THE IMPACT OF COMMUNICATION ON TRUST IN AGILE METHODS

A Thesis submitted for MPhil

By

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Abstract

Background: With the increasing reliance on software, software engineering continues to face many challenges. Previous studies suggest that human factors are as difficult to get right as technical factors, and that trust is one of the human factors that directly influences the way people work. This research looks at how a variety of communication channels can be helpful in achieving trust. The literature suggests that trust is an explicit requirement in Agile Methods. An important element of such interactions between individuals is trust. Individuals and their interactions is one of the key principals of any agile developmental methodology.

Aim: This research aims to investigate the importance of trust between individuals using Agile Methods. The investigation focuses on how trust is improved with communication. Forms of communication are analysed. In the first study the impact of face-to-face communication is compared to no communication. The second study compared face-to-face communication with instant messaging to further analyse trust.

Method: To investigate the impact of communication on trust, this research used Game Theory in a simulated agile development environment. During the initial study 28 iterated games with 56 practitioners and student participants were conducted. Stand-up meetings are used as the communication intervention. Levels of trust in games using stand-up meetings as a communication channels are compared to games where no stand-up meetings(no communication) are used.

This research then investigates the importance of trust via synchronous communication channels in Agile Methods with 20 iterated games with 40 participants used in a final study. Stand-up meetings are again used as the communication intervention. Levels of trust in games using face-to-face stand-up meetings are compared to games where instant messaging is used.

Results: The findings of this research are that increased communication has a large positive effect upon the level of trust between team members in an Agile setting. This suggests that communication improves trust in development teams.

This research also suggests that face-to-face communication has a particularly positive effect upon the level of trust between team members in an Agile setting. However, this research also suggests that instant messaging communication does also create trust.

Conclusion: This research suggests that trust is an important factor in the software development process. Communication is an important trust building factor. Some forms of communication are better in building trust compared to others. The main contribution to knowledge this research makes is that the use of Game Theory is an effective method by which to investigate trust as it allows the simulation of behaviour in relation to trust and the direct observation that behaviour. Game Theory also enabled the behaviour observed to be analysed objectively. This research also contributes to understanding of the value of trust in relation to communication and provides evidence that opportunities for communication should be built into development processes.

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Declarations

This research contributed to the following publications:

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Journal

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CHAPTER ONE: INTRODUCTION

1.1. Overview

This research investigates the impact of communication on the level of trust between individuals in Agile Methods. The impact of communication on trust is investigated using Game Theory and questionnaires. This chapter explains the main motivation for this research and introduces the related research domains that shape the research context. The aims and objectives are identified for the research problem and motivations. This chapter also provides a brief overview of the methodological approach for this research. This chapter ends by presenting the structure of this thesis.

1.2. Research Motivation

In the last twenty years there has been a move away from highly prescriptive and controlled traditional software development methods to more flexible and incremental approaches (Cockburn and Highsmith, 2001). Such approaches are collectively referred to as Agile Methods. According to a 2011 IT project success rates survey, Agile Methods are becoming more popular and successful than planned approaches. Cao and Ramesh (2008) claim that rapidly changing environments characterized by evolving requirements and tight schedules

require software developers to take an Agile approach. Agile Methods originate from the Agile Manifesto[1]. According to which the key principles of Agile Methods are:

- individuals and interactions over processes and tools
- working software over comprehensive documentation
- customer collaboration over contract negotiation
- responding to change over following a plan

These principles suggest that one of the primary emphasis of Agile Methods is on the interactions of individuals rather than on processes because it is individuals that contribute to success. Various human factors influence the quality of interactions between individuals. One of which is trust. On this the Agile Manifesto says...

> *"Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done"* (Beck et al. 2001).

Trust is likely to be important in agile projects for a number of reasons. According to Fowler and Highsmith (2001) managers must trust their staff to make decisions about the things they are recruited and employed to know about. Trust enhances the interactions between people and leads to enhanced effectiveness since effort does not have to be deployed on controlling risk. Lack of trust between team members can affect team confidence, which in turn can decrease production. In addition, as there is no formal control on individuals in Agile Methods so trust between individuals is even more important.

Trust is a universal phenomenon that underpins interactions between people in many situations. According to Huang and Fox (2005):

> "*Trust is the psychological state in which the trustor believes that the trustee behaves as expected in a specific context, based on evidence of the trustee's competence and goodwill; the trustor is willing to be vulnerable to that belief."*

In Agile Methods trust is demonstrated by the independence given to developers about the development work they do. This is because developers are not driven by a rigid process. For example a study by Robinson and Sharp (2004) found that "Agile development teams have

[1] Agile Manifesto http://agilemanifesto.org/

faith in their own abilities, show respect and responsibility, establish trust". A systematic literature review by Dybå and Dingsøyr (2008) identified seven such empirical studies; however, only one explicitly addressed the issue of trust.

Developer independence is usually structured within daily stand-up meetings. Such meetings are an important element of Agile Methods. According to Yip (2006) the main structure of stand-up meetings centres on developers answering the following four questions: What did I do yesterday? What obstacles do I have? What am I going to do today? What else should the team know about? These stand-up meetings can be used as standard communication forum in Agile Methods. Communication is a trust building factor (Nguyen et al. 2006). This research used stand-ups to investigate the importance of trust in Agile Methods.

According to the Agile Manifesto the most effective and efficient method with which to exchange information in teams is face-to-face conversation. Communication plays a vital role in maintaining trust between individuals. A study by Dorairaj et al. (2010) on the importance of trust in distributed agile projects revealed that trust is one of the key factors in determining the success or failure of distributed agile projects. Their results also suggested that trust can be generated and sustained in distributed agile projects by increasing effective communication and by understanding cultural differences.

Although face-to-face communication one of the keys to success in Agile Methods, instant messaging can also be used as an alternative forum of communication in Agile Methods. This research investigated instant messaging as an alternative communication media in Agile Methods.

Increasingly software development is done in a distributed setting. In the 2010 State of Agile Development survey, conducted by VersionOne, 32% of respondents stated that their teams were distributed (VersionOne 2010). A further 13% of respondents say that they were currently or plan to combine agile with outsourced development. This suggests that the current software industry does not support the key agile concept of the entire team working in a single room (Miller 2008). Team distribution has a significant impact on interactions between team members in terms of communication and trust.

Initial research concentrated on the role of direct communication on trust, later on research will also look at how indirect communication e.g. instant messaging will make an impact on trust.

1.3. Research Questions

The aim of the thesis is to investigate the impact of trust between individuals in Agile Methods. The aim is addressed by answering two research questions. The main motivation is the lack of direct research on the impact of communication on trust between individuals in Agile Methods. Table 1.1 show details of the research questions. The Table shows each Research Question, how they are answered and which chapter addresses the results. These research questions are answered in detail through a number of hypotheses. Details of these hypotheses are shown in Appendix 1. Each research question is explained in detail in Chapter Three (Research Methodology).

Research Question Number	**Research Questions**	**How Answered**	**Which Chapters**
RQ1	What is the impact of face-to-face communication on trust in Agile Methods?	Game Theory	Chapter 4
RQ2	What is the impact of instant messaging on trust in Agile Methods?	Game Theory	Chapter 5

Table 1.1: Research Questions

1.3.1. Research Question 1 (What is the impact of face-to-face communication on trust in Agile Methods?)

RQ1 concentrates on the impact of face-to-face communication on trust in Agile Methods. Communication is the ability of individuals to exchange information. Communication can be either direct or indirect, formal or informal, verbal or non-verbal (Guirdham 1996). Communication is important to the way Agile Methods work. Various studies discuss the value of communication in Agile Methods. Cockburn et al. (2001) discusses people factors in agile software development and described communication as a human factor in Agile Methods. Another study by Lindvall et al. (2002) reports culture, people and communication as three important factors in Agile Methods. Lindvall et al. (2002) highlight communication as a human factor in Agile Methods that cannot be neglected.

Cockburn et al. (2001) also reports that managers should highlight the importance of communication during Agile Methods. Communication in Agile Methods is treated as the foundation of success. A systematic literature review by Abrahamsson et al. (2002) describes four values behind agile modelling as communication, simplicity, feedback and courage.

In summary RQ1 was motivated by the literature suggesting that face-to-face communication in Agile Methods is a key to success. The literature also suggests that communication is a trust building factor (Nguyen et al. 2006). RQ1 investigates the relationship of trust and communication between individuals in Agile Methods.

1.3.2. Research Question Two (What is the impact of instant messaging on trust in Agile Methods?)

RQ2 concentrates on the impact of instant messaging on trust in Agile Methods. Regardless as to the importance of face-to-face communication in Agile Methods, Agile Methods are becoming popular in global software development. There are various studies investigating the combination of agile and global software development. For example Paasivaara et al. (2008) discuss the benefits and problems of combining Agile Methods and global software development. Another study by Farmer (2010) discusses an agile project used in large distributed teams. In this study Farmer (2010) firstly formally organised communication opportunities and scheduled conference calls to increase communication between distributed agile teams. Farmer (2010) also used information distribution where a large quantity of information is available to team members. A study by Fowler (2004) discussed the implications of agile software development in an offshore environment. Fowler's (2010) findings confirm the importance of communication in Agile Methods and show how this becomes even more important when agile is offshore. Another study by Kircher et al. (2001) describes distributed eXtreme Programming and found that different communication methods can improves XP success.

Holmstrom et al. (2006) found that XP and Scrum practices were useful for improving communication, coordination and control within global software development teams. Korkala et al.'s (2007) communication in distributed agile development case study suggest that inefficient communication can cause severe problems even in small scale distributed agile software development projects.

All these previous studies suggest that Agile Methods are being used in various distributed projects. Studies also suggest that during distributed projects Agile Methods are using various communication channels to replace face-to-face communications. This research compliments these previous studies by testing various communication channels during distributed projects.

In summary RQ2 was motivated by the literature suggesting that indirect communication in Agile Methods is also growing with the rapid increase in global software development. RQ2 investigates how indirect communication between individuals in Agile methods can impact on trust.

1.4. Research Methodology

This research used a multi-method approach (Sells et al. 2004). This approach included both qualitative and quantitative methods. Mingers (2001) argues that a multi-method approach is beneficial because the results generated are richer and more reliable when different research methods are combined.

Very little empirical work investigating trust in the context of agile development has been conducted. As a result, it is not only hard to understand the effect of trust on development teams, but it is also difficult to know all the factors that impact upon levels of trust and how they interact. In many ways, this is understandable. Trust cannot be directly measured and it is a difficult phenomenon for humans to investigate. The analysis and interpretation of trust is also value-laden. This means that trust is a difficult and emotive topic to investigate empirically and requires some sensitivity. This research tries to overcome some of these difficulties by experimentally investigating trust using Game Theory (Rasmusen, 1994). Game Theory is a mathematical approach to understanding an individual's behaviour when that behaviour is based on interactions with others. As such it is an excellent means by which to investigate trust particularly by means of iterated (infinite) experimental games. Game Theory is often used to study conflict and cooperation as it provides insight into the actions and interests of game players. It has been used extensively in other fields such as economics, politics and even mental health (Kishida et al. 2010); however, it has not been widely used in software engineering.

In this research, Game Theory is used to investigate the importance of trust in Agile Methods. Game Theory is used because it analyses the behaviour of participants. Game Theory is the formal study of conflict and cooperation. Game Theory is helpful in this research because it applies the trust actions of individuals and provides a language to formulate structure, analyze, and understand strategic scenarios. In this research, Game Theory also helps to understand the phenomena that are observed when two individuals interact. The main

element of Game Theory is a game. A game is a description of strategic interaction that includes the actions that the players can take and the players' interests, but does not specify the actions that the players do take (Osborn 2004). For this research different game scenarios based on Agile Methods are used. Details of all scenarios are described in Chapter Three.

A detailed discussion of the research design is also provided in Chapter Three.

1.5. Thesis Structure

In order to familiarise the reader with this research, the following outline is offered. This thesis is composed of eight chapters. Each of the chapters provides an understanding of various issues critical for this research. Figure 1.1 outlines the research outcomes in detail. The descriptions of each chapter are provided below.

Chapter 2 provides a description and discussion of the literature surrounding the issues to be investigated within the research of this thesis. These arguments provide a basis for the research topics to be investigated and determined in chapters Four, Five and Six. Chapter Two also presents a systematic literature review on the landscape of Agile Methods.

Chapter 3 discusses the reasoning behind the research methods. The inherent problems within the various research methods used are stated and the suitability of these methods to this research is provided. Game Theory is described and discussed in detail within this chapter. This chapter also discusses in detail the pilot study used to test trust using Game Theory.

Chapter 4 investigates, compares and analyses the first set of Game Theory results. These results are based on investigating the importance of trust in stand-ups with face-to-face and no communication.

Chapter 5 investigates, compares and analyses the second set of Game Theory results. These results are based on investigating the importance of trust in stand-ups with face-to-face and instant messaging communication.

Chapter 6 discusses in detail the results presented in chapters Four, Five and Six. This chapter also looks at the relationship between the literature and the results reported here.

Chapter 7 summarises the research presented in this research. Additionally, it provides the major conclusions reached and describes possible limitations of the research. Potential areas for further research are also provided.

CHAPTER TWO: LITERATURE REVIEW

2.1. INTRODUCTION

The main motivation of this research is to investigate the impact of communication as trust building factor in Agile Methods. This chapter discusses the literature relevant to the impact of communication on the role of trust in Agile Methods. This chapter started with literature review about trust. Section three looked at Agile Methods. Section Four discussed communication in Agile Methods and finally Section Five discussed Game Theory.

2.2. Trust

The building and maintaining of trust has been studied over many years across many other disciplines. For example, organisational psychologists have studied how trust affects performance (Costa et al., 2001). Trust has also been widely investigated in health care, where, for example, studies have been conducted on the impact trust has on patient responses to health care recommendations (Hall et al., 2002).

Aspects of trust have also been studied in relation to the discipline of Software Engineering. Much of the previous work is focused on trust in distributed software development settings. Hole and Moe (2008) in their study of coordination in distributed agile software development projects found that trust is needed to reduce the requirement for standardisation and direct supervision. Moe et al. (2010) conducted extensive fieldwork at a software development company using Scrum. Their focus was to understand the teamwork of the people involved. They found trust and shared mental models were of fundamental importance to a successful transition to self-managing teams. Oza et al. (2006) empirically investigated trust in

commercial software outsourcing relationships. Their investigation used 18 high maturity software vendor companies based in India. Their results suggest that initial enhancers of trust are personal relationship/previous experience of vendors in outsourcing engagements, whilst transparency, demonstrability, honesty, process adherence and commitment are trust-maintaining factors.

There are two broad categories of trust: 1) interpersonal trust where there is trust between individuals and 2) institutional, social or system trust where an individual trusts a collective entity such as a business (Zaheer et al., 1998). This research concentrates on interpersonal trust.

There are various factors in Agile Methods that are helpful in investigating trust. McHugh et al. (2011) indicated that while factors such as environmental conditions and the personal characteristics of team members must be considered, agile practices like stand-up meetings (as a communication mechanism) could also contribute to building trust among team members. This research used stand-up meetings to investigate trust between team members. McHugh et al. (2012) also suggest that the use of agile practices can enhance trust amongst agile team members and that Scrum increases trust in the team. This increase is providing reported to be related to transparency and visibility of project status, enhancing accountability and collective responsibilities, increasing open and frequent communication, and sharing of knowledge and obtaining feedback. Team members that collaborate and trust each other are imperative for the success of an agile project. This interdependence may be difficult for developers who are used to working predominantly on their own (Nerur et al., 2005).

Dorairaj et al. (2012) further suggests that trust increases team performance in teams. Trust among team members is imperative for the success of an agile project. Dorairaj et al. (2012) also presents seven techniques for trust building and suggests that regular interaction helps to build trust and suggests that teams wanted to have daily stand-up meetings in order to establish trust among team members.

Recently there has been some work done on the importance of trust in Agile Methods. Hasnain and Hall (2008) systematically investigated all the previous research published in Agile conference. This Literature review suggests that in spite the importance of trust in Agile Methods, there are no empirical studies that have previous investigate trust in Agile Methods. The research presented in this thesis investigated trust in Agile Methods using Game Theory.

2.3. Agile Methods

The English dictionary definition of "Agile" says it is "Characterized by quickness, lightness, and ease of movement; nimble." This suggests that it is a quick and lightweight method to enhance the fast growing environment of software development. The modern definition of agile software development evolved in the mid-1990s as part of a reaction against "heavyweight" methods. Initially, Agile Methods were called "lightweight methods." In 2001, prominent members of the agile community met at Snowbird Utah, and adopted the name "Agile Methods". Later, some of these members founded the non-profit organisation "The Agile Alliance".

Agile Methods are based on the Agile Manifesto (Beck et al. 2001). This manifesto is widely regarded as the definition of agile development. It is accompanied by a set of agile principles.

The motivation of this research is the first principle of the Agile Manifesto "individuals and interactions over processes and tools". The full sets of principles are provided in Table 2.1.

The first agile principle states the importance of individuals over processes. This shows that Agile Methods emphasises dependence on individuals rather than the process used during software development. The importance of individuals may be similar in plan driven methodologies, but emphasis that is more explicit is given to individuals in Agile Methods.

Several different Agile Methodologies have become popular. However, all promote the same basic principles. According to the Agile Manifesto the twelve principles are:

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. **Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.**
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.

8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity--the art of maximizing the amount of work not done--is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly.

Principles	**Description**
Individuals and Interactions over Processes and Tools	To implement this principle, open floor plans are used instead of developers sitting down in their own cabins. This minimizes privacy so that programmers can see and hear what everyone else is doing.
Working Software over Comprehensive Documentation	More concentration on software production from the project leadership rather than writing documentation.
Customer Collaboration over Contract Negotiation	The developers demonstrate the prototype software to their customers with the expectation that the customers will provide them with useful feedback
Responding to Change over Following a Plan	The developers immediately use the customer feedback to guide development of the project's next phase.

Table 2.1: Agile Key Principles (Agile Manifesto Beck et al. 2001)

Principle number five states that individuals should be motivated and trust should be placed in individuals that work is finished on time. This states the individual's independence in Agile Methods. This independence can only be provided by making sure that trust exits between individuals. However, the question arises about what is trust and how can trust be created and maintained? My previous literature review explored the importance of people

factors in Agile Methods, and revealed a lack of research about human factors in Agile Methods, and specifically highlighted a lack of trust research in Agile Methods (Hasnain et al. 2008). The literature emphases individual independence, but trust between individuals is the basis of this research. This research starts by investigating the impact of trust between individuals in Agile Methods.

According to Abrahamsson et al. (2002) Agile Methods include: eXtreme Programming (Beck 1999), Scrum (Schwaber 1995; Schwaber and Beedle 2002), The Crystal family of methodologies (Cockburn 2005), Feature Driven Development (Palmer and Felsing 2002), The Rational Unified Process (Kruchten 2004), Dynamic Systems Development Method (Stapleton 1997), Adaptive Software Development (Highsmith 2000)

My own systematic literature review on a subset of published agile studies (Hasnain 2010):

- Summarises existing research related to Agile Methods.
- Identifies the gaps in current research about Agile Methods in order to suggest areas for further investigation.
- Provides a framework/background in order to appropriately position new research activities in Agile Methods.

This systematic literature review (Hasnain 2010) suggests that fewer paper published about Scrum compared to the total paper published in the Agile Conferences each year. Hasnain (2010) also suggests that there is a need for detailed analyses and studies about Scrum and XP.

The research presented on this thesis concentrates on eXtreme Programming and Scrum.

Agile Teams

Agile teams are small (usually no larger than 10 people each), and they are cross functional. Table 2.2 shows in detail two different Agile Methodologies. It compares the number of teams, team size, team members/roles and project roles between XP and Scrum.

