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Impact of agile practices on organization learning: a model for knowledge creating and sharing in agile teams

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Resumo

O desenvolvimento de softwares é caracterizado como uma atividade intensiva de conhecimento e o sucesso dos projetos depende diretamente do conhecimento mantido pelos profissionais envolvidos no processo. Por esse motivo, são necessárias estratégias de gestão do conhecimento que auxiliem no processo de criação e compartilhamento do conhecimento entre as equipes desenvolvedoras de softwares. A ausência de estratégias para o compartilhamento do conhecimento acarreta em retrabalho, pois os profissionais estarão constantemente criando soluções para situações vivenciadas anteriormente. Além disso, a organização perde conhecimento quando um profissional experiente é transferido de projeto ou deixa a companhia. Nesse sentido, esse projeto propõe um estudo que visa responder à seguinte questão de pesquisa: **Qual o impacto da utilização de práticas ágeis no processo de aprendizagem organizacional em empresas de software considerando os níveis individual, de grupo e organizacional?** Dessa forma, o objetivo do estudo proposto é identificar quais as estratégias para a gestão do conhecimento são mais difundidas entre as equipes desenvolvedoras de software e avaliar qual o impacto causado pela utilização de práticas ágeis sobre o processo de aprendizagem organizacional. A condução desse estudo foi dividida em duas etapas. Na primeira etapa foi realizada uma revisão sistemática de literatura (SLR) com o objetivo de identificar os constructos que compõem o modelo descrito nesse projeto. Na segunda etapa será conduzida uma pesquisa do tipo *survey* com o objetivo de validar o modelo proposto. Os dados coletados nessa pesquisa serão tratados e analisados com a aplicação de técnicas estatísticas, tais como análise fatorial e modelagem de equações estruturais. Os resultados obtidos por essa pesquisa servirão de base para outros estudos no campo da engenharia de software e gestão do conhecimento. Além disso, esse estudo fornecerá mecanismos para que os profissionais da área de engenharia de software implementem estratégias que colaborem com a criação e compartilhamento do conhecimento em suas equipes.

Palavras-chaves: Aprendizagem organizacional; Gestão do conhecimento; Engenharia de software; Metodologias ágeis; Práticas ágeis;

Abstract

Software development is an intensive knowledge activity and the project's success depends directly on the knowledge held by professionals involved in process. Therefore, is necessary to adopt knowledge management strategies to assist in the knowledge creation and sharing among software developers teams. The absence of strategies for knowledge sharing leads to rework, because professionals are constantly creating solutions to situations solved previously. Moreover, the organization loses knowledge when an expert professional goes to other project or leaves the company. In this sense, this project proposes a study to answer the research question: **What is the impact of using agile practices in organizational learning process considering the individual, group and organizational level in software companies?** Thus, the proposed study objective is identify which strategies for knowledge management are more widespread among software development teams and evaluate the impact caused by agile practices adoption on the organizational learning process. The conduct of this study was divided into two stages. In first stage was carried out a systematic literature review (SLR) in order to identify the constructs that compose the model described in this research project. In the second stage will be conducted a survey research in order to validate the proposed model. Collected data in this survey will be processed and analyzed with statistical techniques such as factor analysis and structural equation modeling. Research results will provide basis for further studies in the field of software engineering and knowledge management. Additionally, this study will provide mechanisms for software engineering professionals implement strategies that contribute to the knowledge creation and sharing in their teams.

Key-words: Organizational learning; Knowledge management; Software Engineering; Agile methods; Agile practices;

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List of abbreviations and acronyms

BDD	Behavior-Driven Development
CoP	Community of Practice
CS	Computer Science
DSDM	Dynamic Systems Development Method
FDD	Feature-Driven Development
IS	Information Systems
IT	Information Technology
KM	Knowledge Management
LSO	Learning Software Organization
OL	Organizational Learning
SEM	Structural Equation Modeling
SLR	Systematic Literature Review
TDD	Test-Driven Development
XP	eXtreme Programming

Contents

1 Introduction

Software development is an intensive knowledge activity on which professionals involved need to have specific skills to carry out its activities (1, 2, 3). Intellectual capital for these professionals is a strategic tool to gain quality and productivity (4, 5). From this perspective, knowledge management strategies become necessary to ensure that the available knowledge is shared among organization members (1). Knowledge sharing allows redundancy of key knowledge and minimizes the risk of losses caused by staff turnover (6, 4). The absence of knowledge sharing also leads to rework, since professionals are committed to creating solutions to situations that already have been solved (2, 7). Therefore, knowledge sharing is the key to software development and team effectiveness (4, 5).

However, knowledge management is a challenge to software organizations. Beside the difficulties inherent in the process of identifying and knowledge management (8), the scenario of the information technology (IT) organizations is compounded by the dynamic nature of the sector, so that these companies need to deal with the volatility of the demands presented by customers and need to adapt to technological changes to which software products are subject (9, 10, 11).

There are different methodologies that aim to control and manage the software development process. In these methods there are different strategies with regard to the knowledge sharing (12). On one hand, traditional methods using the extensive documentation as a way to encoding and knowledge transfer. In this case, knowledge is presented explicitly (2). On the other hand, agile methods are lighter processes and rely on direct communication and interpersonal relationship as a mechanism to promote the knowledge transfer (13, 14). Thus, knowledge is no longer explicit and moves tacitly among those involved (13).

Despite that, the agile practices support communication and knowledge sharing among team members (15), the lack of explicit knowledge creates difficulties for the teams that adopt agile methodologies because constantly the experienced professionals need to respond the same inquiries for beginner professionals (2). In addition, professionals are faced with situations or problems experienced in previous projects, but do not remember the solutions that have been adopted (7). Therefore, it is necessary to identify how the use of methods and agile practices assist in creation, sharing and maintaining knowledge available in the organizations.

Thus, the objective of this study is to evaluate the relationship and the impact of the agile practices adoption in the organizational learning process. Organizational learning (OL) is an ongoing process in which the organization produces, disseminates and

applies the knowledge produced in order to promote innovation and competitive advantage (16). The knowledge application promotes changes in routines, procedures, products and services, indicating a change in the organization behavior due to application of the knowledge produced, which suggests that organizational learning has occurred (17, 18). Thus, knowledge management strategies are required to allow that the organization produces new knowledge, share and apply the knowledge produced (19). Therefore, for the objectives of this study, knowledge management is approached as a management strategy that meets a set of practices and processes that provide mechanisms to support the organizational learning process (2, 19, 62).

1.1 Research Problem

Software companies have adopted agile methods and practices to aid accelerate product delivery, enhance ability to manage changing priorities and increase productivity (20). In this sense, agile methods adoption is a current main stream in software engineering and has received attention both researchers and practitioners (21).

However, software development is a series of intensive knowledge activities that are performed daily (3). Therefore, an appropriate strategy to management the knowledge produced during the process is need (19). Furthermore, is necessary the adoption of mechanisms to disseminate this knowledge across organizational (22).

Thus, this work aims to answer the following question: **What is the impact of using agile practices in organizational learning process considering the individual, group and organizational level in software companies?**

1.2 Objectives

In this section we will present the objectives, general and specific, that guide the construction of this research. Because it is a proposed empirical model, the hypotheses related to this model will be presented in a specific session, which aims to report and detail the proposed model, as well as constructs and hypotheses related to this model.

1.2.1 Main Objective

The main objective of this study is the analysis about the impact of the use of agile practices on organizational learning in software companies.

1.2.2 Specific Objectives

The specific objectives of this work are:

- OBJ1 - Identify which are the agile practices most used by software developers teams and how these practices help in the process of sharing knowledge among members of these teams;
- OBJ2 - identify which are the knowledge management strategies used by software development teams that use agile methodologies;
- OBJ3 - Analyze the impact of agile practices adoption in the organizational learning process;

1.3 Motivation

Software development is an intensive activity of knowledge and individuals involved in the process need specific skills to carry out its daily activities (2). In this sense, creation and knowledge sharing among team members are crucial to project success (4, 23). Different approaches to software development are use in order to enhance team productivity, improve quality indicators and accelerate time to market (20, 24). However, these processes do not provide guidelines related to sharing and knowledge retention. In the case of software organizations that use traditional methods, knowledge is treated explicitly. It is encoded in the form of documents and technical artifacts (7). In organizations that use agile methodologies, knowledge is available tacitly and depends on the communication and the relationships established between individuals to occur knowledge sharing (25). Then, the knowledge produced during the software development process is restricted to the project and team (3, 26). So is necessary knowledge management strategies aligned to the software development process to ensure that the knowledge available in the organization will be shared and will be available to individuals who need this knowledge (1). Moreover, the majority existing research in agile practices adoption is industrial experience reports (27) and literature needs more studies that justify agile practices adoption ask knowledge management mechanisms (15). In this sense, is necessary to understand the relationship between the practices adopted by software teams, creation and sharing knowledge process in order to improve organizational learning process.

1.4 Adherence to FUMEC's Graduate Program in Information Systems and Knowledge Management

The theme proposed for this research is consistent with the FUMEC's graduate program in Information Systems and Knowledge Management because it presents adherence to research line named process engineering and systems. The study presents concepts related to software engineering processes, practices and agile methodologies and explores the strategies and models for knowledge management available in the literature. More-

over, the study comes to fill a gap in the literature, which lacks empirical study based on the investigation of the relationship between the use ways of methodologies and agile practices and organizational learning.

This is an interdisciplinary research, addressing aspects of software engineering and knowledge management. The results of this research will be used by researchers and professionals in software engineering and managers interested in promoting the knowledge sharing in their teams. On one hand, researchers can use this material as an informational source and identify new opportunities for research. On the other hand software engineers can base on the results to identify adaptation needs and improvement possibilities in their companies to create mechanisms that contribute to the knowledge management and organizational learning in their organizations.

1.5 Document Structure

The document is structured in 4 chapters. Chapter 1 presented the introduction. Chapter 2 presents a Systematic Literature Review (SLR) on organizational learning and knowledge creation and sharing using agile methods and practices. Chapter 3 shows the related work on agile methods and organizational learning. Lastly, chapter 4 describes the methodological procedures to be followed on the research implementation.

2 Systematic Literature Review

2.1 Introduction

Software development is an intensive activities series of knowledge (3). Each professional involved in this process needs a variety of skills to do their daily work (28). Different knowledge types are required during the software design and construction. Individuals need to know technologies, tools and the methodology used by the company in order to ensure continuity and compliance with the planned steps. In addition, team members need to know the business for which the software is intended (29).

Thus, the success of a software project is dependent on the knowledge available in the team and in the organization (7), since the collaborative work and knowledge transfer are the essence of software development (4). Therefore, strategies needed to enable knowledge sharing among those involved in the project in order to produce new knowledge and promote competitive advantage to the organization (19). This advantage is achieved through innovation in products and services, through the speed with which the organization responds to a market need and by adapting their routines aiming to time and resource saving (3, 30, 31). Therefore, it is necessary to ensure that the appropriate knowledge is available to individuals who depend on this knowledge to properly perform their tasks (23).

Organization's Knowledge is present in the products and services offered to customers, processes and routines of the company and also is found distributed tacitly (cognitive) among organization members (1). On one hand, the stock of knowledge available is incremented when new individuals became part of the company and bring with them leaning obtained through their professional and personal experiences. On the other hand, whenever a professional migrates between functional areas, or leaves the organization, carries the knowledge produced, and there is often no way to fill the knowledge that has been lost (32, 26).

Therefore, strategies are necessary for knowledge preservation and to assist in the production of new knowledge (19). However, knowledge management is a challenge for software companies. Besides the natural difficulty in mapping and managing the knowledge available in the organization the information technology scenario organizations is compounded by the highly dynamic nature of the sector (9, 10).

However, knowledge management is a challenge for software companies (3). Besides the natural difficulty in mapping and managing the knowledge available in the organization, software scenario is compounded by the highly dynamic nature of the sector, either

from the perspective of the volatility of the demands presented by customers, whether from the perspective of technological changes which software products are subjected (9, 10). In addition, in software process the knowledge available is more tacit than explicit (5).

In this sense, the objectives of this study are: (1) summarize the literature regarding creation and sharing of knowledge in agile teams and provide an understanding of the research types used in this area, (2) identify the agile practices and strategies used by teams as knowledge management mechanisms and (3) identify how agile teams members knowledge is institutionalized and becomes part of the organization's knowledge. To reach the objectives of this study, the SLR was chosen as the research method to detect trends in agile methods and knowledge management research and identify gaps and opportunities for further investigation (33).

Our results show that among agile teams the knowledge management strategies are most adopted are those that are based on face-to-face communication and relations between individuals. In addition, practices such as pair programming and daily meeting are widely used by team's members as knowledge sharing mechanisms. Regarding to the research type of the studies related to knowledge management in the methodologies context, we have identified that most papers are experience reports and philosophical papers. In this sense, the literature lacks most empirical studies in this area.

The remainder of the paper is organized as follows. Section 2.2 provides the technical background and related work while section 2.3 discusses the research methodology and data extraction procedures. The results of the study and findings are presented and discussed on section 2.4. Section 2.5 presents the threats to validity. The conclusions and future work are presented on section 2.6.

2.2 Background

This section presents the main concepts that guided the construction of this review. Primarily, we present the agile methodologies for software development followed by a discussion about organizational learning and a brief presentation of the main theories described in the literature regarding organizational knowledge creation. To support our objectives, we discuss knowledge management strategies based on Earl's taxonomy (34). Finally, we present knowledge management in software engineering focusing in agile context and related works to this review.

2.2.1 Agile methods for software development

The Agile term was first used in the context of software development in the 1990s (15). However, the consolidation of agile methodologies, as a category of processes for software development occurred with the release of the Agile Manifesto (35). The Agile

Manifesto was proposed by seventeen experts on methodologies for software engineering, standing among them Kent Beck, author of Extreme Programming (XP) (36) and Ken Schwaber and Jeff Sutherland, authors of Scrum method (37). Agile Manifesto synthesizes four principles and twelve values, which we have showed in Table 1, which according to the authors, should be followed during the software development process.

Table 1: Values and principles of agile methodologies.
Source: Adapted from Beck *et al.* (35).

Principles	Values
Individuals and interactions; Working software; Customer collaboration; Responding to changes;	Early and continuous delivery of valuable software; Changes are welcome; Constant delivering of working software; Interactions between people (customers and developers); Build projects around motivated individuals; Direct communication (face-to-face); Working software is the primary measure of progress; Promote asustainable environment; Continuous attention to technical excellence; Simplicity; Self-organizing teams; Continuous process improvement;

Therefore, agile methodologies are processes to software development, consisting of a set of practices that aim at the constant delivery of software with high value for customers (38). These practices are in compliance with the principles outlined in the agile manifesto and can be subdivided into groups: (1) project management practices and (2) software development practices (39). Dedicated product owner and planning meetings are examples of project management practices. Pair programming and unit tests are software development practices.

However, agile practices are not necessarily new. What in fact makes the agile approach different is how the practices were grouped and placed in the context of the principles laid down by the Agile Manifesto (40). Beck (36) confirmed it when he states that agile methodologies constitute a change in the social factors surrounding the software development process. What is new in agile methodologies is the recognition of the people that they need to work together to obtain success on the project (15). Table 2 shows a mapping of agile practices, provided in XP and Scrum methodologies, organized according to the principles set out in the Agile Manifesto.

Agile methodologies represent an alternative to the traditional development model. In the last decade, the attention of researchers and professionals in software engineering has turned to this group of development methodologies (12). This emphasis is confirmed by recent research that shows the results obtained by the software projects that adopt agile methods (41, 42). Agile projects present good relation between the estimated costs and the actual costs. Also, the deadline indicators show alignment between the established deadlines for the project and practiced deadlines (24). The constant delivery of products

Table 2: Organization of agile practices in terms of agile principles.
Source: Adapted from Singh, Singh and Sharma (15).

Agile Principle	XP	Scrum
Individuals and interactions	Iterations planning; On site customer; Pair programming; Collective ownership;	Scrum team; Daily meeting; Sprint planning; meeting;
Working software	Short iterations; Continuous integration; Unit tests;	Sprint (short iterations); Sprint review;
Customer collaboration	Iterations planning; On site customer;	Product backlog; Sprint planning; meeting;
Responding to changes	Use of metaphors; Refactoring; Simplicity of design; Coding standard;	Sprint planning meeting; Sprint review;

to customers, improving the ability to cope with changes in the environment and increasing the teams' productivity are the main reasons that lead companies to abandon their software development processes and adopt agile methods (21, 20).

