Evaluation of the Framework for Agile Software Development Teams and Measurement of Work Outcomes

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Badri N Srinivasan
Admission No. 13GSOB301012
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School of Business
Galgotias University

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ABSTRACT

Agile methodologies are a different proposition in comparison to conventional software engineering processes for developing software products and systems. They focus on assimilating social and behavioral factors into software development. The emphasis on people is a very important factor in the implementation of agile methodologies in the workplace. The focus on agile teams for developing software systems and products using agile development methodologies focuses the importance on the analysis of the key components of agile teams which are important to ensure that the characteristics of agile teams are factored appropriately in the organization so that the teams are having the pre-requisite environment setup for successfully developing software systems. This study explores the various components and social aspects that contribute to the characteristics of agile. The study aims at highlighting a framework made up of various components that focus on the critical attributes of an agile team and if these attributes are present in an agile team, then the probability for the team to work as a high performance agile team and deliver successful software products in the market place is increased considerably. Various studies during the last ten years indicate the current state of research that have been undertaken in the area of agile development teams ((Dingsøyr, and Lindsjørn (2013); Stray and Dingsøyr (2011); Dyba and Dingsøyr (2008); Moe, Dingsøyr and Dybå (2009); Nedelko (2008); Daniel & Davis (2009); Ross & Adams (2008); Moe, Dingsøyr and Røyrvik (2009)). However, the focus on an overall framework which could identify the key characteristics of agile teams leading to successful software delivery and improved work outcomes was not available and this study tries to bridge that gap by identifying key characteristics of agile teams that lead to a higher probability of successful software delivery and improved work outcomes.

The objective of the study is to focus on the –

- Identification of the key components of a framework that captures the key attributes of agile teams creating/delivering software products/services/applications successfully.
- Consideration of agile teams as Complex Adaptive Systems (CAS).
- Various key attributes considered as part of a framework for agile teams that contributes to the success of agile development teams in delivering valuable software that meet the customer requirements thereby leading to improved work

outcomes and the measurement of improved work outcomes.

Agile methodologies are considered as another alternative process as compared to traditional software engineering practices for developing software products and systems. The focus on integrating behavioral and social factors into software development forms a core part of agile development. Additionally, the focus on people is also a very important feature in the implementation of agile methodologies in the workplace. The emphasis on agile teams for developing software products using agile methodologies focuses on the analysis of the key components of agile teams which are significant to ensure that the attributes of agile teams are factored appropriately in the organization so that the teams are having the appropriate environment for successfully developing software systems. Thus, the outcome of the current research highlights the focus on a framework which identifies the key characteristics of agile software development teams that lead to an improved probability of successful software delivery and improved work outcomes. The high-level factors – People and Environment and Complex Adaptive System Entity and the basic hygiene factors along with the interplay and the interaction among all the variables in the framework leads to a greater possibility of successful project/product/application/services delivery by the agile team and it also strengthens the measurement of improved work outcomes.

Keywords – software development, characteristics of agile teams, agile, complex adaptive systems (CAS), agile methodologies

DEDICATION

I would like to offer my contribution and dedication for this thesis to my father and mother who are in spirit always present to guide me to take the correct path. They have always been supportive of all my endeavors and they would have been happy to see my current endeavor reaching its logical conclusion. People who were always there to support me, congratulate me and show me the best path to always follow.

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1. Srinivasan, Badri N (2013), M474.doc - Role of Agile Software Development in the Global Healthcare Industry -- Published in Conference Proceedings, XIth AIMS International Conference on Management, 21 Dec 2013-24 Dec 2013, ISBN: 978-81-924713-5-8
2. Srinivasan, Badri N and Mukherjee, D (2015), Characteristics of Agile Teams – A Theoretical Discussion on Technology and Culture, IMS Manthan - The Journal of Innovations, ISSN: 0976-1713, pp 75-82, Vol. X.1 (Jan - July 2014), Available at – http://www.myresearchjournals.com/index.php/imsmanthan/issue/view/418, Indexed by Ulrich, UGC's List of Journals Sr. no. 6673
3. Srinivasan, B N & Mukherjee, D, International Journal of Information Technology, Sep 2018, Volume 10, Issue 3, pp 367–378, https://doi.org/10.1007/s41870-018-0122-3, Springer, Singapore

LIST OF ABBREVIATIONS AND SYMBOLS USED

ABB – Asea Brown Boveri

AI – Artificial Intelligence

ANOVA – Analysis of Variance

BA – Business Analyst

BCG – The Boston Consulting Group

BPM – Business Process Management

CAGR – Compounded Annual Growth Rate

CAS – Complex Adaptive System

CFA – Confirmatory Factor Analysis

CI – Confidence Interval

Cum - Cumulative

DBA – Database Administrator

DSDM – Dynamic Systems Development Method

DV- Dependent Variable

EFA – Exploratory Factor Analysis

FY – Financial Year

FDD – Feature Driven Development

GE – General Electric

GDP- Gross Domestic Product

GSD – Global Software Development

IAMAI- Internet and Mobile Association of India

I and O – Infrastructure and Operations

ICT- Information and Communication Technology

IoT – Internet of Things

IT- Information Technology

ITeS - Information Technology enabled Services

IV- Independent Variable

KMO – Kaiser – Meyer - Olkin

LSD – Lean Software Development

Ltd – Limited

LTI – Larsen and Toubro Infotech

MN - Mean

Max – Maximum

Min - Minimum

ML – Machine Learning

Mgr - Manager

MNC- Multi National Corporation

MOD - Model

ODC – Offshore Development Center

OTT – Over the Top

PMI- Project Management Institute

PO – Product Owner

PM – Project Manager

Pvt - Private

PoC – Proof of Concept

PMBOK – Project Management Body of Knowledge

R&D - Research and Development

REG - Regression

ROI- Return on Investment

RPA – Robotics Process Automation

Rs – Rupees

SBD – Set Based Development

SD – Standard Deviation

Sig - Significance

SDLC – Software Development Life Cycle

SM - ScrumMaster

SG GSC – Societe Generale Global Solution Center

SE – Software Engineer

SMAC- Social, Mobile, Analytics and Cloud

SSE – Senior Software Engineer

SPM- Software Project Management

SPSS- Statistical Package for the Social Sciences

Std - Standard

SW – Software

TCS – Tata Consultancy Services

TL – Team Lead

TPS – Toyota Production System

TTM – Time to Market

USP – Unique Selling Proposition

VR - Variance

VSM – Value Stream Mapping

VUCA – Volatile, Uncertain, Complex and Ambiguous

XP – Extreme Programming

LIST OF APPENDICES

CHAPTER ONE - INTRODUCTION TO THE STUDY

1.1 OVERVIEW AND BACKDROP TO THE STUDY

The focus on digitization, Internet of Things (IoT), Artificial Intelligence, Machine Learning and Robotics Process Automation (RPA) in various industrial domains has propelled the growth of IT (Information Technology) industry in the world to an outstanding level. IT and ITeS (IT enabled Services) sector has evolved significantly in the last three decades in India. It is a significant contributing factor to the GDP growth of the country. As per the NASSCOM report, this sector generated revenue of US$147 billion approx. in 2015 (NASSCOM Annual Report, 2015-16). The IT sector also contributed to the generation of employment in the nation to a significant level. As per the details given in the Economic Survey 2014-15, Indian ITeS and IT industry directly employed 3.5 million people in a year and by the year 2020, the employment generation by this sector is expected to reach 20 million (NASSCOM Annual Report, 2015-16). The survey also showcases that the government's "Make in India" mission has included IT among the 25 focus sectors. Thus, the focus and study of software development projects is appropriate in the current scenario. The usage and application of IT is appropriate in all the industrial and non-industrial domains. The usage of IT in all the domains helps to automate the processes, reduce errors and respond in a timely manner to any events that may occur in the system context. For example – in the healthcare domain, uncertainties about safeguarding patient health data are driving the spending on information systems globally. Healthcare technology is changing rapidly and healthcare organizations are shifting to virtual platforms and mobile technologies to support healthcare delivery and operations. Additionally, health records are being digitalized and the IT systems that support the delivery of healthcare services have become more complex over a period of time. The need for automated healthcare systems to respond within a specific period of time to development that supports care delivery while ensuring compliance with regulatory agencies has become critical. Hence, development of software systems using agile methodologies offer solutions to many of these types of industrial challenges in different domains and sub domains (Srinivasan, 2013).

During the past thirty five plus years, novel and innovative approaches to software development were brought into focus as the culture of the software development organizations also evolved over a period of time. Many of the software organizations presently aim to produce software having a short time to market and which is having

high business value to the customer with nominal costs while simultaneously working in an unsteady and fluctuating environment using specific SDLC models. A model which enables and facilitates the organizations to develop software having good quality within a given time and as per the customer requirements is called as an SDLC model. All the software development activities including different tasks like code, test, requirements analysis and design, implement, deploy and support form part of the SDLC model. It is the decision of the project team to decide on which SDLC model is to be chosen for their specific requirement. Under different environments, each SDLC model has a different outcome. Hence, the crucial aspect that needs to be considered is which model needs to be used under the specific scenarios (Dwivedi, 2016).

With reference to the necessity to meet the varying and novel needs of the software organizations, agile methods and frameworks were introduced over a period of time (Hnief and Hock Ow, 2009). Software development organizations focused on the project management techniques during 1980s in order to meet the growing need of software in all the sectors. Projects comprised of a team or teams of people who are specially chosen for their skills, knowledge and abilities to contribute to the final result and they were led by a project manager. In the present scenario, where new software development techniques have been introduced agile software development is influencing the business and the overall economy. These projects are human focused, technology driven and skill based in nature. Agile methods and frameworks are a cluster of software development techniques and methods that are based on development that is iterative and incremental. The four major attributes that are primarily central to all agile methodologies are - collaboration/communication, quick and adaptable response to change, iterative & evolutionary development, and adaptive planning (Begel and Nagappan, 2007). The project relies on teams of preferably co-located members who work together focusing their energy on one goal at a time instead of doing multitasking. With the advancement in information technology and communication, the organizations are able to focus on innovative techniques to work and manage teams. Agile methods provide multiple options in comparison to the long established software engineering processes for developing software products and systems. Agile is focused on social change in the workplace (Beck and Andres, 2004). Agile methodologies stress on assimilating various variables like culture, shared understanding of the vision and other factors while doing software development and they focus on the importance of

the role of individuals in the work place. Software Development is a team cooperative game that is focused on collaboration and invention (Cockburn, 2006). Other concepts that were introduced by Alistair are - learning and updating insights from lean manufacturing (Womack, Jones & Roos, 1990); managing competition and ensuring that the collaboration is maintained; and strategies for pairing in communication. Alistair Cockburn indicated that - Software development is not a science. Hence, the scientific method cannot be applied to software development. If software development was related to model/engineering development, then software models or engineering techniques could be applied to it. However, as it is not related to any of these areas, these techniques cannot be applied to it. Software development can be considered to be similar to game development and it focuses on collaboration with other team members within a specified time and keeping in mind other constraints that may be applicable. When software development is determined as a game, then it gives better alternatives on how to manage the teams, how to allocate the costs and how the work can be undertaken (Coding Horror, 2007). Software development is a finite and cooperative goal directed game. Games can be contemplated as mathematical constructs that need to be worked out so that the end goal or objective can be achieved and they are focused on utilizing planned moves to arrive at the outcome and also having fun at the same time. The emphasis on people is the core as individuals are central to software development. The focus on agile teams for developing software systems, applications and products using agile software development methodologies directs the focus on the analysis of the key components of agile teams which are vital to ensure that the characteristics of agile teams are taken into account appropriately in the organization so that the teams are having the necessary environment setup for successfully developing software systems. The team strength is connected to the team member who is the weakest and the team has to work in unison to ensure an optimal outcome. The weakest member in the team is the key constraint in the team.

There are various components that contribute to the properties of agile teams. Agile teams are observed to exhibit characteristics of complex adaptive systems (CAS) (Appelo, 2011). Conventional general systems theory was not found to be fully adequate to explain the key phenomena occurring in agile teams (Bertalanffy, 1950). Additional emphasis on systems theory demonstrated that whenever a human agent is introduced into a system, then the nature of the system is changed and the technique to

study that system is also changed. Stress needs to be given on understanding additional human traits like pride and other attributes. These features also need to be explored in greater detail in future psychological studies (Peterson & Seligman, 2013).

As per systems theory, there are three types of system categories –mindless or deterministic systems; un-minded or animated systems; and multi-minded systems which are also known as social systems (Gharajedaghi, 1999). When a system is introduced to human agents, then the focus is shifted to human behavior (Ackoff, 1999). The core point is to focus on how the goals of the system and subsystem align with each other and which is different from the conventional cause and effect models of human behavior. Emphasis should also be made for studying the interactions among the various system levels. These details are described further in the following chapters.

In standard systems theory, the system is separated from the environment by boundaries. The social network is home to vibrant interactions and the porous nature of the organizational borders in reality lead to the creation of boundaries (Merali, 2004). Mechanical systems are generally modular as compared to the nature of individuals who are not modular. The process models and the system models should take into account these aspects of non-modularity, otherwise the outcomes will be quite different in reality as compared to theory. The emphasis is on the key attributes of agile teams as compared to the emphasis of only individuals in a team. There is a subtle distinction between a group which is considered as a combined unit in comparison to the persons within a group (Bion, 1961). Significant influence is effected by the group on the persons in the group. The idea of agile teams is viewed as – a team that is made up of individuals and the whole team follows the agile practices and the focus is on the psychological and social/cultural interactions among the persons in the team and with other persons in other teams. A group is generally informal and made up of members who are focused on solving short term issues but a team is more focused on the long term solutions and it requires more collaboration, coordination and structure. To avoid confusion and for the sake of simplicity, a group is considered as a team, even though stringently speaking, a group and a team are different.

As per the Scaled Agile Framework, the Agile Team is defined as –
The Agile Team is a cross-functional group of members that has the capacity to focus and prioritize requirements and design the solution, write the code and test the solution to validate the solution against the requirements within the sprint time limit. The team includes developer, tester, ScrumMaster, Product Owner and shares common members like Database administrator, user experience member, technical documentation member and other members who may be needed to deliver value for the solution (Scaled Agile Framework – Agile Teams Abstract, 2016).

1.2 BACKGROUND OF THE PROBLEM

The need to compete successfully in the digital economy requires organizations to be more adaptable to change and focus on a culture that is agile and implement agile practices and form agile teams. “Digital business demands an agile culture”, a research report from Gartner (2015) focuses on the need for an agile culture to meet the demands of digital business. Another Gartner Report (2015) focused on implementing an agile culture has also indicated that by 2018, about 85+ percent of the organizations who are not focusing on their culture but want to implement DevOps will fail unless they focus on an agile culture and the formation of agile teams. As per the Xth Annual State of Agile Survey Report from Version One (2015), agile methodologies are no longer considered solely the domain of startups and small development shops. The number of large enterprises that are implementing agile continues to increase each year. Agile is going global as the number of enterprises around the world adopt agile. Given this backdrop, it is imperative that we need to know the key attributes of agile teams that will help the organizations to build an agile culture and agile teams and ensure the success of their software product/application/service delivery to their customers within the appropriate effort/cost/schedule parameters. Hence, the creation of a suitable framework for agile software development teams will help to identify key attributes of agile teams that will help them to deliver improved work outcomes. A framework can be generally defined as a set of rules, patterns, attributes, ideas or beliefs which we can use in order to deal with different scenarios. It collects all the key ideas or attributes under a common structure that is helpful to deal with different scenarios and we can built further on the foundation of the framework to solve difficult scenarios more effectively (Whatis.com, 2018). There are various attributes of agile teams that

contribute to improved software delivery and effective outcomes. By identifying the important attributes and bringing them under the purview of a framework, it helps us to identify and classify the key attributes of agile teams that contribute to successful delivery and improved work outcomes. This enables organizations to form teams having these characteristics or attributes which will improve the probability of successful software delivery and improved work outcomes.