Concept	XP	Scrum
Number of teams	1 team per project	1 – 4 or more
Team size	3 – 16	5 – 9
Team Members / Roles	Customer, Programmer, Tester, Tracker, Coach	Scrum master, Experienced Engineer, Junior Engineer
Project Roles	Big Boss	Project Manager/ Scrum master, Product Owner

Table 2.2: Agile Methodologies (adopted from Thomas 2005

This research uses two player stimulated environment. The main purpose of using two players is pair programming in Agile Methods. During pair programming two developers work on same piece of code. This research also uses game scenario to depict the same situation. The game scenario is provided in Appendix Three.

Stand-up Meetings in XP

This research uses stand-up meetings as communication intervention to explore trust. The stand-up is a short meeting that managers and developers are required to attend every day in Agile Methods. Stand-up meetings in Agile Methods are an explicit forum for developers to describe their development tasks. In a stand-up meeting usually everyone stands up in a circle to avoid long discussions**.** A stand-up meeting is used to **communicate problems, and promote team focus** (Beck, 2006). Furthermore, the purpose of the stand-up is to communicate problems, not to solve those (Beck & Fowler, 2001). During stand-ups team members learn what other developers are working on and struggling with and how they can help each other to make the whole team succeed (Laplante, 2003). Stand-up meetings are meant to be short and so the detail of problems is not discussed during the meeting (Beck & Fowler, 2001). According to Yip (2006) the main structure of stand-ups centres on developers answering the following questions:

- What did I do yesterday?
- What obstacles do I have?
- What am I going to do today?
- What else should the team know about?

Mckinney and Denton (2005) found that accountability was an issue in stand-ups. In their study of using stand-ups with Computer Science students, they found that:

> *"Meetings were an efficient way of communicating and maintaining accountability. Stand-up meetings also motivated the students to make*

> *meaningful contributions so that they could have something significant to report. These meetings were announced with little warning, on an as needed basis, but typically were held at the beginning and the end of lab sessions. This practice was an important way to encourage the development of commitment, work ethic, and communication."*

Furthermore, Laplante (2003) asks:

> *"Is there any accountability in these meetings? For example, who said what and when? How are disagreements resolved?"*

This is an important point, as if developers do not do what they say they are going to do in stand-ups then this may be a major problem. When a person reports on what they are doing for the next day, they are expressing a kind of social promise to the team (Larman, 2004). This increases responsibility and follow-through (Larman, 2004).

In stand-up meetings, developers can report completion of work and receive instant recognition from their peers—on a daily basis. Being recognized for work completed reassures the developer and makes him or her feel good about working.

Scrum Meetings

Each workday at the same time and place, a meeting is held with the team members standing in a circle, at which time the same questions are answered by each member (Larman, 2004):

1. What have you done since the last Scrum?
2. What will you do between now and the next Scrum?
3. What is getting in the way (blocks) of meeting the iteration goals?

Ideally, this meeting is on average between 15-20 minutes long with 7-10 people. All these people are encouraged to stand-up in a circle. It is held next to a whiteboard on which all the issues are written when reported. No other discussion is allowed beyond the three questions.

Shared language, values, and practices help a development team. This is created and reinforced in the daily Scrum (Larman, 2004).

The structure of both stand-up and scrum meetings force developers to exchange work related information. This structure also emphases the discussion any problems that developers

encounter during development. These meetings are based on developers talking instead of managers and are an opportunity for developers to discuss problems. For example Kobayashi, etc. (2006) found that:

> "*Throughout our project, we had a stand-up meeting every day, checking the project's condition with story cards and task cards taped on the wall, so we could grasp the progress and problems of the project without project management documents".*

The research in this thesis also used a standard structure of stand-up/scrum meetings. During the research experiments in this thesis participant asked to discuss and answer questions based on questions in stand-up/scrum meetings.

Global Agile Methods

It is hard to maintain face-to-face communication when Agile Methods become global. This means that communication must be maintained through other channels. Various studies discuss communication channels that can be important in implementing Agile Methods globally such as web pages, instant messaging, wikis, telephone, teleconference, video conference, email and desktop sharing (Holmstrom et al. (2006), Hossain et al. (2009), Paasivaara et al. (2008)). Layman et al. (2006) discuss essential communication practices for eXtreme Programming in a global software development team using instant messaging (IM). Braithwaite et al. (2005) discusses distributed eXtreme Programming. Their study suggests different communication channels that can be used during distributed agile projects. These communication channels include individual and conference telephone calls, teleconferencing, video conferencing, email, IM, and wiki.

With the growing popularity of distributed Agile Methods it is important to investigate successful means of communication other than face-to-face. This research uses instant messaging as an alternative to face-to-face communication. This research also compares the impact of trust on face-to-face communication as opposed to instant messaging (Chapter 5).

2.4. Communication

There is a substantial body of empirical research that has sought to explore the phenomenon of communication within projects and apply this work to software engineering. (Herrigel et al., 1995) define communication as the ability to send and receive information and to convey

and understand thoughts, feelings and attitudes. Good communication is widely acknowledged as necessary for cooperation in all areas of life, including within organisations (De Cock et al., 1998).

Communication can be either face-to-face or indirect, formal or informal, verbal or non-verbal (Guirdham, 1996). A variety of media (both synchronous and asynchronous) are available and increasingly used to support communication (Fernando et al., 2011).

Despite the importance of communication, Hall et al. (2007) show that communication between developers in software projects has been systematically neglected in planned development process models. Similarly Hayes (2003) reports on the problems, both in the workplace and in software, as a result of poor communication.

Effective communication underpins successful software projects. In particular good relationships between users and developers are predicated on effective communication. Such relationships are characterised by co-operation and mutual responsiveness; both highly related to trust (Procaccino et al., 2006). Good relationships were also reported to be the third most important contributor to successful software projects. They have also been shown to directly affect software project outcomes. A study of 21 software development teams showed that internal task-related communication accurately predicts overall software project performance (Brodbeck, 2001). Wolf et al. (2009) show that the presence of particular communication structures between developers is a good predictor of whether a system integration will be successful or not. (Sangwan and Ros, 2008) investigate the role communication plays in system architecture to highlight the importance of using communication to establish a "shared project context". They report that a mutual understanding of the system context, the problem domain and the solution is essential to delivering an effective system. Without this mutual understanding they report that the resulting "ignorance, confusion and frustration" undermines trust and reduces the effectiveness of communications.

The effectiveness of particular forms of communication, especially in distributed settings is the subject of study. For example Korkala and Abrahamsson (2007) report their case studies focused on establishing effective communication roles and tools within distributed agile settings. They found that synchronous communication approaches are most effective.

Asynchronous approaches can be effective if people are already actively committed to participating in communication. They also found that direct peer-to-peer communication between developers was related to successful project outcomes.

Overall it would seem that there is a good deal of empirical evidence to support the notions that (i) communication has a significant impact upon project outcome and (ii) the lack of shared understanding harms trust between project members.

Only a few studies investigate trust in agile projects. Those that do include Robinson and Sharp (2004) who highlight trust in relation to Agile teams and suggest that teams in Agile development have faith in their own abilities, show respect and responsibility, establish trust and preserve the quality of working life. Another study by Bhalerao and Ingle (2010) suggests that effective communication is necessary for building trust and discipline among agile team members and customers. The research in this thesis also tests the importance of communication on trust between individuals in Agile Methods.

Due to the nature of trust it is hard to create trust. According to Sepulveda 2003:

"*Trust is the most complicated element of team dynamics to establish and maintain"*

Trust can be created and destroyed as a result of organizational culture created by team members and management (Sepulveda, 2003). Nevertheless, visibility and communication improvement can create trust or increase trust (Jain, 2006). Consequently this research uses communication as an intervention to investigate trust.

Consequently, trust plays an important role in running an organization effectively. The literature suggests that there are various factors that can help to create and maintain trust. Honesty, communication, cultural understanding, personal relationship, working together, performance and capability are trust maintaining factors (Nguyen et al. 2006). This research uses communication as a trust building factor between individuals in Agile Methods.

According to Nguyen et al., (2006):

"Frequent communication not only helps avoid misunderstandings but also improves cultural understanding, which is considered an equally important factor in maintaining trust".

2.5. Game Theory

Background

Game Theory is a mathematical approach originally developed to analyze the behaviour of players in strategic situations (Camerer 2011). Game Theory has been used extensively, predominantly in economics, but also in other subjects such as politics, sociology and biology.

According to Smith (1982):

> *"Game Theory models can be beneficial because they can provide insight into the strategic options and likely outcomes available to people in particular situations. From this insight, decision-makers can better assess the potential effects of their actions, and can make decisions that will more likely produce the desired goals and avoid conflict."*

The concepts of Game Theory provide a language to formulate structure, analyze, and understand strategic scenarios based on the importance of trust in Agile Methods. Game Theory has provided a very successful model for the social sciences. In many settings it fares very well as a predictive model -- particularly where there are many actors, their interactions are **anonymous,** and the underlying institutional mechanisms are incentive compatible (Ostrom, 1998).

Experimental games are a major research tool in behavioural economics particularly when rational behaviour is either unknown or because empirical evidence indicates that people do not necessarily behave according to optimising predictions (Kocher and Sutter, 2005). Games allow researchers to empirically investigate "effects of social preferences, like inequality aversion, fairness or reciprocity that always play a role in simple bargaining games." (Kocher and Sutter, 2005) and to do so under highly controlled conditions.

Many experimental games are based on social dilemmas derived from a payoff matrix similar to the Prisoner Dilemma. These are used to investigate phenomena such as altruism, fairness, revenge, hatred, reciprocity and trust (Camerer, 2011). For example, the game is important from a sociological perspective, because it illustrates the human unwillingness to accept injustice and social inequality. Some researchers suggest that reciprocity may be a bigger driver than morality for co-operative and trusting behaviour in their experimental studies of

iterated PD games (Fehr and Gachter, 2000). For a systematic literature review of experimental games investigating trust in social settings (Sally, 1995).

More recently Game Theory has been used in various studies in computer science, most notably in the context of security. Roy et al. (2010) review extensive game theoretic studies of network security and present taxonomy of the cyber security solutions proposed. Other applications of Game Theory in computer science include the work of Gao-hui (2006) analysis of enterprise software project management. Buisman and Wohlin (2003) use a small study of a single iterated game to investigate bidding behaviour in computer sciences.
Hazzan and Dubinsky (2005) is the only other published research which we are aware of to use Game Theory to study agile development. They use the Prisoner Dilemma game to offer an analytic framework to understand social perspectives in XP but do not use experimental or iterated games. This seems something of a missed opportunity since we believe that projects are better viewed as on-going phenomena as opposed to single events.

Representation of Games

There are two basic forms of game: normal (strategic) and extensive (sequential). In the normal form players act simultaneously and have no knowledge of the other player's actions until after a choice has been made. This is similar to the well-known children's game scissors-paper-rock. In the extensive form players make choices alternately so they know how the other players have acted before they themselves act. This research will use the normal form since it enables us to explore the phenomenon of trust (and betrayal) more effectively as it models making a decision without knowing what the other person will decide.

Typically there are two players though more complex n-player games are possible. Each player is provided with two or more choices and the outcome is defined by a payoff matrix which describes the structure of the game. This matrix sets out the reward (or penalty) that a player will receive for a particular choice dependent upon the other player's choice.

Types of Game

There are number of types of games. Table 2.4 shows these types in detail. This research is using non zero sum games. In a non zero sum game player choices can neither increase nor decrease the overall available resources. These games are based on a payoff matrix where the sum of each row and column is fixed and a player gains only at the expense of others. When

we wish to model situations of mutual trust leading to some improved joint outcome then non-zero sum games can be more appropriate since the idea of mutual benefit can be captured.

Game Types	Description
Cooperative or non-cooperative	A game is cooperative if players manage to create binding between each other's
Symmetric and asymmetric	A game in which the payoffs of playing particular strategy depend on the other player strategy
Zero-sum and non-zero-sum	A game in which players choices neither increase nor decrease the available resources.
Simultaneous and sequential	During simultaneous games both players either move simultaneously or do not move simultaneously. In this case later player will not have any knowledge of earlier player strategies or action. During sequential games later player have knowledge about earlier player's action.

Table 2.3: Types of Games (Morrow 1994)

Prisoners Dilemma

There are a number of classic games, for example the Prisoners Dilemma game and the Work Shirk game variant described by Fudenberg and Ti1 (1991), both of these games are non-zero sum. In the Prisoners Dilemma the two players are accused of a crime but are kept apart. Each player has two choices, either to keep silent or confess to the crime and must decide what to do without communicating with the other player (prisoner). If neither player confesses then both must be released (the Pareto-optimal outcome), however, if one player confesses, they receive a small punishment but the silent (uncooperative prisoner) receives a substantial punishment. If both prisoners confess they receive a middling punishment. Table 2.5 shows the Prisoner's Dilemma payoff matrix.

Note: T is the Temptation to defect, R is Reward for joint cooperation, and P is the Punishment for both defecting and S is the Sucker's payoff (i.e. being betrayed). The specific values from the payoff matrix are not important, however, the relative values do matter. Payoffs (punishments in PD) must satisfy $T > R > P > S$ (where $>$ is a binary preference relation) in order to qualify as a PD type game. In addition, iterated games require $2R > (T +$

S) which are necessary to ensure that in the long run cooperation has a better value for the game than betrayal. Both games exhibit the property that whilst cooperation is mutually beneficial, each player is vulnerable to betrayal and hence they are potentially powerful instruments for studying trust.

		Player 1	
		Cooperate	Defect
Player 2	Cooperate	R, R	S, T
	Defect	T, S	P, P

Table 2.4: Prisoner's Dilemma Payoff Matrix

Work Shirk Game

This is a model of a repeated partnership game. In this game each player has two choices: work and shirk. Each player's payoff depends on his own effort and on the publicly observed output, which they share equally (Fudenberg, et al. 1991). This research uses a variant of the Work Shirk game in the study that is more fully described in Chapter Three. However, in one sense these games are not particularly revealing because by their nature they have well understood Nash equilibrium that means it can be predicted that any rational player will always betray the other player. This is because the defecting (or betraying) choice dominates, in other words irrespective of what the other player chooses it always leads to a better outcome. However, the paradox is that both players are worse off by betraying each other even though this is the best choice for each player. This paradox has been used by economists and others to attempt to explain the use, and abuse of, public shared goods, e.g. the so-called tragedy of the commons where the Nash equilibrium is for each farmer to overgraze the common land (Hardin, 1968).

To overcome the problem of trivial dominant strategies, some researchers e.g. Axelrod (1996) have used infinite iterated experimental games. The games are experimental in the sense of using human players rather than merely seeing them as mathematical artefacts. They are infinite in the sense of an arbitrary and unknown (to the players) number of rounds. In

addition, such games can be resistant to finding analytic solutions unlike the simple one shot PD-type games. The games are iterated an arbitrary number of times so that past behaviour can inform future decisions. For instance, iterated games provide an opportunity to punish betrayal and so this can moderate player behaviour. An example of this is the tit-for-tat strategy where in essence a player will cooperate unless betrayed, then punish the other player for 1 or 2 rounds and then revert to cooperation. For more details see Axelrod and Hamilton (1981). Such games are also a vehicle for research into co-evolutionary search and genetic algorithms where cooperation generally emerges as the dominant strategy (Darwen and Yao, 1995). This demonstrates that iterated games have significantly different properties to their one-shot counterparts.

Terms in Game Theory

Game

A game is a formal description of a strategic situation.

Player

A player is an agent who makes decision in a game.

Strategy

In a game in strategic form, a strategy is one of the given possible actions of the player.

Payoff

A payoff is a number, also called unity, which reflects the desirability of an outcome to a player, for whatever reason. The expected payoff incorporates the player's attitude towards risk.

Nash Equilibrium

Nash equilibrium, also called strategic equilibrium, is a list of strategies, one for each player, which has the property that no player can unilaterally change his strategy and get a better payoff.

2.6. Moon's Personality Exercise

This research used a Moon's personality exercise as part of the research. Personality profiling questionnaires are based on the Philip Moon (1998) exercise. This exercise is

> "*An opportunity to look at some aspects of your own behaviour and value systems and will help you to consider how these might affect the way that you manage your time* (Moon 1998). "

There are several different personality tests in the literature however, the Moon exercise is good way to analyse personalities types based on work capabilities rather than on the characteristics they have in general. Philip Moon's exercise is also free and easy to use and takes less time than other tests such as Big Five or Myers-Briggs Type Indicator (MBTI). Philip Moon's exercise is especially designed for games (Moon 1998) and the questionnaire used in the exercise was specially designed for work environments. Table 2.5 shows the summary of team's member's classification using the Moon exercise.

Movers	Drivers	Relaters	Completers
They are quick decision-makers, often impatient of detail and who enjoy interacting and dealing with a variety of people	They are also quick decision-makers who are often impatient with people and whose primary concern is making sure that the job gets done properly, even if people's feelings are hurt.	They are concerned with the interests of people and are particularly careful in examining the impact of decisions and changes to procedures on individuals.	They are cautious thinkers who are able to focus on details and see their implications for the task and for procedures. They stick to the task and work diligently to complete it.

Table 2.5: Team member Classification

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Introduction

As outlined in Chapter Two, this research explores the impact of communication on trust in Agile Methods. Trust is a difficult phenomenon to investigate as it cannot be measured directly, consequently this research has adopted Game Theory because Game Theory is an approach which is specifically developed to analyze the behaviour of individuals in strategic situations. This research demonstrates how iterated experimental games can be used to explore intangible phenomena such as trust within Software Engineering. This chapter describes the methodology used to address the research questions, and details the approach taken to investigate the research problem. This chapter also explains the pilot study performed to test the methodological issues relating to using Game Theory.

The structure of the chapter is as follows: Section 3.2 provides a general overview of the research approach in this research; Section 3.3 discusses in detail each research approach used; Section 3.4 discusses the data collection methods used in this research and finally Section 3.5 discusses the analysis tools used.

A diagrammatic representation of this research approach used is shown in Figure 3.1 that shows the steps adopted during this research. In part 1 the initial research problem is discussed which result in part 2 about the decision made to adopt Game Theory as the methodology for this research. During part 3, data is collected and analysed in part 4.

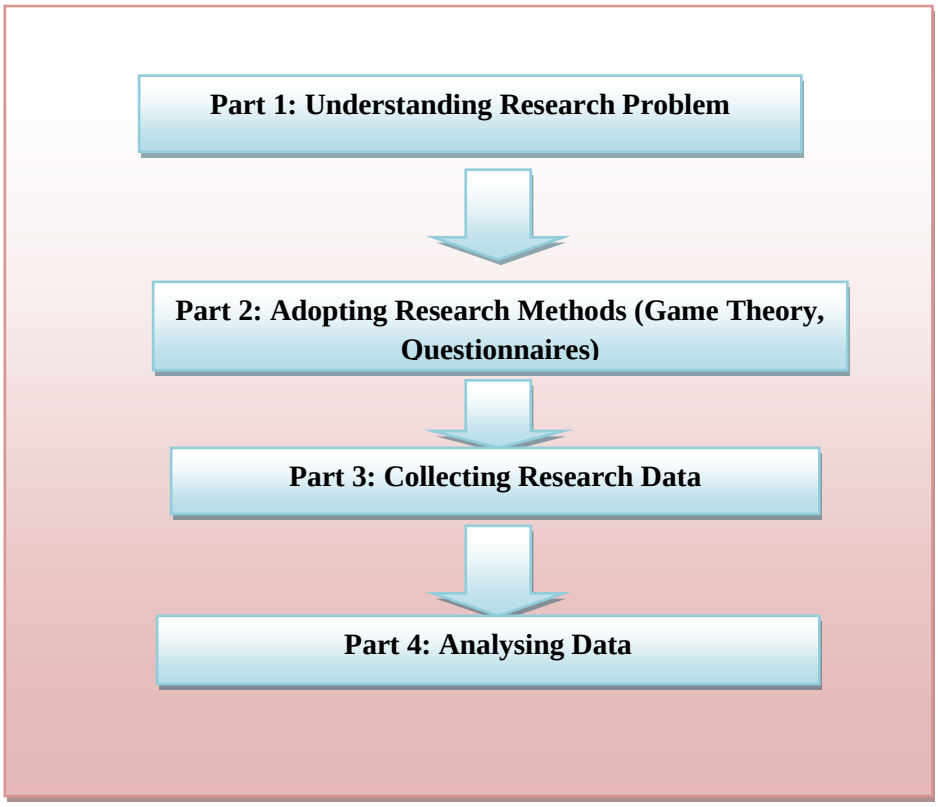

Figure 1.1: Research Diagram

The research conducted involved several individual studies. Although the main method used is Game Theory. A mixed methodology involving both qualitative and quantitative approaches was employed throughout research process. A mixed methodology is more likely to assure the validity and reliability of the results and provide a more comprehensive understanding of the analysed phenomena (Tashakkori and Teddlie, 1998). The main methodology for this research is Game Theory.

