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Knowledge Sharing in an Agile Organization

As enhancer of dynamic capabilities and enabler of innovation.

The Case of CompanyX.

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Abstract

In a rapidly growing and evolving environment, organizations must be able to reconfigure their resource base in order to adapt to changes.

Several studies and research findings have already recognized knowledge management as a mean to enhance an organization's dynamic capabilities and innovation. Effective knowledge management strategies have therefore become essential for an organization to achieve competitive advantage and finally innovate.

Among the challenges for an effective knowledge management strategy, the transformation of "tacit" knowledge, that exists only in the experiences and mind of individuals and as such is difficult to be codified and transmitted, into "explicit" knowledge, which instead can be easily expressed and documented, is essential to guarantee continuous organizational learning.

Modern software development processes, such as Agile, provide to organizations several knowledge sharing techniques, to aid in the transformation of knowledge from "tacit" to "explicit" one.

This study aims at investigating the impact of agile knowledge sharing methodologies on both dynamic and innovation capabilities of a selected case study organization, and further analyses the factors that may be contributing to such relationship.

The research is carried out by surveying a representative sample of employees of a German software development company, CompanyX. In total, 15 responses were received and a semi-structured face-to-face interview was conducted with one senior manager. Correlation and reliability testing are used as statistical tools to test both the reliability and validity of the model. Finally, the causality between the factors affecting knowledge sharing methodologies in use at CompanyX and the organization's dynamic and innovation capabilities are analysed and compared to previous theoretical and empirical research findings.

Several important observations are made as a result of our study. In particular, the overall research findings demonstrate that agile knowledge sharing methodologies can act as enhancers of CompanyX dynamic capabilities and enablers of innovation.

Keywords: agile development, knowledge sharing, tacit knowledge management, dynamic capabilities, innovation.

Table of Contents

Lists of Figures

List of Tables

1. Introduction

This chapter provides an overview of the concept of dynamic capability and their relationship with knowledge management and innovation. It consequently introduces to the challenges of why knowledge sharing and collaboration within an agile development framework is nowadays less than obvious. It then presents the research problem, the issues with previous studies, significance of this study and the purpose statement of the research work. Finally, an overview of the thesis structure and chapter organization is provided.

1.1. Background information

Today's global marketplace often rewards organizations that can take and manage risks. In order to survive in turbulent environments, a firm needs to be able to manage and adapt its tangible and intangible assets in a flexible manner in order to respond to uncertainty while still achieving growth (Zahra 1999).

As firms must be able to seize new opportunities with flexibility, yet follow few "simple rules" (Eisenhardt & Sull 2001) to achieve the set strategic goals, they must also be able to combine deliberate strategies with emergent ones, by incrementally revising the original strategy in response of acquired capabilities and experiences gained with time and collected from various sources across the entire organization (Collis 2016).

The ability by which managers are able to "integrate, build and reconfigure internal and external competencies to address rapidly changing environments" (Teece et al. 1997) has become known in literature as "dynamic capabilities" (Teece 2016; Eisenhardt & Martin 2000).

Learning and knowledge management are at the foundation of a firm's dynamic capabilities (Breznik & Hisrich 2014). Only with a proper knowledge management process, a firm can use its dynamic capabilities to improve its performances (Michailova & Zhan 2015) and achieve innovation (Lawson & Samson 2001).

Today industry is becoming ever more reliant on technology and gaining an increasingly more knowledge-centric standpoint. This has provided an increasing focus on knowledge management as an important resource for an organization to manage (Johannessen et al. 2001) in order to achieve competitive advantage (Lubit 2001). In particular, techniques of learning and knowledge management are at the core of modern software development processes, as such processes are often recognized to be "knowledge driven" (Ghobadi & D'Ambra 2013) and mostly based on dynamic team interactions and knowledge sharing activities (Chau & Maurer 2003; Ghobadi 2015)

Traditional software development practices, such as those typically found in waterfall-based development work around a staged approach and such techniques are suitable for organized, constrained systems. Each stage in the process must be completed before moving onto the next. This division of tasks among different specialist teams aligns well with the Taylor-based approach to working (Chau & Maurer 2003) and is supported by the use of extensive documentation, which make use of "*explicit*", hence written, knowledge which is easy to assimilate and internalize in an organization (Ersoy & Mahdy 2015), being it easily accessible. However, in today's more rapid development practices extensive documentation often quickly becomes irrelevant as the requirements and goals for a project changes. This is supported by notion of "working software over comprehensive documentation", in which knowledge is accessed and maintained mostly through experience rather than in written form (Dingsoyr et al. 2012).

Being less driven by documentation and more by direct knowledge transfer, modern software development ideologies, such as Agile, pose therefore several challenges for an organization to manage knowledge (Johannessen et al. 2001), and such challenges must be assessed as they could ultimately affect the ability of a firm to build up dynamic capabilities and finally innovate.

1.2. Problem formulation and thesis purpose

In order to achieve the needed flexibility to reach the set strategic objectives, more and more companies are moving away from the traditional waterfall-based models and instead adopting Agile Development Methodologies (Cervone 2014).

With the introduction of Agile Development methodologies, the focus has shifted to include less documentation but more attention to experience and verbal communication (Highsmith & Cockburn 2001). Within the Agile framework, knowledge has therefore changed from being "*explicit* ", that is written and shared, to "*tacit* "(Polanyi 1969), that is existing only in the mind of the individual, hence not easily articulated or verbalized, and as such at risk of being lost (Ersoy & Mahdy 2015).

The key difference between these two types of knowledge is that explicit knowledge can be expressed formally and is encoded is some readily transferable medium such as books, electronic media etc., whereas tacit knowledge is influenced by personal characteristics such as belief, individual experience and personal perspective (Nonaka & Takeuchi 1995).

"*Tacit* " knowledge management presents challenges for an organization to handle, as such kind of knowledge is difficult to communicate to others and can therefore often being mismanaged (Johannessen et al. 2001). Nonetheless such challenges present an opportunity for an organization to develop inimitable core competencies based on knowledge (Lubit 2001) and therefore achieve competitive advantage.

To achieve such advantage, organizations have started to make knowledge management sharing practices a direct part of a firm's strategy, by encouraging individual's innovative thinking and competencies sharing (Sunassee & Sewry 2002). By using knowledge sharing practices, tacit knowledge can be converted into explicit knowledge, making it easier for an organization to codify and to harvest.

In this content, a question raises of whether, the introduction of modern agile development methodologies of knowledge sharing, can support an organization to use tacit knowledge management as a mean to enhance its internal dynamic capabilities and finally innovate.

The **purpose** of this thesis work is therefore to gain further understanding of whether practices of agile knowledge sharing, being used for tacit knowledge management, can act as enhancers of a firm's dynamic capabilities and enablers of innovation within the agile organization.

This thesis work will attempt to achieve its purpose by offering an analysis on the way tacit knowledge in managed, focusing on understanding the factors that affect knowledge sharing methodologies in a selected case study organization and further assessing the effect of such factors on both dynamic capabilities and innovation.

1.3. Importance and novelty of the study

The identification and investigation of a framework, which describes the ability of a firm to manage both its tangible and intangible resources in order to adapt to changes, has been one of the most popular object of research in the field of strategic management of the last few years (Barreto 2010; Helfat & Peteraf 2003; Teece 2007).

Several studies have already identified the characteristics of a firm dynamic capabilities and its relationship with a firm performance (Shih-Yi Chen Ching-Han 2012; McKee et al. 1989) and have started to address knowledge management as a fundamental process that enhances such capabilities (Zollo & Winter 2002; Lubit 2001).

Researchers have also been investigating the link between dynamic capabilities and innovation (Liao et al. 2009; Cheng & Chen 2013; Ellonen et al. 2009), and have pointed to knowledge management as the mediating process of such relationship (Sher & Lee 2004; Giniuniene & Jurksiene 2015; Shih-Yi Chen Ching-Han 2012). However, above mentioned studies have only focused in addressing explicit knowledge, hence written and explicit knowledge, rather than tacit knowledge, which is at the core of Agile development methodologies (Endres et al. 2007), and poses additional challenges for an organization to both build dynamic capabilities and innovate (Levy & Hazzan 2009), being itself difficult to express, verbalize and transfer.

The **focus of this thesis work** in exploring the relationship between "tacit" knowledge sharing practices, dynamic capabilities and innovation, **is of particular importance to answer**, as today industry is more and more introducing agile development techniques (Harvard Business Review Analytic Services 2015) and, understanding how such knowledge sharing techniques can influence a firm's ability to change and innovate is fundamental in order to guarantee the long-term competitive advantage of the organization (Lubit 2001).

1.4. Thesis structure

The remainder of this thesis work is structured as follows. The next chapter reviews what is currently known on a firm's strategic management and dynamic capabilities, agile development methodologies and their connection to knowledge management practices to enhance agility and lead to innovation. Chapter 3 describes the research design and questions, as well as the methods used for data collection and analysis. Chapter 4 presents the results of the study, discusses of how the empirical findings correspond to the literature and reflects on why it corresponds or deviates. Chapter 5 provides a summary and final conclusions as well as introduces possible routes for future development of this thesis work.

2. Theoretical framework

This chapter contains the theoretical framework used to support this thesis work. It starts by providing an overview on what dynamic capabilities are and how they are related to the ability of a firm to achieve strategic advantage. It continues by introducing the concept of innovation and by describing the relationship between dynamic capabilities and innovation that are so-far known in literature. Moreover, an introduction on the different types of knowledge is provided and the role of knowledge management as a mediator of the relationship between dynamic capabilities and innovation is discussed. After that, an overview on Agile Development Methodologies for software development is given and the way knowledge is managed in such framework is further analyzed by focusing on the challenges of managing "tacit" knowledge and presenting various techniques of knowledge sharing currently in use to overcome such challenges. Finally, the research question and hypothesis propositions used to support this thesis work are presented.

2.1. Strategic management and dynamic capabilities

Strategic Management aim is for an organization to achieve competitive advantage (Best 2009).

Not only, however, competitive advantage must be obtained, but it also need be sustained through time. This can be accomplished by obsoleting the original strategy and revising it depending on external changes and newly emerging trends (Porter 1990a)

Different frameworks have been developed in literature to help organization's analyze their external environments (Khanna et al. 2005; Ryall 2013; Kim & Mauborgne 2011). Among such frameworks is Porter's Five Forces, according to which the strength of competition is shaped by the power of suppliers, the power of customers, the intensity of rivalry and the threats of new entrants and substitution (Porter 2008).

The main focus of above mentioned frameworks has been however only the one to analyze the external environment, largely ignoring many aspects of an organization internal environment (Teece et al. 1997).

Looking at the internal environment of an organization, (Penrose 1959) was one of the first to recognize the value of a firm's internal resources in the achievement of competitive advantage, consequently setting the basis for the modern Resource Based View (RBV) of the firm (Lockett & Wild 2014). According to the RBV model, presented by Barney in 1991, the collection of a firm intangible and tangible resources, such as human resources, organizational processes and routines, information and knowledge, are at the core of sustained competitive advantage (Barney et al. 2001)

Expanding on the RBV model, in 1997, Teece, Pisano and Shuen presented the "*dynamic capabilities framework*" in order "*to explain how combinations of competences and resources can be developed, deployed, and protected*"(Teece et al. 1997, p.510).

In particular, we refer at the term "*dynamic capabilities*" as a set of "*specific organizational and strategic processes (e.g., product innovation, strategic decision making, knowledge sharing) by which managers alter their resource base" in order to adapt to sudden market changes"* (Eisenhardt & Martin 2000).

The term "*dynamic*" refers to the ability of the organization to renew its environment in response to change (Sher & Lee 2004). "*Capabilities*" needed in a volatile environment might include the adoption, integration, and reconfiguration of organizational skills, resources, and functions that are necessary to the organization to respond to the change (Sher & Lee 2004).

Dynamic capabilities have been defined in literature not only as abilities or capacities (Teece 2007; Eisenhardt & Martin 2000) but also as operating procedures or processes (Zollo & Winter 2002; Helfat & Peteraf 2003) which are used by an organization to solve problems or to transform already existing operating routines into new ones (Helfat & Peteraf 2003).

According to (Teece 2007) dynamic capabilities can be aggregated into three main organizational abilities:

- **Sensing**: the ability of a firm to sense and shape opportunities and threats;
- **Seizing**: the ability of a firm to seize already identified opportunities;
- **Sustaining**: the ability of a firm to maintain seized opportunities by monitoring, enhancing, protecting and when necessary reconfiguring both its tangible and intangible assets.

Following up on Teece (2007) model, (Chiu et al. 2016) extends dynamic capabilities into four categories of sensing, coordination, autonomy and reconfiguration capabilities, and further analyses the relationship between those. In particular, "the sensing capability enhances both coordination capability and autonomy capability. Both coordination capability and autonomy capability facilitate reconfiguration capability. Moreover, the reconfiguration capability improves radical innovation" (Chiu et al. 2016).

Finally, in a strongly volatile market, the level of adaptive capability inherent of an organization has been found to be positively correlated with organizational performance (McKee et al. 1989), and ultimately with the ability of a firm to innovate (Liao et al. 2009; Michailova & Zhan 2015; Shafia et al. 2016).

2.2. Innovation and dynamic capabilities

(Schumpeter 1934) was the first researcher to define innovation as "*new products or processes, as well as new sources of supply, new markets, or even new ways of organizing business*".

(Abernathy & Clark 1985) proposed a framework to analyze innovation depending on the conditions of the market and the technological capabilities of an organization, which is depicted in Figure 1.

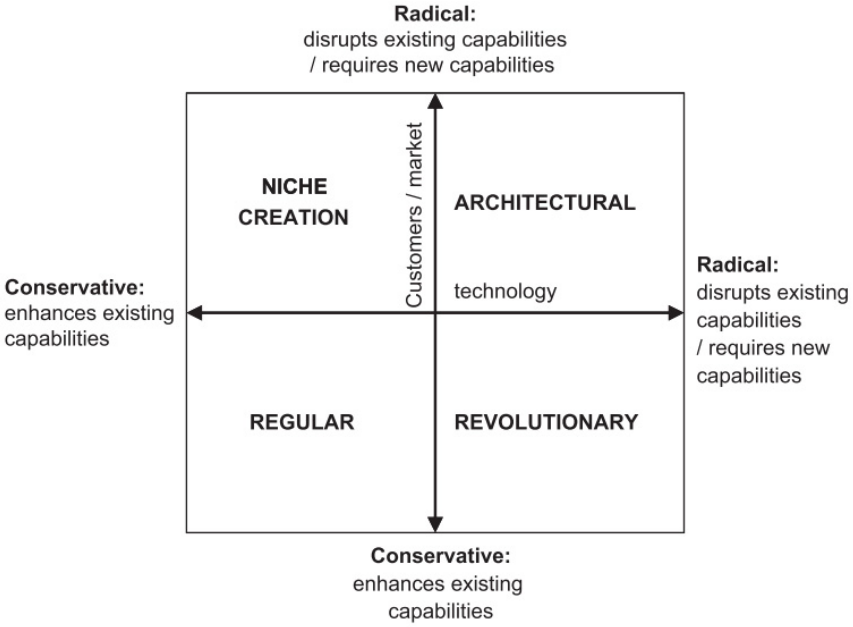


Figure 1 Abernathy & Clark (1985) Innovation Framework. Adapted from Ellonen et al. (2009)

According to (Abernathy & Clark 1985; Ellonen et al. 2009) there are four types of innovation:

- **Architectural Innovation** in which new technology is brought into new markets;
- **Niche creation** in which a firm seeks new market opportunities by targeting a specific customer segment, leveraging existing capabilities and technologies;
- **Revolutionary innovation** in which breakthrough or disruptive technologies emerge in the existing market;
- **Regular innovation** or also "**Incremental Innovation**", in which existing products or technologies are incrementally improved within the existing markets by leveraging existing capabilities.

A first hint on the relationship between dynamic capabilities and innovation can be found in (Porter 1990b): in turbulent environments, a firm is able to innovate only by revising and obsoleting its existing strategy and organizational structure. This relationship has been further explored by (Breznik & Hisrich 2014), who recognized dynamic capabilities to be the precondition or basis for innovation and indicated cases in which there was actually no difference between innovation and dynamic capability at all.

(Ellonen et al. 2009) explored the relationship between dynamic capabilities and the different types of innovation, as proposed by (Abernathy & Clark 1985). Firms that had very strong abilities to reconfigure their resource base were found to be better in leveraging existing technologies and capabilities in innovation development.