Knowledge management and transfer set a crucial difference between traditional methodologies and agile processes. Both models face challenges regarding to manage knowledge that is produced during the software process. Because of it, organizations need knowledge management strategies to ensure that company knowledge is shared, protected and used to promote competitive advantages (1, 3, 19).

Traditional methods are oriented to planning and in-depth documentation. Thus, a collection of documents and artifacts are established to encode and store the knowledge produced during the process (2). Codifying knowledge makes the professional reflects on the topic and about the solutions adopted, reinforcing learning (43) and the availability of codified knowledge facilitates access to this knowledge by other employees (26). However, the codification strategy and knowledge storage in technical documents faces the difficulty of keeping documents updated in function of the software changes (36). Thus, the work to keep documentation updated is a hindrance to software teams and the documentation becomes a burden, rather than assist in knowledge transfer (36, 1). Professionals constantly need to ask each other if the available documentation is updated and most often do not use this documentation because it does not correspond to software state at that time (23). Additionally, the knowledge codification process present losses because codified knowledge cannot express the tacit knowledge depth and can be difficult to interpret even for an expert (44).

As opposed to the traditional model, agile methodologies use an approach centered on individuals and relations between them (36). In this context, the transfer of information and knowledge occurs informally, using face-to-face communication and communication

technologies (1, 3). In this sense, knowledge became more tacit than explicit (25). Therefore, in agile environments, transfer and retention of knowledge depends on the quality of communication and the relationships established between those involved (44). Although agile methods focusing on working software rather than in-depth documentation, it does not signify that there is not documentation. Minimum documentation is used to keep main information (14). The absence of in-depth documentation brings challenges to agile team that constantly need to answer the same questions and do not remember which solution was proposed to similar situations (2). However, the lack of documentation keeps the team in constant communication, constant knowledge sharing and improves individual's communication skills (45).

2.2.2 Organizational learning

The knowledge available to an organization is its most valuable asset, is possible to identify the increased attention and value given by companies to employees' experience and knowledge (46, 1). Determine the knowledge available in the company, promote knowledge sharing and make it accessible to other professionals is vital to the longevity and success of an organization (17). Applying the knowledge and creating a set of new skills based on that may result in an increase of performance, create competitive advantages and develop innovative products and services (16).

Organizational learning emerges as an interdisciplinary field (17) focused on identifying and determining how companies acquire and produce knowledge. For Senge (47), organizational learning is a continuous process in which the experience becomes knowledge throughout organization in order to comply with the company's purposes. Another definition for organizational learning from Levine and Monarch (48), describes the organizational learning as a learning process performed by individuals within an organization. Moreover, organizational learning is a process by which organizations generate, disseminate and apply knowledge to translating it into innovation and competitive advantages (16).

However, the main definition adopted for the organizational learning is a change in the company due to knowledge and experience acquired (18, 49). This change occurs in a cognitive aspect, in which members of the company acquire knowledge, and on behavioral aspects, identified by changes in the company's activities and processes (17, 18). Thus, it is assumed that the organization is learning and therefore modifying the way it conducts its activities.

Besides the term, the measurement of the organization's learning level composes yet another divergent topic among researchers (17), since it is possible to find different approaches to assess how much the company has learned throughout its existence. One way to measure organizational learning is evaluating performance indicators such as

assertiveness and productivity, which indicate that knowledge was acquired and therefore that organizational learning occurred in fact (50, 18). Another way to measure is to identify changes in the company's routines, process innovations and changes in the implementation of activities, which indicates knowledge creation and application of this knowledge to improve the day-to-day business (51, 18). A third approach measures to the organizational learning by evaluating the progress of the cognitive level of staff members (52, 18).

In this sense, there are three levels of the organizational knowledge that are individual, by group and organizational level (53). Organizational learning occurs when knowledge reaches the highest level, that is, the organizational level (32, 54). The knowledge used by an individual in the exercise of their duties only figure at the individual level and does not reach other levels without sharing and dissemination (22).

At the individual level, knowledge is a property of the individual who holds it. Sharing individual knowledge, relationships are established between individuals, creating a common understanding of the knowledge that was disseminated (55). Thus, a group of individuals starts to share a common understanding, creating the possibility to take actions based on that knowledge, reaching group level of organizational knowledge. This knowledge in a group of individuals will be applied and eventually take organizational proportions to be institutionalized in form of routines, processes, products and organizational artifacts (22).

Starting from the need to increase the individual knowledge to the organizational level, there are different theories and models for the creation of organizational knowledge in literature. However, in the software engineering context, most models described in literature are the theory known as single-loop and double-loop, experiential learning theory, SECI model and communities of practice (56).

The double-loop theory proposed by Argyris and Schon (57), considers two forms of learning: single-loop and double-loop. The single-loop happens when the individual observes a phenomenon and produce an understanding of the fact occurred. This understanding will allow the individual to make changes in the process or routines in order to get the expected results. In double-loop, individual need to observe the effects caused by the phenomenon, but identifies and understands the factors that influence these effects. Regardless of the path have taken by the individual, according to the model of Argyris and Schon, learning occurs only at the individual level, since the individual will produce knowledge stemming from the observation and reflection, but there are not mechanisms for sharing the knowledge produced.

Kolb (58) proposes the theory of learning based on experience, or experiential learning. The author presents a model in which experience plays a key role in the learning process. Just like the theory proposed by Argyris and Schon (57), the model proposed

by Kolb (58) includes learning at the individual level and will not progress, by itself, to other levels of organizational knowledge. The learning process takes place in four stages: (1) concrete experience, (2) observation and reflection, (3) abstract conceptualization and (4) active experimentation. Thus, the process starts from a prior experience or knowledge of the individual, which serve as basis for new observations and make reflections. The reflections produced by the individual will give him the possibility of generalizations and allow the production of new mental models. The learning process is complete when the individual experience and apply the new knowledge formulated from the abstractions (58).

The SECI model proposed by Nonaka and Takeuchi (59) assumes the existence of two types of knowledge in organizations: tacit and explicit knowledge. On one hand, tacit knowledge is that which is in people's minds and emerges from individual experiences, treat this type of knowledge is difficult for the organizations (53). On the other hand, explicit knowledge exists in the form of documents, routines, products and knowledge assets such as patents. The knowledge becomes explicit when an individual encodes its own knowledge and transcribes it to pass this knowledge to others (15). The SECI model provides a process of interaction between the tacit and explicit knowledge in order to promote knowledge creation through four phases: (1) socialization, (2) externalization, (3) combination and (4) internalization (59).

Socialization occurs between individuals when they share tacit knowledge, even if the sharing occurs informally through observation, imitation and direct communication. At that time, an individual share their experiences and learning with others. Socialization is an individual learning process. In externalization process, tacit knowledge is encoded and transformed into explicit knowledge, generating reports, documents and templates. Transmitting explicit knowledge to other individuals and units of the company promotes the knowledge to the group level (54). In the combination phase, individuals and groups associate the recently acquired knowledge to prior knowledge and experiences, in order to produce new knowledge, generating knowledge for the organization. The combination may occur synthesizing explicit knowledge. Then, combining two knowledge sources and re-encoding it produces a new explicit knowledge. Finally, internalization corresponds to the assimilation of the knowledge produced. When applied, this knowledge provides the individual subsidies to modify how to perform activities, promote improvements in the products and services of the institution. Thus, the knowledge will be institutionalized and achieve the organizational level (54).

Wenger (60) describes a community of practice (CoP) as a group of individuals who meet regularly to share knowledge for a matter of common interest. Interest in learning and application knowledge keeps the community running. A community of practice sets its own routines, rituals, artifacts and conventions. The application of a community of practice establishes benefits for both the organization and for the individual so who

make up the communities. On one hand, from the perspective of the organization, is highlighted the reduction of time and costs and increase the retention and recruitment of talented employees (61). On the other hand, community members benefit from access to the experience, ability to keep up to date on a specific domain of knowledge and greater ability to contribute to the team (61).

2.2.3 Knowledge Management strategies

Knowledge management (KM) emerges as an interdisciplinary area aligned to organizational learning. Just like the term organizational learning, the literature describes knowledge management in different ways and there is no consensus on the formalization of the term (28). However, for the purposes of this study, the definitions made for the KM direct the understanding of the term as a process or strategy to be applied in the organization in order to promote benefits and competitive advantage for the company (62, 3).

Nonaka and Takeuchi (59) point out that knowledge management is a process by which the knowledge produced by an individual amplified at the organizational level, making this knowledge part of the company's knowledge. For Davenport (46), knowledge management comprises a method that simplifies the creation, sharing, capturing and understanding of the organization knowledge. According to Bukowitz and Williams (63), knowledge management is a process capable of generating wealth for the organization through the protection and enforcement of intellectual capital.

In this sense, knowledge management provides enterprises with mechanisms to manage the knowledge produced on the day to day of the organization, enabling the organizational learning (62). Thus, knowledge management is a management strategy to meet a set of practices and processes in order to ensure that the company knowledge is used to promote benefits for the organization (19). Therefore, it is necessary to establish appropriate strategies for the management of knowledge in order to enable the organization to produce knowledge, share the knowledge produced and protect the intellectual capital available (19).

Regarding strategies for knowledge management, codification and personalization are the main approaches adopted by organizations (8). The codification presents an approach in which the company knowledge is systematized and stored in the form of documents, systems and databases that are available to other members of the organization. Codification is the strategy adopted for the externalization phase proposed by Nonaka and Takeuchi (59). Knowledge encoded and stored in repositories will be available to other individuals and the access to the tools and databases act as a facilitator mechanism. However, codification may result in loss of integrity and depth of such knowledge, since the individual may be general and not express their ideas during encoding (19).

The personalization covers the flow of information contained in the company in order to identify the sources of knowledge that are available. Thus, generating a mapping indicating which individuals has certain knowledge. This approach covers knowledge sharing as a social phenomenon, dependent on the relationship established between people. The personalization strategy is present in the socialization phase of the SECI model (59) and in communities of practice (60). However, the personalization strategy should be followed by strategies to share knowledge, since the risk of losing knowledge is consolidated in cases where the professional who hold key information for organization migrates between sectors or leaves the company, taking away the knowledge (19).

For the purposes of this work, we use strategies for knowledge management based on the taxonomy proposed by Michael Earl (34). The framework proposed by Earl has a broader categorization, which uses seven classifications strategies or schools for the knowledge management, which are divided into three groups. Table 3 shows the focus, the goal and the playing field of seven schools proposed by Earl.

Table 3: Earl's knowledge management schools.
Source: Adapted from Earl (34).

School	**Technocratic**			**Economic**	**Behavioral**		
Attribute	Systems	Cartographic	Engineering	Comercial	Organizational	Spatial	Strategic
Focus	Technology	Maps	Processes	Income	Networks	Space	Mindset
Aim	Knowledge bases	Knowledge directories	Knowledge assets	Knowledge pooling	Knowledge exchange	Knowledge flows	Knowledge capabilities
Unit	Domain	Enterprise	Activity	Know-how	Communities	Place	Business
Philosophy	Codification	Connectivity	Capability	Commercialization	Collaboration	Contactivity	Consciousness

The first group described by Earl (34) is Technocratic Schools. These schools are based and dependent on technology to establish knowledge management strategies. This group consists of three schools: Systems School, Cartographic School and Engineering School. Systems School adopts the oldest formal approach to the knowledge management (34, 28), once again using the coding strategy for documenting and storing the knowledge in databases and expert systems. Therefore, the main strategy used by this school consists in the use of repositories to manage and share the knowledge available in the organization.

Cartographic School presents an approach based on personalization strategy. Thus, this school is focused on identifying the professionals who hold key knowledge for the organization, generating a skills mapping. Thus, the goal is to identify the holders of certain knowledge and make them available to employees who need this knowledge. This school is described as systemic as it will depend on technologies to map the skills, and use of communications technology to hold meetings and technology sharing sessions (34, 28).

The last of the technocratic schools, Engineering School, is guided by the organization's flow of information and knowledge. Earl (34) describes that the school aims to provide professionals with the information and knowledge necessary to perform their actions. The learning supported by these schools is based on the previous experience of the organization so that decisions are based on the results of earlier events and actions performed. Earl gives as example the availability of results and past sales strategies passed

to teams of a particular company. Ensuring that the availability of information's acts as a competitive advantage. The technology acts as a facilitator for the distribution of information to professionals when they need such knowledge.

Economic Schools group consists of only one category described as Commercial School. Commercial school aims to generate revenue from the knowledge assets and intellectual capital of the organization. Explore the knowledge assets, such as patents and copyrights, with the aim of generating income to the company. The organization's knowledge assets are now treated as objects to be managed and marketed (34, 64).

The third category of schools for knowledge management is known as Behavioral Schools. The name of this group is justified by the use of strategies such as communication and interaction between individuals for the production and sharing of knowledge. This group consists of the Organizational school, the Spatial School and the Strategic School.

Organizational School utilizes the professional structure of the organization as a mechanism to share knowledge. The interaction and the relationships established between individuals are facilitators for the knowledge socialization. The focus is to promote connectivity between people and the use of "knowledge communities", which resemble the communities of practice (64).

Organize a workplace environment so that it contributes to the flow of information and knowledge is the strategy adopted by the Spatial School. The use of offices with open spaces without walls, where professionals are in constant contact, is a strategy to facilitate communication and the exchange of knowledge. Furthermore, the use of informative panels promotes the distribution of information. Another strategy adopted by the spatial school is to maintain living spaces such as coffee rooms. These areas are involved in the socialization of knowledge among professionals (54, 34).

Strategic School addresses the knowledge management as a competitive strategy (34). The organization works to nurture the value creation through the promotion of the available intellectual capital. Earl explains that customers of a financial organization will realize the value of the company because the company relies on better-prepared professionals. Therefore, the strategic school acts by creating value through the recognition that knowledge is a precious resource (34).

2.3 Method

Evidence-based research was developed in the medical field (65). However, the method has been used as a basis for research in other fields, such as nutrition, nursing and criminology (65). In software engineering field, Evidence-based Software Engineering (EBSE) (33) is recommended due to the volume of published research in the area in recent

years, which makes it impossible to conduct literature reviews conventionally (33, 66, 65).

Kitchenham *et al.* (65) defines evidence as a synthesis of scientific studies that address a specific topic or a research question. A systematic literature review (SLR) can be used to conduction of an evidence-based research. SLR is the main method used to synthesize relevant studies and conduct a research based on evidence (65). The systematic literature review comprises a systematic and rigorous method for the identification, evaluation and interpretation of works that are relevant to a research question or area of interest (33, 66, 67).

Thus, the method used to conduct this study was a systematic literature review (SLR) because it allowing the summarization of studies relevant to the research question proposed in this work and assists in identifying possible gaps in the literature with regard to matters covered in this study (68, 66, 65).

2.3.1 Research Questions

The definition of the research questions is the most critical step when performing a systematic literature review (66), because these questions will guide the construction of the review protocol and assist in identifying the work scope (68). Table 4 4describes the research questions defined for this study and have as main objective to identify and analyze the literature regarding the use of methodologies and agile practices in knowledge management strategies context.

Table 4: Research questions.
Source: Elaborated by the author.

ID	Research Question
RQ1	Which organizational learning theories are most addressed in agile studies and what is the relationship between these theories and the methods and agile practices?
RQ2	Which knowledge management strategies are most adopted by organizations in agile context?
RQ3	Which agile practices and knowledge management strategies are most used to promote the individual knowledge at the organizational level?

In general, we want to identify which methods and which agile practices are presented in literature as mechanisms to facilitate knowledge management and what types of research that have been used in studies assessed. The results will serve as input to identify best practices regarding the definition of strategies to foster sharing and knowledge management in agile teams. In addition, the results will be compared to the results presented by research with practitioners, such as the annual report proposed by Version One (20). Allowing the identification of gaps in the use of certain practices and methodologies, this could serve as base for the development of future research.

The goal of the first research question (RQ1) is to identify which are most discussed organizational learning theories in literature related to agile methodologies. Thus,

we can identify which practices and agile methodologies support the steps provided for the creation of organizational knowledge. Consequently, the answers obtained may indicate if the agile methodologies, and practices provided by these methodologies, assist the organizational learning process, defining a relationship between the organizational learning theories and agile methods.

The second research question (RQ2) seeks to identify which are strategies for knowledge management most used by agile teams as mechanisms to knowledge sharing. The solutions to this issue may serve as a basis to understand which strategies support the knowledge sharing among agile team members. In addition, we will compare the results with the findings presented in the studies described in chapter 3 of this material.