3.1.1. Quantitative Data

Quantitative research tends to be associated with numbers as the unit of analysis. In quantitative research the aim is to measure phenomena so that they can be transformed into numbers. Once the phenomena have been quantified, they lend themselves to analysis through statistical procedures. Such procedures are powerful but dependent on receiving numerical data as the input. Quantitative research tends to be associated in the large-scale

projects, with a specific focus, researcher detachment, and predetermined research design (Denscombe 2010). In this research the quantitative results are obtained from the games.

Quantitative data uses numbers and can present findings in the form of graphs and tables. There are various types of quantitative data (Denscombe 2010, Blaikie 2003):

- Nominal data (comes from counting things and placing them in category, this is the head count of members of a particular categories e.g. male/female, professional/students (in this research)).
- Ordinal data (they are also based on counts of things assigned to specific categories, but in this case categories stand in some clear, ordered, ranked relationship. This means that data in each category can be compared with data in other category as being higher or lower than, more or less than etc. For example likert scale or five point scale.)
- Interval data (they are like ordinal data, but the category are ranked on a scale e.g. years)
- Ratio data (they are like interval data, except that the categories exist on a scale that has a true zero or an absolute reference point.)
- Discrete data (They are based on phenomena which naturally come in whole units)
- Continuous data(they are certain kind of data which for practical purposes are inevitably measures to the nearest unit simply because they do not come in neat discrete chunks e.g. people age, weight, height etc.)

The main advantages of quantitative analysis include (Denscombe 2010):

- Scientific (data lend themselves to various types of statistical techniques which in turn relevant to mathematics and probabilities)
- Confidence (Statistical test of significance gives confidence)
- Measurement (data provides solid foundation for description and analysis)
- Analysis (data can be analysed quickly)
- Presentation (tables and charts are effective way of presentation)

Some of disadvantages include (Denscombe 2010):

- Quality of data (Quality of data may have to compromised)
- Technicist (Lots of analysis techniques can be misleading)
- Data overload (large quantity of data can be complex to handle)

- False promise (it is not as scientifically objective as it might seem on the surface)

3.1.2. Qualitative data

Qualitative research tends to be associated with words as a unit of analysis. Qualitative research relies on transforming information from observations, reports and recordings into data in the form of words not numbers. Qualitative research tends to associated with small-scale studies; with a holistic perspective, researcher involvement, and emergent research design (Denscombe 2010). The questionnaires results from this research produce qualitative data.

Qualitative data provide an in-depth understanding of human behaviour and the reasons that govern human behaviour. Unlike quantitative research, qualitative research relies on reasons behind various aspects of behaviour.

Qualitative research can be part of an information gathering exercise and useful in its own right. It can be used as the basis for generating theories.

Advantages of qualitative data analysis include (Denscombe 2010):

- The data and the analysis are grounded
- There is a richness and detail to the data
- There is tolerance of ambiguity and contradictions
- There is the prospect of alternative explanations

Disadvantages of qualitative analysis include (Denscombe 2010):

- The data may be less representative
- Interpretation is bound up with the self of the researcher
- There is possibility of decontextualizing the meaning
- There is the danger of oversimplifying the explanation

3.2. Experimentation

This research has used experimentation to collect qualitative and quantitative data. Experimentation provides a systematic and controlled way of evaluating activities (Denscombe 2010). The point of conducting an experiment is to isolate individual factors and

observe their effect in detail. The purpose is to discover new relationships or properties associated with the materials being investigated, or to test exiting theories. Experiments are driven by hypotheses. There are various types of experiments e.g. controlled experiments, natural experiments and field experiments. This research has used controlled experiments. One of the advantages of experiments is that it is possible to replicate to confirm. Experiments also help to compare methods in a controlled environment that is selecting variables and other unrelated factors. Some of the advantages of experiments are that they are repeatable, the procedure should have been carefully recorded and the variables controlled for (Denscombe 2010).

Basic Concepts of Experiments

Hypotheses

Hypothesis is a proposed explanation of the phenomena. The hypotheses of this research are based on Karl Popper *"Theory of Falsification"* which states that (Popper 2002):

> *"Falsifiability is the logical possibility that an assertion can be shown false by an observation or a physical experiment. That something is "falsifiable" does not mean it is false; rather, that if it is false, then this can be shown by observation or experiment."*

Hypothesis can be null, (H_o) which means there is no treatment effect or alternative hypothesis as H1. Hypotheses either use one-tailed or two-tailed test.

Variables

This research constructed hypotheses based on independent and dependent variables. Independent variables are factors that can be controlled during an experiment. This is the feature that is deliberately varied by an experimenter, e.g. the use of stand-up meetings. Dependent variables measure the effect of the treatment and appear in the hypothesis test as responses. For this experiment the dependent variable is the presence of trust or not.

Treatment or Experimental Intervention

This research has used three different treatments or interventions. Below is the detail of all interventions or treatments.

Treatment 1 = No communication

Treatment 2 = Face-to-face stand-ups meetings = Direct Communication

Treatment 3 = Instant messaging stand-ups = Indirect Communication

Sampling and Selection

There are a wide variety of sampling strategies. According to Blaxter et al. (2006) the main options are summarized below:

Probability Sampling:

- Simple random sampling-selection at random
- Systematic sampling-selecting every nth case
- Stratified sampling- sampling within groups of the population
- Cluster sampling-surveying whole clusters of the population sampled at random.
- Stage sampling-sampling clusters sampled at random.

Non-probability sampling:

- Convenience sampling-sampling those most convenient.
- Voluntary sampling-the sample is self-selected
- Quota sampling-convenience sampling within group of population
- Purposive sampling-handpicking supposedly typical or interesting cases
- Dimensional sampling- multi-dimensional quota sampling
- Snowball sampling-building up a sample through informants

Other kinds of sampling

- Event sampling-using routine or special events as the basis for sampling
- Time sampling-recognizing that different parts of the day, week or year may be significant

The main population of this research are individuals with experience in any software development. Students and professionals with software experience were selected. Professionals were personal contacts while students were randomly selected.

This research has used both a random and a convenience sample from the population.

Random Sampling

This approach to sampling involves the selection of people or events literally at random. Behind the use of random sampling lies the assumption that,

- If there are a sufficiently large number of examples selected and
- If their selection has genuinely been at random

Then the resulting sample is likely to provide a representative cross-section of the whole population (Denscombe 2010). In order to generalize the results to the desired population, the section must be representative for that population.

Convenience sampling

Convenience sampling is built upon selections which suit the convince of the researcher and which are first to hand (Denscombe 2010).

Size of the Sample

The population is a set of entities from which results will be drawn. Results can be generalised over the population. For this research all software developer are main population. However, it is not practical to have all software developers so a sample of the population was selected to be representative of the population.

In order to generalize from the findings of a survey, the sample must not only be carefully selected to be representative of the population: it also needs to include a sufficient number. The sample needs to be an adequate size (Denscombe 2010). This research has also used effect size. In statistics, an effect size is a measure of the strength of the relationship between two variables in a statistical population, or a sample-based estimate of that quantity (Weiss et al. 2012). An effect size calculated from data is a descriptive statistic that conveys the estimated relationship without making any statement about whether the apparent relationship in the data reflects a true relationship in the population. In that way, effect sizes complement inferential statistics such a p-values (Weiss et al. 2012).

Presentation of Data

Excel and SPSS have been used in the research to present data. This research has used tables, bar charts, histograms, line graphs and box plots to represent data. Tables can be used for all types of numerical data. This research has used various tables to present raw data. A line graph is used for depicting development or progression in a sequence of data. Such graphs are good for showing trends in data. Bar charts are an effective way of presenting frequencies. They can be used with nominal and discrete data. A histogram, like a bar chart is a valuable aid to presenting data on frequencies or amounts. A histogram is used for continues data (Greenfield 2002). Often there is not enough data to allow histograms to be constructed or the less detailed description of the picture of the distribution is all that is required. In either cases box or whisker plot may be used. Here the central 50% of the ordered data is represented by a rectangular box and the whiskers are lines drawn from the ends of the box to the largest and

smallest t results in the set. Finally, the box is divided in two by the median that is by the middle value of the ordered data set (Greenfield 2002).

Descriptive Statistics

Descriptive statistics describes data distribution and its frequencies. The first most important factor to consider about distribution is mean, median or mode. The mean (average) is the measure of central tendency. The median (the middle point) is the mid-point of a range. The mode (the most common) is the most popular figure (Weiss et al. 2012).

Another method of dealing with the spread of data comes in the form of standard deviation. Standard deviation uses all the values to calculate how far in general the values tend to spread around the mean (Weiss et al. 2012).

Further an effect size is estimated. In 1976 Gene V. Glass proposed an

> *"Estimator of the effect size that uses only the standard deviation of the second group" (Kenny 1987).*

$$\Delta = \frac{\bar{x}_1 - \bar{x}_2}{s_2}$$

Control group may be consider as a second group, and Glass argued that if several treatments were compared to the control group it would be better to use just the standard deviation computed from the control group, so that effect sizes would not differ under equal means and different variances.

Under an assumption of equal population variances a pooled estimate for σ is more precise. Details of all other data analysing techniques are included in relevant chapters of each study.

3.3. Research Approaches

This research is based on a number of methodological approaches: Game Theory and questionnaires are part of this research approach.

3.3.1. Game Theory

The main research approach for this research is Game Theory. Game Theory is the formal study of conflict and cooperation. Game theoretic concepts apply whenever the actions of several agents are interdependent. These agents may be individuals, groups, firms, or any combination of these (Osborn 2004).

Game Theory is an effective method by which to investigate trust as it allowed us to simulate behaviour in relation to trust and to directly observe that behaviour and analyse it objectively. Game Theory is a well equipped instrument to investigate various human related factors.

Game Theory is also an appropriate technique for this research as trust is a sensitive and complex social phenomenon. Testing trust through conventional research methods such as questionnaires and interviews is difficult because people hesitate to show their true intentions as people do not like to talk openly about others and whether they trust others. Secondly, it is hard to observe and measure the exact value of trust. Therefore Game Theory is chosen as an alternative approach to test trust.

Game Theory literature is summarised in Section 2.5 of Chapter Two. Details of how games will be conducted, how many players used the game scenario and the individual game results are provided in both Chapters Four and Five.

3.3.2. Personality Profiling

This research used personality profiling in conjunction with games for the first study. These personalities complement the main game results. Personality profiling is presented in the form of pregame questionnaires. Pregame questionnaires are provided in Appendix 6. The personality test used was Moon's exercise for personality. The main motivation for personality profiling is to investigate the impact that different personality creates on trust between team members in Agile Methods.

3.4. Structure of the Study

Participant Selection

Full details of participant selection is in individual chapters, but below is the summary of what we did.

The participants for the study addressing RQ1[2] were contacted via email. Participants were undergraduate students and professionals. Student participants were selected randomly. Every 10^{th} student in the student register was invited to participate. Not all students agreed to participate in the research. About 50% agreed to participate. To increase participant numbers every 5^{th} student was randomly invited participate. The response rate was again around 30%. In the end, personal contacts are used to participate in the experiments.

[2] What is the impact of face-to-face communication on trust in Agile Methods?

Professional participants were personal contacts. All participants were selected before the game. Participants had no information about the game scenario before game.

The participants for the study addressing RQ2[3] were contacted via email. Response rate was zero. So again personal contact are used to conduct experiments. Participants were also given Amazon voucher in response to their participation. Participants were undergraduate students. All participants were selected before the game. Participants had no information about the game scenario before game.

Full details of all participants' selection are available in relevant chapters of this research.

Research Procedure

This section gives an overview of the research procedures used. Full details of the procedures for each individual study are provided in the specific relevant chapters.

All participants were asked to complete a pregame questionnaire. These questionnaires collected demographic information about participants. Pregame questionnaires are available in Appendix 2.

The game was initiated by giving participants/players an instruction sheet. This instruction sheet includes the game scenario. The instruction sheets are provided in Appendix 3. The game scenario describes the general instructions for the players. This includes like an overview of the game, the goals of the game, the rules of the game and how the game is performed.

The game procedure includes:

1. Participants choose their strategies for the first round from either work or shirk options. Participants hand in their choice via a record sheet to the game organizer.
2. During face-to-face stand-up meeting game participants attend two-minute long stand-up meetings. This is described in detail in Chapters Four and Five.
3. During no communication games participants just carry on choosing any strategy without talking to each other. This is described in detail in Chapter Four.
4. After every round each participants is told the decision of other participant.
5. The game carries on until all 10 rounds are finished.
6. Participants were asked to complete a postgame questionnaire once all rounds of the game are finished. Postgame questionnaires are available in Appendix 4.

[3] What is the impact of instant messaging on trust in Agile Methods?

3.5. Pilot Study

De Vaus (1993) stated: "Do not take the risk. Pilot test first". A pilot study can also be the pre-trial or "trying out" of a particular research instrument. However, Yin (2003) warns that a pilot is not a pre-test. Allowing the investigator to develop relevant lines of questioning is a formative use of the pilot study. A pre-test, on the other hand, is the intended data collection plan employed as a final test run; in other words, a pre-test is a "formal dress rehearsal" (Yin, 2003). He provides an additional warning, that many researchers utilise the collected data from a pilot study in an analysis of subsequent case studies. "You should not permit slippage from the exploratory (or pilot) phase into the actual case study to occur" (Yin, 2003).

A pilot case study has been described by Yin (2003) as a study that can "help investigators to refine their data collection plans with respect to both the content of the data and the procedures to be followed." Yin (2003) also noted that pilot cases assist research by allowing the researchers to develop relevant lines of questioning. These are important reasons for undertaking a pilot study in this research.

The term "pilot study" is used in two different ways in research. It can refer to feasibility studies, which are "small scale version[s] or trial run[s], done in preparation for the major study" (Polit et al. 2001). One of the advantages of conducting a pilot study is that it can provide advance warning about where the main research project could fail, where research protocols may not be followed, or whether proposed methods or instruments are inappropriate or too complicated.

In this research, a pilot study was used to investigate whether some of the research techniques developed for the research are suitable or require changing. The use of Game Theory is piloted. Full details of the pilot study are described in Appendix 5.

The main motivation for the pilot study was to refine the research methodology. Another important motivation for this pilot study was to find out the importance of trust in Agile Methods through Game Theory. Below are some of the factors that came out of the pilot study:

Factors

1. People with different personalities can have different interactions within teams and to other individuals. Some people do not seem to think about how other people are doing in the game. For example during pilot3 game1 player1 said that "I do not mind what people do

but I just do my own work". To further investigate the above concept final study investigated the impact of different personalities.

2. Time is an important factor in building trust. The more people work with each other the more chances they have to build and maintain trust. To investigate it further final study investigated the impact of trust level over time.
3. Trust is an important factor but trust cannot be observed straight away you have to look at other factors that can help to create and maintain trust. In trust a person's belief that the other person will behave according to his/her will. Final study used various other factors that might influence of trust building e.g. honesty.
4. Personal relationship/Previous experience can also create an impact on the level of trust. Final study also investigated the impact of previous/personal relationship on trust.

Future Study

Following the pilot study a much clearer picture emerged regarding the design of the full studies. As said previously the final study will be composed of factors generated from the pilot study. Therefore, the final study will investigate the impact of trust based on various factors generated from pilot study.

CHAPTER FOUR: INVESTIGATING THE IMPACT OF FACE-TO-FACE AND NO-COMMUNICATION ON TRUST USING GAME THEORY

4.1. Introduction

The aim of this chapter is to investigate the impact of different forms of communication upon trust in Agile Methods. The communication intervention is stand-up meetings. This study is comparing the impact of stand-ups to using no communication. Although no communication is an extreme situation it provides us with our control. The second section of this chapter discusses the other outcomes of experiment of this chapter; Section Three discusses the method used. Section Four discusses the results and finally Section Five briefly summarises the findings.

4.2. Hypotheses

Previous literature shows communication as a trust building factor. Due to nature of trust it is hard to measure it directly. Communication is used as an intervention in this chapter to investigate the impact of trust between individuals. This chapter investigate the impact of communication compared with no communication on trust in Agile Methods. This leads to the following pairs of research hypotheses:

$H1_o$: Communication has no impact upon trust between team members in Agile Methods.
$H1_a$: Communication increases trust between team members in Agile Methods (a one-tailed hypothesis).

The research also investigates whether there are any changes in behaviour over time (i.e. over the duration of the game).

$H2_o$: Trust levels do not change over the duration (10 rounds) of the game
$H2_a$: Trust levels do change over the duration of the game (a two-tailed hypothesis).

In all cases the confidence level is set to 0.05.

4.3. Method

The main method used in this chapter is Game Theory. Various games are played between participants using Game Theory. Each game used two participants. During each game participant's were asked some pregame and postgame questionnaires. During game participants asked to choose the option of work or shirk. Trust is calculated on the basis of how many work options participants used in each game.

4.3.1. Participants

There were 56 participants resulting in a total of 28 games with two participants in each game, each game had 10 rounds. Of the 56 participants, 32 were Brunel University undergraduate computing students and 24 were software professionals. The undergraduates were final year students enrolled on a Project Management module and were volunteers. The professional participants were personal contacts of the author all of whom were working in the software industry. As Tables 4.1 and 4.2 indicate there were some imbalance between the age and gender mix of the student and professional participants e.g. most students were female aged 18-25, whereas, most professionals were male aged between 26 and 35. However, as subsequent analysis of gender and job will reveal we do not believe this had much impact upon the results. This research performs post hoc tests whether gender and participant type have any impact upon trust. These post hoc tests are in response to the mix of male/female, and student/ professional participants. The research investigates whether there are any differences in trust between participants:

	18-25 yrs	26-35 yrs	36-45 yrs	Total
Professional	0	22	2	24
Student	27	5	0	32
Total	27	27	2	56

Table 4.1: Participant Age and Type

	Female	Male	Total
Professional	1	23	24
Student	22	10	32
Total	23	33	56

Table 4.2: Participant Gender and Type

4.3.2. Personality Profiling

All participants completed short personality questionnaires before the game started. Once participants finished the questionnaires they moved on to the main game. Details of the possible personality types are provided in Chapter Three (Research Methodology).

	Completer	Driver	Mover	Relater	Total
Professional	3	7	10	4	24
Student	5	5	16	6	32
Total	8	12	26	10	56

Table 4.4: Personality types for professional and student participants

Table 4.4 reveals the overall distribution of personality types and the breakdown between student and professional participants. Table 4.4 suggests that overall nearly 50% of participants are movers. These results also suggest that professional participants are mostly either movers or drivers. However, student participants are mainly movers with the remainder mostly spread between relater, driver and completer. Therefore, this suggests that student participants are mix of all personalities.

Table 4.5 shows in detail the different personality combinations that occurred during games, their total number of counts, and the minimum and maximum individual trust scores during games. For example a combination of completer and driver with four counts has a max value of 8. Whereas, a combination of mover and mover (there were 10 such combinations) has a maximum trust score is 4. Combination of relater and relater (there were 4 such combinations) has a maximum trust score is 8.

Group	Count	Min	Max
CD (Completer and Driver)	4	8	8
CM (Completer and Mover)	10	5	9
CR (Completer and Relater)	2	5	7
DD (Driver and Driver)	2	5	6
DM (Driver and Mover)	14	4	9
MM (Mover and Mover)	10	4	6
MR (Mover and Relater)	8	6	4
RD (Relater and Driver)	2	4	4
RR (Relater and Relater)	4	8	8

Table 4.5 Individual trust for personality combinations

These results suggest that the most interesting combinations are “Completer and Mover” and “Driver and Mover” based on the maximum trust score. Both combinations have movers. Movers are the people who:

“... Enjoy interacting and dealing with a variety of people”

This further confirms that movers are best in creating trust between each other by interacting with other people.