In particular, companies with strong capabilities in all three areas of "*sensing, seizing and reconfiguration*" (Teece 2007) were found to rely both on existing and newly acquired capabilities to improve products for new customers ("niche creation innovation") or develop new technologies for new markets ("revolutionary innovation"). On the other hand, firms which leveraged only one aspect of dynamic capabilities without fostering for example the "reconfiguration" aspect, were found to be mostly relying on pure exploration of new technologies ("architectural innovation").

The above findings are also found in both (Benner & Tushman 2003) and (Cheng & Chen 2013) who demonstrated that "*there are decreasing returns from the pure exploration of new capabilities on new knowledge creation*" (Ellonen et al. 2009). According to (Benner & Tushman 2003) the self-enforcing nature of learning provides in fact more incremental rather than breakthrough innovation. If dynamic capabilities supported by learning contribute proportionally to incremental innovation (Zollo & Winter 2002; Benner & Tushman 2003), on the other hand their relationship with breakthrough innovation has been found to be U-Shaped (Cheng & Chen 2013): the longer firms have dynamic capabilities, the more rooted they become in their own environment, hence the highest degree of breakthrough innovation occurs only during the early stages of dynamic capabilities development (Cheng & Chen 2013), and an increase of process management practices decreases breakthrough innovation yet still enhancing incremental one (Benner & Tushman 2003).

(Lawson & Samson 2001) proposes that innovation management can be viewed as a form of organization dynamic capability and that innovation can be defined as the ability to continuously transform knowledge into new products, processes or services for the benefit of the firm. (Shih-Yi Chen Ching-Han 2012) further expands on such line of research by not only confirming the role of dynamic capabilities in enhancing a firm's performance, but also highlighting the positive contribution of learning in support of such relationship.

Finally, according to (Cheng et al. 2016), the effectiveness of a firm innovation is contingent on the presence of both knowledge acquisition and knowledge sharing capabilities.

2.3. Knowledge management and dynamic capabilities

Knowledge Management and intellectual capital constitute intangible assets that an organization must manage in order to achieve competitive advantage versus its competitors (Sunassee & Sewry 2002).

(Demarest 1997) defines Knowledge Management as "*the systemic underpinning, observation, instrumentation and optimization of a firm's knowledge economies*". (Nonaka & Takeuchi 1995) distinguishes between two different types of knowledge:

- **Explicit Knowledge** is knowledge that can be readily articulated, codified, accessed and verbalized (Nonaka & Takeuchi 1995). The most common forms of explicit knowledge are documents, procedures or manuals that an organization uses;
- **Tacit Knowledge** is knowledge that is defined as skills, ideas and experiences that people have in their minds and that therefore is difficult to access or to express (Polanyi 1969).

According to (Nonaka et al. 1996), knowledge within an organization is created following a never-ending process of both explicit and tacit knowledge conversion. In order to make use of tacit knowledge it is first necessary to represent it in an external, tangible form that can be used by others, hence it is necessary to convert tacit knowledge into explicit one (Nonaka & Takeuchi 1995).

As shown in Figure 2 the process of knowledge creation and conversion is a spiral which is composed of three different phases of *externalization*, *objectification* and *internalization* (Huysman & DeWit 2002).

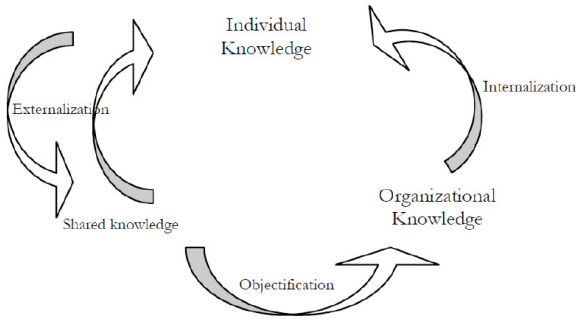


Figure 2: The Knowledge Sharing Cycle (Huysman & DeWit 2002)

Externalization indicates a phase in which individuals share knowledge with their peers. In this phase experience is externalized by means of analogies or concepts which trigger dialogue or collective reflection (hence knowledge moves from being tacit to explicit)(Nonaka et al. 1996).

Objectification is the process of globalizing local knowledge (Von Krogh et al. 2000). In this phase already explicit concepts are systemized and grouped together into a new knowledge system (Nonaka et al. 1996). Such system, which is available and shared among all the community, builds up the organizational knowledge (Huysman & DeWit 2002).

Internalization is defined as the process by which "*business' employees acquire knowledge from their work environment and their interactions with fellow employees*" (Huysman & DeWit 2002).With this process explicit organizational knowledge is internalized by the individual in the form of a shared mental model or technical know-how, which therefore becomes an organization valuable asset (This is

also referred as "*learning by doing*" in which knowledge goes from being explicit back to tacit) (Nonaka et al. 1996).

According to (Eisenhardt & Martin 2000), knowledge management is at the very heart of an organization's dynamic capability. Not only in fact can knowledge be seen an internal intangible resource that the organization has at its disposal, but the process to actually manage knowledge has been recognized to be fundamental for preserving and updating dynamic capabilities in order to sustain organizational performance (Krzakiewicz 2013). In particular, organizations that introduce knowledge management practices are found to be more innovative than the average firm (Lundvall & Nielsen 2007).

Despite being a common understanding that the framework of dynamic capabilities and knowledge management are somehow interrelated (Eisenhardt & Martin 2000), the very first analysis of such relationship was performed by (Easterby-Smith & Prieto 2008; Zollo & Winter 2002), who recognized the importance of Knowledge Management as a supporting infrastructure to enable Dynamic Capabilities and identified the learning process as the linkage that would enable such relationship, as also shown in Figure 3.

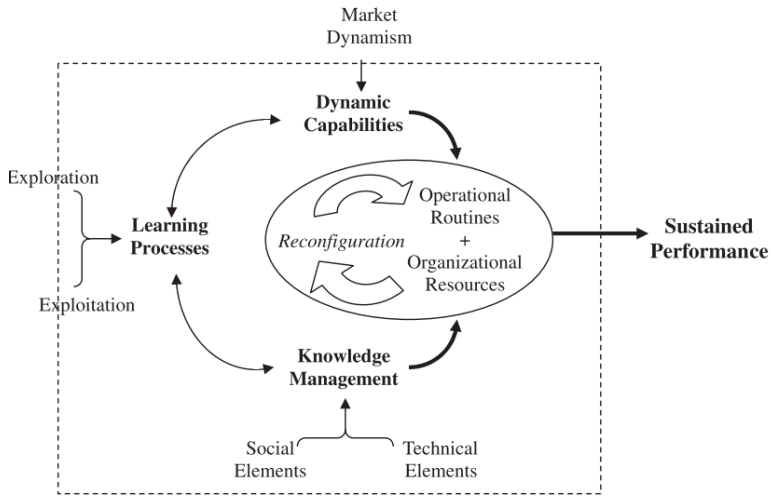


Figure 3 A Framework Linking Knowledge Management and Dynamic Capability (Easterby-Smith & Prieto 2008)

(Giniuniene & Jurksiene 2015) as well recognized organizational learning as a mediating role that supports an organization's dynamic capabilities and further confirmed the role of knowledge management and organizational learning as an important enabler of innovation and ultimately enhancer of a firm's performance.

The mediating role of learning in the relationship between dynamic capabilities and innovation was further analyzed in literature by (Zollo & Winter 2002), who confirmed that dynamic capabilities are shaped by the coevolution of the learning mechanisms of experience accumulation, knowledge articulation and codification. This finding is in line with the previously described organizational knowledge creation models presented by (Nonaka et al. 1996) and (Huysman & DeWit 2002).

In particular, "experience accumulation", refers to the internalization of individual experiences and behaviors as an outcome of performing a task. "Knowledge articulation" takes place when individuals start to externalize the tacit knowledge they possess by sharing it with others.

Such knowledge becomes then "explicit" as its existence moves from the mind of the individual employee to the community and is then finally "codified" in written procedures that become practice of the entire organization (Zollo & Winter 2002).

Since organizational learning can only be achieved through individual learning (Zollo & Winter 2002), organizations have started to make knowledge management sharing practices a direct part of a firm's strategy, by encouraging individual's innovative thinking and competencies sharing (Sunassee & Sewry 2002).

According to (Liu & Cui 2012), within the enterprise, tacit knowledge can be shared by means of trial and error and by fostering communication and experience sharing while working with experts or in a team (Yuqin et al. 2012).

(Ghobadi 2015) has proposed a framework that describes several factors influencing tacit knowledge sharing among teams. The following aspects are considered as main drivers of knowledge sharing activities:

- **Technology-related drivers**, such as project methodology and technologies used for collaboration
- **Organizational-related drivers**, such as roles and task assignments within the team, leadership styles employed, as well as organizational culture and team level of autonomy
- **Task-related drivers**, such as project risks, shared tasks between team members and knowledge on the project
- **People-related drivers,** such as extrinsic and intrinsic motives, sense of identity and belonging to the group.

Finally, (Ryan & O'Connor 2013) underlines how tacit knowledge is acquired and shared mostly thanks to social interactions among team members, and further recognizes both the challenges and the importance of managing tacit knowledge sharing in an Agile Development environment.

2.5. The Agile Development framework

Agile is an industry agnostic framework aimed at providing efficient and timely product iterations that give added value to customers through regular and progressive deliveries, incorporating both increased functionality and customer feedback (Highsmith & Cockburn 2001). This approach is a marked divergence from techniques which due to the length of development often deliver something that the customer didn't ask for, or just as likely, no longer meet the customer current requirements due to changes over time (Schaeffer 2016).

Although widely used in the software development industry, the mechanics as defined in the Agile Manifesto (http://agilemanifesto.org/) can equally be applied to other industries (Conforto et al. 2014), and have in the recent years become a trusted and preferred method for an organization to achieve competitive advantage (Harvard Business Review Analytic Services 2015).

The origins of Agile as a concept were laid down as a response to the shortcomings of the traditional Waterfall-based approaches to software project development. Such development practices had significant disadvantages from the customer perspective in that timescales for product delivery were long, with requirements often changing in the interim, and focus being heavily of documentation at the outset (Huo et al. 2004). The comparison of when documentation is delivered as part of the development lifecycle can be seen from the diagram below (Kumar 2016).

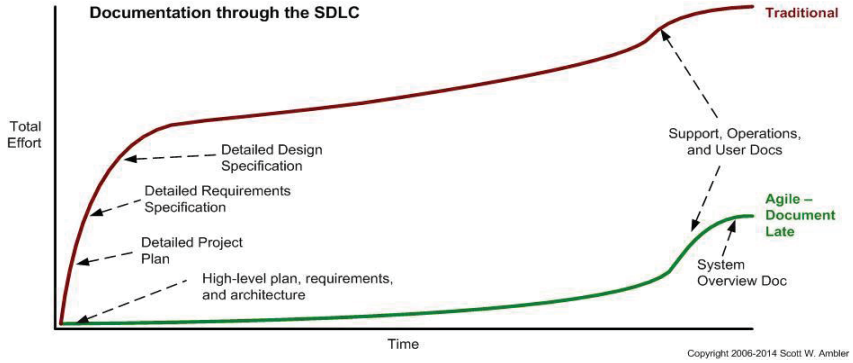


Figure 4 Documentation in Agile and Waterfall (Kumar 2016)

On the other hand, Agile is deliberately lightweight. It has no constraints from either technology or industry but merely lays down several basic customer-centric guidelines upon which implementations, such as Scrum or Kanban, can be built. The commonality across all these implementations is the same - an attempt to create collaborative development by removing the constraints of process in favor of productivity (Dingsoyr et al. 2012).

Previous process-driven mechanisms, such as waterfall were purely sequential in their nature. One step in the sequence had to be completed before the next could be started - this led to lengthy time spans before the product was delivered (the final stage). Agile removed this process by promoting the idea of doing just enough of everything to allow the next release to be completed - whether this be coding, documentation, testing - the exact breakdown is fully and entirely defined within the sprint user stories after completing which a new potentially releasable version of software could be delivered to the customer (Schaeffer 2016), as also shown in Figure 5.

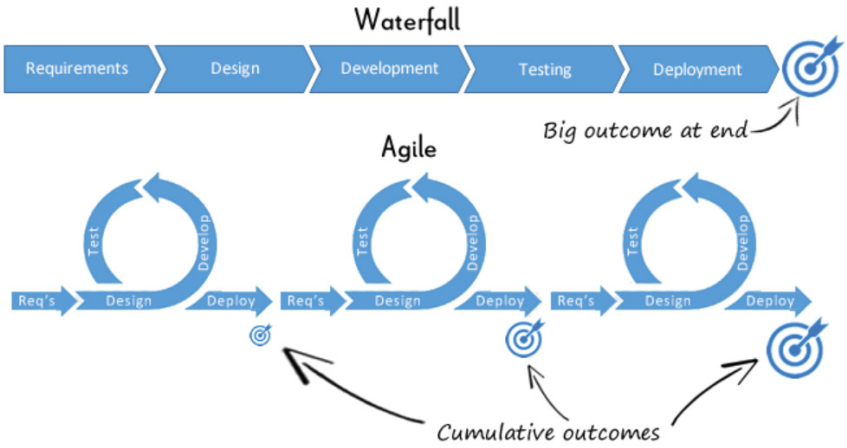


Figure 5 Waterfall vs Agile (Schaeffer 2016)

The Agile Manifesto, upon which this customer focused approach is built upon, can be summarized into the following statements:

- **Individuals and interactions**: self-organization and motivation are important, as are interactions like co-location and pair programming. Teams and team members make the decisions on how problems are solved. Solutions evolve in consensus rather than being dictated from outside. Familiarity of actions providing regular feedback to the customer and the team are essential to steering the project to its goal. Iterative code review and inspection are one of the first pillars of Agile (Roxas 2013);
- **Customer collaboration**: requirements cannot be fully collected at the beginning of the software development cycle, therefore continuous customer or stakeholder involvement is essential; Whereas older methodologies only tended to interact with the user during the initial requirements gather, agile encourages the customer, as another stakeholder, to be involved at all stages of development, providing essential feedback that is fed back into later iterations of the development cycle. Such interactions provide the customer with a cooperative and open work environment and allows them immediately to see the progress that is being made towards their ultimate goals. Transparency (to both the customer and the team) is the second pillar upon which Agile is based (Roxas 2013)
- **Produce working software**: working software is more useful and welcome than just presenting documents to clients in meetings. Incremental improvements are developed over time to provide added functionality and value to the customer. Ideally, the product in its current form would be demonstrated to the customer as a direct means of receiving feedback and possibly changed requirements. At the end of each iteration the task of reflection is performed to gain insights into what went well and what can be improved going forward.
- **Ability to respond to change**: agile methods are focused on quick responses to change and continuous development rather than theoretical processes and static documentation, and are characterized by the ability to adapt to changing environment quickly, to allow changes in directions to be adopted as products evolve and are developed. Adaption to changes is the third pillar of Agile (Kessler & Williams 2013; Roxas 2013).

None of the above principles and components are new to software development, but what made agile different is the way these items are combined into a "theoretical and practical framework" (Highsmith & Cockburn 2001) providing a forum that "actively to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy, quality, and simplicity), through its collective components and relationships with its environment" (Conboy 2009).

2.6. Knowledge Sharing in Agile Development

One of the main differences between Agile Methodologies and waterfall-based approaches lies in the way they manage knowledge (Chau & Maurer 2003).

The waterfall model is "plan-driven" and mostly relies on documentation (explicit knowledge) (Takpuie & Tanner 2016). On the other hand Agile methods favor interactions and individual over processes (Dingsoyr et al. 2012), leading to informal communication among teams and the existence of "tacit" knowledge (Santos et al. 2014), which exists only in the mind of individual and is consequently at risk of being lost (Leon de La Barra et al. 2013). An organization's internal work environment needs therefore to preserve and sustain such knowledge in order to build its core expertise and market value (Amritesh & Misra 2014).

In the attempt to transform and absorb individual's tacit knowledge into the core organizational knowledge, software development processes have developed different techniques for knowledge sharing and creation (Ersoy & Mahdy 2015), of which the Agile Development framework makes particularly intense use of (Amritesh & Misra 2014; Dingsoyr et al. 2012).

Jacobson (2008) described knowledge sharing as "*an exchange of knowledge between two individuals: one who communicates knowledge (the sender) and one who assimilates it (the receiver)*".

