Achieving Agile Quality

An Action Research Study

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ABSTRACT

The Agile Manifesto states certain beliefs that may be in conflict with the underlying philosophy of ISO 9001 and other formal quality systems. Some examples of conflicts are documentation and auditing. This thesis includes an analysis of the literature identifying a conflict where it is included that ISO 9001 stands on a positivist ground while agile is based on a more subjectivist and post positivist paradigm. To try to make the two work together an attempt to bridge the gap in one area, was made using an Action Research Study within an ISO 9001 certified Indian offshore company. A collaborative audit approach was piloted and refined. The result showed that such collaborative auditing methods can support compliance with ISO 9001 while still ensuring more alignment be with the agile paradigm. Significant improvements of Key Performance Indicators were also observed. The author suggests that Action Research and Collaborative Audits both could be used successfully as generic methods for quality improvement in companies using agile in an environment where formal quality systems are used.

Context. Using agile development in an organisation an ISO 9001 certified company may be a challenge both on a practical and a philosophical level.

Objectives. To analyse and understand challenges and try to bridge some of them by using collaborative internal audits to support both the agile culture and the formal ISO 9001 system

Method. Action Research

Results. During totally 7 sprints in two different projects a collaborative audit approach was piloted and generated momentum and ideas for continuous improvement. The participants stated that this reduced the need to cover up or to pay lip service to process. Metrics such as schedule variance percentage and defect density also improved during the five sprints of the second project. The regularity of shorter audits may have made the burden of a rigorous process control less heavy.

Conclusions. A collaborative audit where the whole team is involved is definitely more aligned with the agile culture. While this may not totally remove the chasm or tension between a more positivist quality system and a more subjectivist agile world view (in particular when it comes to requirements) it may mitigate and allow coexistence between the two perspectives.

Keywords: Action Research, Agile Development, Collaborative Design, Defect Density, Documentation, Extreme Programming, Internal Audit, ISO 9001, Paradigms, Positivism, Post-Positivism, Quality, Requirements, Schedule variance %, SCRUM
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Acknowledgement

I would like to thank my wonderful Indian colleagues who have managed to bear with me and supported me over the years while I have tested different theories and researched together with them on how to find better ways of doing what we do in order that everyone benefits; clients, employees and other stakeholders. In particular, I would like to thank the Scrum teams who were directly involved in the Action Research studies. I would also thank my advisor Kari Rönkkö for valuable inputs, ideas and help. Any errors or misinterpretations are entirely my own.

Chennai, July 2016

Mikael Gislén
# Terms used

The terms below are classified by areas. All general academic terms from different disciplines are classified as “Theory”. The rest are classified as Agile, Metrics or Qualoty.

<table>
<thead>
<tr>
<th>Term</th>
<th>Area</th>
<th>Explanation</th>
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<tbody>
<tr>
<td>A/B tests</td>
<td>Agile</td>
<td>Typically, in a web system a new feature may be tested in different varieties towards different users to measure how it is received before being rolled out to all. By being able to test alternative versions or test a new change and compare it is possible to test the user’s usage ahead of final launch (Optipedia, n.d.).</td>
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<tr>
<td>Action Research</td>
<td>Theory</td>
<td>A pragmatic research methodology in which the researcher together with the team to be researched jointly assess the current state, propose some change initiative, act and measure/analyse in an iterative manner both creating positive change for the team and knowledge and experience. Action Research can be used within the framework of various theoretical framework and is very pragmatic in nature (Avison, et al., 1999).</td>
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<tr>
<td>Agile Software Development</td>
<td>Agile</td>
<td>Agile Software Development methods are different development methodologies which share certain common beliefs (Beck, K. et al., 2001) and stand in contrast to traditional life cycle (waterfall) and heavy iterative development methodologies. They are in particular useful for projects where requirements are unknown, ambiguous and/or likely to change and reduces the risk of spending much time on development before testing against the market.</td>
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<tr>
<td>CMM, CMMI</td>
<td>Quality</td>
<td>The Capability Maturity Model and the Capability Maturity Model Integration. American defence software development methodology created by SEI Carnegie Melon University (Wikipedia, u.d.).</td>
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<tr>
<td>Complex Adaptive System (CAS)</td>
<td>Theory</td>
<td>Complex Adaptive Systems (CAS) or Complexity science is an interdisciplinary field based on various theoretical frameworks and covering entirely different fields including biology (e.g. Insects such as bees and our immunity system), economics (The stock market), sociology (E.g. social group behaviours), and information technology. Complex Adaptive Systems are systems made up by parts, acting as dynamic networks of interactions, where continuous adaptive processes wherein the individual and collective behaviour change based on response to changes in the environment through self-organisation, making the wholeness act as one unity (Wikipedia, n.d.).</td>
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<tr>
<td>Context Switching</td>
<td>Agile</td>
<td>When a person changes between different tasks (task switching or multi-tasking). In many types of agile development (particularly Kanban) there is a strong belief that context switching is very costly and that the agile process should try to reduce context switching to help developers to get more effective (Radigan, n.d.).</td>
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<tr>
<td>Continuous Integration/build</td>
<td>Agile</td>
<td>A server which constantly uses any code checked in by a team to the version control system and tries to build a software. If the build is successful it normally runs all unit tests as well. Broken builds or failed unit tests may either result in an email to the concerned developer or the developers have to check a web page to see the status (ThoughtWorks, n.d.).</td>
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<td>Coordination theory</td>
<td>Theory</td>
<td>An analysis of how groups coordinate their activities. It defines coordination as “managing dependencies between activities”, group actions as “actors performing interdependent tasks” and dependencies and management of them are general (Malone, 1990), (Malone &amp; Crowston, 1994),</td>
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<tr>
<td>Corrective Action</td>
<td>Quality</td>
<td>The action identified to fix the specific defect or deviation and when applicable remove the reason why it happened. There are cases when the specific incident cannot be corrected or where it is not economically viable to redo something, but where the corrective action may only relate to ensuring that it does not happen again (Westcott, 2005).</td>
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<td>Defect Density</td>
<td>Metrics</td>
<td>Defect Density=Number of defects injected per average development hour (Humphrey, 2009)</td>
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<td>Double-Loop Learning</td>
<td>Theory</td>
<td>Single loop learning is when someone learns how to correct something based on a defined policy or procedure, while double loop learning is when someone learns to change the policy or procedures in order to fix the underlying problem. Not just learn to correct, but learn to change. When employees just do what they are told that is single learning, when they based on their experience question what they are told in order to reach the real objective that is double loop learning (Argyris, 1977).</td>
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<tr>
<td>Dynamic Capabilities Theory</td>
<td>Theory</td>
<td>“The firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments. Dynamic capabilities thus reflect an organization’s ability to achieve new and innovative forms of competitive advantage given path dependencies and market positions.” (Teece, et al., 1997)</td>
</tr>
<tr>
<td>Empiricism</td>
<td>Theory</td>
<td>Empiricism derives all knowledge from the senses. Inspired by John Locke, George Berkeley, and David Hume. But has roots back in Indian and Greek philosophy (Wikipedia, u.d.).</td>
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<tr>
<td>External Audit</td>
<td>Quality</td>
<td>An external auditor employed by an auditing firm who would conduct regular audits of any ISO 9001 certified company. The auditor will report and recommend certification/recertification to the accreditation body (such as British Standards), the accreditation body will then issue the certificate (International Organization for Standardization, 2008).</td>
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<tr>
<td>Extreme Programming (XP)</td>
<td>Agile</td>
<td>Management wise a simplified variety of SCRUM but with a number of specific engineering practise; Test driven development, continuous builds, refactoring and pair programming stands out (Wells, 1999-2009).</td>
</tr>
<tr>
<td>ICT</td>
<td>Theory</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>Internal Audit</td>
<td>Quality</td>
<td>Any ISO certified company would assign and train a number of people who can conduct internal audits. Internal audits would happen with certain frequency and cover all areas of the company which are within the scope of the company’s quality management system (International Organization for Standardization, 2008).</td>
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<tr>
<td>ISO 9000:1987 First published version</td>
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<tr>
<td>ISO 9000:1994 Started to focus on preventive action rather than just verifying the final product</td>
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<tr>
<td>ISO 9001:2000 Focus on document management and procedures</td>
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<td>ISO 9001:2008</td>
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<tr>
<td>ISO 9001:2015 published 23/9/2015 stronger focus on strategy, risk management, top management involvement and</td>
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alignment with the specific companies need, also introduced alignment with a lot of other standards. Relaxed (less prescriptive) document management standard.

At the moment only the former ISO 9001:2008 and the latter ISO 9001:2015 are valid. ISO 9001:2008 is being phased out and will only be valid during 3 years after the publication of the ISO 9001:2015 standard, e.g. 23/9/2018. (Wikipedia, n.d.), (American Society for Quality, n.d.)

In this paper ISO 9001 will be used to mean the standard as such or the current two valid standards. If the full name is used (ISO 9001:2008, 2015) it should mean only that version.

