The Impact of Collocation on Team Effectiveness

An Empirical Research Paper

Presented to the
Department of Information Systems
University of Cape Town

by
Joanne Smith (SMTJOA007)
and
Stephan van der Watt (VWTSTE003)

in partial fulfillment of the
requirements for
Information Systems Honours
(INF 4014W)

3 September 2008
PREFACE

This research report is not confidential. However, the names of the companies and the team members who participated in this study have not been mentioned.

The researchers would like to acknowledge the following people for their assistance throughout the study:

- Mike Eccles, our research supervisor, for the guidance and insight he provided throughout the research.
- Brian O’Donovan for the excellent direction on how to successfully carry out an empirical research study, and on qualitative research methods.
- Mike Hart for his guidance with regards to quantitative research methods and data analysis.
- The sample companies, coordinators and team members for taking part in this study.
- And finally, our friends and loved ones who were always supportive even though they were terribly neglected.
1. We know that plagiarism is wrong. Plagiarism is to use another’s work and pretend that it is one’s own.

2. We have used the APA convention for citation and referencing. Each contribution to, and quotation in, this Empirical Research Paper entitled ‘The Impact of Collocation on Team Effectiveness’ from the work(s) of other people has been attributed, and has been cited and referenced.

3. This Empirical Research Paper is our own work.

4. We have not allowed, and will not allow, anyone to copy our work with the intention of passing it off as his or her own work.

5. We acknowledge that copying someone else’s assignment or Empirical Research Paper, or part of it, is wrong, and declare that this is our own work.

Date: 3 September 2008

Group Number: ME01

__________________________________________  _______________________________________
Joanne Smith                             Stephan van der Watt
ABSTRACT

The approach of collocating software development team members is becoming increasingly common, especially in agile development environments. There is little evidence to explain what impact this collocation has on the effectiveness of the collocated teams. This empirical research paper aimed to explore the impact of collocating agile software development teams, which are adopting the SCRUM approach to software development, on a number of team effectiveness factors. In addition, other factors that have an influence on the collocated working environment were investigated in order to provide insight into the optimal design of a collocated team environment.

This study focused on South African development teams and made use of questionnaires and interviews in order to gather data from the sample of agile software development team members. The results of the research were analysed both quantitatively and qualitatively in order to identify the main findings and implications, with the purpose of satisfying the research objectives.

A key finding was that collocation has a positive impact on fourteen of the team effectiveness factors that were investigated. These factors are Feedback, Goal, Communication, Team Identity, Performance Targets, Commitment, Fun, Individuality, Learning, Work Approach, Fun, Resources, Conflict Management and Trust / Mutual Accountability. A model of the team effectiveness factors that are positively impacted by collocation was proposed and the relationships between these factors were identified and discussed. In addition, three key aspects relating to the collocated working environment, namely noise and interruptions, break-away areas and the general layout of the environment, were also identified and discussed, and the findings presented.

From the findings of the research it can be concluded that companies should consider collocating their agile software development teams, as this collocation can lead to increased overall team effectiveness. Additionally, the collocation of teams in an open plan environment facilitates communication between teams and promotes team involvement. Noise and interruptions do not have a substantial influence on the productivity of the teams. And finally, teams do not believe that the inclusion of break-away areas in the collocated environment would be particularly beneficial.
# TABLE OF CONTENTS

Preface ........................................................................................................................................ i

Plagiarism Declaration ................................................................................................................ ii

Abstract ...................................................................................................................................... iii

1. Introduction .............................................................................................................................. 1
   1.1. Background to the Research ............................................................................................. 1
   1.2. Purpose of the Research .................................................................................................... 1
   1.3. Plan of Development .......................................................................................................... 2

2. The Development of Collocation ............................................................................................. 3
   2.1. The Introduction of Teams .................................................................................................. 4
   2.2. The Agile Approach ............................................................................................................ 4
   2.3. The Collocation of Teams ................................................................................................ 5

3. Team Effectiveness Factors ..................................................................................................... 8
   3.1. Feedback ............................................................................................................................. 8
   3.2. Goal .................................................................................................................................... 9
   3.3. Communication .................................................................................................................. 10
   3.4. Team Identity ..................................................................................................................... 12
   3.5. Performance Targets ........................................................................................................ 12
   3.6. Role .................................................................................................................................... 13
   3.7. Individuality ....................................................................................................................... 13
   3.8. Learning ............................................................................................................................. 14
   3.9. Resources .......................................................................................................................... 14
   3.10. Morale .............................................................................................................................. 15
   3.11. Trust / Mutual Accountability ........................................................................................ 15
   3.12. Conflict Management ...................................................................................................... 16
   3.13. Work Approach ................................................................................................................ 17

4. Summary of the Literature ........................................................................................................ 20
LIST OF FIGURES

Figure 1: Examples of Radically Collocated Environments ................................................................. 6
Figure 2: Modes of Communication ........................................................................................................ 11
Figure 3: The Role of the Respondents with Teams ............................................................................. 29
Figure 4: Years of Work Experience within a Collocated Working Environment ............................... 29
Figure 5: Years of Work Experience within the IT Field ....................................................................... 29
Figure 6: The Overall Means of the Male Respondents per Team Effectiveness Factor ...................... 30
Figure 7: The Overall Means of the Female Respondents per Team Effectiveness Factor .................. 30
Figure 8: The Ranking of the Overall Means of the Team Effectiveness Factors .................................. 31
Figure 9: The Radically Collocated Team Room .................................................................................. 49
Figure 10: The Open plan Collocated Working Environment .............................................................. 50
Figure 11: The Radically Collocated Environment of Team E ............................................................. 56
Figure 12: A Team Working in the Open plan Collocated Environment .............................................. 57
Figure 13: The Impact of Collocation on the Team Effectiveness Factors ......................................... 62
Figure 14: The Relationships between the Team Effectiveness Factors that are Impacted by Collocation ......................................................................................................................... 63

LIST OF TABLES

Table 1: Characteristics that Contribute to Achieving Common Ground ............................................. 18
Table 2: Company and Team Identifiers ................................................................................................ 26
Table 3: The Descriptive Statistics of the Questionnaire Responses ..................................................... 78
Table 4: The Overall Means of the Factors at Team Level .................................................................... 81
Table 5: Spearman Rank Correlation at a p-value of 0.5 ..................................................................... 82
Table 6: Spearman Rank Correlation at a p-value of 0.0001 ................................................................ 83
Table 7: Results of the Cronbach Alpha Tests ........................................................................................ 84
1. INTRODUCTION

1.1. BACKGROUND TO THE RESEARCH

Throughout the history of software development the structure and layout of the working environment, as well as the way in which employees have been situated within the working environment, has gone through a number of changes, from the individualistic, hierarchical approach to the team approach that is commonly adopted in organisations today (Friedman, 1989). These changes have been brought about in response to the ambition of the software development profession to constantly improve upon the time, cost, quality and productivity of their development projects, and so increase the level of project success within the field (Avison & Fitzgerald, 2003; Cockburn & Highsmith, 2001; Covi, Krishnan, Olson, & Teasley, 2002; Katzenbach & Smith, 1993).

The team structure has been shown to achieve better results overall, including improved productivity, flexibility and performance. Consequently, teams have come to be considered as the optimal working structure for individuals working on a particular project (Katzenbach & Smith, 1993; Olson, Covi, Rocco, Miller, & Allie, 1998). In an effort to further improve the time, cost and quality of software development projects an approach known as ‘radical collocation’ has been devised, in which the members of a team are located in the same room, the ‘war room’, for the duration of the project (Covi et al., 2002). The radical collocation approach has been advocated by agile methodologies, as it largely supports the values on which these methodologies are based (Cockburn, 2002a; Cockburn & Highsmith, 2001). Collocation is a less drastic approach than radical collocation, which involves collocating a number of teams in the same open area.

The collocation of software development teams undertakes to increase the ease, frequency and interaction of communication within the team, reduce the time taken to complete a project, and improve the productivity and performance of the team (Covi et al., 2002).

1.2. PURPOSE OF THE RESEARCH

The purpose of this research is to investigate and determine whether the approach of collocating an agile software development team will have a positive impact on the factors that contribute to the effective performance of teams. The research will go further to identify both the positive and negative aspects of collocation that will provide organisations with guidance on how to design the optimal collocated environment. This research is of relevance as collocation is becoming a widely
adopted approach to software development, and so the impact of collocation on teams and the optimal design of the team room is becoming of increasing interest to many organisations.

1.3. PLAN OF DEVELOPMENT

This empirical research paper will take on the following structure:

The paper will begin by providing some background to the development of collocation as well as a discussion of the literature surrounding the potential impact of collocation on the team effectiveness factors to be investigated throughout the research. The concepts and ideas presented in the literature will then be summarised.

The Research Design section will present the primary and secondary objectives of the research and the main research question. The research methodology and data collection processes used for this study will then be discussed, as well as any limitations and ethical issues relevant to the research process.

The Data Analysis section will provide the results of the data gathered during the research for each of the team effectiveness factors investigated, as well as for the other aspects of the collocated environment identified during the research. The initial implications of all of the aspects discussed will be indicated at the end of each of the sub-sections.

The Findings and Implications section will consolidate all of the initial implications indicated for both the team effectiveness factors, and the various aspects of the collocated environment that were identified. A final model of those factors that are positively impacted by collocation will be drawn, and the relationships between the team effectiveness factors will be considered.

The research will be concluded by evaluating whether the findings and implications have satisfied the objectives of the research, which will be followed by recommendations for both practitioners and future research into the concept of collocation.
Over the years the working structure of software developers, as well as the way in which these software developers are physically situated within their working environments, has evolved. Up until the mid-1960’s there were no formal methodologies in place for developing software, and developers worked in a fairly “individualistic” manner (Avison & Fitzgerald, 2003). This structure of software development was similar to a basic hierarchical structure in that the tasks involved in developing a system were given out according to an employee’s job description. Thus the employees became known as ‘specialists’, with the analysis being done solely by analysts and the programming being done solely by programmers (Friedman, 1989). The management during this time often had little knowledge or understanding of the technical software development environment, which resulted in the management strategies becoming relaxed or even neglectful as the managers were forced to rely quite heavily on their employees (Friedman, 1989).

From the late 1960’s to the early 1980’s a number of programming techniques were introduced in order to provide a more structured approach to systems development, including egoless programming, structured programming, and chief programmer teams (Friedman, 1989). Egoless programming aimed to promote taking a team approach to software development and thus reduce the level of individualism in the working environment. Structured programming emphasised the division between the analysts and developers by separating the two sets of employees into different working spaces. Chief programmer teams involved having a chief programmer who was in control of an entire project. This control included all of the decision making as well as the allocation of small tasks to the other developers on the team (Friedman, 1989).

The management strategies during this period went through a number of changes; from the relaxed, almost neglectful approach, to a direct control approach in which managers limited the level of individuality and decision power available to the employees, to the development of project teams in the early 1970’s. The introduction of these project teams was an attempt to improve the level of management involvement in software development as well as to begin eliminating the divide that had been formed between developers and analysts (Friedman, 1989).
2.1. THE INTRODUCTION OF TEAMS

The use of teams within organisations has become increasingly common over the years as people have recognised the value and importance of teams in improving organisational performance and success (Cohen & Bailey, 1997; Katzenbach & Smith, 1993). A team is defined as “a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable” (Katzenbach & Smith, 1993, p. 45). Team is also defined by Ferran-Urdaneta (1999, p. 128) as a group of a few people that “trust each other, coordinate the work among themselves, understand each other’s importance for the task, and hold each other accountable”.

There are a number of reasons for the tendency towards team structures within organisations. Teams are considered to be effective as the productivity of a team as a whole has proven to be greater than the sum of the productivity of the individuals working within the team (Smith, Harris, Myersclough, & Wood, 2000). This is especially true when a project or task requires a range of knowledge and skill. In addition, teams work towards a common goal and the team members have the same objectives, thus making them more adaptable to change (Katzenbach & Smith, 1993). Team members develop trust relationships with each other which strengthen their aim to accomplish their team objectives, and for the most part teams have more fun than individuals (Katzenbach & Smith, 1993).

Software development has become a “team sport” (Booch & Brown, 2002) as the tasks involved in software development projects are often large and complex (Smith et al., 2000), which is ideal for the team approach. Agile software development in particular is structured around teams.

2.2. THE AGILE APPROACH

“Software development methodologies are constantly evolving due to changing technologies and new demands from users” (Nerur, Mahapatra, & Mangalaraj, 2005, p. 73). The traditional development approaches have always been the most commonly adopted methodologies. These methodologies take a cyclical, process-oriented approach to software development and focus on predicting, planning and specifying the exact software components to be developed before undertaking a project (Nerur et al., 2005). The concept of agile methodologies came into being in order to provide a means to overcome some of the limitations of the traditional methodologies (Nerur et al., 2005).
In 2001, the Agile Software Development Manifesto was created which detailed the four core values and the supporting principles that agile methodologies are based on (Lindstrom & Jeffries, 2004). These core values are namely; individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan (Cockburn, 2002a). These values were created in an effort to introduce an approach to software development that was focused more on people and communication in order to achieve project success, and less on technology and structured processes (Lindstrom & Jeffries, 2004).

According to Cockburn & Highsmith (2001, p132) “people working together with good communication and interaction can operate at a noticeably higher level than when they use their individual talents”. Thus, agile teams have a number of characteristics which differentiate them from other teams. They are self-organised, extremely focused on both the people within the team and collaboration, they aim to increase user involvement to the extent that a user may be part of the team, and they tend to locate team members physically closer together (Cockburn & Highsmith, 2001).

### 2.3. THE COLLOCATION OF TEAMS

The act of physically locating team members closer together is known as collocation. Collocation is defined as “the physical proximity of the various individuals, teams, functional areas, and organisational subunits involved in the development of a particular product or process” (Rafii, 1995, p. 78). It is important not to get collocation confused with collaboration which is “actively working together to develop a work product or make a decision” (Cockburn & Highsmith, 2001, p. 132) and has little to do with the physical proximity of team members. In order to further improve productivity and collaboration, agile teams are known to collocate their team members in a single room known as a ‘team room’.

Almost two thirds of software development projects have exceeded both their schedule and their allocated budgets (Teasley, Covi, Krishnan, & Olson, 2000). It is for these reasons that agile software development has begun to adopt the approach of collocating their teams in war rooms. This collocation of teams is believed to reduce the time taken to complete projects, and reduce the likelihood of exceeding budgets, through the improved communication and collaboration that is afforded by the fact that team members are physically located in the same room (Rafii, 1995).
Radical collocation is a strategy that involves “putting an entire project team in one room for the duration of the project” (Teasley et al., 2000, p. 339). This strategy was developed in response to communication difficulties, such as the time wasted on communication in distributed environments and the regular communication breakdowns that occur on projects (Teasley et al., 2000). According to Cockburn (2002a), the damage done to a project increases with the time that it takes for the members of a team to relay information to each other, and so it is beneficial to emphasise the importance of communication within teams.

The war room is a concept that came into existence in World War II, in which major leaders had “special rooms outfitted with key maps and other information as well as the key figures ‘at hand’” wherein they would meet and discuss their strategies (Teasley et al., 2000, p. 671).

![Figure 1: Examples of Radically Collocated Environments (Covi et al., 2002)](image)

Figure 1 represents two war room layouts that have a capacity for 8-10 people. The walls have floor-to-ceiling whiteboards which allow for visual representations and artifacts to be displayed to all of the workers within the room. Workstations are situated away from the collaboration area, at the conference desk, which aims to provide workers with some privacy when other team members are designing and collaborating at the conference table.

In order to maintain simplicity throughout the research process, the ‘war room’ will be referred to as the ‘team room’ from this point onwards. In addition, this research will concentrate on the concept of collocation rather than radical collocation, and its impact on team effectiveness factors.

Incorporating this team room into software development can have a number of advantages. Communication is continuous, easy and interactive, and team members are able to gain knowledge by overhearing discussions held by their team members (Hinds & Kiesler, 2002). The members of a team are able to create relationships with each other and gain an understanding of how they all
work, and what their moods may be at a particular time, thus reducing the number of unwanted interruptions (Hinds & Kiesler, 2002). Learning and motivation is improved within the team (Olson et al., 1998), and the satisfaction levels of both the customer and the team members are high (Teasley et al., 2000). All of the team members have a common goal, regardless of whether they are working on individual tasks, which remains visible at all times, via work artifacts displayed on the walls for example (Teasley et al., 2000). Most importantly, by collocating team members in a team room, the productivity of the team and thus the timeliness of a project can be improved (Covi et al., 2002).

Collocation in a team room can also have certain disadvantages. The most common of these disadvantages are the lack of privacy afforded by the team room and the frequency of interruptions or distractions that occur (Hinds & Kiesler, 2002). Team members have found that they are often distracted by the communications going on around them when they are working on tasks that require concentration (Covi et al., 2002). Team members also feel that the team room offers little privacy in that they often feel uncomfortable to hold private conversations or make personal calls (Hinds & Kiesler, 2002; Teasley et al., 2000). A further concern identified by Teasley et al. (2000) is that team members are worried that their superiors will not be able to identify or differentiate their individual performance and contributions.

However, despite the disadvantages that have been identified about collocation, people have still found that the value derived from working in a collocated environment outweighs the negatives (Covi et al., 2002). Team members involved in collocated teams have acknowledged they initially feared that working so closely with the rest of the team would cause too many interruptions, but agreed that they were soon able to adapt to the environment, and began realising the value that the collocation provided (Olson & Olson, 2000).

The following section discusses a number of factors that have been identified by Smith et al. (2000) to be contributors to the overall effectiveness of a team. The impact of the collocation of agile software development team members on each of these factors will be considered in order to set the context and focus of the research.
3. TEAM EFFECTIVENESS FACTORS

According to Smith et al. (2000), team effectiveness refers to the extent to which a team has been successful in meeting the objectives of their project. A number of team effectiveness factors have been identified that are necessary in assuring that the environment in which a team works is successfully established, and that a team is able to maximise their effectiveness. The impact and level of importance of these team effectiveness factors determines the effectiveness of the teams involved (Smith et al., 2000).

The collocation of team members is believed to improve the performance of software development teams through the increased communication and interaction that is afforded by the team room, such as continuous face-to-face communication and the easy access to the shared resources of a project (Covi et al., 2002, Hinds & Kiesler, 2002). The impact of collocation on the team effectiveness factors presented, and thus the potential effect on the success of teams, is therefore of interest and will be discussed in the following section.