Knowledge sharing within a business is essential as it promotes the creation of new knowledge which can be used as a means of gaining an advantage over competition (Lesser and Stork, 2001). Several Agile practices are recognized to foster tacit knowledge sharing and management (Levy & Hazzan 2009; Bari & Ahamad 2011; Kavitha & Irfan Ahmed 2011). Among these are:

- **Whole Teams**: Team members that were originally assigned with individual, separated roles are integrated into the development process as a "whole team";
- **Collaborative workplace**: visual management cards and posters are used to communicate the status of the project; hence any stakeholder can know the status of the project at any time;
- **Pair Programming**: Pair programming is an agile development practice in which two programmers work as a producer their combined solution. There are two roles involved in this practice, the "driver" who writes the code and the "observer" who analyses the code written by the driver, as it is written, and assesses it in terms of achieving their goals. The observer considers the impact of the code that is being written with a view to anticipating any potential problems that may occur from the direction the driver is going. It is commonplace for these two roles to be reversed regularly to prevent any subconscious bias being incorporated into the solution by providing two perspectives on the direction and goals that is being taken by the pair (Kavitha & Irfan Ahmed 2011);
- **Open Source Communities/Communities of Practice**: Communities of practice are groups of people who share a concern or passion for something they do and learn how to do it better as they interact regularly (Wenger 1998). Open source communities describe the principle of software development whereby the source code and results are freely available to the public and anyone in the community can contribute to the improvement of the software in a free-form way with minimal constraints and restrictions. Such communities allow the development of software by a team of people who are generally not centralized but work in various locations connected by a network. This approach exhibits many qualities associated with agile development; self-organization of teams, the onboarding of regular feedback from the community and the mutual respect for team members(Corbucci & Goldman 2009).

- **Social Media**: Social media promotes connections being made between people, or groups within a business (Burt 2005). The effectiveness of social media as a tool for knowledge sharing is determined by the ease, degree and impact that knowledge sharing has on the performance of the business. Burt (2005) defined this impact as "*the social capital explains how people do better because they are somehow better connected with other people*".

A survey by Keil and Carmel (1995) indicated that the success or failure of software projects can be attributed for the number of direct links to the customer; the more direct communication that exists the more likely were are of having a successful outcome (Keil & Carmel 1995). This is supported by media richness theory (Daft & Lengel 1986) which support direct communication with customers as a means to improving the richness of the dialogue, receiving immediate feedback to questions and provides cues in more subtle ways, such as body language, voice inflection, rather than the low-bandwidth documentation route supported by the waterfall based approach.

Finally, the above mentioned practices of community knowledge sharing were found to increase organizational performance by dramatically decreasing the learning curve of new employees, enabling quicker responses to customer inquiries and fostering the spawning of new ideas for products and services (Lesser & Storck 2001).

2.8. Hypothesis development & research question

In this thesis work the relationship between dynamic capability, knowledge sharing and innovation, is going to be further investigated in the context of a chosen case study company which adopts agile development methodologies for knowledge sharing and learning.

The **research question** - "*Can the use of agile development techniques for knowledge sharing contribute in enhancing a firm dynamic capabilities and innovation?* "- is going to be further supported by the following **research hypothesis**:

- **Hypothesis 1 (H1):** There is a positive relationship between Agile knowledge sharing practices and enhanced dynamic capabilities
- **Hypothesis 2 (H2):** There is a positive relationship between Agile knowledge sharing practices and innovation

Figure 6 shows the assumed framework used throughout this thesis to support our research questions. The enhancement of dynamic capabilities and innovation within the agile organization are treated as dependent variables. On the other hand, the (tacit) knowledge sharing practices that affect both dynamic capabilities and innovation are considered as independent variables. H1 and H2 predict a ***direct*** and ***positive*** effect of agile knowledge sharing practices on both dynamic capabilities and innovation.

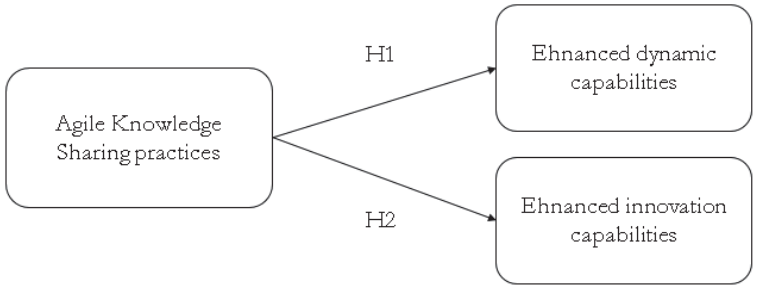


Figure 6 Proposed Hypothesis

The above proposed research question and hypothesis were constructed as a result of the literature review performed during this thesis work and summarized in the previous sections of this chapter.

In particular, the effect of knowledge management on both dynamic capabilities and innovation has been highlighted in literature by both (Zollo & Winter 2002) and (Giniuniene & Jurksiene 2015), who saw in knowledge management the mediating link between an organization's dynamic capabilities and its ability to innovate.

Effective and efficient knowledge flows within firms are in fact critical in establishing and maintaining dynamic capabilities (Sher & Lee 2004), which are the basis of increased organizational performance (Teece 2016; Teece 2013; Mankins & Steele 2005). Furthermore innovation requires as well knowledge to be properly managed and retained (Lawson & Samson 2001; Lubit 2001).

An organization that adopts agile methodologies for product development faces several challenges to manage knowledge (Bari & Ahamad 2011; Yuqin et al. 2012; Johannessen et al. 2001), being such methodologies based on "tacit" knowledge, that is experimental and verbal, rather than easily codified and transmitted across the organization (Polanyi 1969).

By adopting knowledge sharing practices, "tacit" knowledge and "tacit" routines can be externalized into tangible "explicit knowledge" within the organization (Zollo & Winter 2002; Nonaka & Takeuchi 1995; Huysman & DeWit 2002), leading to richer cognitive understandings of an organization activities and behaviors, which ultimately promotes incremental (Benner & Tushman 2003) and to some extent breakthrough innovation (Cheng & Chen 2013; Ellonen et al. 2009).

Practices of agile knowledge sharing that are commonly used among software development teams are recognized to be predictors of improved work efficiency (Ryan & O'Connor 2009; Chau & Maurer 2003) and increased software quality (Huo et al. 2004). However, only with a proper balance on "tacit" and "explicit" knowledge sharing activities, software development teams are able to transfer the acquired knowledge at the organizational level (Ryan & O'Connor 2013), therefore contributing in enhancing its dynamic capabilities (Eisenhardt & Martin 2000).

We have chosen to analyse our research hypothesis with the theoretical framework introduced above, as such framework stems as a direct result of the work of (Teece et al. 1997) and (Eisenhardt & Martin 2000), who were the first to define the essence and importance of dynamic capabilities in an organization. Such framework consequently produced a massive stream of reviews and literature, indicating the importance as well as the actuality of the topic, that continues, despite only a few critiques, until today (Barreto 2010).

3. Methodology

This chapter introduces to the methodologies used to research, collect and analyze data. Finally, an overview of the case study company and its knowledge management framework is provided, as well as ethical considerations commented.

3.1. Research strategy

Yin (2009) describes research strategies as *"an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and the context are not clear… It allows the investigation to retain the holistic and meaningful characteristics of real-life events—such as individual life cycles, organizational and managerial processes, neighborhood change, international relations, and the maturation of industries"* (Yin 2009).

Such strategies can be categorized into five different groupings:

- **Survey-based**: Surveys are often used to gather quantitative data, but may also gather qualitative information through open-ended questions. Surveys are carried out on a sample of respondents from a selected population usually selected by using a questionnaire. They are flexible in nature and are not limited or restricted by the sample or population size. Once completed survey data needs to be analyzed to produce useful meaningful insights (Kelley et al. 2003).
- **Interviews:** Interviews can be highly flexible and may either be highly formalized or informal in nature depending on the desired outcome. Interviews tend to be in one of three main categories, depending upon the degree to which they are structured: structured, semi-structured and unstructured interviews. Structured interviews are based on a predetermined set of questions, allowing no deviation from these questions and structure imposed by the questions' order and format. Unstructured interviews start with a few broad questions or areas for discussion. Once the conversation has begun the interviewer can have the freedom to dig deeper into areas of interest led and prompted by the interviewees' answers and manner (Mack et al. 2011) .
- **Experimental:** An experimental strategy is primarily aimed at establishing a causal link between two variables. One of the two variables are altered under controlled conditions and the effect, if any, of the second is observed and recorded. All other variables in the system are kept constant to remove them from any perceived change.
- **Archival or Historical Analysis:** as its name suggest this approach uses results obtained from previous experiments as the source for new study. The aim being to find patterns and trends in previous independent work, as the foundation to support current findings.
- **Case Studies:** A focused study on a social units, in this case a business, that tries to determine what factors led to its success or failure (Yin 2009).

In selecting a research strategy it is important to choose an approach that is the most suitable for addressing the research problem under investigation and the nature of the results that such an inquiry will produce (Yin 2009). These approaches can broadly be categorized in three ways: qualitative, quantitative and a mixed method approach, which, as its name suggests, uses features of both (Leech & Onwuegbuzie 2009).

3.1.1. Qualitative research methods

Qualitative research methods address the cultural issues of people and their experiences and interactions within social gatherings and group (Holloway 1997).

The nature of the qualitative approach provides a subjective way to analyze the more informal, less concrete attributes of a research topic. Due to its subjective nature, such an approach is more valuable in situations where hard and fast statistical analysis of data is not possible (Yin 2009).

There are three widely used qualitative techniques than can be used to this end (Mack et al. 2011):

- observing the people providing the data and analyzing their behavior whilst in a common and well known environment;
- performing detailed interviews to collect and collate the experiences of the participants and their viewpoints on the topics under discussion;
- using of targeted focus groups for collecting information to be used in creating an overview of the topics being investigated.

3.1.2. Quantitative research methods

These methods are more suited to capturing empirical data about the processes and their interactions. The quantifiable nature of this approach readily allows data analysis to be performed to highlight and correlations and other comparative measurements. There are many ways to capture concrete data using quantitative techniques including the use of surveys and questionnaires with the individuals in the target group (Yin 2009).

3.1.3. Mixed research methods

As it name suggested, mixed research methods *(*or just *mixed method)*, combines elements of each of the above two techniques and tailors them towards the specific research problem, thereby leveraging the benefits of each to achieve the best results given the problem domain (Bryann & Bell 2007). As also suggested by (Yin 2009) the mixed method approach provides the researcher with the flexibility to pick and choose the features of each approach to create a problem specific cocktail of techniques and strategies unique to the problem space and thereby offering strong deductions and a wider range of views (Tashakori & Teddlie 2003).

Our choice of a method has been based on two key factors: the ability to provide an analysis on the influence of the knowledge sharing activities within the organization as suggested by Creswell (2009), together with the need to explore the phenomena in its natural context (Cavaye 1996). These two factors have directed us to undertake an exploratory case study on CompanyX, described in more details in section 3.3 of this thesis work, which will be carried out using a mixed methodology of research (Yin 2009).

The **unit of analysis** of the case study will focus on software development projects and their associated teams. This unit of analysis has been chosen because recognized to be the most adequate to investigate the research question, as several projects run at CompanyX at the same time making it is very easy to gather needed data for the case study and generalize on the eventual research findings.

3.2. The Case Study Company

In this thesis work the name of the selected case study organization has been protected by using the alias "CompanyX".

CompanyX, is a software development company based in the south of Germany, which is dedicated to transform the way its customers sells and owns cars, since its foundation in 2001.

With a proven industry focus and software development expertise, CompanyX provides proprietary software solutions for car manufacturers and their dealer networks around the world and successfully supports all key business processes in the automotive industry by providing tools to drive their efficiency and effectiveness.

Its software solutions are the result of continuous investment and development, incorporating valuable feedback from customers and partners around the world.

CompanyX is committed to delivering global solutions that meet local needs. To achieve this, the company has built a global presence through offices in Europe, Russia, Asia Pacific, Middle East and Latin America as well as a network of selected partners committed to providing excellent customer service and local market expertise.

Provided the global presence of the organization, the case study has been limited to the German site, which constitutes its Headquarters and it is the site where software development activities as well as R&D workforce are centralized.

The German Headquarter is composed of three distinct but interrelated departments:

- **The Research & Development Department** consisting of both junior and senior developers, which are responsible for all software development and product development functions within the business. The resources within this department are allocated to projects on a needs basis. Senior staff members are assigned as team leaders and several cross-functional teams are created below them. The nature of the skills in any given team will depend on the requirements of the project under consideration. Once a team has been created to service a project it is assigned to a Product Owner, who serves as interface between the business and the external customers and is responsible to translate customer requirements into development activities to be fulfilled by the specific project team.

- **The Sales and Marketing Department** which promotes the company's values and ethics to the potential customers and performs all financial and accounting processes such as billing customers and chasing up overdue payments.

- **The Human Resources Department** which is responsible to oversee the organization hiring process, as well as manage employee competencies and professional development with ongoing training activities as well as career development programs.

Throughout the business and its operations, CompanyX makes use of a variegated knowledge management strategy, supported by suitable knowledge management tools used by employees working in the different department, as shown in Figure 7.

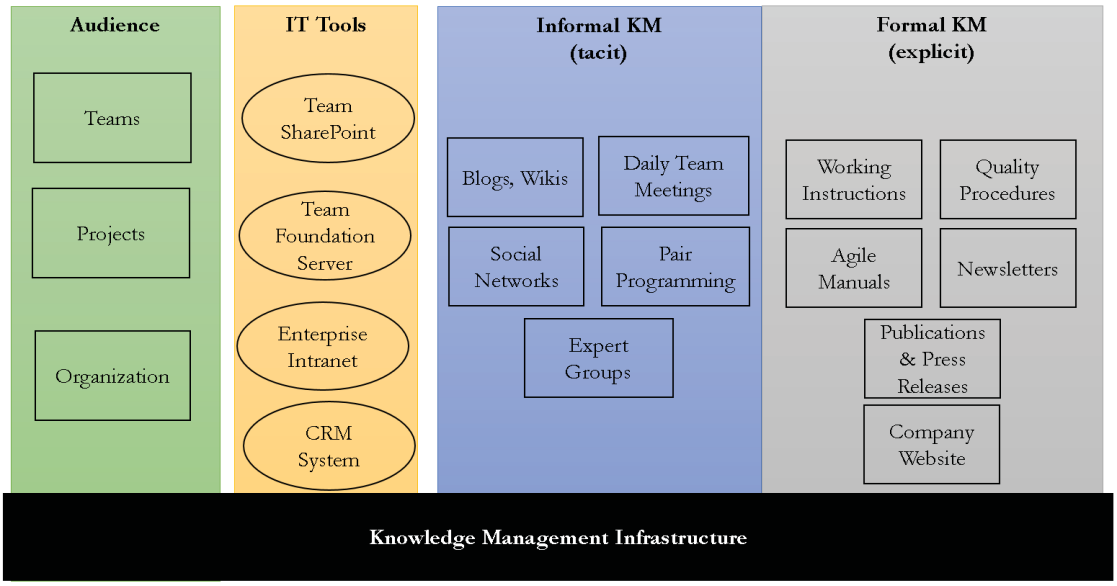


Figure 7 Knowledge Management infrastructure of CompanyX

As shown in Figure 7, tacit knowledge is managed within the organization mostly at the Team and Project level, using team-based wikis, as well as daily management meetings that are carried out by the project team members to share information, experience and discuss on the overall project progresses and direction. During the daily management meetings, the teams make use of visual boards, on which information on the project is posted daily for everyone to review and access. Moreover, pair-programming is used among software developers as the main activity to share technical information on the details for a software project or software unit coding.

The above described activities on knowledge sharing are supported by a systematic IT infrastructure, which sees tools such as SharePoint, Team Foundation Server and Trello as main tools used to share knowledge and project-related news among team members belonging to the software development department.

Finally, the tacit information and experience gathered at project level are reviewed monthly in so-called "Expert Groups", where decision is made of whether to translate lessons learned in documented manuals or working instructions, which are therefore used as a mean to codify the team "tacit" knowledge into an "explicit" form that the overall organization can leverage for its competitive advantage.

3.3. Data Collection Methods

A mixed method approach (Leech & Onwuegbuzie 2009) supported by a survey questionnaire as the main source of captured data together with site observations was used to test the research hypothesis, since the factors that we want to look at, and their relative contributions, include employee involvement in the knowledge management and sharing process (Tashakori & Teddlie 2003).

To increase the reliability of the gathered data, data triangulation was used as suggested by Yin (2009). In particular document reviews and face-to-face interviews were compensated by an analysis of structured surveys with the aim of answering the research question and each related proposition thanks to the use of both qualitative and quantitative data (Yin 2009):

Both the surveys and the face-to-face interviews, as well as direct observations, were used as the foundation for getting information related to the research problem. Using more than one source of information removes any limitations in using one method over the others, giving researchers a better degree of understanding around the research problem as indicated by Creswell (2009).

3.3.1. Study Population and Sampling

This study aimed to access a broad enough set of people in order to reflect as much as possible the employees situation within the business of CompanyX (Creswell 2009).