Thus, through the current research, the researcher is trying to understand -- What are the key components of the framework that will help an agile team to deliver and measure improved work outcomes. The focus on a framework for identifying the key characteristics of an agile team that will help them to deliver software product/service effectively is very important as the framework can highlight the set of important attributes that will help the team to have a higher probability of delivering a successful product/service in the market place. The focus on the measurement of work outcomes is also important as the framework is linked to the outcomes and the outcomes can be known only if they are measured and the focus is on Conformance to Customer Requirements and Business Value Delivered, Delivery within estimated time and budget. The key point is that even if the delivery is made within the time and budget, the customer may still not be satisfied if the conformance to customer requirements and business value delivered is not appropriate. Hence, the focus is also on business value. In some cases, the customer may not be fully aware of the market requirements. In such cases, the project team may help the customer to identify the key requirements of the market place and incorporate these suggestions/changes in the customer requirements and this ensures conformance to the customer requirements. Business value measurement is not an easy activity and hence, the business value is generally worked out indirectly or inferred based on the customer and market place feedback. This helps to ensure that the delivery has met all the parameters as per the customer requirements. Thus, the focus on the evaluation of a suitable framework for agile teams and the measurement of work outcomes.

1.2.1 Statement of the Problem

A Study on the Evaluation of Framework for Agile SW Development Teams and Measurement of Work Outcomes. The focus is on evaluating the key characteristics of

agile teams that lead to a higher probability of successful software delivery and work outcomes.

1.2.2 Study Objectives

- ❖ Identification of the key components of a framework that captures the key attributes of agile teams creating/delivering software products/services/applications.
- ❖ To study the consideration of agile teams as Complex Adaptive Systems (CAS).
- ❖ To study the improved work outcomes that arise from the consideration of a framework for agile teams and the measurement of improved work outcomes.

1.3 STUDY – SIGNIFICANCE AND IMPACT

In India, IT and ITeS sectors contribute significantly to the GDP and in the generation of employment (NASSCOM, 2015). The software development outsourcing activity is a major portion of this sector and the previous work reflects that there is very little empirical work undertaken in the Indian context regarding the understanding and characteristics of agile team performance, the factors and attributes affecting the high performance of the team and the improved work outcomes resulting from a high performing agile team.

With respect to the performance of agile teams in software projects, most of the work done has been tested for agile teams working in an academic environment as compared to the agile teams working in the industry in the software project environment. There is no specific study which comprehensively talks about the three dimensional categories considered in this study and their cumulative impact on the project outcome and the output of the agile team and the measurement of improved work outcomes.

Lot of research studies focus on the role of agile teams in information technology, but there is no substantial work that describes a specific framework identifying the key attributes and components of an agile team that leads to improved work outcomes in software development projects.

The findings of the study will help in understanding the key attributes and components of an agile software development team deployed in software projects that will lead to improved work outcomes and contribute to both academic and corporate body of knowledge in terms of improving the success rate of software development projects and it will also lead to reduction of the failure rate of software development projects as reported by previous researches and surveys.

1.4 THESIS OUTLINE

1.4.1 Chapter One (Introduction and Background of the Study)

This chapter introduces the research topic and lays the background of the study which forms the basis of the current research.

1.4.2 Chapter Two (Previous Work)

This chapter discusses the previous work undertaken in the area of SW life cycles, agile teams and the consideration of the agile team as a complex adaptive system (CAS).

1.4.3 Chapter Three (Gap Analysis and Identification of the Factors)

Identification of gaps in the existing literature on the basis of the details provided in Chapter Two is explained in this chapter. The gap identified leads to the formulation of the objectives of the current study.

1.4.4 Chapter Four (Research Methods)

Explanation of the research techniques adopted for the current study is delineated in this chapter. It also provides the framework for statistical analysis and inference.

1.4.5 Chapter Five (Analysis of Data and Findings of the Research Study)

Analysis of data collected through SPSS and the corresponding findings of the study are indicated in this chapter.

1.4.6 Chapter Six (Conclusions of the Study and Recommendations)

The findings of the research work and the identification of the key attributes and components of the characteristics of an agile team are confirmed through the creation of a framework which leads to improved work outcomes. It also highlights the effect of the consideration of the agile team as a complex adaptive system (CAS).

The first chapter elaborated the overview to the research thesis accentuating on the background of the research work. The significance of the study has been highlighted linking the objectives to the gap in the previous literature. India being one of the chosen destinations for offshore outsourced software development projects, the study is important for identifying the key attributes and components of the characteristics of an agile team in the form of a framework and which leads to better work results and the contemplation of the agile team as a complex adaptive system (CAS). Hypotheses and the research methodology are clearly stated for setting the framework for good research. In the end, this chapter lists out the overall chapter scheme of the thesis. The next chapter highlights the previous work done in the area of identifying the characteristics of agile teams deployed in SW projects and the significance of SW life cycle models and the focus on the agile team as a CAS.

CHAPTER TWO - PREVIOUS WORK

2.1 OVERVIEW OF THE SW LIFE CYCLE (SDLC) MODELS

2.1.1 BACKGROUND

The significance of digitization, Internet of Things (IoT), Robotics Process Automation (RPA), Machine Learning and Artificial Intelligence (AI) in the various areas of life has led to the remarkable expansion of the Information Technology (IT) industry in the world. IT and ITeS (IT enabled Services) sector has evolved rapidly over the last four decades in India. As per the annual report of NASSCOM (2015-16), this sector generated revenue of around US$147 billion in 2015.

The following points highlight the present growth of the IT market in India (NASSCOM annual report (2015-16) and India Brand Equity Foundation highlights (2017)) --

- Revenue generation by the Indian BPM (including hardware) and technology sector may yield US$ 160 billion for the duration of FY16. This is in comparison to US$ 146.5 billion in FY15. This indicates a 9.2 per cent growth rate.
- The Indian IT sector contributed around 9.5 per cent to India's GDP in FY15. In FY 98, it was 1.2 per cent
- 10.4 per cent of the Indian IT & ITeS sector (total) revenue is accounted by TCS which is the market leader in FY16
- Over 25 per cent of the total industry revenue is contributed by the top five IT firms. This indicates that the competition is quite high in the market place.

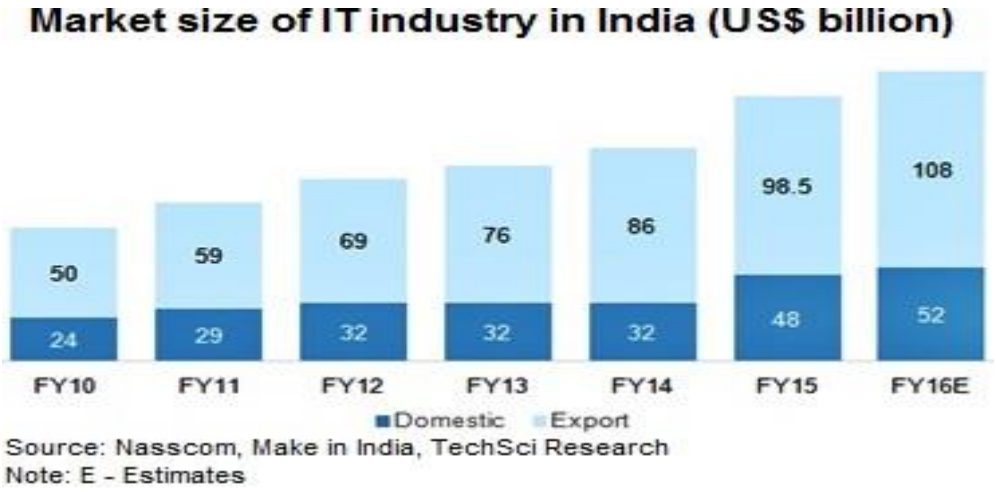


Figure 2.1: Indian IT industry market size (US $ billion)

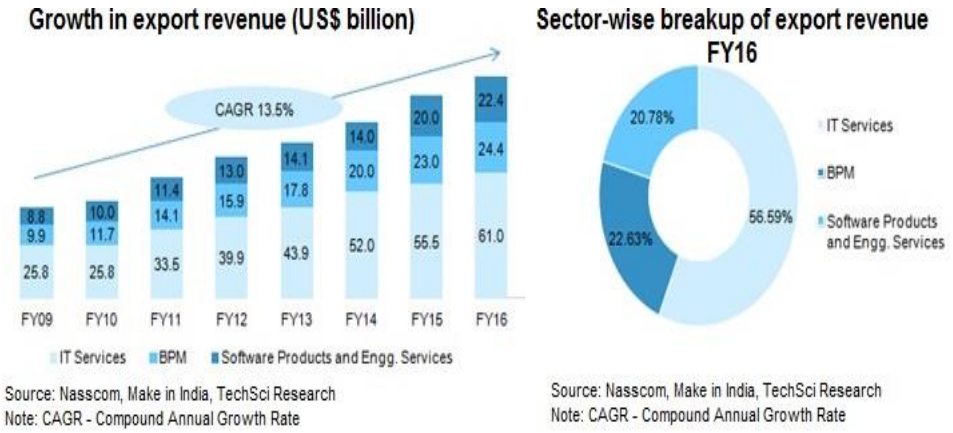


Figure 2.2: Export Revenue Growth (US$ billion) and Export revenue – Sector wise breakup (FY16)

- Substantial demand has been created by the Indian IT industry in the sector related to education, more specifically in engineering and computer science areas. The ITeS and IT industry in India is distributed into four major categories – Engineering services and hardware, software products, Business Process Management (BPM) and IT services. The transformation of the economy in the country has been led by the IT industry and this has transformed the awareness about India in the global market place. The growth rate of the IT sector in India is estimated to increase at about 12 to 14 per cent for FY 2016-17 (constant currency terms). The IT sector is also estimated to increase its current annual revenue by three times and it is anticipated that it will reach US$ 350 billion by the financial year 2025 (NASSCOM Annual Report, 2015-16). The world's biggest destination which is used for sourcing for the IT industry is India. Around 67 per cent of the total US$ 130 billion market is accounted by India. 10 million members are employed by the Indian IT industry. IT services which are provided by the Indian IT industry are about 3-4 times cheaper than the US IT services. This is the main USP of India in the global outsourcing market. With respect to intellectual capital, India is viewed as an important player as many global technology organizations have set up their centers for innovation in India. Many members working in start-ups from India such as Ola, Snapdeal, Flipkart and other start-ups have themselves created more than 700+ start-ups on their own. This has led to the increase in the number of start-ups in the ecosystem in India. In the world start-up environment, India is placed third among the global start-ups. India has more than 4,200 start-ups (Report by

NASSCOM and Zinnov, 2015). The security and banking organizations in India spend a lot on IT and this is estimated to increase by around 8.6 per cent each year to US$ 7.8 billion (by 2017). The economy related to internet in India is estimated to reach around Rs. 10 trillion (US$ 146.72 billion) by 2018. This works out to about 5 per cent of the country's GDP (Report – India@Digital.Bharat – BCG and IAMAI, 2015).

The IT sector has also contributed in generating employment and as per the 2014-15 Economic Survey, Indian ITeS and IT industry directly employ 3.5 million people every year and by the year 2020, the employment generation by this sector is expected to reach around 20 million. The survey also highlights that the "Make in India" mission of the Government has included IT and Business process management among the twenty five focus sectors. Thus, the study of software development projects and the focus on the characteristics of agile teams in the project development context is relevant in the current scenario.

2.1.2 SOFTWARE DEVELOPMENT PROJECTS

Project Management of software projects has been playing a prominent role since 1960's in providing an appropriate framework for planning, control and analysis of a software project. However, despite the established software project management principles, software projects have not been very successful and it is important to focus on the failure of projects in terms of budget and time overrun (Standish Group, 2008). Software project success is defined as the one which is completed within time, budget and as per functional specifications (mapping to business value for the customer after the implementation of the software) (Nokes, 2007; Moran, 2009; Nasir & Sahibuddin, 2011). Thus it is important to understand the various factors that make a software project successful. The failure rate of software is a major concern for the professionals even after the application of software project management principles for many decades.

Software development is a complicated process as it can be considered as a science/art. Additionally, as compared to other engineering projects, it is more complex and inconsistent and the nature of the end product is not tangible and this is also applicable for software project management. Hence, digitization and the development of a cost

effective and real time digital solution is a matter of survival in today's business scenario. However, the software products currently being developed by the industry are not able to fully satisfy the earlier criterion appropriately. In the waterfall software development model, a project has a typical life cycle which moves from the conception stage to the closure of the project. Project conception and initiation is focused on the need to find out if it benefits the organization and if the feasibility of the project is possible to be worked out. Project definition and planning stage is focused on creating a project charter/project plan along with project scope that indicates the scope of the work which needs to be executed. In this stage, the project is prioritized by the team. The team works out the budget. The team also plan the schedule and work out the people needed for the project. The third stage is focused on the launch and execution of the project. The tasks undertaken by the staff are allocated to the members and the responsibilities of the members are indicated to them. The project performance evaluation and analogous controlling measures are an ongoing process which is indicated as the fourth stage/phase. The project status and the progress of the project to the actual plan is monitored by the project manager while the members are executing their activities. In this phase, the schedules may need to be modified by the project manager and he may need to undertake specific activities to ensure that the project does not slip and go off the track. The last phase of any project is the closure phase. An assessment is undertaken after the project activities are completed and the approval has been given by the client. The assessment indicates the outcomes of the project (success or failure) and it also identifies the lessons learnt during the project duration. In different industries, the processes for projects and project management are different and the processes focus on the traditional aspects of the project undertaken as per the waterfall software development life cycle (PMBOK, 5th Edition, PMI, 2013). The main goal of undertaking a software development project is to generally focus on offering a product that automates a process, solve a problem that benefits the customer/organization or for the purpose of improving the outcomes for the customer/organization. The focus on rapid time to market (TTM), improved product quality, capability to counter recurrent market changes, global SW development (GSD) and the development of communication technology has led to the popularity of agile SW teams and the usage of agile SW methodologies in software development projects. In recent years, the rapid development of IT outsourcing across multiple geographies and the collaboration among geographically distributed teams has led to a high focus on the ability to manage

change and deliver good quality software products/services/applications as per the appropriate cost, quality and schedule parameters along with the focus on the business value for the customer/organization. Hence, it is very essential to understand the key performance indicators of IT project success involving agile software development teams. The following sections highlight the different models of software development life cycle (SDLC) that are practiced by the software development teams in the industry.