3.1. FEEDBACK

The study conducted by Smith et al. (2000) found feedback to be the most important factor in distinguishing a highly effective team from one that is not. It allows team members to monitor themselves and also promotes an in-depth understanding of the problem at hand (Verma, 1997). Due to the extensive communication that occurs within a collocated environment, feedback between team members is quick and easy (Rafii, 1995).

Coupling is a concept that refers to the extent as well as the type of communication that a work situation requires (Olson & Olson, 2000). In a software development environment, “tightly coupled work” is common (Olson & Olson, 2000, p. 162), meaning that the team members are strongly dependent on each other in completing the work. The components of tightly coupled work will be highly interdependent on each other and the team members will require frequent and often complex communication. Tightly coupled work can in some instances be broken down into components that are less tightly coupled, but the effect of coupling will rarely be eliminated completely (Olson & Olson, 2000). In addition, tightly coupled work will be very difficult to complete remotely as the existing technology fails to completely support rapid back and forth conversation or the ability to repair ambiguity (Olson & Olson, 2000). Managing tightly coupled work in the software development environment would thus require immediate feedback from fellow team members. The multiple streams of information within the collocated environment will allow team members to get
rich feedback, from multiple sources, which will contribute towards successful execution of work within this environment. Therefore, as feedback is quicker within a team room, collocated teams are better able to deal with tightly coupled work.

Coordination latency is defined as “the amount of time that elapses between a request for information or action and the satisfaction of that request” (Chachere, Kunz, & Levitt, 2004, p. 3). The collocated environment has been proven to provide support for low coordinated latency, meaning that it allows for quick feedback from team members and the customer, which is solved in a satisfactory way (Covi et al., 2002).

Therefore collocation supports both tightly coupled work and coordination latency through the ease and timeliness of feedback in the collocated environment, which in turn improves the performance of a collocated team.

### 3.2. GOAL

Teams that are highly successful share a clear and common understanding of the goals that are set for the project and the value of these goals to the success of the project (Smith et al., 2000). Ensuring that all of the team members involved in a project are actively working towards the same objectives and overall goal facilitates better communication and productivity, and allows for increased focus from the team members on project priorities and improved management (Katzenbach & Smith, 1993). All of these factors resulting from the clear existence of a common goal within a team lead to increased team effectiveness.

The most frequent information items that are requested by teams include queries relating to artifacts and co-workers (Ko, DeLine, & Venolia, 2007). The use of shared artifacts within the collocated environment, aids the team in coordinating activities, assessing progress and also identifying dependencies. This can be done by simply looking at the walls of the team room which are covered with the visual representations that relate to the project the team is currently working on (Olson & Olson, 2003). The walls act as “information radiators” (Cockburn, 2002a, p. 84), which allow the team members to assimilate the information displayed without needing to ask questions.

This coordination in team activities gives the team members a basis for developing common ground and understanding of the project objectives, and places emphasis on the goal of the team.
3.3. COMMUNICATION

Communication is formally defined as “the sending and receiving of information” (Cockburn & Highsmith, 2001, p. 132). For the purposes of this research, communication refers to the sharing of information and knowledge between team members in order to ensure that the team are able to operate and make decisions efficiently and effectively at all times. The collocated environment encouraged by agile methodologies promotes extensive collaboration between team members during work sessions, which involves the members of a team working together in order to deliver a work product or make a project-related decision (Cockburn & Highsmith, 2001). This is the result of the continuous, interactive and easy communication that is facilitated by working in close proximity of team members (Covi et al., 2002).

Less than 30% of the time that software developers spend on projects is used for traditional programming tasks whilst less than 20% is spent on coding the software (Covi et al., 2002, p. 672). The majority of a developer’s remaining time is spent in meetings for designing the system, and resolving problems and misunderstandings that have arisen from ambiguity in the system specification. In a collocated environment, which often even includes the customer, communication breakdowns still occur within teams but less so than in distributed teams (Covi et al., 2002).

An example of a communication breakdown would be if a software development team based the design for a system on their interpretation of the customer requirements. This team might mean working on a project for weeks before meeting the customer for an update meeting, and only then might they discover that their previous work has been rendered useless (Covi et al., 2002). Rectifying this mistake would increase both the cost of the project and the time the project will take.

Team rooms were found to be supportive of promoting interaction between the members of a collocated team (Teasley et al., 2000). If the customer was collocated with the software development team in the scenario above, then inconsistencies in requirements might have been identified earlier on. The risk of communication breakdowns would thus have been mitigated with the developers being able to immediately revaluate the customer requirements. This form of continuous open communication would later allow the developers to anticipate the needs of the customer, whilst the customer would learn to appreciate the efforts of the developers (Law & Charron, 2005).

A common form of communication that is facilitated by the collocated environment is called “osmotic communication” (Cockburn, 2002a, p. 81). This form of communication is described as information flows that go through the team environment, where team members have the option of
assimilating the information as they wish (Cockburn, 2002a). Osmotic communication is ideal in a team environment as it reduces the cost of communication, facilitates quick identification of errors, and allows for knowledge to be disseminated fast (Cockburn, 2002b). Some costs with regards to communication within a distributed project team include the opportunity cost of not asking questions, the cost of transferring information, and a reduction in cost when information is discovered through the background information that is shared within the same space. The collocation of team members would allow teams to avoid a majority of these costs, thus improving the level of efficiency and effectiveness of the collocated team (Cockburn, 2002a).

The following figure represents the effectiveness of communication against the richness of the communication channel. It emphasises the fact that face-to-face interaction at the whiteboard will be more effective than most other communication mediums in translating information between the team members, and thus will add richness to the conversation. Face-to-face conversation is also indicated as a rich and effective means of communicating with team members. Remote teams will generally make use of email and phone conversations (Olson & Olson, 2000), which will have the overall result, according to this graph, of being less effective than the interactions that can be experienced in a collocated environment.

The collocation of software development team members will enable the teams to take full advantage of consistent face-to-face interactions throughout the duration of their projects. This continuous face-to-face interaction will consequently increase the levels of efficiency and effectiveness at which the teams operate.
3.4. TEAM IDENTITY

Team identity is created by the norms, rules and behaviours of the team, which allow for the team members to identify with each other (Smith et al., 2000). This presence of a “strong sense of team identity” can have a positive impact on the effectiveness and productivity of a team (Smith et al., 2000, p. 422).

Team identity can be developed through frequent interaction of team members with each other. This enables the team members to develop relationships with each other, and to begin to identify with the characteristics and work ethics of the various team members (Covi et al., 2002).

As the collocation of teams in a team room has been shown to facilitate continuous and interactive communication between the team members, they are able to develop good relationships with each other and tend to exhibit a greater level of familiarity than is displayed in remote teams (Teasley et al., 2000). As a result teams have a stronger “group mentality” (Covi et al., 2002, p. 678) and thus a stronger team identity, leading to an improvement in the effectiveness of a team.

3.5. PERFORMANCE TARGETS

Performance targets are significant incentives which encourage team members to work hard and excel as much as possible, and are important characteristics of teams. Highly effective teams are able to set and achieve high performance targets. Achieving these targets leads to increased levels of satisfaction within the teams, which drive the teams to increase their team effectiveness further (Smith et al., 2000). Thus the existence of performance targets with teams is considered to be linked to team effectiveness.

The collocation of team members within a team room not only improves the efficiency of resource use, but also reduces the time taken to complete a project. This is mainly attributed to the characteristic of providing an environment which promotes informal communication and allows for quick feedback (Rafii, 1995). Teams collocated in a team room have been found to be more productive than standard teams when compared to the industry as a whole (Becker, Sims, & Schoss, 2003). It has also been found that, in the case of collocated teams, the time taken for a product to go to market was reduced to less than a third compared to the industry baseline (Teasley et al., 2000).
The collocated environment also supports “social facilitation” (Olson et al., 1998, p. 280). This term refers to the situation in which an employee works visibly hard, and so the fellow employees follow their example and work harder than they would originally have done (Olson et al., 1998). Employees also commented that this environment prompted them to reconsider when performing non-business activities such as private phone calls or web surfing (Covi et al., 2002).

3.6. ROLE

According to Smith et al. (2000), the definition of the roles of team members is an important factor that has an influence on the effectiveness of a team. In order to ensure that a team is able to perform effectively, it is necessary to identify and bring together the correct mix of team members in terms of their skills and roles. This will ensure that a project team has the right balance of resources necessary to efficiently and effectively meet project objectives.

Although the roles of the agile software development team members in particular have changed to include more generalists rather than specialists (Paulk, 2002), there has been little evidence to suggest that collocation has any impact on the definition of the roles of team members.

3.7. INDIVIDUALITY

Individuality within a team refers to the individual strength and character of each team member, and whether these factors define the team or are detrimental to the team (Smith et al., 2000). Through encouraging the team members to develop their individual knowledge and skills and express their creativity within the working environment, they will become greater assets to the team (Smith et al., 2000). As a result the team as a whole will benefit, and the collective strength of the team will result in improved team effectiveness (Katzenbach & Smith, 1993).

The team members involved in a collocated team are generally talented people that have been chosen by their managers because of their individual skills, and whether they are currently busy with an important project or not (Covi et al., 2002). However, collocation results in emphasis and recognition being placed on the contributions of the team as a whole. As a result team members working in collocated teams have been found to be concerned about whether their individual contributions are distinguishable and being recognised by their management, or if they are only being evaluated based on the contributions of the team as a whole (Covi et al., 2002). This is a valid concern that needs to be dealt with in the team room environment.
3.8. LEARNING

Throughout the duration of a project the team members involved will develop more and more knowledge and understanding of both the project and the team environment. Some of this knowledge will come from training, but a majority of it will come from interacting in a team situation. High levels of learning are congruent with a highly effective team (Smith et al., 2000). This is due to the increased knowledge, skills and capabilities developed by the team members through learning, which they are then able to apply in their team working environment.

The continuous communication and interaction that occurs between team members in a collocated environment makes learning easier (Hinds & Kiesler, 2002). This is true for a number of reasons: team members that are collocated in a team room are able to overhear each other, they are able to speak to each other easily if any questions arise, and work artifacts relating to the project that they are working on are visible all around the room at all times (Covi et al., 2002; Teasley et al., 2000). Consequently collocation increases the possibility and occurrence of implicit learning within a team (Olson et al., 1998). Therefore, the view that through collocating team members learning will be made easier implies that collocated teams will experience greater effectiveness than distributed teams.

3.9. RESOURCES

Resources are identified by Smith et al. (2000) as an important aspect that will contribute to team success. The different types of resources specified are generic to both collocated and distributed teams and these include: authority, clear targets, resources in terms of time, money and people, information, training, feedback and technical assistance (Smith et al., 2000, p. 422).

The collocated approach to designing software aims to conserve certain resources of a project, such as manpower, with the goal of making the process more efficient. The ease of reusing components between projects will increase as the team becomes accustomed to collocation and working with each other (Rafii, 1995). Shared artifacts such as whiteboards and flipcharts are physical resources. These resources are recommended and promoted in the collocated working environment, and can contribute to increased team effectiveness in a number of ways (Mark, 2002; Olson & Olson, 2003). These include increasing the visibility of the project progress and thus promoting a common goal within a team, improving the motivation of the team members, and improving the ease of communication within the team (Olson & Olson, 2000; Olson et al., 1998).
3.10. MORALE

Law & Charron (2005) hold the belief that motivation within the team is the most important factor in determining the quality and productivity of a software development project. Factors that will contribute towards the motivation of a team include an environment that supports learning, autonomy and social activities (Law & Charron, 2005). As previously discussed, learning is improved in the collocated environment and will thus contribute towards the motivation and morale of the group.

Team members that operate in a physically distributed environment experience motivational problems as they feel isolated, which in turn leads to frustration because they are unable to share their ideas and problems with co-workers (Pawar & Sharifi, 1997).

The use of shared artifacts, which are encouraged in a collocated working environment, not only assist in coordinating the team, but are also a source of motivation. Making use of shared artifacts aims to make intangible work tangible, because when work is completed it can be visually represented. This has a positive effect on the team’s morale (Olson et al., 1998).

In addition, the collocated team environment has been rated highly with regards to the level of satisfaction experienced by the project team members, customers and sponsors working in the environment. These increased levels of satisfaction contribute to the improvement of morale within a team (Covi et al., 2002).

3.11. TRUST / MUTUAL ACCOUNTABILITY

Trust within a team is closely related to many of the other effectiveness factors including conflict management and feedback (Smith et al., 2000). Trust is defined as a “firm reliance on the integrity, ability, or character of a person or thing” (TheFreeDictionary, 2008), and therefore trust within a team is “the common belief” among the team members that another group or individual is honest, does not take advantage of the team members, and is effectively working towards the same goals as the rest of the team (Allen, Bergin, & Pickar, 2004, p. 203). High levels of trust and mutual accountability are necessary in order to enable team members to operate efficiently and effectively within their teams, as team members are more willing and able to rely on each other, remain goal-focused, and provide each other with support (Smith et al., 2000).
In order to form trust in a team environment it is important that the team members feel like they share a common goal, are open and honest, and are able to easily communicate with each other (Allen et al., 2004; Smith et al., 2000). Collocating teams in a team room has been shown to support “interactive, continuous communication” (Covi et al., 2002, p. 678) thus improving the ease of communication within the teams and promoting trust. The close proximity of collocated team members facilitates relationship building between the team members (Covi et al., 2002), consequently improving trust and the sense of team. In addition, having a common goal or focus within a team is facilitated by collocating the team members (Olson & Olson, 2000), as the team members share experiences and norms which further develop trust relationships (Olson & Olson, 2000, p. 168). Collocated teams therefore tend to be more effective than remote teams, a trend which supports the observation that “trust needs touch” (Handy, 1995, p. 46).

A relationship between trust and mutual accountability is present as team members must to be able to trust each other before they can acknowledge that they are mutually accountable for a task (Ferran-Urdaneta, 1999; Smith et al., 2000). Mutual accountability stems from the dependency of each of the tasks and team members in a project on each other (Ferran-Urdaneta, 1999). The most important factor in creating mutual accountability is the presence of a common goal within the team (Ferran-Urdaneta, 1999). As was mentioned above, with collocation the presence of a common goal is more prominent as the team members are sharing experiences and interactive communications constantly (Olson & Olson, 2000).

3.12. CONFLICT MANAGEMENT

Conflict is essentially “a difference between two or more people about the meaning of some information” (Sawyer, 2001, p. 157), and is inevitable in a team environment as team members will often not share the same views. Some level of conflict is therefore necessary within a team in order to ensure that all team members are aligned in their understanding of the project on which they are working (Sawyer, 2001). However, if conflict is not managed effectively it can lead to deterioration in the effectiveness of the team, resentment, and a reduction in the level of motivation within the team (Smith et al., 2000).

Conflict management is the process of resolving the differences that exist between team members (Sawyer, 2001, p. 157). There is a relationship between conflict and team performance (Hinds & Mortensen, 2005; Sawyer, 2001), and so by having good conflict management in place a team is able to improve its effectiveness levels.
Collocated teams, in which the team members are located physically close to each other, are shown to be able to resolve conflicts more easily (Malhotra, Majchrzak, Carman, & Lott, 2001; Rafii, 1995). There are a number of reasons why this is the case. A collocated team often shares a greater level of trust and respect, and is focused on a common goal (Cockburn & Highsmith, 2001), thus reducing the amount of conflict experienced (Hinds & Mortensen, 2005; Rafii, 1995). The ease and frequency of communication afforded by collocation is also a major contributing factor to reduced conflict within a team. In addition, the physical closeness of the team members allows for most conflicts to be identified and dealt with early. Collocated team members are able to see what is going on around them at all times, thus increasing the level of awareness and understanding within the team and reducing conflict (Hinds & Mortensen, 2005).

The ability of collocated teams to manage their conflicts more quickly and effectively than distributed teams reduces the chance of the conflicts deteriorating any further, and studies have shown that overall collocated teams experience less conflict than distributed teams (Hinds & Mortensen, 2005). As a result, collocating team members leads to a higher level of team effectiveness.

3.13. WORK APPROACH

The approach that team members take in order to reach the goals that have been set is considered to be as important as the act of actually reaching and completing the goals (Smith et al., 2000). The work approach within the context of a software development team working environment often involves following some kind of specified process or methodology in order to complete a project. The processes involved in allocating tasks to team members and performing those tasks will differ between a collocated team and one that is not (Smith et al., 2000).

Collocation of software development team members is more likely to encourage the adoption and adherence to a common software development process or methodology. The approach taken by a collocated team member to solving problems involves a variety of processes. All of the team members within the team room can discuss a problem, thus working collectively and reaching an agreement at the end about how they should design a piece of software. In addition, teams can work on their own by moving into private cubicles whilst still remaining in the team room (Olson & Olson, 2000). This allows for quick communication if the need for it arises.
A team is able to buy-in to a common work approach through the establishment of ‘common ground’ within the team, which refers to mutual understanding between team members. The following table represents the different characteristics that aid a team in establishing common ground, and the communication methods that are useful for the different mediums (Olson & Olson, 2000). The mediums of communication available in the collocated and distributed working environments will differ, which will impact the establishment of common ground within the respective teams and thus the work approaches of the teams.

Table 1: Characteristics that Contribute to Achieving Common Ground (Olson & Olson, 2000)

<table>
<thead>
<tr>
<th>Medium</th>
<th>Co-presence</th>
<th>Visibility</th>
<th>Audibility</th>
<th>Contemporality</th>
<th>Simultaneity</th>
<th>Sequentiality</th>
<th>Reviewability</th>
<th>Reviability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face to face</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telephone</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Video conference</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two-way chat</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Answering machine</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>E-mail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Letter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 confirms that face-to-face interaction is the best method to use in order to achieve an alignment of interests between team members. Face-to-face interaction is emphasised when a team is fully collocated and thus it is easy for team members to establish common ground. Face-to-face interaction is also the only medium that supports co-presence and visibility, something that is highly unlikely to be achieved in a remotely located environment, with the exception of the use of video conferencing. Visibility of a co-worker will transfer his/her emotions without verbally communicating, and this will prompt the person to change the form of communication depending on whether the person is happy, stressed or sad (Olson & Olson, 2000).