<table>
<thead>
<tr>
<th>Kanban</th>
<th>Agile</th>
<th>A simplified type of Scrum often used for small teams and for continuous delivery and support. Typically, a developer using a Kanban board should have max 5 tasks in the “doing” column. Kanban focus a lot on reducing context switching (Benett, 2009).</th>
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</thead>
<tbody>
<tr>
<td>Key Performance Indicator (KPI)</td>
<td>Metrics</td>
<td>A measurable value that can be used to determine a company’s progress in reaching its operational, tactical or strategic objectives. It can also be used to compare against other companies or between departments (Daniel, 1961).</td>
</tr>
<tr>
<td>Lean Theory</td>
<td>Lean Manufacturing, Lean Production, Lean Software development, Lean Startup etc. are basically all based on a management philosophy focused on removing or reducing waste. It is basically based on Toyota’s production system (TPS) but has since been deployed across different areas. The focus is to remove anything which does not add value (Poppendieck, 2003). It can be argued that Agile is lean in itself but Lean Software Development is also one type of agile development. Lean has brought in thinking such as Minimum Viable Product and Minimum Viable Feature. Where focus is to identify what is the bare minimum which is valid to reach the market and to consider anything else as waste.</td>
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<tr>
<td>Management Responsible Quality</td>
<td>Each company who is certified according to ISO 9001 would identify one person who would be responsible for the Quality System (International Organization for Standardization, 2008).</td>
<td></td>
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<tr>
<td>Management Review Quality</td>
<td>The management is according to the ISO 9001 standard responsible for regular reviews of the system, non-conformities and actions and for continuous improvements (International Organization for Standardization, 2008).</td>
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<tr>
<td>Non Conformity Quality</td>
<td>When an ISO internal or external auditor finds a deviation to the standard or to the company processes this is documented as a Non Conformity (NC). The person, group or company need to identify a root cause, a corrective action and/or a preventive action. An auditor cannot identify a non-conformity unless there is proper evidence and there is a clear deviation related to a ISO standard clause. A non-conformity can be of type Major (no system exist), Minor (System exist but is partially not working), Observation (deviation from process). In addition the auditor can document areas for improvement (which is an advise and which is not required to act on) or document any noteworthy efforts identified during the audit (Boudreaux, 2009).</td>
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<tr>
<td>Pair programming Agile</td>
<td>Two programmers sitting together with one computer and taking turns and coding. The programmer who don’t code at the moment checks what the other is doing and they both discuss problems and solutions. Often results in better focus, higher quality and with less</td>
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bugs injected the cost may not be significantly higher than when each developer develops alone (Wells, n.d.).

| Paradigm      | Theory                                                                 | The world view of a scientific discipline or as Thomas Kuhn defines it “universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners.” (Kuhn, 1970). Different paradigms are in conflict with each other since they are based on different assumptions (Bryman & Bell, 2007).
|               | Kuhn did not consider using this definition in Social sciences but others have since used his terminology. According to Guba (1990) a paradigm is made up by:  
|               | • What is knowledge (ontology)  
|               | • What kind of questions are to be asked in regards to arrive at this knowledge (epistemology)?  
|               | • What methods can be used (methodology) |

| Post-modernism | Theory                                                                 | As per Encyclopaedia Britannica “Postmodernism as a philosophical movement is largely a reaction against the philosophical assumptions and values of the modern period of Western (specifically European) history—i.e., the period from about the time of the scientific revolution of the 16th and 17th centuries to the mid-20th century.” (Encyclopaedia Britannica, n.d.) it is characterised by a denial that there is anything such as an objective reality, including historical events or social institutions, it denies that truth or false exist, it denies that there are any objective moral or ethical values, it denies the modernist faith in science and technology as creating a better future, it does not except reason and logic as anything else than constructs, it questions language as having any connection to an objective meaning (Encyclopaedia Britannica, n.d.). It may be wrong to describe agile as a post-modern philosophy, but in its scepticism towards requirements it touches similar thoughts. However agile can perhaps be described as a kind of postmodern reaction against positivist view of software development such as waterfall. |

| Post-positivism | Theory                                                                 | Or post-empiricism. A sociology paradigm in which it is believed that an objective reality exists, but that we as human beings are incapable of fully objectively understand it. Hence it shares its ontology with positivism but differ epistemologically. (Kuhn, 1970), (Popper, 2002), (Polanyi, Personal Knowledge, towards a post-critical philosophy 1958, corrected edition 1962) |

| Pragmatism     | Theory                                                                 | A philosophical tradition where focus is on the practical use and effect of the observation is at the centre. Pragmatism is not focused on observation and description of reality but instead is focused on prediction, problem solving and action (Wikipedia, u.d.). |

| Preventive Action | Quality                                                                 | Based on the root cause other potential deviations may have been identified and in case that is the case preventive actions for other deviations to occur can be defined (Westcott, 2005). |

<p>| Reductionism   | Theory                                                                 | The belief that when something complex is broken down into its smallest components or parts, it is sufficient to understand the behaviour or features of the smaller part to understand the wholeness of the complex phenomena. I.e. the wholeness is only the sum of the parts (This is sometimes called ontological reductionism). This is and have been a useful paradigm in particular for basic natural sciences such as traditional physics and chemistry and is one of the reasons for technological development. However it may not be so useful for certain types of complex phenomena where it can be argued that the sum is greater than the parts (Wikipedia, n.d.). |</p>
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<tr>
<th>Root Cause</th>
<th>Quality</th>
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<td>Strictly speaking the ISO 9001 standard does not require root cause analysis to be done. However, from ISO 9001:2008 it is required that corrective actions are effective. Unless the root cause is identified and understood it may be hard to ensure that a certain corrective action is effective. A root cause is the underlying reason for the non-conformity. It may be helpful to use techniques such as 5Y or fishbone analysis to identify the real underlying root cause since it is easy to only scratch the surface (Stiller, 2009).</td>
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<th>Schedule Variance %</th>
<th>Metrics</th>
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<td>Schedule variance is often used to measure how much over- or under-run there was for a project. However to get a more comparable way of comparing a team’s ability to plan and deliver, schedule variance percentage can be used (AcqNotes, 2015). It may be worth mentioning that the agile community generally shy away from measuring projects in this way. However, in consulting companies’ clients often demand a team to estimate the work ahead and in that case it is easy to measure schedule variance.</td>
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\[
\text{Schedule Variance \%} = \frac{\text{Earned Value} - \text{Planned Value}}{\text{Planned Value}} \times 100
\]

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<tr>
<th>SCRUM</th>
<th>Agile</th>
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<tr>
<td>One of the earliest and most used agile methodologies with roots way before the agile movement developed (Takeuchi &amp; Nonaka, 1986). SCRUM is really a management methodology but is often used in combination with various Extreme Programming practices such as continuous integration, test driven development, etc. SCRUM is a flexible process, and a Scrum team will constantly improve their process using a retrospective meeting at the end of each iteration. Scrum defines various roles; a Product owner who adds user stories to a product backlog. A Scrum Master whose main responsibility is to remove impediments, and often leads a daily SCRUM (15 minutes stand-up meeting). The SCRUM team would at the start of each sprint (normally 2-3 weeks) have a Sprint planning meeting in which they together with the Product owner agrees on what should be done in the sprint. They plan exactly who should do what and when and estimate how many story points each task will take, this is called a Sprint backlog. The team may groom the sprint backlog but the sprint is always time boxed. Also a scrum team have a clear definition of done. Every day the team meets for a daily scrum. Each member answer three questions: What have you done since last meeting, what will you do today and are there any impediments. The scrum master is responsible for removing any identified impediments. The team keeps updating a burn down chart and uses a Scrum board where tasks are moved from to do, doing and done. Each sprint ends with a complete tested deliverable. After each sprint a review meeting and a retrospective meeting are conducted, the former to review the product and the latter to review the process, learnings and improvements (Schwaber &amp; Sutherland, 2013).</td>
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<tr>
<th>Self-Organisation</th>
<th>Agile</th>
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<td>From Complexity theory. Various systems emerge from parts to a wholeness. When a system is made up parts which has adapted to the surrounding environment in relationship to each other forming an by equilibrium then this is a self-organised system (Ashby, 2004). In agile this is meant in regards to the members of the team where there is no leadership but the members of the team jointly in collaboration ensures that the objectives are reached following a disciplined process, the point here is not that there is no manager but that the team decides and adjusts themselves in order to reach the goal (Appelo, 2011).</td>
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<tr>
<td></td>
<td>Theory</td>
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<tr>
<td>Social Constructionism</td>
<td>The theory that we jointly construct our understanding of the world.</td>
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<tr>
<td>Sprint retrospective</td>
<td>The review meeting conducted at the end of each sprint to review the</td>
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<td>Story points</td>
<td>A relative measure in which the scrum team tries to subjectively</td>
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<tr>
<td>Test driven development</td>
<td>Wherein users develop unit tests (code which is written to test a</td>
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<tr>
<td>Theory</td>
<td>A scientific theory is “a coherent group of propositions formulated</td>
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<tr>
<td>Time Boxing</td>
<td>Time boxing means defining strict time boundaries for an activity.</td>
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<tr>
<td>Total Quality Management (TQM)</td>
<td>TQM was one of the predecessors to ISO 9001. It was inspired by</td>
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<tr>
<td>User Stories</td>
<td>Initially a very short simple description of a feature, in its shortest</td>
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<tr>
<td>Velocity</td>
<td>Number of story points per / iterations. In Scrum assuming fixed</td>
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1 INTRODUCTION
This section will paint a background for the paper and focus on the problems which will be covered in this paper. It will also present the research question and describe some limitations and finally give an outline for the entire thesis.

1.1 Introduction
A few years back when the author’s company\(^1\) implemented agile methodologies, he realised that there were significant conflicts between the underlying world-view of the agile methodologies and the company’s existing ISO 9001 quality system. The present thesis was written as part of a process to better understand these conflicts. The intention was to identify underlying root causes explaining clashes of views, identify and test and possible suggest ways for how agile development could work better within an ISO 9001 certified company.

