considered valid to our research. Your personal data will be kept in confidence, and your contributions will be used only for academic purposes.

Regards,

Ivaldir H. de Farias Júnior

About you and your Experience

1. What is your name?
2. What is your e-mail?
3. How old are you?
4. What Is your gender?

( ) Female

( ) Male

5. In which city do you live?
6. In which state do you live?
7. What is your scholarship?

( ) Graduation

( ) Specialization

( ) Master

( ) Doctorate

( ) Post-Doctorate

Other (specify)

8. What is your formation area?

( ) Computing/Informatics

( ) Management

( ) Communication

Other (Specify)

9. What position do you actually hold?

( ) Project Manager

( ) Technical Leader

( ) Software Developer

( ) Software Tester

( ) Requirements analyst

( )Student

( )Researcher (professor)

( ) Other

Others (Specify)

10. What type of experience do you have in Distributed Software Development (DSD)

( ) Software Industry

( ) Academy

( )Both

11. How long is your DSD experience?
12. What is the name of the organization that you actually work in?
13. What is the size of the organization that you actually work in?

( ) Micro – Up to 9 employees

( ) Small – from 10 to 49 employees

( ) Medium – from 50 to 99 employees

( ) Large – more than 100 employees

( ) I am Student

14. The organization you actually work in is certified in quality models?

( ) The company does not have certification

( ) CMMI

( ) ISO

( ) MPS.BR

( ) MPT.BR

( ) Other

Other (specify)

Assessment of the C2M – Communication Maturity Model

Next we present the maturity levels of the C2M and their objectives. Consider them when answering the following questions.

LEVEL	OBJECTIVE
Level 1 – Casual	The initial level of every organization, without the practices defined. This means that each organization execute the communication activities in an ad-hoc form.
Level 2 – Partially managed	The organization processes start to change, including basic communication activities. These activities mainly include aspects of communication planning.
Level 3 – Managed	The team members work in a self-organized and simultaneous way to

	maintain an effective communication and attend the Project objectives. The distributed teams understand the process of the work they will perform, understand their objectives, are conscious of the necessary steps to reach these objectives and have the necessary knowledge to execute the tasks.
Level 4 – Reflexive	It Predicts a constant communication and motivation to improve the performance of every team, once the standards (for example, organizational processes, reports, plans and communication media, etc.) are created and institutionalized organizationally.

15. In your opinion, the number of levels of the C2M model is adequate to the assessment of the communication maturity in DSD?

( ) Yes, no changes are required.

( ) No, one or more maturity levels must be included.

( ) No, one or more maturity levels must be excluded.

( ) No, one or more maturity levels must be grouped.

( ) No, one or more maturity levels must be updated.

16. What are your suggestions in case of the need for inclusion, exclusion, grouping or update?

17. In your opinion, the objective of every level of the C2M model is adequate to the assessment of the communication maturity in DSD?

( ) Yes, no changes are required.

( ) No, one or more maturity levels must be included.

( ) No, one or more maturity levels must be excluded.

( ) No, one or more maturity levels must be grouped.

( ) No, one or more maturity levels must be updated.

18. What are your suggestions in case of the need for inclusion, exclusion, grouping or update?

Next, are presented the factors of every maturity level, and their objectives. Consider them to answer the following questions.

Level	Factors	Objective of the factor
2	Managing cultural differences	The objective of this factor is to understand the difficulties existing due to cultural differences and prepare the teams to act in DSD projects knowing and respecting these differences.
	Communication support tools	The objective of this factor is to make an adequate use of the existing tools, considering the scenery of distribution of the teams.
	IT infrastructure	The objective of this factor is to plan the infrastructure which will be made available to the distributed teams.
	Managing the geographic distance	The objective of this factor is to improve the levels of perception of physical distance existing between the teams.
	Managing the time distance	The objective of this factor is to understand and improve the levels of perception of the time distance.
	Stakeholder management	The objective of this factor is to perform the planning and management of the stakeholders, considering the profile and proficiency required for the Project.
	Communication Planning	The objective of this factor is to plan the communication from the beginning to the end of the Project.
	Risk Management	The objective of this factor is to identify, analyze, treat and monitor the risks.
	Communication policies and standards	The objective of this factor is to establish and maintain communication policies and standards that add value to the Project.
	Requirements elicitation and specification	The objective of this factor is to provide a better understanding in the elicitation and specification of the requirements, seeking to improve the spoken and written communication of the artifacts from this activity.

Level	Factors	Objective of the factor
3	Managing cultural differences	The objective of this factor is to understand the difficulties existing due to cultural differences and prepare the teams to act in DSD projects knowing and respecting these differences.
	Communication support tools	The objective of this factor is to make an adequate use of the existing tools, considering the scenery of distribution of the teams.
	IT infrastruture	The objective of this factor is to plan the infrastructure which will be made available to the distributed teams.
	Managing the geographic distance	The objective of this factor is to improve the levels of perception of physical distance existing between the teams.
	Managing the time distance	The objective of this factor is to understand and improve the levels of perception of the time distance.
	Stakeholder management	The objective of this factor is to perform the planning and management of the stakeholders, considering the profile and proficiency required for the Project.
	Communication Planning	The objective of this factor is to plan the communication from the beginning to the end of the Project.
	Risk management	The objective of this factor is to identify, analyze, treat and monitor the risks.
	Communication policies and standards	The objective of this factor is to establish and maintain communication policies and standards that add value to the project.
	Requirements elicitation and specification	The objective of this factor is to provide a better understanding in the elicitation and specification of the requirements, seeking to improve the spoken and written communication of the artifacts from this activity.
	Trust acquiring	The objective of this factor is to solve or minimize the difficulties from the absence of trust between the teams.
	Communication Training	The objective of this factor is to develop abilities and knowledge to permit the members of the project perform

		effectively their roles.
	Configuration Management	The objective of this factor is to establish and maintain the integrity of the artifacts generated (products of the work) along the project, as well as, ease the communication of the alteration in documents and codes which suffered any change.

Level	Factors	Objective of the fator
4	Continuous improvement of the communication	The objective of this factor is to promote continuously the maintaining and improvement of the communication in the organization.
	Monitoring, measurement and analysis	The objective of this factor is to provide subsidies to develop and maintain a capacity for monitor, measure and analyze, with the purpose of providing information to the high management.
	Stakeholder management	The objective of this factor is to perform the planning and management of the stakeholders, considering the profile and proficiency required for the Project.
	Communication Training	The objective of this factor is to develop abilities and knowledge to permit the members of the project perform effectively their roles.

19. In your opinion, the Level 1 (casual) of the C2M model is really needed? Remember that this level actually is only an initial level, without associated maturity factors.

( ) Yes

( ) No

( ) Maybe

20. In case of answering "Yes" to the previous question, point some factors that should be associated to the Level 1 Casual.

21. In your opinion, the maturity factors contained in the levels 2, 3 or 4 of the C2M Model are adequately distributed for the assessment of the communication maturity in DSD?

( ) Yes, no changes are required.

( ) No, one or more maturity factors must be included.

( ) No, one or more maturity factors must be excluded.

( ) No, one or more maturity factors must be grouped.

( ) No, one or more maturity factors must be updated.

22. What are your suggestions in case of the need for inclusion, exclusion, grouping or update?
23. In your opinion, the maturity factors contained in the levels 2, 3 or 4 of the C2M Model are adequately described?

( ) Yes, no changes are required.

( ) No, one or more maturity factors must be moved.

( ) No, one or more maturity factors must be excluded.

( ) No, one or more maturity factors must be grouped.

( ) No, one or more maturity factors must be updated.

24. What are your suggestions in case of the need for move or update?

25. The practices of the factors of the level 2 are described in an adequate way to the assessment of the communication maturity in DSD?

() Yes, no changes are required.

() No, one or more practices must be included.

() No, one or more practices must be excluded.

() No, one or more practices must be grouped.

() No, one or more practices must be updated.

26. What are your suggestions in case of the need for inclusion, exclusion, grouping or update the practices contained in the Level 2 – partially managed?

Next are presented the practices contained in the C2M maturity factors. Consider them when answering the next questions.

Maturity Level	**Communication maturity Factor**	**Communication Practices**
2	Managing cultural differences	Establish policies for the recruitment and selection of new talents for the project; Identify and Institutionalize the cultural context of every team in the project;
	Communication support tools	Adopt synchronous and/or asynchronous communication tools on demand; Adopt collaboration tools;

	IT infrastructure	Define the infrastructure considering the dispersion level of the teams; Monitor periodically the IT infrastructure;
	Managing the geographic distance	Plan face-to-face meetings; Plan and perform the frequent communication;
	Managing the time distance	Plan and manage the synchronization of the team time shifts; Plan and perform the continuity of the tasks (handoffs passage);
	Stakeholder management	Identify the stakeholders; Define roles and responsibilities
	Communication Planning	Establish a communication strategy; Establish mechanisms to confirm the understanding of the activities; Establish a default language for the project; Establish a communication plan; Establish the stakeholder commitment with the communication planning; Define a communication focal point (interlocutor comunicacional); Manage the data (artifacts) of the project;
	Risk Management	Identify communication risks Assess, categorize and prioritize communication risks Identify the relevant stakeholders associated to each risk;
	Communication policies and standards	Establish a communication policy;
	Requirements elicitation and specification	Obtain the confirmation of the requirement understanding by the team members; Manage the requirement changes;

Maturity Level	**Communication maturity Factor**	**Communication Practices**
3	Managing cultural differences	Establish a basis of cultural knowledge; Standardize jargons and vocabulary of the Project; Plan initiatives to mitigate occurrences caused by the cultural differences;
	Communication support tools	Adopt face-to-face communication tools;
	Trust acquiring	Establish integration strategies between the stakeholders; Interchange of members between the disperse Project teams of the Project; Encourage the collaboration and cooperation between the teams
	Infrastructure	Maintain backup of the IT infrastructure;
	Managing the geographic distance	Establish a discussion forum in the project; Plan initiatives to mitigate the occurrences caused by the geographical distance;
	Managing the time distance	Plan and manage the follow-the-sun strategy (almost continuous Development); Plan initiatives to mitigate occurrences caused by the time distance;
	Stakeholder Management	Plan the management of the stakeholders;
	Communication Planning	Plan and manage the meetings; Gather, document and communicate the lessons learned;
	Risk Management	Elaborate Plans of risk mitigation;
	Communication policies and standards	Establish standards for documentation and communication;

	Communication training	Plan trainings in communication; Provide trainings in communication; Register trainings in communication;
	Configuration management	Establish the version and modification control; Establish access control to the configuration items; Establish a configuration plan to the whole Project;
	Requirements elicitation and specification	Maintain the requirement traceability;

Maturity Level	Communication maturity Factor	Communication Practices
4	Stakeholder Management	Monitor and assess the relationship between the stakeholders;
	Continuous improvement of the communication	Perform systematically the analysis of the data collected in the Project; Provide orientation for the use of the data; Research, assess and monitor new communication processes, methods and tools to apply in the organization; Establish, monitor and maintain the strategic action plan for the improvement of the organization's communication;
	Communication Training	Assess the benefits of the communication training;
	Monitoring, measurement and analysis	Establish the objective of the measurement for communication; Establish gathering, storage and analysis procedures for the communication data; Communicate the results of the measurement;

27. The practices of the factors of the level 3 are described in an adequate way to the assessment of the communication maturity in DSD?

() Yes, no changes are required.