A disadvantage of face-to-face interaction is that a conversation cannot be reviewed or revised. Mitigating this gap can be done by immediately writing down ideas and conversations on the wall that is used to display shared artifacts, a practice which is encouraged by people working within the collocated environment (Mark, 2002).
This work approach which emphasises the co-presence and collocation of team members will also promote the use of shared artifacts, such as whiteboards and flip charts, which will allow for references to objects or ideas to be made by team members through simply pointing and explaining their viewpoints or ideas (Olson & Olson, 2000). This approach of making use of physical resource items allows the team to review and revise previous items, as well as providing several chances to “decode” the message that has been transmitted (Olson & Olson, 2000, p. 159).

**SUMMARY**

In summary, a number of team effectiveness factors have been identified which are believed to be impacted by the collocation of software development teams. Throughout the discussion of the literature surrounding these team effectiveness factors, significant evidence was found to support that teams operating in a collocated environment should experience improved performance, and be more effective than distributed teams.
4. SUMMARY OF THE LITERATURE

Throughout the history of software development the structure and layout of the working environment, as well as the way in which employees have been situated within the working environment, has gone through a number of changes. The development of software has evolved from being approached in an individualistic way, where developers and analysts are divided and work in an almost hierarchical structure, to most commonly being approached from a team perspective.

The introduction and adoption of teams has resulted in improved productivity and performance within organisations, as teams exhibit a level of greater productivity than the sum of productivity of the individual team members. Teams promote communication, feedback, relationship-building, and the importance of a common goal. They are adaptable to change, and are well suited to the software development environment. As a result the adoption of the team approach in software development has lead to improved project performance, including an improvement in the time, cost, quality and productivity of the project delivery.

Teams are a critical element in agile software development as the agile methodologies place emphasis on the importance of people and communication when developing software, believing that project success can be achieved through continuous communication and interaction between the people working on the project. The concept of collocation is an approach that has been largely adopted by agile software development methodologies.

Collocation refers to the act of physically situating the members of a software development team in the same room for the duration of a project. This room is known as a team room, and facilitates continuous and interactive communication between project team members. Through collocation, teams are able to further improve their performance as their team members are ‘on hand’ at all times making communication quick and easy, the common goals and objectives of the team are emphasised, and team members are able to build trust relationships with each other thus improving learning and motivation within the team.

A number of factors have been found to have an impact on the overall effectiveness and performance of teams. Of these team effectiveness factors, certain factors have been identified on which collocation of teams can have an impact. By collocating teams within a team room environment, a number of team effectiveness factors such as Feedback, Goal, Trust / Mutual Accountability, Communication, Learning and Performance Targets can be improved, thus increasing the productivity and success of these teams. In addition, although collocation is believed to have an
effect on a number of other factors in a team environment, including Role and Resources, there is little evidence to show that this is the case.

Knowledge gaps have therefore been identified which give way to further research into the impact of collocation on the effectiveness of teams, and whether through collocating a team the overall performance and effectiveness of the team can be improved. In addition, further investigation into the aspects that have an impact on teams in collocated working environments can provide insight into the way in which organisations should design their collocated environments in order to achieve optimal team performance results and effectiveness.
5. RESEARCH DESIGN

The literature surrounding the concept of collocation as well as the factors that impact the effectiveness of teams has been reviewed, and a summary of this literature has been presented. The purpose of this research is to identify those team effectiveness factors that are impacted by the collocation of agile software development team members, assess the level of impact of collocation on each factor, and identify other aspects of the collocated environment that may influence the effectiveness of collocated teams.

5.1. RESEARCH OBJECTIVES

In order to provide a better understanding of the intended purpose and direction of the subsequent research, two main objectives have been identified:

The primary objective of the research is to determine whether collocation has a positive or negative impact on the factors that affect the effectiveness of agile software development teams.

The secondary objective of the research is to identify aspects of collocation that influence team effectiveness. This will provide companies with insight into the design of a collocated working environment in order to optimise the overall effectiveness of a team.

The research that follows will be devoted to providing insights and evidence that support these objectives.

5.2. RESEARCH QUESTION

The research objectives represent gaps that were identified when reviewing the literature which give way to further investigation into the impact of collocation on the effectiveness of teams. The following research question has been constructed in order to address the research objectives identified:

What is the impact of collocation on the factors that affect agile software development team effectiveness?
The team effectiveness factors that are going to be investigated are Feedback, Goal, Communication, Team Identity, Performance Targets, Commitment, Fun, Role, Individuality, Learning, Resources, Morale, Trust / Mutual Accountability, Conflict Management and Work Approach.

Each of the factors mentioned above will be tested and analysed in order to establish whether collocation has a positive or negative impact on them. From this, the impact of the collocation of agile software development team members on the overall effectiveness of the team will be determined.

5.3. METHODOLOGY

The concept of collocating agile software development teams while working on projects is still in its early phases and so little research relating to this topic has been done. As a result a research methodology has been constructed that will enable as comprehensive an investigation into the research objectives as possible.

5.3.1. UNDERLYING PHILOSOPHY AND APPROACH

The research conducted will be exploratory in nature as the purpose of the research is to explore the impacts of collocation on a number of factors that influence the effectiveness of a team, which have not yet been recognised in the literature surrounding the concept of collocation. Both quantitative and qualitative research will be conducted in order to fulfil the research objectives. The quantitative aspect of the research will aim to determine whether collocation has a positive or negative impact on each of the team effectiveness factors, as well as to measure some other aspects of the collocated working environment. Qualitative research will then be done in order to validate and support the findings of the quantitative research, and consequently create a new understanding of the effects of collocation on team effectiveness. In addition, some observation will be carried out in order to gain more information about the physical layout of collocated environments that the sample teams are working in.

Since the research process is under a strict time constraint it is necessary to consider the data over a short time span, and thus the research process will be cross-sectional. The meaning behind the results of the research will be explored and analysed rather than merely taken as fact, which indicates that an interpretivist rather than positivist philosophy will be adopted.
The data and information gathered from both the qualitative and quantitative research is expected to provide empirical evidence, and identify relationships and trends, on which the findings and conclusions of the research will be based. Therefore, inductive reasoning will be exercised when considering the findings of the research.

5.3.2. RESEARCH SAMPLE

The sample for this research was provided by two software development companies based in Cape Town that are making use of agile software development practices and are collocating their development teams. Throughout the research, these companies will be referred to as Company I and Company II. A third company completed the online questionnaire and was contacted for interviews but failed to respond. The questionnaire data received from this company was still used for the purposes of this study. The software development teams at all three of these sample companies currently use the SCRUM methodology for software development.

The process of acquiring data from the sample included both an online questionnaire, to be completed by the members of collocated project teams, and interviews with collocated teams. A contact from a SCRUM training company offered to approach some of their clients that are currently collocating their software development team members, and enquire as to whether they would be interested in participating in this research study. The team members from the three sample companies were also requested to complete the questionnaire. At each of the sample companies, a coordinator took on the responsibility of ensuring that the team members at their respective companies were aware of the questionnaire, and encouraged the team members to participate in the study.

The target sample size in terms of the questionnaire was to receive forty completed questionnaires from the team members. The final sample included 49 completed and validated questionnaires. Two of the sample companies then each provided five teams, to be interviewed once the data collected from the questionnaires was analysed. The average team size across the interviewed sample was 7 team members per team.
5.4. DATA COLLECTION

For the purposes of this research, acquiring data from the sample involved a number of data collection techniques including an online questionnaire, private interviews, and some observation of the collocated working environments. The following section will explain these approaches in more detail.

5.4.1. ONLINE QUESTIONNAIRE

An online questionnaire consisting of approximately 52 questions was distributed to a number of collocated agile software development team members. This questionnaire is shown in Appendix C. It was clearly conveyed to the respondents that participation in this study was completely voluntary. The questionnaire design was based on a five point Likert scale with the following options: Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4 or Strongly Agree = 5.

A motivational cover letter was included with the questionnaire describing the benefits that can be derived by the team members from participating in this research study, and explaining that the results of the research will be freely available to the participating companies. In addition a confidentiality clause was included in the cover letter assuring the participants that their responses would be kept strictly confidential. The cover letter included with the questionnaire is shown in Appendix B. A cover letter was also sent to each of the three coordinators, which is shown in Appendix A.

It was decided that in order for the questionnaires to be included in the final sample they would have to be fully completed, by respondents working in South Africa, and would have to be considered valid. The validity of the responses was determined by including certain questions phrased in a negative manner, and checking whether the answers the respondents gave for these questions correlated with the rest of their answers.

In total, 95 respondents attempted to complete the online questionnaire. 68 of these questionnaires were fully completed. Of the 68 completed questionnaires, 54 were completed by respondents that are currently working in South Africa. The questionnaires received from the respondents in the USA, Germany, Brazil and Argentina were not included in the final sample as it was decided to keep the research solely in a South African context. In addition, 5 questionnaires had to be removed from the sample as a result of them failing the validity check. Therefore, the final sample size of the questionnaire respondents was 49.
5.4.2. SEMI-STRUCTURED INTERVIEWS

Once the results of the questionnaires were initially analysed, face-to-face interviews were conducted with five teams from each of the two sample companies. The interview questions were compiled once the questionnaire data had been analysed, and each team was questioned on different aspects according to their particular questionnaire results. The interview questions have been included as Appendix D.

The interviews were informal and open-ended, and were conducted in order to gather rich feedback and different points of view regarding the aspects of collocation and the team effectiveness factors. The average team size consisted of seven team members, and the interviews were recorded using a video camera. However for privacy reasons, when interviewing the teams from Company II only voice recordings were made. All of the interviews were later transcribed.

The following table shows the names of the companies and the teams as they will be referred to throughout the research:

<table>
<thead>
<tr>
<th>Company I</th>
<th>Company II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team A</td>
<td>Team F</td>
</tr>
<tr>
<td>Team B</td>
<td>Team G</td>
</tr>
<tr>
<td>Team C</td>
<td>Team H</td>
</tr>
<tr>
<td>Team D</td>
<td>Team I</td>
</tr>
<tr>
<td>Team E</td>
<td>Team J</td>
</tr>
</tbody>
</table>

5.4.3. OBSERVATION

Once the interviews had been completed at Company I, the collocated working environment in which the agile software development teams’ work was observed with minimal disturbance to team members. The layout of the environment as well as the use of shared artifacts, such as whiteboards and flipcharts, was noted. For privacy reasons, Company II did not allow any observation of the collocated environment in which their software developers work.
5.5. LIMITATIONS

There are various limitations that have been identified with regards to this research. The final questionnaire sample considered was restricted to South African responses only, and the teams that were interviewed were all based in Cape Town. As a result, the findings of this research may not be reflective of the views of collocated teams on a global scale.

In addition, the teams that were involved in the interviews were all software development teams that adopted the SCRUM agile software development approach. Once again this means that the findings of the research may not be truly reflective of the views of agile software development teams as a whole.

5.6. ETHICAL ISSUES

A number of ethical concerns were taken into consideration when collecting data from the sample and throughout the research project.

The privacy of respondents as well as the participating companies was ensured. This was done by guaranteeing that the names of respondents, the teams and the companies would not be disclosed in the literature or between the companies participating in the research.

A confidentiality clause was included in the cover letter of the questionnaires, which assured the respondents that their responses would remain confidential and anonymous. In addition, consent was given by the interviewed teams to record the interview sessions. The observation of the collocated working environments was done as unobtrusively as possible, and the companies were assured that their work techniques would not be disclosed to other participating respondents.
6. DATA ANALYSIS

The following section aims to evaluate and discuss the various aspects of collocation that were identified from the results of the questionnaires and interviews. This will include evaluating the impact of collocation on each of the team effectiveness factors that were discussed in the literature review, identifying any other team effectiveness factors that are impacted by collocation, and finally, discussing various aspects of the collocated working environment that may have an impact on team effectiveness.

The initial implications of each of the aspects discussed, taking into account the literature and the data gathered, will be indicated at the end of each sub-section. These implications will then be consolidated in the Findings and Implications section that follows, and will be evaluated in terms of their fulfilment of the objectives of the research.

Before the results of the questionnaire and interview data is analysed in-depth in order to fulfil the primary and secondary objectives of the research, a brief description of the demographics of the questionnaire sample respondents will be provided in order to offer some background information about the sample.

6.1. QUESTIONNAIRE SAMPLE DEMOGRAPHICS

This section will introduce some demographics in order to give a better idea of the questionnaire sample that participated in this study. The questionnaire was successfully completed by 49 respondents. As was mentioned in the Research Design section, the questionnaire responses were based on a five point Likert Scale, ranging from 1 = Strongly Disagree to 5 = Strongly Agree.

TEAM ROLES OF THE RESPONDENTS

The following figure represents the roles of the respondents within the SCRUM agile software development environment and within their teams. 78% of the responses came from team members whilst 18% of responses were from SCRUM Masters. 2% of the responses came from one Product Owner, and there was one respondent that selected the ‘Other’ option.
YEARS OF EXPERIENCE

The following figures illustrate the number of years of experience that the respondents have had in a collocated working environment, and the number of years of experience that the respondents have had in the Information Technology field respectively.

![Pie chart showing the role of the respondents with teams.](image1)

**Figure 3: The Role of the Respondents with Teams**

**Figure 4: Years of Work Experience within a Collocated Working Environment**

Figure 4 shows that a majority of the respondents have had more than one year experience within the IT field. Figure 5 indicates that a large amount of the respondents have worked for less than a year in the collocated environment. 73% of the respondents have less than 5 years experience in the collocated environment. Company I and II have recently adopted the SCRUM methodology. Prior to this, the collocated environment and use of shared artifacts were not known to the majority of team members.
DIFFERENCES IN RESPONSES BY GENDER

The questionnaire was completed by 33 males and 16 females. The following figures represent the overall mean responses of the men and woman respectively, grouped according to the team effectiveness factors. Only the factors that have passed a Cronbach Alpha test, with a Cronbach Alpha value higher than 0.6, have been included.

![Figure 6: The Overall Means of the Male Respondents per Team Effectiveness Factor](image)

![Figure 7: The Overall Means of the Female Respondents per Team Effectiveness Factor](image)

Figures 6 and 7 confirm that some high level differences exist between the overall mean responses of the males and females. The most noticeable differences are that the first seven factors from the female responses have a mean that is higher than 4, whereas only the first three factors from the male responses have a mean higher than 4. In addition, Feedback was identified by both parties as the team effectiveness factor that is impacted the most by collocation. The ranking of the rest of the factors differed for the males and the females.

Although it is clear that differences exist between the responses of the males versus the females, the combined overall means of the responses from both groups have been used for the purposes of this research.
6.2. TEAM EFFECTIVENESS FACTORS

The data collected from both the questionnaires and the interviews was collated in order to present the findings of how each of the fifteen team effectiveness factors being investigated are considered to be impacted by the collocation of agile software development team members. The team effectiveness factors investigated include: Feedback, Goal, Communication, Team Identity, Performance Targets, Commitment, Fun, Role, Individuality, Learning, Resources, Morale, Trust / Mutual Accountability, Conflict Management and Work Approach.

The first ten factors have been ordered according to the ranking of their respective overall means. These are the overall means for all of the questions relating to each of the respective factors. The overall standard deviations for these factors range from 0.66 to 0.97. Due to the exploratory nature of the research, a Cronbach Alpha of 0.6 for a factor has been considered to be acceptable. The following graph illustrates the order and the overall means of each of the ten factors that were found to have reasonable Cronbach Alpha results:

![Figure 8: The Ranking of the Overall Means of the Team Effectiveness Factors](image)

Low Cronbach Alpha results were found for the Resources, Morale, Trust / Mutual Accountability, Conflict Management and Work Approach factors, as the questions that were grouped together in order to evaluate each of these factors were rather different and so, got somewhat different scores. As a result, these factors will not be discussed in terms of their overall means, standard deviations and medians. The questions relating to these factors will rather be considered individually.
Each of the team effectiveness factors will be analysed individually taking into account the relevant questionnaire and interview data, and the impact of collocation on each of the factors will be evaluated and discussed in order to realise the primary objective of the research. The interviewed team members will be referenced according to their team name as was defined by Table 2 in the Research Design section.

### 6.2.1. FEEDBACK

The feedback factor was found to have highest positive impact on the effectiveness of collocated agile development teams, with an overall mean for the questions regarding this factor of 4.18. This indicates that a majority of the respondents agree that feedback within their agile development teams is positively impacted by the collocation of the team members.

Of the 49 respondents, 43 believe that feedback has been impacted positively by collocation while 4 respondents remain neutral and 2 disagree. Due to the low standard deviation of 0.74, the feeling that feedback is positively impacted by collocation can be considered a consensus across the sample.

The interviews supported these findings as none of the team members made any comments about collocation having a negative impact on their team effectiveness. The general comment made by the team members was that, because they were all seated in close proximity to each other, they were able to get direct feedback from their team members very easily. In addition, a majority of the team members said that sending and receiving feedback between team members was much faster, sometimes even immediate. One team member in particular was quoted as saying that “the turnaround time for feedback is much quicker. Whereas previously you would have to wait until you were all together in a meeting, now you can just shout over to your team member or you even overhear conversations that you normally wouldn’t have been involved in” (I3).

Team member J3 contrasted his collocated experience with his previous experience in a distributed working environment, and commented that when working in the distributed environment a majority of the feedback was sent and received via email. The drawback of this was that an individual would often have to wait about half a day before any feedback was returned. This team member concluded by saying that, due to the ease of sending and receiving feedback in the collocated environment, “you can get a lot more things done right” (J3). A number of team members also remarked that the improved back and forth feedback afforded by collocation lead to an increase in the visibility of tangible results early on.
An interesting point that was noted during the interviews was that several team members believed that the ease with which team members were able to send and receive feedback within their teams had resulted in a more positive atmosphere within the team.

The results of both the questionnaire data and the interviews suggest that there is consensus across the sample that the feedback factor is positively impacted by the collocation of agile development team members. These results confirm the literature which found feedback to be the most important factor in distinguishing a highly effective team from one that is not, and suggested that the close proximity and ease of communication that could result from the collocation of teams would positively impact feedback within a team.

### 6.2.2. GOAL

The goal factor has been identified as having the second highest overall mean, which indicates that collocation has a strong positive impact on the existence of a common goal within a team. The mean for this factor is 4.14 and the low standard deviation of 0.67 confirms consensus within the sample. On average, only 2% of the respondents disagree with the view that collocation has a positive impact on team effectiveness.