4.3.3. The Game

The experimental intervention was the stand-up meeting which is a short communication between participants. Half of the games (14) required stand-up meetings to be role-played and the other half (14) did not. Short (approximately two minute) stand-up meetings were role played at the end of each round in games holding stand-ups. In these stand-ups players discussed the problems they encountered `yesterday' (i.e. what happened in the previous round), the plans they had for their work today (i.e. the next round) and problems which may

affect this work. Of course no real development was taking place so players had to imagine work based on the scenario provided and their work or shirk decisions.

The hypotheses are tested using an iterated non-zero sum 2-player game based on a Work Shirk game and an agile software development scenario as shown in Appendix 3 (Game Scenario).

Two randomly selected participants (either from the pool of students or from the pool of professionals) played each game. Two players are chosen by keeping pair programming element of the Agile Methods in mind. Game scenario also based both players are working on the same piece of code to generate an output. The pairs were not paired according to age, gender or personality because in real life agile environment individuals do not worked according to any of these. So initially trust will be tested randomly. Each player role-played a software developer within an agile team where they were jointly working on a series of tasks for a fictitious company "Pluto". Each player had two choices, either to "work" or to "shirk". If both players choose to work then good progress is made, their manager will be pleased and there will be some reward (e.g. performance related pay, increased likelihood of promotion, etc.). If one player works and the other shirks then some progress is still made, but the shirker who is carried by the worker benefits most (since he or she receives credit for something that the other person has done and is free to enjoy himself or herself surfing the web, playing games or whatever). However, if neither player works then both get into trouble from their manager since the allotted task is not completed and their shirking cannot be hidden. All information is provided in the game scenario to participants. The structure of the game is similar to the Prisoner Dilemma game (Chapter Two) and the actual payoffs are given in Table 4.5. Participants were unaware of how many rounds would be played; hence the game was infinite, although in fact each game comprised ten rounds.

In each round both game players were required to independently choose `work' or `shirk' strategies. They each privately recorded their decisions which were then submitted at the end of the round. Their decisions were based on the payoff matrix with which they were provided a copy (Table 4.5). This shows that a player gets two points if both choose to work (i.e. cooperate through trust). A player will receive one point if he or she works (trusts) while the other will receive three points if he or she shirks (betrayal). If both players shirk, then both players receive zero points (neither trusts). This payoff matrix benefits a mutual trusting

behaviour where both players decide to work, compared to both players shirking hence it is a non-zero sum game. The aim is for each player to maximise his or her points.

		Player 1	
		Work	Shirk
Player 2	Work	2,2	1,3
	Shirk	3,1	0,0

Table 4.5: Players Payoffs

This research matrix slightly deviates from a standard PD or Work Shirk structure in that it does not satisfy the inequalities of T > R > P > S (see Table 2.4 in Chapter Two), as in this research matrix T is 3, R is 2, P is 0 and S is 1, hence we have 3 > 2 > 0 >1. However, it does have the following properties. A symmetric game models software developers with similar roles, opportunities and vulnerabilities. It is also a synchronous game so that players must make decisions at the same time. Furthermore (R + R) _ (S + S) so shirking is strongly sub-optimal.

The stand-up meetings followed the Yip (2006) standard stand-up structure questions e.g. what did I do yesterday, what obstacles do I have, what am I going to do today, what else should the other player know about? Although no actual software development took place this kind of discussion was encouraged since it helped interaction between the players and for the scenario to be richer. In the case of the intervention without stand-up meetings participants were still in the same room, however, they were not allowed to communicate during the duration of the game. In both sets of games each player was informed of the other player's choice after every round. At the end of each game each player received full details of the points scored by both players in each round of the game. A detailed scenario description is provided in Appendix 3.

Nash equilibrium for payoff matrix

This research uses a variant of the Work Shirk game in the study that is more fully described in Chapter Three. However, in one sense these games are not particularly revealing because by their nature they have well understood Nash equilibrium that means it can be predicted that any rational player will always betray the other player. This is because the defecting (or betraying) choice dominates, in other words irrespective of what the other player chooses it always leads to a better outcome. However, the paradox is that both players are worse off by betraying each other even though this is the best choice for each player. This paradox has been used by economists and others to attempt to explain the use, and abuse of, public shared goods, e.g. the so-called tragedy of the commons where the Nash equilibrium is for each farmer to overgraze the common land (Hardin, 1968).

4.4. Results

In order to test $H1_a$ (that communication increases trust between team members in Agile Methods) pairs of participants were randomly assigned to one of two different types of games reflecting the communication treatment. One set of games was based upon stand-up meetings and the second set was without stand-up meetings (i.e. no communication). Based on standard prisoner's dilemma and work shirk games, in all games participant's intention of choosing the work option is taken as positive intention to create trust between themselves and their work partner because this choice makes the player vulnerable to the other player choosing to shirk. The overall trust level (response variable) is determined by counting the number of work (trust) and shirks (betrayal) choices made by each individual over the ten games; hence the trust count ranges from zero to ten. Every time when a player chooses to work this shows a true intention of making a trust relationship between each other and vice versa. Note that all participants varied their strategies so that no player only chose work or only chose shirk. In practice it ranged from a minimum of 4 to a maximum of 9 across both treatments.

Table 4.6 (raw data is in Appendix 11) shows the summary of the individual trust counts grouped by whether they have stand-up meetings or not. The mean value shows results for all mean values for individual trust. The standard deviation (SD) which measures the spread of the data is greater without the stand-up meet.

Stand up	Count	Mean	Median	Min	Max	SD
N	28	5.64	6	4	7	1.026
Y	28	7.79	8	6	9	0.787

Table 4.6: Summary of Individual Trust Grouped by the Stand-up Intervention

A comparison of the two treatments is shown graphically in Figure 4.1 (raw data is in Appendix 11) as side-by-side boxplots of individual trust grouped by the intervention of stand-up meeting (Y) and no stand-up meeting (N). The notched areas show the 95% confidence limits for the sample medians. These do not overlap indicating that the stand-up meeting promotes significantly higher levels of trust between the game players. As Table 4.5 indicates the medians differ by 2 (out of a possible 10) so communication has the effect of increasing trust by 20%. To further confirm results the author used a 2-Sample, 1-tailed t-Test (alpha= 0:05) to compare the sample means. The $H1_o$ is rejected and instead the alternate hypothesis $H1_a$ of there being a significant increase is accepted (p less than and equal to 0:0001). Analysis of the collective trust of a game (i.e. when both players simultaneously co-operate) produces a similar result also with p less than and equal to 0:0001. Glass's is 2.095 ((7.79-5.64)/1.026) which implies a very large effect size (Kenny, 1987). Note this study did not pool the standard deviations since they differ (see Table 4.6), however, no communication might reasonably be interpreted as the control and therefore a sample of the population alpha prior to the intervention being applied.

Next this research examined the second hypothesis (H2) to see whether participants changed their behaviour over the course of the game. It is hard to see much overall pattern (see Figure 4.2 (raw data is in Appendix 11) which shows the total count of trust (work) decisions over the course of the 10 rounds of the experiment) and a correlation test of Total Trust (summed for all games) over time (round number) indicates a small non-significant correlation coefficient (r = 0:197). Recall that participants were unaware of how many rounds they were to play so they could not avail themselves of the opportunity to betray their colleague in the final round when the threat of revenge would be removed. Nevertheless it is clear that the null hypothesis $H2_o$ cannot be rejected.

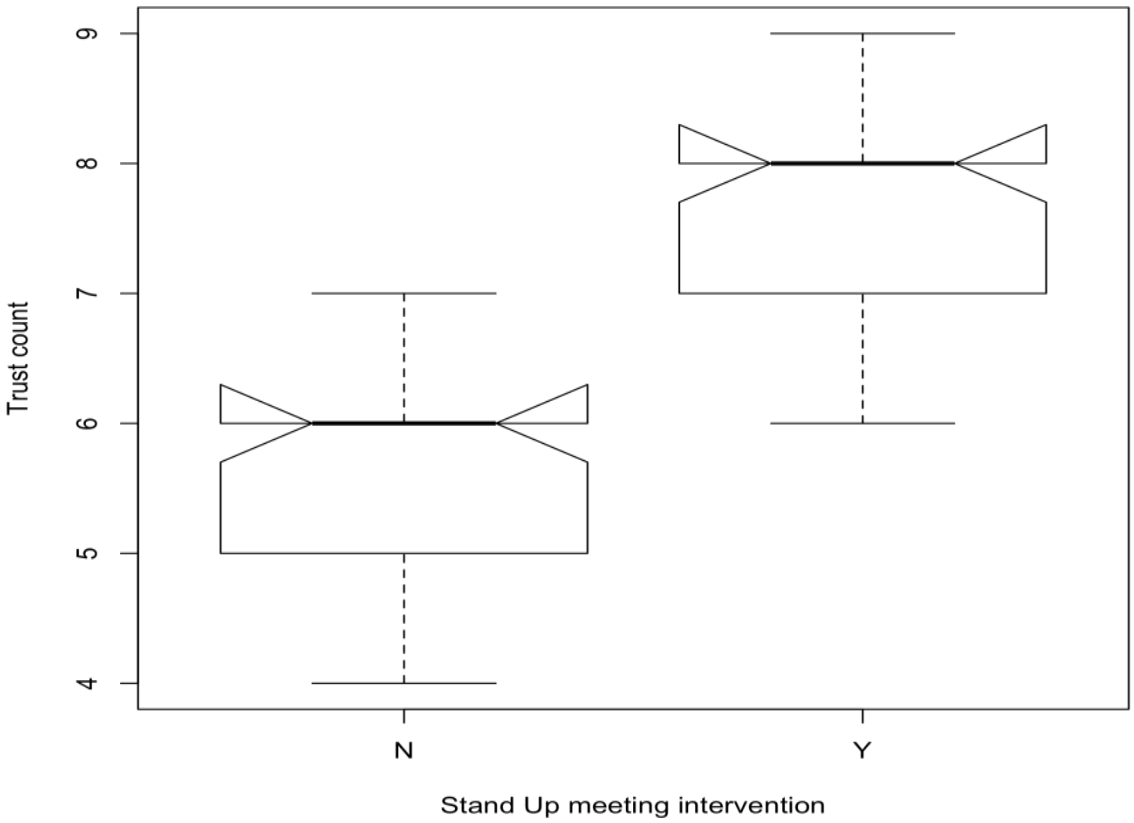

Figure 4.1: Boxplots of Individual Trust Counts

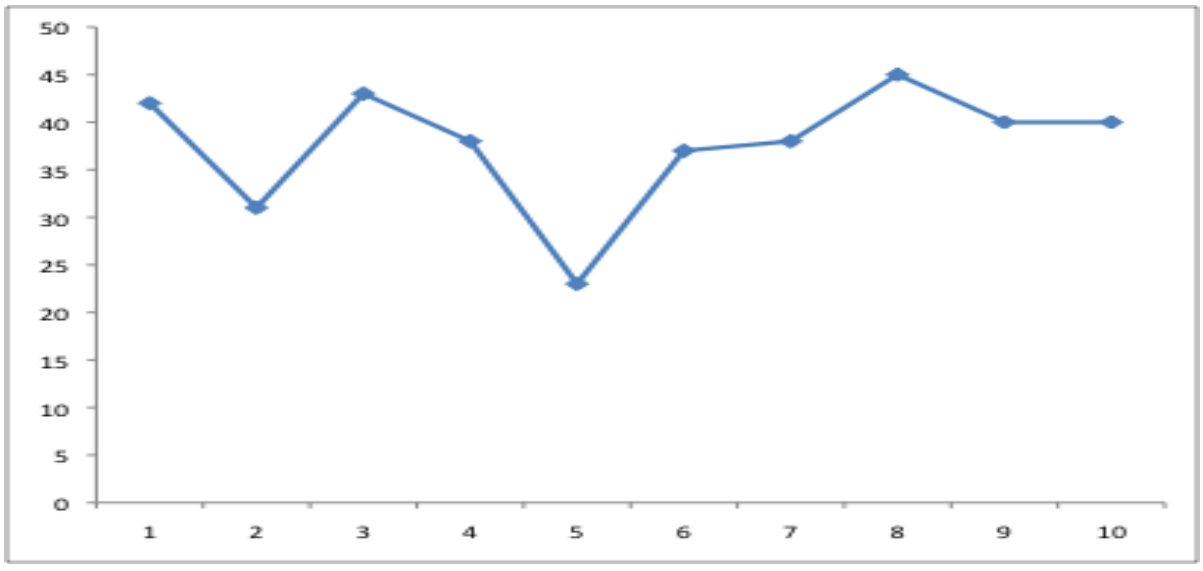

Figure 4.2: Line Plot of the Count of Trust Decisions (out of 56) Per Round

Figure 4.3 (raw data is in Appendix 11) shows the trends in trust level over the duration of the experimental game subdivided by treatment. Results suggest that the participants who are able to communicate always exhibit higher levels of trust. Somewhat curiously the levels for both treatments closely mirror each other for rounds 1 to 6 and then there is a greater decline in trust for the participants who are unable to communicate. It is not immediately apparent why this should be. Perhaps the 12 were initially well disposed to trust and then gave up; however, this is something that might be followed up with interviews in future work.

Research also looked at the trust difference between male and females. No difference was found between the twos. The mean values for trust levels are given in Table 4.5 where we see almost identical values.

In our experiment we used a mixture of students and software professionals which provided the opportunity to see if there were differences in behaviour. No significant difference was found when comparing the individual mean trust level over 10 rounds of a game between professionals and students (p =0.24) using a 2 sample t-Test.

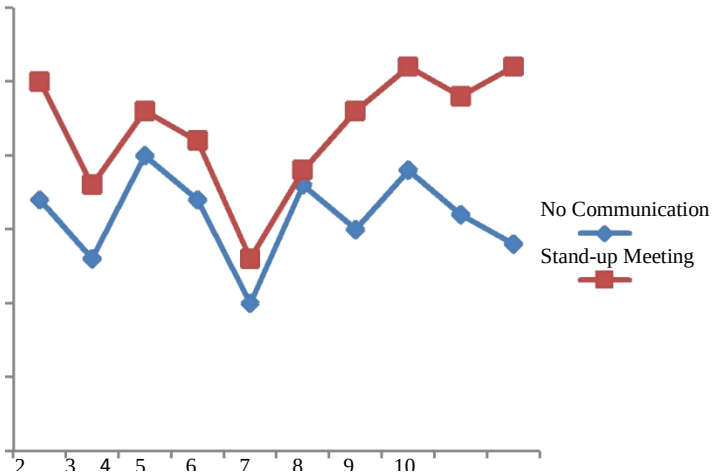

Figure 4.3: Line Plot of the Count of Trust Decisions (out of 28) per Round by Treatment

4.5. Summary

- The communication intervention of short stand-up meetings between rounds of the work-shirk game has a significant and, more importantly, a large positive effect upon the level of trust between pairs of participants in our experimental game.

- The research reported did not detect any statistically significant change in trust levels over time.

- The research reported did not observe any differences between male and female participants.

- The student and professional participants did not display any statistically significant differences in trust or betrayal rates.

- The research reported that “movers” are best in creating trust between each other by interacting with other people.

CHAPTER FIVE: INVESTIGATING THE IMPACT OF FACE-TO-FACE AND INSTANT MESSAGING ON TRUST USING GAME THEORY

5.1. Introduction

One of the fundamental principles of Agile Methods is the importance of communication between the various people involved in the development of software. Furthermore Agile Methods focus on improving communication through face-to-face communication. As the Agile Manifesto states "The most efficient and effective method of conveying information to and within a development team is face-to-face conversation." However, what if the conversation is not face-to-face? Does agile software development support non face-to-face communication as well? The main aim of this chapter is to investigate experimentally the impact of different channels of synchronous communication on trust in an agile software development setting.

5.2. Hypotheses

This chapter compares face-to-face communication with communication using instant messaging in Agile Methods. For the face-to-face communication intervention participants participated in a short face-to-face stand-up meeting and for instant messaging participants participates in short instant messaging stand-up meetings. This leads to the following pairs of research hypotheses:

$H3_o$: Face-to-face communication does not increase trust between team members in Agile Methods as compared to instant messaging.

$H3_a$: Face-to-face communication increases trust between team members in Agile Methods as compared to instant messaging.

$H4_o$: Trust levels do not change over the duration (10 rounds) of the game.

$H4_a$: Trust levels do change over the duration (10 rounds) of the game.

In all cases the confidence level of alpha is set to 0.05.

This research used two different groups to test these hypotheses. Both groups had stand-up meetings: one through face-to-face communication, and the other through instant messaging.

5.3. Method

5.3.1. Participants

There were a total of 40 participants resulting in a total of 20 games, each of which had 10 rounds. All 40 were Brunel University undergraduate Computing students. The undergraduates were final year students enrolled on a Computer Science degree. A general invitation email was sent to all undergraduate students to participant in the experiment. Table 5.1 shows the gender of participants. Figure 5.1 suggests that the game has more male participants as compared to female. This imbalance suggests that research results might have a gender bias.

Gender	Male	Female	Total
Participants	25	15	40

Table 5.1: Participant's Gender

Table 5.2 shows the age of participants. Figure 5.2 suggests that most participants were between age 18 and 24. This suggests that results are also age biased.

Age	18-24	25-34	35-44	Total
Participants	30	9	1	40

Table 5.2: Participant's Age

Participants were also asked if they knew each other previously. This is only possible in games using face-to-face stand-up meetings. As in instant messaging games participants were unable to see each other so they were unable to tell if they know the other participant or not. Table 5.3 shows the results of participant's previous knowledge about each other.

Figure 5.3 suggests that out of the 20 participants only 4 of them did not know each other previously. The outcome is not surprising as participants were students on the same course.

Know Previously	Yes	No	Do Not Know (Instant Messaging)	Total
Participants	16	4	20	40

Table 5.3: Participants Already Know Each Other

5.3.2. The Game

The experimental intervention was the stand-up meeting. Each game comprised of ten rounds. As before participants did not know the numbers of rounds. Ten games role played face-to-face stand-up meetings and ten games used instant messaging during the stand-up meetings. To test the hypotheses this research used an iterated non-zero sum 2-player game based on a variant of the Work Shirk game and an agile software development scenario. The detailed scenario of the game is presented in Appendix 3.

The game matrix follows the Standard Prisoner Dilemma or Work Shirk structure and it does satisfy the inequalities of T>R>P>S, as in our matrix T is 3, R is 2, P is 1 and S is 0, hence we have 3>2>1>0. Table 5.4 shows the payoffs matrix for each developer.

		Player 1	
		Work	Shirk
Player 2	Work	2,2	0,3
	Shirk	3,0	1,1

Table 5.4 Player Payoffs

Nash Equilibrium

What has long made this an interesting case to study is the fact that both players would be better off if they both chose to "cooperate" instead of both choosing to defect. However, each player could improve his own situation by breaking the mutual cooperation, no matter how the other player possibly (or certainly) changes his decision.

$T > R > P > S$

The payoff relationship $R > P$ implies that mutual cooperation is superior to mutual defection, while the payoff relationships $T > R$ and $P > S$ imply that defection is the dominant strategy for both agents. That is, mutual defection is the only strong Nash equilibrium in the game (i.e., the only outcome from which each player could only do worse by unilaterally changing strategy). The dilemma then is that mutual cooperation yields a better outcome than mutual defection but it is not the rational outcome because the choice to cooperate, at the individual level, is not rational from a self-interested point of view.

5.3.3. Game Types

Based on the hypotheses there were two different types of games.