() No, one or more practices must be included.

() No, one or more practices must be excluded.

() No, one or more practices must be grouped.

() No, one or more practices must be updated.

28. What are your suggestions in case of the need for inclusion, exclusion, grouping or update the practices contained in the Level 3 – managed?

29. The practices of the factors of the level 3 – managed are described in an adequate way to the assessment of the communication maturity in DSD?

() Yes, no changes are required.

() No, one or more practices must be included.

() No, one or more practices must be excluded.

() No, one or more practices must be grouped.

() No, one or more practices must be updated.

30. What are your suggestions in case of the need for inclusion, exclusion, grouping or update the practices contained in the Level 3 – managed?

31. The practices of the factors of the level 4 - Reflexive are described in an adequate way to the assessment of the communication maturity in DSD?

() Yes, no changes are required.

() No, one or more practices must be included.

() No, one or more practices must be excluded.

() No, one or more practices must be grouped.

() No, one or more practices must be updated.

32. What are your suggestions in case of the need for inclusion, exclusion, grouping or update the practices contained in the Level 4 - reflexive?

33. How do you evaluate the need for a maturity model which helps the organizations that work with DSD to assess the communication in their projects

( ) Unnecessary

( ) Few necessary

( ) Necessary

( ) Very necessary

( ) Extremely necessary

34. How do you evaluate the ease of implementation of the C2M maturity model for the communication in the DSD context:

() Very simple to implement

() Simple to implement

() Regular

() Moderately complex to implement

() Very complex to implement

35. If you wish, justify the answer of the previous question.

36. Would you adopt this model in a DSD Project?

() Yes

() No

() Maybe

37. If you wish, justify the answer of the previous question.

38. In your opinion, what benefit this communication maturity model brings to the companies that adopt DSD projects?

APPENDIX B– SECUNDARY STUDIES

ID	REF	ANO	REFERÊNCIA
ES_01	[A1]	2008	SMITE, D.; WOHLIN, C.; FELDT, R.; GORSCHEK, T. "Reporting Empirical Research in Global Software Engineering: A Classification Scheme," Global Software Engineering, 2008. ICGSE 2008. IEEE International Conference on , vol., no., pp.173-181, 17-20 Aug. 2008. doi: 10.1109/ICGSE.2008.22.
ES_02	[A2]	2009	JIMÉNEZ, M.; PIATTINI, M.; VIZCAÍNO, A. "Challenges and Improvements in Distributed Software Development: A Systematic Review," Advances in Software Engineering, vol. 2009, Article ID 710971, 14 pages, 2009. doi:10.1155/2009/710971.
ES_03	[A3]	2009	EBLING, T.; AUDY, J. L. N.; PRIKLADNICKI, R. "A Systematic Literature Review of Requirements Engineering in Distributed Software Development Environments". ICEIS 2009 - Proceedings of the 11th International Conference on Enterprise Information Systems, Volume ISAS, Milan, Italy, May 6-10, 2009: 363-366
ES_04	[A4]	2009	KHAN, S.U.; NIAZI, M.; AHMAD, R. "Critical Barriers for Offshore Software Development Outsourcing Vendors: A Systematic Literature Review," Software Engineering Conference, 2009. APSEC '09. Asia- Pacific, vol., no., pp.79-86, 1-3 Dec. 2009 doi: 10.1109/APSEC.2009.16
	[A5]	2009	KHAN, S. U.; NIAZI, M.; AHMAD, R. "Critical Success Factors for Offshore Software Development Outsourcing Vendors: A Systematic Literature Review." In Proceedings of the 2009 Fourth IEEE International Conference on Global Software Engineering (ICGSE '09). IEEE Computer Society, Washington, DC, USA, 207-216. DOI=10.1109/ICGSE.2009.28
ES_05	[A6]	2009	PERSSON, J.S.; MATHIASSEN, L.; BOEG, J.; MADSEN, T.S.; STEINSON, F. "Managing Risks in Distributed Software Projects: An Integrative Framework," Engineering Management, IEEE Transactions on, vol.56, no.3, pp.508-532, Aug. 2009. doi: 10.1109/TEM.2009.2013827
ES_06	[A7]	2009	HOSSAIN, E.; BABAR, M. A.; PAIK, H. "Using Scrum in Global Software Development: A Systematic Literature Review." In Proceedings of the 2009 Fourth IEEE International Conference on Global Software Engineering (ICGSE '09). IEEE Computer Society, Washington, DC, USA, 175-184 DOI=10.1109/ICGSE.2009.25

			http://dx.doi.org/10.1109/ICGSE.2009.25.
	[A8]		HOSSAIN, E.; BABAR, M. A.; PAIK, H.; VERNER, J. "Risk Identification and Mitigation Processes for Using Scrum in Global Software Development: A Conceptual Framework," APSEC, pp.457-464, 2009 16th Asia-Pacific Software Engineering Conference, 2009. http://doi.ieeecomputersociety.org/10.1109/APSEC.2009.56
ES_07	[A9]	2010	SMITE, D.; WOHLIN, C.; GORSCHEK, T.; FELDT, R. “Empirical evidence in global software engineering: a systematic review.” Empirical Software Engineering. 15, 1 (February 2010), 91-118. DOI=10.1007/s10664-009- 9123-y.
ES_08	[A10]	2010	PRIKLADNICKI, R.; AUDY, J. L. N. Process models in the practice of distributed software development: A Systematic review of the literature. Information and Software Technology 52 (2010) 779–791. doi:10.1016/j.infsof.2010.03.009.
ES_09	[A11]	2006	YALAHO, A. "A Conceptual Model of ICT-Supported Unified Process of International Outsourcing of Software Production," Enterprise Distributed Object Computing Conference Workshops, IEEE International, p. 47, 10th IEEE International Enterprise Distributed Object Computing Conference Workshops (EDOCW'06), 2006.
ES_10	[A12]	2009	COSTA, C.; CUNHA, C.; ROCHA, R.; FRANÇA, A.; FABIO Q. B da SILVA; PRIKLADNICKI, R. “Models and tools for managing distributed software development: a systematic literature review”. 14th International Conference on Evaluation and Assessment in Software Engineering (EASE 2010), April 2010.
ES_11	[A13]	2010	COSTA, C.; ROCHA, R.; FABIO Q. B da SILVA; PRIKLADNICKI, R. Desafios e Boas Práticas para o Gerenciamento de Projetos no Desenvolvimento Distribuído de Software. IV Workshop de Desenvolvimento Distribuído de Software – WDDS. Setembro de 2010.
	[A14]	2010	da Silva, Fabio Q. B.; Costa, Catarina; França, A. César C.; Prikladnicki, Rafael. “Challenges and Solutions in Distributed Software Development Project Management: a Systematic Literature Review,”. In Proceedings of the Fifth IEEE International Conference on Global Software Engineering (ICGSE '10). IEEE Computer Society, Washington, DC, USA, 87-96. doi: 10.1109/ICGSE.2010.18

ES_12	[A15]	2009	LOPEZ, A.; NICOLAS, J.; TOVAL, A. Risks and safeguards for the requirements engineering process in global software development. In Proceeding of the 2009 fourth IEEE International Conference on Global Software Engineering (ICGSE '09). IEEE Computer Society Washington, DC, USA, 394-399 doi:10.1109/ICGSE.2009.62
ES_13	[A16]	2010	FAUZI, S.; BANNERMAN, P.; STAPLES, M. "Software Configuration Management in Global Software Development: A Systematic Map," APSEC, 404-413, 2010 Asia Pacific Software Engineering Conference, 2010. http://doi.ieeecomputersociety.org/10.1109/APSEC.2010.53.
ES_14	[A17]	2010	MONASOR, M.; VIZCAÍNO, A.; PIATTINI, M.; CABALLERO, I. "Preparing students and engineers for global software development: a systematic review". Global Software Engineering, 2008. ICGSE 2008. IEEE International Conference on, vol., no., pp.177-186, 23-26 Aug. 2010. doi: 10.1109/ICGSE.2010.28.
ES_15	[A18]	2010	NOLL, J.; BEECHAM, S.; RICHARDSON, I. "Global software development and collaboration: barriers and solutions" In: Proceeding of the Magazine ACM Inroads, ACM New York, NY, USA, 66 – 78, Sep. 2010. doi: 10.1145/1835428.1835445.
ES_16	[A19]	2010	ALI, N.; BEECHAM, S.; MISTRÍK, I. "Architectural Knowledge Management in Global Software Development: A Review,. In Proceeding of the 2010 5th IEEE International Conference on Global Software Engineering (ICGSE 2010), 347-352. http://doi.ieeecomputersociety.org/10.1109/ICGSE.2010.48
ES_17	[A20]	2008	TRINDADE, C. C. M., MEIRA, A. K. O., LEMOS, S. Comunicação em Equipes Distribuídas de Desenvolvimento de Software: Revisão Sistemática, 5th Experimental Software Engineering Latin American Workshop (ESELAW), 2008.
ES_18	[A21]	2010	JABANGWE, R.; NURDIANI, J. "Global Software Development Challenges and Mitigation Strategies: A Systematic Review and Survey Results". Master program Software engineering 120 p/Master´s program in Software engineering 120 p, 2010.
ES_19	[A22]	2010	JALALI, S.; WOHLIN, C. "Agile Practices in Global Software Engineering - A Systematic Map," 5th IEEE International Conference on Global Software Engineering (ICGSE 2010), pp.45-54.

ES_20	[A23]	2010	Alinne C. Corrêa dos Santos, Camila Cunha Borges, Fabio Q. B. da Silva, David E. S. Carneiro. Dificuldades, Fatores e Ferramentas no Gerenciamento da Comunicação em projetos de Desenvolvimento Distribuído de Software: uma Revisão Sistemática da Literatura. IV Workshop de Desenvolvimento Distribuído de Software (WDDS). Salvador, BA, 2010.
	[A24]	2010	Alinne C. Corrêa dos Santos, Camila Cunha Borges, Fabio Q. B. da Silva, David E. S. Carneiro. Estudo baseado em Evidências sobre Dificuldades, Fatores e Ferramentas no Gerenciamento da Comunicação em Projetos de Desenvolvimento Distribuído de Software. 7th Experimental Software Engineering Latin American Workshop (ESELAW), Goiania, GO, 2010.