All interviewed teams are making use of the SCRUM methodology, which specifies the use of shared artifacts that increase the visibility of the progress and objectives of a team. The interviewed team members agreed that these shared artifacts contribute significantly to the team sharing a more focussed and common goal. This finding was contrasted to traditional methodologies in other working environments which do not encourage collocation. It was noted that a number of team members believe that these traditional methodologies fail in this area.

The teams from Company II commented that they set goals for themselves on a day-to-day basis, as well as on a sprint level basis. Both of these actions contributed towards the team as a whole being more aware of the goals and objectives set for their projects. The general opinion of the teams across the interviewed sample was that collocation results in team members being more able to share a clear and common understanding of the goals that have been set for a project. It was also emphasised that goals are usually set for the teams and not necessarily for the team members. Team member G2 remarked that the goal factor might have an influence on the performance targets that are achievable by the team.
In addition, team size was identified as an influencer for the sharing of a common goal. Members of Team J felt particularly strongly that the size of a team has a great influence on the maintenance of a common goal within a team. This team consisted of seven team members and there was consensus amongst the members that the team would struggle to accommodate an additional team member. It was suggested that members of a small team would be more likely to work on similar work items, and when doing this in close proximity to each other, they would be more likely to share a common goal.

On the whole, it can be deduced that collocation has a positive impact on the existence of a common goal within a team. These results agree with the literature in that collocation has been found to increase the use of shared artifacts and improve the communication and understanding of the objectives and goals of a team. Additionally, it has been suggested that the size of a collocated team has an impact on the existence and maintenance of a common goal within the team.

6.2.3. COMMUNICATION

When embarking on this research, the communication factor was expected to experience the greatest positive impact from the collocation of teams. The final results of the research both did and did not satisfy this expectation. The results of the data collected from the questionnaire respondents shows that communication is ranked third with regards to the level of impact that the collocation of agile development team members has on communication, while the general consensus from the team members that were interviewed was that communication was the factor that experienced the greatest positive impact.

Across the questions regarding the communication factor, there was strong agreement that communication is easier and more effective as a result of collocating team members. Once again the standard deviation is low, at 0.72, which indicates that there is consensus across the sample of respondents that collocation has a positive impact on communication within teams. Of the 49 respondents, on average 2 do not think that communication is more positively impacted by the collocated working environment in comparison to any other working environments, and 4 remain neutral. When comparing the results of the negative question that was included as a check of the positive questions, they are consistent with those of the positive questions. This indicates that the respondents are fairly certain of their opinions regarding communication, and that their responses are valid.
The results of the interviews were consistent with those of the questionnaire data, if not more positive. When asked to select the top three factors that they believe are the most positively impacted by collocation, at least one member from each team named communication as the top factor, with one team member quoted as saying “definitely communication” (F3).

Communication was identified as “the most essential factor when dealing with a team” (I4). As a result, any improvement in communication is welcomed and leads to a number of benefits for the team involved.

The team members from Company I in particular made a number of comparisons between the traditional distributed working environment and the collocated working environment. The point that was brought up most often was that in traditional working environments, in which managers and team members were working in separate areas, communication was not effective. This was attributed to both the physical distance between the team members and managers and the feeling that a “buffer of red tape” (B2) existed between the two groups. A majority of the communication within the teams occurred via email, instant messaging and Skype (software that allows users to make telephone calls over the internet, as well as engage in video conferencing and file transferring). These means of communication were found by the team members to inhibit communication. In addition team members said that emails are often read “politically” (B4), and that much of the essence of the communication cannot be properly represented in an email.

There was consensus across the team members that were interviewed that being physically situated in close proximity with other team members improves communication within the team. Three main points have been identified that seemed to be common responses across the teams. The first point is that team members find that they are more able to communicate directly with their team members when working in a collocated environment. The second point is that communication is open within the team. A team member highlighted this point by saying that “the team is talking all the time, having a conversation” (B5). This open communication facilitates working more efficiently as team members are able to ask each other for help and advice with ease. The third point is that team members often overhear the conversations of other team members, and can easily get involved. This type of communication assists team members in finding new approaches to tasks and identifying when they are doing things wrong.
A final aspect that was mentioned by a number of the team members was the importance of inter-team communication. Within a collocated environment where the different teams are also located in close proximity to each other, team members from the different teams are able to communicate easily with each other, which they find extremely beneficial especially when working on cross-platform or related projects.

From the analysis of both the questionnaire data and the results of the interviews it can be deduced that the communication factor is positively impacted by the collocation of agile software development teams. The results of the interviews both validate the literature and provide further insight into the reasons why collocation improves communication within a team.

### 6.2.4. TEAM IDENTITY

The team identity factor has a median of 4, and is ranked fourth due to its high overall mean of 4. The standard deviation for both questions supporting this factor is 0.66, which equates to the strongest consensus across the sample for a particular factor.

The team identity construct consisted of two questions, both referring to a similar concept. The one question was negatively worded in order to check for validity within the questionnaire. The means for these two questions differ by 0.29 and the standard deviations differ by only 0.06. This contributes significantly to the validity of the questionnaire, confirming that the respondents completed the questionnaire truthfully. The result of the Cronbach Alpha test for this factor is 0.62, and confirms that the two questions support the team identity construct.

From the results of the interviews it was found that the SCRUM Master of Team A was of the opinion that collocated teams have a strong sense of team identity. This was said to be due to the fact that team members work in close proximity to each other, thus forming strong team units. This was supported by Team D who said that collocation definitely improves team identity, and suggested that this is due to the close proximity of team members and ease of communication within the team. Team B displayed a great amount of team identity during their interview process. This team also mentioned that they have a personal mailing list to keep members in contact with each other.

The results of the questionnaire data indicate that collocation has a strong positive impact on the team identity factor. However, little mention was made of the team identity factor during the interviews. This implies that collocation may not have as strong an impact on team identity as the questionnaire data suggests. The results of the interviews do support the literature to some extent, but did not identify any new ideas as to why collocation improves team identity.
6.2.5. PERFORMANCE TARGETS

The performance targets factor represents the various objectives within a team, which are the incentives or requirements of a project that the team should work towards. It is important that a person does not confuse the performance targets factor with the goal factor, which represents the existence of a common goal within a team.

The data gathered from the questionnaire shows that 72% of the respondents are in agreement that collocation has increased the visibility of performance targets within their agile software development teams. However the standard deviation for this factor is relatively high at 0.97, indicating that there is a divergence in the responses of the team members. Six of the respondents disagree with the view that the visibility of performance targets is increased through collocation, while five respondents remain neutral.

Throughout the interviews, a number of comments were made with regards to the performance targets factor. A majority of these comments were made by the team members from Company I. The general opinion of these team members was that, as a result of collocation, performance targets were made clearer within their teams. They found that due to the close proximity of team members and visibility of team artifacts, all of the team members are consistently more aware of and well informed about the performance targets for the projects that their teams are working on. In addition, a team member from Company I commented that due to the increase in the visibility of performance targets within his team, he is more able to set personal achievement goals for himself.

Some team members expressed that they did not believe that the increase in visibility of performance targets necessarily improves their team efficiency. However, they did say that it allows for more appropriate and constructive management of project deliverables, which would ultimately translate into increased project efficiency and thus increased team effectiveness.

Another group of team members expressed that the increased visibility of performance targets results in better buy-in from team members. This means that “work becomes lighter and easier for everyone in the team” (I4), which is believed to be a key contributor to improved team success.

The overall results of the data suggest that a bulk of the sample believe that the visibility of performance targets within a team is increased through the collocation of agile software development team members. The information gathered from the interview data also shows that the team members believe that this increase in visibility has a few of its own positive outcomes. These results confirm the findings of the literature, but do not provide any new insights.
6.2.6. COMMITMENT

The commitment between team members aims to measure the extent to which team members will work together and function as a single entity. The mean for this question is 3.86 and the standard deviation is 0.74, representing a fair amount of consensus within the sample.

78% of the responses found that team members are more committed to each other as a result of working together in a collocated environment. 16% of the responses were neutral in this regard and the remainder of the sample disagreed with this statement.

Team G believed that the commitment factor is significantly impacted by collocation with team member G1 commenting that “you don’t want to disappoint your team members because now you are friends and you’re sitting together”. A number of team members commented during the interviews that they definitely experienced a higher degree of team identity, which was a result of being more committed to each other. In addition to this, team member G1 remarked that team members would rarely take the blame for other teams, because they are seen as outsiders to their team. These findings suggest that teams in a collocated environment are highly committed to each other. It was also suggested by some team members that this factor will be closely related to the trust / mutual accountability and goal factors. This correlation between factors will be discussed in the Findings and Implications section.

Furthermore, the interviews identified a different type of commitment, namely the commitment between a team and its work. Work within the collocated environment is seen by teams as a “shared commitment” (I5). The results from the interview of Team I suggested that commitment to work products within the team was visible and shared between members due to members working on similar items at the same time. Due to the ease of communication and also the transparency of information, commitment to the work products was deemed to be easier as a result of being in a collocated environment.

This opinion was highlighted by team member G5 as not being unique to the collocated environment. This team member had previous work experience in which developers and testers were separated. He suggested that even though members were working in a distributed environment, they were still committed to their work. Despite this, the finding remains that team members are likely to be more highly committed to each other and to their work when working in a collocated environment.
Although commitment was identified as one of the factors that contribute to team effectiveness, there was little evidence in the literature to suggest that the collocation of team members would improve commitment within a team. The commitment factor was therefore not included in the literature review. However, the results of the questionnaire and interview data indicate that collocation does have a positive impact on the level of commitment within a team, thus further improving team effectiveness.

6.2.7. FUN

When conducting the initial research into the impact of collocation on team effectiveness factors, little evidence was found to suggest that the fun factor would be at all influenced through the collocation of team members. However, from the results of the questionnaire data, the overall response to whether team members have more fun in a collocated working environment was found to be agreement that more fun is had. In comparison to most of the other factors tested, the standard deviation for the fun factor is high at 0.89. This distribution of opinions is clear in the data, as on average 8% of the respondents either disagree or strongly disagree that more fun is had in a collocated environment, and 18% remain neutral.

The analysis of the interviews found that Team A and Team D, both from Company I, did not think that collocation improves the level of fun within their teams. A member of Team A added that, from his experience, the traditional distributed working environment is more conducive to fun. The opposite statement was made by a member of Team C who opined that it is more of a struggle to have fun in a distributed environment as there is less interaction between the team members.

Across the remainder of the team interviews there was a fairly common opinion that the collocation of agile software development team members does positively influence the fun factor within a team. A team member was quoted as saying that as a result of being collocated with the rest of the team members, “you start to know the people a bit better and you can start to interact with them on a social level as well” (H6). From the interviews, the underlying basis for the perceived increase in the level in fun within teams seems to be the ease of communication and interaction facilitated by collocation.

On the whole, the analysis suggests that results of the interviews are very much in line with those of the questionnaire data. A bulk of the team members believe that collocation has a positive impact on the fun factor within agile software development teams, while the remainder of them either disagree or think that collocation has little to no impact on fun within a team. Once again, although
this factor was identified to be one of the team effectiveness factors, there was no evidence in the literature to suggest that collocation would have an impact on fun within a team, and therefore was not discussed in the literature review.

### 6.2.8. ROLE

The allocation of specific roles within a team was identified as a crucial aspect in ensuring high team effectiveness. From the questionnaire data, however, role was found to be one of the weaker factors with a mean of 3.73. The standard deviation of the role factor is 0.86, indicating that there are a wide range of opinions regarding this factor. This is evident in the data as 29% of the respondents answered neutral to the question of whether collocation has placed emphasis on the role of members within the team, while 6% disagreed. 65% of the respondents agreed that collocation places an emphasis on the roles of team members.

Few teams commented on the role factor and whether it is emphasised within a collocated team. Team member G1 remarked that that the roles of team members are less emphasised due to the team members taking on more generic roles and tasks within their teams. This team member continued, saying that the roles within teams extend beyond your job description, because team members will assist each other in analysis, coding and testing situations. This was supported by team member I5 who mentioned that the roles within a collocated team are intermingled, and was quoted as saying that “you do things that you wouldn’t normally have done”.

As was mentioned in the literature review, little evidence was found in the literature to suggest that collocation has any impact on the definition of the roles of team members. This position was confirmed by the both the questionnaire and interview data, which imply that collocation does not have a great deal of influence on the definition of roles within a team.

### 6.2.9. INDIVIDUALITY

Delivering software products in a collocated team environment could lead to the team members losing recognition for their individual work. The mean for the individuality factor is 3.63, and the standard deviation is 0.67, which represents strong consensus across the sample. An average of 65% of the respondents agree with the statement that team members are better recognised as individuals in the collocated environment, and 29% of the sample remain neutral.
During the interviews conducted at Company I, consensus was reached among team members that there is individual recognition within the collocated environment. These opinions were based on the fact that due to the collocation of team members, the Product Owner is always fully aware of which individual team members are committed to a single piece of work. The members of Team C commented that in previous working environments, where the Product Owner was separated from the team, this was not as clear. According to team member G1, in a collocated environment team members are more aware of what deliverables their fellow team members are working on, stating that “you depend on the individuals to do what they are best at, so in that way we know the strengths of our team members”. Respondent J1 said: “When you’re working on something, everybody knows it because you are able to communicate the facts easily and let everybody know about your progress”. In addition, the close proximity of the team members, and thus the transparency within the team, assisted the Product Owner in getting to know the individual contribution as well as strengths of team members.

The teams from Company I mentioned that they have performance reviews in place to evaluate not only the performance of team members, but also to allow team members to rate management. The SCRUM Master from Team C was satisfied that this action contributed to the company being able to recognise the performance of individuals. Team member B2 disagreed with the idea that collocation improved the level of individual recognition within a team, stating there was not more individual recognition than in the traditional environment. This team member acknowledged that, as he was in a team of only three members, his perception might be different if the team size was larger.

These mixed results might be due to the different attitudes that management have towards recognition of individuals. The questionnaire data shows a clear distinction between the members, with the team members from Company I feeling more individually recognised than those from Company II. The overall responses from Company I versus Company II show a difference in mean of 0.15 between these two companies with regards to the individuality factor, indicating that the team members from Company I responded marginally more positively.

The literature suggested that the collocation of team members may raise concern as to whether the contributions of the individual team members will still be recognised. The results of the research imply that this concern is not valid. The questionnaire and interview results differ slightly in that the results of the questionnaire suggested that collocation does improve the recognition of individual contributions, whereas the results of the interviews were not as supportive of that idea. The overall results therefore indicate that although collocation does improve the recognition of individual contributions, the improvement is not very significant.
6.2.10. LEARNING

The learning factor represents the knowledge and understanding gained both implicitly and explicitly, from working and interacting in a team environment.

The analysis of the questionnaire data shows that the median for the learning factor is 4, which means that typically the sample is in agreement that learning is positively impacted by collocating team members. Although the median is 4, the overall mean of the sample is 3.61, which is the lowest mean across the tested factors. Additionally, this factor exhibits a very high standard deviation of 0.89. These results suggest that even though the general response of the sample is agreement there is a wide distribution of opinions, with 38% of the sample scoring below the average response.

The results of the interviews do not seem to be consistent with the data collected from the questionnaires. In at least six of the ten teams that were interviewed, a team member chose the learning factor as one of the top three factors that they believe to be the most positively impacted by collocation. The point that came across most strongly throughout the interviews was that collocation facilitates learning between team members due to the close proximity of the team members to each other and the ease of interaction between them.

The team members commented that because they work so closely to each other, they are “talking to each other constantly” and are able to “immediately ask anyone for help” (F2). Team member J2 was quoted as saying: “The sessions are very interactive. You get to discuss any problems and issues and risks, so everybody learns from that and you leverage off the next person’s strengths in a particular area and you learn from that.” This comment suggests that collocation enables the team members with their various skills to contribute towards learning within the team. The team members also said that they learn from their team members by overhearing their conversations and “listening to them speak” (J3). Team member I5 remarked that collocation allows team members to take on different roles and undertake tasks that may not fall within their ordinary portfolio of work, which assists with learning and growth of the individual team members.

The comments made by the team members across a majority of the teams imply that they believe collocation has a strong positive impact on the learning factor within a team. This result differs from the results of the questionnaire data gathered, which found that the sample respondents were dispersed in their opinions of the impact of collocation on learning. The results of the research confirm the findings of the literature.
6.2.11. RESOURCES

The resources factor refers to the availability and use of resources within an agile software development team, including time, people, money, and work artifacts. The agile development methodology places emphasis on the use of shared artifacts, such as whiteboards and charts, throughout the duration of a project.

For both of the questions used to evaluate the impact of collocation on the resources factor, the overall response across the sample is a rating of 4 on the Likert scale. This indicates that a majority of the respondents believe that a team’s resources are positively impacted by the collocation of team members. The standard deviations of the responses for each question relating to this factor are however somewhat different, at 0.68 and 0.84 respectively. This indicates that the respondents may be unsure of their opinions regarding the impact of collocation on resources within a team.

Few comments were made about the resources factor during the interviews. However, any comments that were made were positive. The main observation was that in a collocated environment resources are much more readily available than in a distributed working environment. This was attributed to the close proximity of the team members and, due to the agile development approach being adopted by the teams, the managers and customers. A member of Team H was quoted as saying that when considering the team members as resources, “we’re much more aware of what everybody is doing and how much time it takes to do things, as opposed to previously when it was just pass the task along and it happens, you didn’t see it happening” (H2). Another team member remarked that due to collocation “there is a lot more visibility as to what the team is doing, and the team members within that team” (F3).

With regards to the use of shared artifacts, much mention was made about the extensive utilisation of these artifacts within the teams in order to facilitate project execution. With the adoption of the SCRUM agile development methodology comes the requirement that the teams make use of shared artifacts. At least four team members individually stated that shared artifacts have contributed to their team effectiveness. A number of the teams expressed that collocation of their team members increases the visibility of the shared artifacts across the team, and consequently increases the visibility of the progress and goals of the team. Team F, however, said that they paid little attention to shared artifacts and remarked that “shared artifacts do not improve team effectiveness” (F2).