1. Face-to-face communication
2. Instant messaging communication

Face-to-Face Communication Game

This game was based on two players in one room. In each game each player chose to work or shirk in each round. In each round of the game players were given a sheet to record their game choices. After every round both players were told what the other player chose in the previous round. Each round is followed by a stand-up meeting (brief meeting). During the

stand-up meeting players discussed the problems they encountered during their work. Players also discussed their future goals for their work. Players were not allowed to reveal his/her strategy decisions to the other player. However, they discussed other matters that can affect their work e.g. work related problems, family problems, sickness etc. Participants also answered pre and postgame questionnaires (Appendix 2 and 4).

Instant Messaging Game

This game was based on two players communicating via instant messaging. Communication was via Windows live messenger. Both players were in different locations. The rest of the game followed the same pattern as face-to-face games.

5.4. Results

5.4.1. Hypotheses Results

In order to test the hypothesis H1 (face-to-face communication can create higher level of trust in Agile Methods) face-to-face games are compared to instant messaging games. Two participants were randomly allocated to each type of game. One set of games used face-to-face stand-ups and the other used instant messaging as a tool to communicate during stand-ups. In all games selecting the work option is interpreted as a positive intention to create trust. Results were generated by counting all work (trust) options and shirk (betray) options chosen by each participant over ten games. The results show that trust levels for individuals ranged from 5 to 10.

Table 5.5 shows the summary of individual trust counts grouped by either face-to-face stand-ups or instant messaging stand-ups. The mean value shows the results for all mean values for individual trust. Table 5.5 also indicates the standard deviation measuring the spread of data. These results suggest that face-to-face communication creates higher levels of trust as compared to instant messaging. These results do suggest that instant messaging also create trust.

Stand-up Type	Count	Mean	Median	Min	Max	SD
Face-to-face	20	7.65	7.00	5	10	1.348
Instant Messaging	20	6.80	7.00	6	9	0.834

Table 5.5: Summary of the Individual Trust Grouped by the Stand-Up Intervention

To further confirm the results shown in Table 5.5 a 2-sample, 1-tailed t-Test (Alpha = 0.05) was used to compare the sample means. The H21 is accepted with a significant difference (p = 0.0215). Therefore, this means there is more trust when communication is through face-to-face as compared to instant messaging communication.

In addition Glass's Δ = 0.245 = ((7.65-6.80)/3.465) which implies a large effect size. Note the standard deviations are pooled in this measure of effect size.

Next this research examined the second hypothesis (H4) to see whether participants changed their behaviour over the course of the game. It is hard to see much of an overall pattern in

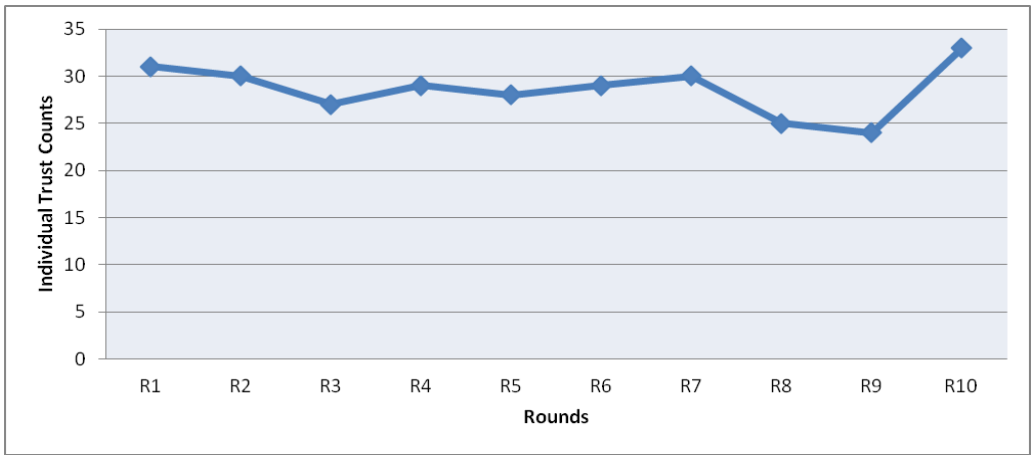

Figure 2.1: Line Plot of the Count of Trust Decisions per Round

Figure 5.1 shows the total count of trust (work) decisions over the course of the 10 rounds of the experiment.

Note that participants did not know how many rounds were in the game. Nevertheless $H4_0$ is accepted. Figure 5.2 shows trust counts trends over the ten rounds. Figure 5.2 suggests that participants using face-to-face communication do not show any particular pattern for trust (work). Whereas, participants using instant messaging started with more trust in the second round as compared to face-to-face communication. However, this trust reduces and remains below face-to-face trust (work) until the last round. Analysing the instant massaging scripts suggest that participants' enthusiasm levels fall after several rounds. This is only built up again when participants are told that this is the last round they have to perform. This pattern is shown in Figure 5.2.

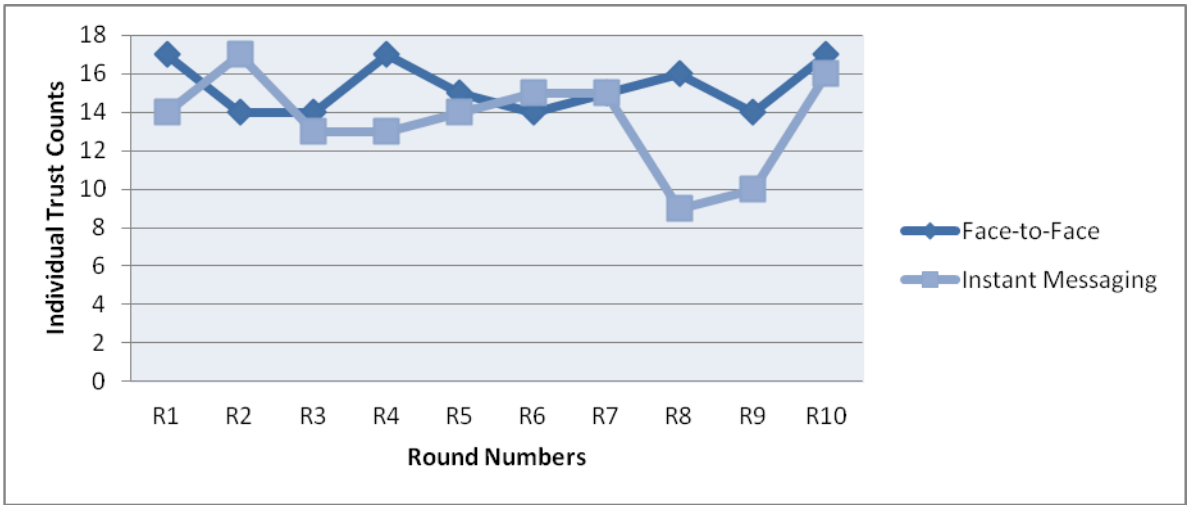

Figure 5.2: Line Plot of the Count of Trust Decisions per Round by Treatment

5.5. Postgame Questionnaires

Participants were asked to complete a postgame questionnaire (Appendix 4). Table 5.7 shows the results of the postgame questionnaires.

In response to the first question "I usually do not like to work with other people" most participants disagree with this statement. This suggests that most of the participants liked to work with other people. Further analysis of question 1 also suggests that people who do not like to work with others still created trust during the games.

In response to the second question "I would like to work with the same developer in the experiment again"; the results suggest that most participants would like to work with the

same person again. One explanation of this may be related to games participants already knowing each other previously, and working might create further bond between them.

In response to the third question statement "I think that the other developer in the experiment was not honest (not false or misleading; genuine)", in this questionnaire statement most of participants disagreed.

In response to the fourth question, "I think that the other developer in the experiment was not trustworthy (worthy of being trusted; honest, reliable, or dependable)". Again most participants disagreed that the other participant was not trustworthy. Again this might be because most knew each other previously.

Questions	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
I usually do not like to work with other people.	0	8%	15%	47%	30%
I like to work with the same developer in the experiment again.	20%	40%	30%	7.5%	2.5%
I think that the other developer in the experiment was not honest (not false or misleading; genuine).	0	5%	15%	45%	35%
I think that the other developer in the experiment was not trustworthy (worthy of being trusted; honest, reliable, or dependable).	2.5%	10%	7.5%	45%	35%
You choose to shirk because you suspect that the other developer is going to work.	0	27.5%	10%	40%	22.5%
You work because you trusted the other developer to work as well	32.5%	37.5%	10%	10%	10%

Table 5.7 Postgame Questions and Results

In response to the fifth question "You choose to shirk because you suspect that the other developer is going to work". 40% disagree with this statement. This suggests participant's positive intention of trust building. Only 27.5% agree that they shirk because they suspect that the often person was going to work.

In response to question six "You work because you trusted the other developer to work as well", most participants agree that they work because they trusted the other developer to work as well. This could be because most of the time people expect others to work during teamwork.

5.6. Summary

- The face-to-face communication intervention of short stand-up meetings between rounds of the work-shirk game has a significant and, more importantly, a positive effect upon the level of trust between pairs of participants in our experimental game. As opposed to

- The research reported did not detect any statistically significant change in trust levels over time.

- Research suggests that face-to-face communication is the best communication media to create trust in Agile Methods, but still instant messaging create some level of trust as compared to no communication.

CHAPTER SIX: DISCUSSION

6.1. Overview

Chapters Four and Five of this research presented the results of studies performed in response to the research questions posed in Chapter One. The results presented in Chapters Four and Five generate some important points of discussions. In order to further investigate the data collected in this research, the study's findings must be analysed and discussed in relation to existing theory and knowledge. To facilitate that analysis, the discussion of the study's findings focuses upon the key concepts presented in this research.

This chapter analyses the data collected in relation to the literature to understand the role of trust in Agile Methods. It is also appropriate now to step back and look at all two studies conducted in this research to provide an analysis of the importance of trust in Agile and plan driven methodologies.

The Second Section of this chapter explains the impact the direct and indirect communication has on trust. Section Three discusses relationship between trust and honesty, Section Four discusses the trust judgements that are made, and Section Five discusses trust levels over time and the implications of these levels. Section Six discusses the relationship between trust and productivity. Section Seven discusses communication and trust in relation to gender. Section Eight discusses the implications of using student and professional participants during research. Section Nine considers the impact of previous relationships on trust in Agile

Methods. Section Ten discusses the use of Game Theory in this research. This chapter ends by focusing on trust in relation to planned and agile methodologies.

6.2. The Impact of Communication on Trust

The first study (Chapter Four) of this thesis investigates the impact of communication on trust in Agile Methods. This research used communication as a vehicle to investigate trust between developers. Communication is the ability of individuals to exchange information between them. Two forms of communication were used i.e. direct communication and indirect communication. As established in Chapter Two (literature review) communication is a trust maintaining factor. Stand-up meetings are a particularly important communication channel in Agile Methods; stand-ups are used in this research (Chapters Four, Five) to investigate trust. As there is no formal control in Agile Methods so trust is even more important (Ramesh et al.2008). Chau et al. (2003) also suggest the use of stand-up meetings can promote mutual trust between developers.

> *"Through collective code ownership, stand-up meetings, onsite customer, and in the case of XP, pair programming, Agile Methods promote and encourage mutual trust, respect and care among developers themselves and with respect to the customer."*

Our research showed that stand-up meetings can be helpful in promoting communication between developers. Communication created during stand-ups can then be helpful in generating a trust relationship between developers. The research in this thesis used communication as an intervention to investigate the importance of trust in Agile Methods. According to Eckstein (2004):

> *"Trust is based on communication."*

Agile Methods rely heavily on communication and collaboration to access and share knowledge within project teams (Chau et al. 2003). The work in this thesis elaborated the importance of communication as part of Agile Methods. Agile Methods emphasise repeatedly human interaction e.g. communication. Cockburn (2007) also described communication as a human factor in Agile Methods.

Our results show that with an increase in communication between participants, trust also increased between participants. Our results also suggest that better communication can lead

towards higher levels of trust. Our results suggest that communication and trust have a direct connection to each other. This connection is demonstrated using a standard prisoner dilemma work shirk game. Games in which participants communicated created more trust as compared to games where there was no communication. The findings from our results indicate that in order to have good trust relationship between developer's communications should be improved. Communication can be improved in various ways. Our research suggests that short meetings like stand-ups can be helpful as effective means to increase communication and in turn trust between developers.

During stand-up in this research participants discussed personal issues which affected their work practice. Later on results depict this, as in games where participants indicated in the previous stand-ups that they are unable to do next task actually scored higher trust. This is completely opposite to the occasions where participants said that they would achieve the target before next stand-ups actually unable to finish their task, trust level decreased in those games.

6.2.1. Direct Communication

This section discusses how direct communication can be helpful in creating trust.

In order to investigate the impact of direct communication on trust this research used face-to-face communication. The important finding generated from the first study (Chapter Four) is that face-to-face communication as compared to no communication creates more trust in Agile Methods. The findings from Chapter Four provide evidence that frequent face-to-face communication in the form of stand-up meetings creates higher levels of trust as compared to no communication. This is also supported by the Agile Manifesto which states:

> "*The most efficient and effective method of conveying information with and within a development team is face-to-face conversation.*"

Face-to-face communication is the key to Agile Methods. A lower emphasis on documentation interaction bas been given more priority in Agile Methods. Agile Methods relay heavily on face-to-face communication. Cataldo et al.'s (2011) study on the impact of the structure of communication on Agile Methods also suggests:

> *"Agile methods emphasise communication, particularly, face-to-face interaction when the configuration of the teams so permits"*

Our research used face-to-face communication meetings where developers can exchange their problems and concerns more easily. These meetings can be helpful in creating more trust between developers. Regular communication through face-to-face meetings can resolve many conflicts. A study by Cao et al. (2008) also suggests a link between effective communication and trust:

> *"The effectiveness of communication between the customer and team depends on several factors, including customer availability, consensus among customer groups, and trust between the customer and the developer, especially during the project early stage."*

This implies that regular face-to-face communication can be helpful in creating trust between developers.

Project Managers in Agile Methods can create various informal communication opportunities for developers to enhance discussions between themselves. These informal face-to-face discussions do not need to be long. Short informal direct communication between developers can be helpful in creating, enhancing and maintaining trust. These face-to-face discussions or direct communication opportunities can be especially important for distributed projects.

6.2.2. Indirect Communication

In the second study this research compared trust using direct communication and indirect communication. Instant messaging is used as a form of indirect communication.

The second study results suggest that face-to-face communication creates higher levels of trust as compared to instant messaging communication (Chapter Five). The results from Chapter Five imply that direct communication can create more trust and improve work levels as compared to indirect communication. This research also suggests that although overall there is more trust in games where face-to-face communication is used, instant messaging games also show some trust created in each game. This is an important finding because it suggests that indirect communication also creates trust. A study by Green et al. (2010) on communication and quality in distributed projects also suggests:

> *"The use of other synchronous techniques may supplement continuous face-to-face and proximity shortfalls*."

The above quote suggests that when face-to-face communication is not possible then other synchronous techniques e.g. telephone conversation, a chat room event or instant messaging should be adopted. The main implication of this finding is that project managers should promote using other communication channels when face-to-face communication is not possible because instant messaging has particular implications for globally distributed projects. A study by Cataldo et al. (2011) on the impact of the structure of communication confirms the importance of informal communication for software teams. Lee et al. 2010 also suggest that to enhance the trust, teams should use instant messaging as a facilitator of communication. Schwaber (2008) also show how instant messaging is used as an alternative to face-to-face communication in distributed Scrum projects. McInerney et al. (2005) and Layman et al. (2006) suggest the use of instant messaging as a communication channel in Agile Methods.

Agile Methods are becoming increasingly globally distributed. The main principles of Agile Methods emphasises individuals and their interactions. This research suggests and provides a way for project managers to use instant messaging to increase interactions and communication between developers when face-to-face communication is not possible. Instant messaging has many advantages. Instant messaging is a cheap and synchronous reply mechanism. Instant messaging helps to save time when developers are globally distant while working on the same project at the same time. Quick and free accessible instant messaging tools can be helpful in creating informal communication between developers. Our results suggest that introducing specific communication points in the form of stand-ups seems a very powerful way to improve trust. Introducing regular meetings during a project can be helpful in creating good trust relationships between developers. Stand-up meetings can even be more important when teams are globally distributed. This research claims that communication in the form of instant messaging can be very helpful in creating trust. This is even more important when there is no face-to-face communication.

These findings are important for project managers as they suggest an alternative communication channel when face-to-face communication is not available. Therefore, project managers should promote various non-facial communications in the form of instant messaging in globally distributed agile projects. Communication in the form of instant messaging might be informal, but again this may lead to openness and in return trust between developers.

6.3. Trust and Honesty

Various other factors emerge while researching trust between developers. For example, the results of this research suggest a link between trust and honesty. The relationship between trust and honesty is described in detail in Chapter Two of this thesis (honesty is reported to be a trust maintaining factor). This research suggests that during games when the first participant tries to create trust by choosing the work option and the second responds positively, the first individual described the second participant as "honest". This suggests that more honesty can lead towards better trust. According to Eckstein (2004):

"Trust is based on communication, transparency, honesty and touch".

These results suggest that Project Managers should promote more honesty between developers, as honesty can be helpful in creating more trust between developers. Encouraging developers to share problems between each other can facilitate honesty between developers. Also good communication channels may improve such honesty. Because Agile Methods are highly people-oriented with culture of minimal hierarchy, self-organization, equity, empowerment, commitment, responsibility, participation, learning and continuous improvement, consensus, respect, compromises, trust, honesty, openness, communication (Siakas et al. 2007), developing honest and trusting relationships between developers should be possible.

6.4. Making Trust Judgements

The results from this thesis suggest that during games participants initially decide that other participants are not trustworthy. This initial decision decreases their trust level in each other's. This is especially the case where people shirk in the first round. So making a decision on other individuals right at the beginning of work can damage trust between individuals. Various factors seem to be associated with this initial decision e.g. working previously with the same individual, having had a bad experience or just making a decision without any previous knowledge of the individual. To mitigate this initial negative decision Project Managers should try to set projects very well right from the start. For example, if one developer is unable to start work at the same time as other developers, project managers should share this information with everyone in the group, so that other developers do not make any judgements about the developer before even working with them. Lee et al. (2010) also suggest that:

> *"Teams need to trust each other at the beginning of a project and use effective communication to help build a foundation of trust."*

Any minor misunderstandings between developers can create the wrong impression between developers and in turn generate reduced trust. As Nguyen et al. (2008) suggest:

> *"... Increased familiarity reduces communication problems such as misunderstandings and mistrust across sites."*

When participants decide to shirk because they think that the other participant is going to work, this also decreases trust. However, starting to judge that the other person will not work without any prior knowledge can more seriously damage trust and will not be helpful in the long term.

6.5. Trust Levels Over Time

The study presented in Chapter 4 of this research also looked at trust levels over time. This research did not detect any statistically significant change in trust levels over time. This suggests that trust remains stable over time. The results from this research suggest that continuous working together does not increase trust between team members. This is also supported by Vanneste et al.'s (2009) study of trust over time where no significant trust increases over time were observed. Our results also did not show any pattern of trust building over the period. This could be related to the nature of the game, but there was no obvious reason why there was no continues trust building.

Although in our results there was no statistically significant difference found for trust levels over time, some patterns of trust were found. For example, during the second study an increase in trust was observed in the second round using instant messaging. This then deceased with time until in the last round. Before the last round, participants were told that this was going to be the last round. Trust levels in the last round then increased. This increase suggests that telling them the work is almost finish might motivate individuals. This suggests that factors other than working together affects increases and decreases in trust. For example, Ferrin et al. (2003) analysed rewards as a trust-creating factor and reported:

> *"Our analysis, combined with prior research, suggests that managers can expect rewards to have strong, predictable effects on interpersonal trust. Yet our analysis also suggests that, rather than having a straightforward, direct effect on trust, rewards appear to*

> *affect trust by influencing individuals' perceptions about each others' motives, their perceptions of joint performance, and their evaluations of their own behaviour based on those reward structures."*

Project Managers should use incentives that promote trust. For example, during our research when individuals realised that they were near in the last round trust levels increased. This has particular implications for long projects. Giving developers interim end points during the project might help to increase trust between developers.