APPENDIX C – QUALITY ASSESSMENT FORM

Quality Criteria	0	0,5	1
QC1: Are the Inclusion and Exclusion criteria well described and appropriate?	□	□	□
QC2: Did the literature research potentially include all the relevant studies?	□	□	□
QC3: Did the included studies have their quality/validity assessed?	□	□	□
QC4: Has the database/study base been adequately described?	□	□	□

APPENDIX D – QUALITY ASSESSMENT

Reference of the secondary studies	ID	1	2	3	4	TOTAL	QUARTILE
		Inclusion and Exclusion Criteria	Contemplation of all the relevant studies	Evaluation of the quality and/or Validity of the Studies	Adequated description of the basis of data/studies		
ES_05	[A6]	1	1	1	1	4	4th
ES_11	[A14]	1	1	1	1	4	
ES_14	[A17]	1	0,5	1	1	3,5	
ES_18	[A21]	1	1	1	0,5	3,5	
ES_20	[A24]	0,5	1	1	1	3,5	
ES_07	[A9]	1	1	0	1	3	3rd
ES_08	[A10]	1	1	0	1	3	
ES_10	[A12]	1	1	0	1	3	
ES_13	[A16]	1	1	0	1	3	
ES_15	[A18]	1	0,5	1	0,5	3	
ES_19	[A22]	1	1	0	1	3	
ES_02	[A2]	0,5	1	0	1	2,5	
ES_12	[A15]	1	0,5	0	1	2,5	
ES_04	[A4]	0,5	0,5	0,5	0,5	2	2nd
ES_06	[A7]	1	0,5	0	0,5	2	
ES_16	[A19]	1	0,5	0	0,5	2	
ES_17	[A20]	1	0,5	0	1	2	
ES_03	[A3]	0,5	0,5	0	0,5	1,5	
ES_01	[A1]	0	0,5	0	0,5	1	1st
ES_09	[A11]	0	0,5	0	0,5	1	

APPENDIX E – SCRIPT OF THE SEMISTRUCTURED INTERVIEW

Part 1 – Practic Script

Personal Data

Name:

E-mail:

Age:

Gender**:**

() Male

() Female

City/State:

Scholarship:

() Graduation

() Specialization

() Master

() Doctor

() Others: _____

Formation Area**:**

() Administration

() Computing/Informatics

() Communication

() Others: _____

Role:

() Director

() Project manager

() Technical Leader

() Others: _____

Professional experience time

1. How many years of experience do you have in the Information Technology (IT) Area?

2. How many years of experience do you have in Project management/technical leadership/software Development?

3. How many years of experience do you have in projects with distributed teams?

About the organization

4. What is the name of the organization where you work?

5. What is the size of your organization?

() Micro – up to 9 employees

() Small - from 10 to 49 employees

() Medium – from 50 to 99 employees

() Large –more than 100 employees

6. Your organization has subsidiaries or branches in other places?

() Yes

() No

Where_____

7. The subsidiaries or branches have a specific role in the development of global projects? How every branch participates in the DSD projects?

8. Your organization is certified in any quality model (CMMI, Mps.Br, ISO e etc.)?

() Yes

() No

What _____

When the certification occurred?_____

9. What was the criterion or motivation to the adoption of projects with geographically distributed teams?

Characteristics of the DSD Project

10. Project type:

() Innovation

() Maintenance

() Development of a new product

() Others_____

11. What is the dispersion level of the Project that you work?

() National

() Continental

() Global

12. How many organizations are involved in this Project? Outsourced or subsidiary company?

() 1 organization

() 2 organizations

() 3 organizations OR

() 1 subsidiary

() 2 subsidiaries

() 3 subsidiaries

Other _____

13. How many distributed software Development teams exist in the current DSD Project?

() 2

() 3

() 4

() 5

Specify the quantity _____

14. How many people exist in every DSD team?

15. What are the places (cities, states or countries) where are found every team?

16. The policies and Development standards of the software Development in the organization are followed by all the geographically distributed teams?

() Are totally followed

() Are partially followed

() Every team have their own standards

() There are not defined standards

17. In the DSD Project you participates is (are) adopted any software development methodologie(s) (eg.: Rup, Agile methodologies, etc.)

Communication in DSD

18. In your opinion, what is the impact of the DSD over the way the teams communicate with each other?
19. In what moment the communication planning is done for the DSD projects?
20. There exist meetings for integration of the teams in the initial stages of the DSD projects? What is the impact of this action in the project?
21. There is somebody responsible by the communication of the DSD Project?
22. What are the attributions (responsibilities) of the responsible by the communication in relation to the distributed (remote) teams?
23. When and how the distributed teams communicate with each other?
24. In what moment of the Project the team members have a greater need to meet in person?
25. How long the teams work together? (Familiarity)?
26. Throughout the Project, how many times on average the geographically distributed teams physically gather?
27. What make the teams to have the need to communicate in the Project? What are the purposes? How often?
28. What is the Software Development stage in the DSD context that demands more communication dedication? Why? (Requirement, Analysis, Development, Test or Deployment)?
29. What are the main communication difficulties (problems) in the DSD context, and how you manage/solve them in your project?
30. What were the problems most difficult to solve about communication during the execution of the project?
31. In what priority order these problems must be solved or managed?
32. Do you remember of well succeeded communication practices in your DSD Project? What were they? Why do you believe that they resulted in success?
33. In your opinion, how the communication would be improved or evolved?
34. The distributed teams communicate mostly in a synchronous or asynchronous way? Generally what are the used tools?
35. The members of the geographically distributed teams know who to call when having communication related problems?
36. In your opinion, is relevant for DSD projects to have a maturity model to measure the quality of the communication?

() Yes
() No
() Maybe
Justify:_____

37. Would you like to add some information that you think is relevant for the study?

APPENDIX F – QUESTIONNAIRE OF EVALUATION FOR THE PROTOCOL

After the Reading of the protocol of the Systematic Literature Review about communication in distributed software projects, please, answer the following questions. For each of the 7 questions, must be considered the following levels of agreement or disagreement:

- **Fully Agree (Weight 4):** must be attributed case the protocol attend totally the criteria of the question;
- **Partially Agree (Weight 3):** must be attributed case the protocol attend partially the criteria of the question;
- **Neutral (Weight 2):** must be attributed case the protocol does not make it clear if it attend or not the criteria of the question;
- **Partially Disagree (Weight 1):** must be attributed case the protocol attend not the criteria of the question;
- **Totally Disagree (Weight 0):** must be attributed case the protocol does not attend the criteria of the question anyway, that is, do not exist anything in the protocol that attend the criteria of the question.

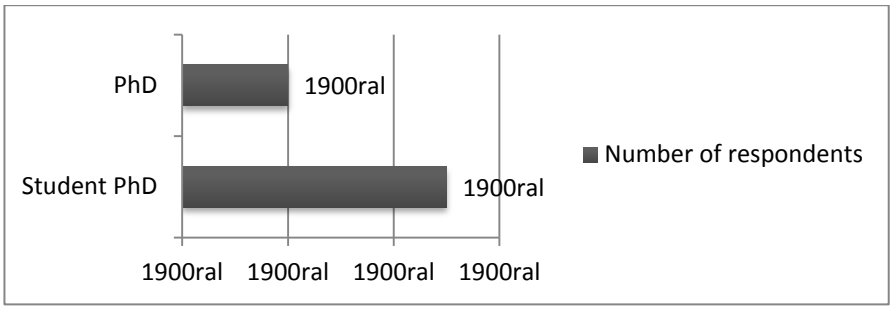
Questions:

1) Can be found an important question of the Software engineering that the review is dedicated to solve.
2) The search string is derived adequately from the research questions.
3) The literature search probably will cover all the relevant studies.
4) The criteria for inclusion and exclusion of the primary studies are described and suitable.
5) The researchers will evaluate appropriately the quality/ validity of the include studies.
6) The procedure of data extraction approaches properly the research questions.
7) The procedure of data analysis is proper to answer the research questions.
8) Case you answered any question as “Neutral”, “Partially Disagree” or “Totally Disagree”, we ask you to justify below the reasons for each one. However, all the questions are open to feedback. At last, give us your general comments or suggestions for the improvement of the protocol.

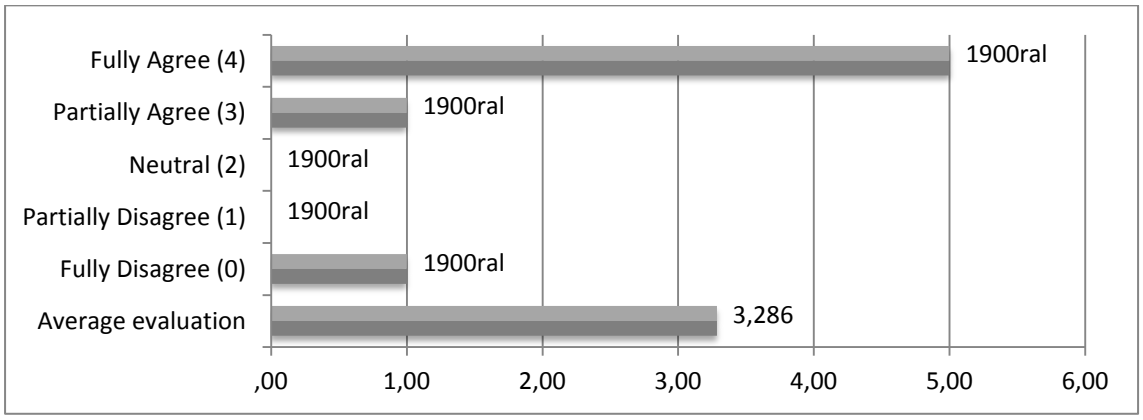
APPENDIX G – RESULT OF THE EVALUATION OF THE PROTOCOL

Next, the answers for the protocol evaluation questionnaire will be presented.

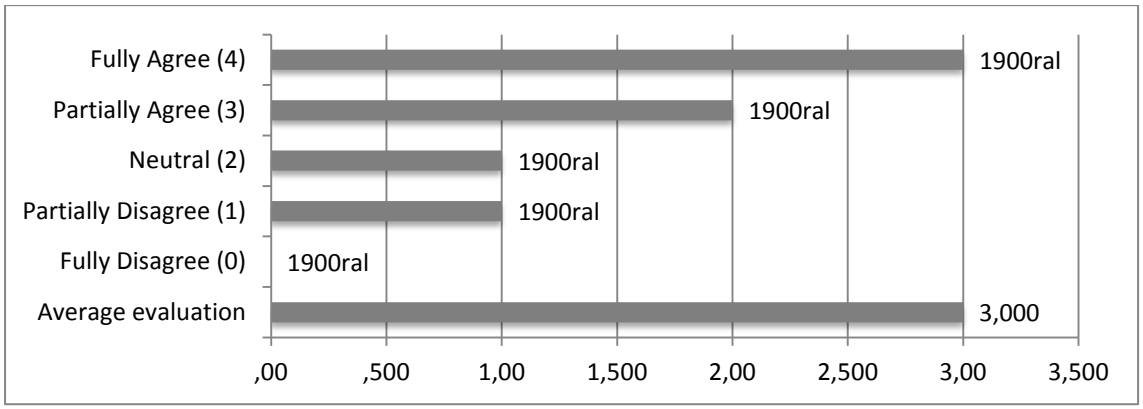
Respondent profile



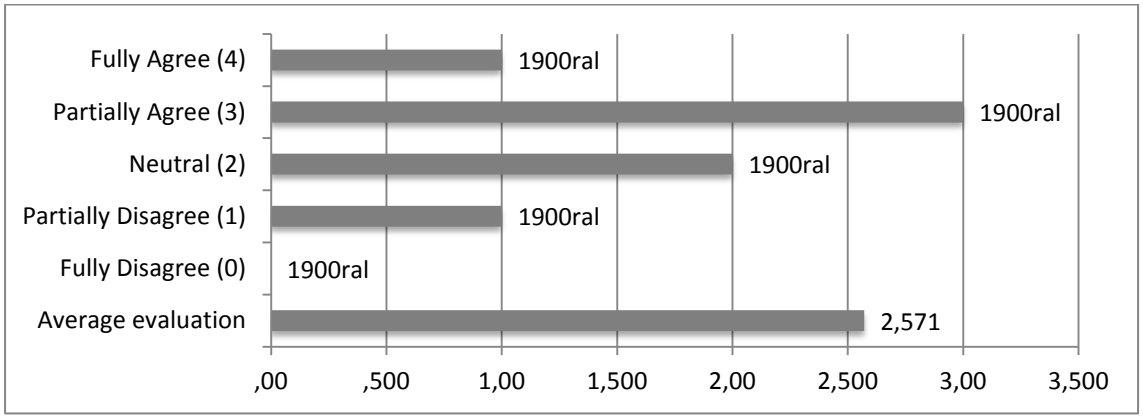
Question 1 – Can be found an important question of the Software engineering that the review is dedicated to solve.