The results of the research agree with the literature in that the collocated environment has been found to encourage the use of shared physical resources, which increases visibility and communication within a team. In addition, the results indicate that collocated team members are
more aware of the available resources within a team. The results of the interviews seem to be well aligned with the data collected from the questionnaire responses. For the most part the team members are in agreement that collocation leads to increased availability and use of resources within a team. A portion of the sample, however, remains neutral as these team members are unsure as to whether collocation influences a team’s resources.

6.2.12. MORALE

The morale of team members refers to the motivation and attitude of the team members working in a collocated environment. 73% of the respondents agree with the notion that working in a collocated environment increases a team member’s motivation. The mean for this question is 3.78, but the high standard deviation of 0.85 represents a fair amount of divergence across the sample. For the second question relating to the morale factor, 85% of the team members agree that the ease with which ideas and information can be shared with co-workers will increase the team members’ motivation. The mean for this question is 4.06 and significant consensus was reached with a standard deviation of only 0.66.

In addition, 71% of team members agree that the use of shared artifacts contributes to the team members experiencing increased levels of motivation. The mean for this question is 3.86 and the standard deviation is 0.71. Lastly, only 65% of members agree that the fellow team members are satisfied with the collocated working environment. This is represented by a mean of 3.65 and a standard deviation of 0.75, indicating that a fair amount of consensus exists.

The statistics from the questionnaire were supported by the information gathered from the interviews where morale was identified as having a major influence on team performance. Team A made the point that due to the fact that collocated team members are located in such close proximity to each other, the morale of individual team members has a significant influence on the morale of the team as a whole. The SCRUM Master of Team A commented that if a team member is “down” (A1), the whole team will be affected and as a result the morale of the team will also decrease. Team C supported this view by saying that having a good vibe within the team is important in order to ensure that a team is able to perform effectively.

The Product Owner in Team B had experience working in a traditional distributed environment and commented that in this environment management and the development team were located on different floors of a building. In this situation if the development team experienced problems and a deadline was overrun, the Product Owner would become displeased with the team, and the team
members would be forced to work extra hours in order to make up for the issue. From the perspective of a developer in Team B, the following was said: “Why is it my emergency when the product owner has failed to plan?” (B4). According to Team B, this additional stress led to an increase in the staff turnover, and a decrease in team morale.

Team B was of strong opinion that being collocated with the team meant that the Product Owner could clearly understand the team’s situation at all times and take appropriate action well in advance, without running the risk of being unrealistic and basing decisions on incomplete information. The collocated environment has thus increased the morale of the team members in that the team is less likely to be subjected to unfair treatment or criticism. This would in return prevent the morale of the team being decreased unnecessarily.

The results of the research confirmed the literature, although no mention was made about the impact of shared artifacts on morale. The research also identified that by being collocated with management or team leaders leads to decreased stress and improved morale. The overall results of the research indicate that collocation leads to increased morale within a team.

6.2.13. TRUST / MUTUAL ACCOUNTABILITY

The questions relating to this factor were devised in order to determine whether team members believe that collocation improves the level of trust and mutual accountability between team members.

The means and standard deviations of the questions relating to the trust / mutual accountability factor are fairly similar to each other respectively. The medians for both of the questions are 4 and standard deviations are relatively low. Taking that into account, the general consensus across the sample seems to be agreement that trust and mutual accountability are positively impacted by the collocation of agile software development team members. This is evident in the data as, for each question, approximately 70% of the respondents are in agreement while only 30% either disagree or have little opinion about the relationship between collocation and the trust / mutual accountability factor within their teams.

The trust / mutual accountability factor was not often selected during the interviews as one of the factors that are the most positively impacted by collocation. Team members from Teams H and J did however select trust / mutual accountability, with team member H5 volunteering that “it is very visible that you are working and that you’re working on team tasks because you are much more inclined to talk to your colleagues about what you’re working on. And so it becomes evident what
you’re working on, and you have that much more of a feeling that you trust each other and you can feel that you’re all accountable for the same goal”.

When questioned about the trust / mutual accountability factor, a number of different opinions from the various teams arose. Some team members remarked that collocation does not have an impact on the trust or mutual accountability within a team. Other teams contrasted collocation with the distributed working environment, saying that the collocation of team members’ increases transparency within a team and provides more clarity as to what all of the team members are working on and where responsibility lies, and as a result trust and accountability are improved. A member of Team C commented that in a distributed working environment, the mentality is one of “‘them’ and ‘us’, and because of this nobody can take responsibility for a situation” (C2).

From the results of the interview and questionnaire data it can be deduced that, generally speaking, the sample believe that trust and mutual accountability within a team is positively impacted by collocation, though there are a number of team members that do not agree or do not have an opinion with regards to the matter. The results of the interviews are perfectly aligned with the literature, as both the ease of communication and the increased presence of a common goal were mentioned by the team members as factors of collocation that increase trust and mutual accountability within a team.

### 6.2.14. CONFLICT MANAGEMENT

The management of conflict is of great necessity within a team as it can potentially destroy the morale and performance of a team. Three questions were presented to the sample with regards to conflict management in the collocated environment.

67% of the sample responded positively that the physical closeness of the collocated environment allows for earlier identification of conflict, 24% of which agreed strongly. The mean for this question is 3.80, and the high standard deviation of 0.96 represents significant divergence across the sample. 61% responded positively to the question that collocation allows for easier conflict resolution. This question has a very low mean at 2.84 and also the highest standard deviation at 1.01. It is thus questionable as to whether conflict resolution is made easier by collocating team members. In addition to this, 47% of respondents disagreed with the view that conflict occurs more frequently than in other environments, whereas only 29% agreed, and consensus across the sample was fairly distributed with a high standard deviation of 0.89.
Team B were in agreement that the level of politics within a team has been reduced due to collocation. In addition to this, Team B believed that the politics between the business and technology functions has decreased as a result of the collocation of the different team member roles such as business analysts and developers. Team member B3 remarked that the fact that team members are located in close proximity to each other, and with managers, has put a face to the business and technology functions. Because team members are located closely to each other, all of the unimportant and irrelevant issues can be omitted.

Conflict and political disputes are however, inevitable. Collocated teams have taken a self managed approach where team members are encouraged to talk to each other immediately with the goal of resolving the issue at hand because prolonged conflict will be detrimental to the team as a whole. Team members B2 commented that team members are able to discuss and resolve any conflicts that arise very easily due to the close proximity of all of the team members.

Team member H4 was quoted as saying: “I don’t think conflict is an issue, but that depends on the people I suppose. If you want to say something we’re all mature adults so just say it”. This team member was of opinion that the collocated environment does not have any more or less conflict than the traditional distributed environment.

On the whole the results of the research seem to agree with the literature, although the team members tended to be less enthusiastic about the impact of collocation on the conflict management factor than was expected. The results of the research suggest that collocation does have a positive impact on conflict management within a team, but there is not consensus across the sample with regards to this factor.

6.2.15. WORK APPROACH

The work approach factor refers to the approach that team members take in order to complete their tasks and reach the goals of their teams.

This factor was not measured in the questionnaire, as the questions required in order to obtain sufficient data that would effectively measure the factor proved to be too complex. The factor was however included in the interviews, and a number of comments regarding the impact of collocation on work approach were made by the team members. These comments were predominantly made by the teams from Company I.
The general consensus from the interviews was that due to the team members working so closely together, the work approach taken by each of the team members becomes more transparent. Team members get to know each others’ work ethics and are able to follow the progress of work within the team. This means that team members are able to assess the performance of other team members and gauge whether those team members are underperforming and need to work harder or need assistance and support. As a result collocation encourages team members to adopt similar work approaches in order to keep up with each other and maintain a consistent level of progress within the team. This is extremely positive in terms of increasing the effectiveness of a team. A team member from Team A added that maintaining a consistent level of progress through improving the work approaches of the team members promotes working together towards a common goal within a team. Another team member from Team B said that due to collocation, all of the team members are aware of each others’ work approaches and strengths, which enables more efficient delegation and completion of tasks within a team.

The results of the interviews suggest that although the factor was not tested in the questionnaire, the interviewed sample largely believe that collocation has a positive impact on the work approach of team members and thus improves the efficiency and effectiveness of the team as a whole. These results do agree with the literature to some extent but not address all of the aspects relating to work approach that were indentified in the literature, including the impact of the increased use of shared artifacts encouraged in a collocated environment.
6.3. DESIGN OF THE COLLOCATED ENVIRONMENT

In order to further identify aspects of collocation that impact team effectiveness and fulfil the secondary objective of the research, questions were asked in both the questionnaire and the interviews regarding factors that relate to the design of the collocated working environment.

The following aspects were identified and discussed as key factors that could have an impact on the effectiveness of a team working in a collocated environment:

- Noise and Interruptions
- Break-away Areas
- The Physical Working Environment

Each of these factors will be analysed individually taking into account the relevant questionnaire and interview data, and initial implications regarding each aspect will be drawn, which will contribute to accomplishing the secondary objective of the research.

For privacy reasons, only the collocated working environments at Company I were allowed to be observed. The physical layouts of these collocated environments will be briefly discussed before analysing the aspects that have been identified in order to provide an example of the layout of a collocated working environment.

![Figure 9: The Radically Collocated Team Room](image-url)
Other Business Functions are on a different level, but still part of the open space.

**Figure 10**: The Open plan Collocated Working Environment

- Wall
- 1.3m Wall
- Double sided white board
- Desk with flat surface (no separators)
Figure 9 represents a radically collocated team room at Company I. Team E currently occupies this room, and consists of 4 team members. The floor area is approximately 25m$^2$. Figure 10 provides a basic representation of the open plan environment of Company I, consisting of many collocated teams. These teams operate in areas of approximately 35m$^2$ and generally consist of 6 team members. The collocated team areas are separated from each other, and from the other business functions within the collocated environment, by double sided white boards, filing cabinets and separator panels.

The following sections will discuss the three factors that address the secondary objective of this study, which involves looking at aspects of the collocated environments that have an influence on the effectiveness of a team.

### 6.3.1. NOISE AND INTERRUPTIONS

Due to the many activities happening simultaneously within the collocated environment, noise and interruptions are inevitable. The purpose of this section is to identify whether collocated team members are being positively or negatively influenced by these factors.

There is a significant difference between the results of the questions regarding the noise factor. 69% of the respondents agree with the statement that the collocated environment is noisier than other types of environments, while only 29% agree that the noise level decreases productivity. The mean for the first question is the higher of the two at 3.73 whereas the latter is only 2.82, the lowest of all questions in the questionnaire. In terms of consensus, there is only a small difference between the standard deviations of the two questions at 0.88 and 0.95 respectively, which indicates that there is very little consensus within the sample with regards to noise in a collocated environment.

The interruptions construct consists of two questions, the results of which have the highest level of disagreement in the sample. The overall mean for this factor is 3.53. 59% of the sample is in agreement that individuals are more often interrupted when working within the collocated environment. 57% agree that the quality of work produced by individual team members would increase were there fewer interruptions within the team, whereas 24% disagree with this statement. The standard deviations for these two questions are 1.10 and 1.08 respectively.

Rich feedback was gathered from the interviews of the teams with regards to noise and interruptions in the collocated working environment. The layout of the collocated environment at Company I open plan, consisting of many collocated teams. The teams from Company I acknowledged that noise is a problem within this environment and a need for improvement in this
area has been identified. This situation has been questioned by managers who commented that concentration during software development is very important and the noise levels could negatively influence the team members. Noise within this environment was therefore seen by managers as disruptive and invasive on the team members’ execution of work.

The team member view, however, differed somewhat from the management perspective. One team member commented that “it might be an issue when you start, but after a while you just get so used to it. You just learn to filter it out” (F2). Another member within this team said that team members use earphones if they do not want to be disturbed and this would generally be sufficient. These views were also supported by the other interviewed teams. Some teams acknowledged that they were noisier than others and were aware that they may distract the other collocated teams.

A team member who commented about the noise said, “it is definitely sometimes distracting, and I think the more you’re into what you’re doing at that stage, the more distracting it is” (H6). This particular view was identified in a minority of the team members interviewed, but still shows that some individuals are susceptible to being negatively influenced by noise. It was mentioned however that, generally speaking, noise is not a big factor of concern within the collocated environment.

An interesting finding was that teams within Company I are located within the same open area as other business functions, including the sales function. Generally, development teams have tasks that are related to other teams, but in this case the sales function is a completely separate unit. The fact that the software development teams are located in close proximity to this sales function leads to unnecessary interruptions and noise levels which are unrelated to the software developers.

Interruptions by fellow team members were rarely seen as problematic. The majority of interruptions were from fellow collocated teams within the environment. Consensus was reached within the sample that there were more interruptions in the collocated environment than other environments, but these interruptions were not necessarily considered negative. The collocated teams within the open plan environment often worked on components that were dependent on each other, thus requiring clarification from other teams that might have been involved. It was mentioned by team member C4 that “by being interrupted 30% more, 20% of this will increase your productivity and 10% might be useless”. This team felt strongly that the interruptions were important to their work.

Teams from Company I have previously worked at this company in a traditional distributed environment where managers were located on a different floor than the rest of the development teams. Interviewed teams felt strongly that, when previously operating in the distributed
environment, walking between offices wasted a lot of time. It was found that the close proximity of team members in the collocated environment, and the ease with which members could get information from each other through interruptions led to this environment being much more efficient. According to Team D, interruptions would also trigger sessions where the team members were able to identify if there was a need to get the team as a whole together to discuss a certain issue. The ease with which this could be done was deemed to be invaluable.

As was mentioned before, a majority of the teams remarked that headphones were used by team members if there was too much noise in the collocated environment, but they also inadvertently acted as a sign to other team members that the individual wished not to be interrupted. Team members would usually defer interrupting members who wore headphones. Apart from this, Team D said that there was no need for a flag type system where team members would have some sort of status to show whether they wanted to be interrupted or not.

From the results of the questionnaires and interviews it is evident that there are mixed feelings within the sample about the impact of noise and interruptions on the effectiveness of collocated teams. The literature suggested that noise and interruptions would be an inhibitor to team effectiveness. This was supported by the finding from the questionnaire data that the collocated environment is perceived to be significantly noisier than other environments. However, the majority of team members commented that they were able to quickly get use to, and effectively cut out noise. In conjunction with this, interruptions were identified by the literature as a disadvantage of the collocated environment, yet the opposite was found during the interviews. This is due to the fact that the work of the different teams is often dependent on each other and as a result, team members find the interruptions to be useful in clarifying issues and ambiguity. Overall, the interruptions contribute towards team effectiveness within the collocated environment.

### 6.3.2. BREAK-AWAY AREA

The concept of a break-away area, also known as a “hotelling space” (Covi et al., 2002), was identified during the information gathering phase of the literature, but very little evidence was found to support the adoption or use of this area by collocated teams. This concept was thus omitted from the literature review, but included in the study in order to identify if the use of break-away areas in a collocated working environment would have an impact on team effectiveness. The break-away area is a private area in which individuals can work alone for a period of time, separating themselves temporarily from the collocated environment (Covi et al., 2002). Its use stems from the need of team members to work in isolation when work requires in-depth focus.
Questions relating to the use of break-away areas were omitted from the questionnaire as this concept was likely to be foreign to the respondents and thus the responses could potentially have been unreliable. The use of break-away areas was however discussed in interviews after a brief explanation of this concept had been provided to the team members.

Teams had very different responses with regards to the use of break-away areas. Company I had previously made use of break-away rooms. However, due to a lack of space, these rooms had to later be used to accommodate some other business functions. Team C commented that break-away rooms are available for team members at their home office, but that these rooms are too small and people rarely make use of them. It was added that team members only make use of the break-away areas when tasks and work items are difficult and require more concentration and focus.

Other teams within Company I, who have not made use of break-away areas before, were asked if they would find these areas useful and would utilise them if they had the option at their offices. The majority of team members said that they would not. Team members felt strongly that their own collocated environment was adequate. Another aspect mentioned was that team members constantly needed each other for information and support during software development and so working alone in a separated room would bring unnecessary complexity to this process.

Team members from Company II had very similar responses to Company I. Company II did not have break-away areas, but team members were of strong opinion that this concept would not increase team member productivity. Team member G2 commented that “you get comfortable with your own desk”. The teams from Company II showed a fair amount of resistance to the idea of break-away areas, saying that these would prove to be inconvenient for team members. Team members from Teams G and H expressed concern about how they would be able to use their fixed desktop computers in a room like this. This concern was due to the fact that team members at Company II were not issued with laptops, and so could not easily take their work into another area. Remote desktop software might be a viable solution in their case.

With regards to the idea of having break-away areas at Company II, team member G5 remarked: “I don’t support the whole working by yourself thing because you are part of a team so there’s no reason to go sit by yourself.” This view supports some of the literature, where team members have been frowned upon when break-away rooms were used (Covi et al., 2002, 679).
Despite these negative feelings towards the break-away room, a minority of team members did comment that they would make use of this type of area if they had the option. Member J4 was quoted as saying: “I think that would be a good idea because every now and then you just need an hour with no interruptions. So I think that would work, people would use it”. Team member I5 supported this statement by commenting: “I do it sometimes, I go and find a meeting room and I work there for a few hours. If there was a break-away room then I would use that. But I don’t know that it would be necessary because a normal meeting room serves that function.”

A suggestion was made by Team G to have a form of break-away room where team members could have meetings or take phone calls. This may reduce the amount of noise within the collocated environment and thus potentially increase team effectiveness.

Relatively little literature was found to support the use of break-away areas, but it was suggested that rooms be provided in collocated environments in which team members are able to work separately and in private. The results from the interviews suggested that the companies did not currently make use of break-away rooms. Consensus was reached amongst the majority of team members that, if break-away areas were available, they would rarely be used. It was also suggested that the rooms could potentially negatively impact a team’s effectiveness, as the concept would contradict the purpose of the collocated environment.

6.3.3. PHYSICAL WORKING ENVIRONMENT

Certain aspects of the physical collocated environment have been identified that might have an influence on the effectiveness of collocated team members.

The questionnaire included two questions with regards to the physical design of the collocated environment. 59% of respondents agree that the layout of the collocated team room is important for team success, and 39% are satisfied with the current design of the team rooms. The means for these two questions are 3.73 and 3.16 respectively. Exactly 37% of the sample answered neutral to both questions, suggesting that team members were either unsure about their feelings or had little opinion with regards to the design of their collocated environment. The standard deviations for the questions are 0.81 and 0.90 respectively, indicating that there is little consensus between the sample respondents.