Employees in the present thesis’s studied company had earlier commented that the auditing process tended to have an overly negative focus on fault finding, which was a demotivating experience for the audited teams. It was also perceived that ISO auditors had a lot of power and that it was hard to question the assessment of what was right or wrong; it was a top-down model that stood in strong contrast to the collaborative paradigm of agile methodologies and which did not sufficiently take the developers perspective into consideration. It is likely that the challenge is accentuated by the Indian culture and the challenge should be seen in this context. Other studies on financial auditing shows differences in how auditing works across cultures. In particular, there are challenges with audits in cultures which have higher power distance and are more collectivistic (Alzeban, 2015), (Hsueh-ju, et al., 2007).

If Agile methodologies and ISO 9001 are indeed, as will be shown in this thesis, based on different world-views; then it is essential for a company who wants to successfully use agile development within an ISO 9001 framework to seriously consider these challenges. Thereafter the company needs to decide which world-view should have preference in different situations and what can be done to mitigate differences. Agile methodologies where initially to a large extent focused on the development teams and the focus to scale them up and create agile companies has only been around in the last 5-10 years (Rudd, 2016), (Appelo, 2011).

There is a conflict between traditional top-down management and agile (Rigby, et al., 2016). When using agile in a company it is therefore essential that top-management understands the agile paradigm. It would therefore be to let agile developers down, not helping them by making an effort to understand the underlying philosophies and to better support agile development and then harvest the benefit.

1.2 Research Objective
The research objective was to elaborate on the challenges and philosophical clashes between ISO 9001 and the agile software development paradigm. In particular, the focus was on analysing the context of how internal audits were conducted and how they could possibly be improved to better support agile methodology.

\(^1\) The company is an Indian Software Development company working mainly with Scandinavian and British clients (Gislen Software Private Limited, n.d.).
While there are challenges conducting audits in the Indian cultural context, the studied company on the whole has a strong collaborative culture in which the agile methodology was well aligned there were challenges in the quality of the internal audit. It was also an objective to relieve the workers from the authoritarian burden of an unnecessary heavy Quality Management System\(^2\) and thereby reaching higher efficiency level, better alignment and increase the quality of the deliveries to the clients.

1.3 Research Questions
In light of the research objective the following research questions were defined:

1. Does available literature support the kind of clash between formal quality systems and agile development which was experienced at the studied company?
2. Is it possible to reduce the perceived tension between ISO 9001 system and the agile methodology by creating a collaborative audit which could become less intrusive and ensure that the trust level is improved compared to the traditional audit?

1.4 Limitations
This action research study is conducted in one Indian company with a Swedish founder who is also the main researcher. That the researcher is the Managing Director is a challenge which will be discussed specifically.

The company is not necessary typical since the Swedish cultural aspects inherited from the Swedish founder, as well as the combination with the local culture of the Indian staff may have affected the corporate culture from the setup and hence the specific challenges, experiences and findings may have to be understood with that in mind.

Action research as a method has a potential to include subjective bias. Therefore, two metrics – schedule variance percentage and defect density were chosen and used during the latter iterations. This was done to somehow more objectively measure the impact of the initiated actions and also to create increased rigour in the positivist sense.

ISO 9001 includes a number of components which are not discussed in this thesis and which are beyond the scope of this thesis. This includes management review, control of documents and outsourcing to subcontractors.

Having said that, ISO 9001 and the Agile processes used at the company are much used across the world and the available literature give, as we will see, some support for that the challenges found from other companies in other cultural contexts across the world are of similar nature and hopefully the experiences could have some applicability beyond the specific context. However, it should be stated at the outset that it is the intent of the author of this present paper to find ways of overcoming these challenges.

1.5 Outline of the paper
This thesis will start with a background using prominent literature in the subjects to describe the Quality as well as the Agile Movement leading over to a description of a philosophical paradigm clash between the two. This introduction may be extensive and may come across as overly philosophical but during discussing on the research with practitioners as well as researchers the philosophical clash perceived has not generally been well understood and this somewhat lengthy background may therefore be required.

\(^2\) ISO 9001 standard does not state any need for a heavy system. But the literature as we will see supports that this often nevertheless is the case (Seddon, 2000).
The second half of the paper presents an action research study conducted within an Indian IT company working mainly with clients in Scandinavia (Gislen Software Private Limited, n.d.), wherein the presented tensions have been reduced by replacing the traditional audit with a collaborative approach.
2 LITERATURE STUDY

This chapter will describe the quality movements as well as agile software development leading over to an analysis based on the literature which shows a philosophical clash between the two.

2.1 Selection of literature

Most literature references used are based on systematic search on the Internet using ACM or Google scholar on central key words such as QMS, ISO9000, and Agile Quality. In general, literature of strong normative nature or which lacks a critical stand has been avoided. The purpose of this chapter is to give a background to and introduce the reader to the concepts and challenges which will be researched in the latter part of this thesis.

2.2 Formal Quality Systems

2.2.1 Total Quality Management (TQM)

It is difficult to define what “Quality” really means. Sower (2011) suggests that Quality is multidimensional and subjective in nature (Sower, 2011). He quotes a few different definitions:

- Juran – “Fitness for use”
- Deming – “Quality is subjective and must have commercial use”,
- Parasuraram – “Meeting and exceeding customer expectations”

Quality systems used within Software Development are mostly based on ISO 9001 or CMMi. These quality models have got significant influence from the Total Quality Management (movement TQM) which in turn emerged from W. Edwards Deming’s work in Japan during the 50's to the 80's, and which came to the West in the late 80's. While TQM is not identical to ISO 9001 or CMMi. These have inherited much from TQM and much of the critique of TQM is valid for ISO 9001 and CMMi as well.

While proponents often describe TQM as a model supporting worker development, involvement, and empowerment (Boje & Dennehy, 1994), critiques claim it is just a whitewashed neo-modernist device where only one view is allowed. While proponents and critiques alike rarely conduct empirical studies they (surprisingly) often share a view that the systems are effective (Boje & Winsor, 1993). Proponents of Quality Systems are often too optimistic and critiques too pessimistic about the power balance between stakeholders. However, the effectiveness of Quality-systems are not at all given, and the ability for employees to question or even resist management initiatives remains (Knights & McCabe, 2002) this may in particular be true for knowledge workers who often have far more bargaining power than traditional industry workers (Davenport, 2010).

While most of the proponents of Quality Management Systems seem to define quality as meaning adherence to requirements with minimum variation and high customer satisfaction, critiques question this as single-minded since it only satisfies the owners/management's and the customer's perspective. Apart from criticising the resulting power perspective, there are requests for a more holistic view, which needs to include perspectives of the workforce, environment, gender, minorities, etc. (Knights, 1997). Critiques of quality systems have also stated that quality should include use quality, aesthetic quality, symbolic quality and ethics (Martinez-Lorente och Martinez-Costa 2004).

TQM has been questioned for neither being as rational nor as effective as it claims, due to resistance, inconsistency and organisational politics (Knights & McCabe, 2002).
In earlier research (Gislen, 2012) the author found support in the literature for various distortions including paying lip-service to the process and outright cheating while filling in checklists (Boiral, 2003). Processes were also not used as much as stated (Fitzgerald, 1998), there were gaps between what was said and what was practiced when it came to adherence to the quality system (Beirne, et al., 1997), which affected the real adherence to process. The reasons for these deviations to practices were sometimes found to be mere survival tactic since the methodologies were badly fitted for the needs (Fitzgerald, 1997).

Outside quality related research Fosch (2000) shows that stricter standards are often applied when evaluating lower status persons than higher status persons (status could be determined based on gender, ethnicity, beauty or socio-economic class. The quality auditor has significant power and may not always be as objective as he or she should (Paris, 2016). There are therefore good reasons to believe that such bias could impact the impartiality of the internal as well as external audits (Brecken, 2009).

2.2.2 ISO 9001 background

ISO 9001 has its roots in the United States Department of Defence which was further developed by British Standard. It had its roots from the defence forces, who needed to enforce certain standards for defence production during World War II (The British Assessment Bureau, 2012). The standard was later given over to the international ISO-organisation. ISO 9001 has however also taken inspiration from and shares a lot of practices with TQM, even though it is on the whole less proactive and less flexible than TQM and tend to demand more documentation and bureaucracy. However unlike TQM, which has no defined certification system, there is in ISO 9001 an outside control of actual compliance. Compliance may however not necessary result in increased operational result compared to TQM (Martínez-Lorente och Martínez-Costa 2004).

ISO 9001 is a quality system which tries to ensure that streamlined processes are defined and followed across the production process. This is done based on a quality manual which is based on the ISO 9001 standard. All parts of the standard must be covered (International Organization for Standardization , 2008).

The current version if ISO 9001 is ISO 9001:2015 (just released in September 2015) however many companies including the studied company have not yet migrated from the former version ISO 9001:2008. Hence this thesis assumes the former version of the standard unless otherwise specifically mentioned.

The International Organization for Standardization (2008) states that for a company to adhere to the 9001:2008 standard it must have a Quality Policy (4.2.1 a, 5.3), a Quality Manual (4.2.1 b, 4.2.2) and have documented processes for the areas prescribed by the standard (4.2.1 c), and defined policies for any other areas required for its operation

- Control of Documents (4.2.3)
- Control of Records (4.2.4)
- Internal Audits (8.2.2)
- Control of Nonconforming Product / Service (8.3)
- Corrective Action (8.5.2)
- Preventive Action (8.5.3)

In addition to this the company must plan its quality management work (5.4) and define responsibilities (5.5) in particular it must define one Manager responsible for the quality system (5.5.2) there are requirements for management of requirements (7.2.1), review of the same (7.2.2), customer communication (7.2.3), design (7.3.1-3) and review, verification, validation and changes (7.3.4-7). The purchasing process including
verification (7.4), Control, validation of production or service (7.5), planning and implementation of measurement, analysis and improvements (8)

The International Organization for Standardization (2015) has in the latest version of the standard - ISO 9001:2015 increased the flexibility in regards to documentation, while adding a risk based thinking approach.