We restricted our target population to software developers, as they are the ones closer to the software development processes and knowledge sharing activities, and their managers, as they are the ones being accountable for the overall product innovation and knowledge management process.

An independent selection process was setup to create a sample that would be representative of the overall population (Walliman 2006). Among the 100 employees working in the Research & Development Department, 4 software developers belonging to 5 different R&D projects were selected randomly, for a total of 20 software development engineers that were used as the main target audience for the survey process. This random selection process guarantees that each employee within the targeted group had an equal chance of being selected from the sample.

Only a representative subsample of employees, was chosen to take part in the face-to-face interviews. The selection criteria for this choice was based upon the following key criteria:

- Level of Seniority
- Years of experience in knowledge management practices of agile development
- Ability to influence organizational capabilities of resource planning, deployment and reconfiguration.

Based on the above key criteria, only 1 senior manager, among the 20 randomly selected software developers was interviewed. The remainder of the population was instead queried via the survey.

3.3.2. Survey Design

An online survey questionnaire, hosted by Survey Monkey (www.surveymonkey.com), was used to collect and collate quantitative data from within the organization.

The survey was organized and standardized by giving all survey candidates the same set of questions, in the same order, together with the same set of completion instructions at the same time via a link provided by email. This removed any unintentional bias for the survey distribution and external factors that might influence those taking the survey, such as time of day, location etc. (Kelley et al. 2003).

Respondents were also being informed that the answers they would give will be confidential and anonymous and further the information would not be communicated beyond the researchers, although the overall analysis details may be shown to the business management for future planning and analysis purposes (Yin 2009):

The survey questionnaire (as stated in Appendix A: Survey & **Interview Questions**s), contained a first section composed by open-ended questions being focused on demographics data, which were used to build up an overall picture of the survey participants and allowed us to identify any potential demographic trends that might have influenced the survey responses. The second part of the survey was composed of closed-end questions in which participants were asked to rate (on a 5-point Linkert Scale between 1 (Extremely disagree) to 5 (Extremely Agree)) their agreement and personal perception on several statements which were used to measure each one of the research hypothesis.

For each variable used in our research framework (as in Figure 6) the following measurements were developed, taking into account relevant precedent research literature (Kelley et al. 2003), as showed in the below tables:

Agile knowledge sharing practices as enhancer of dynamic capabilities	
Measurement	**Sources of previous research**
Firm can share information effectively	(Cheng et al. 2016)
Agile practices of knowledge sharing increase the mutual understanding among team members if well utilized by employees	(Bari & Ahamad 2011) (Ersoy & Mahdy 2015) (Santos et al. 2014)
Agile practices of knowledge sharing reduce uncertainties in work	(Amritesh & Misra 2014) (Endres et al. 2007)
Agile practices of knowledge sharing reduce dependencies on personnel retention and prevent knowledge loss	(Pee et al. 2010) (Bari & Ahamad 2011)
Agile practices of knowledge sharing increase team work output and facilitate team coordination	(Endres et al. 2007) (Lesser & Storck 2001) (Takpuie & Tanner 2016)
Knowledge sharing outputs are internalized and used for continuous organizational learning	(Shih-Yi Chen Ching-Han 2012) (Zollo & Winter 2002)

Table 1 Survey Measurements for agile knowledge sharing as enhancer of dynamic capabilities

Agile knowledge sharing practices as enabler of innovation	
Measurement	**Sources of previous research**
Agile knowledge sharing practices are contributors of competitive advantage	(Leffingwell & Muirhead 2004)
Agile knowledge sharing practices enable a better exploitation of innovation capabilities	(Donate & Guadamillas 2011) (Lee 2016) (Lundvall & Nielsen 2007)
Agile knowledge sharing practices contribute to the ability of continuously transforming knowledge into new ideas, products or practices	(Breznik & Hisrich 2014) (Santos et al. 2014)
Agile knowledge sharing practices allow the production of better software quality	(Huo et al. 2004) (Johannessen et al. 2001)
Agile knowledge sharing practices are used to create and explore new knowledge	(Leon de La Barra et al. 2013) (Ryan & O'Connor 2009)

Table 2 Survey Measurements for agile knowledge sharing as enabler of innovation

Dynamic and Innovation Capabilities	
Measurement	**Sources of previous research**
Firm has enhanced capabilities of communication and coordination	(Sher & Lee 2004) (Lawson & Samson 2001)
Firm has enhanced customer relationships and continuously gather and use feedback from customers	(Sher & Lee 2004) (Cheng et al. 2016)
Firm has enhanced integration of knowledge in new product development	(Eisenhardt & Martin 2000)
Firm has enhanced responsiveness to changes	(Shih-Yi Chen Ching-Han 2012)
Firm introduces new products /services that are more innovative than competitors	(Cheng et al. 2016) (Lubit 2001) (Wilson & Doz 2011)

Table 3 Survey Measurements for dynamic and innovation capabilities

Following the good practices indicated by (Kelley et al. 2003), the questionnaire was piloted with a sample of members of the target population in order to verify if respondents would understood the instructions and the questions being provided. Adjustments to the survey questions based on feedback received during the pilot phase were made as necessary.

To guarantee high level of response rates, the survey questionnaire was left open for ten working days and after 5 working days an email was sent out as a reminder to all survey participants to solicit timely responses (Kelley et al. 2003). This approach was done to reduce the biasing of the survey responses and eliminate any top down pressure from managers that may have been inadvertently introduced.

3.3.3. Interviews Design

The second phase of the study was based on a smaller set of faces to face interviews, carried out with a subset of employees chosen to be representative of the larger employee population, as well as performing a review of available documentation from the organization.

Once again great effort was made to standardize the interview process and the recording of data taking during these interviews (Mack et al. 2011). The questions used for the interview (were standardized as much as possible and followed the same pattern as the survey questionnaire. Also, the same meeting room was used for all interviews, together with identical surroundings and the same means of recordings and methods for transcribing the interviewees' responses.

Each interview candidates received an identical email which invited them to participate in the interview and provided them with a summary of what the interview would entail; the overall structure nature of the interview together with the focus of the research for which it is being used. Candidates had the choice to decline the interview request without reason, if so desired.

3.4. Ethical Considerations

As also indicated by Yin (2009, p.73) ethical considerations should be part of the design of a case study as ethics come into play when involving individuals.

In this case study, the name of the company has been protected by the alias name "CompanyX".

We obtained permission from the institution before carrying out the study. In this case, the heads of each department were contacted individually and each agreed that employees in their department could be used as part of the study.

All participants in the case study were clearly informed before the data collection process began on the scope of the research as well as its methods and were given the possibility to express feedbacks or concerns on the data collection methods employed as well as were let free to decline participation in the study if wanted.

As surveys were taken with an online tool, it was guaranteed by protecting the IP address of the survey participants that the anonymous nature of the surveys was guaranteed, as well as anonymizing the survey responses in terms of interviewee's names, email addresses and other relevant personal information.

3.5. Data Analysis Methods

The analysis of the data gained from the survey and the face to face interviews in its simplest form is concerned with filtering out the useful information from the rest of the data to support both the research hypothesis and research questions, which were presented in section 2.7.

To avoid making false assumptions about the data (Saunders et al. 2009), it is advisable to create a framework to ensure the empirical data is processed correctly. Some assumptions may still need to be made and it is essential that the researcher make weighted judgement calls on the impacts of these assumptions.

The choice of empirical methods used to perform data analysis were mostly influenced by the theoretical framework presented in Chapter 2, putting an emphasis on "*tacit*" knowledge sharing techniques as enhancers of dynamic capabilities and enablers of innovation, as a way to understand the potential relationship between dynamic capabilities and innovation within the Agile environment of the case study CompanyX (0).

We analyzed the data to gain a clearer understanding of each aspect of the problem and establish how these elements are interconnected. As Mansour (2012) stated "…*those who possess the most of the company's knowledge are very often swamped with work, which prevents the individuals from sharing of their knowledge.*", and as such this bottleneck needs to be dispersed to improve knowledge management (Mansour 2012).

3.5.1. Qualitative data analysis

We used the concept of hermeneutic circle (Cole & Avison 2007) as the basis for our analysis which revolves around the idea of a "spiral of understanding", depicted in Figure 8.

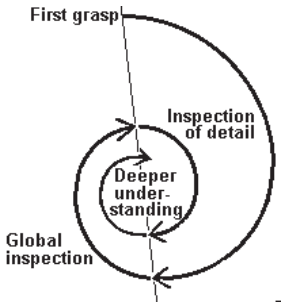


Figure 8 Hermeneutic circle adapted from (Cole & Avison 2007)

This construct has allowed us to look at the problem under investigation and put forward the idea that a problem can be understood by understanding its constituent parts and the relationships between them (Cole & Avison 2007).

Each piece of qualitative data gathered through direct observations, desk review of company information as well as face to face interviews, was analyzed after the event, common themes were highlighted and gathered depending on its important and relevance to the main research focus, and final conclusions drawn from comparison of observed data with literature.

Using the hermeneutic circle approach to ensure that each collected observation was aligned with the overall aims of the research, gave us a better understanding of the key topics and their interrelationship.

3.5.2. Quantitative data analysis

The collected quantitative data needs to be represented in a suitable numerical form. Only then statistical analysis can be performed (Christensen 2007).

After the ten working days in which the survey was open, the individual responses were collected from the participants and transferred in an Excel file for further analysis. Out of 20 software developers originally queried for the interview, only 15 provided a response within the indicated time-frame, for an overall 75% of response rate obtained.

Initially, the demographics of the survey participants were analyzed and descriptive statistics in the form of average and standard deviation of across the subset of survey questions were determined to provide an overview on the overall responses obtained, as shown in section 4.1.

As part of the sanity checking process a reliability and consistency check was performed on the variables used to perform the survey. The internal consistency of the data was determined using the Cronbach alpha correlation test (Tavakol & Dennick 2011).

The Cronbach Alpha Test (Tavakol and Dennick, 2011, p.53) shows how consistent a set of variables are within the value of its coefficient of reliability (the Alpha in the name). This consistency is rated on a fixed scale of between zero and one. An alpha rating approaching the upper end of this scale signifies a higher level of confidence of reliability than a variable towards the lower end of the scale (Cortina 1993; Tavakol & Dennick 2011).

In a real-world scenario, confidence is gained by having as many environment variables with high alpha values being close to one as possible. Naturally most variables will have reliability measure somewhere within this range and not at the upper and lower extremes. How these intermediate values are interpreted, beyond the high-level definition offered by Cortina (1993), is open to a degree of subjectivity. One possible linear segregation is offered by George and Mallory (2003) as shown in the table below:

Cronbach's alpha reliability coefficient	Internal consistency
$0.9 \leq \alpha \leq 1$	Excellent
$0.7 \leq \alpha < 0.9$	Good
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$0 \leq \alpha < 0.5$	Unacceptable

Table 4 Cronbach's alpha interpretation of internal consistency (George and Mallory 2003)

After the quantitative data was collected, a Cronbach alpha reliability test was conducted on the questions related to each hypothesis proposition presented in section 0. The scale presented in Table 4 was used to assess the internal consistency of the results.

Following the reliability testing, cross-correlation among each individual measurement presented in section 3.3.2 was assessed by computing the Spearman correlation coefficient.

Additionally, to deepen the investigation on the relationship between "*tacit*" knowledge management, dynamic capabilities and innovation in the agile environment of CompanyX, a Principal Component Analysis (PCA) was performed.

The main purpose of the PCA, according to Jolliffe (2002), is to reduce the number of variables by transforming the initial large number of correlated variables into a relatively smaller subset of uncorrelated components. Consequently, the PCA analysis also helps in mitigating effects of collinearity between the variables, which would otherwise introduce bias in the analysis results (Jolliffe 2002).

After an initial extraction of the principal components, only the ones that had eigenvalues higher than 1 were retained. To make the interpretation of the retained components easier, the components were transformed using an Oblimin with Kaiser Normalization rotation (Delta=0), which is a linear transformation that is often applied to factors with the purpose of making their interpretation easier by highlighting the factor loadings into each component (Jolliffe 2002).

The rotated components were finally analyzed by identifying the variables which carried the highest loadings. The decision to be made at this stage is to decide how large a factor loading must be to be considered "large". For simplicity, we considered a loading to be "large" if its absolute value exceeds .50.

Once the variables were reduced using PCA, we then applied a multiple linear regression analysis to determine the causality between the dependent variables (respectively dynamic and innovation capabilities at CompanyX) and the reduced independent variables (principal components). We then interpreted the significance of the model using the values of R square and the standardized coefficients (Beta values).

All empirical data collected through Survey Monkey was transferred to an Excel file and after that imported in SPSS. The statistical analysis of the empirical data was performed in SPSS using already built in functions of the tool (e.g. Cronbach Alpha, Spearman correlation, PCA analysis). The complete results of the analysis are reported in Appendix B: Correlations in SPSS, Appendix C: Principal Component Analysis Results, and Appendix D: Multiple Regression Analysis in SPSS.

4. Empirical Findings

The results of the data collection and analysis are presented in this chapter. Also, the empirical findings are discussed and compared to the theoretical framework and conclusions are drawn upon the collected data.

4.1. Profile of respondents and descriptive statistics

Table 5 reports the demographics of the obtained 15 survey responses, sorted according to their job title, years within the company and years of experience with Agile Knowledge Sharing practices.

Demographics (Job Title)	Responses (% of Grand Total)	Years within the company (Avg. Years)	Years of agile experience (Avg. Years)
Functional Designer	6.67%	5	2
Functional Tester	6.67%	4	3
Junior Software Developer	13.33%	2.5	1
Junior Software Tester	6.67%	2	1
Product Designer	13.33%	4	2.5
Senior Software Developer	20.00%	9.3	4
Software Developer	6.67%	3	2
Software Manager	6.67%	10	5
Software Tester	13.33%	4	2.5
Technical Writer	6.67%	2	0.8
	100%	**5**	**2.52**

Table 5 Demographics of Survey Responses (N=15)

As shown in Table 5, the survey addressed a variegated audience of individuals, ranging from Junior Software Developers to Software Managers. On average, the survey participants have been working in CompanyX for 5 years and have had experience or exposure with agile methodologies of knowledge sharing for half of their time within the company (2.52 years on average).

For each survey question, the responses associated with the individual measurement factors reported in section 0 were summarized by computing the average of the responses and their standard deviation for each hypothesis measurement. The survey responses are summarized in Figure 9, Figure 10 and Figure 11 respectively, in the form of box plots developed for each survey question.