A strong form of collocation called ‘radical collocation’ was discussed in the literature. This form of collocation is being adopted by only two of the ten interviewed teams, both from Company I. Team D is collocated together with a research and design team in a single room, and for purposes of this
study is considered to be radically collocated. Team members from Team D have been operating in the radically collocated environment for two months, and are generally satisfied with the working environment. This team commented that they do not mind sharing the room with another team, and added that they prefer the radically collocated environment to the open plan working area. The layout of the room was deemed to be adequate and the only dissatisfactory feature identified was that the air conditioning was too cold.

Team E is the only interviewed team that is radically collocated as per definition. This team consists of three team members and a SCRUM Master. An interesting observation that was made was that the team members of Team E were generally unsatisfied about being radically collocated. The main concern of the team members was that they felt disconnected from the other collocated teams working in the open plan area. These team members also complained about the air conditioning unit being too cold.

![Figure 11: The Radically Collocated Environment of Team E](image)

Although factors such as the air conditioning unit are relatively unrelated to the effectiveness of teams in the collocated environment, it has been identified as an issue that is negatively influencing the team members’ perceptions of the radically collocated room environment.

During the interview with Team C it was noted that they were temporarily located in single room for two days, and that these team members did not enjoy the radically collocated working environment. The team members commented that they did not feel part of the “vibe and the buzz” (C4) during that time. An interesting observation made by the team was that the working environment should also not be too quiet. This team established that it is necessary to interact with the other teams
within the company, and found that when they were radically collocated it was difficult to communicate with these teams due to the physical distance between the teams.

Company II had many collocated teams within one open plan area, but none of the teams were radically collocated. There was consensus amongst the teams of Company II that a radically collocated team would not necessarily be more productive. Team member H6 commented: “I’m not sure if I would prefer it. It would be like cutting me off from the rest of the business, from the rest of the people”. Member H4 said: “I would feel claustrophobic I think, boxed in with these eight people. Having that sense of openness helps; it’s like your energy is not just bouncing off a wall, it’s going into the open space”.

The collocated teams within Company II were highly dependent on the other teams for completing the daily work, as a lot of the systems are tightly integrated with each other. Team member J1 remarked: “I personally like working closely with the other teams because we work on similar things, and what we do affects each other. So in a way our team is collocating with their team”.

In support of the open plan area consisting of many collocated teams, H6 said that “sometimes you pick up on conversations from other teams and you can help them or you can trigger something about what you need to go and look at”. The flow of information within the environment was seen as invaluable and definitely contributed to the team members’ daily execution of work.

Team I had mixed opinions about the concept of being radically collocated. One team member said that it might be beneficial at certain times whilst team member I2 commented: “I would say that it would be best if we were together in our room. I think we distract other teams”. This team acknowledged that they were one of the noisier teams within the open plan environment. Team I
was also situated in the centre of the open plan environment and as a result often disturbed other teams. Space seemed to be an issue for the team and team member I5 made a suggestion for an improved collocated team working environment for their team in particular: “Not a closed-off, private room maybe, but I think it would be better if we were more to the side. So it’s not perfect as it is. When we do our stand-up meetings, they’re in the passage. So we could do with an improvement. Maybe not in a closed-off, private room, but with a bit more of a sense of own space.”

The literature suggested that a radically collocated team would be the preferred choice for teams using agile methodologies such as SCRUM. The results from the interviews were however very different from what was expected. Only one of the two teams enjoyed the radically collocated environment, and the other collocated teams would not want to move to a single, dedicated team room, had they the option to do so. Team members were not keen to be disconnected from the rest of the collocated teams, and so the increase in the distance between teams which would come with the radically collocated environment would be considered to negatively impact team effectiveness.
7. FINDINGS AND IMPLICATIONS

The following section will consolidate the implications of the impact that collocation has on each of the team effectiveness factors, as well as identify and discuss any relationships that exist between the factors. In addition, the implications of the aspects that influence the collocated working environment will be brought together, and used in order to provide some insight into the secondary objective of the research.

7.1. TEAM EFFECTIVENESS FACTORS

Fifteen team effectiveness factors in total were identified and explored during the research, of which only thirteen were initially discussed in the literature review.

Of the fifteen factors that were investigated, six were found to confirm the literature but did not provide further insight into the impact that collocation of teams has on them. These factors are Feedback, Performance Targets, Trust / Mutual Accountability, Team Identity, Conflict Management and Learning. The findings of the literature and the research show that each of these factors is positively impacted by collocation.

The research of the Role factor was also found to confirm the literature, both of which indicated that collocation does not have a significant impact on the definition of the roles of team members within a team. As a result, the Role factor should no longer be considered as one of the team effectiveness factors that are impacted by collocation, and so should not form part of the final model.

The results of the research for the Work Approach factor were found to support the literature surrounding this factor to some extent, but did not address all of the aspects that were uncovered in the literature review. The research did find that the close proximity of the team members in a collocated working environment promotes the adoption of a common work process by team members, and assists the team members in establishing common ground. However, no mention was made about the influence of the use of shared artifacts within a team on work approach, or of the influence of face-to-face communication and interaction.

The research surrounding four of the fifteen team effectiveness factors was found to agree with, as well as provide additional insight into the literature, which indicated that these factors are all positively impacted by the collocation of software development teams. These factors are Goal, Commitment, Resources and Morale.
The literature with regards to the Goal factor found that the use of shared artifacts, which is encouraged in a collocated environment, lead to the increased awareness of a common goal within a collocated team. The research confirmed this view and added that the close proximity of team members in a collocated environment, the increased existence of a common process within a collocated team, and the generally small team size of collocated teams increase the existence and awareness of a common goal within a collocated team.

The findings of the research surrounding the Communication factor agreed with the main points made in the literature with regards to the impact of collocation on communication within a team. These were that, due to the close proximity of team members, collocation promotes direct and open communication as well as increases the level of osmotic communication, which was explained in the literature review as information and knowledge that is transferred by overhearing communication within a team. The research also found that by working in an environment in which a number of teams are collocated in the same area, communication and knowledge transfer between the teams is improved. This further increases the effectiveness of a collocated team as the team members are easily able to discuss inter-team issues with and get support from people that may not necessarily be part of their team.

The research surrounding the impact of collocation on the Resources factor suggested that collocation does not only improve the use of shared artifacts, and thus team effectiveness, within a team. Collocation was also found to improve the awareness and availability of the resources within a team. These resources include people, time, shared artifacts, software and information. However, although the research provided additional insights into the impact of collocation on the Resources factor, it was found that while collocation does influence this factor positively, this influence is very minor.

The findings of the research surrounding the Morale factor confirmed the literature, which suggested that collocation leads to increased team morale and satisfaction. This was largely attributed to the close proximity of the collocated team members. The research also found that collocation of team members with the team leader or manager leads to decreased stress levels within the team, as team members are easily able to communicate with these authority figures whenever necessary, and thus increased morale.

Due to the lack of literature surrounding the impact of collocation on the Commitment and Fun factors, they were not included in the literature review. Both of these factors were, however, believed to be positively influenced by collocation and so were investigated in the research.
From the research, collocation was found to have a significant positive impact on the Commitment factor. This increased commitment in a collocated working environment was attributed to the increased team identity and trust also found in a collocated environment. In addition it was suggested that the close proximity of the team members leads to the development of good relationships between the team members, and increases the overall transparency within a team. As a result, team members tend to be more committed to performing to the best of their ability.

The research findings with regards to the Fun factor indicated that this factor is positively impacted by the collocation of software development team members. It was suggested that, in contrast to traditional distributed environments, collocated team members are more able to become familiar with each other and develop good relationships, as well as communicate and interact with each other. This ease and frequency of communication and interaction also results in team members developing social relationships with each other. Consequently, collocated team members were found to have more fun.

These findings show that the collocation of agile software development teams has a positive impact on a majority of the team effectiveness factors investigated, and thus increases overall team effectiveness. These finding thus fulfil the primary objective of the research, which was to determine the impact of collocation on each of the team effectiveness factors investigated.
The following figure illustrates the final model representing those team effectiveness factors that are positively impacted by the collocation of agile software development teams:

![Collocation Model](image)

*Figure 13: The Impact of Collocation on the Team Effectiveness Factors*

The strength of the impact that collocation has on each of the team effectiveness factors has also been depicted in the model above. Strong relationships, as identified by both the quantitative and qualitative study, are represented by thick, green arrows. Likewise, the medium relationships are represented by pink arrows, and the weak relationships are represented by thin, grey arrows.
7.2. RELATIONSHIPS BETWEEN THE TEAM EFFECTIVENESS FACTORS

The relationships that have been identified from both the questionnaire and interview results have been combined to form the following model of the team effectiveness factors that are impacted by the collocation of teams.

Figure 14: The Relationships between the Team Effectiveness Factors that are Impacted by Collocation
All of the factors that have been included in the model were identified by Smith et al. (2000) as factors that contribute to team effectiveness. As a result, all of these factors are related to each other in some way. In addition, all of these factors are positively impacted by the collocation of agile software development team members. The Role factor has been excluded from this model as the findings of the literature suggested that collocation does not have a significant impact on this factor.

The relationships illustrated in this model have been identified by the results of both the qualitative and quantitative research. In terms of the quantitative research, the relationships demonstrated are exceptionally strong as they were found using the Spearman Rank Order Correlation test at a p-value of 0.0001. These correlations can be seen in Appendix E.

The blue factors represent those factor relationships that were identified by the quantitative research only. The green factors represent those factor relationships that were identified by the qualitative research, but many were also identified by the quantitative research. No relationships were identified in the research for the Resources and Conflict Management factors. These factors remain in the model as they are still positively impacted by collocation, but have been represented in pink.

It is interesting to note that the Goal factor has the most relationships with other team effectiveness factors. The results gathered from the interviews indicated that the sample team members believe that the existence and awareness of a common goal within a team is extremely important, and influences a number of other aspects within a collocated team. In addition, a relationship between the level of morale and fun within a collocated working environment was expected, but the findings of the research did not fulfil this expectation.
7.3. THE COLLOCATED WORKING ENVIRONMENT

In order to fulfil the secondary objective of this study, which was to provide insight into the design of the collocated working environment, aspects were identified that companies should take into consideration when establishing a collocated environment for their software development teams. From the analysis of the data that was gathered, rich information about these aspects of the collocated working environment was gained.

The most interesting finding from this study was that the teams were against the concept of working in a radically collocated environment. The collocated environment, consisting of many collocated teams in an open plan area, was the optimal choice for the layout of the work environment. The most important reason for this was that as a result of working with other collocated teams, team members felt part of a larger group, and gained invaluable benefits from the information and energy that was shared in the open plan area. In addition, noise and interruptions which are common in the collocated environment were not seen as a negative influencer of the team effectiveness. In contradiction to what the literature found, interruptions were even believed to contribute towards improved team effectiveness.

Finally, break-away areas are not available at the sample companies. This is not considered to be a disadvantage as a majority of the team members do not believe that these areas would be utilised or have a significant impact on team effectiveness. The teams felt strongly that break-away areas would contradict the concept of the collocated working environment, and that isolating team members would result in more disadvantages than advantages for the team.
8. CONCLUSION

The main purpose of this research was to determine the impact of collocation on a number of factors that influence the effectiveness of teams. In addition, various aspects relating to the collocated environment were explored in order to provide insight into the optimal design of a collocated working environment. This research was conducted using a sample of collocated agile software development teams that were all adopting the SCRUM approach to software development.

From the analysis and findings of the questionnaire and interview data that was gathered, the following conclusions can be drawn:

PRIMARY OBJECTIVE

Collocation has a positive impact on all but one of the team effectiveness factors discussed in the literature. The impact of collocation on the Role factor was found to be negligible, and so it has been suggested that this factor should no longer be considered as a part of the model. The Commitment and Fun factors, two team effectiveness factors which were not discussed in the literature due to lack of evidence to support that collocation has an impact on them, are positively impacted by collocation and thus should both be included in the model. Figure 13 illustrates the final model of the team effectiveness factors that are positively impacted by collocation. In addition, when considered in terms of the collocated environment, many relationships exist between the various team effectiveness factors. These relationships are shown in Figure 14.

SECONDARY OBJECTIVE

The SCRUM software development teams that are working in the collocated environment are generally satisfied with the designs of their collocated environment. Working in an open plan area and being collocated with other software development teams is beneficial as it leads to increased knowledge and information sharing, and promotes the feeling of involvement and inclusion of each team. As a result, teams do not see the need to be radically collocated in separate team rooms as this will not necessarily improve team effectiveness any more. Additionally, noise and interruptions do not have a significant influence on the effectiveness of teams. Interruptions can sometimes even positively contribute to team effectiveness due to the information transfer between team members by these interruptions. Finally, break-away areas are not common within the agile software development collocated environment, and for the most part will not be regarded as valuable by the development teams.
9. RECOMMENDATIONS

The following recommendations can be made taking into account the findings and conclusions of the research:

9.1. RECOMMENDATIONS FOR PRACTITIONERS

TEAM EFFECTIVENESS FACTORS

Companies should examine the final model of those team effectiveness factors that are positively impacted by collocation, and consider collocating their agile software development teams in order to increase the overall effectiveness of the teams. This is recommended as collocation has been found to have a positive impact on fourteen team effectiveness factors, which indicates that the collocation of agile software development teams would increase overall team effectiveness.

THE COLLOCATED WORKING ENVIRONMENT

Team members should not only be collocated with each other, but also with other teams in an open plan environment, as this contributes to the feeling of connectivity and involvement that is shared within the environment.

NOISE AND INTERRUPTIONS

The close proximity of the team members within a collocated environment, and with other collocated teams, will increase the noise level and the frequency of interruptions. This should, however, not discourage companies as these interruptions increase the information transfer within a collocated environment and allow team members to discuss areas of concern and ambiguity with ease. As a result, issues are able to be resolved in a timely manner without the need to arrange formal meetings. Noise and interruptions can thus positively influence team effectiveness.
9.2. RECOMMENDATIONS FOR FUTURE RESEARCH

RELATIONSHIPS BETWEEN THE TEAM EFFECTIVENESS FACTORS

No relationships have been identified for the Resources and Conflict Management factors in the proposed model. In addition to this, a relationship between the Morale and Fun factors was expected, but could not be proven. Future research should be conducted with regards to these factors to determine whether any notable relationships do exist.

COLLOCATED VERSUS DISTRIBUTED TEAM EFFECTIVENESS

Future research should take a quantitative approach to determining the difference in the level of effectiveness of distributed and collocated teams. In order to increase the reliability of the research, a control group should be used.

AGILE DEVELOPMENT METHODOLOGIES

This research focused on agile development teams adopting the SCRUM development approach. Future research could be expanded to include other agile development methodologies, such as Extreme Programming (XP) and Feature Driven Development (FDD).

GEOGRAPHIC LOCATION

The sample used in this research included agile software development teams from South Africa only. Future research could be expanded to include agile software development teams from other countries.

THE DESIGN OF THE COLLOCATED ENVIRONMENT

This study was limited to observing only one of the sample companies’ collocated environments, and thus analysis in this section was limited. Future research into this area should focus on specific design issues and office layouts, with the aim of identifying a generalised model of an office layout that would optimise team effectiveness.
REFERENCES


APPENDIX A: COORDINATOR QUESTIONNAIRE COVER LETTER

Department of Information Systems  
Leslie Commerce Building  
Engineering Mail  
Upper Campus  
University of Cape Town  
Rondebosch  
77001  
Tel: (021) 650-2261  
Fax: (021) 650-2280

22 July 2008

Dear [Coordinator name and surname],

Thank you for agreeing to participate in our research study. The following questionnaire is aimed at members of agile software development teams that are currently, or have previously been, collocated with their project team members whilst working on a software development project. A number of factors have been identified as having an impact on the effectiveness and performance of software development teams. The purpose of this study is to determine whether the act of collocating team members has an influence on the effectiveness of the teams.

This research will be conducted at a team level. All the members of the participating teams are requested to complete an online questionnaire. We would appreciate it if this could be done within the next 7 working days. A link to the questionnaire is provided below. We will contact the teams within the following two weeks in order to arrange face to face interviews with each of the teams or, if this is not possible, representatives from each team. These interviews will take approximately 15 minutes per team. Please be assured that the information collected is for research purposes only and that your responses will be kept strictly confidential.

Definition of terms that will be used in the questionnaire:

- **Collocation:** Grouping team members into a single, open area with breakaway facilities
- **Team Room:** The project room where the team members work in close proximity for the duration of a project
- **Break-away Area:** A private area that is available if an employee prefers to work alone
- **Meeting Room:** A separate room or private area that is available for meetings and group discussions
- **Shared Artifacts:** The use of shared, visible representations to communicate project deliverables and progress between team members (i.e. whiteboards, burn-down charts, etc)

In order to complete the online questionnaire, please allow participants to follow this link: http://www-commerce.uct.ac.za/Services/SelectSurveyASP/TakeSurvey.asp?SurveyID=3J09o52L4m4LM

Please feel free to contact us if you have any further queries. Thank you for your support.

Yours sincerely,

Joanne Smith  
(Honours Student)  
smtJoa007@uct.ac.za

Stephan van der Watt  
(Honours Student)  
svdwatt@gmail.com

Michael Eccles  
(Supervisor)  
michael.eccles@uct.ac.za  
Tel: 021 650 2267

*Our Mission is to be an outstanding teaching and research university, educating for life and addressing the challenges facing our society.*
APPENDIX B: RESPONDENT QUESTIONNAIRE COVER LETTER

Dear Sir / Madam

Questionnaire on Determining the Impact of Collocation on Team Effectiveness

We are Information Systems Honours students that are conducting a study on the Collocation of software development team members for our empirical research project. The following questionnaire is aimed at members of agile software development teams that are currently, or have previously been, collocated with their project team members whilst working on a software development project. A number of factors have been identified that have an impact on the effectiveness and performance of software development teams. The purpose of this study is to determine whether the act of collocating team members will have an influence on the effectiveness of the teams.

We kindly request that you participate in this study. Participation is voluntary and will remain completely anonymous. Please be assured that the information collected from you will be for research purposes only and your responses will be strictly confidential. The findings of this study can be made available to you on request.