6.6. Productivity and Trust

Trust in this research is measured by the number of times participants select the option to work. The research presented in this thesis suggests that more trust results in more work output.

Edwards et al.'s (2003) study which analysed the effectiveness of global virtual teams in software engineering projects reports:

> *"It is expected that as trust improves, all the outcome variables can be expected to improve as well ... An increase in trust also increases the efficiency of the software engineering process itself."*

Edwards et al. (2003) suggest that increased levels of trust makes a positive impact on the level of work as well. Trust can be a positive or negative influence on the work environment. Due to the nature of trust, it is difficult to judge trust directly, but trust seems to have direct impact on work. This idea is also noted by Moe et al.'s (2010) study which suggests that lack of trust leads to decrease in productivity.

Project Managers should be aware of and effectively manage, and control factors, which are associated with the creation and maintenance of trust, as such factors influence the effectiveness of the work place.

6.7. Gender Trust

The first study conducted on the impact of communication on trust presented in Chapter Four also looked at the levels of trust created by male and female participants. The mean values for trust levels are almost identical. This might be slightly surprising as a number of studies have

reported evidence women behave in a more altruistic fashion than men (Eckel 2008). However, a study by Croson and Buchan (1999) reported no significant difference in trust in relation to gender and culture. A study by Scott (1983) also investigated trust differences between men and women in superior-subordinate relationships and found no significant difference in trust between men and women. Our results support that gender does not seem to be related to trust.

6.8. Student and Professional Trust

The research presented in this thesis used both student and professional participants. Our first study compares the impact of face-to-face communication with no communication on trust in Agile Methods. This first study used both student and professional participants. The use of student participants has often been criticised (Sjoberg et al., 2002) although a study by (Höst et al., 2000) reported only minor differences between student and practitioner performance. In our study no significant difference was found between student and professional participants. This tends to support the view of Höst et al. that there are fewer distinctions between professional and student individuals than expected. This lack of difference is likely to be because most of the student participants in this study were either final year degree students or PhD students. On the other hand, most professionals in our experiments only had one to five years of industrial experience. Therefore the difference in experience between the two groups was minimal. Our results are also supported by Runeson (2003) who found small differences between student and industrial professionals in empirical investigations.

Our second study compared face-to-face communication and instant messaging. This second study only used student participants. In software engineering many empirical studies report students as their participants e.g. Basili et al. 1996 and Porter et al. 1998. Depending on the actual experiment, students may actually be representative of junior/inexperienced professionals.

A study by Porter et al., 1998 used student participants and compared detection methods for software requirements inspections. Porter et al. then repeated their study with professional participants. Porter et al., 1998 reported that the outcomes of almost all statistical tests were identical. Porter et al., 1998 suggests that students provide an adequate model of the

professional population and that the much greater expense of conducting studies with professionals may not always be required.

6.9. The Impact of Previous Relationships on Trust

The study conducted on the impact of face-to-face communication and instant messaging also investigated differences in the levels of trust created when participants have known each other previously. This is important as a previous relationship with another person is also a trust maintaining factor reported in the literature (Babar et al. 2007). However, as there were only 4 individuals who did not know each other previously (students were used in this experiment who mostly knew each other from this course) it was difficult to generate statistically significant results. Investigating this in detail is worthwhile future work.

6.10. The Impact of Personality Type on Trust

The study (Chapter Four) conducted on the impact of face-to-face communication and no communication also investigated the personality types of participants. The study used both students and professionals as participants. The results from personality tests show some interesting outcomes, most participants are movers or drivers. However, the results suggest that paired combinations of relater and relater generate most trust. The research presented in this thesis suggests that some combinations of personalities are better in creating trust compared to other combinations. Sutherland and Tan (2004) explicitly acknowledge the influence of personality in their multidimensional trust model; they propose that extroversion and openness to experience leads to a higher disposition to trust and, conversely, that neuroticism and conscientiousness leads to a lower disposition to trust. Lumsden (2006) investigated different levels of trust on different personalities and suggests:

> *"...results indicate that there is some evidence that different personalities attribute different importance levels to each of the accepted trust triggers."*

6.11. Game Theory

This research demonstrated the use of Game Theory as a novel approach to Agile Methods and trust research. Game Theory is an effective method by which to investigate trust as it allowed us to simulate behaviour in relation to trust and to directly observe that behaviour and analyse it objectively. Game Theory is a well equipped instrument to investigate various

human related factors. The research in this thesis suggests that Game Theory is helpful in exploring sensitive topics like trust that are difficult to investigate directly. A study by Hazzan et al. (2008) also looked at how the prisoner dilemma game can be helpful in analysing behaviour and trust between team members.

Our experiments have been very simple but there is considerable potential to explore more complex scenarios such as multi-player games ($n > 2$), multi-role games where the games with more sophisticated interventions (e.g. email, Skype meetings, etc.). This is in contrast to most previous studies where human issues like trust, are explored only indirectly (often using questionnaires or interviews). However, emphasis is given to experimental games as a complementary technique and one that might pinpoint problems or raise questions that might better be resolved by more traditional qualitative methods. A good example of this is why trust levels over time seemed to have so little impact upon trust behaviour. Interviewing the participants is likely to yield insights.

Our research also suggests that Game Theory can be implemented in various software engineering scenarios. For example Game Theory can also be used in real life scenario to test trust between developers. Various real life scenarios or daily work pattern scenarios can be used in real practical environments to implement Game Theory. Real stand-ups can be used to investigate and test various human related factors using Game Theory in real work place.

Project Managers can use Game Theory to help and analyse various human related issues and concerns where developers are unable to show their true intentions. Game Theory is also helpful in generating answers in scenarios where ethical issues are a big factor. Our research suggests that for factors like trust where, people may be are afraid to show their true intentions, Game Theory can be helpful.

CHAPTER SEVEN: CONCLUSIONS AND FUTURE RESEARCH

7.1. Introduction

This chapter summarizes the research conclusions and presents future research directions. It starts by summarising the research along with its findings. Thereafter, the threats to validity are presented. In the next section, the research contributions are discussed, organised in three sub-sections: contribution to theory, contribution to practice and contribution to methodology. Next, significant future research opportunities that would provide further development to this important area of research are suggested.

7.2. Main Findings

This research provides a detailed insight into the link between communication and trust. The research shows how different communication channels create different levels of trust. Before going into the detail of each contribution. A summary of answers to the initial research questions posed in Chapter One is provided in Table 7.1.

Research Question Numbers	Research Questions	Findings
RQ1	***What is the impact of face-to-face communication on trust in Agile Methods?***	Face-to-face communication creates higher levels of trust as compared to no communication.
RQ2	***What is the impact of instant messaging on trust in Agile Methods?***	Instant messaging creates trust but at a lower level then face-to-face communication.

Table 7.1: Research Outcome

This research used Game Theory to explore the impact of communication on trust. Two separate studies were conducted to investigate this. The first study compared the impact of face-to-face communication with no communication on trust. The second study compared face-to-face communication with instant messaging communication. For the first study this research used a mixture of student (ns = 32) and professional participants (np = 24) to conduct 28 iterated 2-player experimental games. In the game the players could choose to work or shirk. The payoff matrix is broadly similar to a PD game with the characteristic that mutual betrayal is Pareto sub optimal. The intervention was a simulated stand-up meeting and the control was no communication. From this research, two sets of findings emerge. First that Game Theory is an effective method by which to investigate trust as it allowed us to simulate behaviour in relation to trust and to directly observe that behaviour and analyse it objectively. The experiments used in this research are simple but demonstrate considerable potential to explore more complex scenarios such as multi-player games (n > 2), multi-role games where the payoff matrix is not symmetric, dynamic payoff matrices and games with more sophisticated interventions (e.g. email, Skype meetings, etc.). This is in contrast to previous studies where human issues like trust, are explored only indirectly (often using questionnaires or interviews). Second, the study allowed accepting hypothesis $H1_a$ that communication increases trust between team members in Agile Methods. The results strongly suggest that communication plays a very important role in trust. The experiment revealed a very large difference (> 2 SDs (this is the mean counts of trust occurrence from the two treatments)) in trust between games where communication between players was required in the form of a stand-up compared to games where no stand-up was required. However, no particular trend over the duration of the game was found so no evidence was found; that trust might evolve (or be lost). This is slightly surprising and might be a topic to pursue further. Nor did this

research find any statistically significant difference between the behaviour of students and professionals, though this might be in part due to the artificial nature of the task and the setting. Research also suggests that different personalities combinations create different levels of trust.

The second study in this research took a step further and investigated the impact of face-to-face communication and instant messaging communication. For the second study this research used 40 students (ns = 40) to conduct 20 iterated 2-player experimental games. The games setup was exactly the same as for the first game. The results suggest that communication creates trust. However, face-to-face communication creates high levels of trust as compared to instant messaging.

Previous studies have shown that trust plays an important role in developing effective software teams. Our results suggest that introducing specific communication points in the form of stand-ups seems a very powerful way to improve trust. This is an important finding for project managers and suggests that much attention should be given to the frequency and nature of communication points in any software development process.

7.3. Contribution to Knowledge

The contributions made by this research are academic, practical and methodological. This thesis contributes to research and practice communities concerned with Software Engineering, Agile Methods, trust and communication.

7.3.1. Academic Contribution

Providing evidence that face-to-face communication is better than no communication and better than indirect communication e.g. instant messaging. However, this research also suggests that instant messaging can also lead to some trust building. This research also suggests that both agile and plan driven methodologies value trust similarly.

7.3.2. Practice Contribution

The contribution this research makes to practice is the rich knowledge and insights it supplies to practitioners concerned with Agile Methods and plan driven methodologies in the context of human related issues e.g. trust and communication. The research provides practitioners in the Software industry with valuable, systematic information of how to increase trust and in turn increase work output. The thesis has suggested specific recommendations to project

managers and suggests that attention should be given to the frequency and nature of communication points in any software development process.

7.3.3. Methodological Contribution

The use of Game Theory in Software Engineering is relatively new. This research is also the first study conducted on Agile Methods using Game Theory to investigate trust. Therefore, this research adds a new methodology (Game Theory) to investigate sensitive issues like trust. In addition, this research confirms the use of such quantitative methodologies as Game Theory for human related issues in the software engineering work place.

7.4. Threats to Validity

Representativeness

The student participants volunteered so it is possible that they differ in some sense from non-volunteers perhaps by being naturally more cooperative. As a result, the student sample used in this research may contain some bias. The professionals were also not selected randomly. This means that this research cannot claim that sample of participants in this research is fully representative.

Communication

The players in games without stand-up meetings were located in the same room as each other. Although players did not verbally communicate there is a possibility that non-verbal communication took place, e.g. facial expressions were interpreted by players.

Payoff Matrix

As previously discussed, to have the form of a PD or Work-Shirk, a game needs to satisfy certain conditions. One of the conditions is that it should satisfy the inequalities T > R > P > S. Our matrix does not fully satisfy this condition and this anomaly may influence the behaviour of players. However this does not affect the results we report here as we do not report the pay-off scores achieved by players. Instead we report only the number of times players choose the option work, shirk, i.e. trust, or not trust.

Role-Play Scenario

All participants role-played as software developers in an agile team. Some participants also role-played stand-up meetings. Although we asked participants to base their role playing on their previous work experiences, it is difficult to know how participants would actually have

behaved in a real agile team. Therefore it is difficult to know how well our simulated results reflect real-world behaviour.

Moon's Personality Test

For the first study of this research which compares trust between face-to-face communication and no communication the research used Moon's personality profiling. Results suggest that different personalities can impact on the level of trust created between each other. However it subsequently became clear that Moon's personality test is not an ideal tool with which to investigate trust. Moon's test also has no previous literature showing how it was to investigate the personalities of individuals. This can be a threat to the validity of results for different personality could have different impact on the level of trust.

There is no personality test conducted for second study of the research. This is a threat to validity for the study as both studies concentrated on different sets of elements. Despite first study suggests the importance of personality's impact on the level of trust between individuals.

Pairing

Both studies in this research used participants which were not paired on the basis of their age, gender or professional background. However, randomly picked up pairs were used. Random pairing can lead to the lack of control. Also this did not cover all aspects of results when pre paired could have been made. For example level of trust betweens males only or females only, level of trust between students and professionals etc.

Personal Contacts

During both studies it was hard to get hold of participants. All professional participants are either direct or indirect contacts. Part of students participants were also known as well. Therefore, research is based on many personal contacts which can create a bias on the level of results generated from the study.

7.5. Future Research and PhD Recommendation

The research provides some important directions for future research in order to continue developing this vital field.

Game Scenario

This research used a basic scenario that can match Agile Methods. However, a game scenario that can be detailed and match more Agile Methods will be ideal.

Infinite Number of Players

This research used a two player's game only. In future trust between infinite number of players can be interesting to investigate as well.

The Impact of Video Conferencing on Trust in Agile Methods

With the increase of distributed agile projects, it is hard for teams to see each other regularly. Video conferencing is a mechanism used to replace face-to-face communication. When teams are distributed, they often use video conferencing to save time and money while maintaining face-to-face contact. Video conferencing at face value seems to preserve face-to-face communication. One future study is to investigate the impact of video conferencing on trust in Agile Methods.

The Impact of Stand-up Meetings on the Working Environment in Agile Methods

This research has used stand-up meetings as an intervention to investigate trust in Agile Methods. Stand-up meetings are small meetings that occur every day between teams in Agile Methods. Few published studies exist on the real impact of stand-ups. Future work is to investigate stand-up meetings in real practice and their impact on the working environment.

The Impact of Personal Relationship/Previous Relationship on Trust in Agile Methods

This research has studied the impact of previous relationship on trust in Agile Methods. Due to lack of enough data there was no significance impact was reported. So in order to investigate it fully a future study

The Impact of Trust Levels Over Time in Agile Methods

This research has studied the impact of trust levels over time. Study did not find any significance result on the levels of trust over time. To explore this in detail future study will be important.

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Appendix 1- Research Questions

Research Question Number	**Research Questions**	**Hypotheses**	**How Answered**	**Which Chapters**
RQ1	***What is the impact of face-to-face communication on trust in Agile Methods?***	$H1_o$: Communication has no impact upon trust between team members in Agile Methods. $H1_a$: Communication increases trust between team members in Agile Methods (a one-tailed hypothesis). $H2_o$: Trust levels do not change over the duration (10 rounds) of the game $H2_a$: Trust levels do change over the duration of the game (a two-tailed hypothesis).	***Game Theory***	***Chapter 4***
RQ2	***What is the impact of instant messaging on trust in Agile Methods?***	$H3_o$: Face-to-face communication does not increase trust between team members in Agile Methods as compared to instant messaging. $H3_a$: Face-to-face communication increases trust between team members in Agile Methods as compared to instant messaging. $H4_o$: Trust levels do not change over the duration (10 rounds) of the game. $H4_a$: Trust levels do change over the duration (10 rounds) of the game (a two-tailed hypothesis).	***Game Theory***	***Chapter 5***

Appendix 2-Pregame Questionnaire

Please answer all questions as accurately as you can. Your answers will be kept confidential.

1. What is your age?

18-24

25–34

35–44

45–54

Over 55_

2. Which of the following describes you?

Male/Female

3. Do you know the other developer previously?

Yes/No/Don't know

If yes then go to question 4.

4. How well do you know the other developer? Please tick one box only

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
I worked with the other developer previously					
I know the other developer personally					
I know the other developer through social circle or through friend.					

Appendix 3-Game Scenario and Participants Instruction Sheets

Participant Instruction Sheet-Face-to-face

The Company

Pluto is a software development company. It mainly makes educational software for schools, colleges and universities. Pluto is an established company in the software industry. It has developed many different types of educational software. The company is multinational and has offices in the UK and USA. In the UK Pluto has 25 employees.

Project

Pluto recently won a bid to develop a system for a university. It is a small project. The main purpose of the system is to enable its users (lecturers) to send regular online feedback and online assessment results to their students. Although the university has not given any final requirements they want the system to be delivered in small releases.

Your Role in the experiment

During the experiment, you will role play the part of a developer from the Pluto UK office. This experiment is between two developers from Pluto. Your co-developer is also based in the same office. As you are not doing the real work, you have to take all your personal experiences of working of any software development project.

For this project you are working with another developer (who is another participant of the experiment). Both of you are responsible to code/program/implement user stories for the whole project. Assume both of you are experienced developers and each have two years of experience of same sort of projects.

Methodology

The company is using eXtreme Programming as the methodology to develop this project. As part of the project you have to do regular releases. You have to do one release a week. You have to create daily iterations as part of release. For each iteration you have to plan the iteration, create a new user story for that iteration and finally develop the latest version by implementing the user stories. Every day you have to produce a latest version from the previous day. At the end of the week you have to do a release. Participants have to report to their manager every day.

What you have to do?

Each day you can choose one of the following options:

- You can choose the option “Work” if you want to show your manager that you are working.

- You can choose the option “Shirk” if you want to show your manager that you are spending your time surfing the web and online games.

You will score points on the basis of what option you and your co-developer each select.

Table 1: Participant choices and scores

		Other developer	
		Work	Shirk
You	Work	2, 2	0, 3
	Shirk	3, 0	1, 1

Table1 shows how points are scored on the basis of what choices each of participant chose in the same round. The first number is your score and the second number will be the other developer's score. You must both choose independently, i.e. without knowing the decision of the other person. This will be repeated each day until the end of the project.

For example if both of you chose to work for each round of the experiment you will have more chances to finish the project on time. But if both of you shirk for all rounds you only score few points and project will fail in the end. It is important for both of you to work well in the project and make it success as this will make it likely you are promoted. It is very awkward if both of you do nothing as the manager will find out and you may get into trouble and might even lose your current. It is also annoying if you are doing all the work and the other developer keeps shirking. However it is nice for you to take some time off work as long as the other developer does enough work to keep the project going.

Rounds and daily meetings

The experiment is composed of number of rounds. You will not know how many rounds are within an experiment. In each round of the experiment you will be given a sheet to record your experiment choices. After the end of each round the experiment organizer will tell you the choices that both of you have made. Between these rounds there are daily meetings. During these daily meetings you will discuss following issues:

- What did you accomplish yesterday?
- What will you do today?
- What obstacles are impeding your progress?

Experimental Details

You can leave the study, or request a break, at any time. Once all rounds will be finished, each developer will be asked to fill up the questionnaire.

I hope that this has helped to clarify for you the purpose of the study. Your participation in the study is greatly appreciated and will help the research for my PhD in software engineering.

This study is conducted in accordance with Brunel University ethical guidelines. Your rights as a participant, including the right to withdraw at any point without penalty, are ensured.

It is anticipated that the findings of the study will be written up for publication in a peer reviewed journal and presented at international conferences. All results will be anonymised and it will not be possible to identify individual participant's data.

Please contact for further information: Eisha Hasnain at Eisha.Hasnain@brunel.ac.uk

If you have any questions at all, please ask them now.

If you would like to participate, please ask for a consent form.

If participants have any concerns or complaints regarding this research project, he/she can directly contact to siscm-srec@bruenl.ac.uk **or Dr Laurence Brooks Tel. No. +44 (0)1895 266010.**

Participant Instruction Sheet(S) (Instant Messaging)

The Company

Pluto is a software development company. It mainly makes educational software for schools, colleges and universities. Pluto is an established company in the software industry. It has developed many different types of educational software. The company is multinational and has offices in the UK and USA. In the UK Pluto have 25 employees.

Project

Pluto recently won a bid to develop a system for a university. It is a small project. The main purpose of the system is to enable its users (lecturers) to send regular online feedback and online assessment results to their students. Although the university has not given any final requirements they want the system to be delivered in small releases.

Your Role in the experiment

During the experiment, you will role play the part of a developer from the Pluto UK office. This experiment is between two developers from Pluto. Your co-developer is based in the US office. Both of you use instant messaging as a mode of communication. As you are not doing the real work, you have to take all your personal experiences of working of any software development project.

For this project you are working with another developer (who is another participant of the experiment). Both of you are responsible to code/program/implement user stories for the

whole project. Assume both of you are experienced developers and each have two years of experience of same sort of projects.