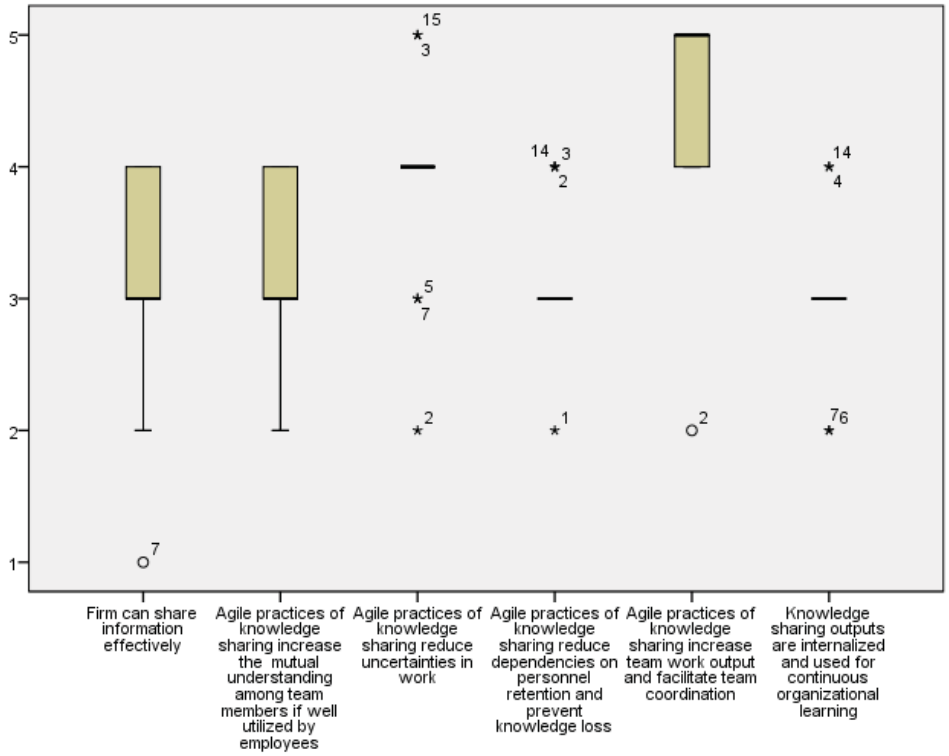


Figure 9 Boxplot for "Agile knowledge sharing as enhancer of dynamic capabilities" measurements (N=15)

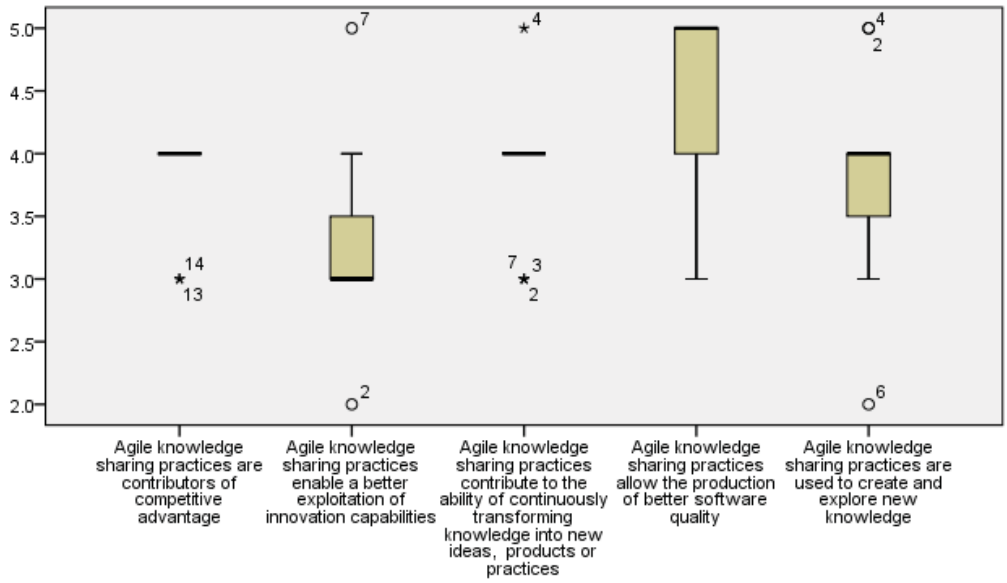


Figure 10 Boxplot for "Agile knowledge sharing as enabler of innovation" measurements (N=15)

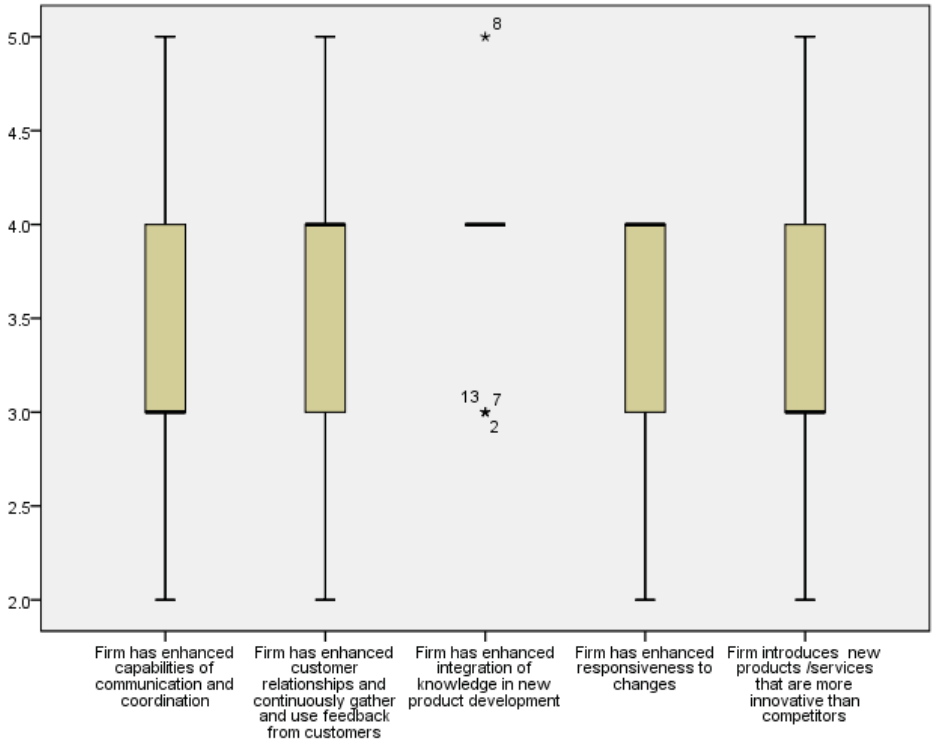


Figure 11 Boxplot for "Dynamic and Innovation Capabilities" measurements (N=15)

4.2. Reliability of Measurements

The results of the correlation analysis performed on the data is reported in Appendix A: Survey & **Interview Questions**, where statistically significant correlations are highlighted with (*) for alpha values equal to 0.05, and with (**) for alpha values equal to 0.01.

Furthermore, the reliability of both dependant and independent variables was tested by means of a Cronbach Alpha test, as discussed in section 0. Results are reported in Table 6.

Hypothesis	Variable Type	No. of Measurements	Min	Max	α
Agile knowledge sharing as enhancer of dynamic capabilities	Independent	6	1	5	0.9268
Agile knowledge sharing as enabler of innovation	Independent	5	1	5	0.9018
Enhanced dynamic capabilities and innovation	Dependent	5	1	5	0.6728

Table 6 Reliability of measurements

Cronbach's α for the 6 measurements of "agile knowledge sharing as enhancer of dynamic capabilities" (H1) was 0.9268. The α for the 5 measurements of "agile knowledge sharing as enabler of innovation" (H2) was 0.9018. Finally, the α for the dynamic capabilities and innovation measurements was 0.6728, demonstrating a high reliability for the measurements, ranging from "Excellent" to "Acceptable" rating, according to the scale in Table 4 Cronbach's alpha interpretation of internal consistency (George and Mallory 2003).

4.3. Principal Component Analysis

Principal Component Analysis was used to reduce the number of factors used to describe each variable and to transform correlated variables into un-correlated ones, to avoid multi-collinearity during regression.

4.3.1. Creating a new set of independent variables

A PCA was conducted on the independent variables "Agile Knowledge Sharing as enhancer of dynamic capabilities" (Table 1) and "Agile Knowledge Sharing as enabler of innovation"(Table 2), which led to the reduction of the factors used to describe such variables from an original number of 11 to 4 principal components.

For the independent variable "*Agile Knowledge Sharing as enhancer of dynamic capabilities*", 2 principal components which accounted for the 70.82% of cumulative variance of the data were extracted, as shown in Figure 12 and Table 7.

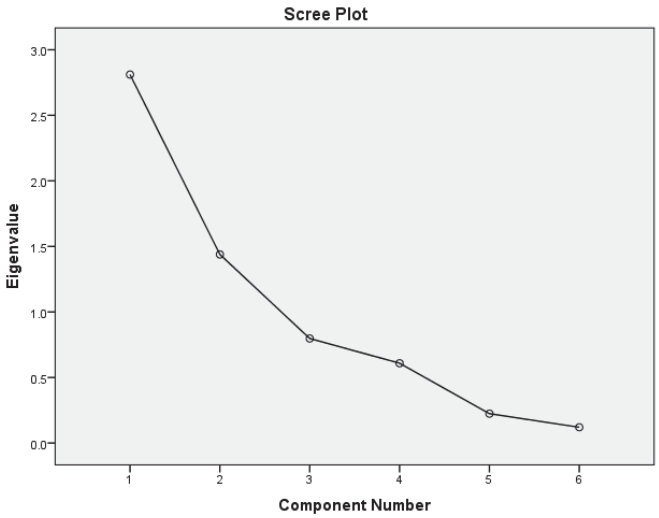


Figure 12 SPSS Scree Plot for Independent Variable "Agile Knowledge Sharing as enhancer of dynamic capabilities"

Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total
1	2.811	46.847	46.847	2.808
2	1.439	23.981	70.828	1.447
3	.797	13.286	84.115	
4	.609	10.148	94.263	
5	.224	3.732	97.995	
6	.120	2.005	100.000	

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 7 Total variance explained of independent variable "Agile Knowledge Sharing as enhancer of dynamic capabilities"

The results of the principal component extraction and consequent Oblimin rotation are showed in the table below:

Variables for "Agile Knowledge Sharing as enhancer of dynamic capabilities"	Principal Components	
	1	2
Agile practices of knowledge sharing reduce uncertainties in work	**.883**	-.208
Agile practices of knowledge sharing increase team work output and facilitate team coordination	**.816**	-.399
Firm can share information effectively	**.771**	.350
Agile practices of knowledge sharing increase the mutual understanding among team members if well utilized by employees	**.729**	.152
Agile practices of knowledge sharing reduce dependencies on personnel retention and prevent knowledge loss	-.223	**.766**
Knowledge sharing outputs are internalized and used for continuous organizational learning	.429	**.712**

Table 8 Principal Components for Independent Variables

In Table 8 the factors which have a loading value of more than 0.50 were highlighted in bold and used as a mean to match the principal components to categories that would reflect the literature expressed in Chapter 2. :

- Principal Component 1 was renamed as "**Team Performance**" as the factors included to such group describe the effect of knowledge sharing on "reduction of uncertainties at work", "increased team work and team coordination", "share of information effectively" and "mutual understanding among team members";
- Principal Component 2 was renamed "**Organizational Performance**", as the factors belonging to such group deal with the ability of the organization to use Agile Knowledge practices for "continuous organizational learning", and to "prevent knowledge loss".

For the independent variable "*Agile Knowledge Sharing as enabler of innovation*", 2 principal components which accounted for the 61.57% of cumulative variance of the data were extracted, as shown in Figure 13 and Table 9.

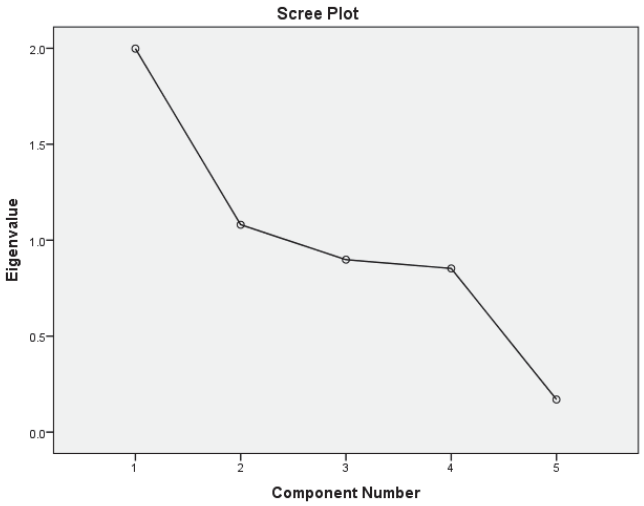


Figure 13 SPSS Scree Plot for Independent Variable "Agile Knowledge Sharing as enabler of innovation"

Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total
1	1.998	39.965	39.965	1.854
2	1.081	21.614	61.579	1.387
3	.898	17.970	79.548	
4	.853	17.057	96.605	
5	.170	3.395	100.000	

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 9 Total variance explained of independent variable "Agile Knowledge Sharing as enabler of innovation"

The results of the principal component extraction and consequent Oblimin rotation are showed in Table 10.

Variables for "Agile Knowledge Sharing as enabler of innovation"	**Principal Components**	
	1	**2**
Agile knowledge sharing practices allow the production of better software quality	**.920**	-.120
Agile knowledge sharing practices contribute to the ability of continuously transforming knowledge into new ideas, products or practices	**.841**	.086
Agile knowledge sharing practices are contributors of competitive advantage	.280	**.819**
Agile knowledge sharing practices enable a better exploitation of innovation capabilities	.165	**-.555**
Agile knowledge sharing practices are used to create and explore new knowledge	-.330	**.529**

Table 10 Principal Components Extraction

In Table 10 the factors which loading more than 0.50 were highlighted in bold and used as a mean to match the principal components to categories that would reflect the literature expressed in Chapter 2:

- Principal Component 3 was renamed "**Product Performance**", as the factors belonging to such group deal with the effects of Agile Knowledge sharing practices on "producing better software quality" and "transforming knowledge into new products";
- Principal Component 4 was renamed as "**Innovation Performance**" as the factors belonging to this component describes the contribution of Agile Knowledge sharing practices to "achieve competitive advantage" as well as the ability of the firm to "explore new knowledge" to "exploit innovation capabilities".

4.3.3. Creating a new set of dependent variables

The 5 original factors used to measure the dependant variable of "Enhanced Dynamic Capabilities and Innovation" (Table 3) were also reduced using the PCA method to 2 Principal Components, which are accounting for 73.75% of the cumulative variance within the data, as showed in Figure 14 and Table 11.

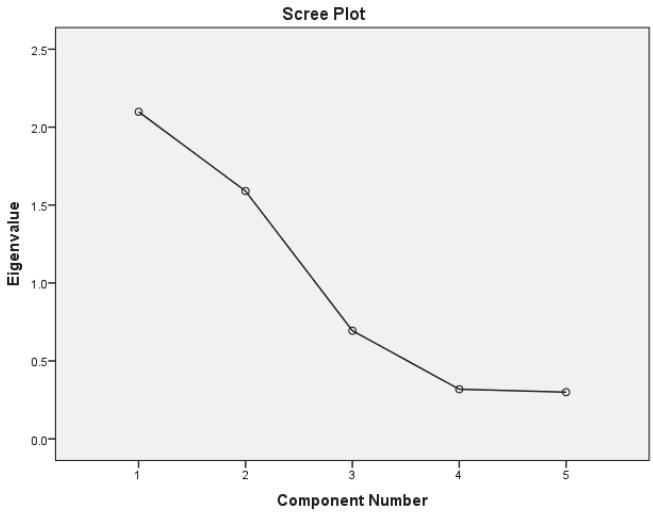


Figure 14 SPSS Scree Plot for Dependent Variables

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.098	41.964	41.964	2.098	41.964	41.964	2.063	41.250	41.250
2	1.590	31.793	73.757	1.590	31.793	73.757	1.625	32.507	73.757
3	.694	13.880	87.637						
4	.318	6.370	94.007						
5	.300	5.993	100.000						

Extraction Method: Principal Component Analysis.

Table 11 SPSS Total variance explained for dependent variables

The results of the principal component extraction and consequent Oblimin rotation process is reported in Table 12, where the factors loading higher than 0.5 are highlighted for each principal component.

Dependent Variables	Components	
	1	2
Firm has enhanced capabilities of communication and coordination	**.877**	-.193
Firm has enhanced responsiveness to changes	**.814**	.316
Firm has enhanced customer relationships and continuously gather and use feedback from customers	**.711**	-.041
Firm introduces new products /services that are more innovative than competitors	-.250	**.871**
Firm has enhanced integration of knowledge in new product development	.248	**.851**

Table 12 Summary of Principal Component Extraction with Oblimin Rotation

Based on the results of the PCA reported in Table 12 and considering the relevant literature, the following principal components are identified as dependent variables:

- Principal Component 1 was renamed as "**Dynamic Capabilities**" as the factors included to such group describe the ability of the firm for "communication and coordination", "responsiveness to change" and "increased customer relationships";
- Principal Component 2 was renamed "**Innovation Capabilities**", as the factors belonging to such group deal with the ability of the organization to "introduce products that are more innovative than competitors" and "integrate knowledge into new product development.

4.4. Multiple Regression Analysis

Multiple regression analysis was used to further investigate the relationship between the dependent variables, respectively "Dynamic Capabilities" and "Innovation Capabilities", and the independent variables as principal components extracted in section 4.3.1, in support of the research hypothesis and research questions presented in section 2.7.

4.4.1. Testing Hypothesis 1

Hypothesis 1 predicted a positive and direct relationship between "dynamic capabilities" and "agile knowledge sharing practices", within CompanyX environment. To test Hypothesis 1, a linear regression was performed on the dependant variable "Dynamic Capabilities", using the independent variables (extracted principal components) of "Team Performance", "Organizational Performance", "Product Performance" and "Innovation Performance" as predictors. Detailed results of the linear regression can be found in Appendix D: Multiple Regression Analysis in SPSS.

Looking at the results of the regression analysis, it is important to note first that the overall statistical significant of the model is supported, since $p<0.05$.

Of the four independent variables "Team Performance", "Organizational Performance", "Product Performance", "Innovation Performance", only the predictor "Innovation Performance" reported a statistically significant coefficient ($b=0.527$, $p=0.044 <0.05$), being able to explain 52.7% of the variation in the dependent variable ($R=0.527$). The remainder predictors did not yield any significant result, therefore were excluded from the model.

The statistically significant factor "Innovation Performance" describes the ability of CompanyX to leverage Agile Knowledge sharing practices to "achieve competitive advantage" as well as the ability of the firm to "explore new knowledge" to "exploit innovation".