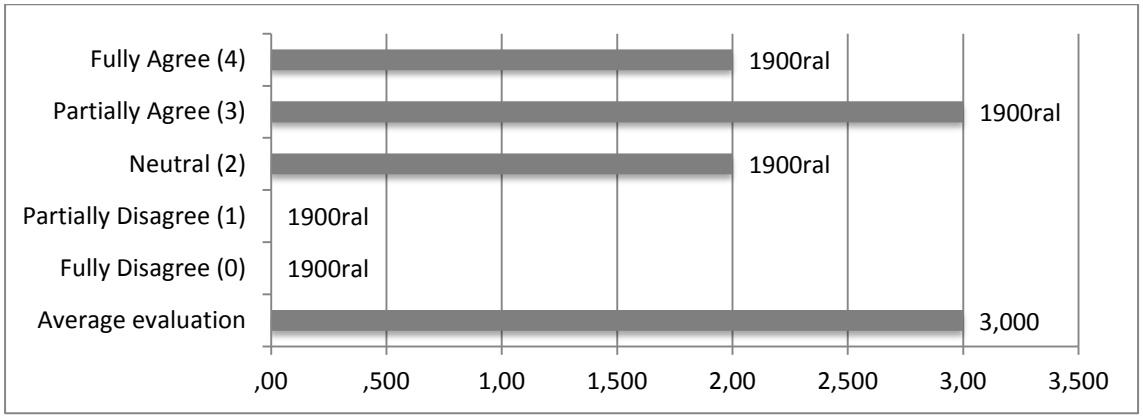
Question 2 – The search string is derived adequately from the research questions.



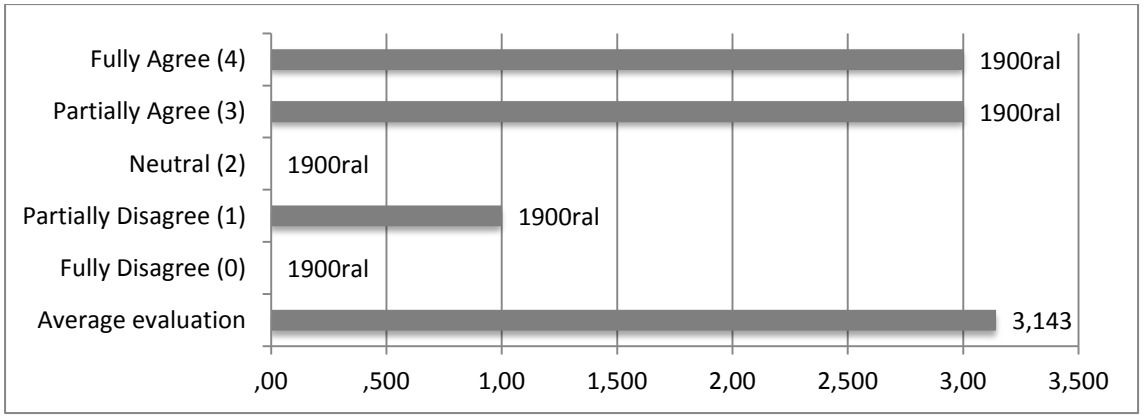
Question 3 – The literature search probably will cover all the relevant studies.



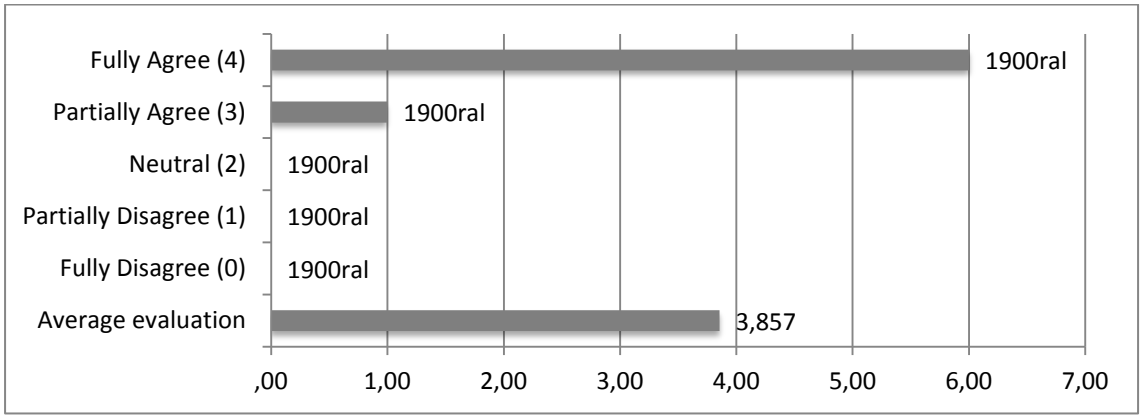
Question 4 – The criteria for inclusion and exclusion of the primary studies are described and suitable.



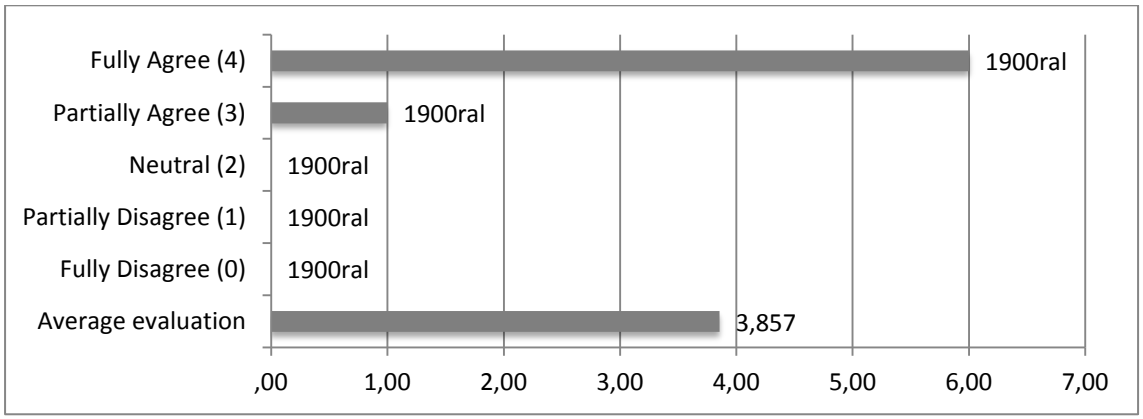
Question 5 – The researchers will evaluate appropriately the quality/ validity of the include studies.



Question 6 – The procedure of data extraction approaches properly the research questions.



Question 7 – The procedure of data analysis is proper to answer the research questions.



APPENDIX H - PRIMARY SOURCES OF STUDIES

As for the place of publication, 72.28% (133) of the studies came from Conferences, and others 27.71% (51) came from Journals and Magazines, as detailed below.

Conferences	Primary Studies	(%)
International Conference on Global Software Engineering	44	33,08
International Conference on Computer Supported Cooperative Work	10	7,52
International Conference on Software Engineering	8	6,02
Workshop on Collaborative Teaching of Globally Distributed Software Development	8	6,02
International Symposium on Empirical Software Engineering and Measurement	4	3,01
Hawaii International Conference on System Sciences	4	3,01
International Conference on Requirements Engineering	3	2,26
International Conference on Product-Focused Software Process Improvement	3	2,26
Pacific Asia Conference on Information Systems	3	2,26
Software Engineering Approaches For Offshore and Outsourced Development	3	2,26
Agile Conference	3	2,26
Conference on Human Factors in Computing Systems	2	1,50
Conference on Computer Personnel Research	2	1,50
International Symposium on Empirical Software Engineering	2	1,50
International Conference on Collaborative Computing: Networking, Applications and Worksharing	2	1,50
European Conference on Information Systems	2	1,50
International Conference on Computer and Management	1	0,75
International Workshop on Web 2.0 for Software Engineering	1	0,75
International Workshop on Groupware: Design, Implementation, and Use	1	0,75
International Conference on Global Software Engineering Workshops	1	0,75
International Symposium on Collaborative Technologies and Systems	1	0,75
International Conference on Human-Computer Interaction	1	0,75
International Symposium on Management, Engineering and Informatics	1	0,75
International Conference on Information Systems	1	0,75
International Workshop on Recommendation Systems for Software Engineering	1	0,75
International Conference on Open Source Systems	1	0,75
Malaysian Conference in Software Engineering	1	0,75
International Conference on Product Focused Software	1	0,75
International Symposium on Computer and Information Sciences	1	0,75
Conference of The Center for Advanced Studies on Collaborative Research	1	0,75
Conference on Software Engineering and Advanced Applications	1	0,75
International Conference on Collaboration and Technology	1	0,75
International Workshop on Global Sourcing of Information Technology and Business Processes	1	0,75
International Conference on Agile Processes in Software Engineering and Extreme Programming	1	0,75
International Workshop on Intercultural Collaboration	1	0,75

International Conference on Supporting Group Work	1	0,75
International Workshop on Social Software Engineering	1	0,75
On the Move to Meaningful Internet Systems Workshops	1	0,75
Conference on Software Maintenance and Reengineering	1	0,75
Canadian Conference on Electrical and Computer Engineering	1	0,75
Computer Software and Applications Conference	1	0,75
International Conference Companion on Object Oriented Programming Systems Languages and Applications Companion	1	0,75
International Multitopic Conference	1	0,75
India Software Engineering Conference	1	0,75
International Professional Communication Conference	1	0,75
Total	133	100

Journals/Magazine	primary studies	(%)
IEEE Software	5	9,80
Communications Of The ACM	5	9,80
Journal of Software: Evolution And Process	4	7,84
IET Software	4	7,84
Expert Systems	3	5,88
Information Systems Journal	3	5,88
Software Process: Improvement and Practice	2	3,92
Information and Software Technology	2	3,92
Transactions on Professional Communication	2	3,92
Transactions on Software Engineering	2	3,92
SPIE Conference	1	1,96
Journal of Universal Computer Science	1	1,96
Journal of Systems and Software	1	1,96
International Conference on Collaboration Technologies and Systems	1	1,96
Research Journal of Applied Sciences, Engineering and Technology	1	1,96
International Journal Empirical Software Engineering	1	1,96
Information Technology & People	1	1,96
Electronic Markets	1	1,96
Journal of Theoretical and Applied Electronic Commerce Research	1	1,96
Asia-Pacific Software Engineering Conference	1	1,96
Requirements Engineering	1	1,96
International Workshop on Global Software Development for the Practitioner	1	1,96
Information Systems Management	1	1,96
International Workshop on Managing Requirements Knowledge	1	1,96
The Computer Journal	1	1,96
Journal of Information Technology	1	1,96
Conferences on Advances in New Technologies, Interactive Interfaces and Communicability	1	1,96
International Journal of Information and Communication Engineering	1	1,96
International Journal of Project Management	1	1,96
Total	51	100