The last research question (RQ3) aims to identify how the use of methods and agile practices affects the transmission of knowledge within the organization, considering individual level, group level and organizational level and understand which practices affect more the transmission of knowledge for each level. Thus, the objective of this research question is to assess whether the knowledge produced is disseminated in the organization in order to benefit the organization and promote advantages through the use of this knowledge.

2.3.2 Search Strategy

We conduct a search process in electronic databases to locate the relevant work to the study. The strategy to recover studies belongs to the SLR conduction phase and we divided it in the following steps, which are: (1) definition of terms and preparation of the search string, (2) definition of electronic databases, and (3) definition of the criteria for inclusion and exclusion of material.

2.3.2.1 Search Terms

The definition of the search terms was based on the objectives of this work. The basis for the definition of search terms was composed of two pillars: "agile" and "knowledge management", since the main objective of this study is to identify the aspects of knowledge management in the agile methodologies context.

Thus, combinations were made of the term "agile" with the terms "method", "methodologies" and "practices", in addition to the use of the names of the main agile methodologies (20). In the same manner, the "knowledge" expression was combined with terms such as "sharing", "create" and "management" in addition to the use of "Organizational Learning".

The search expression used in electronic databases is the result of the conjunction of these combinations, as shown in Table 5.

Table 5: Keywords for data retrieval.
Source: Elaborated by the author.

Agile Methods keywords		Knowledge management keywords
agile method OR agile methodology OR agile development OR agile approach OR XP OR Scrum OR Kanban OR Lean OR FDD OR Feature Driven Development	AND	knowledge management OR knowledge create OR knowledge share OR knowledge discovery OR knowledge application OR organization learning OR knowledge management strategy OR knowledge management process OR knowledge management approach

2.3.2.2 Data Retrieval

We recovered relevant studies to this research using the terms defined in the previous section on the chosen electronic libraries (Table 6). The found files and their metadata were stored in a tool for bibliography management called Zotero[1]. The electronic databases were chosen following the Kitchenham recommendations (33), which points these libraries as a reference in the publication of studies related to software engineering. These electronic libraries are presented in Table 6 as well as the dates on which the searches were processed and the total number of articles obtained in each base.

Table 6: Digital libraries researched.
Source: Elaborated by the author.

Digital Library	Date of search	Hits
ACM Digital Library	February 5, 2016	133
IEEE Xplore	February 6, 2016	233
Science Direct	February 6, 2016	60
Springer Link	February 7, 2016	88
Wiley	February 7, 2016	28
	Total:	**542**

2.3.2.3 Selection Criteria

After the identification and recovery of articles through the application of keywords on the described databases, it was required the evaluation of these studies in order to determine which would be relevant to the proposed revision. This evaluation was performed using a set of criteria discussed and agreed between authors to the selection of materials. These criteria are described in the systematic review protocol, and were developed based on the research questions and objectives (68, 66). Each of the studies retrieved from the databases were assessed following these criterias, present in Table 7.

[1] Available at https://www.zotero.org/download/.

Table 7: Inclusion and exclusion criteria for papers selection.
Source: Elaborated by the author.

ID	Type	Criteria
C01	Inclusion	Articles describing the use of methods and agile practices and establish relationship between this subject and knowledge management, knowledge creation, knowledge sharing or organizational learning theories.
C02	Inclusion	Study that presents the use of traditional software methodology but uses agile practices in their experiments as knowledge management mechanisms.
C03	Inclusion	Articles published since 2001, because it is the year of publication of the Agile Manifesto. Therefore, previous work is unlikely to mention terms such as "Agile" and "Agile Methodologies".
C04	Inclusion	Articles published on journals or conferences related to computer science, software development, education in computer sciences, software engineering and knowledge management.
C05	Exclusion	Books, book chapter, thesis, prefaces, article summaries, interviews and reviews.
C06	Exclusion	Studies that not contemplate agile practices neither agile methods.
C07	Exclusion	Studies that not contemplate knowledge management and organizational learning.
C08	Exclusion	Studies that not establish relationship between agile and knowledge management.
C09	Exclusion	Duplicate studies found in digital libraries.
C10	Exclusion	Secondary studies such as Systematic Lireture Reviews (SLR).

2.3.3 Screening of Papers

Screening of papers was done in six steps conducted by first and second author. Step 1 of the study selection process included the search for materials in electronic databases, resulting in 542 articles, as shown in Table 8.

Table 8: Screening of papers.
Source: Elaborated by the author.

Step	Action / Selection Criteria	Results	%
1	Search results	542	100%
2	Remove duplicates - Selection criteria 9 (C09)	485	89%
3	Filter by publication date, type of article and type of publication - Selection criteria 3 and 5 (C03 and C05)	422	78%
4	Filter by article title - All of selection criteria	194	36%
5	Filter by article abstract - All of selection criteria	55	10%
6	Full read - All of selection criteria	39	7%

In Step 2, duplicate work was removed (selection criterion C09). This removal was accomplished in two steps. First with the help of the tool Zotero identify studies with the same title, author and place of release. Then, the authors assessed manually possible remaining duplicates that were not identified by Zotero. At the end of this stage 485 papers remained, which corresponds to 89% of the total retrieved in Step 1.

Step 3 was performed by first author and corresponds to the application of the filter indicating the study's publication date, in addition to applying the filter by type of publication (selection criteria C03 and C05). We removed the papers published before

2001, as provided in selection criterion C03. At the end of this stage 422 studies remained, which corresponds to 78% of the total described in Step 1.

The evaluation of the articles' titles was conducted in Step 4, applying all the defined selection criteria. The authors evaluated the titles independently classifying the studies into three categories to allow them to be moved to the step: Yes, No and Maybe. The study identified as "Yes" were those who established compliance with all criteria and should certainly move on to the next evaluation stage. The work classified as "No" clearly contravened one or more selection criteria. The studies labeled in the "Maybe" did not allow the clear identification of any selection criteria and therefore should be included in the next step so a more detailed assessment could performed.

After the assessment of the titles, the results of the two authors were confronted with the objective to review and make a reliable classification. For each of the cases where there was disagreement in the classification of the study, the authors discussed until a consensus was established. At the end of this stage 194 articles remained, corresponding to 36% of all studies obtained in Step 1.

The last stage of the study selection process before full reading (step 5) included the assessment of articles' abstracts, based on all the defined selection criteria. The authors carried out step 5 following the same classification established in Step 4. The articles' abstracts were evaluated and studies classified as "Yes", "No" or "Maybe". In similar way to Step 4, the authors evaluated the articles independently. At the end of the evaluation, the results were compared in order to establish agreement among all the authors for the classification of all studies. This step resulted in the identification of 55 studies that followed to the next stage, to a full reading and classification. The total number of articles resulting from this step corresponds to approximately 10% of the total retrieved in Step 1.

The full reading stage of the work (Step 6) was carried out by the authors, with the all selection criteria in mind. The end number selected of articles for data extraction, after the full read was 39, resulting in 7% of the total described in Step 1.

2.3.4 Data Extraction

During the step of full reading articles, the information listed in Table 9 was extracted from each paper. This information corresponds to the classification categories that were defined in the review protocol in terms of research questions and the established objectives. Each of these categories will be present in the next section 2.3.5.

The extraction of these data was performed by authors, similarly to steps 4 and 5 described in screening papers section. Thus, each author proceeded with extraction of the data independently. After completes, the authors confronted the classification performed.

Table 9: Extracted data
Source: Elaborated by the author.

Group	**Name**
Agile	Agile methodologies Agile practices
Knowledge management	Knowledge management strategy Organizational learning theory Organizational learning level
Research	Empirical study type Research types
Generic	Publication year Source (publisher) Author's country

Where there was divergence in the classification, the authors discussed the divergent matter to reach a consensus on the classification.

2.3.5 Classification

The studies identified as relevant to the purpose of this review were classified according to the following categories: (1) agile methodologies, (2) agile practices, (3) strategies adopted to knowledge management, (4) theory to the addressed organizational learning (5) achieved learning level, (6) empirical study type and (7) research type. It is noteworthy that each of classified studies may appear in more than one item in the described categories. Thus, a particular study may have more than one agile methodology and more than one kind of knowledge management strategy.

For classification of agile methodologies, we used the list of methods identified by Version One (20) as the most popular among software engineering professionals, as follows: Agile Modeling, Agile Unified Process (AgileUP), Custom Hybrid (multiple methodologies), DSDM/Atern, Feature-Driven Development (FDD), Iterative Development, Kanban, Lean Development, Scrum, Scrum/XP Hybrid, Scrumban and eXtreme Programming (XP). The classification is “Unknown" for cases where it is not possible to identify the methodology used. The description of other methods, which are included in the list above, is "Other".

Regarding agile practices, the most popular practices pointed out by Version One (20) will be used as items for classification: agile games, automated acceptance testing, Behavior-Driven Development (BDD), coding standards, collective code ownership, continuous deployment, continuous integration, daily standup, dedicated product owner, iteration planning, iteration reviews, kanban, open work area, pair programming, prioritized backlogs, refactoring, release planning, retrospectives, short iterations, single team (integrated dev & testing), story mapping, task board, team-based estimation, Test-Driven Development (TDD) and unit testing.

We use knowledge management strategies described by Michael Earl (34) to classification this category. Thus, the items in this category are subdivided into three groups: (1) Technocratic Schools, (2) Economic School and (3) Behavioral Schools. The technocratic group consists of three schools (systems, cartographic and engineering). The economic group is formed by a single school (economic and commercial). Like the technocratic schools, behavioral group consists of three schools (organizational, spatial and strategic). Strategies from different schools can be combined and implemented in an organization in order to get the best benefits of knowledge management. Thus, studies evaluated in this review can be classified in more than one school at the same time.

For the classification of organizational learning theory, it was adopted more theories described in the literature in the context of software engineering (56). The adopted theories for classification in this category are: (1) single-loop and double-loop theory described by Argyris and Schon (57), (2) experiential learning theory proposed by Kolb (58), (3) SECI model proposed by Nonaka and Takeuchi (59) and (4) communities of practice described by Wenger (60).

The achieved learning level was classified into three items: individual, group and organizational level (54, 22). Individual level is understood as the creation and application of knowledge by a single individual in the exercise of their daily activities. For this knowledge reaches the group level, this knowledge needs to be shared, generating other knowledge sources. However, so that the organizational level is reached it is necessary that the knowledge generated by an individual and shared with a group to be institutionalized in the form of a process, product or service. Thus, the organizational level will be achieved if knowledge is applied in order to change the organization's behavior.

Regarding the empirical study type, the classification was performed as defined by Tonella *et al.* (69). Thus, the items used were: experiment, observational study, experience report, case study and systematic review. Table 10 presents the definition of these items. However, because it is a systematic literature review, only primary studies were included in the evaluation as guidelines Kitchenham *et al.* (65). Thus, none systematic literature review was contemplated in this review.

The research types used are shown in Table 11 and follow the recommendation of Wieringa *et al.* (70). Thus, this category presents the items: validation research, evaluation research, solution proposal, philosophical papers, opinion papers, experience papers.

2.4 Results

Based on the data extraction from the 39 papers evaluated, we identified that the common agile methodologies in the context of knowledge management are XP with 17 articles (44%) and Scrum with 15 articles (38%). On one hand, the result is in conformity

Table 10: Empricial study types.
Source: Tonella *et al.* (69).

Type	Description
Experiment	Controlled study to observe the outcomes and the factors involved on it. Requires observation of multiple cases.
Observational Study	Gathers information to connect factors and effect variables. It is not controlled and requires observation of multiple cases. Normally is applied as a survey to collect data to be observed.
Experience Report	Analysis of one case and there is no controlled context. The goal is to describe the success of the proposed/adopted technique and setup, data collection and analysis are not discussed in details.
Case Study	Analysis of one case and setup, data collection and analysis are discussed in details.
Systematic Review	Selects cases of the topic of interest studied in the past for evaluation and interpretation.

Table 11: Research types.
Source: Wieringa *et al.* (70).

Type	Description
Validation Research	Investigates proposed techniques not yet implemented using a strong research method. The technique may have been proposed on a different paper and by any author.
Evaluation Research	Involves the practical investigation or implementation of a technique. Normally results in a new knowledge claim around the studied phenomena and that claim should be evaluated on the research.
Solution Proposal	Presents a technique, normally a novel or an improvement of an existing technique, and justifies its relevance. It is not necessary to completely implement the technique but a proof of concept could be presented.
Philosophical Papers	Conceptual frameworks or a new point of view on existing techniques or approaches.
Opinion Papers	Personal opinion of the authors about a technique highlighting the advantages and disadvantages of it. Not supported by related work and research methods.
Experience Papers	Relates author's experience on implementation and practical use of techniques. Should contain the lessons learned from the experience.

with the Version One report (20), presenting Scrum as one of the most used agile methodology. On the other hand, there is divergence regarding the use of XP methodology that is used by only 1% of the practitioners (20). In the analyzed papers, XP appears as the most adopted agile method regarding the creation and knowledge sharing on agile teams.

Regarding the use of agile practices, our research showed that the most adopted practices as mechanisms to facilitate the creation and knowledge sharing are: daily standup (21 articles), pair programming (18 articles), short iterations (17 articles), iteration planning (17 articles) and retrospectives (12 articles). We found that practices provided by different methods are used at the same time by teams suggesting a method customization as pointed out by Campanelli and Parreiras (71). Table 12 describes agile practices adoption in the analyzed papers. Part of the results of agile practices adoption as knowledge management mechanisms converge with agile practices adoption by practitioners in the

Version One report (20). Version One presents daily standup as the agile practice most used on day-by-day of agile teams. Our results demonstrate that in knowledge management context daily standup is most used agile practice as knowledge sharing mechanisms between agile teams members. The main difference between our research and the Version One report is the use of pair programming. Version One (20) shows that pair programming is used by only 1% of agile practitioners. However, we found that 46% of analized papers use pair programming as knowledge sharing strategy.

Table 12: Most adopted agile practices.
Source: Elaborated by the author.

#	Research in Knowledge Management	Practitioners (20)
1	Daily standup	Daily standup
2	Pair programming	Short iterations
3	Short iterations	Prioritized backlogs
4	Iteration planning	Iteration planning
5	Retrospectives	Retrospectives

As part of the objectives of this review, we assessed the articles based on research aspects, such as empirical study types and research types (see section 2.3.5). Empirical studies were used in 79.5% of the articles. It suggests that research on knowledge management and agile is mature. The main empirical type is case studies with 16 articles (41%). In addition, we find eight observational studies (20.5%) and seven experience papers (18%) that presented agile practices adoption as mechanisms to promote knowledge management. We could not identify the empirical research type on eight articles (20.5%). Because of it, we classify then as "unknown". Our results show that the major part of studies (82%) are philosophical papers and experience papers. Philosophical papers dominates the research types with 17 articles (44%) while 15 articles (38%) are experience papers. While the empirical research type indicator suggests that research in knowledge management and agile methods is mature, the research types points out that we need more research that produce more applicable results such as solution proposals, evaluations and validations. Figure 1 shows the research type used to explain agile practices adoption. We could not find any occurrence of validation research and, because of it, this research type was hidden in figure 1.

2.4.1 RQ1 - Which organizational learning theories are most addressed in agile studies and what is the relationship between these theories and the methods and agile practices?