Certification of companies is done by specially authorised organisations based on a separate standard - ISO/IEC 17021-1:2015 (International Organization for Standardization, 2015) which the external auditor must follow. Certified companies need to be re-certified at regular interval.

Since ISO 9001 was not well aligned with the specific needs of Software Development, a variety called TickIT was developed specifically for Software Development. External Auditors for TickIT certified companies will also always have an IT industry background they may have a deeper understanding of the specific needs of a software company. TickIT has recently been developed into TickIT+ which adds maturity levels in a similar way as CMMi (IT Governance Ltd, 2012). However, ISO 9001 on the whole have developed and today the basic standard supports services much better.

Most of the writing regarding ISO 9001 I have found focus mainly on implementation of the system. Some sources discuss success or lack of success, and some compares certified and non-certified companies. Critical views are rare. Perhaps it may be difficulty for researchers to get hold of dissidents, since ISO 9001 is often required as a marketing tool, related to the identity of a company or because many of the concerned professionals make their livelihood from the system in question (Boiral, 2003). There is however some evidence that the quality movement is listening and takes input from post-modern critique and is implementing changes (McAdam & Henderson, 2004).

2.2.3 Underlying Paradigm

Formal quality systems are on the whole based on a positivist paradigm assuming reductionism, rationality and positivism (Knights & McCabe, 2002), (Skarp, 2013). Some authors suggest there is an emerging post-modern systems theory coming from a synthesis of modern and post-modern views (McAdam & Henderson, 2004), (Montuori & Purser, 1996). Indeed, there is some evidence of slight changes in perspective. For example ISO 9001:2008 has introduced a statement that waste should be reduced, which could be used to argue for some of the agile practices (International Organization for Standardization, 2008). ISO 9001:2015 goes one step further and tries to reduce the dependency of documentation and also adds clauses stressing the need for better understanding of the organisational external context, stakeholders and risks (Bureau Veritas Group, 2015). However, while the move towards a more holistic perspective is welcome, the overwhelming part of the standard still stresses processes that reduce the potency of the new additions.

The ISO 9001 system is based on a quantitative engineering perspective and focused on manufacturing and there has been challenges to adopt it for services (McManus & Wood-Harper, 2007). Since unlike in many engineering and manufacturing disciplines requirements for software projects are often fluid or non-existent at the beginning of a project and that the picture of what should be developed is often emerging during the development of a software product, a quantitative and reductionist methodology may fail to deliver the value expected by the clients, hence some quantities measures suitable for a project where all requirements are known in advance may in effect work contrary to the customer’s expectations (Hellens, 1997).
Certainly pragmatic managers and auditors have a certain amount of freedom when designing, implementing and auditing the system. But unless the paradigm differences presented in this paper are not well understood the risk for clashes may occur.

2.2.4 Research on audit quality in different cultural contexts.

Different authors have used different constructs to measure differences between cultures (Hall 1976), (Hall & Hall, 1990), (Hofstede, Culture's consequences 1980), (Hampden-Turner & Trompenaars, 2000) and (World Values Survey Association). Hofstede being one of these most quoted of these defined initially four constructs; Power Distance (PDI), Individualism/Collectivism (IDV), Masculinity/Femininity (MAS) and Uncertainty avoidance (UAI). There are evidence for challenges in regards to financial auditing in cultures where Power distance or Uncertainty Avoidance is higher and in more collectivist cultures (Alzeban, 2015), (Hsueh-ju, et al., 2007). In another study Indians scored higher than Canadians on paternalism, power distance, uncertainty avoidance, loyalty toward community, reactivity, and futuristic orientation. ISO 9001 has its root in a specific cultural context. The United Kingdom scores low on Power distance, High on individualism and low on Uncertainty Avoidance. India scores much higher on Power distance, much lower on Individualism and a bit higher on Uncertainty Avoidance

2.3 Agile Development

When Software Projects got larger in the 1960's and the complexity increased, various software development methodologies were developed to support professional software development. However most of the focus was on how to develop rather than on what or why it should be developed (Unhelkar, 2013). These development methodologies unquestionably delivered value, in particular for projects where it was possible to define requirements in advance. When that was not the case or when significant changes occurred during development, the same methodologies often led to overruns, defects and failed projects (Unhelkar, 2013).

Over the next decades numerous methodologies were developed, first focusing mainly on planning and later more on iterations (Avison & Fitzerald, 2006). These early software development methodologies such as the Waterfall Model (Royce, 1970) as mentioned above assumed a positivist ontological viewpoint (Vickers, 1999), (Avison & Fitzgerald, 2006) including beliefs that it is possible to define objective requirements ahead of development and that the software product would exist in a stable environment (such as medical devices or air craft control systems).3

Agile methodologies first appeared on the scene in the mid 1990's. Agile is the common name for a number of methodologies and while agile methodologies differ in many ways, they may be generalised, based on the Agile Manifesto (Beck, K. et al., 2001), as a disciplined set of practices based on the paradigm that individuals, interactions, working software, customer collaboration and responding to change, are higher weighted than processes, tools, comprehensive documentation, contract negotiation and following a plan.

3 That’s not to say that agile methodology cannot be used for these areas.
Different agile methodologies existed before and the move towards agile can be tracked in different writers works (Cockburn, 2000), (Fowler, 2000). Before the agile manifesto was framed, there was a debate among proponents calling the methodologies; Lightweight, Light methodologies, and included in particular Extreme Programming, Adaptive Software Development, Crystal, and SCRUM which all had been around for a few years. The name “agile” itself was suggested by Martin Fowler (Beck, K. et al., 2001).

While Agile Development Methodologies are pragmatic when it comes to theory they are at least partially based on post-positivist paradigms where it is often understood that the software need to be tested against the users or real world as early as possible and that the inventor / developer has no way of knowing what will work or not. Paradigms which have influenced the Agile Software methodologies are among other Social Constructivism (Gibbs, 2015), Complex Adaptive Systems (Appelo, 2011) but there has also been inspiration from Lean Manufacturing (Wanga, et al., 2012). It would therefore make sense to call Agile Software Development a post-modern approach to software development. It is however important to remember that Agile Software Development (as is the case with Post-modern architecture) implement rigid engineering practices such as detailed planning (for short iterations), continuous build, Test driven development, A/B-tests, metrics such as story points and velocity, etc. There is evidence that the practises of agile methodologies are consistent with or borrow from organisational theories such as

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4 Free for copying in its entirety
Dynamic Capabilities Theory, Coordination theory and Double-Loop Learning Theory (Cao & Ramesh, 2007). While some methodologies such as Scrum have early theory base (Takeuchi & Nonaka, 1986), many others are founded based on empirical and pragmatic experiences and theory to explain or motivate the methodologies, in those cases it exist has been developed along the way.

Accordingly, while there is commonality between them, agile methodologies are not based on any single homogeneous philosophy. In this paper “agile” will mainly relate to a very common approach where Scrum (which is one of the most used methodologies) is used together with some Extreme Programming (XP) practices. This combination is based on common thoughts from the agile movement as a whole. It includes a rigid management framework (Scrum) that demands estimation, planning, monitoring and certain key artefacts but it is a lightweight methodology and it assumes that requirements are subjective, ambiguous and will change as a result of changes in the environment the software will be used in (Waltmunson, 2011), (Appelo, 2011). Scrum is based on three pillars;

- Transparency (Definition of “Done”),
- Inspection and Adoption (fast corrective actions whenever deviations are found)

Extreme Programming (Wells, 1999-2009), while being similar to Scrum in structure is less rigid in its management practices and can more be seen as a set of engineering practices (which are rigid enough). The two methodologies, being complimentary rather than conflicting, can work seamlessly together (Cohn, 2014).

Companies often use the word “agile” to mean mere ad hoc development with very limited process control without really understanding the true meaning of agile development in that form it is described by the founders of the agile movement (O’Connell, 2014). It may therefore be worth to investigate whether agile developers following their processes or just pay lip service to the agile paradigm? Based on internet search in the authors earlier work it seemed that very little empirical research has been carried out on process adherence for agile development (Gislen, 2012) and whatever research had been done on agile development quality was more focused on adherence to schedule rather than adherence to process (Cohn, 2006). Zazworka et al (2010) suggest an interesting approach to measure agile process adherence. They propose (and tested) a non-intrusive framework using data directly from the version control system for measuring process adherence. But no evidence was found that any such framework was commonly found.

2.4 Different Paradigms

TQM, ISO 9001 and CMMi are all as we have seen to a large extent based on a positivist, top-down reductionist paradigm, where a documented plan-based approach assumes that requirements are seen to be non-ambiguous, collected and which should be (and can be) defined ahead of development (Knights & McCabe, 2002) (Skarp, 2013).

5 The ISO standard states that companies should assess the requirements for risks ahead of development (International Organization for Standardization, 2008).
As a result, they often stress the opposite prioritisation than the agile manifesto (e.g. Processes & tools, comprehensive documentation, contract negotiation and following a plan). Agile proponents also tend to have a more pessimistic view than quality system proponents on the ability to develop software which meet original requirements. They believe that requirements are subjective, ambiguous, incomplete, emerging and changing (Appelo, 2011). In fact, the 12 principles of agile stress that one of the principle behind the Agile Manifesto is “Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage” (Beck, et al., 2001)

The Agile Manifesto states that the main characteristics for agile software development, leading to its perceived benefits, are customer collaboration, iterative development, self-organising teams, and adaptability to change (Beck, K. et al., 2001). There is to my knowledge no direct statements from the authors of the manifesto that they were directly inspired by any particular post-modern paradigm, but some writers have suggested that agile philosophy has been inspired by subjectivist thoughts, in particular social constructivism (Benton & Radziwill, 2011) (Mitchell, 2010). The Agile Manifesto’s statement “Individuals and interactions over processes and tools” has been understood as team members helping to iteratively creating the software, testing it against reality and adjusting the requirements and direction based on learnings for the methodology to be effective (Fogarty, 2009). This may include making hypotheses, implementing the one or more different minimum viable feature, testing and piloting them against a limited number of the existing users and using heat maps to track user’s behaviour and analysing the result. This is double-loop learning in practice.