2.1.3 DIFFERENT TYPES OF SDLC MODELS

The user requirements were assumed to be stable during the initial years of software development and SW was expected to be developed as per the plan without any major changes to the SW. But as the SW developed became more important to the business, other issues began to emerge as the organizations began to grow over a period of time (Hnief and Hock Ow, 2009).

The issues focused on the following factors -

- Customer involvement: Many organizations generally do not allocate any effort for involving the customer during the development of the SW. This may lead to a higher probability that the project may fail due to the customer not being involved during the course of the project.
- Evolving requirements: The requirements given by the customer are varying frequently as the market needs are also evolving frequently. Hence, almost all the customers are having an unclear vision regarding their requirements during the initial phase of the project. A few customers understand their actual requirements only after they have used an application which does not really meet their need. On the other hand, some of the customers use an application like a proof of concept and subsequently, they are able to understand their requirements more effectively. Another source of change is the experience and learnings gained during the course of SW development.
- Miscommunication: Another focus area is the miscommunication that occurs between the SW team and the customer. This leads to not understanding the requirements properly. For e.g., each entity has its own jargon and hence, there is a degradation of communication and the consequent loss in understanding the requirements of the customer.

- ❖ Deadlines and budgets: Generally, customers do not like to focus on failure. However, organizations usually have budgets that are truncated and deadlines that are constricted. Additionally, the organizations need to focus on building superior quality products while also ensuring that the product/service is delivered quickly. This is due to high competition in the market place.

Thus, different types of SDLC models evolved over a period of time focusing on the critical characteristics of how to improve the delivery model and thereby leading to improved focus on cost, schedule, quality, effort, business value and other parameters. The types of different SDLC paradigms are given in the ensuing sections.

2.1.3.1 SDLC MODELS

With a view to improving the quality of the software products/services, time to market and other attributes, various types of frameworks were created during the preceding fifty years (Pressman, 2001). But these frameworks were observed to be successful in varying degrees. Additionally, it is observed that no specific approach can prevent the failure of the project under all scenarios. A critical understanding of the project context and the application of an appropriate and judicious SDLC model that may meet the needs of the project may lead to an improved probability of successfully meeting the project and customer requirements. SDLC Model is a process structure that is executed for developing a SW product/service/application (Gupta, 2015). Several different types of models are available for these processes and each of these processes define the different methods/practices that could be implemented to complete different tasks/activities as part of the process. The activities that make up the SW engineering processes are as given below -

Analysis (requirements) and Design, Architecture (software), Coding or Implementation, Test, Product/Service Documentation, Release, Post Release Support and Training, Production Support/Maintenance/Operations

(Source – Stylus, Inc., 2017)

Figure 2.3: Model - SDLC

Even though, a number of SDLC models are available, each organization adopts the appropriate SDLC model which is best suited for the particular project and which increases the output of its team members. This may indicate that a higher probability of project success is possible when viewed in relation to cost, schedule, quality and business value apart from customer satisfaction.

The different types of SDLC models are -

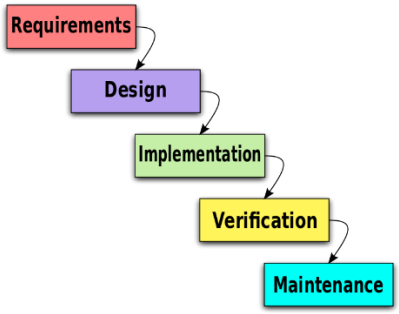
Waterfall model –In this model, there are individual and discrete phases for the requirements, design, code, test and other phases. Prototyping model – The prototype is initially created and based on the feedback, further development takes place. Evolutionary development –In this model, the requirements, development and test phases are interwoven. Rapid application development model (RAD) – Emphasis on delivering the project in small pieces. Incremental model/Iterative Enhancement model– Focused on incremental/iterative model of development. Spiral model – risk driven process model for software development. V – Model – This model could be viewed as an addition to the waterfall model. SW engineering (component based) model–In this model, the overall systems are built from the prevailing components. Agile – focus on iterative, incremental, risk driven and client focused approach to software development (Jovanovich and Dogsa, 2003).

Additionally, there are many alternatives for these SW life cycle models where the development process may entail the usage of a formal waterfall type of model but the requirements and some other phases could be evolutionary through an iterative refinement process.

The basic activities/processes that are executed while building SW systems are - Identification of the requirements (customer and market need), Designing the system, Software Implementation (code), Testing of the system, Release of the system (software), Maintenance and support of the system (change management, bug fix, new enhancement releases), The important characteristics of some of the key SDLC models are given below -

1. **Waterfall Model**

In this model, the phases are in sequential mode and the various steps followed in this model are Initiation, analysis of the requirements, design, code, test, deploy to production and maintenance (Royce, 1970).



(Source – Wikimedia, 2017)

Figure 2.4: Model - Waterfall

Basic Principles

The development process is improved if there is a project life cycle plan that is available. If the problems are clearly defined, they can be solved easily. If the code is structured, then the code structures can be traced. A by-product of the development process is system documentation.

Advantages of Waterfall Model

It is appropriate for those projects where the customer requirements and needs are clearly understood. As the model is somewhat rigid, it is easy to manage and each stage

has a stage gate review process and there are specific deliverables for each stage. The model is simple, easy to understand and can be implemented easily. The stages do not overlap with each other and the stages are generally completed one stage at a time.

Disadvantages of Waterfall Model

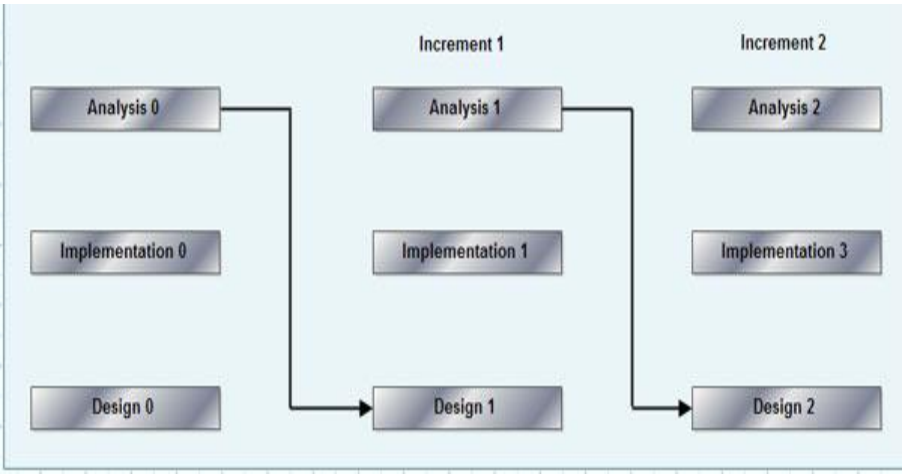
It is difficult to use for complicated and object-oriented projects. There is a high probability of risk and uncertainty. Software that is working and provides business value to the customer is available only later in the life cycle of the project. Not fully suitable for long and ongoing projects. If the application is in the testing phase and if it is required to make a change, then it becomes very difficult, especially if it is not well thought through during the concept phase.

2. Incremental/Iterative Enhancement Model

In an iterative life cycle model, the development begins by understanding the initial specification and the software is then implemented. This implementation is further enhanced by understanding additional pieces of the requirements of the customer. This process is iterative and a new version of the enhanced software is produced incrementally after each cycle (Jamwal, 2010).

Key Principles

The conditions, constraints, requirements and specifications of the customer are managed through the usage of use cases and understanding nonfunctional requirements. Tasks are not focused per se. In order to meet the schedule dates, budget targets and the business goals, the requirements are managed appropriately.



(Source – http://www.ecomputernotes.com, 2017)

Figure 2.5: Incremental/Iterative Enhancement Model

The focus is on starting with a very beginning with a modest implementation of the subset of the customer requirements. This highlights the key attributes of the system parameters -

The focus is on the implementation of diminutive cycles that vary from 1 to 6 weeks. This is made up of phases that overlap with each other – initial requirements, design, code, test, release and production support. Design for small sets of related requirements that are focused on isolated, easy-to-find modules that can be grouped. Finish or re-code one module per iteration. The need for redoing design/code may be necessitated if there are problems in design/code/test. During the iteration, the scope for the specific iteration cannot be changed by the external customer or the project manager. However, the team may modify the scope by truncating features if there is a possibility that it may be difficult to meet the end date. Re-design may be needed if modifications are difficult to implement as the iterations progress.

Advantages of the Incremental/Iterative Enhancement Model

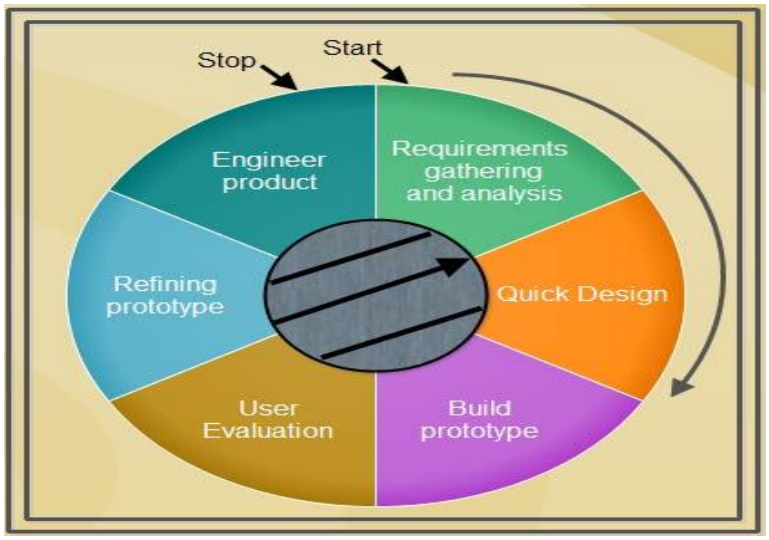
This model represents the software process in a better manner. The later stages in the model can receive feedback, as required. Projects where the requirements are not clear or not well understood can use this model.

Disadvantages of Incremental/Iterative Enhancement Model

Milestones are not clear in the development process. System architecture or design issues may be costly. This is due to the fact that all the requirements are not captured fully in the initial stage. Additional rigidity as there is no overlap in each phase of an iteration.

3. Prototyping Model

In order to understand the initial requirements better, a proof of concept (PoC) is built and which could be disposed if not required. This helps to understand the requirements in a better manner as compared to freezing the requirements in the initial stage itself. Based on the current known requirements, the prototype is developed. By using the PoC, the customer gets to have an actual experience of the product/service and this helps him to better understand the requirements of the system (Gomaa and Scott, 1981).



(Source – http://www.ecomputernotes.com, 2017)

Figure 2.6: Prototyping Model

Basic Principles

Prototyping model focuses on understanding a small area of the requirements and then expanding the implementation to include other parts of the requirement. This helps to improve the probability of success as the customer is able to understand the needs of his system in a better manner. This model is preferred when we need to have a lot of interfaces with the end users. As the project is broken up into multiple sections and there is also adaptability during the requirements stage, the risk in the project is reduced. As feedback is provided periodically by the end users who are using the system, the feedback is fed back to the prototype. The prototype is then modified based on the feedback comments from the customer. This results in a fit for purpose system which meets the needs of the customer.

Advantages of the Prototyping Model

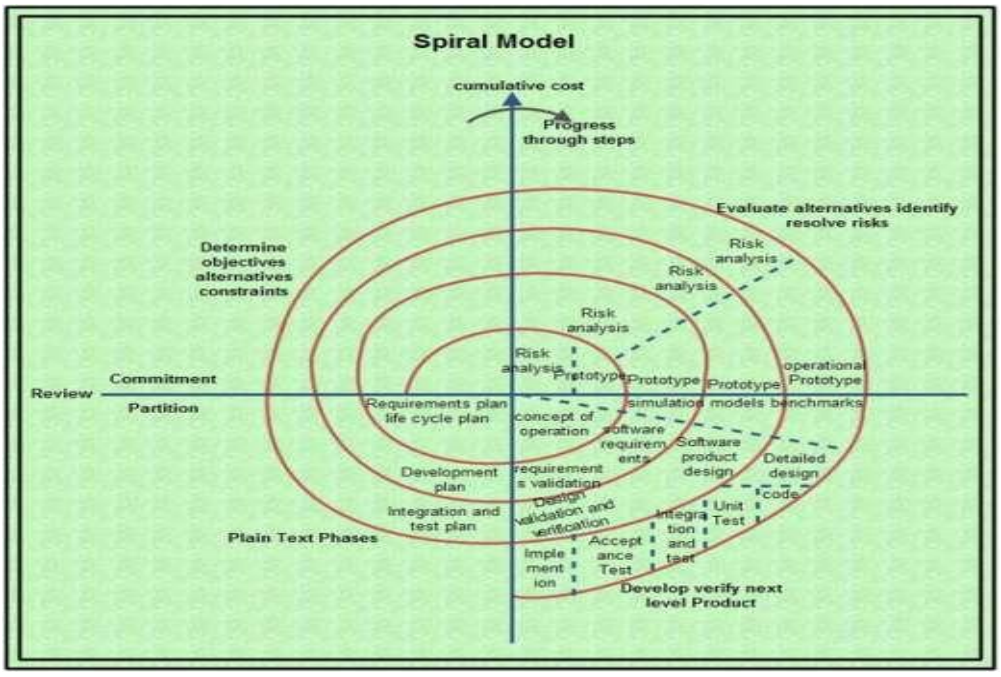
Active involvement of the users in the development of the prototype. The users have an improved perception of the system under development since a model (working) is accessible to them. Detection of errors much earlier in the life cycle. Identification of confusing/difficult functions.

Disadvantages of Prototyping Model

There is a likelihood that the systems may be left unfinished. There is a likelihood of the implementation of the systems before they are ready.

4. Spiral Model

The spiral model is a model (process) that is focused on being driven by risk (Boehm, 1988). It helps a team to focus on the specific sections of other models (waterfall, prototyping (evolutionary) or incremental) based on the specific patterns of risk that are identified.



(Source – http://www.ecomputernotes.com, 2017)

Figure 2.7: Spiral Model

Basic Principles

Complex Requirements to be managed in the project. Users are not clear or sure about their needs. Throughout the life cycle, the focus is on cost and risk assessment.

Advantages of Spiral Model

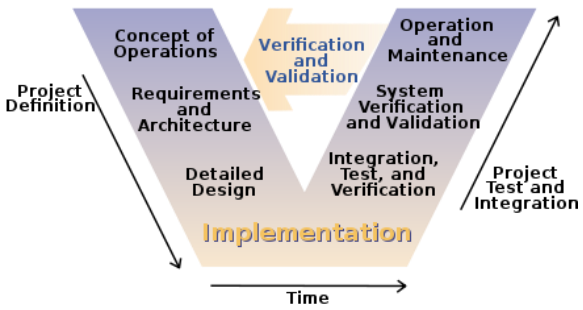
Production of software early in the life cycle. Additional Functionality can be added later in the life cycle. On account of the high focus on risk analysis, risk avoidance is improved. Focus on clear approval and documentation control. Suitable for mission-critical and large projects.