The research question RQ1 goal is to demonstrate which are the most discussed organizational learning theories in the context of agile methodologies, and identify how these theories are relate to agile methods and practices. Thus, we identified that the

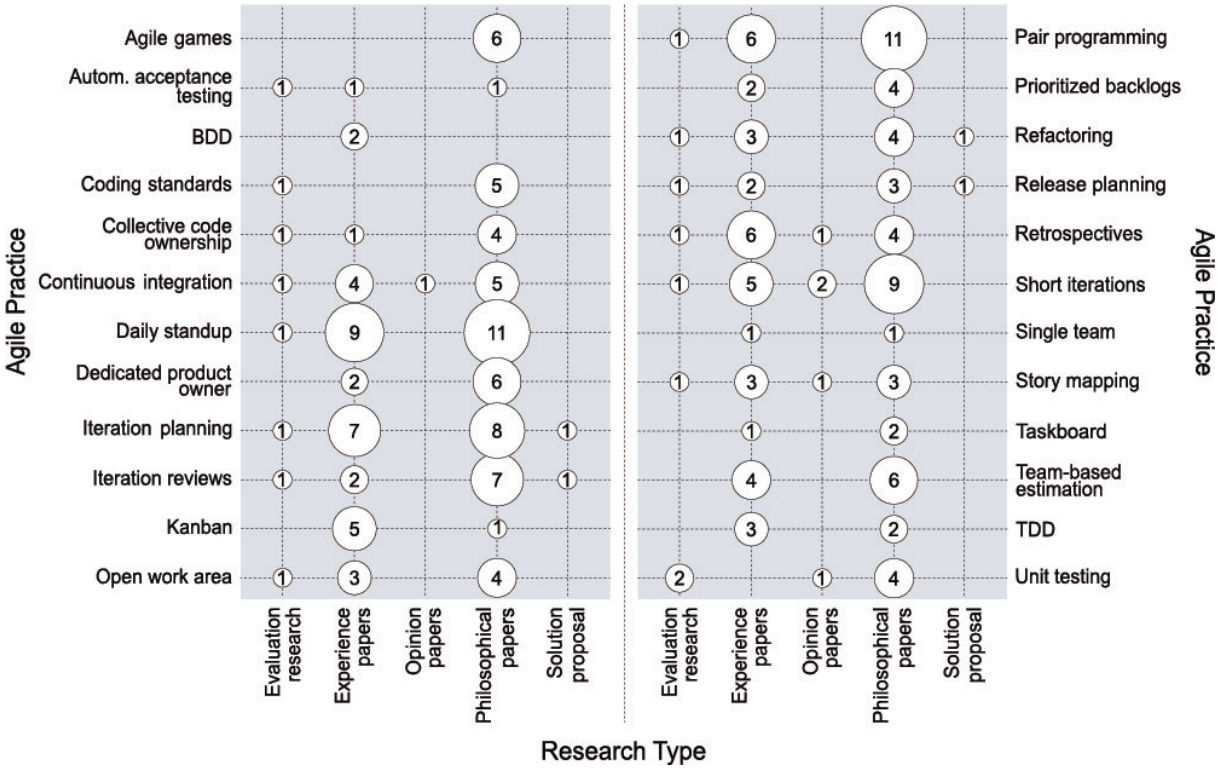

Figure 1: Research type used to explain agile practices adoption.
Source: Elaborated by the author.

most discussed theories are communities of practice (23%), the SECI model (21%) and the experiential learning theory (21%). The results presented in Table 13 show that 12 studies evaluated (30%) did not provide information to allow the identification of the organizational learning theory. The 5A model (72), although not a part of the classification provided in this review, was cited in two of the studies that uses communities of practice (5%). We also found two studies (5%) that addressed the use of communities of practice and SECI model in conjunction. In this case, we classify these studies in both theories.

Table 13: OL Theories results.
Source: Elaborated by the author.

OL Theory	Number of articles	Percentage (%)
Comunity of Practice	9	23
SECI	8	21
Experimential Learning	8	21
Double-loop Theory	4	10
Unknown	12	30

When evaluating the results obtained based in the theories of organizational learning in the context of agile methodologies, we identified the alignment between the use of communities of practice and XP adoption. We identified six studies addressing the use of communities of practice alongside XP methodology and four more studies that use communities of practice in conjunction with Scrum (Figure 2). The usage of communities

of practice allows face-to-face communication and enables knowledge sharing. In case of the SECI model, the use of methodologies such as Scrum and XP that provide practices as daily standups, pair programming and planning meetings encourages socialization.

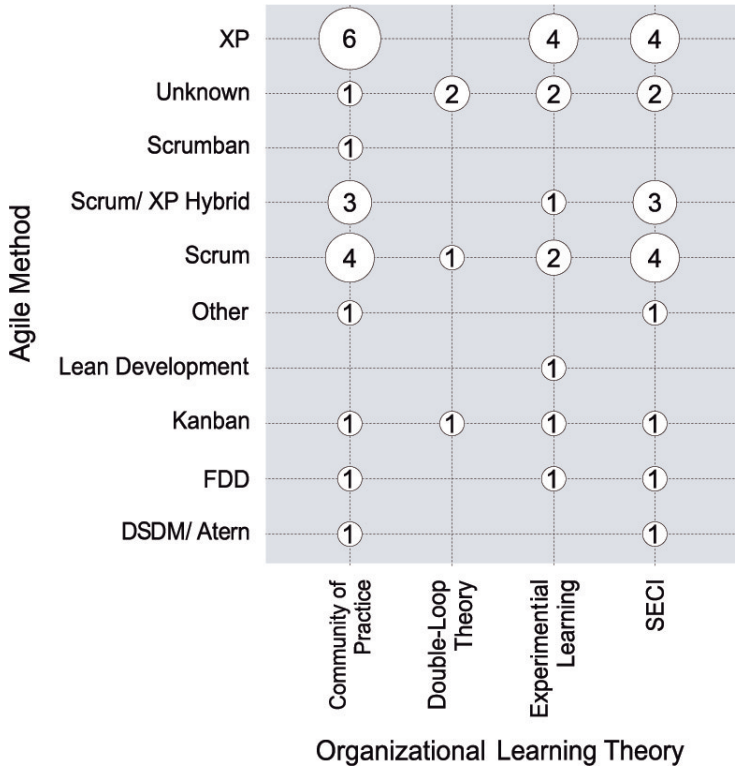

Figure 2: OL theories applied on agile methods context.
Source: Elaborated by the author.

In this sense, the adoption of agile practices maintains compliance with procedures laid down by the theories of organizational learning. The daily standups produce a moment of socialization, supporting part of the SECI model (six articles) and allow a community of practice to share knowledge about the team and about the progress of the project (four articles), as well as allowing individuals to absorb the experiences of others, enabling new experiments based on these past experiences and promote experimental learning (four artigos). In Figure 3 we show the agile practices used in the evaluated papers as mechanisms to support the organizational learning theories .

The use of pair programming practice is one of the main mechanisms for knowledge sharing according to the analyzed articles. Pair programming allows socialization and internalization (SECI) of knowledge by individuals, allows the sharing of knowledge and the discussion of problems of common interest (communities of practice) and enables learning based on previous experience of the pair that works together (experimental learning).

Short interactions allow constantly reflection on the work produced because the team can perform a retrospective at the end of each iteration. Thus, retrospectives allow

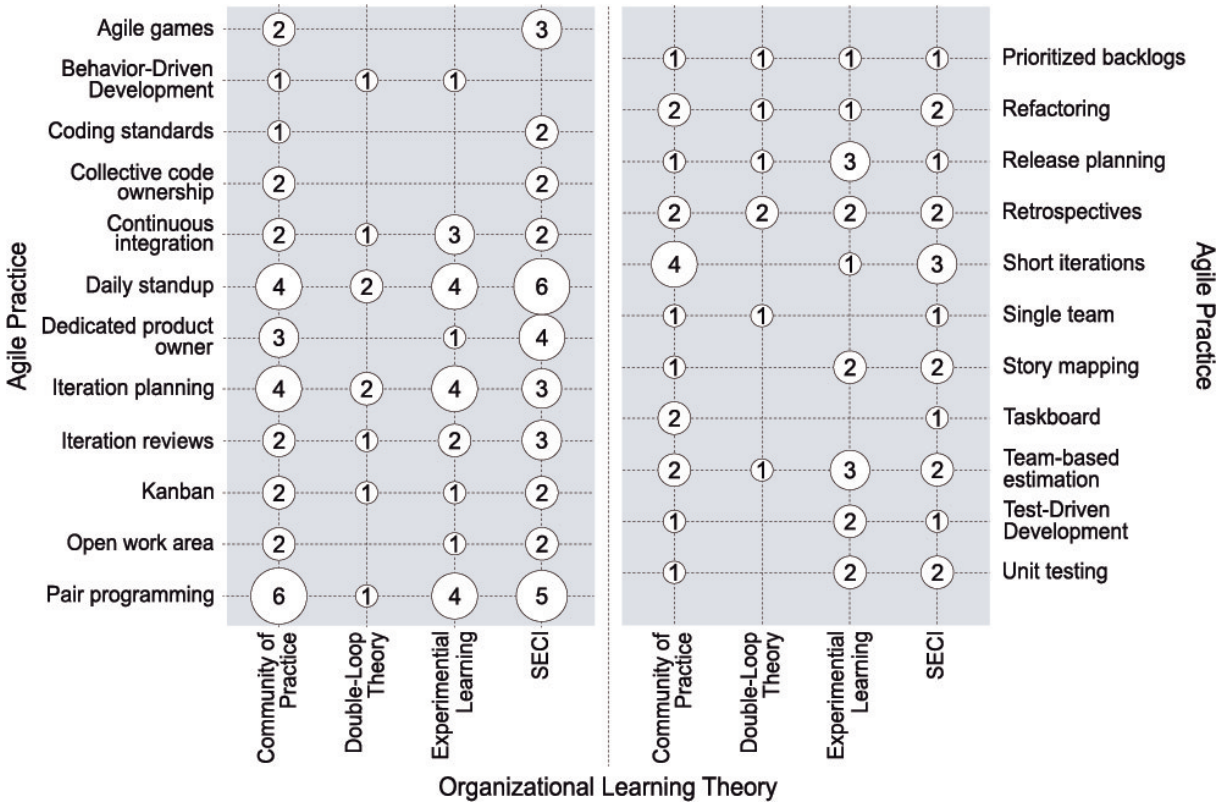

Figure 3: Agile practices adopted to support OL theories phases.
Source: Elaborated by the author.

the team to reflect on the work done during the iteration, supporting the double-loop (73). The results of this review suggest two pieces of evidence of the use of retrospectives as a strategy for the promotion of double-loop.

Combination of short iterations and dedicated product owner practices support different processes of organizational learning theories. At each iteration, the client can evaluate a piece of functional software. During the assessment, knowledge about the new features will be produced, internalized and combined (SECI) with the knowledge obtained in previous iterations. This will enable the client make reflections (double-loop) and produce new insights about the software based on its previous experiences (experimental learning). This new knowledge will be shared with the developer team (communities of practice), producing new knowledge that can be externalized (SECI) and applied to new requirements demanded for the software.

Iteration reviews and planning meetings are practices founds in studies that adopt all organizational learning theories presented. During a meeting to review the iteration and during the iteration planning the team socialize the knowledge, combine this knowledge with the knowledge acquired in other iterations and document it into technical artifacts such as story mappings. In addition, these meetings allow discussions about the work done to date, enabling the alignment of expectations and defining future task strategies.

2.4.2 RQ2 - Which knowledge management strategies are most adopted by organizations in agile context?

The research question RQ2 aims identify which are knowledge management strategies most adopted in agile context. The results of this review indicated that the strategies of behavioral schools are the most used by agile teams of software development. We have identified that 34 articles (87%) use behavioral strategies and 20 articles (51%) use the strategies provided by at least one of the technocratic schools. Regarding the economic school, we could not identify any studies that addressed the use of strategies provided by this school, according to the results presented in (28) and (64).

Organizational school is one of behavioral schools and we identified 34 articles (87%) indicating the use of organizational strategies. This is mainly due to the alignment between the agile principles and the nature of the organizational school strategies. Thus, the organizational school depends on the relationships established between individuals and communication between them, as well as the principles that guide agile methodologies.

Moreover, we found 14 studies (36%) that address the strategies of spatial school in conjunction of organizational strategies. Therefore, agile teams use space as a facilitating mechanism for knowledge sharing. The spatial knowledge is a social knowledge and allows the use of other knowledge management strategies in conjunction with the environment in which the team is allocated (21). This result is opposite to (64) that pointed out no evidence of the use of spatial strategies in software engineering process. We could not find any articles that use strategic school in the context of agile methodologies.

Among technocratic schools, the main strategy in agile context is provided by systems school. We found 17 articles (44%) that use strategies of systems school. This is mainly due to the use of wikis as knowledge repositories specially in distributed teams who need that knowledge is encoded and storage in repositories to allow knowledge recovery in cases in which team members work geographically distributed and with different time zones (44). Six articles (15%) addressed the engineering school, while three articles (7%) have cartographic school strategies

The use of agile practices support adopting knowledge management strategies provided by KM schools described by Earl (34), since the use of agile practices collaborates with the transmission and sharing of knowledge (2). Figure 4 shows the most adopted agile practices and the strategy for knowledge management. Because there are no results for the commercial and strategic schools, the data on these schools were removed from the chart.

In the organizational school context, the most used practices are those where there is a strong interaction between individuals. This is due to the fact that the strategy of

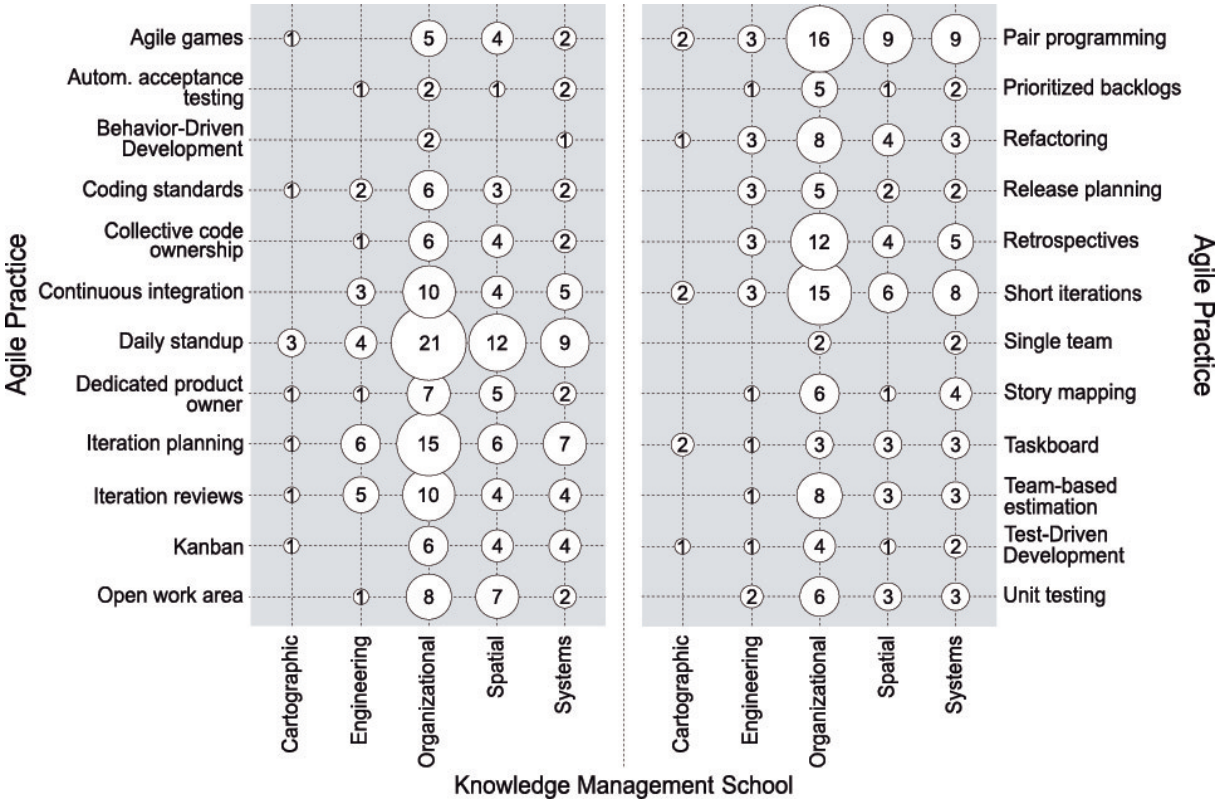

Figure 4: Agile practices adopted to aid KM strategies.
Source: Elaborated by the author.

this school is based on the social structure of the company and depends on the interaction between individuals to share knowledge. Daily standups, pair programming and iteration planning were the most identified in analyzed articles that use the organizational strategy for knowledge management.

As for spatial schools, open work area, kanban and taskboard are common practices among teams. In addition, the adequacy of the environment is a spatial strategy that facilitates the realization of pair programming and daily standups, because the position of members in the workplace facilitates the implementation of these practices and promotes direct communication between individuals.

Regarding to technocratic schools, systems school relies on the use of repositories for storing the coded knowledge. We have identified this strategy in the evaluated studies, since different teams use wikis and intranets as knowledge repositories. It is present specially in distributed teams. However, these same teams use other practices such as daily standups and pair programming with the help of communication tools and collaborative work.

Cartographic school is strongly based on the personalization strategy (8), but it depends on technology to maintain the mappings that link which individuals holding certain knowledge. Regarding the use of agile practices daily standup is common used

as a strategy to allow team members know each other and identify the skills of each individual. None of the reviewed articles pointed out the use of technologies or specific systems to knowledge mapping . However, distributed teams require the use of communication technologies to perform daily standups, iteration review and other meetings-based practices.