While certainly subjectivist views have been instrumental in developing agile methodologies and they must be understood as a reaction against early positivist approaches (e.g. waterfall model) it would be wrong to say that agile methodologies strictly follow any particular paradigm. Rather it could be argued that agile methodologies are based on a pragmatic synthesis between an objectivist, but “hard to reach”, ontological view (since there is a strong emphasis on verification against reality) and a social constructivist epistemology (where all stakeholder actively tries to reconstruct their view of this reality). The subjectivist perspective is therefore in my view more based on a pessimism in regards to our ability to effectively understand reality (and what should be developed) and therefore also an inability to predict and plan actions. Instead a strong pragmatic experimentation approach is used in order to constantly test, review, learn and correct an emerging understanding of the world the software artefact exists in.

It is important to note that while Agile methodologies are based on a more subjectivist world view this does not mean that they are in any way less rigid. There is a dichotomy between “hard” and “soft” methodologies in Software development and it would be easy to expect agile to come in the soft category, but that is not correct (Karrbom Gustavsson & Hallin, 2014). Indeed, agile methodologies are in general made up by very disciplined approaches. SCRUM in particular is a rigorous process and includes practices and artefacts such as;

- Product backlog,
- Sprint backlog,
- Test driven development (e.g. Unit tests that are constructed before coding of functions)
- Tasks that are broken down into manageable size,
- Progress that is constantly followed up using burn-down charts
Continuous builds, and automatic continuous testing is used to control the expected outcome.

This means that the project management practices themselves can relatively easily be accommodated within an ISO based quality system (Stålhane & Hanssen, 2009). But, as is shown in the table below - on a deeper philosophical level there are far more concerning conflicting aspects. The ISO 9001 standard also assumes a top-down process improvement approach (International Organization for Standardization, 2008), while the agile community believes that this should be managed by and within the team itself (Beck, K. et al., 2001), (Scrum Alliance Inc., 2009). Can the differences be mitigated?

**Table 1 Conflicts on different levels**

<table>
<thead>
<tr>
<th>Area</th>
<th>ISO 9001⁶</th>
<th>Agile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver</td>
<td>Plan driven (IT Governance Ltd., 2011).</td>
<td>Value driven (Hamdi, 2014)</td>
</tr>
<tr>
<td>Requirements</td>
<td>Requirements are seen as non-ambiguous descriptions of what should be developed and should be evaluated for ability to implement, approved and frozen (IT Governance Ltd., 2011).</td>
<td>Requirements are seen as subjective, emerging and based on context and are perspectives based on the acquisition process wherein heterogeneous views of different stakeholders are considered (Apshvalka &amp; Wendorff, 2006), (Berki, et al., 2007), (Holmström &amp; Sawyer, 2011).</td>
</tr>
<tr>
<td>Quality</td>
<td>Deliverables should adhere to defined requirements. Changes may be accepted but are understood as deviations from plan (IT Governance Ltd., 2011).</td>
<td>Quality is seen as subjective, hence feedback-loops are required and changes encouraged in order to capture the emerging needs (Scrum Alliance Inc., 2009).</td>
</tr>
<tr>
<td>Control</td>
<td>Management is responsible for control (IT Governance Ltd., 2011).</td>
<td>Teams are self-managed and external control during sprints is discouraged (Schwaber &amp; Sutherland, 2013).</td>
</tr>
<tr>
<td>Metrics</td>
<td>Metrics should be collected to demonstrate the ability to achieve planned result (IT Governance Ltd., 2011).</td>
<td>Subjective internal metrics such as Story Points and Velocity are generally used. The meaning of these are defined by the team and cannot be used for comparison between teams and there is no connection to hours (Vishwanath, 2011)⁷ Working software is the primary measure of progress (Beck, K. et al., 2001)</td>
</tr>
</tbody>
</table>

Accepting that different paradigms can be useful even though they may be incomplete or even partially conflicting, can help and allow a generous coexistence of different paradigms within the discourse and perhaps improve and help to make sense of the messy reality, which constitutes Software Development.

On a more practical level Stålhane & Hanssen (2009) analysed the different clauses of ISO 9001 in order to understand which of them are potentially in conflict with agile methodologies. The authors suggest solutions for how to satisfy ISO 9001's demand for

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⁶ References are made to TickIT’s manual but these are identical to the standard ISO 9001 standard.
⁷ While ISO 9001 does not specify which metrics should be used and the agile metrics surely should be able to satisfy the ISO 9001 standard as such they are problematic in that they cannot be used to compare performance between different teams or departments. There are references showing that the agile metrics indeed create confusion since managers tend to misunderstand them and their usage (Green, 2014).
documented complete requirements, reviews and documented evidences when using agile software development methodologies. As long as requirements are documented in a satisfactory way, reviews are conducted and all key practices and actions are documented in any way required (Photos of the Scrum board may be sufficient evidence (Stålhane & Hanssen, 2009), it should not be too difficult to achieve formal alignment. This however does not necessarily mean that deeper differences mentioned above are mitigated. In particular, the agile view that teams should be self-managed would be a challenge for the more hierarchical approach suggested by ISO 9001.

While conflicting paradigms can be a challenge it doesn’t follow that it is always wrong to use conflicting paradigms at the same time. In academia mixed methods have been used which may include conflicting paradigms. However, if there is an assumption of coherence when in reality there are different paradigms assumed by different stakeholders this can lead to inability to reach common objectives.

When an organisation is trying to implement agile development, the existing ways to measure quality and performance are often used and since they tend to support the existing way of developing software (Damborg Frederiksen, & Rose, 2003) this can easily lead to manipulation or lip service (Bollinger & McGowan, 2009), (Spitzer, 2005)

2.5 Audit of agile processes

ISO 9001 uses internal and external audits to ensure compliance with the standard and with internal policies and procedures:

- Internal audits are made by employees who are properly trained who on regular intervals conduct an audit of different departments, functions and/or projects.
- External audits are done by a third party organisation authorised by the certification body. ISO 9001 assumes a rational and objective audit.

This is well intended, but in reality auditing can become a relatively subjective process and the auditor may easily become the sole judge assessing and deciding what is acceptable and what is not.

While ISO 9001 and most other corporate Quality Systems assumes that employees follow directives and instructions from managers (Knights & McCabe, 2002), agile methodologies are instead primarily based on team-based continuous improvements by dedicated self-managed employees (EMC Consulting, 2010) and discourages external interference in how the team works. These perspectives need of course not be in conflicts as long as managers treat carefully and avoid interference with the daily work of the teams.

This is often exemplified with, in agile circles, the famous fable of the chicken and the pig where a chicken asks a pig if they should start a joint restaurant and call it Bacon and Egg. The pig replies that this is not fair, since it is committed but the chicken is only involved (Rouse, 2010).

Among agile practitioners it is therefore common to speak about “chickens” (outsiders such as managers) who are “involved” but not committed, and “pigs” (insiders, mainly such as team members, but also the product owner who is the customer representative and whose neck is also on the line). An auditor is by this definition obviously a “chicken”. You can’t be both a chicken and a pig at the same time (Vizdos , 2006). Obviously as stated above, there need not be any conflict, but managers, auditors and other externals who wants to interfere, micromanage or control exactly how the team works can easily derail the underlying paradigm which is the strength of the agile methodology. It is
certainly not in conflict with the paradigm to contribute in various way but for the team to be truly self-managed there need to be a clear limit of such involvement. This may in particular be true in cultures, such as India, with higher power distance and more respect for managers, auditors and customers.

Apart from internal audits, compliance to ISO 9001 demands external audits. The external auditor has a strong power position and may enforce his or her perspective on the team. The focus of the auditing should be only on compliance to the ISO 9001 standard and it should be conducted in as objective way as is possible and clear evidence of any non-conformity must always be documented (International Organization for Standardization, 2008). However, there are external auditors that goes beyond this limit and the training and ability of the individual auditor may destroy this good intention. Some references suggest that audits should not focus on fault-finding (The National Computing Centre Limited, 1996) but even when this is avoided, an outsider auditing is a challenge to the agile philosophy. If the auditor is careful and understands this dynamic this can possibly be at least partially mitigated (Ramakrishnan, 2011).

In Scrum each Sprint is supposed to end with a Sprint Review meeting (to review the Product) and a Sprint Retrospective meeting (to review the process) wherein the team meets for 2-4 hours to walk through of the previous sprint and recollects what went well and what did not, what they learnt and what they would change in the future to improve the product and their performance (EMC Consulting, 2010), (Mountain Goat Software, n.d.). This means that even the agile process should be seen as work in progress and is constantly improving.

The difference compared to a more normal internal ISO 9001 audit is that this is conducted as a group activity in which the team itself assesses its performance. If the internal auditor participates in this process and ensures that the retrospective meeting also covers adherence to the ISO standard such as document standard, or other parts of the scrum teams work which is affected by the ISO 90001 standard. If any deviation is found which would be considered a non-conformity and this is document, this should both satisfy the requirement of the standard and become a less intrusive way of managing the audit.