On the other hand, the dependant variable of "Dynamic Capabilities" describes the characteristics of CompanyX of experiencing "increased responsiveness to change", "increased communication and coordination capacities" and "increased reception of customer feedback".

The positive value of the beta coefficient of the "Innovation Performance" factor indicates a positive and direct relationship between Dynamic Capabilities and Agile Knowledge Sharing practices, posing focus on the benefits of such practices in allowing a better exploration of knowledge to exploit innovation, thus allowing us to reject the null Hypothesis and to confirm Hypothesis 1 with a 95% level of confidence.

The above finding is consistent with the literature, according to which knowledge sharing practices, if used to explore new knowledge, can be beneficial for an organization to enhance its internal dynamic capabilities and achieve competitive advantage (Lubit 2001; Zollo & Winter 2002).

4.4.2. Testing Hypothesis 2

Hypothesis 2 predicted a positive and direct relationship between "innovation capabilities" and "agile knowledge sharing practices", within CompanyX environment.

To test Hypothesis 2, a linear regression was performed on the dependant variable "Innovation Capabilities", using the independent variables (extracted principal components) of "Team Performance", "Organizational Performance", "Product Performance", and "Innovation Performance" as predictors. Detailed results of the linear regression can be found in Appendix D: Multiple Regression Analysis in SPSS.

Looking at the results of the regression analysis, it is important to note first that the overall statistical significant of the model is supported, since $p<0.05$.

Of the four independent variables "Team Performance", "Organizational Performance", "Product Performance", "Innovation Performance", only the predictor "Team Performance" reported a statistically significant coefficient ($b=0.553$, $p=0.033 <0.05$), being able to explain 55.3% of the variation in the dependent variable ($R=0.553$).

The statistically significant factor "Team Performance" describes the effect of knowledge sharing practices for the "reduction of uncertainties at work", "increased team work and team coordination", "share of information effectively" and "understanding of employees".

On the other hand, the dependant variable of "Innovation Capabilities" describes the ability of CompanyX of to "introduce products that are more innovative than competitors" and "integrate knowledge into new product development practices".

The positive value of the beta coefficient of the "Team Performance" factor indicates a positive and direct relationship between Innovation Capabilities and Agile Knowledge Sharing practices, highlighting focus on the benefits of such practices in increasing team work coordination and synergies, as well as better information sharing, thus allowing us to reject the null Hypothesis and to confirm Hypothesis 2. As such we can conclude that there is a direct and positive relationship between the use of Agile Knowledge Sharing practices and increased innovation capabilities.

The above finding is consistent with the literature, according to which an organization can benefit from the use of knowledge sharing practices to increase team work, which will in turn lead to better product development as well as more effective innovation processes (Santos et al. 2014; Takpuie & Tanner 2016; Ryan & O'Connor 2013).

4.6. Discussion of the results

The purpose of this study was to assess of whether practices for tacit knowledge management and knowledge sharing, can act as enhancers of a firm's dynamic capabilities and enablers of innovation within the agile organization.

We have attempted to support our hypothesis by analyzing the factors that affect knowledge sharing methodologies at CompanyX, a case study company using agile methodologies of knowledge sharing, and further assessing the effect of such factors on both dynamic capabilities and innovation.

Using a two-fold approach based on both survey and face to face interviews as well as document reviews, we queried a sample of CompanyX employees, with measurements drawn upon relevant literature that aimed at weighing the benefits of knowledge sharing techniques on both dynamic capabilities and innovation, and further testing the perceived level of both dynamic and innovation capabilities within the organization.

From a first screening of the survey responses (which contributed for a 75% of response rate) and their descriptive statistics (as in section 4.1) as well as box plots, agile knowledge sharing methodologies employed at CompanyX are perceived to have a positive effect on both dynamic capabilities and innovation. Furthermore CompanyX is perceived to experience enhanced dynamic capabilities and innovation from the use of agile knowledge sharing methodologies.

Based on the result of the Cronbach's Alpha test (reported in section 4.2), an "Excellent" level of inter-agreement was found among the survey participants concerning the role of Agile Knowledge Sharing methodologies as enhancers of dynamic capabilities ($\alpha = 0.9268$) and enablers of innovation ($\alpha = 0.9018$). On the other hand, the level of inter-agreement among participants concerning the role of enhanced dynamic capabilities and innovation could only be rated as "Acceptable" ($\alpha = 0.6728$).

The difference among such ratings may lie in the fact that most the survey participants were software developers who are very close to the development process and therefore have direct experience of the effects of agile knowledge sharing methodologies on, for example, the increased quality of the produced software or the dynamics of teamwork activities. This may have contributed to an easier assessment of both Hypothesis 1 and 2 measurements, which resulted inevitably in higher level of inter-agreement, as all survey participants were most likely to experience such factors in first person (Santos et al. 2014; Ghobadi & D'Ambra 2013).

On the other hand, the overall perceived level of dynamic capabilities and innovation might not have appeared to be that immediate to the survey participants as knowledge of such relationship would require an overall understanding of CompanyX dynamics that a software developer might not necessarily have or have yet experienced, therefore potentially explaining the lower inter-agreement rating of such measurement.

Regardless of the above described differences, all measurements resulted to be reliable, hence further analysis was carried out to test our research model.

From the results of the cross-correlation analysis among the measures (reported in Appendix B: Correlations in SPSS), several statistically significant correlations (marked with (*) for 0.05 significance and (**) for 0.01 significance) among the factors of agile knowledge sharing that might contribute to enhanced dynamic capabilities and innovation were noted.

In particular, the ability of the firm to share information effectively was indicated to help in reducing uncertainties at work (*), facilitate team coordination (**), enable the exploration of knowledge to create new products or practices (*), as well as producing better software quality (**). The above noted correlations are consistent with the findings of (Ryan & O'Connor 2009) and (Takpuie & Tanner 2016), according to which there is a positive relationship between team social interactions to share knowledge and produced software quality.

The extent by which employees understand and apply agile knowledge sharing methodologies at work was also found to be correlated with the ability of the firm to experience enhanced capabilities of communication and coordination (**), as well as its ability to use knowledge for the development of new products or services (**). On the other hand, agile knowledge sharing practices was observed to be inversely correlated with the ability of CompanyX to retain knowledge and prevent its loss (**). As also suggested by (Johannessen et al. 2001), both tacit and explicit knowledge management should be employed in order to prevent knowledge loss. CompanyX methodologies of tacit knowledge sharing might therefore not be enough to guarantee knowledge is internalized within the organization.

Following the cross-correlation analysis, four different groups (components) of independent factors were identified using the principal component analysis (as described in section 4.3). These variables fell under similar categories as previous empirical research and were categorized as "*Team Performance*", "*Organizational Performance*", "*Product Performance*" and "*Innovation Performance*", following the research tradition described in chapter 2.

Multiple regression analysis was used to investigate the causal relationship between the above-mentioned factors and the dependent variables of "*Dynamic Capabilities*" and "*Innovation Capabilities*", to test our research hypothesis respectively.

Both research hypothesis, which predicted a direct and positive relationship between the use of agile knowledge sharing methodologies and both dynamic capabilities and innovation, were sustained statistically by our model with a 95% confidence level.

From hypothesis 1 testing (section 4.4.1), it is evident how CompanyX is currently leveraging agile knowledge sharing practices to "achieve competitive advantage", in particular by "exploring new knowledge" to "exploit innovation". These factors, which belong to the principal component of "Innovation Performance", were found to be directly related to CompanyX's enhanced dynamic capabilities. On the other hand, the factors of "*Team Performance*", "*Product Performance*", "*Organizational Performance*" and "*Strategic Performance*" did not provide a statistically valid contribution in the regression model.

From hypothesis 2 testing (section 4.4.2), only the principal component of "*Team Performance*", which describes the use of agile knowledge sharing to "enhance team coordination", "improve communication" and "share information effectively", was found to be statistically related to the enhancement of CompanyX innovation capabilities, expressed in terms of the ability of CompanyX to develop new products which are more innovative than competitors.

The results of both correlation and regression analysis, performed to test both Hypothesis 1 and Hypothesis 2, have allowed us to answer our research question, since agile knowledge sharing practices at Company X appear to contribute to the enhancement of both its dynamic and innovation capabilities. However, only few of the initially supposed variables seem to have a statistically valid effect on such relationship.

The above illustrated observations are line with Ryan and O'Connor (2009) findings, according to which tacit knowledge sharing practices among software development teams are predictors of work effectiveness but not efficiency. In particular, despite CompanyX teams are experiencing effective knowledge transfer, that results in improved product development processes and enhanced team coordination, the inverse correlation between the use of agile knowledge sharing methodologies and the ability to retain organizational knowledge is consistent with the definition of "tacit" knowledge which, being not always explicitly expressed or documented, might not always be preserved by the team sharing activities (Ryan & O'Connor 2009; Ryan & O'Connor 2013) .

Finally, such results seems to indicate that CompanyX dynamic and innovation capabilities are mostly based on the act of "*sensing*", in the form of acquiring and sharing new knowledge to innovate its products (Teece 2016), and only partially on the aspect of "*seizing*", in the form of using agile knowledge sharing methodologies to reduce uncertainties at work or enhance team coordination by sharing of new information (Eisenhardt & Martin 2000; Zheng et al. 2011). The principal components of "Product Performance" and "Organizational Performance" did not produce in fact any statistically valid contribution to neither CompanyX's dynamic nor innovation capabilities. These components describe the ability of the organization to "*seize*" knowledge in order to produce better software quality as well as internalize knowledge for continuous organizational learning, both aspects which fall into the "*reconfiguring*" attribute of dynamic capabilities (Eisenhardt & Martin 2000; Shih-Yi Chen Ching-Han 2012).

According to (Ellonen et al. 2009), firms that have a strong sensing capability, but on the other hand present moderately low seizing and reconfiguring capabilities might run into "*the risk of developing too radical innovations which the firm is unable to absorb*". It might in the long-run also be the case of CompanyX, which has managed so far to leverage its core software development expertise to develop radical software solutions for the automotive dealership market, but that might need in the future to better internalize its "tacit" knowledge for continuous innovation. According to (Sher & Lee 2004) and (Johannessen et al. 2001) a possible way to do so is to leverage the company IT infrastructure to better guarantee efficiency in the transfer of tacit knowledge to explicit one.

5. Conclusion

This chapter presents the limitations of our research findings as well as routes and suggestions for further development are presented. At the end, a summary as well as a final conclusions are reported.

5.1. Limitations and routes for development

This study aimed to determine whether the introduction of the agile knowledge sharing methodologies into a business could increase innovation by enhancing its internal dynamic capabilities. No study is complete and perfect, and this was no exception. Several limitations exist which should be considered during future studies.

First of all, one must look at the reliability and validity of our findings**.** Although several measures were taken to ensure the process and results were unbiased, the reliability and validity of the research should be considered.

Validity is obtained only if there is a logical process and sequence to the questions that are used to investigate the research problem (S. and Ylöstalo 2002). One way to improve the reliability and validity is to base future studies on past ones, building the validity over time using known previously valid studies as a foundation modifying them to suit the study currently under way. The minimum criteria for validity was supported by our study by development survey measurements which were directly extracted from past research studies and their findings. Furthermore, the internal reliability of our findings was measured and verified statistically using Cronbach's alpha - showing that our survey met the requirements for reliability. However, an important limitation of our research lies in the fact that the organization selected for this case study only recently introduced agile knowledge sharing practices into its operations. This aspect constitutes a limitation of our research as, with more time, the impact of agile knowledge sharing practices on CompanyX dynamic capabilities would have better emerged among the sampled population, and would have therefore resulted in a higher reliability of the research results.

Additionally, our research findings were generated from a sampled population which was relatively small (N=15). A larger target population, and sample, should be addressed to determine whether our findings provide and accurate reflection of a wider audience.

Finally, another important limitation concerns the generalizability of the research findings (Walliman 2006). In our case, it cannot be guaranteed that our results are sufficiently general since they were born out of a specific case study in a single company, and as such no indications of how typical, or not, this company is in any wider sphere of business can be determined from our results. A multi-company case study might be interesting to be developed in the future, in order to assess eventual differences on the use of agile knowledge sharing practices within different types of businesses.

5.2. Summary and Conclusions

This study aimed to determine whether the introduction of the agile knowledge sharing methodologies into a business could increase innovation by enhancing its internal dynamic capabilities.

The results of our research have shown that there is a direct relationship between applying an agile mindset and employee innovation and this has been reinforced by the observations made at CompanyX.

The agile mindset is becoming more prevalent as the approach of choice in many industries, not only the IT sector, and the increasing important of innovation and leverage of employee knowledge to maintain competitive edge is becoming a critical factor in today's competitive marketplaces.

Although agile cannot, and should not, be seen as the solution to all knowledge sharing issues, its merits have been shown by this and other independent research and as such should not be dismissed before it has been adequately considered.

The knowledge possessed by both individual employees, and groups of likeminded employees, should be considered a valuable asset and as such employees need to be treated as such.

The days of company or brand loyalty have long gone and the increasing adoption of technologies no longer restricts employees either geographically or temporally to any single business. New technology is evolving at a rapid paces and so as this progresses new approaches and techniques to address these issue will inevitably arise, widening the opportunities of research in this area.

6. References

Abernathy, W.J. & Clark, K.B., 1985. Innovation: mapping the winds of creative destruction. *Research Policy*, 14, pp.3–22.

Amritesh & Misra, S.C., 2014. Conceptual modeling for knowledge management to support agile software development. *Knowledge Engineering Review*, 29(4), pp.496–511.

Bari, M. a & Ahamad, S., 2011. Managing Knowledge in Development of Agile Software. *International Journal of Advanced Computer Science and Applications*, 2(4), pp.72–76.

Barney, J., Wright, M. & Ketchen, D.J., 2001. The Resource-Based View of the Firm: Ten Years After. *Journal of Management*, 27, pp.625–641.

Barreto, I.I., 2010. Dynamic Capabilities: A Review of Past Research and an Agenda for the Future. *Journal of Management*, 36(1), pp.256–280.

Benner, M.J. & Tushman, M., 2003. Exploitation , Exploration and Process Management : the Productivity Dilemma Revisited. *Academy of Management Review*, 28(2), pp.238–256.

Best, R.J., 2009. *Market-based management: strategies for growing customer value and profitability* 6th ed., Pearson.

Breznik, L. & Hisrich, R.D., 2014. Dynamic capabilities vs. innovation capability: are they related? *Journal of Small Business and Enterprise Development*, 21(3), pp.368–384.

Bryann, A. & Bell, E., 2007. *Business Research Methods* 2nd ed., New York: Oxford University Press.

Burt, R.S., 2005. *Brokerage and closure*, Oxford: Oxford University Press.

Cavaye, A.L.M., 1996. Case study research: a multi-faceted research approach for IS. *Information System Journal*, 6(5), pp.310–340.

Cervone, H.F., 2014. Improving Strategic Planning by Adapting Agile Methods to the Planning Process. *Journal of Library Administration*, 54(2), pp.155–168.

Chau, T. & Maurer, F., 2003. Knowledge Sharing in Agile Software Teams. In *IEEE International Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises(WETICE 03)*.

Cheng, C.C.J. & Chen, J.-S., 2013. Breakthrough innovation: the roles of dynamic innovation capabilities and open innovation activities. *Journal of Business & Industrial Marketing*, 28(5), pp.444–454.

Cheng, C.C.J., Yang, C. & Sheu, C., 2016. Effects of open innovation and knowledge-based dynamic capabilities on radical innovation: An empirical study. *Journal of Engineering and Technology Management*, 41, pp.79–91.

Chiu, W.H. et al., 2016. Dynamic capabilities and radical innovation performance in established firms: a structural model. *Technology Analysis & Strategic Management*, 28(8), pp.965–978.

Christensen, P., 2007. Knowledge Sharing: Moving Away From the Obsession with Best Practices. *Journal of Knowledge Management*, 11(1), pp.36–47.

Cole, M. & Avison, D., 2007. The Potential of Hermeneutics in Information Systems Research. *European Journal of Information Systems*, 16, pp.820–833.

Collis, D.J., 2016. Lean Strategy. *Harvard Buisness Review*, (March), pp.63–68.

Conboy, K., 2009. Agility from first principles: Reconstructing the concept of agility in information systems development. *Information Systems Research*.

Conforto, E. et al., 2014. Can Agile Project Management be Adopted by Industries Other than Software Development ? *Project Management Journal*, 45(3), pp.21–34.

Corbucci, H. & Goldman, A., 2009. Open Source and Agile: Two worlds that should have a closer interaction. *Instituto de Matemática e Estatística (IME)*.

Cortina, J.M., 1993. What is Coefficient Alpha? An Examination of Theory and Applications. *Journal of Applied Psychology*, 78(1), pp.98–104.