Disadvantages of Spiral Model

It does not work well for smaller projects. The phase where the risk is analyzed is crucial for the success of the project as this helps to focus on the overall approach that needs to be adopted for the project. Due to the repetitive focus on risk analysis, the cost of the project can become very high. Specific expertise is needed for risk analysis.

5. V Model

The V-Model can be considered as an extension of the waterfall model. A typical V-shape is formed as the process activities are bent in the shape of a V. The horizontal axis focuses on time and the completion stage of the project (Yadav, 2012). The vertical axis focuses on the level of project abstraction (upper level specifies coarse grain abstraction). The V Model links the specific stage of the development cycle with the specific stage of the testing process (Wikipedia, 2017).



(Source – Clarus Concept of Operations, 2005)

Figure 2.8: V Model

Basic Principles

It is considered as an extension of the waterfall model. The focus is on the linkages between the specific stage of the model and the testing phase. Focus on a highly disciplined approach to software development.

Advantages of V Model

Promotes design, development and documentation that is required to develop stable products. The model is simple, easy to understand and can be implemented easily. Each phase of the model has an associated testing phase that helps to validate the product.

Disadvantages of V Model

It is a simplistic model. Hence, it does not highlight the actual complexity of the SW development process in reality. No inherent ability to respond to change. Lacks coherence and precision. Implicitly encourages ineffective testing methodologies.

Features	Waterfall Model	Iterative Model	Prototyping Model	Spiral Model
Requirements Specification	Beginning	Beginning	Frequently Changed	Beginning
Cost	Low	Low	High	Expensive
Simplicity	Simple	Intermediate	Simple	Intermediate
Expertise Required	High	High	Medium	High
Risk Involvement	High	Easily Manage	Low	Low
Overlapping Phases	No	No	Yes	Yes
Flexibility	Rigid	Less Flexible	Highly Flexible	Flexible
Maintenance	Least Glamorous	Promoted Maintainability	Routine Maintenance	Typical
Reusability	Limited	Yes	Weak	High
Documentation Required	Vital	Yes	Weak	Yes
User Involvement	Only At Beginning	Intermediate	High	High
Cost Control	Yes	No	No	Yes
Resource Control	Yes	Yes	No	Yes
Guarantee of success	Less	High	Good	High

(Source – Gupta, Ashish Kumar, 2015)

Table 2.1: Key SDLC Models – A Comparison

SDLC models help to facilitate the SW development team to adopt the key steps of the specific SDLC so that the team can create software that meets the need of the customer appropriately. Each individual model has been built on the earlier gaps observed in the older models thereby addressing the weaknesses of the earlier models. An analysis of all the SDLC models indicates that -

1. The models - Waterfall and Spiral are used by many large organizations for their internal projects and other projects. However, projects that have many changing requirements that need to be managed appropriately over a period of time are

increasingly being managed using agile methods. A survey of development and IT professionals indicated that agile is now being used by many companies in the IT/ITeS domain (TechBeacon, 2015). The majority of development teams and projects now at least use agile in some form or the other and have embraced the methodology, while pure waterfall approaches are becoming less used by the organizations. The study consisted of an online survey of about 600 software developers and IT professionals by Hewlett-Packard (HP).

2. For developing systems with different requirements, many of the existing SDLC models can be used.

3. New models that are developed try to address the shortcomings of the older models. Additionally, each model can have its own plus points and minus points when systems are developed using these models. Thus, the new models try to address these gaps.

4. SW development – Agile Model - The key characteristics of agile SDLC model are given in the following sections (Ionel, 2009).

2.1.4 OVERVIEW OF LEAN

Lean is a method that is focused on shortening the time from concept to cash and focusing on maximum business value delivered to the customer in the shortest possible time through the elimination of waste in the system (muda). It was actually a derivative of the knowledge gained from lean manufacturing / lean production techniques. It was subsequently applied to SW development. It is also focused on reducing waste through muri (waste due to unevenness) and mura (waste due to uneven workloads). Lean SW development (LSD) is a method that focuses on transforming the lean IT principles and the principles derived from lean manufacturing and applying it to the SW development processes (Wikipedia, 2017). The renowned car manufacturer – Toyota had created the Toyota Production System (TPS) and Lean is adapted from this system.

Lean software development focuses on seven key principles which are very similar to the concepts prevalent in lean manufacturing (Poppendieck and Poppendieck, 2003) -

- Amplify learning–When developers are writing code in the iterations, they are also learning how to improve the code base. Hence, SW development is focused on continuous learning. Additionally, when developers write the code based on their understanding of the problem domain, they are focusing on the design

process which is actually a problem solving exercise. SW business value is measured with respect to meeting the requirements of the customer and also meeting the fitness for use.

- Eliminate waste - Lean philosophy focuses on all activities that is considered as waste for the customer and which does not add value for the customer. The classification of the different types of waste is given below (as applicable to software development) -
    - Time spent waiting for some activity/person
    - Work that is partially done
    - Defects
    - Motion
    - Management activities
    - Switching of tasks
    - Processes that are extra
    - Features that are considered as extra

Waste is identified using the value stream mapping (VSM) technique. Subsequently, the causes of waste are investigated and these sources of waste are then studied to see how they could be eliminated or reduced.

- Decide as late as possible–Options based approach is generally used as SW development is a knowledge-based work that is linked to uncertainty. This may lead to better outcomes. Hence, if the decisions are delayed until the last responsible moment, they can be decided based on the actual facts rather than being based on assumptions and estimations that are uncertain. This in turn facilitates the development of SW with better quality.
- Deliver as fast as possible – On account of changing market place priorities, customers focus on the time to market of a product/service. Hence, the quicker the service/product is delivered to the customer, the better it is as quicker feedback can be obtained and the changes, where required can be integrated into the next product/service increment as part of the next sprint/iteration. Thus, this focuses on evolving the product/service as per the needs of the customer and also meeting the customer requirements.
- Empower the team - The members who are involved in product development are also involved in taking decisions. Hence, the team is empowered to take decisions as they know how the product is evolving over a period of time.

- Build integrity in–The focus in this principle is on ensuring that the customer has an overall beneficial experience regarding the system. This aspect is known as perceived integrity which focuses on how the system is perceived by the customer, how it is advertised, delivered, accessed and deployed, how intuitive its user interface is and other factors. Similarly, conceptual integrity focuses on how well the system is integrated and how the system's individual components work together as a whole system and how the balance is maintained with respect to maintainability, efficiency, flexibility and responsiveness. Thus, in the case of perceived integrity, the focus is on how the user/customer perceives the system whereas in the case of conceptual integrity, the focus is on the integrity of the system. This can be achieved through the implementation of a simple design and architecture that is fit for purpose, usable, extensible, maintainable and flexible.
- See the whole–It should be possible for the team to see the big picture based on the vision and the business objectives.

Some types/examples of lean practices are – Value Stream Mapping (VSM), Seeing Waste, Set Based Development (SBD) and Queuing Theory. As agile software development is an all-encompassing expression indicating the set of methods, practices and frameworks that are based on the agile values and agile principles as articulated in the Agile Manifesto and as LSD is based on the agile manifesto, it is also considered as an agile SW development method.

2.1.5 OVERVIEW OF AGILE

Agile SW development is based on the agile manifesto which consists of a set of values and principles for SW development (Al-Zewairi, Biltawi, Etaiwi, and Shaout (2017)). The customer requirements and the customer solutions progress through the integrated effort of the teams which are cross functional and self-organizing in nature (Agile Manifesto, 2011; Wikipedia, 2013). This facilitates quick feedback, adaptive planning, iterative delivery and continuous improvement. It also facilitates quick response to change. The agile values and principles form the bedrock of the agile mindset and which facilitates the development and evolution of the various agile methods, frameworks and processes. The word agile was first thought up in 2001 as part of the Agile SW Development Manifesto.

Basic Values and Principles

The important aspects of the agile manifesto are given below in the form of "Values" –

(Source – Agile Serbia, 2015)

Figure 2.9: Agile Manifesto - Values

The secondary aspects are important, but the primary aspects are considered as very important and critical for project/delivery success. This indicates the following characteristics–

- **Individuals and interactions**

  The focus is on people and other factors like motivation and self-organizing teams are considered as important. It also meant additional focus on interactions with people through practices like pair programming and being co-located.

- **Working SW**

  Working SW is taken as the ultimate proof of delivery and as the most important product/service delivered to the customer. It is considered to be more effective and useful as compared to the preparation of only documents.

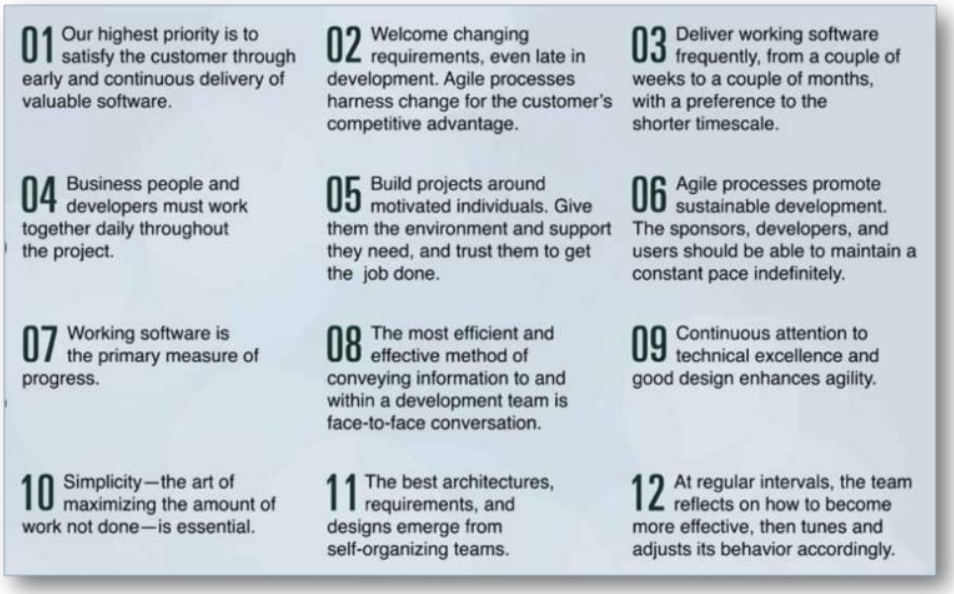
- **Collaboration with the Customer**

  Discussions and collaborating with the customer is considered as an important activity. It is known that all the requirements cannot be collected in the beginning of the life cycle. Hence, continuous periodic interactions with the customer is considered to be of paramount importance for project success.

- **Change Responses**

The focus is on responding to change quickly rather than focusing on a plan that is static. This also leads to focusing on continuous improvement and development.

The important principles of the agile manifesto are given below –



(Source – Herding Cats, 2014)

Figure 2.10: Agile Manifesto - Principles

There are many agile methods/frameworks/methodologies which have as their source – agile values and agile principles. Scrum is a popular agile framework that is used by many organizations to deliver better software to their customers. Other agile methods are Kanban, XP, DSDM, Crystal, FDD and other methods.

Scrum

Scrum is a framework which is based on the agile values and agile principles. It is more suited for projects that generally operate in the complex domain. Scrum was initially created for SW development projects, but it can be used for any innovative and complex type of project in any domain (Almseidin, Alrfou, Alnidami and Tarawneh (2015)). The key activities/processes carried out in Scrum are given below –

The product owner initially creates the product backlog which contains the list of work items that need to be completed over a period of time. It is generally a wish list as it contains all the conceivable items that the customer would like to have in the

product/service. The work is carried out through releases that are made up of sprints (one sprint is usually ranging in duration from one week to four weeks). The requirements obtained from the customer are in the form of epics/user stories. Subsequently, on the first day of the sprint, the sprint planning ceremony is held. During the meeting, the team and the product owner discuss together to work out the approach to be followed for the completion of the user stories or epics maintained in the product backlog as part of the first sprint. Thus, the team commits to a set of user stories in the initial sprint. The output of the sprint planning meeting is a sprint backlog that contains the user stories and how it will be completed by the team in the sprint. The team meets daily and which is time boxed to 15 minutes. This meeting is called the Daily Scrum meeting. In the meeting, the team assesses the work done, to be done and roadblocks/challenges, if any. The Scrum ceremonies and the events are facilitated by the ScrumMaster. He facilitates the team to stay focused on the goal (sprint and release goal). On the last day of the sprint, sprint review and sprint demo is held. The demo is held with the product owner, customer, if available and other stakeholders. They indicate whether the product/service increment met the goals committed at the beginning of the sprint. At the completion of the sprint, the work should be potentially shippable, i.e. it should be possible to ship the software product increment/software service to the customer, if needed. The sprint closes with the sprint retrospective. Sprint retrospective focuses on continuous improvement and how to improve things in the next sprint. An analysis of the past sprint activities through various methods helps to identify which areas could be improved further as part of the continuous improvement activities. Finally, as the next sprint begins, the team again picks another set of work items from the product backlog and the same steps as indicated above is repeated. Finally, the release is made as per the requirements. The above process is repeated for each release.

(Source – Scrum Alliance, 2017)

Figure 2.11: Scrum

Advantages of Agile Model

Focused on iterative, incremental, risk driven, business value development. The model is simple, easy to understand and can be implemented easily. Customer and market focus ensures higher success of the project.

Disadvantages of Agile Model

Not fully suitable for fixed price contracts if other constraints like scope are not negotiable. Not easily implementable if customer/customer proxy is not available for the project. Not easily implementable for government/regulatory projects in the healthcare/aviation domain on account of high level of documentation, process and standards to be followed.

2.1.6 HIGH LEVEL CHARACTERISTICS OF AGILE TEAMS

The basic high-level characteristics of agile teams are given below -

Team members should follow and practice the agile values and agile principles. The team is a cross-functional team. The team is also empowered and self-organized which indicates that it has the trust of the stakeholders. The team delivers work at a sustainable pace in order to deliver high quality software. The team is comprised of self-motivated people who have the necessary competency and skills as well as the commitment and motivation to be in the team. The team members trust each other in order to complete the work successfully. Work activities of the team members reflect uniformity and are

aligned to the team goals. The capacity of the team and the support from the team members is taken into account while executing the work so that timelines are worked out rather than being forced on the team. Members exhibit Servant Leadership qualities. Members may also be co-located, long lived, cross functional and empowered/autonomous teams in which case they may also be considered as feature teams. Finally, the consideration of the agile team as a complex adaptive system (CAS) is also one of the key high-level attributes (McGeachy, 2010), (Jain and Meso, 2004).

The performance of the agile team is not up to the mark and it is affected if the above mentioned basic traits are missing in the team. The team may then become dysfunctional and it is not in a position to manage and respond to the quick changes occurring in the market place. This affects the quality of work output and the team is not able to meet the customer expectations appropriately.

Besides these attributes, additional characteristics of agile teams are given below -

- Clear Roles and duties (responsibilities)
- Transparent Communication
- Effective conflict management
- Collaborative environment
- Goal Clarity
- Value Diversity
- Leadership through participation (situational leadership)
- Effective decision making
- Well managed team relationships

The above characteristics are expected to be present in a typical agile team and when a suitable framework is applied to an agile team based on the project requirements, the probability of the team to respond to market changes quickly and successfully and deliver the product to the customer is increased considerably.