If this is done more frequently than the normal audit it may be sufficient to cover only some areas of the standard in each retrospective meeting since over time, there would be plenty of opportunity to review and reinforce all aspects. Since the retrospective meeting is the preferred SCRUM method for continuous process improvement, perhaps it could in this way be extended to satisfy the objectives of the ISO 9001 audit as well?

In the latter part of this thesis a pilot case with this proposed method was used to try to mitigate the perceived conflict between agile and the quality system and create more opportunity to jointly and collaboratively look at improvements within the team.

There may be a risk that the retrospective meeting becomes too much of an audit, the retrospective meeting becomes too extensive or that it derails the agile process in other ways. That need to be avoided. But if the proposed method means that internal audits in reality happens more frequently perhaps each retrospective could focus on one part of the standard and over a period all parts.

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8 All aspects of the standard paragraph 9.2 (which covers the Internal Audit) must of course be satisfied.
2.6 Answer to the first research question
It can be concluded that there is indeed support in the available literature that there is a dichotomy between the underlying philosophies of formal quality systems and agile development.
3 RESEARCH METHODOLOGY
This chapter describes the methodology for the Empirical Research and it also discusses the internal and external validity of any findings.

3.1 Action Research
Action Research (Reason & Bradbury-Huang, 2008) was identified as a suitable research approach and it seemed that it would be useful for trying out potential mitigating strategies to resolve the experienced tension between Agile and ISO 9001 and in particular to prototype a collaborative audit. Action research is easily compatible with, and somewhat similar in philosophy and nature to agile methodologies (in a way it may even qualify as an agile methodology itself). It is iterative in nature, and the team members are co-researchers and as a result increasing awareness and learning in the studied company.

Action Research has often been used in nursing and education (Santos & Travassos, 2009) and has been and can be used with different research paradigms. The methodology is based on an experimental approach where after an initial assessment of the situation, an intervention is done, which is followed by a review of the impact of the intervention. This is done over and over again in an iterative cycle. While Action Research was initially mostly used within an interpretivism paradigm, the method can easily be used with different paradigms –

- Interpretivism (critical theory) - A certain management approach can be questioned and the collaborative approach itself could be used to empower workers (Goldkuhl, 2012), (Kemmis, 2001).
- Grounded theory (Baskerville & Pries-Heje, 1999)
- Pragmatic epistemology (simply testing and learning from the experiences, keep what works) (Goldkuhl, 2012)
- Feminist epistemology (Reid, et al., 2006)
- Constructivist epistemology where knowledge is built socially by jointly trying it out (Babüroglu & Ravn, 1992)
- Positivist epistemology (e.g. defining and testing hypotheses) (Kock, et al., 1997), (DeLuca & Kock, 2007) but many action research writers have seen action research as an anti-thesis of positivism (Richardson, 2001).

Action research empowers the participants and changes the power balance in favour of the workers (Reason & Bradbury-Huang, 2008). From a pragmatic perspective none of the above paradigms are necessarily mutually exclusive and within the framework of action research it should be possible to consider different paradigms even at the same time.

Action Research generally focuses on knowledge in action and hence the researcher’s closeness to the data itself often stands out compared to philosophical theoretical frameworks (Coghlan & Brannick, 2010). Rather than taking a strong stand on ontological and epistemological perspectives, this thesis instead assumes that different paradigms coexist, needs to be understood and can even jointly help to build a deeper understanding of reality (Olsen, 2004). By acknowledging that different paradigms exist and are useful in their context we may reach a deeper understanding of the research context. Some tension will certainly remain and this tension may not necessary be bad. Using different paradigms in parallel may also give support for using theory triangulation and therefore reach a broader understanding (Steenhuis & de Bruijn, 2006).
Metrics can be used to strengthen the rigour of the process and give some means of comparable evaluation. From the literature such tension between the positivist nature of the quality systems and the more subjectivist agile view of requirements is already there in the situation we will research.

Action research is a fairly old methodology. The name was given by Professor Kurt Lewin in 1944. In his well quoted paper he described it as “a comparative research on the conditions and effects of various forms of social action and research leading to social action” (Lewin, 1948). He described the basic steps which has since been the standard steps within action research (Lewin, 1958) –

1. Analysis
2. Fact finding
3. Conceptualization
4. Planning
5. Implementation of action
6. Evaluation

But in the Action Research literature it is sometimes simplified to Plan, Action, Analyse and Reflect (Vaccarino, et al., 2007)

In Action Research typically a problem area is first identified and the group involved comes up with a possible action which can resolve or remove the challenge, this action is then tried out and is then analysed and reflected upon. What stands out compared to general problem solving is the reflection in which the group and the researcher tries to understand why and create theory along the way. This process is done in an iterative way (Vaccarino, et al., 2007, p. 6).

Action Research is often defined as a two sided research methodology. First the team with the researcher as a participant should create knowledge for the benefit of the team.
Then the researcher should if and when possible define and contribute academic learning (Rapoport, 1970).

A substantial part of social research in ICT is done away from the industry. Action Research gives a mean to test theory in reality. Action Research has a long and interesting history and has been used in various contexts (Gustavsen, 2008). Action Research has contributed in major ways such as the development of the Multiview contingent system development framework, Soft Systems Methodology, the Tavistock School’s sociotechnical design, Scandinavian trade union research and ETHICS. In Action Research the focus should always be on what practitioners actually do and not what they say they do (Avison, et al., 1999).

3.2 Validity

Any research of this type would have limited external validity unless tested in different organisations and contexts. Every organisation is unique and national culture may differ, hence the conflict described in this document may not be perceived in the same way everywhere and therefore the need for a collaborative audit may not be the solution required in other contexts. However, to get the maximum benefit of agile development methodology in an organisation using ISO 9001 or CMMi, Action Research may be used as a method to reach better quality and get better insight into the developer’s reality than when a top-down one-size-fit-all approach to quality is used.

Internal validity has been verified through circulating meeting minutes to all participants and through continuous progress reviews.

The methodology with collaborative audits has, after this study was conducted, successfully been used for more than a year in the organisation. This should also give some internal validity to the findings since the methodology piloted has been well received by the developers beyond the pilot described in this thesis.

3.2.1 Action Research in your own organisation

Due to the author’s role as the Managing Director of the company, there are obvious challenges, but such challenges are well described in the action research literature and can be mitigated (Coghlan & Brannick, 2010). The Action Research literature often refers to insider research in where the researcher is already a participant in the company being studied and sometimes having a management role. There is an acknowledgement of that challenges exist, but the general view is that the methodology is still useful as long as the researcher is open about these challenges and there is an active effort made to mitigate them (Coghlan, 2001). This is somehow complicated by the Indian cultural context in which there is a strong power distance (Hofstede & Hofstede, 2005) and earlier research by the author indicates that there are indeed further challenges (Gislen, 2010). To some extent this can hopefully be mitigated by the author’s more than 20 years' experience of living in India.
4 THE STUDY

This chapter will describe the application, the background of the studied company and the different iterations of Action Research conducted in the company.

4.1 Application

The action-research iterations followed the Scrum sprints. Totally 7 iterations\(^9\) were done; 2 as a first prototype in one team where the approach was tested. Then, since the customer of this project took a break after this iteration we instead continued doing 5 more iterations with a second team. Various initiatives were tested such as collaborative audit (in which the internal auditor acted as facilitator) and in-process auditing. We tried to use the normal team-dynamic of the scrum-team to avoid a high-handed audit experience. Instead we used different methods such as:

- Brain-storming based on the headings 'Start doing', 'Stop doing' and 'Continue doing' (Mountain Goat Software)
- Check-lists such as the scrum unofficial checklist (Kniberg, 2010)
- Analysis of metrics (schedule variance % and defect density)
- Non-conformities, root-causes and corrective actions were identified and in most cases corrected and implemented during the next sprint.

It may be mentioned that while the ISO 9001 standard was used for verifying compliance, the ISO 9001 terminology itself was intentionally avoided; rather than stressing non-conformities we decided to talk about hits & misses\(^{10}\) (The team used this terminology but in the official documentation of the Non-conformities we used ISO 9001 terminology of non-conformities, areas for improvements and noteworthy effort). Since metrics were collected and presented continuously (for the second team), the team proactively identified and worked with continuous mitigation and improved activities such as developer testing and improved unit-tests during the sprints. All relevant aspects of ISO 9001 within the scope and related to the specific work done by the scrum teams were covered.

4.2 The studied company

Gislen Software was started by the author in 1994 and has currently about 65 employees. The company provides software development and software support services mainly to large customers and start-ups. The typical project size is anything between 500 hours and ten thousands of hours over years of development. A lot of work includes mobile and server development. The company also provides Integration Services using TIBCO and Biztalk to large multinational clients. Most clients are located in Sweden, Norway and United Kingdom. While it happens that employees of the company go onsite or clients visit India, in particular for knowledge transfer or framing of requirements, most of the work is carried out in India using Internet (email, Skype or video-conferencing) as the main communication channels.

The company has experienced a journey from using very less development methodology (ad hoc) in the mid 1990’s, through fairly rigid Life Cycle Development processes and in the last few years’ employees have more and more started to use agile

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\(^9\) Each iteration followed one sprint in a Scrum team.

\(^{10}\) ISO 9001 terminology would be Major/Minor Non Conformity, Observation or Noteworthy efforts
Development methodologies, in particular SCRUM with some Extreme Programming practices such as test driven development, continuous build etc.

The company got ISO 9001 certified in 2006. While certification according to ISO 9001 is rarely a demand from these clients, it certainly creates credibility.

The author has earlier identified and analysed some challenges related to ISO 9001 faced in this company (Gislen, 2012). The managers involved in the research below has worked in the company for many years and has extensive experience working with Scandinavian clients.