The teams that adopt engineering school strategies use the ceremonies planned in the process (daily standup, review iteration, iteration planning and retrospectives) to ensure that the necessary knowledge to reach the people who need this knowledge. Because it is a technocratic school, engineering school depends on the technology. Therefore, the compliance process by distributed teams depend on the use of information technologies such as video conferencing, instant messaging tools, collaborative editing tools to ensure that the ceremonies take place and that knowledge will be available to individuals.

2.4.3 RQ3 - Which agile practices and knowledge management strategies are most used to promote the individual knowledge at the organizational level?

The intention of research question RQ3 is identify which are agile practices and knowledge management strategies used to promote knowledge in different organizational levels. The 39 studies evaluated in this review addressed knowledge creation by individuals involved in the process and 27 studies (69%) addressed knowledge creation at the group level. However, evaluated studies provided no evidence to permit the conclusion that the knowledge created by agile teams reached the organizational level. None of the studies assessed described the institutionalization of practices, processes, creation of new products and services or the change in organization behavior due to a knowledge produced by the teams.

Nonaka and Konno (54) state that during the stages of internalization and socialization provided by the SECI model knowledge is institutionalized and reaches the organizational level. However, we have not identified evidence of knowledge institutionalization in the reviewed articles. Similarly, Wenger (61) describes that the use of communities of practice generates benefits for the organization and contributes to knowledge sharing throughout the company. However, it was not possible to identify evidence that would point the production of knowledge at the organizational level in the analyzed articles using communities of practice. These results confirm that learning in the agile process only reaches the group level, because the knowledge is retained at the project level and the team as occurs in software engineering in general (11, 3, 26).

The use of agile practices favor the production and knowledge sharing, but only the use of such practices does not provide mechanisms to institutionalize the knowledge

produced. Figure 5 shows the agile practices adopted by the teams and the organizational learning level achieved due to the use of such practices.

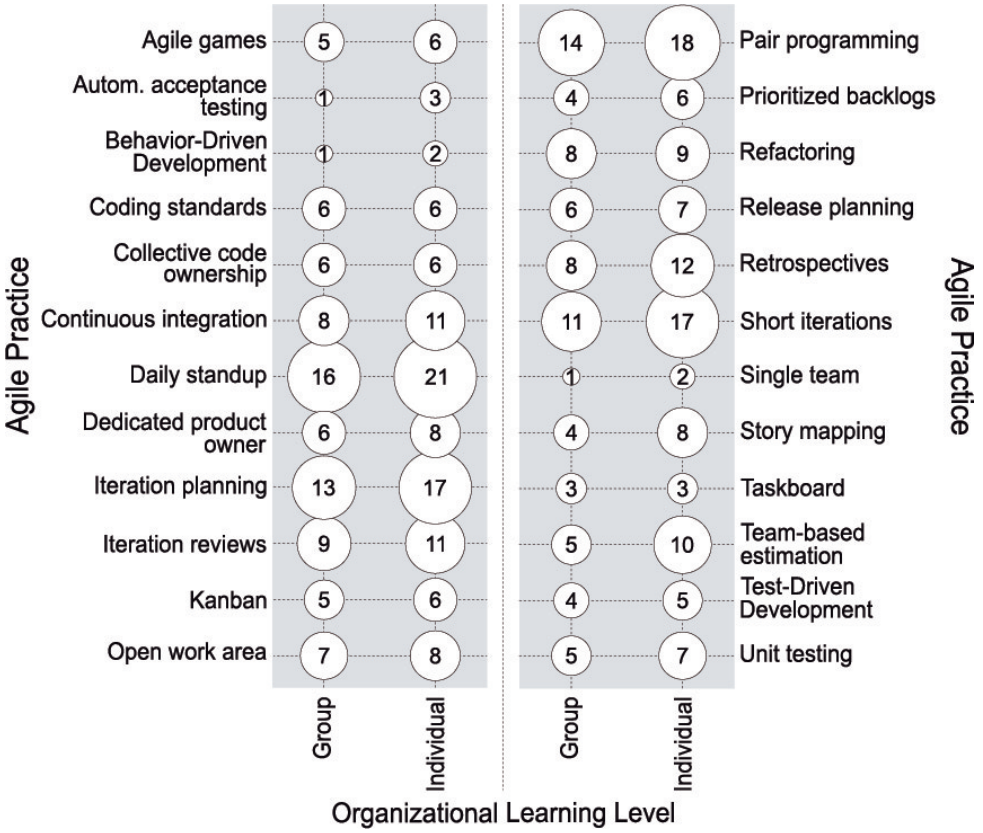

Figure 5: Agile practices and organizational learning level.
Source: Elaborated by the author.

Daily standup, iteration planning, release planning, iteration reviews and retrospectives assist the production of individual knowledge, since individuals learn from experiences and knowledge that are shared during meetings. Moreover, these practices allow the sharing and discussion among team members. Thus, there is the creation of a common understanding among team members, making the individual knowledge becomes a collective knowledge, which promotes this knowledge to the group level.

The pair programming practice provides the interaction between individuals, fostering the creation and knowledge sharing. Thus, individual knowledge is produced while work is done and knowledge is shared among those involved in the task. When combined with the pair rotation technique, pair programming helps promote knowledge at the group level, since the pairs will change and the knowledge produced will be disseminated among the team and produce a common understanding on agile team.

The combination of dedicated product owner, team-based estimation, story mapping and short iteractions generates a stream of production and knowledge sharing. The use of short iterations allow the team meets regularly to assess the progress of the work

and discuss the proposed solutions. At each iteration, the customer demand new requirements that are described in user stories that will be evaluated and discussed by the team. At this time, individual knowledge is shared with the rest of the team and produces a discussion leading to a consensus and a common understanding of the team, both on the process and on the technology used.

Practices such as refactoring and continuous integration produce a flow of knowledge creation that begins with the individual and reaches the group level. By using the practice of refactoring the individual will reflect on the work produced and produce a new individual knowledge. The results of this refactoring, as well as other artifacts produced by the individual will be integrated with the artifacts provided by other team members. Thus, the knowledge produced by team members is combined and disseminated among individuals. Continuous integration allows knowledge combination and storing in repositories, suggesting intitucionalização this knowledge. However, we could not find no evidence that point the transmission of this knowledge to other teams in the organization. Thus, the knowledge produced by the teams was held at the project and group level.

As part of this research question objective, we analized the knowledge management strategies used to promote knowledge in different organizational levels. We identified that strategies used in agile teams reach only individual and group level. We could not find any paper that present evidences that allow us to conclude that knowledge reached the organizational level. Figure 6 shows the results regarding knowledge management strategies as mechanisms to reach organizational levels.

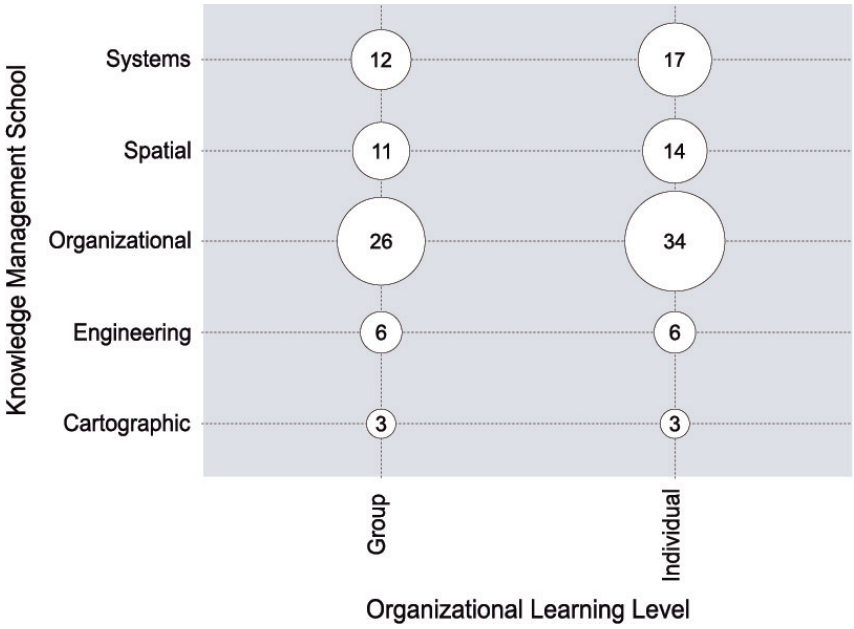

Figure 6: Agile practices and organizational learning level.
Source: Elaborated by the author.

In agile context the main strategies are provided by organizational school. In this sense, we found that organizational strategies are most used to create knowledge in individual level with 34 papers (87%). We found these same strategies as mechanisms to disseminate knowledge at the group level in 26 studies (67%). Spatial strategies are used in 14 articles (36%) as mechanisms to support individual knowledge creation. These strategies were found in 11 papers (28%) where knowledge achieved the group level. System school is the most evident technocratic school in agile teams. This evidence is mainly due to distributed teams. Despite codification and knowledge storage in form of documents and tecnical artifacts is one way to achieve organizational level (32, 54, 18) we found that in agile context this strategy is used to share knowledge between team members and don't achieve the organization as a whole.

2.5 Threats to validity

To ensure the study validity is necessary to identify the possible factors that can affect the accuracy and reliability of the results (44). In our case, because it is a secondary study, the main threat is related to the recovery of relevant studies to our research. In this sense, we can highlight two possible threats. The first risk is related to the identification and use of electronic libraries that have relevant studies to our work. To minimize this risk, we use the bases suggested by Kitchenham (33), that argues these bases as a reference in the publication of studies related to software engineering (see section 2.3.2.2).

The second risk is related to recovery of the studies in the chosen bases. To minimize this risk, we determined the possible keywords related to the two constructs that compose our goals and we also used the main synonyms, methods and theories related to these constructs to compose our search string. In addition, the two authors used the search string described in section 2.3.2.1 to perform searches on related bases autonomously. Upon completion of these searches, the results obtained by the authors were compared and validated. This validation showed that the results obtained by the authors were equal in all the bases, which indicates the possibility of reproducing this study.

Another possible threat is related to the papers screening. We discarded books and sections of books recovered during our search in agreement with the inclusion criteria and defined exclusion (see section 2.3.2.3). In addition, we evaluated the articles titles (see section 2.3.3) and we applied the inclusion or exclusion criteria. This step of filtering based on titles produces the risk of excluding relevant articles to our study. To minimize this risk the two authors preceded the evaluation of titles independently and confronted the evaluations results. When it was not possible determine from the title if the article were relevant to our study we adopted the strategy of keeping the article and carry out further evaluation.

One last identified threat is related to research aspects that we used to classify the articles. There are different taxonomies to classify research aspects. To minimize the risk of ambiguities and allow reproduction of our study, we classified the research aspects based on taxonomies proposed by Wieringa *et al.* (70) and Tonella *et al.* (69) (see section 2.3.5).

2.6 Conclusion

This study summarized the literature regarding knowledge management in software engineering, specially in agile methods context. We reach 39 studies that were analyzed and the extracted data were classified into categories focusing on research aspects (research type), knowledge management aspects (KM Schools, OL theories and OL level) and agile context aspects (agile methods and agile practices).

Research on knowledge management and agile methods can be considered mature, since we found 79.5% empirical studies. That is a fact that the major part of these articles (82%) are philosophical papers and experience papers. This suggests that literature is poor in generalist models and evaluation studies. We find only two studies with solution proposals and two studies that make evaluations. But we could not find validation researches.

XP is the most agile method used in knowledge management context, followed by Scrum. However, we find practices of different methods in use at the same time suggesting a method customization as pointed out by Campanelli and Parreiras (71). In this sense, the main practices used as knowledge sharing mechanism are daily standup, pair programming, iteration planning, iteration reviews and retrospectives supported by short iterations. It presents convergence with practitioner reports, except by pair programming that is a practice used as knowledge management mechanism but is not practice used on day-by-day for many practitioners (20).

We analyzed the main organizational learning theories used by agile teams and we conclude that theories presented by Menolli, Reinehr and Malucelli (56) are the main stream in agile context, as well as pointed out in a general software engineering context. Communities of practice and the SECI model are the main theories approached in agile studies. Our results show an alignment between the use of communities of practice and XP adoption. Regarding to strategies taken for knowledge management in agile teams, we find that organizational school's strategies are common in agile context but systems school's strategies are present too, mainly in distributed teams that need encoded knowledge for later recovery.

Although agile practices provide a knowledge management mechanism and we found evidences of organizational learning theories in the analyzed papers we could not

conclude that knowledge has reached all levels of organizational learning. As pointed out by Hoda, Babb and NørbJerg (11) and Babb, Hoda and NørbJerg (73) we found studies that show creation and knowledge sharing in project and team scope but it's impossible determine that knowledge created was institutionalized and change organization behavior. In this sense, more studies are needed to determine how strategies are needed to promote knowledge sharing in all organizational levels.

The contributions of this study are syntheses of knowledge management in agile context summarizing the research aspects about this area. We describe limitations on the literature that can be followed by researchers interested in proposing new approaches and also provide initial guidance for organizations on how start their strategies to better manage their knowledge creation and knowledge sharing in agile teams. Currently we are working on a model for knowledge management in agile companies based on the results of the literature review.

3 Related work

Software development is an intense knowledge activity in which the individuals involved need to have specific skills that enables the design and construction of applications demanded by the clients (5). Therefore, is necessary that the organization's knowledge been available to the right people to performing its activities (23).

The correct distribution of information between the members of a software development team is a differentiating factor for the organization, since less time is wasted in finding solutions to previously solved problems (7). Thus, the success of a software project depends on the knowledge available in the members who make up the teams (1), since the individuals will need knowledge regarding the methodology used, the context for which the software is intended and which technologies are adopted (3).

However, the management of production and knowledge transfer is a challenge for companies operating in the software development sector (3). Besides the natural difficulty in mapping and managing the knowledge available in the organization, the scenario of the information technology organizations is compounded by the highly dynamic nature of the sector, either from the perspective of the volatility of the demands presented by customers, whether from the perspective of technological changes which software products are subjected (9, 10). In addition, companies operating in the IT landscape are dependent on the knowledge of which they possess, and most of that knowledge is available tacitly (5).

In this sense, we found related works to our review that aims to identify the knowledge management in agile context. The main study related to our research was proposed by Bjørnson and Dingsøyr (28). These authors present a systematic literature review that identifies the knowledge management strategies used in software engineering context without a focus on types of methods or software process. The authors found that the majority of publications in this area are lessons learned reports. Case studies are the main type of empirical studies. Regarding knowledge management strategies, this study uses Earl's taxonomy (34) and shows that technocratic schools are the main knowledge management strategies adopted in software engineering. Behavioral schools were presented as second strategy most used, but the authors did not find evidences of use the spatial school. Although there is not a focus on software process type, authors suggest that traditional methods rely on technocratic strategies while the agile methods are based on behavioral schools.

Another study is presented by Dingsøyr, Bjørnson and Shull (64). Their study presents a survey applied on 15 small and medium companies in Norway, Belgium, and

Cyprus. This study aims identify which knowledge management strategies are used by teams. To reach the objectives, the authors used a questionnaire that scored the companies on their current situation and how they imagined their future situation regarding knowledge management strategies. Authors used the taxonomy proposed by Earl (34) as knowledge management strategies and found the use of technocratic schools. The authors argue that system school promotes benefits to software process. Moreover, engineering school is mainly approached by lessons learned repositories and knowledge sharing occurs across projects in the company. In addition, the authors pointed out a gap in the literature and the need for further studies to evaluate the use and combination of other knowledge management schools, such as behavioral schools, in software teams.

Dorairaj, Noble and Malik (3) conducted a study on 28 companies, totaling 45 professionals aiming to identify how software organizations work regarding to knowledge management. The authors used the Prusak model that describes four processes for knowledge management: creation, storage, sharing and application. The results show that the knowledge creation occurs with customer collaboration, formal training and socialization among individuals. Storage occurs in wikis, forums and technical documents that are produced and used by individuals during formal training. Teams use practices such as daily meeting and pair programming as mechanisms for the knowledge share and the knowledge is applied when there are situations similar to those that have been experienced in other projects.

In India's telecom industry a survey with 28 companies conducted by Singh, Singh and Sharma (15) pointed out that 60% of interviewed believe that are positive relationship between agile practices adoption and knowledge management. Moreover, 50% of interviewed uses repositories to store codified knowledge, good practices and lessons learned but face-to-face communication prevalece in organizations as knowledge sharing mechanism.

According to Babb, Hoda and Nørbjerg (73), the use of short iterations causes the team acts on constant pressure, decreasing the possibilities of reflection and hence impacting on the learning process. For the authors, the main obstacle to learning is the pressure motivated by the need for constant deliveries. In these situations, the team sacrifices practices and activities, especially those related to lifelong learning, such as retrospectives. Based on this, the authors propose a model called Realm that integrates the practice of reflection to daily activities of the team.