Methodology

The company is using eXtreme Programming as the methodology to develop this project. As part of the project you have to do regular releases. You have to do one release a week. You have to create daily iterations as part of release. For each iteration you have to plan the iteration, create a new user story for that iteration and finally develop the latest version by implementing the user stories. Every day you have to produce a latest version from the previous day. At the end of the week you have to do a release. Participants have to report to their manager every day.

What you have to do?

Each day you can choose one of the following options:

- You can choose the option "Work" if you want to show your manager that you are working.
- You can choose the option "Shirk" if you want to show your manager that you are spending your time surfing the web and online games.

You will score points on the basis of what option you and your co-developer each select.

Table 1: Participant choices and scores

		Other developer	
		Work	Shirk
You	Work	2, 2	0, 3
	Shirk	3, 0	1, 1

Table1 shows how points are scored on the basis of what choices each of participant chose in the same round. The first number is your score and the second number will be the other developer's score. You must both choose independently, i.e. without knowing the decision of the other person. This will be repeated each day until the end of the project.

For example if both of you chose to work for each round of the experiment you will have more chances to finish the project on time. But if both of you shirk for all rounds you only score few points and project will fail in the end. It is important for both of you to work well in the project and make it success as this will make it likely you are promoted. It is very awkward if both of you do nothing as the manager will find out and you may get into trouble and might even lose your current. It is also annoying if you are doing all the work and the other developer keeps shirking. However it is nice for you to take some time off work as long as the other developer does enough work to keep the project going.

Rounds and daily meetings

The experiment is composed of number of rounds. You will not know how many rounds are within an experiment. In each round of the experiment you will be given a sheet to record your experiment choices. After the end of each round the experiment organizer will tell you the choices that both of you have made. Between these rounds there are daily meetings. During these daily meetings you will discuss following issues with your other developer via instant messaging:

- What did you accomplish yesterday?
- What will you do today?
- What obstacles are impeding your progress?

Experimental Details

You can leave the study, or request a break, at any time. Once all rounds will be finished, each developer will be asked to fill up the questionnaire.

I hope that this has helped to clarify for you the purpose of the study. Your participation in the study is greatly appreciated and will help the research for my PhD in software engineering.

This study is conducted in accordance with Brunel University ethical guidelines. Your rights as a participant, including the right to withdraw at any point without penalty, are ensured.

It is anticipated that the findings of the study will be written up for publication in a peer reviewed journal and presented at international conferences. All results will be anonymised and it will not be possible to identify individual participant's data.

Please contact for further information: Eisha Hasnain at Eisha.Hasnain@brunel.ac.uk

If you have any questions at all, please ask them now.

If you would like to participate, please ask for a consent form.

If participants have any concerns or complaints regarding this research project, he/she can directly contact to siscm-srec@bruenl.ac.uk **or Dr Laurence Brooks Tel. No. +44 (0)1895 266010.**

Appendix 4-Post Game Experiment

Please answer all questions as accurately as you can. Your answers will be kept confidential.

Please tick one box only

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
I usually do not like to work with other people.					
I like to work with the same developer in the experiment again.					
I think that the other developer in the experiment was not honest (not false or misleading; genuine**).**					
I think that the other developer in the experiment was not trustworthy (worthy of being trusted; honest, reliable, or dependable).					
You choose to shirk because you suspect that the other developer is going to work.					
You work because you trusted the other developer to work as well					

Do you want to add anything about the experiment or about other developer?

1_____

2_____

3_____

4_____

Appendix 5 – Pilot Study

Game

Hypothetically Pluto is a software company. It mainly makes educational software for schools, colleges and universities. As part of the game you will be part of this company.

This game is between two developers of the Pluto. Players will play the role of software developer in this game. Game scenario is as follows:

Game Scenario

During the game players will act as if they are working in the Pluto. Players are part of an extreme programming project. As players are not doing the real work, that is why they have to take all their personal experiences of working of any software development project.

In the game players shall be given two options to pick up: “work” and “shirk”. To show their manager that players are working players can pick the option “work”. While if players want to tell that they are not working then they can pick up the option “shirk”.

Players and their Strategies

Below are the strategies that players can choose during the game.

Player	Strategies
Developer	Work
	Shirk

3.3.1. Payoff

The game consists of x rounds and in each round each player will score points. The player with the highest score will win the game. The next section explains how points are scored:

The Developer/player

- Players will get two points if they and the other developer choose to work.
- Players will get one point if he/she works while the other will receive three points if he/she chooses to shirk.
- Players will receive three points if he/she chooses to shirk, while other developer will receive 1 point if he/she decided to work.
- If both players to shirk both of players will receive zero points.

Below Table 5.1 shows these rules:

		Developer 1	
		Work	Shirk
Developer 2	Work	2, 2	1, 3
	Shirk	3, 1	0, 0

Player's task is to play this game and make the most points.

Rounds

The game is composed of a number of rounds. Players will not know how many rounds are within a game. In each round of the game players shall be given a sheet to record their game choices. Only the game organizers will know players game choices from the previous round.

3.3.2. Stand-up Meetings

Between the rounds there will be two minutes long meetings. In these meetings players will discuss about the problems they encountered during their work. Players will also discuss about their future goals of the work as well. Players must not reveal their strategy decisions to the other player. But they can discuss other matters that can affect their work.

All rounds will be similar and stand-up meetings will be similar as well.

Once all rounds will be finished, each player will be asked to fill up the questionnaire.

Results

Game 1 ----With no Stand-up Meetings

Game 2--- With Stand-up Meetings

Pilot was composed of two games. One game used stand-up meetings and the other game without stand-up meetings. Two separate participants played each game. I did not use the same participants in both games. Two participants participated in the game with no stand-up meetings whereas; four participants participated in the game with stand-up meetings.

Game Results

Initially both players were asked to come and sit down in the same room. As in agile teams developers normally sit in the same big room. So I decided to have both players in the same room. Initially each player was given player information sheet S1. Once sheet was handed in to the players. They were given five minutes to go through the sheet. Further I explained if explanation is needed. Then they were asked to play the game which is discussed in detail in section 6. Table 1 below shows the results of the game 1.

Players	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	
Player1 choices	**Work**	Work	Shirk	Shirk	Work	**Work**	Work	Work	Shirk	Shirk	
Points	**2**	1	0	0	1	**2**	1	1	0	0	**8**
Player2 choices	**Work**	Shirk	Shirk	Shirk	Shirk	**Work**	Shirk	Shirk	Shirk	Shirk	
Points	**2**	3	0	0	3	**2**	3	3	0	0	**16**

Table 1-Pilot 1 Game 1 Results

Results from game 1 shows that both players only created trust twice between each other. This trust can be seen in round 1 and round 6 when both players decided to work with each other. Whereas, the results from all other rounds shows that there is no trust between both

players. Also player1 try to create more trust relationship as compared to player 2. Out of 10 rounds player 1 tried to work in 6 rounds, whereas player 2 only worked in two rounds.

Table 2 below shows game 2 results. Results from game 2 shows that players 1 and 2 created trust relationship between each other three times: round 1, round 4 and round 6. Player 1 tries to create trust relationship five times, whereas player 2 tries to work six times.

Players	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	
Player1 choices	**Work**	Work	Shirk	**Work**	Work	**Work**	Shirk	Shirk	Shirk	Shirk	
Points	**2**	1	0	**2**	1	**2**	3	0	3	3	**17**
Player2 choices	**Work**	Shirk	Shirk	**Work**	Shirk	**Work**	Work	Shirk	Work	Work	
Points	**2**	3	0	**2**	3	**2**	1	0	1	1	**15**
Player3 choices	Work	Work	Shirk	Work	Shirk	Shirk	Work	Shirk	Work	Work	
	2	1	0	0	1	2	1	1	0	0	**8**
Player4 choices	Shirk	Shirk	Shirk	Shirk	Shirk	Shirk	Shirk	Shirk	Shirk	Shirk	
	2	3	0	0	3	2	3	3	0	0	**16**

Table 2-Pilot 1 Game 2 Results

As both players: player1 and player2 knew each other before we decided to run game in which we decided to pick up the people who don't know each other before. The game results suggest no trust between player3 and player4. Player 3 tried to work together with player 4 six times, whereas player 4 did not work in any round.

Both tables table1 and table2 are showing the number of rounds in each game. Both games have 10 rounds. Both tables also showing the choices that developer made during each round. Results show that in game1 developer1 trusts twice on developer2. Whereas in game 2 developer 1 trusts trice on developer 2. This means game results show that both developers created less trust in non-stand-up game as compared to stand-up game. However, in game 2 player3 and player4 who do not know each other before did not have any trust between each others. This shows that previous relationship make an effect on the level of trust between people.

Questionnaire Results

Players	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Player1	1	1	5	5	5	4	5	4	3
Player2	2	1	5	5	5	5	5	3	2

Table 3- Pilot 1 Game 1 Questionnaire Results

Table 3 shows results of the questionnaire of game 1. The details of the questionnaire are in Appendix6. Results suggest that one developer was less than 25 years of age, whereas other was between 25 and 34. Results also suggest that 100% were male. Both players strongly agree that they know the other developer previously. Both players strongly agree that they usually like to work with other people. Both players strongly agree that they like to work with the same developer again in the game. One player strongly agrees that he/she thinks that the other developer in the game was honest, whereas other player agrees to the response of this question. Both players strongly agree that they think that the other developer in the game was trustworthy. One player agrees that he/she choose to shirk because he/she suspects that the other developer is going to work, whereas other player was neutral about this question. One player disagrees with the fact that he/she work because he/she trusted the other developer to work as well, whereas other player was neutral.

Players	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Player1	2	2	5	1	1	4	4	5	1
Player2	2	2	5	4	5	4	2	5	5

Players	**Q1**	**Q2**	**Q3**	**Q4**			**Q5**					
				4.1	**4.2**	**4.3**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**5.6**
Player1	1	2	2				3	3	3	3	4	3
Player2	2	1	2				3	2	4	5	1	1
							6	5	7	8	5	4

Table 4-Pilot 1 Game 2 Questionnaire Results

Table 4 shows results of the questionnaire of game 1. Results suggest that one developer was less than 25 years of age, whereas other was between 25 and 34. Results also suggest that both players were male. Both players strongly agree that they know the other developer previously. One player strongly disagrees that he/she usually likes to work with other people, whereas, other player agrees. One player strongly disagree that they like to work with the same developer again in the game, whereas other player strongly agree to the response. Both players agree that they think that the other developer in the game was honest. One player agrees that he/she think that the other developer in the game was trustworthy, whereas other player disagrees. Both players strongly agree that they choose to shirk because they suspect that the other developer is going to work. One player strongly disagrees that he/she works because he/she trusted the other developer to work as well, whereas other player strongly agree.

The questionnaire we used in game2 players3 and 4 is in Appendix7. One player was male and the other player was female. One was player age was 25-34 and the other was less than 25 years. Both players did not know each other before. That is why they went straight onto question5. Both players were neutral in their response to usually do not like to work with the other people. One player was neutral, whereas other player disagrees that they like to work with the same person again. One player was neutral; whereas other player agrees in response to the question on that they think that the other player in the game was not trustworthy. One

player agrees, whereas other player disagrees in response for the question you choose to shirk because you suspect that the other developer is going to work. One player was neutral about the question "You work because you trusted the other developer to work as well", whereas other player was disagrees.

Games comparisons

Factor	Game1—no stand-up meeting	Game 2 --- stand-up meetings	
Collective Trust	2	3	0
Individual Trust	6, 2	5, 6	6,0
Total Points	8, 16	17,15	8,16

Table 5

In order to check the trust between different players we consider these two things:

1. If one player works this means he/she tries to create individuals trust.
2. If both players' works together this means this is collective trust.

Table 5 shows that during non stand-up meeting game players only managed to trust twice. However in the first game of stand-up meeting players trusted each other thrice whereas in the game three players did not trust each other.

Appendix 6 Personality Test

1	I like to have control over a job without being dependent on other people.	**P**
	I enjoy the stimulus of interacting with people.	**L**
2	I believe that entering new working relationships is a valuable stimulus to creative thinking.	**L**
	I believe that working with people one already knows and understands is the best way to get a job done properly.	**P**
3	I believe that long-term opportunities are more important than short-term problems.	**R**
	I believe that more attention should be paid to solving immediate problems rather than focusing on long-term opportunities.	**G**
4	I tend to help others out with their problems, even if it means giving a lower priority to my own jobs.	**L**
	I encourage other people to sort out their own problems so that I am not distracted from achieving priority tasks.	**Q**
5	I enjoy the stimulus of new ideas and challenges.	**S**
	I am cautious about the dangers of change for change's sake.	**H**
6	I believe that it's useful to have as many contacts as possible, as you never know when they'll be useful.	**M**
	I believe that sticking to the task in hand is more important than extending contacts which may not be immediately useful.	**Q**
7	I believe that people should be as careful as possible over any decision that they make, and that wrong decisions should be avoided at all costs.	**H**
	I accept that decisions can't be right all the time, and that some misjudgements should be tolerated.	**R**
8	I am happy to delegate work and leave others to get on and do the job in their own way.	**M**
	I delegate only clearly-defined jobs and always establish and maintain a clear monitoring method.	**P**
9	I believe that informal communication channels help people to develop a fuller understanding of tasks and opportunities.	**S**
	I prefer people to stick to established channels of communication so as to avoid confusion and misunderstanding.	**G**
10	I like to see early evidence that my efforts are succeeding.	**S**
	I am happy to work patiently before seeing results.	**H**
11	I enjoy developing existing skills and consolidating expertise.	**G**
	I enjoy developing new skills and knowledge.	**S**
12	I believe that talking about personal matters is important to developing effective working relationships.	**M**
	I believe that talking about personal matters at work too often distracts people from the important tasks at hand.	**Q**

13	I respond enthusiastically to ideas, and recognise possibilities.	**R**
	I provide a valuable brake on other people's enthusiasms and see detailed implications that others might overlook.	**H**
14	I like to be given clear instructions, and to work on well-defined tasks.	**H**
	I like to work out my own way of doing things.	**S**
15	I believe that effective performance requires that everyone stick to the directions that they are given.	**Q**
	I believe that people perform best when they are given the scope to decide their own working methods and priorities.	**L**
16	I believe that people should be flexible in their roles at work.	**R**
	I believe that people should stick to what they are good at and not get involved in other people's jobs.	**G**
17	I believe that rules should be bent to meet the needs of individuals.	**L**
	I believe that bending rules for individuals is short-sighted, a it may damage established procedures.	**P**
18	I believe that people should be informed before changes which affect them are introduced.	**M**
	I believe that people should only be informed of changes when their agreement is necessary to introduce them.	**P**

Appendix 7 Texting Scripts

Participant 1	Participant2 ---green
GAME11	
Hello Hello Hello We should work to so we can get ahead of the project	Yeah that's a good idea, so we stay ahead of the game
if you want to have a break today I will work then we can alternate	Let's recap quickly on what we did and then I don't mind having a break
?? Let's both continue with this iteration on the next day	OK kll
Are you concentrating on coding?	Yh Tomorrow Jam
Kl And the you work I'll take some time off	Working on my iteration 2moro jam
No we should finish it otherwise manager will know	I am doing my part ?
Now next one you can take time off an d I'll do the work	Finish it now ? "
GAME12	
	I'm going to do my part on the first one, you going to do the same
Have u managed to do your work on time	Yes, the second day I'll work and you can take time off and then we can swap
Third	Third day I'll take some time off and you continue working
Fourth	4th day we both work yeah
Yeah yeah cool	5th day both time off lol
Yeah yeah cool I'm on that	6th day both work yeah
6th day why u on?	Ayt ne 7th day
7th day you work and I'll take time off yeah	Na
Lol	Loll
8th day	Way u wanna do for 8th
I'll work yeah	I'll take time off on thy day
Kl	9th we both don't work and do some fun 10th both work yeah
10th day	Both work
Kl kl man	
GAME13	
Hii are u working	Hiii yeah I am working
Yeah	Snamp
Shall we work again	Yeah we shall

Lol day off?	What are you doing working or behind ur schedule
Time off	Time off
Okay I am doing my coding now	Ok I'm gna code now
Okay I'm going to party now	Ok shall we both finish our code nw
Okay we have to now lol Coding	Lol um code Shll we both tke a day off
I think I need to break from this hard work so time off	Same
I need more time off	code code again
codingggggggggg	
GAME14	
Work	I will be working ☺
This is more code than before Taking a break	Hahaha switch? iteration?
Yea	Going well?
Hardworkers right here	Time off
Yea its challenging but ok	
GAME15	
	Hey did you do much yesterday
? Lol Work together	Okay
I am going away	Okay lets see Finish coding For 2 days
Cooo	And then discuss progress
K	So how do you think we've done so far?
I am going away	Progress wise
Time off	K I more time off
Iteration	Then code all of them
K not able to do work K	code from now on
J KK	
GAME16	
	Sup Let's start coding
Let's code for 2 more days	Ok What now? =P
I'll work one extra day and you have break	Ok
Now I want time off	I'll code I'll release iteration
code 2 more days and time off in the end?	Kk

	Just listening to u now
I release iteration And now taking time off	
GAME17	
Hi	Hi
How was ur working day?	Hmmm not tat good
I am up till mark	I am trying my level best
Coding is nearly finishing	I am finishing mine as well
Need time off now	Releasing iteration now
Let's start coding now Hope u do some work. We should finish this part today	I am doing my part
Gd that is what I like	Think I need a break been working hard lately
I need some break have a head ache	Yeah ur rite Can't stop becoming a working holic
GAME18	
	Hi, I don't really want to work
Time off Let's start coding man 3 days now let's code code 4 days code code	Yeah let's code now
Code man code	coding
Not coding	Keep working
Releasing iteration	Coding
Code Code	Code
Code	Lol No
GAME19	
I will be start coding Wht abt u?	Let's code together
Ggg	Working on code
Me aswell What for next	coding Play
Next	coding
Next coding and then finish	I am away
No boss work	Boss tired
Now iteration	Break
K More code	
GAME20	

Hi	Hello
How is work going	Ok
Shall we both work together	Yes good idea
I am off tomorrow can you do my work	Yes sure I am off day after will you cover me
Yes I will be ok	
We both are back	Yes
I had lovely time but I am bit behind the work	Ok let's both work together and finish this iteration
Good idea I am doing ok now	Carry on next iteration
How is your work going	I am up to mark but I am fed up now need some rest
Ok but I am still behind so will work	I am resting now will concentrate tomorrow
I need rest now can u do my work	Ok I will try
Thanks I am working hard now	Same here
Finished now	finished

Appendix 8 Constant Form

MODEL CONSENT FORM

Please note that more information about obtaining consent can be found in the General Ethical Guidelines and Procedures which is available on the university website of the Research Ethic Committee (http://intranet.brunel.ac.uk/registry/minutes/researchethics/home.shtml)

(Please adapt this form to make it suitable to your own research situation)

The participants should complete the whole of this sheet by themselves.

	Please tick an appropriate box	
	YES	**NO**
Have you read the Research Participant Information Sheet?	☐	☐
Have you had an opportunity to ask questions and discuss this study?	☐	☐
Have you received satisfactory answers to all your questions?	☐	☐

Who have you spoken to?……

Do you understand that you will not be referred to by name in any report concerning the study?	☐	☐

Do you understand that you are free to withdraw from the study?

at any time	☐	☐
without having to give a reason for withdrawing	☐	☐
(remove if not relevant) without affecting your future care	☐	☐
Do you agree to take part in this study?	☐	☐

Signature of Research Participant……..……..

Date……..