APPENDIX I – ADDRESS OF THE SEARCH SOURCES

Automatic Search

ACM Digital Library
URL: http://portal.acm.org

El Compendex
URL: http://www.engineeringvillage2.org

Elsevier ScienceDirect
URL: http://www.sciencedirect.com

IEEEXplore Digital Library
URL: http://www.ieeexplore.ieee.org/Xplore

Scopus
URL: http://www.scopus.com

Wiley InterScience
URL: http://onlinelibrary.wiley.com/

Manual Search – Journals and periodicals

Annals of Software Engineering (Indexado por Scopus)
URL: http://www.scopus.com/source/sourceInfo.url?sourceId=59840&origin=sbrowse

Communications of the ACM (CACM) (Indexado por ACM e Scopus)
URL: http://dl.acm.org/pub.cfm?id=J79

Empirical Software Engineering (Indexado por Scopus)
URL: http://www.scopus.com/source/sourceInfo.url?sourceId=18650&origin=sbrowse

IEEE Software(Indexado por IEEE e Scopus)
URL: http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=52

Information and Software Technology (IST) (Indexado por ScienceDirect)
URL: http://www.sciencedirect.com/science/journal/09505849/55/5

Information Systems Journal (Indexado por Wiley InterScience)
URL: http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1365-2575/issues

Journal of Computer-Mediated Communication (Indexado por Wiley InterScience)
URL: http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1083-6101/issues

Journal of Global Information Management (Indexado por Scopus)
URL: http://www.scopus.com/source/sourceInfo.url?sourceId=20608&origin=sbrowse

Journal of Global Information Technology Management (Indexado por Scopus)
URL: http://www.scopus.com/source/sourceInfo.url?sourceId=19900194826&origin=sbrowse

Journal of Software: Evolution and Process (Indexado por Wiley InterScience)
URL: http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)2047-7481/issues

Journal of Systems and Software (JSS) (Indexado por ScienceDirect)
URL: http://www.sciencedirect.com/science/journal/01641212

Software Practice and Experience (SPE) (Indexado por Scopus e Wiley InterScience)
URL: http://www.scopus.com/source/sourceInfo.url?sourceId=20007&origin=sbrowse

Transactions on Software Engineering (TSE) (Indexado por IEEE e Scopus)
URL: http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=32

Manual Search – Conferences.

Collaboration and Intercultural Issues on Requirements: Communication, Understanding and Softskills (CIRCUS) (Indexado por IEEE)
URL: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1800032

Conference on Computer Supported Cooperative Work (CSCW) (Indexado por ACM)
URL: http://dl.acm.org/event.cfm?id=RE169

IET Software (Antigo EE Proceedings Software) (Indexado por Scopus)
URL: http://www.scopus.com/source/sourceInfo.url?sourceId=5400152714&origin=sbrowse

International Conference on Collaboration Technologies and Systems (CTS) (Indexado por IEEE)
URL: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1001747

International Conference on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom) (Indexado por IEEE)
URL: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1001767

International Conference on Computer Supported Cooperative Work in Design (CSCWD) (Indexado por IEEE)
URL: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1000144

International Conference on Cooperation and Promotion of Information Resources in Science and Technology (COINFO) (Indexado por IEEE)
URL: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1003011

International Conference on Global Software Engineering (ICGSE) (Indexado por IEEE)
URL: http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=4031725
URL: http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=4299825
URL: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1001266

International Conference on Intercultural Collaboration (ICIC) (Indexado por ACM)
URL: http://dl.acm.org/event.cfm?id=RE477&CFID=212374159&CFTOKEN=96730226

International Conference on Software Engineering (ICSE) (Indexado por ACM)
(ICSE, CHASE, CTGDSD, FLOSS, GSD, HSSE, WOSSE, Web2SE)
URL: http://dl.acm.org/event.cfm?id=RE228&CFID=212374159&CFTOKEN=96730226

International Conference on Supporting Group Work (GROUP) (Indexado por ACM)
URL: http://dl.acm.org/event.cfm?id=RE210&CFID=212374159&CFTOKEN=96730226

International Conference Professional Communication (IPCC) (Indexado por IEEE)
URL: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1000591

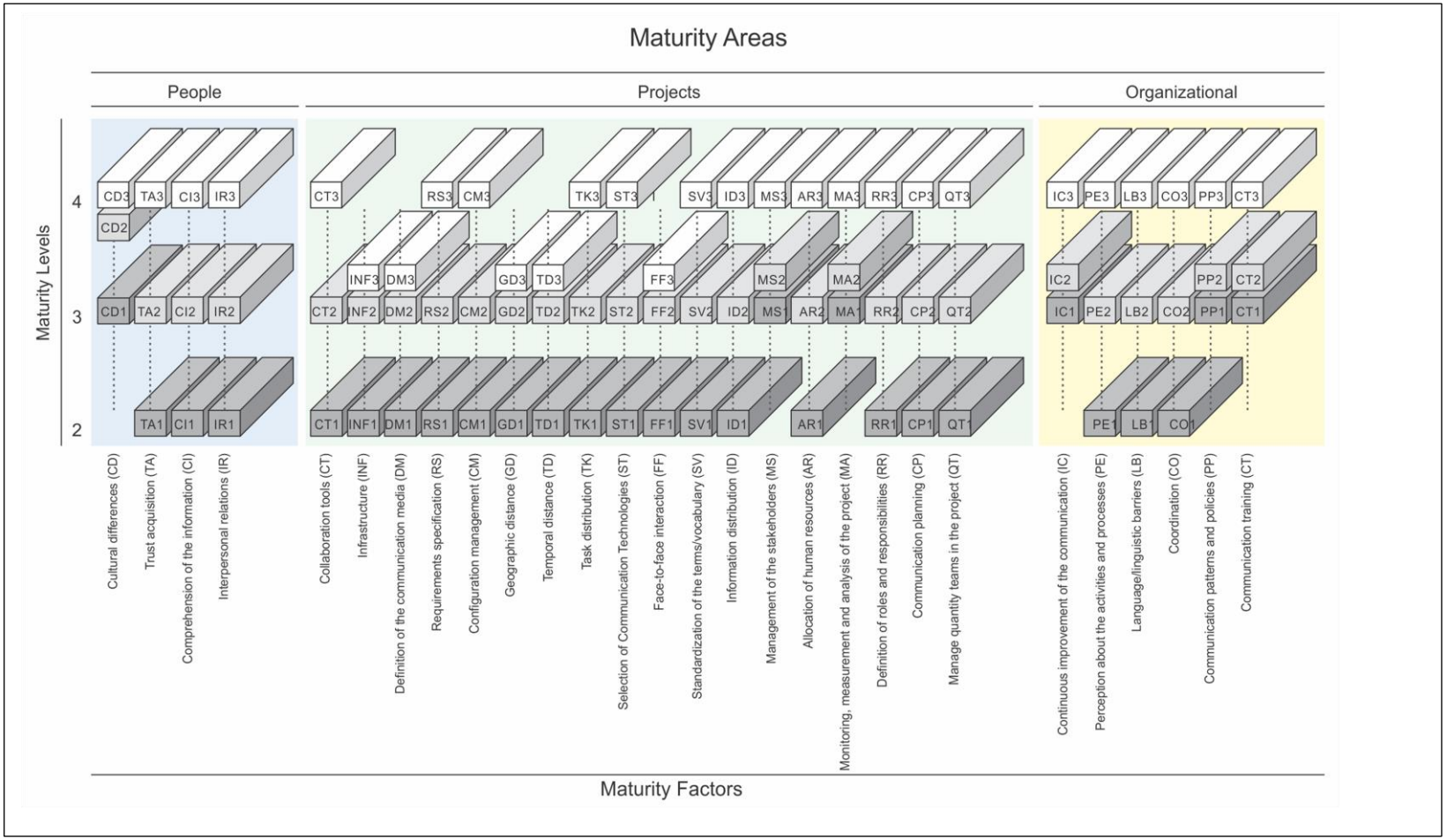
International Symposium on Empirical Software Engineering and Measurement (ESEM)
(ESEM, ISESE) (Indexado por ACM)
URL: http://dl.acm.org/event.cfm?id=RE242&CFID=212374159&CFTOKEN=96730226

Symposium on Advanced Management of Information for Globalized Enterprises (AMIGE) (Indexado por IEEE)
URL: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1002551

Workshop de Desenvolvimento Distribuído de Software (WDDS) (Indexado por WDDS)
URL: http://www.wdds.ufpb.br/2013/index.php

Workshop on Wikis for Software Engineering (WIKIS4SE) (Indexado por IEEE)
URL: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1002754

APPENDIX J - FIRST VERSION OF C2M (DRAFT VERSION)



APPENDIX L - LIST OF PRIMARY SELECTED STUDIES FROM SLR2

The following table presents data from the primary studies selected in SLR2.

ID	Título	Autor (es)	Fonte	Ano
E002	"Now, I Have a Body": Uses and Social Norms for Mobile Remote Presence in the Workplace	Lee, Min Kyung ; Takayama, Leila	Conference on Human Factors in Computing Systems	2011
E005	A Case Study of Customer Communication in Globally Distributed Software Product Development	Korkala, Mikko ; Pikkarainen, Minna ; Conboy, Kieran	International Conference on Product Focused Software	2010
E007	A Comparative Empirical Study of Communication in Distributed and Collocated Development Teams	Al-Ani, Ban ; Edwards, H. Keith	International Conference on Global Software Engineering	2008
E010	A Controlled Experiment on the Effects of Synchronicity in Remote Inspection Meetings	Calefato, Fabio ; Lanubile, Filippo ; Mallardo, Teresa	International Symposium on Empirical Software Engineering and Measurement	2007
E013	A framework to improve communication during the requirements elicitation process in GSD projects	Aranda, Gabriela N. ; Vizcaíno, Aurora ; Piattini, Mario	Requirements Engineering	2010
E036	Agile vs. Structured Distributed Software Development: A Case Study	Estler, H.-Christian ; Nordio, Martin ; Furia, Carlo a. ; Meyer, Bertrand ; Schneider, Johannes	International Conference on Global Software Engineering	2012
E037	Aligning Software Maintenance to the Offshore Reality	Seybold, Christian ; Keller, Rudolf K.	Conference on Software Maintenance and Reengineering	2008
E041	An Empirical Study of Global Software Development: Distance and Speed	Herbsleb, James D ; Mockus, Audris ; Finholt, Thomas A ; Grinter, Rebecca E	International Conference on Software Engineering	2001
E043	An empirical study of requirements engineering in distributed software projects: is distance negotiation more effective?	Damian, Daniela	Asia-Pacific Software Engineering Conference	2001
E045	An Exploratory Study on Open Conversation Spaces In Software Engineering	Dullemond, Kevin ; Gameren, Ben van ; Solingen, Rini van	International Conference on Collaborative Computing: Networking, Applications and Worksharing	2011
E047	An Industrial Experience on the Application of Distributed Testing in an Agile Software Development Environment	Collins, Eliane ; Macedo, Gisele ; Maia, Nayane ; Dias-Neto, Arilo	International Conference on Global Software Engineering	2012
E061	Architectures, Coordination , and Distance : Conway's Law and Beyond	Herbsleb, James D ; Grinter, Rebecca E	IEEE Software	1999
E063	Assessing the Impact of Real-Time Machine Translation	Calefato, Fabio ; Lanubile, Filippo ; Conte,	International Symposium on Empirical	2012