2.1.7 SUMMARY

The above sections focused on the different types of SDLC models and how agile compares with the other models. It is observed that agile models are suited for projects that have changing requirements and which require the ability to respond quickly to the customer and market changes. By defining the high-level characteristics of agile teams and evolving a framework to identify the characteristics, the probability of the agile team to deliver software product/package/application/service to the customer is

improved significantly. Additionally, the appropriate agile method may be used depending on the project context.

Many organizations (IT/ITeS – Domestic/MNCs) in the industry are already focused on the usage of agile teams to deliver software and some of them are – Infosys, Wipro, TCS, Cognizant and HCL Group (service organizations); Symantec, Cisco, Google, Yahoo, Amazon, Facebook, Apple (product/design organizations) and other organizations. Many of these organizations are trying to improve the delivery success of their agile teams. The identification, evolution and creation of a framework for identifying the key characteristics of agile teams will add to the existing knowledge repository in this area. It will also help the industry to improve their delivery success ratios through appropriate identification of the key characteristics of agile teams which could lead to improved work outcomes.

2.2 PERSPECTIVE ON COMPLEX ADAPTIVE SYSTEMS (CAS)

2.2.1 INTRODUCTION

Many artificial and natural systems (e.g. artificial intelligence systems, parallel and distributed computing systems, brains, immune systems and societies) are described by seemingly complex behaviors that emerge as a result of the spatial/temporal interactions that are often nonlinear among a large number of component systems at different levels of the organization. These systems have generally come to be known as Complex Adaptive Systems (CAS) (Honavar, 2001). A complex adaptive system is generally a system in which a complete understanding of the individual parts of the system does not necessarily and automatically imply a complete understanding of the whole system's behavior (Wikipedia, 2017). The study of complex adaptive systems is interdisciplinary as it incorporates various disciplines like systems theory, team dynamics and other areas and it focuses on composite insights from the natural and social sciences to develop models at the system level and understanding that allow for heterogeneous agents, phase transition and emergent behavior.

2.2.2 DEFINITION OF CAS

A CAS is generally made up of a large number of entities known as agents. These agents behave as per a set of guidelines. The agents adapt to the requirements of other agents. This helps them to interact with each other. Important concepts of CAS are - emergence, feedback loops, hierarchy, self-organization, robustness, edge of chaos and inter-connected autonomous agents. The rules necessitate the agents modify their behavior as per the other agents existing in the system. A software development team is anticipated to be made up of autonomous team members who have their own schemata (values, beliefs, standards) that are held by individuals (Senge, 1990; Schein, 1997).

2.2.3 ROLE OF CAS IN ORGANIZATIONS

In organizations, the role of agile teams as complex adaptive system (CAS) ensures that the agile teams are considered as teams made up of agents and follow the rules and guidelines of CAS. Agile teams are observed as complex adaptive systems (CAS) (Appelo, 2011). Traditional general systems theory (Bertalanffy, 1950) is not found to be fully adequate to explain the key reasons regarding the characteristics of agile teams. When a human agent is introduced as per systems theory, then the nature of the system is changed and the way to study that system is also changed. Hence, focus needs to be given on also incorporating and studying additional human traits like pride and other factors and these aspects are also observed in more detail in teams (Peterson & Seligman, 2003). The interplay of these factors across agents working in a CAS also needs to be focused so that the attributes of the agile team take into account the focus on CAS.

2.2.4 SIGNIFICANCE OF CAS

As per systems theory, systems are organized into three types -animated or un-minded systems; social and which are also known as multi-minded systems; and deterministic or mindless systems (Gharajedaghi, 1999; Ackoff, 1999). When human agents are introduced into a system, then the focus is on the human behavior. The focus is on how system and subsystem goal align with each other and how the role of CAS is incorporated into the agile team characteristics and this is different from the typical models (cause and effect) of human behavior. Focus is on exploring the interactions among the various system levels and how CAS theory influences agile team behavior and actions.

2.2.5 UNDERSTANDING CAS

The systems is separated from its environment by boundaries as per conventional systems theory. This is due to the effervescent interactions among the community network and the porous character of the structural borders in reality (Merali, 2004). Mechanical systems are generally modular but the nature of individuals is not modular. If this aspect of non-modularity is not taken into account by the process models and the system models, then the outcomes will be very different in reality as compared to theory. Hence, the focus of agile teams functioning as CAS is important to understanding the characteristics of agile teams.

2.2.6 CONSIDERATION OF AGILE TEAMS AS CAS

If the agile teams are not considered as CAS, then the characteristics of the CAS will not be covered in the attributes of agile teams. This will lead to the degradation in the performance of the agile teams as their focus and attributes will be affected and the teams may not be able to deliver successfully. In order for agile teams to be fully functional, the focus of agile teams as CAS needs to be considered as the guidelines/rules of CAS and the attributes of an agile team are fully coherent and match the principles and characteristics of agile teams.

2.2.7 PREVIOUS RESEARCH RELATING TO CAS

The focus on the key factors in agility and discerning their mapping linkages with the CAS concepts further bolsters the positive relationship between improved work outcomes and the understanding of the agile team as a CAS. When viewed through the CAS lens, some of the key aspects of agility – autonomous and sharing team pertaining to the attribute – inter connected autonomous agents and self-organizing teams indicates a strong linkage (Anderson, 1999; Mitleton-Kelly, 1997, 2003) toward understanding the influence of CAS while considering the attributes of agile teams. Similarly, from the agility perspective – stability with uncertainty linked to the edge of chaos (CAS concept) (Brown and Eisenhardt, 1998; Stacey, 2003) is also linked/mapped along with the third agility variable – team learning is linked to the CAS concept of emergence (Mitleton-Kelly, 2003; Stacey, 2003). All these variables indicate the power of CAS as a key area to be considered while working out the characteristics of agile teams.

The concepts related to the brink of disorder facilitates the organizations with adequate independence and incentive to try out and adjust their structures. It also provides them

with appropriate guidelines and edifice to guarantee that they escape full disordered breakdown. Additionally, establishments must know what to construct and what not to construct so that they can promote collaboration and also gain cross-domain interactions in order to compete at the brink of disorder (Brown and Eisenhardt, 1998). Being agile is neither chaotic nor static and it needs stability but not to the extent that innovation is suppressed and order is present as per the edge of chaos concept. It is a delicate balance of both the factors. The concept of emergence focuses on learning. Learning is considered as a collective behavior of producing new thought patterns occurring at the team level. The learning is based on the interaction of the agents within the team instead of being the prerogative of individual learning. Learning focuses on gaining insight and new understanding which leads to original knowledge and behavior apart from training and acquisition of new skills. The team is considered to have adapted and evolved to a new state when learning leads to new behavior (Mitleton-Kelly, 2003). An agile team behavior and activities leads to new team learning and creation of new knowledge which is shared among other agents within the team. This leads to further generation of new learnings, insights, knowledge, wisdom and behavior. Hence, the role of CAS as a key independent variable in the context of agile teams and the focus on important variables – autonomous and sharing team through agents, team learning and stability and embracing uncertainty highlights the importance of CAS as an influencing factor in the consideration of key characteristics of agile teams. These aspects can be focused only through the consideration of the agile team as a CAS. If we do not consider the agile team as a CAS, then the focus on the CAS attributes are annulled and the agile team may not perform very effectively. This will lead to ineffective work outcomes. It also specifies how the role of CAS influences the inter-relationships and the role of other variables that constitute the important characteristics of agile teams.

2.2.8 SUMMARY

The above sections highlight the role of CAS acts as a deep force which is at work in agile teams and which highlights the value of agile methods. High levels of community acceptance, responsibility and sustenance are facilitated by agile practices like sprint planning meetings and daily standups. The role of information radiators which improve the team awareness regarding the activities being undertaken by the project team, cross pollination of information and other factors enhances the emotional state of the

individuals toward safety, security and control in the work environment. The software engineering area focuses on agile teams as self-organized teams and this is another key aspect of CAS. Hence, CAS is an inextricable and interlinking factor while considering the key characteristics of agile teams. Thus, the probability for the team to work as a high performance agile team and deliver successful software products in the market place is improved considerably when considering the agile team as a CAS.

2.3 COMPREHENSIVE ASPECTS OF THE PRECEDING WORK DONE IN THE TOPICPERTAINING TOAGILE SW DEVELOPMENT TEAMS

This section gives the comprehensive aspects of the preceding work undertaken in the topic pertaining to agile SW development teams -

Currently, in the industry, agile teams are formed based on various factors like organizational policies, rules, guidelines, market requirements, customer focus, cost considerations, schedule completion, regulatory requirements, some key attributes of agile teams and a host of other factors. However, a suitable framework is not available to decide on the key characteristics of agile teams which will help the organizations to form effective agile teams that will be able to deliver software products/service/applications effectively to the customer. Hence, the formation of the existing agile teams in the organizations do not focus much on the key characteristics of agile teams and they keep trying to find out how to improve their project delivery as highlighted by the industry research which indicates that agile teams are better suited for rapid and quality delivery as per the changing market requirements (Dyba & Dingsøyr, 2008). A compendium of SW development methods based on client focused delivery and the adoption of a risk driven incremental and iterative approach to develop project solutions through interactions among teams that are self-organized is called as agile SW development (Wikipedia - Agile Software Development, 2013). It encourages evolutionary development and quick and supple response to change (Williams & Cockburn, 2003). The literature review indicates that various studies are available regarding frameworks for identifying the key attributes and characteristic of effective teams that will facilitate them to effectively deliver good quality software products as per the evolving and changing market requirements in a short period of time. The return derived from vastly effective and focused teams and frameworks for high performing teams are given in various studies (Nedelko, 2008; Ross, Jones & Adams, 2008; Ulloa & Adams, 2004; Daniel & Davis, 2009; Hoegl & Proserpio, 2004; Thamhain, 2004;

Salas, Sims & Burke, 2005). The industry research also showcases how agile software development methodologies could help facilitate the development of strong software systems for the marketplace (Dyba & Dingsøyr, 2008; Abrahamsson, Salo, Ronkainen, & Warsta, 2002).

However, the research studies diverge on the key components that will result in effective agile teams. Additional research gives more information on the gregarious nature of agile teams and explains how community identity and cooperative effort are buttressed by agile methodologies (Whitworth and Biddle, 2007) and building agile teams focuses on the study of highly proficient teams and the results of the study are applied to teams that have incorporated agile methodologies (McGeachy, 2010). A very important characteristic for agile teams is the concept pertaining to social identity. Comparative research pertaining to self-organized work teams has focused on social psychology (Ilgen, Hollenbeck, Johnson and Jundt, 2005) as compared to organizational psychology. Various characteristics of agile teams can be described in a better manner by using the construct of social perspective. Social Identity theory gives recognition to individual psychology operating in the social context (Tajfel and Turner, 1986). A number of factors regarding team work in the agile context are highlighted. Individuals have several 'social identities' coherent with their observed membership in social groups (Hogg and Vaughan, 2002). In contrast, personal identity is derived from self-knowledge of one's distinctive personal qualities and relationships with other individuals. At any single point in time, an individual has an identity that varies from the core social identity based on the context of the community. Hence, some specific environmental settings may escalate the occurrence of personal or community identity. Diverse environmental settings make a person to think, act and feel differently. These community characteristics are generally observed to be part of the fundamental facet of an individual's self-model. Agile methods support constant collaboration with the team as a whole and this supports the development of a shared identity. Thus, agile methods are expected to increase the significance and status of a team personality as compared to a personal or character centered personality. The idea of social comparison is another concept that is related to social identity theory (Festinger, 1954). Positive self-model is essential to the working of the psychological make-up of the individual and it is posited as the concept of social comparison. It is based on the assessment of the self in comparison with other similar members. Hence, positive persona(self) and esteem (self)

can be expanded in contrast with other persons in the team. When we identify with a team that holds itself with a high amount of prestige, positive image (self) and esteem (self) is enhanced. Thus, members of cohesive agile teams are expected to show positive spirit in accordance with the fact that they are recognized within the team on account of their abilities and the self-importance with which they hold themselves as part of their membership in the project team. Group comparisons lead to increase in the heightened stature of the individuals and groups (Tajfel and Turner, 1979). Agile teams also associate their growth to the anticipation and feedback of the business members and the users for their SW product/service. As agile SW teams deliver working software to the customer at frequent intervals, it leads to rapid delivery and feedback to the team. Therefore, agile methods are expected to support improved stature and identification within the project group and with other project teams. These practices also provide a common platform for resolving common social occurrences like comparison of inter-groups.

However, simple categorization into groups can lead to bias which can further affect communication and collaborate in organizations (Goodman and Olivera, 1998). This could affect the agile team's delivery and project success. Collective goal commitment and consistency in agile SW team settings are generally expected to be high. Key attributes of unified teams were seen to arise due to an inculcation of a culture steeped in agile in the teams. Thus, characteristics of agile teams may be considered to be more than a specific software development methodological property and individuals in agile teams strongly identified themselves with the agile culture (Gladwell, 2000). The connection between agile culture and characteristics of unified agile SW teams may indicate the significance of detecting the interfaces between the organization culture and the agile culture. Thus, where there is a clash of the agile culture and the organizational culture, it becomes difficult for the teams to exhibit all the characteristics of agile teams and they find it difficult to collaborate with other teams. Agile teams are also expected to exhibit increased levels of social accountability and social awareness. Amplified mindfulness in the team setting is associated to a decrease in community (or social) malingering (loafing); i.e., the propensity for members to do little exertion on an activity when they are part of a team as compared to when they are working alone (Latane, Williams & Harkins, 1979). However, agile teams should be cautious to shun employing agile techniques in modes that facilitate control collectively but that do not

facilitate team flexibility and freedom of the individual. Thus, cohesive agile teams are generally expected to engage in some form of team contemplation or retrospection (Kerth, 2001). Agile culture is focused on producing the greatest value in the smallest amount of time. This is a key characteristic of agile teams. As indicated in the initial sections, agile methods also derive their basic principles from lean thinking concepts. Thus, conceptual tools used in agile methods like - do the simplest activity that will possibly work, eliminate waste, facilitate group tendency towards intransigence and obstinacy and maintain team flexibility, malleability and efficiency also help to ensure successful project delivery. The nature of agile culture which is action based is also expected to reduce team influence and which generally leads to apathy in large teams. If the engineering practices of agile methods are implemented without focusing on the allied factors related to culture, then it could lead to the growth of restraining team norms and activities which may lead to an inflexible and inexorable grip of agile control. This can inhibit the growth of agile teams as the key characteristics of agile teams will not develop further. Additionally, an excessive focus on yield and output to the omission of additional factors may also lead to exhaustion in the team environment (Whitworth and Biddle, 2007). Thus, the need to focus on the appropriate characteristics of agile teams that will enable them to function effectively in the agile work place is very important.

The above literature study of agile teams (Srinivasan and Mukherjee, 2015) indicates that agile techniques facilitate and enable the attributes of agile SW teams. Agile techniques enable, support and recognize social identity and collective effort as one of the important characteristics of agile teams. In the next chapter, the literature study is collated and formalized to arrive at a gap analysis that will drive the exploration and creation of a key framework that identifies the appropriate characteristics of agile teams that will make the team successful at the work place and these details will be evolved in the following chapters. The other chapters give details of a probable framework that will effectively try to address the key characteristics and attributes of agile teams that need to be taken into consideration for the team to be successful in the agile work place.