Definition of terms that will be used in this questionnaire:
- Collocation: Grouping team members into a single, open area with breakaway facilities
- Team Room: The project room where the team members work in close proximity for the duration of a project
- Break-away Area: A private area that is available if an employee prefers to work alone
- Meeting Room: A separate room or private area that is available for meetings and group discussions
- Shared Artifacts: The use of shared, visible representations to communicate project deliverables and progress between team members (i.e. whiteboards, burn-down charts, etc)

We kindly request that you complete our questionnaire by navigating to the following link:

Thank you for your time and support.

Yours faithfully

Joanne Smith
(Honours Student)
smtjoa007@uct.ac.za

Stephan van der Watt
(Honours Student)
vwtste003@uct.ac.za

Michael Eccles
(Supervisor)
michael.eccles@uct.ac.za
Tel: 021 650 2267

“Our Mission is to be an outstanding teaching and research university, educating for life and addressing the challenges facing our society.”
APPENDIX C: QUESTIONNAIRE

GENERAL INFORMATION

1) Company Name: _______________________________________________
2) Team / Project Name (Identifying the team): ____________________________
3) Gender: _______________
4) How long have you been working in the Information Technology field? __________ years
5) How long have you been working in a collocated environment? ____________ years
6) How many hours, on average, do you work in the team room per week? ___________ hours
7) What percentage of your working time do you spend in the team room? ____________ %
8) How many people are currently on your project team (include yourself)? __________ persons
9) What is the average size of a collocated team at your company? ____________ persons

WORKING ENVIRONMENT

Please indicate with a (X) which of the following types of work are executed in the corresponding environment within your team:

<table>
<thead>
<tr>
<th></th>
<th>Team Room</th>
<th>Break-Away Room</th>
<th>Meeting Room</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem solving at the whiteboard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussion of a political issue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Status meeting using the to-do list (usually on a whiteboard or flip chart)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working solo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working in pairs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussion to acquire customer input</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simultaneous problem solving meetings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team building discussion (social)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private conversations with outsiders</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The following questions refer to your experience of the collocated environment in comparison to the other environments in which you have worked. Please mark the most relevant option:

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

1. Collocation increases the availability of information
2. Collocation increases the transparency of information
3. Feedback from team members about my work is transferred more easily in a collocated environment than in other environments
4. There is more noise in the collocated environment
5. The physical closeness in the collocated environment enables earlier identification of conflict between team members
6. My quality of work would increase if I were interrupted less
7. Team members are more able to communicate effectively with each other
8. Collocated teams are more focused on a common goal
9. My team makes more use of shared artifacts in the collocated environment
10. Mutual accountability is more prevalent within my team
11. Working in the collocated environment increases my motivation
12. My personal development is encouraged in the collocated environment
13. Performance goals are more visible within my team
14. My collocated team has a stronger sense of team identity
15. There is a greater level of trust between my team members
16. Conflict between team members occurs more frequently than in other environments
17. Decision making about deliverables is easier
18. The collocated environment is a more productive working environment in comparison to traditional environments
19. I am able to achieve a better understanding of system requirements
20. An implicit learning environment is encouraged within my team
21. I am more often interrupted in the collocated environment when working
<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>22. I enjoy working in the collocated environment more than in other working environments</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Being able to easily share ideas with co-workers improves my morale</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. I receive feedback faster than in the collocated environment</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Collocation better promotes the existence of a common goal within my team</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Collocation allows for easier conflict resolution</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Collocation has increased the emphasis on my role within the team</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. The use of shared visual artifacts motivates the team</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. The presence of shared artifacts leads to increased coordination of team activities</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. My collocated team members are more committed to each other</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. Teams are more often rewarded for their accomplishments in the collocated environment</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. I have more fun in the collocated environment</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33. The collocation of team members leads to the resources of a project being used more efficiently</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34. My fellow team members are very satisfied with the collocated work environment</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. The noise level in the team room decreases my productivity</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. I do not sense a strong team identity within my collocated team</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37. Communication is more difficult within my collocated team</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38. I feel my contribution to the team is better recognised</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39. The layout of the team room is important for team success</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40. I am satisfied with the design of our team room</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D: INTERVIEW QUESTIONS

The interviews were conducted after the results of each of the team’s questionnaires were analysed. Any items of interest from these results were discussed with the respective teams during the interviews in order to get more rich feedback and clarity on the team effectiveness factors. During the interviews, a list of the team effectiveness factors was presented to the team members, accompanied by a brief explanation of the research, after which the following questions were discussed:

1. Which of the team effectiveness factors do you feel have been impacted the most by collocation? Discuss two or three, and why?

2. Which of the following team effectiveness factors do you feel have been impacted the least by collocation? Discuss two or three, and why?

3. What are your feelings about the impact of collocation on the following factors?
   - Certain team effectiveness factors were identified for each team according to the results of the questionnaire data for that particular team.

4. Discuss the design of your team room?
   - Are you satisfied with the design of your team room?
   - Would you improve the design?
   - If you had the option to redesign the team room, what changes would you make?

5. Discuss the concepts of break-away areas and shared artifacts.
   - Do you have a break-away facility?
   - Do you think that a break-away facility would improve productivity within your team?
APPENDIX E: STATISTICAL ANALYSIS

DESCRIPTIVE STATISTICS

This section contains the aggregate responses for the 49 responses and grouped according to the Likert Scale options. A descriptive statistics section is also included consisting of the mean, median and standard deviation of the respective questions. Note that only constructs that passed the Cronbach Alpha test were averaged (see Appendix F). The constructs that failed the Cronbach Alpha test were discussed individually in the Data Analysis section.

Table 3: The Descriptive Statistics of the Questionnaire Responses

<table>
<thead>
<tr>
<th>Responses Grouped by Score</th>
<th>Descriptive Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>1</td>
</tr>
<tr>
<td>Disagree</td>
<td>2</td>
</tr>
<tr>
<td>Neutral</td>
<td>3</td>
</tr>
<tr>
<td>Agree</td>
<td>4</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>5</td>
</tr>
</tbody>
</table>

Communication

- Q 21: 0 1 2 29 17
- Q 33: 0 3 6 31 9
- Q 51: 0 3 4 32 10
- Average: 0 2.33 4 30.67 12

Feedback

- Q 17: 0 3 5 27 14
- Q 38: 0 1 2 27 19
- Average: 0 2 3.50 27 16.50

Conflict Management

- Q 19: 0 6 10 21 12
- Q 30: 1 23 11 3 3
- Q 40: 1 6 12 26 4

Trust / Mutual Accountability

- Q 24: 0 4 13 28 4
- Q 29: 0 2 10 33 4

The Impact of Collocation on Team Effectiveness | 78
<table>
<thead>
<tr>
<th>Performance Targets</th>
<th>Q 27</th>
<th>1</th>
<th>5</th>
<th>5</th>
<th>26</th>
<th>12</th>
<th>3.88</th>
<th>4</th>
<th>0.97</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Identity</td>
<td>Q 50</td>
<td>0</td>
<td>2</td>
<td>9</td>
<td>32</td>
<td>6</td>
<td>3.86</td>
<td>4</td>
<td>0.68</td>
</tr>
<tr>
<td>Q 28</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>30</td>
<td>13</td>
<td>4.14</td>
<td>4</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0</td>
<td>1</td>
<td>7.50</td>
<td>31</td>
<td>9.50</td>
<td>4.00</td>
<td>4</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Individuality</td>
<td>Q 52</td>
<td>0</td>
<td>3</td>
<td>14</td>
<td>30</td>
<td>2</td>
<td>3.63</td>
<td>4</td>
<td>0.67</td>
</tr>
<tr>
<td>Learning</td>
<td>Q 26</td>
<td>2</td>
<td>3</td>
<td>17</td>
<td>20</td>
<td>7</td>
<td>3.55</td>
<td>4</td>
<td>0.96</td>
</tr>
<tr>
<td>Q 34</td>
<td>1</td>
<td>3</td>
<td>12</td>
<td>28</td>
<td>5</td>
<td>4.67</td>
<td>4</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>1.50</td>
<td>3</td>
<td>14.50</td>
<td>24</td>
<td>6</td>
<td>3.61</td>
<td>4</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>Morale</td>
<td>Q 25</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>29</td>
<td>7</td>
<td>3.78</td>
<td>4</td>
<td>0.85</td>
</tr>
<tr>
<td>Q 37</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>31</td>
<td>11</td>
<td>4.06</td>
<td>4</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Q 42</td>
<td>0</td>
<td>1</td>
<td>13</td>
<td>27</td>
<td>8</td>
<td>3.86</td>
<td>4</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>Q 48</td>
<td>0</td>
<td>4</td>
<td>13</td>
<td>28</td>
<td>4</td>
<td>3.65</td>
<td>4</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Goal</td>
<td>Q 22</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>25</td>
<td>18</td>
<td>4.20</td>
<td>4</td>
<td>0.76</td>
</tr>
<tr>
<td>Q 39</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>34</td>
<td>12</td>
<td>4.16</td>
<td>4</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Q 43</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>29</td>
<td>11</td>
<td>4.04</td>
<td>4</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>29.33</td>
<td>13.67</td>
<td>4.14</td>
<td>4</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>Resources</td>
<td>Q 23</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>32</td>
<td>7</td>
<td>3.90</td>
<td>4</td>
<td>0.68</td>
</tr>
<tr>
<td>Q 47</td>
<td>0</td>
<td>4</td>
<td>11</td>
<td>25</td>
<td>9</td>
<td>3.80</td>
<td>4</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>Role</td>
<td>Q 41</td>
<td>1</td>
<td>2</td>
<td>14</td>
<td>24</td>
<td>8</td>
<td>3.73</td>
<td>4</td>
<td>0.86</td>
</tr>
<tr>
<td>Commitment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q 44</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>31</td>
<td>7</td>
<td>3.86</td>
<td>4</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>Fun</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q 36</td>
<td>2</td>
<td>3</td>
<td>8</td>
<td>26</td>
<td>10</td>
<td>3.80</td>
<td>4</td>
<td>0.98</td>
<td></td>
</tr>
<tr>
<td>Q 46</td>
<td>0</td>
<td>3</td>
<td>10</td>
<td>27</td>
<td>9</td>
<td>3.86</td>
<td>4</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>26.50</td>
<td>9.50</td>
<td>3.83</td>
<td>4</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q 18</td>
<td>0</td>
<td>6</td>
<td>9</td>
<td>26</td>
<td>8</td>
<td>3.73</td>
<td>4</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>Q 49</td>
<td>2</td>
<td>20</td>
<td>13</td>
<td>13</td>
<td>1</td>
<td>2.82</td>
<td>3</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>Interruptions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q 20</td>
<td>1</td>
<td>11</td>
<td>9</td>
<td>19</td>
<td>9</td>
<td>3.49</td>
<td>4</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>Q 35</td>
<td>1</td>
<td>9</td>
<td>10</td>
<td>19</td>
<td>10</td>
<td>3.57</td>
<td>4</td>
<td>1.08</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>1</td>
<td>10</td>
<td>9.50</td>
<td>19</td>
<td>9.50</td>
<td>3.53</td>
<td>4</td>
<td>1.09</td>
<td></td>
</tr>
<tr>
<td>Team Room Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q 53</td>
<td>0</td>
<td>2</td>
<td>18</td>
<td>20</td>
<td>9</td>
<td>3.73</td>
<td>4</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Q 54</td>
<td>1</td>
<td>11</td>
<td>18</td>
<td>17</td>
<td>2</td>
<td>3.16</td>
<td>3</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0.50</td>
<td>6.50</td>
<td>18</td>
<td>18.50</td>
<td>5.50</td>
<td>3.45</td>
<td>4</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Rewards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q 45</td>
<td>1</td>
<td>8</td>
<td>17</td>
<td>20</td>
<td>3</td>
<td>3.33</td>
<td>3</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q 15</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>24</td>
<td>20</td>
<td>4.31</td>
<td>4</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>Q 16</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>30</td>
<td>13</td>
<td>4.14</td>
<td>4</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>Q 31</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>25</td>
<td>14</td>
<td>4.04</td>
<td>4</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>Q 32</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>28</td>
<td>11</td>
<td>3.90</td>
<td>4</td>
<td>0.94</td>
<td></td>
</tr>
</tbody>
</table>
The following tables represent the overall means, per factor, for the individual teams. Note that only factors that have passed the Cronbach Alpha test from Appendix F have been included. The performance targets, commitment, role and individuality factors were made up of single questions and thus also included in this comparison table.

Table 4: The Overall Means of the Factors at Team Level

<table>
<thead>
<tr>
<th>Team Name</th>
<th>Feedback</th>
<th>Goal</th>
<th>Communication</th>
<th>Team Identity</th>
<th>Performance Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team A</td>
<td>4.50</td>
<td>4.33</td>
<td>4.33</td>
<td>3.83</td>
<td>4.67</td>
</tr>
<tr>
<td>Team B</td>
<td>4.50</td>
<td>4.42</td>
<td>4.50</td>
<td>4.50</td>
<td>4.75</td>
</tr>
<tr>
<td>Team C</td>
<td>4.13</td>
<td>4.17</td>
<td>4.08</td>
<td>4.25</td>
<td>3.50</td>
</tr>
<tr>
<td>Team D</td>
<td>3.63</td>
<td>3.58</td>
<td>3.58</td>
<td>3.50</td>
<td>3.50</td>
</tr>
<tr>
<td>Team E</td>
<td>4.17</td>
<td>4.00</td>
<td>4.33</td>
<td>4.33</td>
<td>4.33</td>
</tr>
<tr>
<td>Team F</td>
<td>3.90</td>
<td>4.07</td>
<td>3.80</td>
<td>3.40</td>
<td>4.00</td>
</tr>
<tr>
<td>Team G</td>
<td>4.58</td>
<td>4.44</td>
<td>4.33</td>
<td>4.25</td>
<td>4.33</td>
</tr>
<tr>
<td>Team H</td>
<td>4.25</td>
<td>4.17</td>
<td>3.83</td>
<td>3.75</td>
<td>4.00</td>
</tr>
<tr>
<td>Team I</td>
<td>4.10</td>
<td>4.07</td>
<td>3.73</td>
<td>3.90</td>
<td>2.80</td>
</tr>
<tr>
<td>Team J</td>
<td>4.90</td>
<td>4.40</td>
<td>4.27</td>
<td>4.10</td>
<td>4.40</td>
</tr>
<tr>
<td>Team K</td>
<td>3.88</td>
<td>4.08</td>
<td>4.17</td>
<td>4.00</td>
<td>3.25</td>
</tr>
<tr>
<td>Team L</td>
<td>3.50</td>
<td>3.75</td>
<td>3.83</td>
<td>4.13</td>
<td>3.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Team Name</th>
<th>Commitment</th>
<th>Fun</th>
<th>Role</th>
<th>Individuality</th>
<th>Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team A</td>
<td>4.00</td>
<td>3.67</td>
<td>3.67</td>
<td>4.00</td>
<td>3.50</td>
</tr>
<tr>
<td>Team B</td>
<td>4.50</td>
<td>4.38</td>
<td>4.00</td>
<td>4.25</td>
<td>4.38</td>
</tr>
<tr>
<td>Team C</td>
<td>4.00</td>
<td>4.38</td>
<td>4.25</td>
<td>3.75</td>
<td>3.50</td>
</tr>
<tr>
<td>Team D</td>
<td>3.25</td>
<td>2.88</td>
<td>3.25</td>
<td>3.00</td>
<td>3.25</td>
</tr>
<tr>
<td>Team E</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Team F</td>
<td>3.80</td>
<td>3.70</td>
<td>3.00</td>
<td>3.20</td>
<td>3.50</td>
</tr>
<tr>
<td>Team G</td>
<td>4.33</td>
<td>4.50</td>
<td>4.00</td>
<td>3.67</td>
<td>3.83</td>
</tr>
<tr>
<td>Team H</td>
<td>4.00</td>
<td>4.00</td>
<td>4.50</td>
<td>4.00</td>
<td>3.75</td>
</tr>
<tr>
<td>Team I</td>
<td>4.00</td>
<td>3.40</td>
<td>3.20</td>
<td>3.40</td>
<td>2.90</td>
</tr>
<tr>
<td>Team J</td>
<td>3.80</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>3.80</td>
</tr>
<tr>
<td>Team K</td>
<td>3.75</td>
<td>3.38</td>
<td>3.75</td>
<td>3.50</td>
<td>3.38</td>
</tr>
<tr>
<td>Team L</td>
<td>2.75</td>
<td>3.50</td>
<td>3.75</td>
<td>3.25</td>
<td>3.75</td>
</tr>
</tbody>
</table>
The Spearman Rank Order correlation test was conducted on the team effectiveness factors that passed the Cronbach Alpha test. At a p-level of 0.05, a majority of the factors were related to each other, confirming the findings of the literature that the factors contribute towards team effectiveness. In order to create the model discussed in the Findings and Implications section, a Spearman Rank Order correlation test was conducted at a p-level of 0.0001, in order to identify the strongest correlations between the team effectiveness factors. The following two tables contain the results of the two individual tests at a p-level of 0.05 and 0.0001 respectively.