	on Requirements Meetings: A Replicated Experiment	Tayana ; Prikladnicki, Rafael	Software Engineering and Measurement	
E066	Automatic Status Updates in Distributed Software Development	King, Abayomi ; Lyons, Kelly	International Workshop on Web 2.0 for Software Engineering	2011
E067	Awareness in the Wild: Why Communication Breakdowns Occur	Damian, Daniela ; Izquierdo, Luis ; Singer, Janice ; Kwan, Irwin	International Conference on Global Software Engineering	2007
E070	Can distributed software development be agile?	Ramesh, Balasubramaniam ; Cao, Lan ; Mohan, Kannan ; Xu, Peng	Communications Of The ACM	2006
E076	CodeSaw: A Social Visualization of Distributed Software Development	Gilbert, Eric ; Karahalios, Karrie	International Conference on Human-Computer Interaction	
E080	Collaboration Patterns and the Impact of Distance on Awareness in Requirements-Centred Social Networks	Damian, Daniela ; Marczak, Sabrina ; Kwan, Irwin	International Conference on Requirements Engineering	2007
E082	Collaborative Embedded Systems Development: Survey of State of the Practice	Hyysalo, Jarkko ; Parviainen, Päivi ; Tihinen, Maarit	International Symposium and Workshop on Engineering of Computer Based Systems	2007
E086	Communication and Quality in Distributed Agile Development: An Empirical Case Study	Green, R; Mazzuchi, T ; Sarkani, S	International Journal of Information and Communication Engineering	2010
E088	Communication in Distributed Agile Development: A Case Study	Korkala, Mikko ; Abrahamsson, Pekka	Conference on Software Engineering and Advanced Applications	2007
E089	Communication Metaphors-in-Use: Technical Communication and Offshore Systems Development	Wareha, Jonathan ; Mahnke, Volker ; Peters, Sanjay ; Bjorn-Andersen, Niels	Transactions on Professional Communication	2007
E090	Communication Networks in Geographically Distributed Software Development	Cataldo, Marcelo ; Herbsleb, James D	Internationl Conference on Computer Supported Cooperative Work	2008
E092	Communication, coordination and control in distributed development: an OSS case study	Persson, Anna ; Lings, Brian ; Lundell, Björn ; Mattsson, Anders ; Ärlig, Ulf	International Conference on Open Source Systems	2005
E093	Communication, Knowledge and Co-ordination Management in Globally Distributed Software Development: Informed by a scientific Software Engineering Case Study	Taweel, Adel ; Delaney, Brendan ; Arvanitis, Theodoros N.; Zhao, Lei	International Conference on Global Software Engineering	2009
E094	Communications in Global Software Development: An Empirical Study Using GTK + OSS Repository	Yu, Liguo ; Ramaswamy, Srini ; Mishra, Alok; Mishra, Deepti	On the Move to Meaningful Internet Systems Workshops	2011
E098	Computer-mediated communication to support distributed requirements elicitations and negotiations tasks	Calefato, Fabio ; Damian, Daniela ; Lanubile, Filippo	International Journal Empirical Software Engineering	2011
E104	Coordination Practices in Distributed Software Development of Small Enterprises	Boden, Alexander ; Nett, Bernhard; Wulf, Volker	International Conference on Global Software Engineering	2007

E105	Coping with cultural and maturity inequality in offshore outsourcing: is minimizing interaction the solution ?	Hertzum, Morten ; Pries-Heje, Jan	European Conference on Information Systems	
E106	Coping with Distance: An Empirical Study of Communication on the Jazz Platform	Sindhgatta, Renuka ; Sengupta, Bikram ; Datta, Subhajit	International Conference Companion on Object Oriented Programming Systems Languages and Applications Companion	2011
E108	Critical issues of offshore software development project failures	Philip, T; Schwabe, G; Ewusi-Mensah, K	International Conference on Information Systems	2009
E110	Cultural and linguistic problems in GSD: a simulator to train engineers in these issues	Monasor, Miguel J ; Vizcaíno, Aurora ; Piattini, Mario	Journal of Software: Evolution And Process	2012
E112	CVS Integration with Notification and Chat: Lightweight Software Team Collaboration	Fitzpatrick, Geraldine ; Marshall, Paul ; Phillips, Anthony	Internationl Conference on Computer Supported Cooperative Work	2006
E117	Design, Implementation, and Evaluation of a Virtual Meeting Tool-Based Innovation for UML Technology Training in Global Organizations	Koivulahti-Ojala, Mervi ; Käkölä, Timo	Hawaii International Conference on System Sciences	2012
E120	Detecting and Classifying Patterns of Requirements Clarifications	Knauss, Eric ; Damian, Daniela ; Poo-caamaño, Germán ; Cleland-huang, Jane	International Conference on Requirements Engineering	2012
E127	Distributed Software Development Course: Students' and Teachers' Perspectives	Feljan, Juraj ; Crnković, Ivica ; Bosnić, Ivana ; Orlić, Marin ; Mario, Žagar	Workshop on Collaborative Teaching of Globally Distributed Software Development	2012
E137	Elicitation of Communication Inherent Risks in Distributed Software Development	Junior, Ivaldir H. De Farias ; Azevedo, Ryan R. De ; Moura, Hermano P. De ; Silva, Dennis S. Martins Da	International Conference on Global Software Engineering Workshops	2012
E142	Essential communication practices for Extreme Programming in a global software development team	Layman, Lucas ; Williams, Laurie ; Damian, Daniela ; Bures, Hynek	Information and Software Technology	2006
E146	Evolving an Infrastructure for Student Global Software Development Projects : Lessons for Industry	Gotel, Olly ; Kulkarni, Vidya ; Phal, Des ; Say, Moniphal ; Scharff, Christelle ; Sunetnanta, Thanwadee	India Software Engineering Conference	2009
E147	Experiences of Instant Messaging in Global Software Development Projects: A Multiple Case Study	Niinimäki, Tuomas ; Lassenius, Casper	International Conference on Global Software Engineering	2008
E151	Exploring the communication breakdown in global virtual teams	Daim, Tugrul U. ; Ha, Anita ; Reutiman, Shawn ; Hughes, Brennan ; Pathak, Ujjal ; Bynum, Wayne ; Bhatla, Ashok	International Journal of Project Management	2012
E152	Exploring the Media Mix during IT-Offshore Project	Wende, Erik ; Schwabe, Gerhard ; Philip, Tom	International Workshop on Global Sourcing of Information Technology and Business Processes	2010
E153	Exploring the Role of Instant Messaging in a Global	Dittrich, Yvonne ; Giuffrida, Rosalba	International Conference on Global	2011

	Software Development Project		Software Engineering	
E155	Extending Socio-technical Congruence with Awareness Relationships	Kwan, Irwin ; Damian, Daniela	International Workshop on Social Software Engineering	2011
E156	Extreme programming in global software development	Xiaohu, Yang ; Bin, Xu ; Zhijun, He	Canadian Conference on Electrical and Computer Engineering	2004
E158	Factors Affecting Audio and Text-Based Communication Media Choice in Global Software Development Projects	Niinimaki, Tuomas ; Piri, Arttu ; Lassenius, Casper	International Conference on Global Software Engineering	2009
E160	Five Years of Lessons Learned from the Software Engineering Course: Adapting Best Practices for Distributed Software Development	Neto, Crescencio Rodrigues Lima ; Almeida, Eduardo Santana de	Workshop on Collaborative Teaching of Globally Distributed Software Development	2012
E165	From RUP to Scrum in Global Software Development: A Case Study	Noordeloos, Ramon ; Manteli, Christina ; Vliet, Hans Van	International Conference on Global Software Engineering	2012
E166	Fully Distributed Scrum: Linear Scalability of Production between San Francisco and India	Sutherland, Jeff ; Schoonheim, Guido ; Kumar, N. ; Pandey, V. ; Vishal, S.	Agile Conference	2009
E171	Global Software Development and Delay: Does Distance Still Matter?	Nguyen, Thanh ; Wolf, Timo ; Damian, Daniela	International Conference on Global Software Engineering	2008
E172	Global Software Development at Siemens: Experience from Nine Projects	Herbsleb, James D ; Paulish, Daniel J ; Bass, Matthew	International Conference on Software Engineering	2005
E173	Global software development projects in one of the biggest companies in Latvia: is geographical distribution a problem?	Šmite, Darja	Software Process: Improvement and Practice	2006
E175	Global Software Development: Who Does It?	Begel, Andrew ; Nagappan, Nachiappan	International Conference on Global Software Engineering	2008
E177	Global Software Servicing: Observational Experiences at Microsoft	Bugde, Shilpa ; Nagappan, Nachiappan ; Rajamani, Sriram ; Ramalingam, G.	International Conference on Global Software Engineering	2008
E178	Global Virtual Teams: How to manage them	Johnston, K A ; Rosin, K	International Conference on Computer and Management	2011
E181	Group Awareness in Distributed Software Development	Gutwin, Carl ; Penner, Reagan ; Schneider, Kevin	Internationl Conference on Computer Supported Cooperative Work	2004
E188	How to Choose Groupware Tools Considering Stakeholders' Preferences During Requirements Elicitation?	Aranda, Gabriela N ; Vizcaíno, Aurora ; Cechich, Alejandra ; Piattini, Mario	International Workshop on Groupware: Design, Implementation, and Use	2007
E192	IBM Industry Practice: Challenges in Offshore	Musio, Ilario	Software Engineering Approaches For Offshore and Outsourced Development	2009
E194	Impact of Changing Communication Media on Conflict Resolution in Distributed Software Development Projects	Khan, Huma Hayat ; Malik, Nauman	Malaysian Conference in Software Engineering	2011

E197	Information Flow within a Dispersed Agile Team: A Distributed Cognition Perspective	Sharp, Helen ; Giuffrida, Rosalba ; Melnik, Grigori	International Conference on Agile Processes in Software Engineering and Extreme Programming	2012
E201	Intelligent Analysis of User Interactions in a Collaborative Software Engineering Context	Corbellini, Alejandro ; Schiaffino, Silvia ; Godoy, Daniela	Conferences on Advances in New Technologies, Interactive Interfaces and Communicability	2011
E203	Interaction Patterns among Global Software Development Learning Teams	Serce, Fatma Cemile ; Swigger, Kathleen ; Alpaslan, Ferda Nur ; Brazile, Robert ; Dafoulas, George ; Lopez, Victor	International Symposium on Collaborative Technologies and Systems	2009
E208	Investigating an 'Agile-Rigid' Approach in Globally Distributed Requirements Analysis	Yadav, Vanita ; Adya, Monica ; Nath, Dhruv ; Sridhar, V	Pacific Asia Conference on Information Systems	2007
E212	Knowledge Management: A Solution to Requirements Understanding in Global Software Engineering	Khan, Hashim ; Ahmad, Arshad ; Alnuem, Mohammed A	Research Journal of Applied Sciences, Engineering and Technology	2012
E216	Leadership Roles and Communication Issues in Partially Distributed Emergency Response Software Development Teams: A Pilot Study	Plotnick, Linda ; Ocker, Rosalie ; Hiltz, Starr Roxanne ; Rosson, Mary Beth	Hawaii International Conference on System Sciences	2008
E218	Lessons Learned from an eXtremely Distributed Project	Hogan, Ben	Agile Conference	2006
E219	Leveraging expertise in global software teams: Going outside boundaries	Ehrlich, Kate ; Chang, Klarissa	International Conference on Global Software Engineering	2006
E224	Managing Communication among Geographically Distributed Teams: A Brazilian Case	Almeida, Ana Carina M ; Junior, Ivaldir H De Farias ; Carneiro, Pedro Jorge De S	Software Engineering Approaches For Offshore and Outsourced Development	2009
E226	Managing coordination and cooperation in distributed software processes: the GENESIS environment	Aversano, Lerina ; De Lucia, Andrea ; Gaeta, Matteo ; Ritrovato, Pierluigi ; Stefanucci, Silvio ; Luisa Villani, Maria	Software Process: Improvement and Practice	2004
E227	Managing distributed software development in the Virtual Astronomical Observatory	Evans, Janet D. ; Plante, Raymond L. ; Boneventura, Nina ; Busko, Ivo ; Cresitello-Dittmar, Mark ; D'Abrusco, Raffaele ; Doe, Stephen ; Ebert, Rick ; Laurino, Omar ; Pevunova, Olga ; Refsdal, Brian ; Thomas, Brian	SPIE Conference	2012
E230	Managing knowledge on communication and information flow in global software projects	Stapel, Kai ; Schneider, Kurt	Expert Systems	2012
E235	Mastering Dual-Shore Development – The Tools and Materials Approach Adapted to Agile Offshoring	Kornstädt, Andreas ; Sauer, Joachim	Software Engineering Approaches For Offshore and Outsourced Development	2007
E237	Media Choices and Trust in Partially Distributed Global Teams	Plotnick, Linda ; Hiltz, Starr Roxanne ; Ocker, Rosalie J	Hawaii International Conference on System Sciences	2010
E238	Media Choices over Time in Partially Distributed Teams	Plotnick, Linda ; Hiltz, Starr Roxanne ;	Hawaii International Conference on	2012