Creswell, J.W., 2009. *Research design: qualitative, quantitative, and mixed methods approach* 3rd ed., SAGE Publications Inc.

Daft, R. & Lengel, R., 1986. Organizational Information Requirements, Media Richness and Structural Design. *Organizational Information Requirements, Media Richness and Structural Design*,

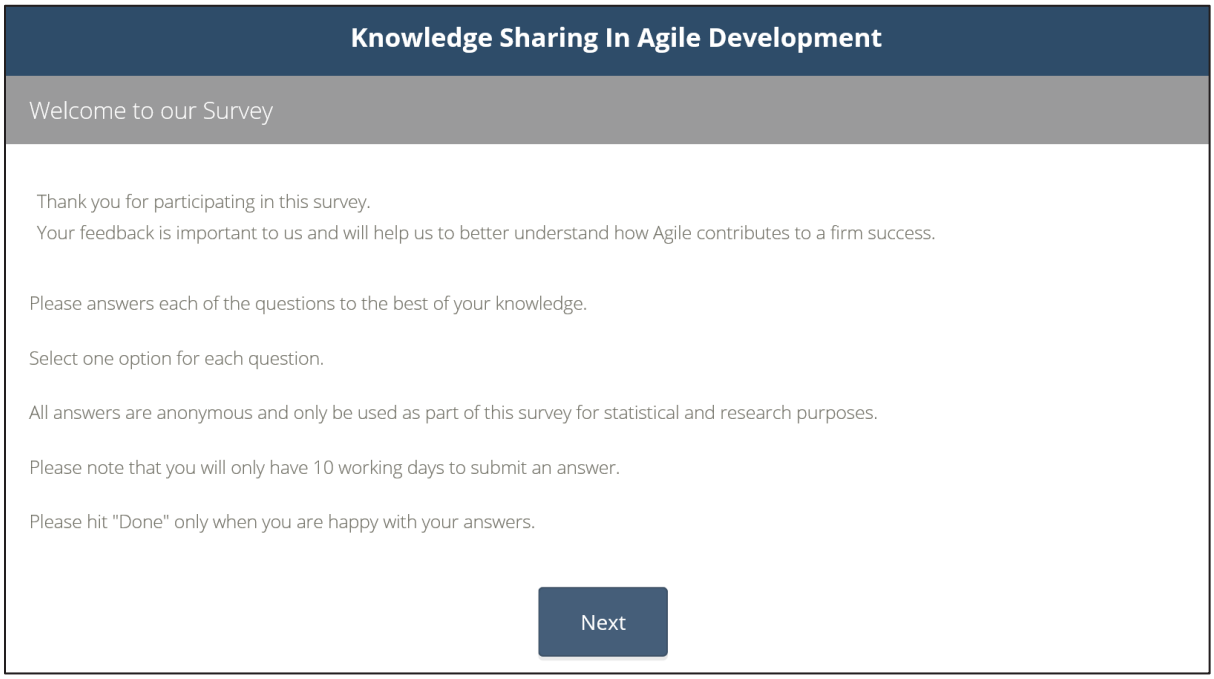
32(5), pp.554–571.
Demarest, M., 1997. Understanding knowledge management. *Long Range Planning*, 30(3), pp.374–384.
Dingsoyr, T. et al., 2012. A decade of agile methodologies: Towards explaining agile software development. *Journal of Systems and Software*, 85(6), pp.1213–1221.
Donate, M.J. & Guadamillas, F., 2011. Organizational Factors to Support Knowledge Management and Innovation. *Journal of Knowledge Management*, 15(6), pp.890–914.
Easterby-Smith, M. & Prieto, I.M., 2008. Dynamic capabilities and knowledge management: An integrative role for learning? *British Journal of Management*, 19(3), pp.235–249.
Eisenhardt, K.M. & Martin, J. a., 2000. Dynamic Capabilities: What Are They? *Strategic Management Journal*, 21, pp.1105–1121.
Eisenhardt, K.M. & Sull, D.N., 2001. Strategy as simple rules. *Harvard Business Review*.
Ellonen, H.K., Wikström, P. & Jantunen, A., 2009. Linking dynamic-capability portfolios and innovation outcomes. *Technovation*, 29(11), pp.753–762.
Endres, M.L. et al., 2007. Tacit knowledge sharing, self-efficacy theory, and application to the Open Source community. *Journal of Knowledge Management*, 11(3), pp.92–103.
Ersoy, I.B. & Mahdy, A.M., 2015. Agile Knowledge Sharing. *International Journal of Software Engineering*, 6(1), pp.1–15.
Ghobadi, S., 2015. What drives knowledge sharing in software development teams: A literature review and classification framework. *Information and Management*, 52(1), pp.82–97.
Ghobadi, S. & D'Ambra, J., 2013. Modeling High-Quality Knowledge Sharing in cross-functional software development teams. *Information Processing and Management*, 49(1), pp.138–157.
Giniuniene, J. & Jurksiene, L., 2015. Dynamic Capabilities, Innovation and Organizational Learning: Interrelations and Impact on Firm Performance. *Procedia - Social and Behavioral Sciences*, 213(1997), pp.985–991.
Harvard Business Review Analytic Services, 2015. Agile practice: the competitive advantage for a digital age. *Harvard Business Review*.
Helfat, C.E. & Peteraf, M.A., 2003. The dynamic resource-based view: Capability lifecycles. *Strategic Management Journal*, 24(10 SPEC ISS.), pp.997–1010.
Highsmith, J. & Cockburn, A., 2001. Agile software development: The business of innovation. *Computer*, 34(9), pp.120–122.
Holloway, J., 1997. *Basic Concepts for qualitative research*, Bournemouth: Blackwell Science.
Huo, M. et al., 2004. Software quality and agile methods. *Computer Software and Applications Conference, 2004. COMPSAC 2004. Proceedings of the 28th Annual International*, pp.520–525 vol.1.
Huysman, M. & DeWit, D., 2002. *Knowledge sharing in practice*, MA,USA: Kluwer Academic Publisher Norwell.
Johannessen, J.-A., Olaisen, J. & Olsen, B., 2001. Mismanagement of Tacit Knowledge : The Importance of Tacit Knowledge , the Danger of Information Technology , and What to Do About it. *International Journal of Information Management*, 21, pp.3–20.
Jolliffe, I.T., 2002. *Principal Component Analysis* 2nd ed., New York: Springer Science & Business Media.
Kavitha, R.K. & Irfan Ahmed, M.S., 2011. A Knowledge Management Framework for Agile Software Development Teams. *2011 International Conference on Process Automation, Control and Computing*, pp.1–5.
Keil, M. & Carmel, E., 1995. Customer-Developer Links in Software Development. *Communications of the ACM*, 38(5), pp.33–44.
Kelley, K. et al., 2003. Good practice in the conduct and reporting of survey research. *International Journal for Quality in Health Care*, 15(3), pp.261–266.
Kessler, D. & Williams, C., 2013. Agile Manifesto - Responding to Change Over Following A

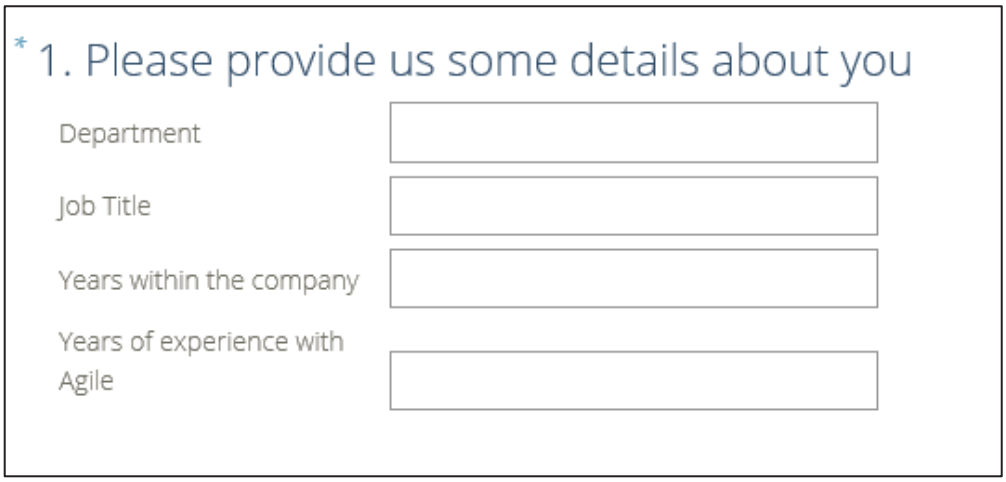
Plan. Available at: http://blogs.sourceallies.com/2013/08/agile-manifesto-responding-to-change-over-following-a-plan/.
Khanna, T., Palepu, K.G. & Sinha, J., 2005. Strategies that fit emerging markets. *Harvard Business Review*, 83(6), pp.63–76.
Kim, W.C. & Mauborgne, R., 2011. Blue Ocean Strategy Blue Ocean Strategy. *Management*, pp.1–16.
Von Krogh, G., Ichijo, K. & Nonaka, I., 2000. *Enabling Knowledge Creation*, Oxford University Press.
Krzakiewicz, K., 2013. Dynamic capabilities and knowledge management. *Management*, 17(2), pp.1–15.
Kumar, M., 2016. *Agile Methodolgy: A Seminar Report*, Available at: https://www.slideshare.net/mk9990144226/report-repaired-65282138.
Lawson, B. & Samson, D., 2001. Developing Innovation Capability in Organisations: a Dynamic Capabilities Approach. *International Journal of Innovation Management*, 5(3), pp.377–400.
Lee, M.C., 2016. Knowledge management and innovation management: best practices in knowledge sharing and knowledge value chain. *International Journal of Innovation and Learning*, 19(2), p.206.
Leech, N. & Onwuegbuzie, A., 2009. A typology of mixed methods research designs. *Qual Quant*, 43, pp.265–275.
Leffingwell, D. & Muirhead, D., 2004. Tactical Management of Agile Development : Achieving Competitive Advantage. , pp.1–23.
Leon de La Barra, C. et al., 2013. Agile Software Development : It Is about Knowledge Management and Creativity. *Computational Science and Its Applications – ICCSA*, 7973, pp.98–113.
Lesser, E.L. & Storck, J., 2001. Communities of practice and organizational performance. *IBM System Journal*, 40(4), pp.831–841.
Levy, M. & Hazzan, O., 2009. Knowledge Management in Practice: The Case of Agile Software Development. *2009 Icse Workshop on Cooperative and Human Aspects of Software Engineering*, pp.60–65.
Liao, J., Kickul, J.R. & Ma, H., 2009. Organizational dynamic capability and innovation: An empirical examination of internet firms. *Journal of Small Business Management*, 47(3), pp.263–286.
Liu, Z. & Cui, J., 2012. Improve Technological Innovation Capability of Enterprises Through Tacit Knowledge Sharing. *Procedia Engineering*, 29, pp.2072–2076.
Lockett, A. & Wild, A., 2014. Bringing history (back) into the resource-based view. *Business History*, 56(3), pp.372–390.
Lubit, R.O.Y., 2001. Tacit knowledge and knowledge management: the keys to sustainable competitive advantage. *Organizational Dynamics*, 29(4), pp.164–178.
Lundvall, B.-A. & Nielsen, 2007. Knowledge management and innovation performance. *International Journal of Manpower*, 28(3/4), pp.207–223.
Mack, N. et al., 2011. *Qualitative Research Methods: A Data collector's Filed Guide*, Family Health International.
Mankins, M.C. & Steele, R., 2005. Turning great strategy into great performance. *Harvard Business Review*, 83(7–8).
Mansour, O., 2012. The Not-So-Open Wikis: Structures of Collaboration at Work. In *Research to Practice in the Design of Cooperative Systems: Results and Open Challenges*. pp. 65–80.
McKee, D., Varadarajan, P. & Pride, W., 1989. Strategic adaptability and firm performance: a market-contingent perspective. *The Journal of Marketing*, 53(july), pp.21–35.
Michailova, S. & Zhan, W., 2015. Dynamic capabilities and innovation in MNC subsidiaries. *Journal of World Business*, 50(3), pp.576–583.
Nonaka, I. & Takeuchi, H., 1995. *The Knowledge-Creat- ing Company: How Japanese Companies Create*

the Dynamics of Innovation, London & New York: Oxford University Press.
Nonaka, I., Takeuchi, H. & Umemoto, K., 1996. A theory of organizational knowledge creation. *IJTM, Special Publication on Unlearning and Learning*, 11.
Pee, L.G., Kankanhalli, A. & Kim, H.-W., 2010. Knowledge Sharing in Information Systems Development: A Social Interdependence Perspective. *Journal of the Association of Information Systems*, 11(10), pp.550–575.
Penrose, E., 1959. *The Theory of the Growth of the Firm* 4th ed., Oxford University Press.
Polanyi, M., 1969. *The Tacit Dimension*, Chicago: University of Chicago Press.
Porter, M.E., 1990a. The Competitive Advantage of Nations. *Harvard Business Review*, pp.73–93.
Porter, M.E., 1990b. The Competitive Advantage of Nations. *Harvard Business Review*, pp.73–93. Available at: http://esc-web.lib.cbs.dk/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=9005210820&login.asp&site=ehost-live&scope=site.
Porter, M.E., 2008. The five competitive forces that shape strategy. *Harvard Business Review*, (January), pp.78–94.
Roxas, J., 2013. The Three Pillars of Scrum. Available at: https://jerryroxas.wordpress.com/2013/01/18/the-three-pillars-of-scrum/.
Ryall, M.D., 2013. The new dynamics of competition. *Harvard Business Review*, 91(6), pp.1–9.
Ryan, S. & O'Connor, R. V., 2013. Acquiring and Sharing tacit knowledge in software development teams: An empirical study. *Information and Software Technology*, 55(9), pp.1614–1624.
Ryan, S. & O'Connor, R. V., 2009. Development of a team measure for tacit knowledge in software development teams. *Journal of Systems and Software*, 82(2), pp.229–240.
S. and Ylöstalo, P.A.T.P., 2002. *Sosiaalitutkimuksen kvantitatiiviset menetelmät* 4th ed. Juva, ed., WSOY.
Santos, V., Goldman, A. & de Souza, C.R.B., 2014. Fostering effective inter-team knowledge sharing in agile software development. *Empirical Software Engineering*, 20(4), pp.1006–1051.
Saunders, M., Lewis, P. & Thornhill, A., 2009. *Research methods for business students* 5th ed. Pearson Education Limited, ed., Essex - England.
Schaeffer, C., 2016. Comparing Agile and Waterfall CRM Implementation Methods. *CRM Search*. Available at: http://www.crmsearch.com/agile-versus-waterfall-crm.php.
Schumpeter, J.A., 1934. *Theory of economic development*, Cambridge, MA: Harvard University Press.
Shafia, M.A. et al., 2016. Mediating effect of technological innovation capabilities between dynamic capabilities and competitiveness of research and technology organisations. *Technology Analysis & Strategic Management*, 28(7), pp.811–826.
Sher, P.J. & Lee, V.C., 2004. Information technology as a facilitator for enhancing dynamic capabilities through knowledge management. *Information & Management*, 41(8), pp.933–945. Available at: http://www.sciencedirect.com/science/article/pii/S0378720603001472 [Accessed January 29, 2017].
Shih-Yi Chen Ching-Han, T., 2012. Dynamic capability, knowledge, learning, and firm performance. *Journal of Organizational Change Management*, 25(3), pp.434–444.
Sunassee, N.N. & Sewry, D.A., 2002. A Theoretical Framework for Knowledge Management Implementation. , pp.235–245.
Takpuie, D. & Tanner, M., 2016. Investigating the Characteristics Needed by Scrum Team Members to Successfully Transfer Tacit Knowledge During Agile Software Projects. *Electronic Journal of Information Systems Evaluation*, 19(1), pp.36–54.
Tashakori, A. & Teddlie, C., 2003. *Handbook of mixed methods in social and behavioral research* T. Oaks, ed., California CA: SAGE Publications Inc.
Tavakol, M. & Dennick, R., 2011. Making sense of Cronbach's alpha. *International Journal of Medical Education*, 2, pp.53–55. Available at: http://www.ijme.net/archive/2/cronbachs-alpha/.