Table 5: Spearman Rank Correlation at a p-value of 0.5

<table>
<thead>
<tr>
<th></th>
<th>Communication</th>
<th>Feedback</th>
<th>Performance Targets</th>
<th>Team Identity</th>
<th>Individuality</th>
<th>Learning</th>
<th>Goal</th>
<th>Role</th>
<th>Commitment</th>
<th>Fun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td><strong>1.0000</strong></td>
<td>0.4670</td>
<td>0.3616</td>
<td>0.7545</td>
<td>0.4754</td>
<td>0.3482</td>
<td>0.5729</td>
<td>0.2795</td>
<td>0.5068</td>
<td>0.4215</td>
</tr>
<tr>
<td>Feedback</td>
<td>0.4670</td>
<td><strong>1.0000</strong></td>
<td>0.2574</td>
<td>0.3437</td>
<td>0.3083</td>
<td>0.2292</td>
<td>0.6394</td>
<td>0.2984</td>
<td>0.4475</td>
<td>0.4809</td>
</tr>
<tr>
<td>Performance Goals</td>
<td>0.3616</td>
<td>0.2574</td>
<td><strong>1.0000</strong></td>
<td>0.1983</td>
<td>0.3026</td>
<td>0.4108</td>
<td>0.3184</td>
<td>0.3476</td>
<td>0.2616</td>
<td>0.2619</td>
</tr>
<tr>
<td>Team Identity</td>
<td>0.7545</td>
<td>0.3437</td>
<td>0.1983</td>
<td><strong>1.0000</strong></td>
<td>0.4125</td>
<td>0.3789</td>
<td>0.4241</td>
<td>0.3888</td>
<td>0.5178</td>
<td>0.3894</td>
</tr>
<tr>
<td>Individuality</td>
<td>0.4754</td>
<td>0.3083</td>
<td>0.3026</td>
<td>0.4125</td>
<td><strong>1.0000</strong></td>
<td>0.4579</td>
<td>0.3190</td>
<td>0.4813</td>
<td>0.3007</td>
<td>0.4403</td>
</tr>
<tr>
<td>Learning</td>
<td>0.3482</td>
<td>0.2292</td>
<td>0.4108</td>
<td>0.3789</td>
<td>0.4579</td>
<td><strong>1.0000</strong></td>
<td>0.3780</td>
<td>0.5885</td>
<td>0.4401</td>
<td>0.6987</td>
</tr>
<tr>
<td>Goal</td>
<td>0.5729</td>
<td>0.6394</td>
<td>0.3184</td>
<td>0.4241</td>
<td>0.3190</td>
<td>0.3780</td>
<td><strong>1.0000</strong></td>
<td>0.4727</td>
<td>0.6935</td>
<td>0.5787</td>
</tr>
<tr>
<td>Role</td>
<td>0.2795</td>
<td>0.2984</td>
<td>0.3476</td>
<td>0.3888</td>
<td>0.4813</td>
<td>0.5885</td>
<td>0.4727</td>
<td><strong>1.0000</strong></td>
<td>0.4067</td>
<td>0.5079</td>
</tr>
<tr>
<td>Commitment</td>
<td>0.5068</td>
<td>0.4475</td>
<td>0.2616</td>
<td>0.5178</td>
<td>0.3007</td>
<td>0.4401</td>
<td>0.6935</td>
<td>0.4067</td>
<td><strong>1.0000</strong></td>
<td>0.5953</td>
</tr>
<tr>
<td>Fun</td>
<td>0.4215</td>
<td>0.4809</td>
<td>0.2619</td>
<td>0.3894</td>
<td>0.4403</td>
<td>0.6987</td>
<td>0.5787</td>
<td>0.5079</td>
<td>0.5953</td>
<td><strong>1.0000</strong></td>
</tr>
</tbody>
</table>
Table 6: Spearman Rank Correlation at a p-value of 0.0001

Marked correlations are significant at p < 0.0001

<table>
<thead>
<tr>
<th></th>
<th>Communication</th>
<th>Feedback</th>
<th>Performance Goals</th>
<th>Team Identity</th>
<th>Individuality</th>
<th>Learning</th>
<th>Goal</th>
<th>Role</th>
<th>Commitment</th>
<th>Fun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td><strong>1.0000</strong></td>
<td>0.4670</td>
<td>0.3616</td>
<td>0.7545</td>
<td>0.4754</td>
<td>0.3482</td>
<td>0.5729</td>
<td>0.2795</td>
<td>0.5068</td>
<td>0.4215</td>
</tr>
<tr>
<td>Feedback</td>
<td>0.4670</td>
<td><strong>1.0000</strong></td>
<td>0.2574</td>
<td>0.3437</td>
<td>0.3083</td>
<td>0.2292</td>
<td>0.6394</td>
<td>0.2984</td>
<td>0.4475</td>
<td>0.4809</td>
</tr>
<tr>
<td>Performance Goals</td>
<td>0.3616</td>
<td>0.2574</td>
<td><strong>1.0000</strong></td>
<td>0.1983</td>
<td>0.3026</td>
<td>0.4108</td>
<td>0.3184</td>
<td>0.3476</td>
<td>0.2616</td>
<td>0.2619</td>
</tr>
<tr>
<td>Team Identity</td>
<td>0.7545</td>
<td>0.3437</td>
<td>0.1983</td>
<td><strong>1.0000</strong></td>
<td>0.4125</td>
<td>0.3789</td>
<td>0.4241</td>
<td>0.3888</td>
<td>0.5178</td>
<td>0.3894</td>
</tr>
<tr>
<td>Individuality</td>
<td>0.4754</td>
<td>0.3083</td>
<td>0.3026</td>
<td>0.4125</td>
<td><strong>1.0000</strong></td>
<td>0.4579</td>
<td>0.3190</td>
<td>0.4813</td>
<td>0.3007</td>
<td>0.4403</td>
</tr>
<tr>
<td>Learning</td>
<td>0.3482</td>
<td>0.2292</td>
<td>0.4108</td>
<td>0.3789</td>
<td>0.4579</td>
<td><strong>1.0000</strong></td>
<td>0.3780</td>
<td>0.5885</td>
<td>0.4401</td>
<td>0.6987</td>
</tr>
<tr>
<td>Goal</td>
<td>0.5729</td>
<td>0.6394</td>
<td>0.3184</td>
<td>0.4241</td>
<td>0.3190</td>
<td>0.3780</td>
<td><strong>1.0000</strong></td>
<td>0.4727</td>
<td>0.6935</td>
<td>0.5787</td>
</tr>
<tr>
<td>Role</td>
<td>0.2795</td>
<td>0.2984</td>
<td>0.3476</td>
<td>0.3888</td>
<td>0.4813</td>
<td>0.5885</td>
<td>0.4727</td>
<td><strong>1.0000</strong></td>
<td>0.4067</td>
<td>0.5079</td>
</tr>
<tr>
<td>Commitment</td>
<td>0.5068</td>
<td>0.4475</td>
<td>0.2616</td>
<td>0.5178</td>
<td>0.3007</td>
<td>0.4401</td>
<td>0.6935</td>
<td>0.4067</td>
<td><strong>1.0000</strong></td>
<td>0.5953</td>
</tr>
<tr>
<td>Fun</td>
<td>0.4215</td>
<td>0.4809</td>
<td>0.2619</td>
<td>0.3894</td>
<td>0.4403</td>
<td>0.6987</td>
<td>0.5787</td>
<td>0.5079</td>
<td>0.5953</td>
<td><strong>1.0000</strong></td>
</tr>
</tbody>
</table>
Cronbach Alpha tests were conducted on the proposed team effectiveness factor constructs. Due to this study being exploratory in nature, the limit for accepting a construct was based on a Cronbach Alpha value that is equal to or greater than 0.6. The following table summarises the results from the Cronbach Alpha tests. Note that the Performance Targets, Commitment, Role, and Individuality factors were omitted from the Cronbach Alpha tests as these constructs were each tested by a single question.

**Table 7: Results of the Cronbach Alpha Tests**

<table>
<thead>
<tr>
<th>Team Effectiveness Factors</th>
<th>Cronbach Alpha</th>
<th>Accepted?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedback</td>
<td>0.77</td>
<td>Yes</td>
</tr>
<tr>
<td>Goal</td>
<td>0.74</td>
<td>Yes</td>
</tr>
<tr>
<td>Communication</td>
<td>0.61</td>
<td>Yes</td>
</tr>
<tr>
<td>Team Identity</td>
<td>0.62</td>
<td>Yes</td>
</tr>
<tr>
<td>Fun</td>
<td>0.79</td>
<td>Yes</td>
</tr>
<tr>
<td>Learning</td>
<td>0.63</td>
<td>Yes</td>
</tr>
<tr>
<td>Conflict Management</td>
<td>0.21</td>
<td>No</td>
</tr>
<tr>
<td>Trust / Mutual Accountability</td>
<td>-0.04</td>
<td>No</td>
</tr>
<tr>
<td>Morale</td>
<td>0.59</td>
<td>No</td>
</tr>
<tr>
<td>Resources</td>
<td>0.52</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Factors</th>
<th>Cronbach Alpha</th>
<th>Accepted?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>0.53</td>
<td>No</td>
</tr>
<tr>
<td>Interruptions</td>
<td>0.71</td>
<td>Yes</td>
</tr>
<tr>
<td>Team Room Design</td>
<td>-0.78</td>
<td>No</td>
</tr>
<tr>
<td>Other</td>
<td>0.81</td>
<td>Yes</td>
</tr>
</tbody>
</table>
The following section contains the summary results from the individual Cronbach Alpha tests. The factors that require additional clarification will be discussed individually.

### 1. FEEDBACK

Summary for scale: Mean=8.36735 Std.Dv.=1.31805 Valid N:49 (20080824 - Working Data (Validated)) Cronbach alpha: .771415 Standardized alpha: .781428 Average inter-item corr.: .641265

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 17</td>
<td>4.306122</td>
<td>0.416493</td>
<td>0.645363</td>
<td>0.641265</td>
<td></td>
</tr>
<tr>
<td>Question 38</td>
<td>4.061224</td>
<td>0.628905</td>
<td>0.793035</td>
<td>0.641265</td>
<td></td>
</tr>
</tbody>
</table>

### 2. GOAL

Summary for scale: Mean=12.4082 Std.Dv.=1.63195 Valid N:49 (20080824 - Working Data (Validated)) Cronbach alpha: .742337 Standardized alpha: .752341 Average inter-item corr.: .506328

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 22</td>
<td>8.204082</td>
<td>1.142024</td>
<td>1.068655</td>
<td>0.555160</td>
<td>0.691466</td>
</tr>
<tr>
<td>Question 39</td>
<td>8.244898</td>
<td>1.368596</td>
<td>1.169870</td>
<td>0.658739</td>
<td>0.572124</td>
</tr>
<tr>
<td>Question 43</td>
<td>8.367347</td>
<td>1.416077</td>
<td>1.189990</td>
<td>0.518212</td>
<td>0.712941</td>
</tr>
</tbody>
</table>

### 3. COMMUNICATION

Summary for scale: Mean=12.2041 Std.Dv.=1.59399 Valid N:49 (20080824 - Working Data (Validated)) Cronbach alpha: .609940 Standardized alpha: .615562 Average inter-item corr.: .352482

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 21</td>
<td>7.938776</td>
<td>1.404415</td>
<td>1.185080</td>
<td>0.457903</td>
<td>0.465006</td>
</tr>
<tr>
<td>Question 33</td>
<td>8.265306</td>
<td>1.378592</td>
<td>1.174135</td>
<td>0.324142</td>
<td>0.651360</td>
</tr>
<tr>
<td>Question 51</td>
<td>8.204082</td>
<td>1.182841</td>
<td>1.087585</td>
<td>0.489447</td>
<td>0.400000</td>
</tr>
</tbody>
</table>

### 4. TEAM IDENTITY

Summary for scale: Mean=8.00000 Std.Dv.=1.09924 Valid N:49 (20080824 - Working Data (Validated)) Cronbach alpha: .620690 Standardized alpha: .622843 Average inter-item corr.: .452267

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 28</td>
<td>3.857143</td>
<td>0.448980</td>
<td>0.670059</td>
<td>0.452267</td>
<td></td>
</tr>
<tr>
<td>Question 50</td>
<td>4.142857</td>
<td>0.367347</td>
<td>0.606092</td>
<td>0.452267</td>
<td></td>
</tr>
</tbody>
</table>
## 5. FUN

Summary for scale: Mean=7.65306 Std.Dv.=1.61440 Valid N:49 (20080824 - Working Data (Validated)) Cronbach alpha: **785644** Standardized alpha: .796438 Average inter-item corr.: .661734

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl - Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>3.857143</td>
<td>0.612245</td>
<td>0.782461</td>
<td>0.661734</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>3.795918</td>
<td>0.937943</td>
<td>0.968474</td>
<td>0.661734</td>
<td></td>
</tr>
</tbody>
</table>

## 6. LEARNING

Summary for scale: Mean=7.22449 Std.Dv.=1.53114 Valid N:49 (20080824 - Working Data (Validated)) Cronbach alpha: **633297** Standardized alpha: .638070 Average inter-item corr.: .468504

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl - Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>3.673469</td>
<td>0.668888</td>
<td>0.817856</td>
<td>0.468504</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>3.551020</td>
<td>0.900458</td>
<td>0.948925</td>
<td>0.468504</td>
<td></td>
</tr>
</tbody>
</table>

## 7. CONFLICT MANAGEMENT

The Cronbach Alpha value for the Conflict Management factor was 0.21. Even if Question 30 was deleted, the result would not have been acceptable. The questions relating to this factor were discussed individually in the analysis section of this study.

Summary for scale: Mean=10.1633 Std.Dv.=1.78357 Valid N:49 (20080824 - Working Data (Validated)) Cronbach alpha: **214515** Standardized alpha: .226788 Average inter-item corr.: .092787

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl - Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>6.367347</td>
<td>1.620158</td>
<td>1.272854</td>
<td>0.248388</td>
<td>0.000000</td>
</tr>
<tr>
<td>30</td>
<td>7.326530</td>
<td>2.219908</td>
<td>1.489936</td>
<td>-0.032809</td>
<td>0.489306</td>
</tr>
<tr>
<td>40</td>
<td>6.632653</td>
<td>1.946689</td>
<td>1.395238</td>
<td>0.158215</td>
<td>0.057338</td>
</tr>
</tbody>
</table>

## 8. TRUST / MUTUAL ACCOUNTABILITY

Summary for scale: Mean=7.44898 Std.Dv.=.980247 Valid N:49 (20080824 - Working Data (Validated)) Cronbach alpha: -.04071 Standardized alpha: --- Average inter-item corr.: -.02018

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl - Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>3.795918</td>
<td>0.407330</td>
<td>0.638224</td>
<td>-0.020182</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>3.653061</td>
<td>0.553103</td>
<td>0.743709</td>
<td>-0.020182</td>
<td></td>
</tr>
</tbody>
</table>
9. MORALE

The morale factor could have been used in this study if question 42 was deleted from the construct. The Cronbach Alpha value would have improved from 0.59 to 0.64, which would have made it acceptable. It was however decided to discuss the questions relating to morale individually as question 42 was deemed to be important for purposes of this study.

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl - Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 25</td>
<td>11.57143</td>
<td>2.285714</td>
<td>1.511858</td>
<td>0.358357</td>
<td>0.536807</td>
</tr>
<tr>
<td>Question 37</td>
<td>11.28571</td>
<td>2.285714</td>
<td>1.511858</td>
<td>0.603561</td>
<td>0.353134</td>
</tr>
<tr>
<td>Question 42</td>
<td>11.48980</td>
<td>2.943774</td>
<td>1.715743</td>
<td>0.194239</td>
<td>0.642615</td>
</tr>
<tr>
<td>Question 48</td>
<td>11.69388</td>
<td>2.457310</td>
<td>1.567581</td>
<td>0.381545</td>
<td>0.511525</td>
</tr>
</tbody>
</table>

10. RESOURCES

Summary for scale: Mean=7.69388 Std.Dv.=1.26168 Valid N:49 (20080824 - Working Data (Validated)) Cronbach alpha: .522436 Standardized alpha: .530613 Average inter-item corr.: .361112

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl - Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 23</td>
<td>3.795918</td>
<td>0.693045</td>
<td>0.832493</td>
<td>0.361112</td>
<td></td>
</tr>
<tr>
<td>Question 47</td>
<td>3.897959</td>
<td>0.458975</td>
<td>0.677477</td>
<td>0.361112</td>
<td></td>
</tr>
</tbody>
</table>

11. NOISE

Summary for scale: Mean=6.55102 Std.Dv.=1.51467 Valid N:49 (20080825 - Coded Sample Data (Validated).sta) Cronbach alpha: .530764 Standardized alpha: .531767 Average inter-item corr.: .362182

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl - Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 18</td>
<td>2.816327</td>
<td>0.884632</td>
<td>0.940549</td>
<td>0.362182</td>
<td></td>
</tr>
<tr>
<td>Question 49</td>
<td>3.734694</td>
<td>0.766347</td>
<td>0.875413</td>
<td>0.362182</td>
<td></td>
</tr>
</tbody>
</table>
### 12. Interruptions

Summary for scale: Mean=7.06122 Std.Dv.=1.91929 Valid N:49 (20080825 - Coded Sample Data (Validated).sta) Cronbach alpha: .707756 Standardized alpha: .707845 Average inter-item corr.: .547801

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl - Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 20</td>
<td>3.571429</td>
<td>1.142857</td>
<td>1.069045</td>
<td>0.547801</td>
<td></td>
</tr>
<tr>
<td>Question 35</td>
<td>3.489796</td>
<td>1.188671</td>
<td>1.090262</td>
<td>0.547801</td>
<td></td>
</tr>
</tbody>
</table>

### 13. Team Room Design

Summary for scale: Mean=6.89796 Std.Dv.=1.02561 Valid N:49 (20080825 - Coded Sample Data (Validated).sta) Cronbach alpha: -.78254 Standardized alpha: --- Average inter-item corr.: -.28270

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl - Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 53</td>
<td>3.163265</td>
<td>0.789671</td>
<td>0.888634</td>
<td>-0.282697</td>
<td></td>
</tr>
<tr>
<td>Question 54</td>
<td>3.734694</td>
<td>0.643898</td>
<td>0.802433</td>
<td>-0.282697</td>
<td></td>
</tr>
</tbody>
</table>

### 14. Other

Summary for scale: Mean=16.3878 Std.Dv.=2.42226 Valid N:49 (20080825 - Coded Sample Data (Validated).sta) Cronbach alpha: .808696 Standardized alpha: .823107 Average inter-item corr.: .541699

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean if deleted</th>
<th>Var. if deleted</th>
<th>StDv. if deleted</th>
<th>Itm-Totl - Correl.</th>
<th>Alpha if deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 15</td>
<td>12.08163</td>
<td>3.707622</td>
<td>1.925519</td>
<td>0.653233</td>
<td>0.753539</td>
</tr>
<tr>
<td>Question 16</td>
<td>12.24490</td>
<td>3.817576</td>
<td>1.953862</td>
<td>0.659794</td>
<td>0.755728</td>
</tr>
<tr>
<td>Question 31</td>
<td>12.34694</td>
<td>3.369430</td>
<td>1.835601</td>
<td>0.616175</td>
<td>0.765019</td>
</tr>
<tr>
<td>Question 32</td>
<td>12.48980</td>
<td>2.862141</td>
<td>1.691786</td>
<td>0.640577</td>
<td>0.769208</td>
</tr>
</tbody>
</table>