The previous work in the area of software project management, SDLC, agile teams, the consideration of the agile team as a CAS and the literature study on agile teams leads to the identification of gaps that needs to be considered while working out the key characteristics of agile teams and while developing a framework to capture these key

characteristics. The gap is coupled with the identification of the key attributes of agile teams that need to be considered for successful project delivery within appropriate cost, schedule and quality and value parameters. These factors help in the development of the research model and the framework for evaluating the characteristics of agile teams. The following chapters highlight the key aspects of various components of agile teams and the derivation of a suitable framework for identifying the key attributes of agile teams.

CHAPTER THREE: GAP ANALYSIS AND IDENTIFICATION OF FACTORS

3.1 GAP ANALYSIS

This chapter focuses on the gap analysis to work out the areas of focus and research. A lot of work has been done to understand the factors governing the key characteristics of agile teams. Most of the work done in this area has been tested for agile teams working in the academic setup or on few teams in the industrial work place as compared to the agile teams deployed fully in the software projects in the industrial work place. There are many studies undertaken on empirical work done in this space and most of the preceding studies are focusing on many of the individual factors considered in this study. The literature review also indicates that multiple studies are available for identifying the key attributes and characteristic of effective teams that will facilitate them to effectively deliver good quality software products as per the changing market requirements. However, the research studies diverge on the total set of key components of a specific framework that will result in effective agile teams in the work place. There is no study which comprehensively talks about the nine dimensions considered in this study and their cumulative impact on the effective performance of an agile team. There is also a lack of research done on this topic in the Indian context. Most of the previous work is exploratory and qualitative and they do not focus on all the key dimensions together as a composite framework as is indicated in this study and this study is also causal and quantitative in nature. Through extensive literature review, some of the recent empirical studies along with the gap in the respective studies have been mentioned in the table below -

Sl. No.	**Objectives of the Research**	**Authors**	**Study Outcome with Gap Analysis**
Theme 1	Team Performance Study on tribulations related to team work – ❖ Learning ❖ Communication ❖ Choosing the tasks as per the list of priorities	Stray, Moe and Dingsøyr (2011)	• Discusses how to overcome problems linked to learning, communication and how to manage the tasks as per the list of priorities

			• However, all the challenges related to team work are not explored in the study – team dynamics, skills of the team members, physical and virtual work environment
2	Study on team performance and focus on shared team commitment, team member skills	Katzenbach, and Smith (1993)	• Discussed how to overcome the challenges to team performance and how to improve shared team commitment • No specific discussion on all the other factors which may impact the performance of a team like disruptive innovative techniques for problem solving, team as a complex adaptive system
3	Agile teams are better suited for rapid and quality delivery as per the changing market requirements	Dyba & Dingsøyr (2008)	• Discusses the role of agile teams and how they are better suited for managing changing market requirements. However, no specific focus on the complex adaptive system as a key variable is indicated. • Role of disruptive innovative techniques to

			enable work to be completed quickly and appropriately is not fully considered. Other factors related to agile teams like work environment are not focused.
4	Team Performance in Agile SW Teams. Focus on attributes that affect performance of the team	Dingsøyr and Lindsjørn (2013)	• Findings from 18 Focus Groups • Focus on factors – mutual trust, orientation of the team, adaptability, team leadership, backup behavior, shared mental models, mutual performance monitoring and closed loop communication • Big Five teamwork model of Salas Model adopted as the context for the study • Does not focus on other factors that may also be important for teamwork like disruptive innovative techniques for problem solving, team as a complex adaptive system

Theme 1	Motivation Study on motivation and job satisfaction in a large agile team. Focus on various factors like the ability to complete a task fully, variety, autonomy and feedback are considered as important factors to ensure motivation and satisfaction among the workers.	Tessem and Maurer (2007)	• The Job Characteristics Model (JCM) -- five critical factors of Hackman and Oldham which is adopted as the context for the study • Consideration of a specific framework indicating all the key components of a successful agile team is not fully discussed
Theme 1	Evolutionary Development Agile software development encourages evolutionary development and boosts quick and lithe response to change	Williams & Cockburn (2003)	• Important concepts of agile software development are discussed and how it harnesses change for managing the customer requirements effectively. However, it does not indicate the key characteristics of agile teams in the context of a CAS. • All the components of a specific framework do not discuss all the people related aspects sufficiently

Theme 1	Self-Managed Team/Self-Organizing Team Surmounting obstacles to self-management in SW teams	Moe, Dingsøyr and Dybå (2009)	• Study focused on overcoming obstacles to self-management in SW teams • Focus on other attributes of agile teams are not explored and which will make the agile teams deliver improved work outcomes
2	Focus on self-managed agile teams that lead to improved work outcomes	Moe, Dingsøyr & Dybå (2009)	• Study focused on self-managed agile teams and improved work effectiveness • Teamwork model -- Dickinson and McIntyre – The model is used as the context for explaining self-managed agile teams • However, all the characteristics that lead to improved agile team effectiveness like work environment and other factors are not fully considered.

3	Focus on self - organizing teams	Hoda, Noble and Marshall (2010)	• Focus on how teams organize themselves • However, all the factors of teams that improve work outcomes are not considered like disruptive innovative techniques and other factors
Theme 1	High Performing Teams Returns derived from vastly effective and focused teams and frameworks for high performing teams	Nedelko (2008); Ross, Jones & Adams (2008); Ulloa & Adams (2004); Daniel & Davis (2009); Hoegl & Proserpio (2004); Thamhain (2004); Salas, Sims & Burke (2005)	• Different studies focus on the advantages of focused teams and the different types of frameworks for high performing teams • Focus on CAS as a key variable is not indicated • Role of disruptive innovation is not fully considered and other factors related to people are not fully considered • Consideration of a specific framework indicating all the key components of a successful agile team is not fully discussed

2	Study focused on an instrument that addresses key characteristics of teamwork	Moe, Dingsøyr and Røyrvik (2009)	• Focus on the key characteristics of teamwork through a dimensional approach – autonomy, learning, redundancy, shared leadership and team orientation • However, other additional characteristics of teams that lead to improved work outcomes are not discussed nor is a framework available to identify all the key characteristics of agile teams
3	How agile software development methodologies could help facilitate the development of robust software systems for the marketplace	Dyba & Dingsøyr (2008); Abrahamsson, Salo, Ronkainen & Warsta (2002)	• Focus on agile SW methodologies that help facilitate the development of software systems • Focus on CAS as a key variable is not indicated • People related factors are not sufficiently discussed as part of a single framework
4	Study focused on self-monitoring SW development team performance using an	Kettunen and Moilanen, (2012)	• Focus on an instrument for self-monitoring agile teams and how to improve the performance

	instrument and analyzing the findings		of the team through improved work outcomes • However, all the characteristics of agile teams are not fully covered like work environment and other factors that lead to improved work outcomes
5	Building agile teams focuses on the study of highly accomplished teams	McGeachy (2010)	• The results of the study are applied to teams that have embraced the Agile methodologies • Focus on CAS as a key and independent variable is not indicated • Aspects of disruptive innovation enabling work is not fully considered
6	Focus on factors impacting high performance teams	Castka, Bamber, Sharp and Belohoubek (2001)	• Study focused on the results of collaborative research intended at determining the attributes that affect the working of high performance teams • Focus on the factors related to teamwork, quality management

			• Development of a model for the successful implementation of high performing teams • However, all the characteristics of agile teams like usage of disruptive innovative techniques and consideration as complex adaptive systems are not contemplated in the model
Theme 1	Social Identity, People Factors and Productivity Focus on the community and gregarious nature of agile teams and the explanation of how community identity and shared effort are facilitated by agile methods	Whitworth and Biddle (2007)	• Study focused on the results of collaborative research intended at determining the attributes that affect the working of high performance teams • Focus on the factors related to teamwork, quality management • Development of a model for the successful implementation of high performing teams • However, all the characteristics of agile

			teams like usage of disruptive innovative techniques and consideration as complex adaptive systems are not contemplated in the model
2	Concept of social identity as a very important characteristic for agile teams	Ilgen, Hollenbeck, Johnson and Jundt (2005)	• Study pertaining to self-organized work teams has focused on social psychology and social identity • Focus on CAS as a key variable is not indicated • Aspects of disruptive innovation enabling work is not fully considered
3	Social Identity Theory -- Individual psychology operating in the social context is focused	Tajfel and Turner (1986)	• Social perspective is focused to highlight the importance in describing various characteristics of agile teams • Focus on CAS as a key variable is not indicated
4	Focus on understanding which are the factors that affect the productivity of agile teams	de O Melo, Cruzes, Kon and Conradi (2013)	• Focus on factors that lead to improved work outcomes of agile teams • Development of a framework using thematic analysis • Focus on agile team management

			• However, other factors like complex adaptive systems, behavioral factors, disruptive innovative techniques were not fully considered • Hence, a comprehensive framework for identifying the characteristics of agile teams that lead to improved work outcomes was not available
5	Focus on theory on social contract in order to understand the role of community (social) contracts in agile teams	Power (2014)	• Focus on Teams and organizations as CAS • Role of Social Contract Theory and the usage of simple rules in nurturing self-organization in agile SW teams • However, all the attributes of agile SW teams are not considered and which would lead to improved work outcomes
6	People factors affecting the characteristics of agile teams that are	Lalsing, Kishnah and Pudaruth (2012)	• Focus on people factors in agile teams • Study focuses on identifying the underlying people

	focused on improved work outcomes		factors and attributes to be considered for agile teams to obtain improved work outcomes • However, no overall framework is available to identify all the key characteristics of agile teams that could lead to improved work outcomes
Theme 1	Team Effectiveness Focus on team effectiveness	Salas, Stagl, Burke and Goodwin (2007)	• Study focused on understanding the effectiveness of teams in organizations • However, all the characteristics of agile teams that could lead to improved work outcomes are not considered fully
2	Focus on Scrum and team effectiveness to ensure improved work outcomes	Moe and Dingsøyr (2008)	• Study focused on the agile framework – Scrum and the effectiveness of team. • However, other factors that impact team effectiveness were not considered like complex adaptive systems, work environment and other factors

3	Focus on how radical collocation helps a team to succeed	Teasley, Covi, Krishnanand and Olson (2000)	• Study focuses on essential co-location as a key factor for improved work outcomes in agile teams • However, other factors like leadership, behavioral factors, disruptive innovation are not fully considered • Additionally, how to manage distributed teams that need to be present due to certain constraints and how to ensure optimized work outcomes in such cases are not fully considered • Overall framework for the identification of characteristics of agile teams leading to improved work outcomes are not considered
4	Study focused on factors that make team effective	Cohen and Bailey (1997)	• Focus on factors impacting the effectiveness of teams • Focus on team effectiveness as a function of group, task and organization design factors, and other factors

			• Focus on generic teams effectiveness • No specific framework for identifying all the key characteristics of agile teams that lead to improvement of work outcomes
5	Focus on team interactions in distributed agile teams	Dorairaj, Noble and Malik (2012)	• Study focused on how to improve work outcomes in distributed agile teams • Focus on team dynamics • However, other factors impacting agile team performance and effectiveness are not considered
6	Focus on effectiveness of agile teams	So (2010)	• Focus on agile teams' effectiveness • However, all the factors for the effectiveness of agile teams in the form of a framework is not considered
7	Focus on teamwork in agile teams using adapted Big Five teamwork theory	Strode (2015)	• Focus on teamwork in agile teams • Adapted form of Big Five teamwork theory to explain factors affecting team work in agile software development teams

			• Framework does not consider all the factors that may affect the characteristics of agile teams
Theme 1	CAS Focus on CAS and how agile software development organizations function to accomplish work	Jain and Meso (2004)	• Focus on the various characteristics of CAS and how agile organizations operate and function to complete the work • However, all the characteristics that affect the performance of agile teams are not considered
2	Focus on the role of being agile in SW teams as viewed from the CAS standpoint	Wang and Conboy (2009)	• How being agile is viewed in teams from a CAS standpoint • However, all the characteristics of agile teams leading to improved work outcomes are not covered fully

Table 3.1: Analysis of Previous Work, Study Outcome and Gap Analysis

The gap in the previous work has been identified with respect to software projects, agile team's performance and the focus on CAS as an attribute of agile teams. There is also a lack of adequate empirical work undertaken with a specific reference to the Indian context. No complete referent framework as per the detailed literature study is available and which highlights all the key attributes of agile teams as part of a framework that

lead to improved work outcomes (project success). The above mentioned gaps gave impetus to undertake more research in this area. The mapping of the independent variables to the previous work undertaken in the study area is given in the Appendix.

3.2 Challenges that led to the identification of key characteristics of agile teams

The study of previous work highlights the extent of research that has been undertaken to identify the factors affecting the characteristics of agile teams and which thereby affect the success of software projects. Through extensive literature review, the challenges which affect the key characteristics of agile teams deployed in software projects for creating/offering applications/products/services to the customer have been identified. These key attributes are captured in the form of a framework. The identification of these challenges and the mapping of these challenges in the context of the agile team as a CAS have been undertaken in three steps as follows –

3.2.1 Challenges faced by agile teams

The extensive literature review resulted in the identification of thirty one challenges that affected the key characteristics of the agile teams. The detailed tabular extraction of these variables has been shown in Appendix 1 and the summary of these variables or challenges is given below (the variables have been aggregated together as per the specific group) –

1. Team Cohesion (TECO)
2. Skills of Team Members (SKIL)
3. Team Dynamics (TEDY)
4. Roles and Responsibilities (RORE)
5. Value Diversity (VADI)
6. Trust (TRST)
7. Commitment (COMT)
8. Empathy (EMPA)
9. Maturity (MATU)

10. Goal Clarity (GOCL)
11. Impact of Leadership (LEAD)
12. Impact of Motivation (MOTI)
13. Impact of Reward (REWA)
14. Personal Satisfaction (PERS)
15. Social Identity (SOCI)
16. Recognition (RECG)
17. Impact of Organizational Culture (CULT)
18. Consensus Decision (COND)
19. Team Empowerment (TEEM)
20. Decision Making (DECM)
21. Impact of Communication (COMM)
22. Coordination (COOR)
23. Impact of Collaboration (COLL)
24. Impact of Physical Work Environment (PHWE)
25. Impact of Virtual Work Environment (VIWE)
26. Innovative Techniques (INNT)
27. Creativity (CREA)
28. Agile Mindset (AGMI)
29. Knowledge Transfer (KNOT)
30. Adaptive System (ADPS)
31. Inter Relationships among agents (INRE)

The identification of the dimensions for the above set of challenges is discussed in the next section.