Razzak and Ahmed (74) conducted a study that evaluated the knowledge management strategies used by agile teams that work distributed. The authors showed that between these teams technocratic strategies described by Earl (34) are more broadcasted, especially the use of systems school. Although agile teams draw on the direct communication and interpersonal relationships, the authors argue that distributed teams need

the codified knowledge and use of knowledge repositories to promote knowledge sharing between individuals.

Regarding to the use of spatial school strategies for knowledge management, Razzak, Ahmed and Smite (44) argue in their study that agile teams use strategies of organizational and spatial schools together. Even distributed teams use the environment as a tool for knowledge sharing. For the authors, in the distributed teams the use of repositories of knowledge and technocratic strategies prevail over the behavioral strategies only by limitations of investments in processes and technological tools.

4 Methods

4.1 Research Classification

This study is characterized as an applied research that will use a quantitative and descriptive approach. Applied research aims to generate knowledge from a practical application of the proposed solution (75). Thus, this study proposes a model that will be evaluated and the result will be the analysis of the impact caused by agile methodologies and practices adoption in the knowledge sharing process and organizational learning in software development companies.

The research is quantitative and includes data collection and measurement for the studied object or phenomenon (76). From the quantification of the collected data, statistical methods will be used to allow the data analysis aim at explaining the object or the observed phenomenon (76, 77). This type of research is widely used in organizational studies and is characterized by the ability to measure opinions, reactions and habits through simple or complex statistics techniques (78). Quantitative research is based on the data collection and analysis so that the application of statistical methods makes reliable and passive research generalizations (79).

Considering the objectives of the study, the research is classified as descriptive, because the study aims to find out the frequency that a certain phenomenon occurs, and to identify the relationship with other phenomena that appear in the same context (75, 79). Descriptive studies aim to discover the nature and characteristics of the phenomenon studied, correlating the facts without the intervention of the researcher (80, 81). A descriptive research is used to characterize actions and behaviors of a group from the use of standardized data collection tools such as survey questionnaires (77).

4.2 Population

Hair *et al.* (82) argues the research universe or research population is the number of elements that have a common set of characteristics. Vergara (83) defines the research universe as a set of elements that have the characteristics of the object of study. The research universe proposed by this study is made up of information technology (IT) professionals operating in the field of engineering and software development. These professionals need to know about agile methodologies for software development and meet the practices laid down by those methodologies.

4.3 Research procedures

The procedures adopted for the conduct of this study classify it as a bibliographical and survey research. A bibliographical research aims to review the literature related to the theme proposed in order to identify existing contributions to a particular subject, to evaluate proposals for specific problems and identify which areas can be explored because it allows the analysis of multiple approaches and helps to identify new methods (75).

A bibliographical research can be part of an experimental or descriptive research, because will assist the researcher in identification of related work to the proposed theme (80). The bibliographical research of this work was conducted in the form of a systematic literature review (see chapter 2) in order to identify which are the agile practices and methods used by software developer's teams as mechanisms to promote knowledge sharing. In addition, during the literature review were identified knowledge management strategies and approaches to organizational learning related to software development context.

Regarding to data collection, a survey questionnaire will be used. A survey research allows the researcher to obtain a detailed view of the subject studied from the data collection that will be mapped and quantified (84) and allows the researcher to obtain information directly with the interest group without the need to identify the respondent, guaranteed the anonymity of those involved in research and the preservation of confidentiality (81). A survey questionnaire is suitable for a standardized data collection (85) and allows the researcher to gather relevant information in order to get answers to the research hypotheses (86).

The data collection instrument will consist of single choice questions and the options will be based on the Likert scale of 5 points, as follows: 1. Disagree; 2. Disagree in part; 3. Neutral; 4. I agree in part; 5. Totally agree. The questionnaire will be sent to the target audience electronically. The use of electronic questionnaires allows flexibility for collection and data tabulation, because the consolidation and tabulation of these results is performed automatically (87). However, when using electronic questionnaire, researchers will be subject to the low percentage of responses obtained, related to the number of questionnaires sent (88). For this reason, printed questionnaires will be used during the events promoted by the communities that make up the universe of this research, in order to maximize the number of responses obtained.

4.4 Data analisys

The data analysis will be done based on the Structural Equation Modeling technique (SEM), because it is a multivariate technique that allows the use of relations for each set of dependent variables (89). This technique combines aspects of multiple regres-

sion and factor analysis with the aim of estimating a set of dependency relationships simultaneously (86).

The Structural Equation Modeling is characterized by indicate, evaluate and test existing hypothetical relationships between the variables defined in the proposed model (89). This technique has often been used in the areas of Computer Science (CS) and Information Systems (IS) because it is a technique that allows the construction of models of relationships using multiple variables and constructs (86).

SEM are distinguished from other models by (1) allowing the estimation of multiple relationships of dependence and inter-related, (2) allow the representation of concepts not seen in these relationships and correct measurement errors during the estimation process and (3) allow the definition of a model to explain the entire set of relations (86).

4.5 Research model

This study aims to identify the practices and knowledge management strategies that impact on the organizational learning process in software companies adopting agile methodologies. Thus, from the systematic literature review (see chapter 2) we identified the practices and the strategies adopted by agile teams as mechanisms to knowledge sharing. In addition, models and theories describing the organizational knowledge creation are addressed in order to understand the organizational learning process. Thus, the constructs defined to compose the research model were: (1) agile adoption, (2) knowledge management strategies and (3) organizational learning. Figure 7 shows the proposed model and the relationship established by constructs that compose the model.

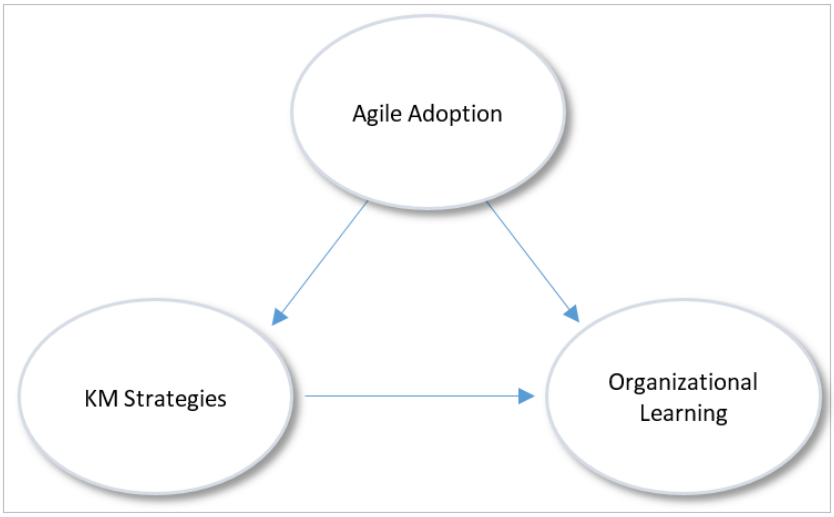

Figure 7: Research model.
Source: Elaborated by the author.

Proposed model suggests that adoption of agile methodologies impacts both in knowledge management strategies and in the organizational learning process. This relationship is justified by the fact that agile methodologies are based on learning processes (90), the use of agile methodologies requires constant learning of teams (11) and knowledge management practices are embedded in agile practices (43, 2, 15).

The construct related to agile methodologies adoption will subdivided into two constructs that classify agile practices in "project management practices" and "software development practices" (39). In this way, the construct variables are agile practices that fall into each classification. We choose this subdivision because agile methods tailoring is a reality in companies that adopt agile methods (71) and the utilization of agile methods as constructs maybe not be suit able. This subdivision is based on justification that methods as Scrum is more focused on management practices while XP provide more development practices (39). Figure 8 shows the variables that compose the constructs proposed in the model.

Regarding to knowledge management strategies construct, we use as variables the strategies that were identified during the systematic literature review as the strategies adopted by agile teams (see chapter 2). These strategies show how organizations promotes the knowledge sharing (28, 64, 44) and therefore influences the organizational learning process (34).

Organizational learning is described as a process in which the organization produces, disseminates and applies knowledge (16). Knowledge application alters organizational behavior because create new routines, processes, products and services (18). Organizational learning process is dependent on different levels (54, 22) and we use these levels to subdivide organizational learning construct.

The first construct of organizational learning is individual level and assumes that only individuals are capable to do intuitions, create mental models and thus produce new knowledge (54, 22). This process corresponds to the knowledge creation step (32). Argote (17) argues that knowledge creation is result of interaction between individuals and tools used to carrying out activities and tasks proposed. During our research we identified different models and theories that explain individual knowledge creation (see chapter 2) and we use it as individual level construct variables. Kolb (58) argues that the individual learns from the experimentation of new insights created based on previous experiences. Argyris (55) points out that process of evaluate and reflect about results of previous work leads the individual to a new knowledge while Nonaka and Takeuchi (59) argues that individual can learn from observation and imitation, using codified knowledge as source to perform their tasks (54), besides obtaining knowledge from the experience of others that is passed during the socialization moments.

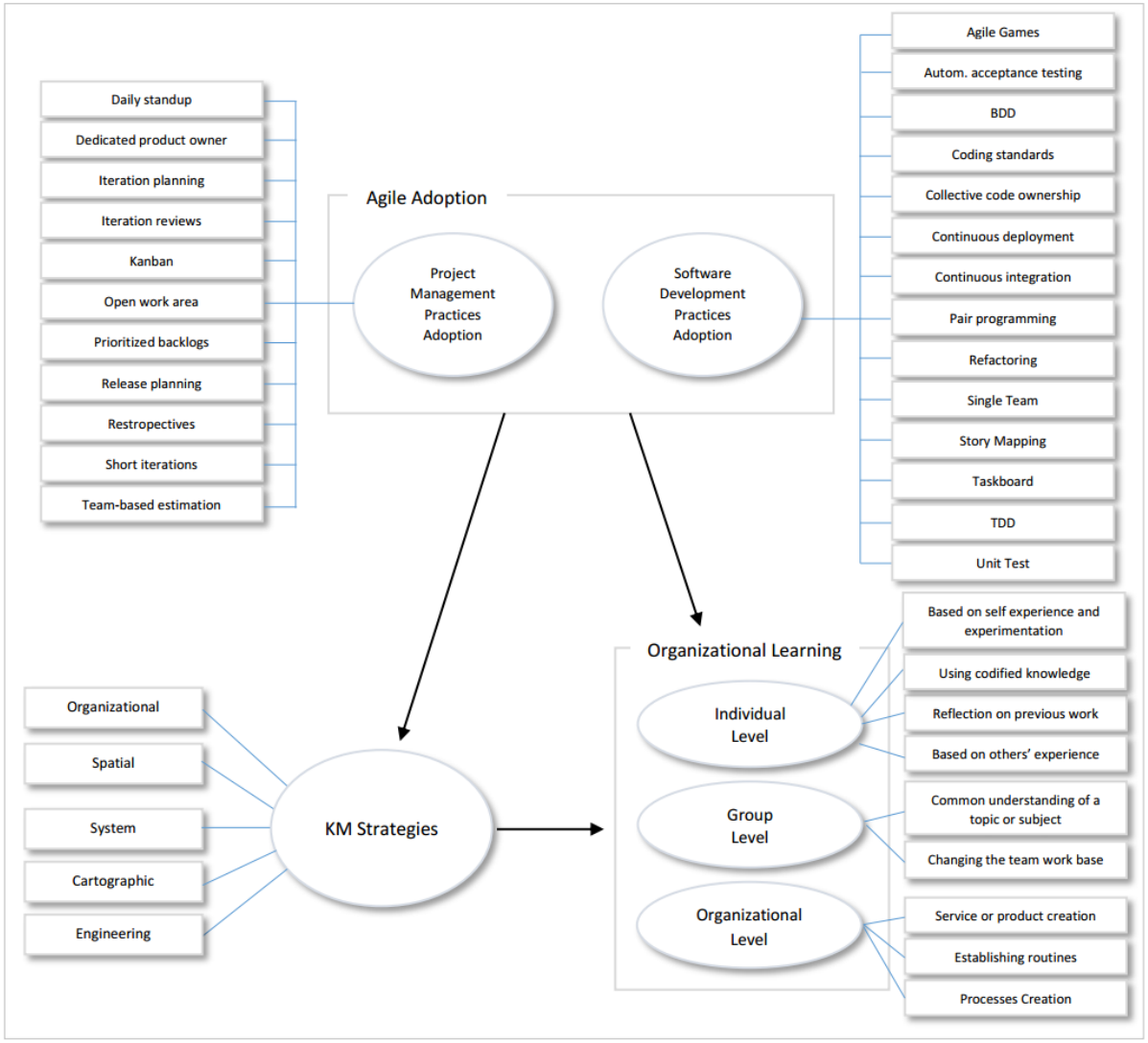

Figure 8: Research model with constructs and variables.
Source: Elaborated by the author.

From the knowledge created, individuals will share that knowledge, reaching the group level. This step is described as interpretation and integration (22), externalization and combination (54) or distribution and interpretation (32). To reach this level a group of individuals need produce a common understand about a topic or subject (22). This shared knowledge will change the way that group performs their tasks and routines (22, 62).

Organizational learning reaches the last level when knowledge is applied and translated into changes that are displayed in the organization (18, 16). At this point is reached the organizational level, which is described as institutionalization (22), combination and internalization (54) or organizational memory (32). When knowledge reaches this organizational learning level new products and services are created, routines and procedures are produced or improved and new processes are implanted in organization (62, 18, 16).

The proposed constructs to compose the research model of this work and the

variables of each construct are summarized in the Table 14.

Table 14: Research model constructs and variables.
Source: Elaborated by the author.

Agile Adoption Context Constructs		
Project management practices adoption		
ID	**Variables**	**References**
APM-1	Daily standup	
APM-2	Dedicated product owner	
APM-3	Iteration planning	
APM-4	Iteration reviews	
APM-5	Kanban	
APM-6	Open work area	(2, 43, 39, 15, 90)
APM-7	Prioritized backlogs	
APM-8	Release planning	
APM-9	Restropectives	
APM-10	Short iterations	
APM-11	Team-based estimation	
Software development practices adoption		
ID	**Variables**	**References**
ASD-1	Agile games	
ASD-2	Automated acceptance testing	
ASD-3	Behavior-Driven Development	
ASD-4	Coding standards	
ASD-5	Collective code ownership	
ASD-6	Continuous deployment	
ASD-7	Continuous integration	(2, 43, 39, 15, 90)
ASD-8	Pair programming	
ASD-9	Refactoring	
ASD-11	Single team	
ASD-12	Story mapping	
ASD-13	Taskboard	
ASD-14	Test-Driven Development	
ASD-15	Unit Testing	
Knowledge Management Strategies		
ID	**Variables**	**References**
KMS-1	Organizational	
KMS-2	Spatial	
KMS-3	System	(34, 28, 64, 44)
KMS-4	Cartographic	
KMS-5	Engineering	
Organizational Learning Context Constructs		
Individual Level		
ID	**Variables**	**References**
OLI-1	Self experience and experimentation	(58)
OLI-2	Using codified knowledge	(59)
OLI-3	Reflection on previous work	(55)
OLI-4	Based on other's experience	(54)
Group Level		
ID	**Variables**	**References**
OLG-1	Common understanding of a topic	(60, 22, 18, 16)
OLG-2	Changing the team work base	(60, 22, 18, 16)
Organizational Level		
ID	**Variables**	**References**
OLO-1	Service or product creation	
OLO-2	Establishing routines	(22, 18, 16)
OLO-3	Processes creation	

4.5.1 Hypotheses

From the proposed model to conduct this study, 11 hypotheses were drawn up in order to respond to the proposed research problem (see section 1.1). The proposed hypotheses are presented in Figure 9 and described below.