Teece, D., 2016. Uncertainty, Innovation, and Dynamic Capabilities: An introduction. *California management review*, 58(4), pp.5–13.
Teece, D.D., 2013. Dynamic Capabilities and StrategicManagement: Organizing for Innovation and Growth. *Journal of R&D Management*, 74(4), p.272.
Teece, D.D., Pisano, G. & Shuen, A., 1997. Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), pp.509–533.
Teece, D.J., 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28, pp.1319–1350.
Walliman, N., 2006. *Social Research Methods*, London: SAGE Publications Inc.
Wenger, E., 1998. *Communities of Practice: Learning, Meaning, and Identity.*, Cambridge: Cambridge University Press.
Wilson, K. & Doz, Y.L., 2011. Agile Innovation: A footprint balancing distance and immersion. *California management review*, 53(2), pp.6–26.
Yin, R.K., 2009. Case Study Research: Design and Methods. *Applied social research methods series*, 5, p.219.
Yuqin, Z. et al., 2012. A Game between Enterprise and Employees about the Tacit Knowledge Transfer and Sharing. *Physics Procedia*, 24, pp.1789–1795. Available at: http://dx.doi.org/10.1016/j.phpro.2012.02.263.
Zahra, S. a., 1999. The changing rules of global competitiveness in the 21st century. *Academy of Management Perspectives*, 13(1), pp.36–42.
Zheng, S., Zhang, W. & Du, J., 2011. Knowledge-based dynamic capabilities and innovation in networked environments. *Journal of Knowledge Management*, 15(6), pp.1035–1051.
Zollo, M. & Winter, S.G., 2002. Deliberate Learning and the Evolution of Dynamic Capabilities. *Organization science*, 13(3), pp.339–351.

7. Appendix A: Survey & Interview Questions





* 2. To what extent do the observations below apply to your organization ?

	Extremely Disagree	Moderately Disagree	Neither Agree nor Disagree	Moderately Agree	Extremely Agree
The firm is able to share information effectively	○	○	○	○	○
Agile practices of knowledge sharing increase the mutual understanding among team members if well utilized by employees	○	○	○	○	○
Agile practices of knowledge sharing reduce uncertainties in work	○	○	○	○	○
Agile practices of knowledge sharing reduce dependencies on personnel retention and prevent knowledge loss	○	○	○	○	○
Agile practices of knowledge sharing increase team work output and facilitate team coordination	○	○	○	○	○
Knowledge sharing outputs are internalized and used for continuous organizational learning	○	○	○	○	○

* 3. To what extent do the observations below apply to your organization ?

	Extremely Disagree	Moderately Disagree	Neither Agree nor Disagree	Moderately Agree	Extremely Agree
Agile knowledge sharing practices are contributors of competitive advantage	○	○	○	○	○
Agile knowledge sharing practices enable a better exploitation of innovation capabilities	○	○	○	○	○
Agile knowledge sharing practices contribute to the ability of continuously transforming knowledge into new ideas, products or practices	○	○	○	○	○
Agile knowledge sharing practices allow the production of better software quality	○	○	○	○	○
Agile knowledge sharing practices are used to create and explore new knowledge	○	○	○	○	○

* 4. To what extent do the observations below apply to your organization ?

	Extremely Disagree	Moderately Disagree	Neither Agree nor Disagree	Moderately Agree	Extremely Agree
Firm has enhanced capabilities of communication and coordination	○	○	○	○	○
Firm has enhanced customer relationships and continuously gather and use feedback from customers	○	○	○	○	○
Firm has enhanced integration of knowledge in new product development	○	○	○	○	○
Firm has enhanced responsiveness to changes	○	○	○	○	○
Firm introduces new products/services that are more innovative than competitors	○	○	○	○	○

Prev Done

8. Appendix B: Correlations in SPSS

		Firm can share information effectively	Agile practices of knowledge sharing increase the mutual understanding among team members if well utilized by employees	Agile practices of knowledge sharing reduce uncertainties in work	Agile practices of knowledge sharing reduce dependencies on personnel retention and prevent knowledge loss	Agile practices of knowledge sharing increase team work output and facilitate team coordination	Knowledge sharing outputs are internalized and used for continuous organizational learning	Agile knowledge sharing practices are contributors of competitive advantage	Agile knowledge sharing practices enable a better exploitation of innovation capabilities	Agile knowledge sharing practices contribute to the ability of continuously transforming knowledge into new ideas, products or practices	Agile knowledge sharing practices allow the production of better software quality	Agile knowledge sharing practices are used to create and explore new knowledge	Firm has enhanced capabilities of communication and coordination	Firm has enhanced customer relationships and continuously gather and use feedback from customers	Firm has enhanced integration of knowledge in new product development	Firm has enhanced responsiveness to changes	Firm introduces new products /services that are more innovative than competitors
Firm can share information effectively	Correlation Coefficient	1.000	.382	.493*	-.156	.491*	.571*	-.074	.151	.544*	.759**	-.194	.303	-.028	.348	.095	.013
	Sig. (1-tailed)	.	.080	.031	.289	.032	.013	.396	.296	.018	.001	.245	.137	.461	.102	.369	.481
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Agile practices of knowledge sharing increase the mutual understanding among team members if well utilized by employees	Correlation Coefficient	.382	1.000	.622**	.021	.441	.134	.304	-.050	.340	.300	-.256	.593**	.273	.593**	.355	.005
	Sig. (1-tailed)	.080	.	.007	.471	.050	.317	.135	.430	.107	.139	.179	.010	.162	.010	.097	.494
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Agile practices of knowledge sharing reduce uncertainties in work	Correlation Coefficient	.493*	.622**	1.000	-.017	.702**	.214	-.054	.207	.248	.465*	-.410	.048	.263	.479*	-.022	.255
	Sig. (1-tailed)	.031	.007	.	.477	.002	.222	.424	.230	.187	.040	.065	.432	.172	.035	.469	.179
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Agile practices of knowledge sharing reduce dependencies on personnel retention and prevent knowledge loss	Correlation Coefficient	-.156	.021	-.017	1.000	-.161	.270	-.293	-.086	-.494*	-.394	.060	.007	-.082	-.202	-.282	-.387
	Sig. (1-tailed)	.289	.471	.477	.	.283	.165	.145	.381	.031	.073	.416	.489	.386	.235	.154	.077
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Agile practices of knowledge sharing increase team work output and facilitate team coordination	Correlation Coefficient	.491*	.441	.702**	-.161	1.000	.252	.109	.253	.434	.644**	-.233	-.097	.079	.706**	.032	.378
	Sig. (1-tailed)	.032	.050	.002	.283	.	.182	.349	.182	.053	.005	.201	.365	.390	.002	.454	.082
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Knowledge sharing outputs are internalized and used for continuous organizational learning	Correlation Coefficient	.571*	.134	.214	.270	.252	1.000	-.380	.161	.501*	.242	.254	.193	.222	.270	-.138	.000
	Sig. (1-tailed)	.013	.317	.222	.165	.182	.	.081	.283	.028	.193	.180	.245	.214	.165	.312	.500
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Agile knowledge sharing practices are contributors of competitive advantage	Correlation Coefficient	-.074	.304	-.054	-.293	.109	-.380	1.000	-.190	-.117	.052	.206	.415	.130	.293	.419	.207
	Sig. (1-tailed)	.396	.135	.424	.145	.349	.081	.	.249	.339	.426	.231	.062	.323	.145	.060	.229
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Agile knowledge sharing practices enable a better exploitation of innovation capabilities	Correlation Coefficient	.151	-.050	.207	-.086	.253	.161	-.190	1.000	.223	.311	-.242	-.387	-.098	.008	-.535*	-.085
	Sig. (1-tailed)	.296	.430	.230	.381	.182	.283	.249	.	.212	.130	.192	.077	.365	.488	.020	.381
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Agile knowledge sharing practices contribute to the ability of continuously transforming knowledge into new ideas, products or practices	Correlation Coefficient	.544*	.340	.248	-.494*	.434	.501*	-.117	.223	1.000	.655**	-.107	.171	.082	.494*	.170	.103
	Sig. (1-tailed)	.018	.107	.187	.031	.053	.028	.339	.212	.	.004	.352	.271	.386	.031	.272	.358
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Agile knowledge sharing practices allow the production of better software quality	Correlation Coefficient	.759**	.300	.465*	-.394	.644**	.242	.052	.311	.655**	1.000	-.468*	-.047	-.209	.431	.157	.016
	Sig. (1-tailed)	.001	.139	.040	.073	.005	.193	.426	.130	.004	.	.039	.434	.227	.054	.288	.477
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Agile knowledge sharing practices are used to create and explore new knowledge	Correlation Coefficient	-.194	-.256	-.410	.060	-.233	.254	.206	-.242	-.107	-.468*	1.000	.295	.324	-.280	-.194	.012
	Sig. (1-tailed)	.245	.179	.065	.416	.201	.180	.231	.192	.352	.039	.	.143	.120	.156	.244	.484
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Firm has enhanced capabilities of communication and coordination	Correlation Coefficient	.303	.593**	.048	.007	-.097	.193	.415	-.387	.171	-.047	.295	1.000	.481*	.171	.553*	-.290
	Sig. (1-tailed)	.137	.010	.432	.489	.365	.245	.062	.077	.271	.434	.143	.	.035	.271	.016	.148
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Firm has enhanced customer relationships and continuously gather and use feedback from customers	Correlation Coefficient	-.028	.273	.263	-.082	.079	.222	.130	-.098	.082	-.209	.324	.481*	1.000	.082	.393	.007
	Sig. (1-tailed)	.461	.162	.172	.386	.390	.214	.323	.365	.386	.227	.120	.035	.	.386	.074	.490
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Firm has enhanced integration of knowledge in new product development	Correlation Coefficient	.348	.593**	.479*	-.202	.706**	.270	.293	.008	.494*	.431	-.280	.171	.082	1.000	.394	.547*
	Sig. (1-tailed)	.102	.010	.035	.235	.002	.165	.145	.488	.031	.054	.156	.271	.386	.	.073	.017
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Firm has enhanced responsiveness to changes	Correlation Coefficient	.095	.355	-.022	-.282	.032	-.138	.419	-.535*	.170	.157	-.194	.553*	.393	.394	1.000	-.005
	Sig. (1-tailed)	.369	.097	.469	.154	.454	.312	.060	.020	.272	.288	.244	.016	.074	.073	.	.493
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Firm introduces new products /services that are more innovative than competitors	Correlation Coefficient	.013	.005	.255	-.387	.378	.000	.207	-.085	.103	.016	.012	-.290	.007	.547*	-.005	1.000
	Sig. (1-tailed)	.481	.494	.179	.077	.082	.500	.229	.381	.358	.477	.484	.148	.490	.017	.493	.
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

9. Appendix C: Principal Component Analysis Results

PCA Results for Agile Knowledge Sharing as enhancer of dynamic capabilities

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Firm can share information effectively	3.2667	.88372	15
Agile practices of knowledge sharing increase the mutual understanding among team members if well utilized by employees	3.4000	.63246	15
Agile practices of knowledge sharing reduce uncertainties in work	3.8667	.74322	15
Agile practices of knowledge sharing reduce dependencies on personnel retention and prevent knowledge loss	3.1333	.51640	15
Agile practices of knowledge sharing increase team work output and facilitate team coordination	4.5333	.83381	15
Knowledge sharing outputs are internalized and used for continuous organizational learning	3.0000	.53452	15

Component Correlation Matrix

Component	1	2
1	1.000	.036
2	.036	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Pattern Matrix[a]

	Component 1	Component 2
Agile practices of knowledge sharing reduce uncertainties in work	.883	-.208
Agile practices of knowledge sharing increase team work output and facilitate team coordination	.816	-.399
Firm can share information effectively	.771	.350
Agile practices of knowledge sharing increase the mutual understanding among team members if well utilized by employees	.729	.152
Agile practices of knowledge sharing reduce dependencies on personnel retention and prevent knowledge loss	-.223	.766
Knowledge sharing outputs are internalized and used for continuous organizational learning	.429	.712

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 9 iterations.

PCA Results for Agile Knowledge Sharing as enabler of innovation

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Agile knowledge sharing practices are contributors of competitive advantage	3.8667	.35187	15
Agile knowledge sharing practices enable a better exploitation of innovation capabilities	3.2667	.70373	15
Agile knowledge sharing practices contribute to the ability of continuously transforming knowledge into new ideas, products or practices	3.8667	.51640	15
Agile knowledge sharing practices allow the production of better software quality	4.5333	.63994	15
Agile knowledge sharing practices are used to create and explore new knowledge	3.8000	.77460	15

Component Correlation Matrix

Component	1	2
1	1.000	-.208
2	-.208	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Pattern Matrix[a]

	Component 1	Component 2
Agile knowledge sharing practices allow the production of better software quality	.920	-.120
Agile knowledge sharing practices contribute to the ability of continuously transforming knowledge into new ideas, products or practices	.841	.086
Agile knowledge sharing practices are contributors of competitive advantage	.280	.819
Agile knowledge sharing practices enable a better exploitation of innovation capabilities	.165	-.555
Agile knowledge sharing practices are used to create and explore new knowledge	-.330	.529

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 7 iterations.

PCA Results for Enhanced Dynamic Capabilities and Innovation

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Firm has enhanced capabilities of communication and coordination	3.3333	.81650	15
Firm has enhanced customer relationships and continuously gather and use feedback from customers	3.6667	.72375	15
Firm has enhanced integration of knowledge in new product development	3.8667	.51640	15
Firm has enhanced responsiveness to changes	3.5333	.63994	15
Firm introduces new products /services that are more innovative than competitors	3.3333	.72375	15

Component Correlation Matrix

Component	1	2
1	1.000	.041
2	.041	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Pattern Matrix[a]

	Component 1	Component 2
Firm has enhanced capabilities of communication and coordination	.877	-.193
Firm has enhanced responsiveness to changes	.814	.316
Firm has enhanced customer relationships and continuously gather and use feedback from customers	.711	-.041
Firm introduces new products /services that are more innovative than competitors	-.250	.871
Firm has enhanced integration of knowledge in new product development	.248	.851

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 5 iterations.

10. Appendix D: Multiple Regression Analysis in SPSS

Hypothesis 1 Regression Analysis Results

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.527[a]	.277	.222	.88215339	2.293

a. Predictors: (Constant), Innovation Performance

b. Dependent Variable: Dynamic capabilities

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.883	1	3.883	4.990	.044[b]
	Residual	10.117	13	.778		
	Total	14.000	14			

a. Dependent Variable: Dynamic capabilities

b. Predictors: (Constant), Innovation Performance

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	8.472E-17	.228		.000	1.000	-.492	.492
	Innovation Performance	.527	.236	.527	2.234	.044	.017	1.036

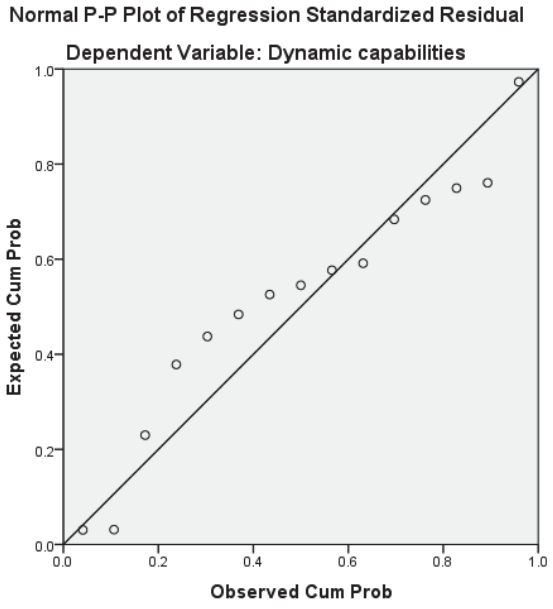
a. Dependent Variable: Dynamic capabilities

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Team Performance	.303[b]	1.305	.216	.353	.981	1.019	.981
	Organizational Performance	.235[b]	.994	.340	.276	.998	1.002	.998
	Product Performance	.162[b]	.656	.524	.186	.957	1.045	.957

a. Dependent Variable: Dynamic capabilities

b. Predictors in the Model: (Constant), Innovation Performance



Hypothesis 2 Regression Analysis Results

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.553[a]	.306	.252	.86474817	2.151

a. Predictors: (Constant), Team Performance

b. Dependent Variable: Innovation capabilities

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.279	1	4.279	5.722	.033[b]
	Residual	9.721	13	.748		
	Total	14.000	14			

a. Dependent Variable: Innovation capabilities

b. Predictors: (Constant), Team Performance

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-1.175E-16	.223		.000	1.000	-.482	.482
	Team Performance	.553	.231	.553	2.392	.033	.054	1.052

a. Dependent Variable: Innovation capabilities

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Organizational Performance	-.353[b]	-1.619	.131	-.423	.999	1.001	.999
	Product Performance	.094[b]	.268	.793	.077	.469	2.132	.469
	Innovation Performance	.213[b]	.906	.383	.253	.981	1.019	.981

a. Dependent Variable: Innovation capabilities

b. Predictors in the Model: (Constant), Team Performance