3.2.2 Mapping of the Challenges to the broader dimensions

Subsequent to the factors affecting the key characteristics of agile teams being identified in the form of challenges faced by these teams, a second phase of literature review was done to identify the broader dimensions to which these variables belong. The following three broad categories or dimensions are indicated with the corresponding reference (as per the previous literature study) -

1. People Related Factors (Whitworth, Elizabeth and Biddle, Robert, 2007; McGeachy, Robert, Building agile teams, 2010) – 1 to 18

2. Interaction of the people with the environment (McGeachy, Robert, Building agile teams, 2010) – 19 to 26
3. Innovative Work Techniques for Problem Solving (McCandless Keith, Lipmanowicz, Henri, 2014; Marion & Uhl-Bien, 2001) –27 to 31

Thus, it is observed that the thirty one challenges identified in the first phase of the literature review are ultimately categorized as three broad set of challenges. Most of the empirical studies are either on one or more of the thirty one variables indicated or on part of the dimensions indicated above but they do not cover all the variables fully. Some of the studies which have focused on many of the dimensional variables have also just proposed the theoretical frame work and lack empirical support. Hence, with respect to the section on Gap Analysis, it is important to observe that there is no specific study which has taken into account all the three dimensions together for the research activity.

3.2.3 Mapping of the effect of the consideration of the Agile Team as a Complex Adaptive System (CAS) to the dimensions

The third phase of the literature review was focused on identifying previous work undertaken with reference to the effect of the consideration of the agile team as a CAS and its mapping with the dimensions identified in the second phase of the literature review. The following table summarizes the mapping of the effect of the consideration of the agile team as a complex adaptive system to overcoming challenges of an agile team delivering software application/product/services to the customer successfully -

	Factors /Dimensions	---->>>							
Research Study	Self-Organization	Emergence	Complex Adaptive Systems Theory	Open Systems	Interactions and Relationships among agents	Distributed Control	Transformative Feedback Loops	Shallow Structure	Growth and Evolution
Anderson, P (1999)			✓						
Highsmith, J (1999)		✓	✓						
Kauffman, S (1991)			✓						
Gerber, M (2002)	✓								
Arthur, Defillipp & Lindsay (2001)			✓		✓				
Chiva-Gomez, R. (2004)			✓						
Cilliers, P (1998)			✓						
Cilliers, P (2000)		✓	✓						
Eoyang, G (1996)		✓	✓		✓				
McKelvey, B (1999)		✓		✓			✓		✓
McKelvey, B (2001)		✓	✓		✓	✓			
Rhodes & MacKechnie (2003)		✓	✓						
Simon, H (1996)	✓		✓	✓		✓	✓	✓	✓
Tan, Wen & Awad (2005)	✓		✓	✓			✓		✓
Meso, Peter & Jain, Radhika (2006)			✓	✓	✓	✓	✓	✓	

Table 3.2: Mapping the consideration of an agile team as a CAS

Thus, it is observed from the above sections that there exists a gap in the earlier literature in terms of little empirical work having been undertaken, specifically in the Indian context. It is also observed that different variables and dimensions have been studied by previous researchers but there is no work undertaken by taking into account the cumulative effect of all the dimensions while mapping the consideration of the agile team as a CAS. Hence, it is evident that the challenges in identifying the key characteristics of agile teams deployed in the software projects that will make them successful in the project/product/service delivery can be categorized in three broad categories and the previous literature highlights the consideration of the agile team as a

CAS and which helps to overcome the challenges faced by agile teams in doing successful delivery to the customer.

The focus of considering the agile team as a CAS is mainly on account of the fact that the agile method of software development is aligned with complex adaptive systems theory and principles and this aspect needs to be kept in mind while forming agile teams. This is also considered as one of the key attributes or characteristics of an agile team promoting disruptive innovation and this also leads to successful project delivery to the customer as per appropriate and agreed scope (also keeping in view the changes required as per the customer requirements), schedule, cost and business value. This aspect will be empirically tested during the research and analysis phase and this has been indicated in the research findings section.

CHAPTER FOUR - RESEARCH METHODOLOGY

4.1 RESEARCH

4.1.1 RESEARCH METHODOLOGY AND DESIGN

Research is a process of organized and meticulous investigation through the searching of new facts. Research methodology is the method utilized to gather information and data for the purpose of taking decisions related to business (Kothari, 2004). This research is predominantly focused on collection of primary data and the usage of data analysis techniques and interpretation through statistical tools. Prior to starting the actual research, the focus on research methodology and research design provides a blueprint for better planning of research, its execution and for obtaining the intended results.

4.1.2 RESEARCH OBJECTIVES

The gaps identified in the previous chapters have led to the formation and formulation of the research objectives. This study focuses on the identification and evaluation of a framework for software development teams and the measurement of work outcomes. These challenges act as the overarching factors governing the overall success of the software project. The global workplace has a lot of challenges that need to be overcome along with the opportunities offered. The identification of the important characteristics of agile SW teams is a significant factor in the creation of the framework for SW teams that will lead to successful work outcomes. In this context, the study aims to identify and understand the key characteristics of agile software development teams that lead to success in project delivery through the identification and evaluation of a framework for software development teams and the measurement of work outcomes. The importance of the identification of the various characteristics of agile SW teams that lead to successful work outcomes and the focus on the consideration of the agile teams as a complex adaptive system (CAS) have been established through this study. The research objectives mentioned below are giving the detailed line of study -

1. To identify the various characteristics of agile software development teams that could lead to successful project delivery and work outcomes.

2. To study the impact of these characteristics on the agile software development team's performance measured in terms of successful work outcomes (conformance to customer

requirements and business value delivered, adherence to time and budget) and thereby project success.

3. To study the consideration of the agile SW team as a CAS that leads to successful work outcomes and greater probability of project success.

The first research objective to identify the key characteristics of agile software development teams through the creation of an appropriate framework has been achieved through rigorous literature review. The key characteristics are defined as follows and the corresponding citations have been given in the previous chapters/sections –

A. Agile methodologies are more suitable for emergent requirements and specifications that are based on capability than conventional top-down approaches. Agile methods provide rapid business value to the customer, often delivering capability while conventional methods are still focused on plans. Agile methods empower the teams who might be burdened by heavy process constraints. Agile practices have been proven over a period of time as per various agile tool vendors (Rally Software, Version One, Atlassian) and research agencies (Gartner, Forrester) and they generally work as well as or better than some of the currently accepted practices (Boehm & Turner, 2005;McGeachy, Robert, 2010).

B. It is important to understand the relevance and origin of the key components that are needed in a successful agile team in order to comprehend the key characteristics of agile teams. Agile SW teams need to exhibit characteristics and traits that emphasize the ability to respond to change quickly, which is a basic characteristic of agility, apart from other factors. These traits enable the agile teams to be successful at the work place and meet the requirements of the fluctuating market place. In order for this to occur, key component categories that need to be focused are related to people, the interaction of the people with the environment and the innovative work techniques used to arrive at the solution to a problem or business need quickly and comprehensively (indicated below).

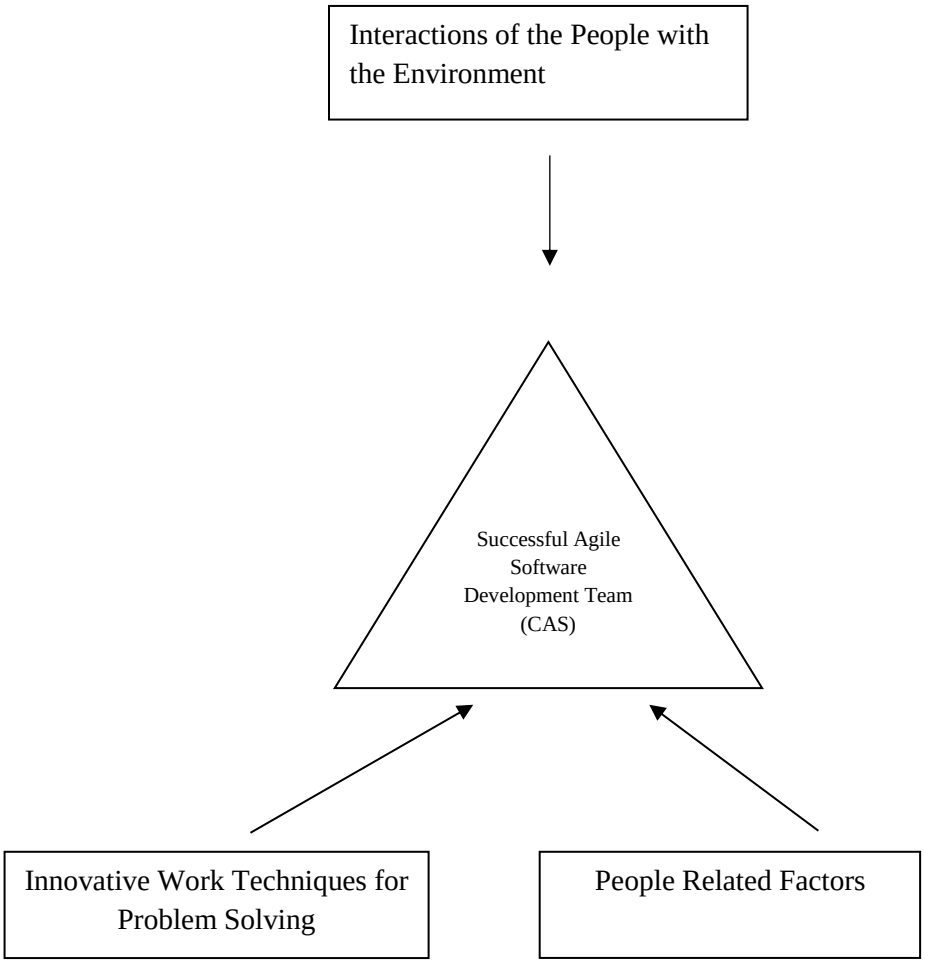


Figure 4.1: Successful Agile Team (Complex Adaptive System (CAS)) - Key Component Categories

C. Generally, as per the industry or problem domain and the nature of work, people usually adopt generally practiced and accepted techniques for solving problems. However, in order to respond quickly to change and to arrive at solutions for complex problems (which is generally the case for problems in the software product development domain), innovative work techniques are generally a pre-requisite to

resolve these complex problems. We may still obtain the solution using the same generally practiced and accepted repetitive techniques, but the response to obtain the specific solution may be slow. Additionally, there are still chances that the issue may recur again in the future, if it has not been solved thoroughly. Hence, only a combination of these factors will enable the team to deliver the product successfully in the market place and also facilitate them to respond quickly to any change that may happen in the market place.

D. The relevant component/dimensional categories may or may not be inter-dependent among each other. Further, within a component category, the components may or may not be inter-related. While responding to a stimulus from the environment, an agile team viewed as a CAS will give an emergent output that is more than the simple addition of all the constituent components within the component categories. This is generally the case when people operating as agents within the context of CAS respond or interact with the environment.

E. The people related factors component is made up of various people related factors. Behavioral factors include various traits of people like maturity, empathy, creativity and related factors. Apart from this, other key people related factors are – Leadership, Reward and Motivation and team member skills (diversity). The team is comprised of people who come together to work in a common place called the workplace. Hence, other key aspects under focus are - collaboration and communication, physical work environment and the impact of the organizational culture which are prevalent at the work place. Additionally, due to advances in technology, many teams are no longer able to be co-located due to space, cost and other constraints. A team comprising of multiple team members may be geographically distributed across the world. In these cases, an additional key factor – virtual work environment also has to be considered. However, in the background of agile SW teams, co-location of teams is preferred, wherever possible to maximize the benefits/outcomes for agile teams.

F. For teams to be viewed as high performing agile teams, the team members should also know and focus on innovative techniques to arrive at solutions for complex problems. This is a breakthrough and key component that facilitates an agile team to respond quickly to the changes that may need to be undertaken on account of the market factors. This will also enable the agile team to maximize their ability to respond quickly

and appropriately to the market place changes. The nomenclature of teams which are called as agile teams also implies that the teams exhibit agile behavior effectively by imbibing the agile values and agile principles effectively. These various component categories when they are combined together lead to the formation of a structure and framework within which we can identify, focus and channelize the key characteristics of agile teams appropriately to achieve successful work outcomes and project delivery. It is important to note that the outcomes should also meet the fitness for purpose requirement apart from other requirements.

In the context of this entire study, agile teams imply agile software development teams only (as agile teams can also be formed in other areas). Software development implies development, maintenance, research and development and related activities performed by the agile teams.

The above objectives lead to the formation of the research hypotheses and the hypothetical framework.

4.1.3 HYPOTHESES

In research studies, hypotheses are a technique to forecast or predict certain assumptions which can be further tested subsequently. This study aims at understanding the relationship of nine independent variables (IV) with the dependent variable (DV).

4.1.3.1 Hypothesis for Independent Variables

The earlier work undertaken in the area of SPM (Software Project Management), Agile Software Development Teams and Complex Adaptive Systems (CAS) has led to the formation of various hypotheses which have been worked out. (Appendix 1 and Appendix 2 give detailed information on the derivation of the hypothesis and the linkage to the literature). The attributes/characteristics of agile teams are measured through a common framework that identifies the key attributes and components of an agile team that lead to improved work outcomes leading to software project success and hence the effect of the three high level dimensional categories identified through literature review on the attributes of agile teams that lead to improved work outcomes and thereby software project success is attempted to be measured through the following hypotheses –

$H1_a$ – There is a significant relationship between the improved work outcomes of the software project and the selection of team and skills in an agile team.

$H2_a$ – There is a significant relationship between the improved work outcomes of the software project and the behavioral factors in an agile team.

$H3_a$ – There is a significant relationship between the improved work outcomes of the software project and the leadership in an agile team.

$H4_a$ – There is a significant relationship between the improved work outcomes of the software project and the reward and motivational factors in an agile team.

$H5_a$ – There is a significant relationship between the improved work outcomes of the software project and the impact of the organizational culture in an agile team.

$H6_a$ – There is a significant relationship between the improved work outcomes of the software project and the collaboration and communication in an agile team.

$H7_a$ – There is a significant relationship between the improved work outcomes of the software project and the virtual and physical work environment in an agile team.

$H8_a$ – There is a significant relationship between the improved work outcomes of the software project and the disruptive innovation practices in an agile team.

Figure 4.2: Alternative Hypothesis for Independent Variables

4.1.3.2 Focus on Agile SW Teams as CAS

The consideration of agile software development teams as CAS is an important focus area that changes the way we view agile teams when they are executing work to meet the customer requirements.

$H9_a$ - There is a significant and positive relationship between the improved work outcomes for the software project and the application, understanding and consideration of the agile team as a complex adaptive system (CAS).

Software project success can be viewed differently by different customers. Hence, improved work outcome measures which are generally linked to software project success in the context of agile SW teams are considered as an appropriate focus area. Thus, all the research objectives are converted to nine hypotheses which will be further tested empirically.