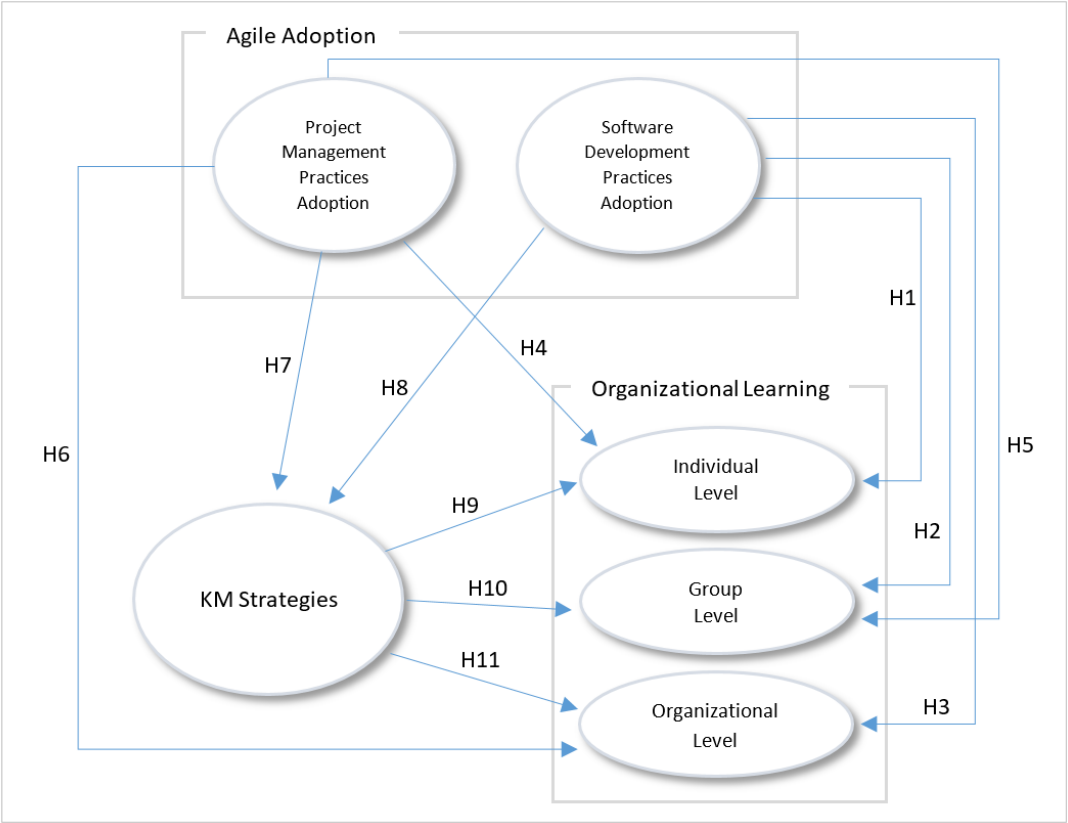

Figure 9: Hyphotesis model.
Source: Elaborated by the author.

H1: Software Development practices adoption affects individuals' knowledge production.

H2: Software Development practices adoption affects the organizational learning in group level.

H3: Software Development practices adoption affects the institutionalization of knowledge produced by individuals and groups.

H4: Project management practices adoption affects individuals' knowledge production.

H5: Project management practices adoption affects the organizational learning in group level.

H6: Project management practices adoption affects the institutionalization of knowl-

edge produced by individuals and groups.

H7: Software Development practices adoption positive impact on knowledge management strategy.

H8: Project management practices adoption positive impact on knowledge management strategy.

H9: Knowledge management strategies impact positively on individual learning.

H10: Knowledge management strategies impact positively the learning of groups and work teams.

H11: Knowledge management strategies impact positively on the institutionalization of knowledge produced by individuals and groups.

4.6 Schedule

The schedule for the thesis is presented on Table 15.

Table 15: Schedule for thesis.
Source: Elaborated by the author.

	2016								2017				
Activities	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Pre-project	x	x											
Systematic literature review	x	x	x	x	x								
Qualification project			x	x	x								
Qualification project review				x	x								
Qualification project submission						x							
Qualification						x							
Survey execution							x	x	x	x			
Data analysis										x	x		
Write results and discussion sections											x	x	
Thesis revision												x	x
Thesis presentation													x

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Appendix

APPENDIX A – Instrument for data collection

A.1 Presentation

You have been invited to participate in a master degree research that aims identify the impact of agile practices adoption in the organizational learning process in software companies. This research is being carried out by me, under Professor Dr. Fernando Silva Parreiras, in the FUMEC's Graduate Program in Information Systems and Knowledge Management.

The questionnaire takes about 10 minutes to be completed. Your contribution is critical to the success of this research.

It is known that ethics in the scientific research development, as well as current legislation, ensures the confidentiality of information collected. Therefore, the information collected here are confidential and for exclusive use in this research.

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A.2 Identification

Identification questions are questions related to your profile. Choose an answer for each question.

What is your current position on the organization?

( ) Development Staff
( ) Development Leadership
( ) Team Leader / Scrum Master / Project Management
( ) Consultant

How long have you been working with agile methods and agiles practices?

( ) Less than 1 year.
( ) Between 1 and 2 years.
( ) Between 2 and 3 years.
( ) Between 3 and 5 years.
( ) More than 5 years.

How would you consider your experience level with agile methods and agile practices?

( ) Very little / no knowledge
( ) Knowledgeable
( ) Moderately knowledgeable
( ) Extremely knowledgeable

A.3 Impact of software development practices on organizational learning

In this section we list questions that aim to identify the relationship between software development practices and the organizational learning process. Thus, this section consists of three subsections representing organizational learning levels, that are individual level, group level and organizational level.

A.3.1 Individual level

Below we present questions that aim to establish the relationship between the agile practices for software development and the individual learning.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 16: Questions to evaluate impact of software development practices on organizational learning at the individual level.

	1	2	3	4	5
The use of agile games collaborates with my learning about the project and tools.					
Coding standard and collective code ownership collaborates with my learning.					
Carrying out refactoring makes me improve my technical skills, because I am constantly thinking about the work produced.					
The use of task board allows me to learning about the progress of the project.					
The use of unit testing, as well as TDD, make me improve my technical skills and learn more about the project and about the software rules.					
The use of pair programming allows me to learn new techniques and improve my skills.					
The use of continuous integration collaborate with my learning because I can compare and integrate my work with the artifacts produced by my team.					
The use of story mapping collaborates with my learning about the requirements because the client describes the features and I can learn about the software requirement from that description.					
The use of single team (the same team develops and tests the software) allows me to learn new techniques, discover other parts of the project and improve my skills.					

A.3.2 Group level

Below we present the questions that aim to establish the relationship between the agile practices for software development and organizational learning at the group level.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 17: Questions to evaluate impact of software development practices on organizational learning at the group level.

	1	2	3	4	5
The use of agile games collaborates with the team's learning about the project and about the tools used, creating a common understanding among the team members.					
Coding standards and collective code ownership favors the team's learning, creating a common understanding among team members.					
Carrying out refactoring collaborates with improving team skills, because the team constantly reflects over work produced, sharing knowledge and creating a common understanding about the techniques and tools used.					
The use of task board makes my team have an understanding and common learning about the progress of the project.					
The use of unit testing, as well as TDD, allow my team create knowledge, generating a common understanding of the requirements that are under construction.					
The use of pair programming allows knowledge leveling in my team.					
The use of continuous integration allows the team to share knowledge, because members are in touch with the artifacts produced by other individuals.					
Story mapping allows the team's learning about the requirements because the client describes the features and the team can produce a common understanding from that description.					
The use of single team (the same team develops and tests the software) allows the team to share knowledge and exchange experiences, generating a common understanding of the software.					

A.3.3 Organizacional level

Below we present the questions that aim to establish the relationship between the agile practices for software development and organizational learning at the organizational level.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 18: Questions to evaluate impact of software development practices on organizational learning at the organizational level.

	1	2	3	4	5
Agile games contributes to the team's knowledge create and change the routines, institutional documents and processes that change the way of working of the company's software teams.					
Coding standard and collective code ownership assist in the definition and identification of best practices and the creation and improvement of processes that will be adopted by other software development teams of the company.					
Carrying out refactoring assist in the definition and identification of best practices and the creation and improvement of processes that will be adopted by other software development teams of the company.					
The use of task board allows to identify improvement opportunities in processes and routines that will be adopted by other software development teams of the company.					
Unit testing and TDD collaborates to definition and improving processes and routines that will be adopted by other development teams.					
Pair programming allows team's knowledge assist in the creation and improvement of processes, products and services of the organization.					
Continuous integration assists in the creation and improvement of processes, products, services and routines from the knowledge produced by team.					
Story mapping collaborates with the production and improvement of processes and routines among software development teams.					
The use of single team (the same team develops and tests software) contributes to the creation and improvement of processes and routines of the company that will be adopted by other software development teams.					

A.4 Impact of project management practices on organizational learning

In this section we list questions that aim to identify the relationship between project management practices and the organizational learning process. Thus, this section consists of three subsections representing organizational learning levels, that are individual level, group level and organizational level.

A.4.1 Individual level

Below we present the questions that aim to establish the relationship between the agile practices for project management and the individual learning.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 19: Questions to evaluate impact of project management practices on organizational learning at the individual level.

	1	2	3	4	5
Daily standup, iteration planning, iteration reviews and retrospectives, as well as short iterations, collaborates with my learning about the project, about the technologies and tools used.					
Dedicated product owner and a prioritized backlog collaborates with my learning about the project.					
Team-based estimation and the use of kanban collaborates with my learning about the project, about the technologies and tools used.					
Work at a open workspace without partitions, where I have constant contact with the other team members collaborates with my learning.					

A.4.2 Group level

Below we present the questions that aim to establish the relationship between the agile practices for project management and organizational learning at the group level.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 20: Questions to evaluate impact of project management practices on organizational learning at the group level.

	1	2	3	4	5
Daily standup meetings, iteration planning, iteration reviews and retrospectives, as well as short iteractions, helps with the learning of my team about the project, about the technologies and tools used, allowing team members create an common understanding.					
Dedicated product owner and prioritized backlog collaborates with the learning of my team, allowing team members share knowledge and create a common understanding of the topics covered.					
Team-based estimation and the use of kanban collaborates with the learning of my team, allowing team members share knowledge and create a common understanding of the topics covered.					
Work at an open workspace without partitions where I have constant contact with the other team members collaborates with learning from my team about the project, about the technologies and tools used, allowing team members to create an common understanding.					

A.4.3 Organizational level

Below we present the questions that aim to establish the relationship between the agile practices for project management and organizational learning at the organizational level.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 21: Questions to evaluate impact of project management practices on organizational learning at the organizational level.

	1	2	3	4	5
Daily standup, iteration planning, iteration reviews and retrospectives, as well as short iteractions, helps create and improve processes that become common in other software development teams of the company.					
Dedicated product owner and prioritized backlog assists in the creation and improvement of processes that become common in other software development teams of the company.					
Team-based estimation and the use of kanban assists in the creation and improvement of processes that become commons in other software development teams of the company.					
Work at an open workspace without partitions where I have constant contact with the other team members assists in the creation and improvement of processes and routines that become commons in other software development teams of the company.					

A.5 Impact of agile practices adoption on knowledge management strategies

In this section we list questions that aim to identify the relationship between agile practices adoption and the knowledge management strategies. Thus, this section consists of two subsections representing agile practices classification adopted in this research, that are software development practices and project management practices.

A.5.1 Software development practices

Below we present the questions that aim to establish the relationship between the agile practices for software development and knowledge management strategies.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 22: Questions to evaluate impact of software development practices on knowledge management strategies.

	1	2	3	4	5
Agile games favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
Coding standard and collective code ownership favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
Refactoring favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
The use of task board favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
Unit testing and TDD favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
Pair programming favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
Continous integration favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
Story mapping favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
The use of single team favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					

A.5.2 Project management practices

Below we present the questions that aim to establish the relationship between the agile practices for project management and knowledge management strategies.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 23: Questions to evaluate impact of project management practices on knowledge management strategies.

	1	2	3	4	5
Daily standup, iteration planning, iteration reviews and retrospetivas, as well as short iteractions favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
Dedicated product owner and prioritized backlock favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
Team-based estimation and use of kanban favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					
Work at an open workspace without partitions where I have constant contact with the other team members favors communication between individuals, allows the information flow in the working environment, contributes to individuals know each other and helps to document the solutions in repositories as forums and wikis.					

A.6 Impact of knowledge management strategies on organizational learning

In this section we list questions that aim to identify the relationship between knowledge management strategies and the organizational learning process. Thus, this section consists of three subsections representing organizational learning levels, that are individual level, group level and organizational level.

A.6.1 Individual level

Below we present the questions that aim to establish the relationship between knowledge management strategies and organizational learning at the individual level.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 24: Questions to evaluate impact of knowledge management strategies on organizational learning at the individual level.

	1	2	3	4	5
The organizational structure of my company and constant communication with experienced individuals collaborates with my learning.					
The open work environment, with the layout of workstations without partitions, and the use of panels and bulletin boards collaborates with my learning process.					
The use of repositories of project lessons learned, forums and wikis helps me to learning because I can find important information to help me during the development of my work. The use of a system that identifies the company's employees and determine what knowledge and skills that these employees hold helps my learning process, because I can find people who have certain knowledge of which I need to perform my tasks.					
A communication process that provides information relevant to my work using tools such as email or news page collaborate with my learning process.					

A.6.2 Group level

Below we present the questions that aim to establish the relationship between knowledge management strategies and organizational learning at the group level.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 25: Questions to evaluate impact of knowledge management strategies on organizational learning at the group level.

	1	2	3	4	5
The organizational structure of the company and constant communication with experienced individuals promotes knowledge sharing among team members and allows individuals to create a common understanding of the topics covered.					
The open work environment, with the layout of workstations without partitions, and the use of panels and bulletin boards facilitates communication and contributes to the knowledge sharing among the team members.					
Repositories of project lessons learned, forums and wikis facilitates knowledge sharing among team members and allows individuals to create a common understanding of the knowledge that is stored in these repositories.					
The identification of the knowledge that each employee of the company hold facilitates the process of sharing this knowledge among team members.					
A communication process that provides information relevant to the work of my team allows the creation of a common understanding and encourages knowledge sharing among team members.					

A.6.3 Organizacional level

Below we present the questions that aim to establish the relationship between knowledge management strategies and organizational learning at the organizational level.

You must mark one of the options according to the degree to which these statements apply to you and your company.

Consider the following options: **1 - Strongly Disagree; 2 - Disagree; 3 - Neutral; 4 - Agree; 5 - Strongly Agree**.

Table 26: Questions to evaluate impact of knowledge management strategies on organizational learning at the organizational level.

	1	2	3	4	5
The organizational structure of the company and constant communication with experienced individuals favors the creation of new products and services, in addition to support the creation and improvement of processes and routines that will be adopted by the company's software development teams.					
The open work environment, with the layout of workstations without partitions, and the use of panels and bulletin boards collaborates with the creation and improvement of processes that will be adopted by other software development teams of the company.					
Repositories of project lessons learned, forums and wikis facilitates the creation and improvement of processes that will be adopted by other software development teams of the company.					
The use of a system that identifies the company's employees and determine what knowledge each employee holds collaborates with creation and improvement of processes and routines that will be adopted by other software development teams of the company.					
A constant communication process to provide information through the use of tools such as email and news pages collaborates with the creation and improvement of processes and routines that will be adopted by desenolvimento teams of enterprise software.					

APPENDIX B – Instrument for data collection - Brazilian Portuguese version

B.1 Apresentação da pesquisa

Você foi convidado a participar de uma pesquisa de mestrado que tem objetivo identificar qual o impacto causado pela adoção de práticas ágeis no processo de aprendizagem organizacional em empresas de software. Essa pesquisa está sendo realizada por mim, sob orientação do professor Dr. Fernando Silva Parreiras, no âmbito do Programa de Pós-Graduação Sistemas de Informação e Gestão do Conhecimento da Universidade FUMEC.

O questionário leva em média 10 minutos para ser preenchido. A sua contribuição é fundamental para o sucesso dessa pesquisa e para a credibilidade dos resultados encontrados.

Sabe-se que a ética no desenvolvimento de pesquisas científicas, bem como a legislação vigente, garantem o caráter confidencial das informações coletadas. Portanto, as informações aqui coletadas são de caráter sigiloso, confidencial e para uso exclusivo nessa pesquisa.

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B.2 Identificação

As perguntas de identificação se relacionam ao seu perfil. Escolha uma resposta para cada questão.

Qual das opções abaixo melhor descreve a sua posição atual em sua empresa?

( ) Equipe de desenvolvimento
( ) Líder de desenvolvimento
( ) Scrum Master / Gerente de Projeto
( ) Consultor

Quanto tempo de experiência você tem com a utilização de métodos e práticas ágeis?

( ) Menos de 1 ano.
( ) Entre 1 e 2 anos.
( ) Entre 2 e 3 anos.
( ) Entre 3 e 5 anos.
( ) Mais de 5 anos.

Como você considera o seu nível de experiência com metodologias e práticas ágeis?