		Ocker, Rosalie J.	System Sciences	
E248	Mum Effect as an Offshore Outsourcing Risk: A Study of Differences in Perceptions	Sajeev, A.S.M. ; Ramingwong, S.	The Computer Journal	2009
E252	Obtaining Requirements for Designing a Tool to Support Distributed Development	Hernández, José Luis ; Vizcaíno, Aurora ; Caballero, Ismael ; Aranda, Gabriela	Journal of Universal Computer Science	2012
E254	Offshore middlemen: transnational intermediation in technology sourcing	Mahnke, Volker ; Wareham, Jonathan ; Bjorn-Andersen, Niels	Journal of Information Technology	2008
E261	Offshoring Attitudes, Relational Behaviours, And Departmental Culture	Não informado	European Conference on Information Systems	
E262	On Coordination Mechanisms in Global Software Development	Cataldo, Marcelo ; Bass, Matthew ; Herbsleb, James D ; Bass, Len	International Conference on Global Software Engineering	2007
E263	On Educating Globally Distributed Software Development – a Case Study Distances in GSD	Mäkiö, Juho ; Betz, Stefanie	International Symposium on Computer and Information Sciences	2009
E264	On the Need for Mixed Media in Distributed Requirements Negotiations	Damian, Daniela ; Lanubile, Filippo ; Mallardo, Teresa	Transactions on Software Engineering	2008
E265	On The Roles of APIs in the Coordination of Collaborative Software Development	Souza, Cleidson R. B. ; Redmiles, David F.	Internationl Conference on Computer Supported Cooperative Work	2009
E276	Out of Sight but Not Out of Mind? Informal Networks , Communication and Media Use in Global Software Teams	Chang, Klarissa T ; Ehrlich, Kate	Conference of The Center for Advanced Studies on Collaborative Research	2007
E282	Performing a Project in a Distributed Software Development Course: Lessons Learned	Ciccozzi, Federico ; Crnkovic, Ivica	International Conference on Global Software Engineering	2010
E294	Providing Training in GSD by Using a Virtual Environment	Monasor, Miguel J ; Vizcaíno, Aurora ; Piattini, Mario	International Conference on Product-Focused Software Process Improvement	2012
E296	Quality indicators on global software development projects: does getting to know you' really matter?	Gotel, Olly ; Kulkarni, Vidya ; Say, Moniphal ; Scharff, Christelle ; Sunetnanta, Thanwadee	Journal of Software: Evolution And Process	2012
E300	Recommending Experts Using Communication History	Moraes, Alan ; Silva, Eduardo ; Trindade, Cleyton ; Barbosa, Yuri	International Workshop on Recommendation Systems for Software Engineering	2010
E301	Reflecting the choice and usage of communication tools in global software development projects with media synchronicity theory	Niinimäki, Tuomas ; Piri, Arttu ; Lassenius, Casper ; Paasivaara, Maria	Journal of Software: Evolution And Process	2012
E304	Removing Barriers to Trust in Distributed Teams: Understanding Cultural Differences and Strengthening Social Ties	Mikawa, Suzanne P ; Cunnington, Sharon K ; Gaskins, Scott A	International Workshop on Intercultural Collaboration	2009
E310	Requirements Understanding: A Challenge in Global	Alnuem, Mohammed Abdullah ; Ahmad,	Computer Software and Applications	2012

	Software Development, Industrial Surveys in Kingdom of Saudi Arabia	Arshad ; Khan, Hashim	Conference	
E321	Selective availability: coordinating interaction initiation in distributed software development	Palacio, R.R. ; Morán, A L. ; González, V.M. ; Vizcaíno, a.	IET Software	2012
E323	Shared Waypoints and Social Tagging to Support Collaboration in Software Development	Storey, Margaret-anne ; Cheng, Li-Te ; Bull, Ian ; Rigby, Peter	Internationl Conference on Computer Supported Cooperative Work	2006
E329	Sociomaterial bricolage: The creation of location-spanning work practices by global software developers	Johri, Aditya	Information and Software Technology	2011
E331	Software Architecture as a Means of Communication in a Globally Distributed Software Development Context	Svensson, Richard Berntsson ; Aurum, Aybüke ; Paech, Barbara ; Gorschek, Tony ; Sharma, Devesh	International Conference on Product-Focused Software Process Improvement	2012
E333	Software Engineering Across Boundaries: Student Project in Distributed Collaboration	JOHANSSON, CONNY ; DITTRICH, YVONNE ; JUUSTILA, ANTTI	Transactions on Professional Communication	1999
E344	Successful Collaborative Software Projects for Medical Devices in an FDA Regulated Environment: Myth or Reality?	Sudershana, Subita ; Villca-roque, Abel ; Baldanza, Jonathan	International Conference on Global Software Engineering	2007
E347	Supporting Collaboration in the Geographically Distributed Work with Communication Tools in the Remote District SME's	Liukkunen, Kari ; Lindberg, Kai ; Hyysalo, Jarkko ; Markkula, Jouni	International Conference on Global Software Engineering	2010
E357	Teaching Students Global Software Engineering Skills using Distributed Scrum	Paasivaara, Maria ; Lassenius, Casper ; Damian, Daniela ; Petteri, R ; Schr, Adrian	International Conference on Software Engineering	2013
E364	Temporal coordination through communication: using genres in a virtual start-up organization	Im, Hyun-Gyung ; Yates, JoAnne ; Orlikowski, Wanda	Information Technology & People	2005
E375	The Impact of Media Selection on Stakeholder Communication in Agile Global Software Development: A Preliminary Industrial Case Study	Junius, Biyagamage Agra ; Hall, Tracy ; Fitzpatrick, Anthony	Conference on Computer Personnel Research	2011
E376	The impact of stakeholders' geographical distribution on managing requirements in a multi-site organization	Damian, Daniela E ; Zowghi, Didar	International Conference on Requirements Engineering	2007
E387	Tool to facilitate appropriate interaction in global software development	Palacio, R.R. ; Vizcaíno, a. ; Morán, A .L. ; González, V.M.	IET Software	2011
E399	Towards an ontology for global software development	Vizcaíno, A. ; García, F. ; Caballero, I. ; Villar, J.C. ; Piattini, M.	IET Software	2011
E404	Trusty: A Tool to Improve Communication and Collaboration in DSD	Aranda, Gabriela Noemi ; Vizcaíno, Aurora ; Hernández, José Luís ; Palacio, Ramón R ; Morán, Alberto L	International Conference on Collaboration and Technology	2011
E405	Two Worlds Apart: Bridging the Gap Between Physical	Everitt, Katherine M ; Klemmer, Scott R ;	Conference on Human Factors in	2003

	and Virtual Media for Distributed Design Collaboration	Lee, Robert ; Landay, James A	Computing Systems	
E407	Understanding Lacking Trust in Global Software Teams: A Multi-case Study	Moe, Nils Brede ; Šmite, Darja	International Conference on Product-Focused Software Process Improvement	2007
E408	Using Audio and Collaboration Technologies for Distributed Requirements Elicitation and Documentation	Menten, Achim ; Scheibmayr, Sven ; Klimpke, Lars	International Workshop on Managing Requirements Knowledge	2010
E409	Using Content and Text Classification Methods to Characterize Team Performance	Swigger, Kathleen ; Brazile, Robert ; Dafoulas, George ; Serce, Fatma Cemile ; Alpaslan, Ferda Nur ; Lopez, Victor	International Conference on Global Software Engineering	2010
E410	Using Developer Activity Data to Enhance Awareness during Collaborative Software Development	Omoronyia, Inah ; Ferguson, John ; Roper, Marc ; Wood, Murray	Internationl Conference on Computer Supported Cooperative Work	2009
E413	Using Scrum in Distributed Agile Development: A Multiple Case Study	Paasivaara, Maria ; Durasiewicz, Sandra ; Lassenius, Casper	International Conference on Global Software Engineering	2009
E421	Virtual Open Conversation Spaces: Towards Improved Awareness in a GSE Setting	Dullemond, Kevin ; van Gameren, Ben ; van Solingen, Rini	International Conference on Global Software Engineering	2010
E425	What Counts as Success? Punctuated Patterns of Use in a Persistent Chat Environment	Halverson, Christine A ; Erickson, Thomas ; Sussman, Jeremy	International Conference on Supporting Group Work	2003
E427	What Is Chat Doing in the Workplace?	Handel, Mark ; Arbor, Ann ; Herbsleb, James D	Internationl Conference on Computer Supported Cooperative Work	2002
E429	When No One's Home : Being a Remote Writer on Distributed Teams	Larbi, Nancy E ; Springfield, Susan	International Professional Communication Conference	2003
E434	Work Item Tagging: Communicating Concerns in Collaborative Software Development	Treude, Christoph ; Storey, Margaret-Anne	Transactions on Software Engineering	2012
E457	A Practical Management and Engineering Approach to Offshore Collaboration	Cusick, James ; Prasad, Alpana	IEEE Software	2006
E458	A rule-based model for customized risk identi fi cation and evaluation of task assignment alternatives in distributed software development projects	Lamersdorf, Ansgar ; Münch, Jürgen ; Torre, Alicia Fernández- del Viso ; Sánchez, Carlos Rebate ; Heinz, Markus ; Rombach, Dieter	Journal of Software: Evolution And Process	2012
E462	A Study of Collaboration in Software Design	Graham, James Wu T C N ; Smith, Paul W	International Symposium on Empirical Software Engineering	
E469	Agile Practices Reduce Distance in Global Software Development	Holmström, Helena ; Fitzgerald, Brian ; Ågerfalk, Pär J. ; Conchúir, Eoin Ó.	Information Systems Management	2006
E477	An empirical study of groupware support for distributed software architecture evaluation process	Babar, Muhammad Ali ; Kitchenham, Barbara ; Zhu, Liming ; Gorton, Ian ; Jeffery, Ross	Journal of Systems and Software	2006
E488	Assessing communication media richness in requirements	Erra, U. ; Scanniello, G.	IET Software	2010