4.3 Action Research implementation

The following Action Research steps have been used; Plan-Act-Observe-Reflect which has been repeated for each iteration. Below, the Action Research has been described in chronological order. The first four iterations are described in details (the two first in one team and the two latter in a second team). For the teams mentioned the sprint length was 3 weeks. The intervention was light and the extra effort for the teams were intentionally reduced to a bare minimum in line with the agile philosophy. After that the same methodology was used in three more iterations but no significant changes were done, hence no detailed descriptions of these iterations is included.

4.3.1 Iteration 1

Plan

In the first iteration the approach was first discussed with 3 managers, background to the problem was described and the principles of Action Research was explained. Apart from mitigating the shortcoming of the ISO 9001 audit we also wanted to look into how we could use the retrospect meeting for collecting data about needed learning\(^\text{11}\) in order to replace the current corporate performance appraisal process which we also had concerns with mainly due to its incompatibility with the agile methodology.

A specific Scrum team was selected. The participants were mostly relatively junior developers, some of the managers as well as the author had participated in their last retrospective meeting and had found that the atmosphere was very positive and many of the members were happy to share concerns and challenges on their own and the team’s shortcomings and had discussed constructively how they could improve.

We agreed on a plan to use a collaborative approach and on certain principles for the Action Research;

1. The team should be informed about our intention and we would ask for their collaboration ahead of conducting the research
2. We decided to allow the team members to decide from which iteration the findings could later be used as a proper ISO 9001 audit record and that they should not feel that management demanded this from the beginning
3. For the collaborative audit, any identified non-conformity would be discussed, its root cause would be defined and corrective and preventive actions would be defined during the retrospective meeting itself.
4. No records collected from the team should be used for any corrective action from management’s side without the team’s full buy-in. This was to avoid any risk of people holding back or being careful with what they revealed or discussed

\(^{11}\) To identify areas for learning is normal but we wanted to collect this for corporate purpose as well.
5. In particular, no records directly collected from this experiment would be used for adjusting salaries or taking any other management actions.

6. The production manager would meet with all the participants after the retrospective meeting for coaching. The details discussed during these coaching sessions would not be made public.

**Act & Observe**

On February 19, 2013 the first or our sprint retrospective meetings was held. We went through the headings of the SCRUM Guide (Schwaber & Sutherland, 2013) and ensured that all parts had been covered, the members listed their individual or team based learning needs based on the shortcomings during the last sprint. They further discussed whether they would learn this on their own or if they needed coaching by someone else (in or outside the team).

The team brainstormed for answers to the questions – ‘Start doing’, ‘Stop doing’, ‘Continue doing’ for the next sprint. The team discussed and agreed on various changes to the process and to continue role rotation to ensure that everyone in the team would learn new things every. Individual and team learning areas were also discussed and each member decided on 1-2 areas to learn during the next sprint.

The focus was mainly on lessons learned and how well the Scrum process worked. We spent less time on formal ISO 9001 compliance in this iteration, even if we reviewed the tailored process agreement. At the end we decided not to use the findings from this sprint as a formal audit (since this was a “prototype” meeting).

**Reflect**

We agreed that the learning from this iteration was that a collaborative method can bring forward a lot of issues and areas for improvement. But a lot of lessons learned had to be fine-tuned. Some of this was used during the second iteration.

**4.3.2 Iteration 2**

**Plan**

Based on our experience from the last retrospective meeting which took a lot of time partially since not all data was prepared, we decided to collect more data in advance therefore we agreed that the Quality Manager together with one team member would collect data ahead of the retrospect meeting. The author would facilitate the retrospect meeting, which should include identification, analysis and definition of corrective actions while the non-conformity report itself would be prepared by one of the team member.

**Act & Observe**

The pre-retrospect data collection was conducted during a couple of meetings between the Quality Manager and one of the Scrum team members. They went through all the artefacts available and sent their analysis to the team members ahead of the meeting. The retrospect meeting which itself includes a reflection on the just finished sprint together with a brainstorming activity facilitated by the author generated a lot of issues. After

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12 For each client/project a tailored process agreement is prepared where details of which specific process elements are included are listed.

13 A few months later, all the original participants of this sprint were asked to document how they had implemented their lessons learned both individually and in the other sprints in which they had participated since. With a few exceptions where someone had not had sufficient time to implement the lessons learned, the implementation and reflections on the lessons learned was very positive.
agreeing on root causes and corrective actions, we agreed that one person should produce a non-conformity report. Unfortunately, since the customer of this scrum team took a break after this sprint and the team was split, hence the intended implementation during the next sprint did not happen.

Reflect

The result of the exercise was satisfactory as a mean to collect areas for improvement. After the meeting we discussed if we needed to internally call the findings something else than non-conformities since it was agreed that the term itself was problematic from an agile perspective. When the team identified something which they wanted to change it was agreed that the term non-conformity sounded wrong (even if that would be the right term as per ISO 9001 and indeed we used that in the official report). A “Non-conformity” makes it sound bad, while in reality many of the findings were just areas we found we could improve. The audit report can as per ISO 9001 include items identified as Noteworthy Efforts Opportunities for Improvement, Observations, Minor and Major Non-conformities. We agreed to internally call them hits and misses. Hits for anything which we thought was a good practice which we wanted to continue doing and misses for anything which we thought could be done better.

Some of the participants raised some concerns about the total time spent on the exercise including the preparation and questioned if it added enough value compared to the negative aspects of the traditional audit. The amount of data collected was high which gave an overwhelming feeling for the members. It was considered that it may be better to instead identify a few important areas rather than analyse and reflect on too many at the same time.

Just after this audit we had an external ISO 9001 audit and this pilot study was discussed with the external auditor. In particular, what was discussed was to what extent we as a company had freedom to design the internal audit process. The external auditor had no concerns with the collaborative audit process we had conducted, but suggested that we could also consider in-process audit in which the assigned auditor is participating in daily stand-up meetings, and observes the performance and then presents this to the retrospect meeting. We decided to consider this in the next iteration of the action research process.

4.3.3 Iteration 3

Plan

Since the customer of the project team we had worked with in the former two sprints took a break and since we wanted to find out how well the model we had started worked we decided to use the same method for a completely different Scrum team. The new Scrum team had just finished their first sprint on a new project. It was anyway time for a retrospective meeting.

This time it was decided that the team members themselves should collect the data. We shared the process we had used with the first team and we stressed that we wanted to try the same process with a new team. We did not give as extensive explanation of Action Research as we did for the first team, instead we focused on what we had done and what we wanted to achieve with a collaborative audit. Even though we wanted to verify ISO 9001 compliance, most of the focus was on the Scrum process. We reviewed the document used for describing the tailored process for each project to understand how well the project...

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14 In Lean Manufacturing the term Kaizen is often used (Kaizen Institute, n.d.)
adhered to ISO 9001 and the Unofficial Scrum checklist (Kniberg, 2010) to cover the Scrum process.

Act & Observe

The retrospective meeting went well and there was a good collaborative atmosphere and good participation from all team members. Three non-conformities were found\(^\text{15}\) whereof two were related to missed reviews and one to the Scrum process. It was however found that on the whole the Scrum process was well followed. The non-conformity related to Scrum was that the team had different understanding of what their “Definition of done” was (Schwaber & Sutherland, 2013), something which is critical in Scrum to create transparency between the team members. It was agreed that the team would shape a clear “definition of done” before their next sprint\(^\text{16}\).

Team-members contributed freely and the meeting was clearly focused on how to improve and not on “fault finding”.

Reflect

We were in agreement that the retrospective audit process seemed to work quite well and we decided that we were almost ready to train other internal auditors to continue using this collaborative methodology. However, we finally wanted to try out an in-process audit which had been suggested by the external auditor. In-process-audit means that the internal auditor would follow the team during the sprint instead of just participating in the retrospective meeting. Therefore, it was agreed that a fourth iteration should be conducted.

4.3.4 Iteration 4

Plan

There were two aspects we had still not tried out;

- In-process-auditing, wherein the auditor will visit the daily scrum and observe, suggest and document during the development rather than waiting until the end. To do this audit the internal auditor can use a checklist to ensure that Scrum is properly followed, but he or she must also ensure that the ISO 9001 requirements are satisfied (Ramakrishnan, 2011). But the auditor should raise and discuss them immediately in order to ensure that if it is a deviation and give the team a chance to correct ASAP.

- To encourage the team members to report deviations whenever they happen and suggest correction, this would be more like Kaizen (Kaizen Institute, n.d.), the auditor's role would then be to ensure that actions are taken and that they are relevant.

We allocated one of our existing internal auditors who had taken part in some of the earlier retrospective meetings described in this thesis to visit some of the Scrum meetings and instructed her on the task. The team in question was the same as in the last sprint, but the Scrum master was changed since last time the Scrum master had been one of the developers in the team which had meant that the Scrum master had been too busy with

\(^{15}\) 1) Design review not done 2) Test-plan review not done 3) Definition of done must be clear to the whole team, risk: When a task depends on another, unless the first is fully done, there may be a need of rework which can make it impossible for the team to complete the sprint on time and budget. The overrun in the project likely depends on this to some extent.

\(^{16}\) It should be noted that each Scrum team should agree on their own definition of done.
development. This time another person who had no other role in the team than being the Scrum master was selected.

Act & Observe

The internal auditor was only able to visit two Scrum meetings and her contribution was mainly to encourage the team to implement the corrective actions from the earlier sprints non-conformities (this itself was very useful).

When conducting the retrospective meeting, we started by verifying the last sprints non-conformities. It was clear that the team had taken effort to avoid the earlier shortcomings, and this time the Scrum process had been really successfully used. We did not manage to find any concerning shortcomings which could be labelled as non-conformities, and the lessons learned from the last sprint was well implemented. There was now a written “definition of done”, and the members were all well aware of it.