( ) Muito pouco ou nenhum conhecimento
( ) Pouco conhecimento
( ) Conhecimento moderado
( ) Conhecimento avançado

B.3 Impacto da adoção de práticas ágeis para o desenvolvimento de software

Nessa seção são listadas afirmações que apontam como as práticas ágeis, classificadas como "práticas de desenvolvimento de softwares", impactam no processo de aprendizagem organizacional. Dessa forma, essa seção é composta por três subseções que representam os níveis de aprendizagem organizacional, sendo eles o nível individual, o nível de grupo e o nível organizacional.

B.3.1 Nível individual

A seguir são apresentadas as afirmações que apontam como a adoção de práticas ágeis de desenvolvimento de software impacta na aprendizagem dos indivíduos.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 27: Questions to evaluate impact of software development practices on organizational learning at the individual level - Brazilian Portuguese version.

	1	2	3	4	5
A utilização de agile games colabora com a minha aprendizagem sobre o projeto e sobre as ferramentas utilizadas.					
A utilização de padrão de codificação e propriedade coletiva de código colaboram com a minha aprendizagem.					
A realização de refactoring faz com que eu melhore as minhas habilidades técnicas, pois estou constantemente refletindo sobre o trabalho produzido.					
A utilização de task board faz com que eu aprenda sobre o andamento do projeto.					
A utilização de testes unitários, assim como de TDD, fazem com que eu melhore minhas habilidades técnicas e aprenda mais sobre o projeto no qual estou trabalhando.					
A utilização de pair programming possibilita que eu aprenda novas técnicas e melhore minhas habilidades.					
A utilização de integração contínua colabora com a minha aprendizagem, pois eu consigo comparar e integrar o meu trabalho com o artefatos produzidos pela minha equipe.					
A utilização de story mapping colabora com a minha aprendizagem sobre os requisitos, pois o cliente descreve as funcionalidades que deseja e eu consigo aprender sobre o requisito a partir dessa descrição escrita.					
A utilização de single team (o mesmo time desenvolve e testa o software) permite que eu aprenda novas técnicas, conheça outras partes do projeto e melhore minhas habilidades.					

B.3.2 Nível de grupo

A seguir são apresentadas as afirmações que apontam como a adoção de práticas ágeis de desenvolvimento de software impacta na aprendizagem dos grupos e equipes ágeis.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 28: Questions to evaluate impact of software development practices on organizational learning at the group level - Brazilian Portuguese version.

	1	2	3	4	5
A utilização de agile games colabora com a aprendizagem da minha equipe sobre o projeto e sobre as ferramentas utilizadas, criando um entendimento comum entre os membros do time.					
A utilização de padrão de codificação e propriedade coletiva de código fazem com que o time aprenda de forma coletiva, compartilhe um entendimento comum e com isso nivele o conhecimento dos membros da equipe.					
A realização de refactoring colabora com melhoria das habilidades do time, pois a equipe constantemente reflete sobre o trabalho produzido, compartilha conhecimento e cria um entendimento comum sobre as técnicas e ferramentas utilizadas.					
A utilização de task board faz com que a minha equipe tenha um entendimento e aprendizado comum sobre o andamento do projeto.					
A utilização de testes unitários, assim como de TDD, fazem com que a minha equipe produza e compartilhe conhecimento, gerando um entendimento comum sobre os requisitos que estão sendo construídos.					
A utilização de pair programming permite que a minha equipe compartilhe conhecimento e nivele as habilidades dos membros do time.					
A utilização de integração contínua permite que a equipe compartilhe conhecimento, pois assim é possível que os membros estejam em contato os artefatos produzidos pelos demais indivíduos.					
A utilização de story mapping colabora com a aprendizagem do time sobre os requisitos, pois o cliente descreve as funcionalidades que deseja e a equipe consegue produzir um entendimento comum a partir dessa descrição.					
A utilização de single team (o mesmo time desenvolve e testa o software) permite que a equipe compartilhe conhecimento e troque experiências, gerando um entendimento comum sobre o software.					

B.3.3 Nível organizacional

A seguir são apresentadas as afirmações que apontam como a adoção de práticas ágeis de desenvolvimento de software impacta na aprendizagem organizacional no nível da instituição.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 29: Questions to evaluate impact of software development practices on organizational learning at the organizational level - Brazilian Portuguese version.

	1	2	3	4	5
A utilização de agile games colabora para que o conhecimento do time crie e altere as rotinas, documentos institucionais e processos que alteram a forma de trabalho das equipes de software da empresa.					
A utilização de padrão de codificação e propriedade coletiva de código auxiliam na definição e identificação de melhores práticas, além da criação e melhoria de processos que passam a ser adotados pelos demais times de desenvolvimento de software da empresa.					
A realização de refactoring colabora para que o conhecimento do meu time atue na definição, criação e melhoria de processos e rotinas que são adotadas pelos demais times de desenvolvimento de software da empresa.					
A utilização de task board permite que sejam identificadas possibilidades de melhorias em processos e rotinas que passam a ser adotadas pelas demais equipes de desenvolvimento de software da empresa.					
A utilização de testes unitários, assim como de TDD, colaboram para que o conhecimento produzido pela minha equipe atue na definição e melhoria de processos e rotinas que passam a ser adotadas pelas demais equipes de desenvolvimento.					
A utilização de pair programming permite que o conhecimento da minha equipe auxilie na criação e melhoria de processos, produtos e serviços da organização.					
A utilização de integração contínua auxilia na criação e melhoria dos processos, produtos, serviços e rotinas a partir do conhecimento produzido pela minha equipe.					
A utilização de story mapping colabora com a produção e melhoria dos processos e rotinas entre os times de desenvolvimento de software da organização.					
A utilização de single team (o mesmo time desenvolve e testa o software) colabora para que o conhecimento da minha equipe contribua para a criação e melhoria dos processos e rotinas da empresa que passam a ser adotadas pelas demais equipes de desenvolvimento de software.					

B.4 Impacto da adoção de práticas ágeis para o gerenciamento de projetos

Nessa seção são listadas afirmações que apontam como as práticas ágeis, classificadas como "práticas de gerenciamento de projetos", impactam no processo de aprendizagem organizacional. Dessa forma, essa seção é composta por três subseções que representam os níveis de aprendizagem organizacional, sendo eles o nível individual, o nível de grupo e o nível organizacional.

B.4.1 Nível individual

A seguir são apresentadas as afirmações que apontam como a adoção de práticas ágeis para o gerenciamento de projetos impacta na aprendizagem dos indivíduos.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 30: Questions to evaluate impact of project management practices on organizational learning at the individual level - Brazilian Portuguese version.

	1	2	3	4	5
A utilização de reuniões como daily standup, iteration planning, reviews e retrospetivas, assim como a realização de short iteractions colabora com a minha aprendizagem sobre o projeto, sobre as tecnologias e ferramentas utilizadas.					
Ter um cliente com dedicação exclusiva e um backlog priorizado colabora com a minha aprendizagem sobre o projeto.					
A realização de estimativas de esforço realizadas pela equipe e a utilização de kanban colabora com a minha aprendizagem sobre o projeto, sobre as tecnologias e ferramentas utilizadas.					
A utilização de um espaço de trabalho aberto, sem divisórias onde eu tenho contato constante com os demais membros da minha equipe colabora com a minha aprendizagem.					

B.4.2 Nível de grupo

A seguir são apresentadas as afirmações que apontam como a adoção de práticas ágeis de gerenciamento de projetos impacta na aprendizagem dos grupos e equipes ágeis.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 31: Questions to evaluate impact of project management practices on organizational learning at the group level - Brazilian Portuguese version.

	1	2	3	4	5
A utilização de reuniões como daily standup, iteration planning, reviews e retrospetivas, assim como a realização de short iteractions, colabora com a aprendizagem da minha equipe sobre o projeto, sobre as tecnologias e ferramentas utilizadas, permitindo que os membros do time criem um entendimento comum.					
Ter um cliente com dedicação exclusiva e um backlog priorizado colabora com a aprendizagem da minha equipe, permitindo que os membros do time compartilhe conhecimento e criem um entendimento comum sobre os temas abordados.					
A realização de estimativas de esforço realizadas pela equipe e a utilização de kanban colabora com a aprendizagem da minha equipe, permitindo que os membros do time compartilhe conhecimento e criem um entendimento comum sobre os temas abordados.					
A utilização de um espaço de trabalho aberto, sem divisórias onde eu tenho contato constante com os demais membros da minha equipe colabora com a aprendizagem da minha equipe sobre o projeto, sobre as tecnologias e ferramentas utilizadas, permitindo que os membros do time criem um entendimento comum.					

B.4.3 Nível organizacional

A seguir são apresentadas as afirmações que apontam como a adoção de práticas ágeis de gerenciamento de projetos impacta na aprendizagem organizacional no nível da instituição.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 32: Questions to evaluate impact of project management practices on organizational learning at the organizational level - Brazilian Portuguese version.

	1	2	3	4	5
A utilização de reuniões como daily standup, iteration planning, reviews e retrospetivas, assim como a realização de short iteractions, auxilia na criação e melhoria de processos que passam a ser adotados pelos demais times de desenvolvimento de software da empresa.					
Ter um cliente com dedicação exclusiva e um backlog priorizado auxilia na criação e melhoria de processos que passam a ser adotados pelos demais times de desenvolvimento de software da empresa.					
A realização de estimativas de esforço realizadas pela equipe e a utilização de kanban auxilia na criação e melhoria de processos que passam a ser adotados pelos demais times de desenvolvimento de software da empresa.					
A utilização de um espaço de trabalho aberto, sem divisórias onde eu tenho contato constante com os demais membros da minha equipe auxilia na criação e melhoria de processos e rotinas que passam a ser adotados pelos demais times de desenvolvimento de software da empresa.					

B.5 Impacto da adoção de práticas ágeis sobre as estratégias de gestão do conhecimento

Nessa seção são listadas afirmações que apontam como as práticas ágeis impactam nas estratégias para a gestão do conhecimento. Dessa forma, essa seção é composta por duas subseções que representam as classificações adotadas para as práticas ágeis nessa pesquisa, sendo elas as práticas ágeis para o desenvolvimento de softwares e as práticas ágeis para o gerenciamento de projetos.

B.5.1 Práticas ágeis para o desenvolvimento de softwares

A seguir são apresentadas as afirmações que apontam como a adoção de práticas ágeis para o desenvolvimento de softwares impacta nas estratégias para a gestão do conhecimento.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 33: Questions to evaluate impact of software development practices on knowledge management strategies - Brazilian Portuguese version.

	1	2	3	4	5
A utilização de agile games favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
A utilização de padrão de codificação e propriedade coletiva de código favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
A realização de refactoring favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
A utilização de task board favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
A utilização de testes unitários, assim como de TDD, favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
A utilização de pair programming favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
A utilização de integração contínua favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
A utilização de story mapping favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
A utilização de single team (o mesmo time desenvolve e testa o software) favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					

B.5.2 Práticas ágeis para o gerenciamento de projetos

A seguir são apresentadas as afirmações que apontam como a adoção de práticas ágeis para o gerenciamento de projetos impacta nas estratégias para a gestão do conhecimento.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 34: Questions to evaluate impact of project management practices on knowledge management strategies - Brazilian Portuguese version.

	1	2	3	4	5
A utilização de reuniões como daily standup, iteration planning, reviews e retrospetivas, assim como a realização de short iteractions favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
Ter um cliente com dedicação exclusiva e um backlog priorizado favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
A realização de estimativas de esforço realizadas pela equipe e a utilização de kanban favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					
A utilização de um espaço de trabalho aberto, sem divisórias onde eu tenho contato constante com os demais membros da minha equipe favorece a comunicação entre os indivíduos, permite que a informação circule pelo ambiente de trabalho, colabora para que os indivíduos se conheçam e auxilia na documentação de soluções em repositório como fóruns e wikis.					

B.6 Impacto das estratégias para a gestão do conhecimento sobre a aprendizagem organizacional

Nessa seção são listadas afirmações que apontam como as estratégias para a gestão do conhecimento impactam no processo de aprendizagem organizacional. Dessa forma, essa seção é composta por três subseções que representam os níveis de aprendizagem organizacional descritos nessa pesquisa, sendo eles o nível individual, o nível de grupo e o nível institucional.

B.6.1 Nível individual

A seguir são apresentadas as afirmações que apontam como as estratégias para a gestão do conhecimento impactam na aprendizagem organizacional no nível individual.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 35: Questions to evaluate impact of knowledge management strategies on organizational learning at the individual level - Brazilian Portuguese version.

	1	2	3	4	5
A estrutura organizacional da empresa e o incentivo à comunicação constante com os indivíduos mais experientes colabora com o meu aprendizado.					
O ambiente de trabalho aberto, com a disposição das estações de trabalho sem divisórias, e a utilização de painéis e quadros informativos colabora com o meu processo de aprendizagem.					
A utilização de repositórios de lições aprendidas dos projetos, fóruns e wikis facilita o meu processo de aprendizagem, pois consigo localizar informações importantes que me auxiliam durante o desenvolvimento do meu trabalho. A utilização de um sistema que identifique os colaboradores da empresa e determine quais os conhecimentos e habilidades que esses colaboradores detêm facilita o meu processo de aprendizagem, pois assim eu consigo encontrar as pessoas que possuem determinados conhecimentos dos quais eu preciso para executar as minhas tarefas.					
A utilização de um processo de comunicação que forneça informações pertinentes ao meu trabalho utilizando ferramentas como emails ou sistema de página de notícias colabora com a minha aprendizagem.					

B.6.2 Nível de grupo

A seguir são apresentadas as afirmações que apontam como as estratégias para a gestão do conhecimento impactam na aprendizagem organizacional no nível de grupo.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 36: Questions to evaluate impact of knowledge management strategies on organizational learning at the group level - Brazilian Portuguese version.

	1	2	3	4	5
A estrutura organizacional da empresa e o incentivo à comunicação constante com os indivíduos mais experientes favorece o compartilhamento de conhecimento entre os membros da minha equipe e permite que os indivíduos criem um entendimento comum sobre os temas abordados.					
O ambiente de trabalho aberto, com a disposição das estações de trabalho sem divisórias, e a utilização de painéis e quadros informativos facilita a comunicação e colabora com a troca de conhecimento entre os membros da minha equipe.					
A utilização de repositórios de lições aprendidas dos projetos, fóruns e wikis facilita o compartilhamento de conhecimento entre os membros da minha equipe e permite que os indivíduos criem um entendimento comum sobre o conhecimento que é armazenado nesses repositórios.					
A identificação dos conhecimentos que cada colaborador da empresa detêm facilita o processo de compartilhamento desse conhecimento entre os membros do time.					
A utilização de um processo de comunicação que forneça informações pertinentes ao trabalho da minha equipe permite a criação de um entendimento comum e fomenta o compartilhamento de conhecimento entre os membros do time.					

B.6.3 Nível organizacional

A seguir são apresentadas as afirmações que apontam como as estratégias para a gestão do conhecimento impactam na aprendizagem organizacional no nível da instituição.

Você deve assinalar uma das opções de acordo com o grau em que essas afirmações se aplicam à você e à sua empresa.

Considere as seguintes opções: **1 - Discordo Totalmente; 2 - Discordo; 3 - Neutro; 4 - Concordo; 5 - Concordo Totalmente.**

Table 37: Questions to evaluate impact of knowledge management strategies on organizational learning at the organizational level - Brazilian Portuguese version.

	1	2	3	4	5
A estrutura organizacional da empresa e o incentivo à comunicação constante com os indivíduos mais experientes favorece a criação de novos produtos e serviços, além de colaborar com a criação e melhoria de processos e rotinas que passam a ser adotadas pelas equipes de desenvolvimento de software da empresa.					
O ambiente de trabalho aberto, com a disposição das estações de trabalho sem divisórias, e a utilização de painéis e quadros informativos colabora com a criação e melhoria de processos que são adotados pelas demais equipes de desenvolvimento de software da empresa.					
A utilização de repositórios de lições aprendidas dos projetos, fóruns e wikis facilita a criação e melhoria de processos que são adotados pelas demais equipes de desenvolvimento de software da empresa.					
A utilização de um sistema que identifique os colaboradores da empresa e determine quais os conhecimentos e habilidades que esses colaboradores possuem facilita a criação e melhoria de processos e rotinas que passam a ser adotadas pelas demais equipes de desenvolvimento de software da empresa.					
A utilização de um processo de comunicação constante que forneça informações por meio da utilização de ferramentas como emails e páginas de notícias colabora com a criação e melhoria de processos e rotinas que passam a ser adotadas pelos times de desenolvimento de software da empresa.					