Name in capitals……

Appendix 9 Ethics Approval

School of Information Systems, Computing and Mathematics

David Gilbert, Head of School, Professor of Computing

Jasna Kuljis, Head of Information Systems and Computing, Professor of Computing

Julius Kaplunov, Head of Mathematical Science, Professor of Applied Mathematics

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Email: Annette.Payne@brunel.ac.uk

Laurence.Brooks@brunel.ac.uk

Allan.Tucker@brunel.ac.uk

Date: 04th August 2009

STATEMENT OF ETHICS APPROVAL

Proposer: Eisha Hasnain

Title Role of Trust in Agile Methods

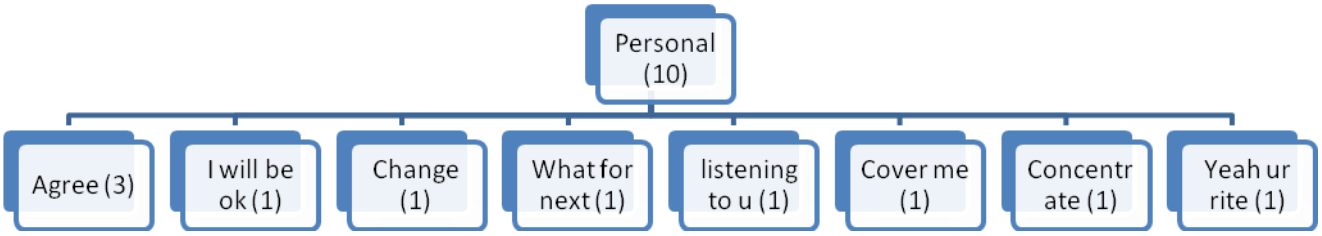
The school's research ethics committee has considered the proposal recently submitted by you. Acting under delegated authority, the committee is satisfied that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that you will adhere to the terms agreed with participants and to inform the committee of any change of plans in relations to the information provided in the application form.

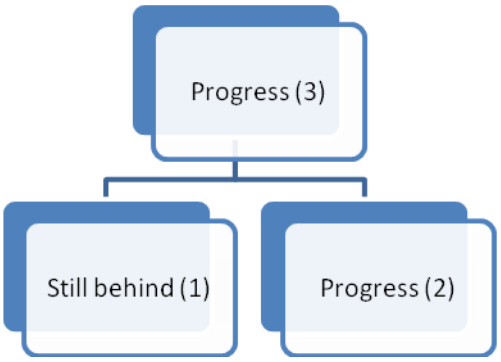
The approval is given on the condition that the phrase "without affecting your future care" is removed from the consent form.

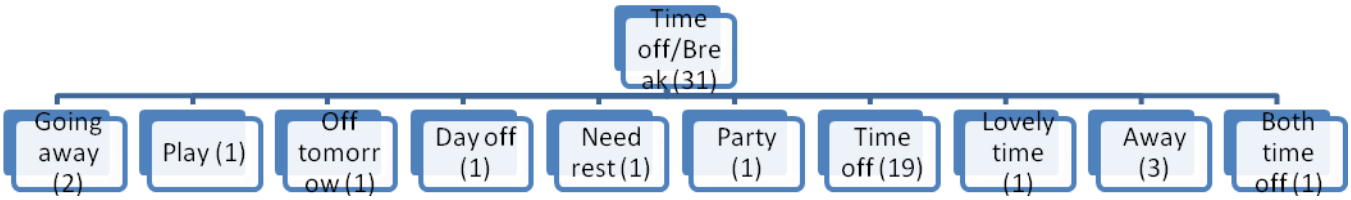
Yours sincerely,

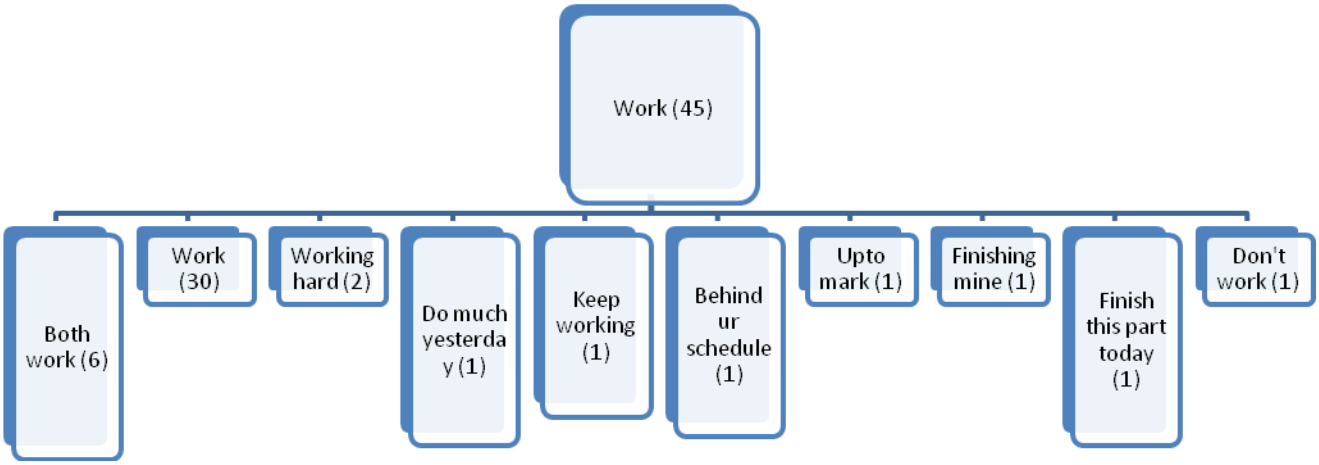
A. M. Payne

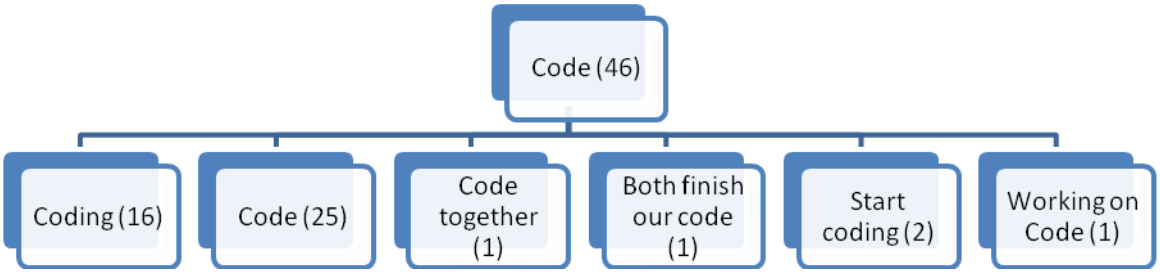
APPENDIX 10 TEXTING SCRIPTS CODING

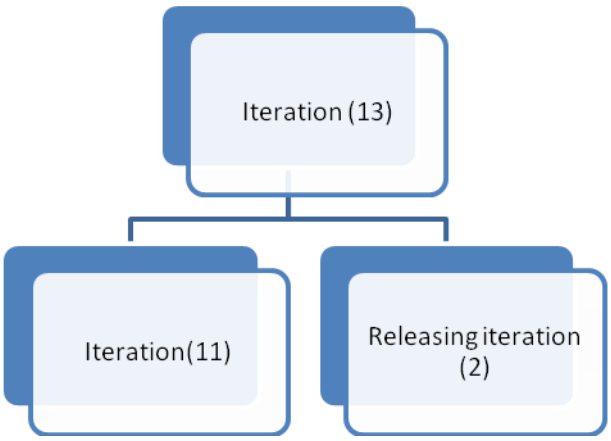




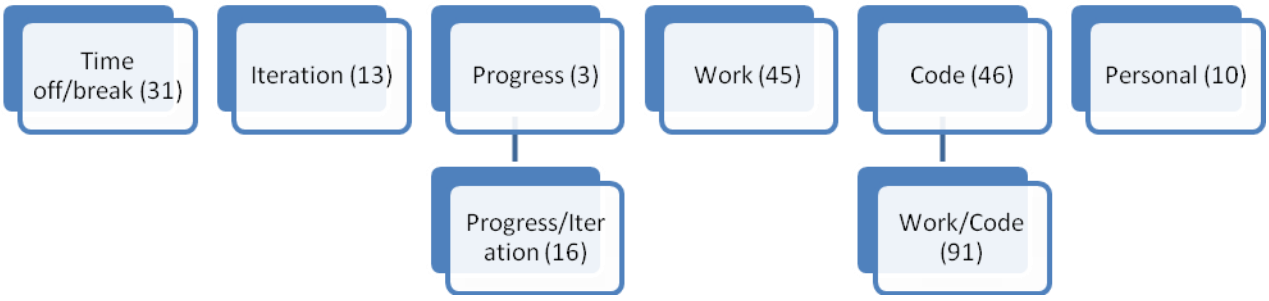

Time off/Break (31)
Going away (2)
Play (1)
Off tomorrow (1)
Day off (1)
Need rest (1)
Party (1)
Time off (19)
Lovely time (1)
Away (3)
Both time off (1)


Work (45)
Both work (6)
Work (30)
Working hard (2)
Do much yesterday (1)
Keep working (1)
Behind ur schedule (1)
Upto mark (1)
Finishing mine (1)
Finish this part today (1)
Don't work (1)

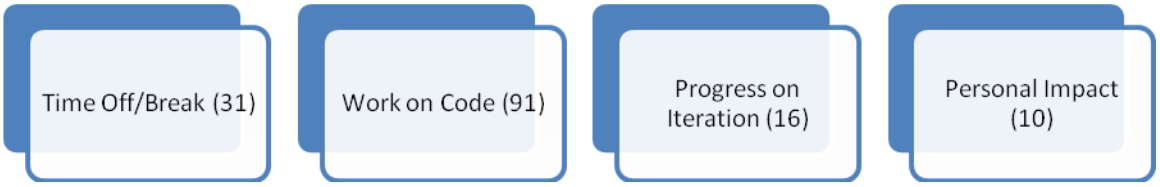

Code (46)
Coding (16)
Code (25)
Code together (1)
Both finish our code (1)
Start coding (2)
Working on Code (1)


Iteration (13)
Iteration(11)
Releasing iteration (2)

Core Code


Time off/break (31)
Iteration (13)
Progress (3)
Progress/Iteration (16)
Work (45)
Code (46)
Work/Code (91)
Personal (10)

Selective Code



APPENDIX 11 RAW DATA CHAPTER 4

Games	Stand-up	Players + Individual Scores in each Round	Individual trust	Collective trust	Let down	Personality type	Participant type
G1	N	P1 1 1 1 0 0 1 0 1 1 0	6	4	2	Mover	Professional
G1	N	P2 0 0 1 1 0 1 1 1 1 0	6	4	2	Driver	Professional
G2	N	P3 1 1 1 1 0 0 1 1 0 1	7	5	2	Mover	Student
G2	N	P4 1 0 1 1 0 1 0 1 1 1	7	5	2	Mover	Student
G3	N	P5 1 0 1 0 0 1 0 1 0 0	4	2	2	Relater	Professional
G3	N	P6 0 0 1 1 0 1 1 0 1 0	5	2	3	Driver	Professional
G4	N	P7 1 0 1 1 1 0 0 0 1 1	6	2	4	Mover	Student
G4	N	P8 0 0 0 1 0 1 1 0 1 0	4	2	2	Driver	Student
G5	N	P9 1 0 0 1 1 1 1 1 0 1	7	4	3	Mover	Student
G5	N	P10 0 0 1 1 1 1 0 0 1 1	6	4	2	Mover	Student
G6	N	P11 0 1 1 1 0 0 1 1 0 0	5	2	3	Completer	Student
G6	N	P12 1 0 1 1 1 1 0 0 1 1	7	2	5	Relater	Student
G7	N	P13 1 1 0 1 0 1 1 0 0 1	6	3	3	Driver	Professional
G7	N	P14 1 1 1 0 1 1 0 0 1 0	6	3	3	Mover	Professional
G8	N	P15 1 0 1 0 0 0 1 1 0 1	5	2	3	Mover	Student
G8	N	P16 0 0 1 1 0 0 0 1 1 0	4	2	2	Mover	Student
G9	N	P17 0 0 1 1 0 1 1 1 0 1	6	5	1	Mover	Professional
G9	N	P18 1 0 1 1 1 1 1 1 0 0	7	5	2	Mover	Professional
G11	N	P21 1 1 0 0 0 0 0 1 0 1	4	2	2	Relater	Professional
G11	N	P22 0 1 0 0 0 1 1 1 0 1	4	2	2	Mover	Professional
G12	N	P23 1 1 1 0 0 1 0 1 1 0	6	2	4	Driver	Student
G12	N	P24	5	2	3	Driver	Student

		1	1	1	0	0	0	0	1	1	0				
G13	N	P25										7	4	3	Mover	Student
		1	1	1	0	0	0	1	1	1	1					
G13	N	P26										6	4	2	Relater	Student
		0	1	0	0	1	1	1	1	1	0					
G14	N	P27										5	2	3	Completer	Professional
		1	1	1	1	1	0	0	0	0	0					
G14	N	P28										6	2	4	Mover	Professional
		1	1	0	0	0	0	1	1	1	1					
G15	N	P29										6	3	4	Driver	Student
		0	0	1	1	1	1	1	1	0	0					
G15	N	P30										5	3	2	Mover	Student
		0	0	0	1	1	1	0	0	1	1					
G17	Y	P33										7	4	3	Mover	Professional
		1	1	1	0	0	1	1	1	1	0					
G17	Y	P34										7	4	3	Relater	Professional
		1	0	0	1	1	0	1	1	1	1					
G18	Y	P35										9	6	3	Mover	Student
		1	1	1	1	1	1	1	0	1	1					
G18	Y	P36										7	6	1	Driver	student
		1	0	1	0	0	1	1	1	1	1					
G19	Y	P37										8	6	2	Mover	Professional
		1	0	1	1	1	1	0	1	1	1					
G19	Y	P38										7	6	1	Driver	Professional
		0	0	1	1	0	1	1	1	1	1					
G20	Y	P39										8	6	2	Mover	Student
		1	0	1	1	1	0	1	1	1	1					
G20	Y	P40										8	6	2	Completer	Student
		1	1	1	1	0	1	1	0	1	1					
G21	Y	P41										8	7	1	Mover	Student
		1	1	0	1	0	1	1	1	1	1					
G21	Y	P42										9	7	2	Completer	Student
		1	0	1	1	1	1	1	1	1	1					
G22	Y	P43										9	7	2	Relater	Student
		0	1	1	1	1	1	1	1	1	1					
G22	Y	P44										8	7	1	Relater	Student
		1	0	1	1	1	1	0	1	1	1					
G23	Y	P45										8	7	1	Driver	Professional
		1	1	1	1	0	1	1	1	0	1					
G23	Y	P46										8	7	1	Completer	Professional
		1	1	1	1	1	1	0	1	0	1					
G24	Y	P47										7	5	2	Mover	Student
		1	0	1	1	0	0	1	1	1	1					
G24	Y	P48										6	5	1	Mover	Student
		0	0	1	1	1	0	0	1	1	1					
G25	Y	P49										7	4	3	Mover	Professional
		1	1	1	0	0	1	0	1	1	1					
G25	Y	P50										7	4	3	Relater	Professional
		1	0	0	1	1	0	1	1	1	1					

G26	Y	P51 1 1 1 1 0 1 1 1 1 1	9	7	3	Completer	Student
G26	Y	P52 1 1 1 0 0 0 1 1 1 1	7	7	0	Mover	Student
G27	Y	P53 1 1 1 1 0 0 1 1 1 1	8	7	1	Mover	Professional
G27	Y	P54 1 1 1 0 0 0 1 1 1 1	7	7	0	Driver	Professional
G29	Y	P57 1 1 0 0 1 1 1 1 1 1	8	8	0	Completer	Student
G29	Y	P58 1 1 1 0 1 1 1 1 1 1	9	8	1	Mover	Student
G30	Y	P59 1 1 1 1 0 0 1 1 1 1	8	7	1	Relater	Student
G30	Y	P60 1 1 0 1 0 1 1 1 1 1	8	7	1	Relater	Student
G31	Y	P61 1 1 1 1 1 1 1 1 0 0	8	7	1	Driver	Professional
G31	Y	P62 1 1 1 1 0 1 1 1 0 1	8	7	1	Completer	Professional

APPENDIX 12 RAW DATA CHAPTER 5

Games	Face-to-Face	Instant Messaging	Players	Age	Gender	Know Other Player Previously	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Individual Trust	Collective Trust
G1	Y	N	P1	2	2	1	0	1	1	1	0	1	1	0	1	1	7	5
G1	Y	N	P2	2	1	1	0	1	0	1	1	0	1	1	1	1	7	5
G2	Y	N	P3	1	1	1	1	1	0	1	1	1	0	1	1	0	7	6
G2	Y	N	P4	2	1	1	1	1	1	0	1	1	1	1	1	1	9	6
G3	Y	N	P5	1	2	1	1	0	1	1	1	1	1	0	1	1	8	8
G3	Y	N	P6	1	2	1	1	1	1	1	1	1	1	1	1	1	10	8
G4	Y	N	P7	2	1	1	1	1	1	1	1	1	1	1	1	1	10	10
G4	Y	N	P8	3	2	1	1	1	1	1	1	1	1	1	1	1	10	10
G5	Y	N	P9	1	1	1	1	0	1	1	1	0	0	1	0	0	5	3
G5	Y	N	P10	1	1	1	1	1	0	1	0	1	1	1	0	1	7	3
G	Y	N	P1	1	1	2	1	0	1	0	1	1	1	0	1	1	7	3

6			1															
G6	Y	N	P12	2	1	2	1	1	0	1	0	1	1	1	0	0	6	3
G7	Y	N	P13	1	2	1	0	1	1	1	0	1	1	1	0	1	7	7
G7	Y	N	P14	1	2	1	1	1	1	1	0	1	1	1	1	1	9	7
G8	Y	N	P15	1	2	1	1	1	1	0	1	0	1	1	0	1	7	5
G8	Y	N	P16	1	1	1	1	1	0	1	1	1	0	1	1	1	8	5
G9	Y	N	P17	1	2	2	1	0	1	1	1	0	0	1	1	1	7	6
G9	Y	N	P18	1	2	2	1	1	0	1	1	0	0	1	1	1	7	6
G10	Y	N	P19	2	2	1	1	0	1	1	1	1	1	0	1	1	8	6
G10	Y	N	P20	2	1	1	1	0	1	1	1	0	1	1	0	1	7	6
G11	N	Y	P21	1	1	3	1	1	0	1	1	0	1	0	1	1	7	7
G11	N	Y	P22	1	2	3	1	1	0	1	1	0	1	0	1	1	7	7
G12	N	Y	P23	1	1	3	1	1	1	1	0	1	1	0	1	0	7	5
G12	N	Y	P24	1	1	3	1	1	1	0	1	1	1	0	0	1	7	5
G13	N	Y	P25	2	2	3	0	1	1	1	1	1	1	1	1	0	8	5
G13	N	Y	P26	2	1	3	1	1	0	0	1	1	1	0	1	1	7	5
G	N	Y	P2	1	1	3	1	1	1	0	0	1	1	0	0	1	6	4

14			7															
G 14	N	Y	P28	1	1	3	1	1	0	0	1	0	1	1	0	1	6	4
G 15	N	Y	P29	1	2	3	1	1	1	1	0	1	1	0	0	1	7	6
G 15	N	Y	P30	1	2	3	1	1	1	0	1	1	1	0	1	1	8	6
G 16	N	Y	P31	1	2	3	1	1	0	1	0	1	0	1	0	1	6	4
G 16	N	Y	P32	1	1	3	1	0	1	1	0	1	1	0	0	1	6	4
G 17	N	Y	P33	1	1	3	1	1	0	1	1	1	0	1	0	1	7	4
G 17	N	Y	P34	1	1	3	0	1	1	0	1	1	0	0	1	1	6	4
G 18	N	Y	P35	1	1	3	1	1	1	0	0	1	0	1	0	1	6	6
G 18	N	Y	P36	1	1	3	1	1	1	1	1	1	1	1	0	1	9	6
G 19	N	Y	P37	1	1	3	0	0	1	1	1	1	0	1	1	1	7	5
G 19	N	Y	P38	1	1	3	0	0	1	1	1	1	1	0	0	1	6	5
G 20	N	Y	P39	1	1	3	0	1	0	1	1	0	1	1	1	0	6	6
G 20	N	Y	P40	1	1	3	0	1	1	1	1	0	1	1	1	0	7	6