The schedule adherence had also improved since last sprint and the number of defects injected was reduced. The required time for the retrospective meeting this time was much shorter and the team was truly satisfied with their effort.

Reflect

After a number of iterations, the combination of retrospective meeting and internal audit felt easy to combine and conduct. The teams were not feeling threatened and there was a common understanding that the retrospective meeting was a very useful learning experience and that the ISO 900§ audit requirement was used to further strengthen the need to change the way of doing things in a better way.

4.4 Metrics

The second team continued using the same methodology after the first 2 iterations described above and collected metrics for defect density and schedule variance %

The next sprint (3) was an odd sprint since it was shorter (due to external constraints) and hence it was an outlier compared to the other. The purpose of the collection of metrics was to create some measure for the team to focus on and suggest improvements to if possible improve the metrics along the way. But since metrics were used in the action research reflection it was an important part of the process itself. The metrics shows an improvement over the iterations. In discussions it was clear that the team felt inspired to improve quality at source, e.g. by improving the quality of the unit test cases less errors were injected and less time was spent on fixing defects. This in turn led to less number of test points and overruns were therefore reduced which led to less schedule variance.

In SCRUM the most common metrics are story points and velocity. However, since the specific client demanded hourly estimates we instead used the metrics described above since they were easy to collect. The described metrics are also easy to use for comparison between teams while story points and velocity cannot be used for any type of external analysis. Below two diagrams showing the development of the two metrics over the iterations/sprints.

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17 Number of defects injected per average development hour (Humphrey, 2009)
18 Deviation between actual and planned time divided by planned time * 100 (AcqNotes, 2015)
Figure 2 – Development of the defect density over 5 sprints with team 2

Figure 3 – Development of Schedule variance over 5 sprints with team 2
5 Discussion

While using internal audits and focusing on improving the defined key performance indicators we found significant improvements. This section will try to draw some conclusions based on the study and the literature in order to try to answer the research question.

The Key Performance Indicators improved dramatically over time. It may be presumptuous to claim that this was a direct result of the collaborative audit, but perhaps it can be claimed that the Action Research together with the focus on a few key metrics made the team make a more focused effort to improve the numbers. In the second team schedule variance improved from 60% overrun in the first sprint to 10% overrun in the last sprint and the defect density reduced from 0.30 to 0.15 defects per hour. In the latter retrospective meetings, it was also observed that the meetings were shorter while the team still found areas for improvement and since the focus was on quality at source, the cost of quality (Feigenbaum, 1956) went down. It should in this context be stressed that it was never the intention to change the focus of the retrospective meetings (which is continuous improvement) but to ensure that the adherence to the ISO 9001 standard was also covered.

In the discussions the participants stated that, thanks to constant review of defect density and schedule adherence, they proactively focused on methods to remove defects at source.

Both the teams stated that the collaborative audit was less intrusive than the earlier formal audits and were in particular more based on trust than the traditional audit. While other factors than those observed may have contributed, the result of the present study indicated that the collaborative audit was a key factor for the fast improvements noted, since it inspired active brainstorming and participation from all team members to improve various aspects.

The agenda for each audit was set from the beginning. From the outset the internal auditors made clear that they would not conduct fault-finding exercises and that members were free to raise their opinions. The collaborative spirit shown by the team could be a major factor for the improvements. In addition, the auditors had a much easier job than in the traditional internal audits, since the agile philosophy for how to resolve quality issues were at the centre of every discussion.

The team members reported that they did not experience blame, which they said had been an obstacle in earlier internal audits. The participants of these retrospective meetings have stated that this would be a useful practice to roll out for all Scrum projects in the whole company. Since this study was done, the collaborative audit has been implemented across the company and is now the main way audits are conducted for agile projects. Traditional internal audits are still used for life cycle projects, maintenance projects and for other non-developing departments (such as HR/Admin, system administration and procurement).

5.1 Answers to the second research question

Through the Action Research Study, it was found that including a collaborative internal audit within a retrospective meeting may add significant value, but it must be assessed if all aspects of what is required by internal audit as per the standard can be covered in this way or if additional internal audit of the whole department or project would be required in addition.

19 Partially due to customer induced changes
6 CONCLUSIONS
This section concludes the result of the study

The research objective was to elaborate on the challenges and philosophical clashes between ISO 9001 and the agile software development paradigm. In particular, the focus was on analysing the context of how internal audits were conducted and how they could possibly be improved to better support agile methodology.

The first research question was to identify if there was support in the literature for a clash between ISO 9001 and agile methodology. After thorough reading through the available literature and analysing the specifics it can be concluded that there indeed is such a conflict. However, it was also found that there may at least be ways to mitigate some of these.

While the low level incompatibilities between ISO 9001 and Agile can be easily mitigated, the literature study showed challenges to manage the clashing philosophical perspectives. While external audits (as internal audits) are compulsory for compliance the way they are conducted is outside control of the company being audited, hence it is entirely up to the individual auditor’s understanding of agile methodology how well it will work. Since external audits are only conducted periodically and not as often as internal audits, it was concluded that as long as the external auditor is positive to agile philosophy this may not become a major challenge. It should, with good effort, be possible for agile methodology to coexist with ISO 9001 based quality system if management and auditors have a good understanding on how and why there may be potential conflicting aspects which can if not managed create tensions between the two paradigms. However, in cultures with higher power distance such as India the risk for conflicts may be more likely and may be more difficult to mitigate.

To answer the second research question - if it was possible to reduce this perceived tension using a collaborative audit, Action Research was used to pilot an alternative approach for the internal audit. The study covered only a few sprints with two teams in one company, which means that this should not be considered a conclusive study. Further research is required to show if this approach will give the same result elsewhere. However, the result of the present study indicate that a collaborative audit is a workable way to proceed. The participants in the teams indeed released far more creativity during the audits and the approach was, according to the participants, far more consistent with the agile philosophy. In addition, the improvements in metrics observed were impressive. The author admits that the result noted by the metrics cannot be entirely attributed to the form of audit used. However, outside the scope of this thesis, subsequent adoption in other teams in the company shows similar results. It can be concluded that the question was answered positively by the study. The team members did indeed say that the new approach added more value and that higher level of trust was established. More research is needed in other organisations which could perhaps establish some kind of external validity.

Our experiences from this study shows that there is a lot of scope for experimenting and changing the audit process to help the entire internal working of ISO 9001 to be more aligned with the agile software development paradigm. If enough freedom is given to agile teams within the boundaries of the Scrum process, the philosophical incompatibility may not matter so much, and perhaps the two systems can indeed co-exist within the organisation adding different heterogeneous values to the company and its stakeholders.
Action Research should both add value through practise and contribute to the Body of Knowledge (Coghlan & Brannick, 2010). Even though the concerns raised by post-modern critical scholars against TQM and formal quality system has been highlighted, the philosophical dichotomy between agile and the quality systems deserves more analysis and further studies. This thesis contributes a little bit towards increased congruence, where agile teams can be better supported by their organisations and agile methodologies can also be better integrated within formal quality systems. The result of the present study indicate that a collaborative audit approach can be used as a method of Software Quality Improvement.

After the study was finished the company has continued with the same approach and the same methodology has been implemented in other teams. This has been done without direct personal involvement of the author of this study. Data from hundreds of sprints are now available and there are some interesting trends. The methodology is now starting to become a part of the culture of the company. The collaborative audit described in this paper is now the standard way for managing audits for all software development in the company.
7 FURTHER STUDIES & SUGGESTIONS
This chapter introduces some inconclusive findings from later implementation which resulted from the research covered in this thesis and suggests needs for further studies and gives some advices for practitioners.

7.1 Further findings after the present study was concluded
In the present paper we only focused on two metrics; schedule variance and defect density. Since we have also used story points and velocity which are more common in agile developments some other inconclusive learnings may be of some interest. E.g. One client demanded 2-weeks sprints rather than 3-weeks sprint and we found that the defect density increased and there seemed to be a correlation between higher velocity and increased defect density. Also the high pressure when using short sprints made it difficult to have frequent retrospective meetings, and while many clients may prioritise velocity we have so far found that for projects where low defect rate is required longer sprints may be preferable. The work/life balance for the employees also suffered when 2-week sprints were used20, which may in the longer term lead to lower quality and potentially increased staff turn-over. However, these preliminary findings are more included to give ideas for further research and the results are also inconclusive and outside the scope of this thesis.

7.2 Need for further studies
For evaluating and learning if the proposed collaborative audit would add generic value the same should be tested in other companies as well. Also, since the extensive data material built up from using this method in the company after this study was conducted, further study can be done on areas such as;
• Impact from Velocity focus on defect density
• Impact from Velocity focus on schedule variation
• Impact on frequency of collaborative internal audit
• Analysis of Non Conformities found across different focus areas and type of projects and the impact of the same

7.3 Suggestions to practitioners;
Creating awareness among software developers for the concerns raised with support from literature in regards to the conflict between agile philosophy and formal quality systems should have a major impact in the agile development culture in companies with ISO 9001 or CMMi quality systems. Ensuring that the wings of agile practitioners would not be cut by well-intended internal auditors or quality managers should have a major benefit on the productivity and the results from the developers. Not understanding the built-in conflict and therefore not mitigate these challenges may kill or at least reduce the benefits of agile development methodology in an organisation. Hence awareness of the presented findings should have a major positive benefit for agile developers in quality conscious organisations.

20 There are references to two week sprint length being problematic (Galanakis, 2014) but the solution may not necessary be longer sprints but shorter sprints could also be a solution. The ideal sprint length differs based on the nature of the project and the agility of the team including how long overhead is required for customer validation and deployment.
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