	negotiation			
E493	Avoiding Scylla and Charybdis in Distributed Software Development Course	Bosnić, Ivana ; Čavrak, Igor ; Orlić, Marin ; Žagar, Mario ; Crnković, Ivica	Workshop on Collaborative Teaching of Globally Distributed Software Development	2011
E495	Back to Basics: The Role of Agile Principles in Success with an Distributed Scrum Team	Berczuk, Steve	Agile Conference	2007
E497	Bringing Global Sourcing into the Classroom: Experiential Learning via Software Development Project	Adya, Monica ; Nath, Dhruv ; Sridhar, Varadharajan ; Malik, Amit	Conference on Computer personnel research	2007
E502	Can Real-Time Machine Translation Overcome Language Barriers in Distributed Requirements Engineering?	Calefato, Fabio ; Lanubile, Filippo ; Minervini, Pasquale	International Conference on Global Software Engineering	2010
E504	Collaboration in Global Software Projects at Siemens: An Experience Report	Bass, Matthew ; Herbsleb, James D ; Lescher, Christian	International Conference on Global Software Engineering	2007
E530	Developing Trust In Virtual Software Development Teams	Casey, Valentine	Journal of Theoretical and Applied Electronic Commerce Research	2010
E533	Differentiating Local and Global Systems Requirements Gathering Processes in IS Software Development Projects	Hanisch, Jo ; Corbitt, Brian ; Thanasankit, Theerasak	Pacific Asia Conference on Information Systems	
E539	Distributed Versus Face-to-Face Meetings for Architecture Evaluation: A Controlled Experiment	Babar, Muhammad Ali ; Kitchenham, Barbara ; Jeffery, Ross	International Symposium on Empirical Software Engineering	2006
E543	Does Distributed Development Affect Software Quality? An Empirical Case Study of Windows Vista	Bird, Christian ; Nagappan, Nachiappan ; Devanbu, Premkumar ; Gall, Harald ; Murphy, Brendan	International Conference on Software Engineering	2009
E544	Effects of Four Distances on Communication Processes in Global Software Projects	Jaanu, Tuomas ; Paasivaara, Maria ; Lassenius, Casper	International Symposium on Empirical Software Engineering and Measurement	2012
E557	Experience and Recommendations for Distributed Software Development	Carlson, Patrick ; Xiao, Nan	Workshop on Collaborative Teaching of Globally Distributed Software Development	2012
E558	Experiences in Global Software Development - A Framework-Based Analysis of Distributed Product Development Projects	Lane, Michael T. ; Ågerfalk, Pär J.	International Conference on Global Software Engineering	2009
E560	Experiments in Distributed Side-By-Side Software Development	Dewan, Prasun ; Agrawal, Puneet ; Hegde, Rajesh	International Conference on Collaborative Computing: Networking, Applications and Worksharing	2009
E568	Global Software Development Challenges: A Case Study on Temporal, Geographical and Socio-Cultural Distance	Holmstrom, Helena ; Conchúir, Eoin Ó ; Ågerfalk, Pär J ; Fitzgerald, Brian	International Conference on Global Software Engineering	2006
E569	Global Software Development: Are Architectural Rules the	Clerc, Viktor ; Lago, Patricia ; Vliet, Hans	International Conference on Global	2007

	Answer?	Van	Software Engineering	
E572	Globally Distributed System Developers: Their Trust Expectations and Processes	Al-Ani, Ban ; Bietz, Matthew J. ; Wang, Yi ; Trainer, Erik ; Koehne, Benjamin ; Marczak, Sabrina ; Redmiles, David ; Prikladnicki, Rafael	Internationl Conference on Computer Supported Cooperative Work	2013
E581	Impact of Discrepancies in Effective Written Communication on Organizational Quality of Geographically Dispersed Software Organizations in Software Industry of Pakistan	Akram, Adnan ; Ahsan, Dr. Ali	International Symposium on Management, Engineering and Informatics	
E589	Instructional Design and Assessment Strategies for Teach ing Global Software Development: A Framework	Damian, Daniela ; Hadwin, Allyson ; Al-ani, Ban	International Conference on Software Engineering	2006
E591	Integration by communication: knowledge exchange in global outsourcing of product software development	Kristjánsson, Baldur ; Helms, Remko ; Brinkkemper, Sjaak	Expert Systems	2012
E594	Investigating the Role of organizational Structure in Developing Shared understanding of Requirements within GSD	Humayun, Mamoona ; Gang, Cui	International Multitopic Conference	2012
E602	Knowledge Transfer in IT Offshore Outsourcing Projects: An Analysis of the Current State and Best Practices	Betz, Stefanie ; Oberweis, Andreas ; Stephan, Rolf	International Conference on Global Software Engineering	2010
E605	Management at the Outsourcing Destination - Global Software Development in India	Deshpande, Sadhana ; Richardson, Ita	International Conference on Global Software Engineering	2009
E614	Mutual Dependency of Distribution , Benefits and Causes: An Empirical Study	Gumm, Dorina-c	International Conference on Global Software Engineering	2007
E615	Near-Synchronicity and Distance: Instant Messaging as a Medium for Global Software Engineering	Jaanu, Tuomas ; Paasivaara, Maria ; Lassenius, Casper	International Conference on Global Software Engineering	2012
E616	Of Deadlocks and Peopleware - Collaborative Work Practices in Global Software Development	Avram, Gabriela	International Conference on Global Software Engineering	2007
E639	Student Motivation in Distributed Software Development Projects	Bosnić, Ivana ; Čavrak, Igor ; Orlić, Marin ; Žagar, Mario	Workshop on Collaborative Teaching of Globally Distributed Software Development	2010
E641	Supporting Creative Collaboration in Globally Distributed Companies	Gumienny, Raja ; Gericke, Lutz ; Wenzel, Matthias ; Meinel, Christoph	Internationl Conference on Computer Supported Cooperative Work	2013
E643	Surviving the paradoxes of virtual teamwork	Dubé, Line ; Robey, Daniel	Information Systems Journal	2008
E646	Teaching a Global Project Course: Experiences and Lessons Learned	Gloor, Peter ; Paasivaara, Maria ; Lassenius, Casper ; Schoder, Detlef ; Fischbach, Kai ; Miller, Christine	Workshop on Collaborative Teaching of Globally Distributed Software Development	2011
E655	The Usefulness of Architectural Knowledge Management	Clerc, Viktor ; Lago, Patricia ; Vliet, Hans	International Conference on Global	2009

	Practices in GSD	Van	Software Engineering	
E664	Uncovering the Reality Within Virtual Software Teams	Casey, Valentine ; Richardson, Ita	International Workshop on Global Software Development for the Practitioner	2006
E666	Using a Real-Time Conferencing Tool in Distributed Collaboration: An Experience Report from Siemens IT Solutions and Services	Damian, Daniela ; Marczak, Sabrina ; Dascalu, Madalina ; Heiss, Michael ; Liche, Adrian	International Conference on Global Software Engineering	2009
E672	Virtual team collaboration: building shared meaning, resolving breakdowns and creating translucence	Bjørn, Pernille ; Ngwenyama, Ojelanki	Information Systems Journal	2009
E690	A risk profile of offshore-outsourced development projects	Iacovou, Charalambos L. ; Nakatsu, Robbie	Communications Of The ACM	2008
E695	A Taxonomy and Visual Notation for Modeling Globally Distributed Requirements Engineering Projects	Laurent, Paula ; Mäder, Patrick ; Cleland-Huang, Jane ; Steele, Adam	International Conference on Global Software Engineering	2010
E703	Advanced Hands-on Training for Distributed and Outsourced Software Engineering	Nordio, Martin ; Mitin, Roman ; Meyer, Bertrand	International Conference on Software Engineering	2010
E708	Ambidextrous coping strategies in globally distributed software development projects	Lee, Gwanhoo ; Delone, William ; Espinosa, J Alberto	Communications Of The ACM	2006
E714	An Evolving Collaborative Model of Working in Students' Global Software Development Projects	Scharff, Christelle	Workshop on Collaborative Teaching of Globally Distributed Software Development	2011
E729	Be successful, take a hostage or outsourcing the outsourcing Manager	Pichler, Horst	International Conference on Global Software Engineering	2007
E736	Collaboration in Software Development Lesson Learned from Two Large Multinational Organizations	Mettovaara, Vesa ; Siponen, Mikko T. ; Lehto, Jari A.	Pacific Asia Conference on Information Systems	2006
E752	Cultural Perceptions og Tassk-Technology Fit	Massey, Anne P ; Montoya-Weiss, Mitzi ; Hung, Caisy ; Ramesh, V	Communications Of The ACM	2001
E763	Distributed Development – an Education Perspective on the Global Studio Project	Richardson, Ita ; Milewski, Allen E ; Keil, Patrick ; Mullick, Neel	International Conference on Software Engineering	2006
E773	Empirical Study of Tool Support in Highly Distributed Research Projects	Prause, Christian R. ; Reiners, Rene ; Dencheva, Silviya	International Conference on Global Software Engineering	2010
E774	Enabling Collaboration in Distributed Requirements Management	Sengupta, Bikram ; Sinha, Vibha ; Chandra, Satish	IEEE Software	2006
E788	Global Cooperative Design in Legacy System Reengineering Project	Xu, Bin ; Yang, Xiaohu ; He, Zhijun ; Ma, Albert	Electronic Markets	2003
E795	Having a Foot on Each Shore - Bridging Global Software Development in the Case of SMEs	Richardson, Ita ; Avram, Gabriela ; Deshpande, Sadhana ; Casey, Valentine	International Conference on Global Software Engineering	2008
E799	How Do Distribution and Time Zones Affect Software	Nordio, Martin ; Estler, H. Christian ; Meyer,	International Conference on Global	2011

	Development A Case Study on Communication	Bertrand ; Tschannen, Julian ; Ghezzi, Carlo ; Nitto, Elisabetta Di	Software Engineering	
E806	Impression Formation in Online Peer Production Activity Traces and Personal Profiles in GitHub	Marlow, Jennifer ; Dabbish, Laura ; Herbsleb, Jim	Internationl Conference on Computer Supported Cooperative Work	2013
E814	Inter-team Coordination in Large-Scale Globally Distributed Scrum Do Scrum-of-Scrums Really Work	Paasivaara, Maria ; Lassenius, Casper ; Heikkilä, Ville T.	International Symposium on Empirical Software Engineering and Measurement	2012
E825	Knowledge-related challenges and solutions in GSD	Parviainen, Päivi ; Tihinen, Maarit	Expert Systems	2011
E827	Leveraging Resources in Global Software Development	Battin, Robert D. ; Crocker, Ron ; Kreidler, Joe ; Subramanian, K.	IEEE Software	2001
E837	Managing the Iterative Requirements Process in a Multi-national Project Using an Issue Tracker	Prause, Christian R. ; Scholten, Marius ; Zimmermann, Andreas ; Reiners, René ; Eisenhauer, Markus	International Conference on Global Software Engineering	2008
E845	Microblogging's Impact on Collaboration Awareness : a field study of microblogging within and between project teams	Zhao, Dejin ; Rosson, Mary Beth ; Matthews, Tara ; Moran, Thomas	International Conference on Collaboration Technologies and Systems	2011
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