4.1.4 HYPOTHETICAL RESEARCH MODEL

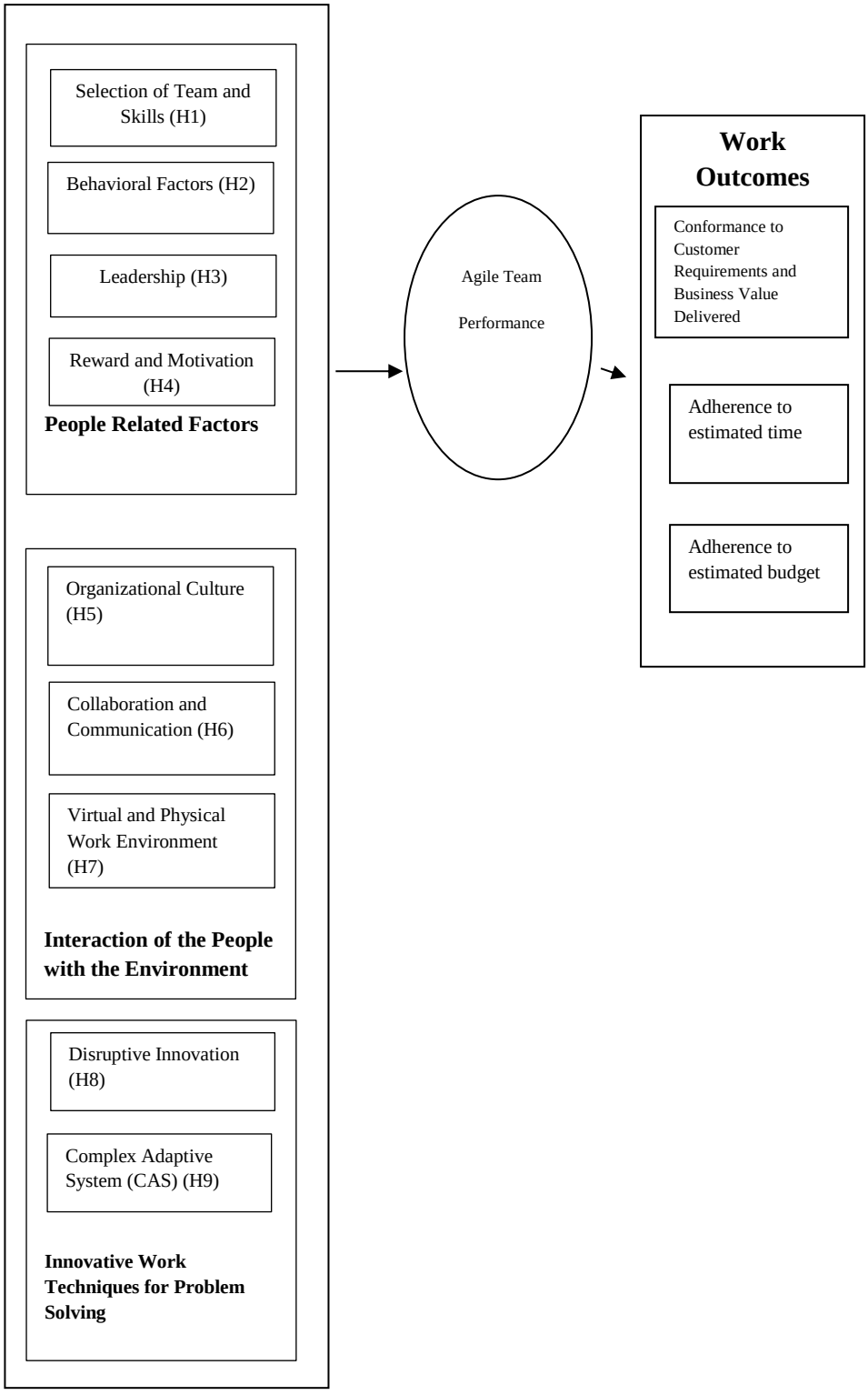


Figure 4.3: Hypothetical Research Model

The hypothetical research model proposed in this research recommends to bridge the gaps discovered in the preceding work. The empirical testing of the proposed model has been elaborated in chapter five.

4.2 SAMPLING DESIGN

In most of the research studies, it may not be possible to consider the entire population for collecting the data in order to carry out the research. Thus, a sample form the population is taken for the study. The various methods of determining the sample and the sample size is labeled as the sample design (Zikmund, 2010).

4.2.1 POPULATION

All the IT companies operating and registered in India and all the branches in India of the Multi-National Corporations (MNC) working in the field of software development was the total population for this research.

Polit and Hungler (1999) define population as a cumulative or the total group of all the objects, members or subjects that meet a set of criteria.

4.2.2 SURVEY AREA

The research aims at identifying the key attributes and components of agile software development teams working for software projects for Indian IT companies/MNCs having branches in India and hence, the entire country was considered as the sample area for the study. All cities may not have an IT setup and hence, NASSCOM report has been taken as the basis for selecting the cities for the survey. This has been further elaborated in the population and sampling section. The Appendix section gives the map of the Indian Cities having major IT Hubs.

4.2.3 DESIGN OF THE RESEARCH STUDY

Design of the research acts as a blueprint for all the systematic steps that are taken during the research to obtain the answers in accordance with the goals of the study (Zikmund, 2010). There are broadly two approaches that can be considered - qualitative and quantitative. This research is based on a quantitative approach by formulating the hypotheses and then testing the hypotheses empirically. The research is explanatory and causal in nature since the area of study is focused on the identification of the key

attributes and components of the framework of an agile team which lead to improved work outcomes through the use of three dimensional categories.

4.2.4 COLLECTION OF DATA

The information and data are gathered through direct interactions with the respondents at various industrial locations and the questions measured the respondent's agreement. A Likert scale having a seven point answer set was used as the collection mechanism in the questionnaire (Boone, Harry and Boone, Deborah, 2012). A Google form was designed to create web based questionnaire and emails were sent to various software members in organizations as per the sampling details.

4.2.5 SAMPLING AND SAMPLE SIZE

As part of the research and data gathering exercise, the sampling technique used is Simple Random sampling, which is a type of probability sampling. There is an equivalent chance or probability of each unit being selected from the population under study when the sample is under creation (when the simple random sample is under focus), since a simple random sample is an unbiased surveying technique.

When the cases are selected and included in the sample, there is a possibility that the samples may not be up to the mark due to human bias. However, this aspect is reduced when the simple random sampling technique is used. Thus, this technique gives us a sample that is greatly illustrative of the population under study. It is also assumed that there is limited data that is missing. This technique also helps us to make statistical inferences (i.e. generalizations) from the sample to the population. This is on account of the fact that probabilistic methods are used for identifying the units that will be included in the sample. This is also a key benefit as these generalities are more probable to be considered as having external validation. The administration of the sample is focused on -

a. Frame: IT organizations

b. Elements: Managers, Team Leads, Agile Coaches, Designers, Architects, Database administrators and software developers, Testers, Business Analysts, Product Owners, Unit Heads, ScrumMasters

The data was collected from cities in India termed as IT hubs by NASSCOM. As ninety percent of the software development work is concentrated in Delhi–NCR, Bangalore, Hyderabad, Pune, Kolkata, Mumbai, Coimbatore, Kochi, Thiruvananthapuram, Bhubaneswar, Chennai and Indore, these cities were considered as the prime target areas for the study. The respondents were from the organizations – Societe Generale GSC, TESCO, Target, General Electric, ABB, Honeywell, Tata Consultancy Services, IBM, Cognizant, Wipro, Infosys, Capgemini, HCL, Valtech India, Nokia, Tech Mahindra, L and T Infotech, Accenture, Mphasis and R1 RCM. The following paragraphs give brief details of these organizations --

1. Societe Generale GSC – It is a subsidiary of Societe Generale (SG), the European banking and financial services organization and it is 100% owned by SG. It came into being in 2000. It is founded as an ODC in Bangalore and it also has an office in Chennai. SG GSC has more than 15 years of expertise in sustainable delivery to its name. It has developed best practices globally to promote the strategic ideasof the group.

2. TESCO – It has got its headquarters in England (Hertfordshire, Welwyn Garden City), United Kingdom. TESCO PLC is one of the largest retailers in the world. It is a British multinational general merchandise and grocery retailer. Tesco Bengaluru, the services arm globally for Tesco worldwide provides important services related to business for global Tesco operations. The Tesco team in Bengaluru is currently taking part in creating and executing strategic initiatives focused on Commercial, Financial, IT and Property.

3. Target - Target Corporation (NYSE TGT) is a discount retailer serving the upscale market segment and who provides high-quality and trendy merchandise at prices that are reasonable in friendly and clean environments. It is the second-largest discount store retailer in the United States. It is behind Walmart. It forms a component of the S&P 500 Index. Currently, key functions related to business at the Target headquarters in Minneapolis are supported with team members in India. They provide additional knowledge and capacity. It started operations in Bangalore in 2005 and the technology unit supported the retail domain in the US.

4. General Electric - GE India Technology Center in Bangalore is focused on providing tech support in various industrial domains. General Electric (GE) is a US MNC and it is having its headquarters in Massachusetts (Boston), USA. Currently, the organization

has its presence in various market segments - Transportation, Renewable Energy, Aviation, Healthcare, Global Research, Oil and Gas, Lighting, Power and Capital which meets the needs of the Automotive, Engineering, Life Sciences, Financial Services, Pharmaceutical, Medical Devices and Software Development domains.

5. ABB - ABB is an MNC focused on the engineering domain. In Bangalore, it is focused on providing tech support in various industrial domains. ABB has got its headquarters in Switzerland (Zürich). It operates predominantly in the power, automation and robotics domain. It has operations in about hundred countries. It has about 0.13 million employees (December 2016).

6. Honeywell – They have five global centers of excellence and seven engineering and manufacturing centers focused on innovation and technology development in India. It is a $40 billion software-industrial company with about 130,000 employees across the world. They help to solve difficult issues focusing on productivity, energy, security and urbanization (global).

7. TCS- It is the one of the biggest IT organizations in Asia and India. It is one of the main organizations belonging to the Tata Group. The organization was established in 1978. It is spread across the globe in 47 countries.

8. IBM–They have branches and main centers in many of the key cities in India. IBM came to India in 1992. They are focused on the IT domain and other areas.

9. Cognizant - It is headquartered in Teaneck, New Jersey, United States. Cognizant is an American multinational corporation that provides consulting, technology, digital and operations services. Cognizant has branches in many of the IT hubs in the major cities of India – Mumbai, Chennai, Gurgaon, Kochi, Kolkata, Bangalore, Noida, Hyderabad, Coimbatore, Mangalore and Pune.

10. Wipro - The organization has branches in most of the IT Hubs in India. It is an IT organization focused on application development services, consulting services and outsourcing services.

11. Infosys - It is headquartered in Bengaluru, India. Infosys is an Indian multinational corporation that provides information technology, business consulting and outsourcing services. It is an IT organization focused on consulting services and technology

services.The organization has branches in most of the IT Hubs in India. They facilitate customers to enable them to build and deliver their digital transformation strategy.

12. Capgemini- Capgemini has 85,000+ people working in India. It has branches in the important cities - Gurgaon, Gandhinagar, Noida, Bangalore, Mumbai, Hyderabad, Tiruchirappalli, Chennai, Pune, Kolkata, and Salem. Capgemini India was established in 2001 with its first office in Mumbai.

13. HCL Technologies - It is headquartered in Noida, Uttar Pradesh. It has branches in Hyderabad, Gurgaon, Bangalore, Mumbai, Chennai, and Kolkata. It was started in 1991.

14. Valtech India - Valtech is a global digital agency that provides digital and advisory services across the entire value chain with a mission to challenge the OTT-business beyond merely technology. They have offices in Bangalore, Gurugram, many cities in Europe and Singapore.

15. Nokia- Nokia development is an innovative leader in technology and has software development center in Noida and Bangalore in India.

16. Tech Mahindra - It is the fifth largest software exporter in India. It has seen good growth since its beginning in 1986. The Mahindra Group and the BT Group plc, UK established a joint venture to execute IT services and related activities.

17. L&T Infotech (LTI) - It was established in 1997. L&T Infotech is known for its Business to IT connect solutions. It has offices in Mumbai, Pune, Bangalore and Chennai. Larsen & Toubro Infotech (LTI) is a subsidiary of Larsen & Toubro. It is a global IT solutions & services organization headquartered in Mumbai, India.

18. Accenture- It is headquartered in Mumbai, India. Its branches are in eight cities - Chennai, Bangalore, Hyderabad, Pune, Kolkata, Noida, Gurgaon & Delhi. Accenture India operates as a management consulting, outsourcing and technology services organization. The company was incorporated in 1991.

19. Mphasis - It is an IT services organization headquartered in Bangalore, India. It is spread across 14 countries in the world. Mphasis was founded in India in 2000. They focus on providing IT services, outsourcing services and other services in the related areas. It has offices in the major cities in India.

20. R1 RCM – The head office is in Chicago, Illinois, USA. They have offices in Gurgaon and Noida in India. R1 RCM is one of the United States' largest hospital revenue cycle management organizations. It sells finance related services to the healthcare industry. The organization provides end-to-end revenue cycle management solutions through shared service operations, operational processes and technology solutions.

Sample Size Calculation

The sample size is based on the confidence interval (Naing & Rusli, 2006). The study is based on 95% confidence interval and the sample size is calculated as given below -

$n = Z^2 * R * (1 - R) / d^2$

Where n = sample size,

Z = Z statistic for a level of confidence,

R = expected prevalence or proportion

(In proportion of one; if 20%, R = 0.2), and

d = precision

(In proportion of one; if 5%, d = 0.05).

Z statistic (Z): For the level of confidence of 95%, which is conventional, Z value is 1.96.

Figure 4.4: Sample Size Calculation (Formula)

1. Calculation of Sample Size:

Sample Size = A / B

A = (Distribution of 50%)

B = ((Margin of Error% / Confidence Level Score) squared)

2. Correction of Finite Population: True Sample = C / D

C = (Sample Size X Population)

D = (Sample Size + Population – 1)

Figure 4.5: Sample Size Calculation (Finite Population Correction)

Confidence level score and the distribution details and the explanation for these details are given below –

The confidence level score is the confidence level indicate along with the standard deviation details. When the confidence level is 95%, the confidence level score is taken as 1.96. Similarly, Distribution indicates how the respondents on a topic are skewed. It is appropriate to work out the details at a 50% distribution level. This is taken as a conservative distribution level.

1. Sample Size = (0.5 x (1 - 0.5)) / ((0.05/1.96) squared). Sample Size = 0.25 / ((0.02551…) squared). Sample Size = 0.25 / 0.00065077… Sample Size = 384.16…

2. True Sample = 384.16… x 1000 / 384.16… + 1000 – 1. True Sample = 384160.3024… /1383.1603. True Sample = 277.7409…

$n= (1.962)^2 * (0.5)* (0.5)/(0.05)^2$

Or

Necessary Sample Size = (Z-score) ^{2} * StdDev*(1-StdDev) / (margin of error) ^{2}

@ 95% confidence level, 0.5 standard deviation and a margin of error (confidence interval) of +/- 5%.

The calculation is worked out as given below -

$= ((1.96)^2 \times 0.5 (0.5)) / (0.05)^2 = (3.8416 \times 0.25) / 0.0025$

$= 0.9604 / 0.0025$

$= 384.16$

~ 385 respondents are needed approximately

Thus, it is evident that the sample size for a research study based on 95% confidence interval has to be around three hundred and eighty five.

For this study, the sample size covered is 400.

4.2.6 INSTRUMENT DESIGN AND DATA COLLECTION

The extensive literature review provided the three dimensions affecting the framework identifying the key characteristics of agile team leading to improved work outcomes. The questionnaire is created on the foundation of the definition of these dimensions in order to conduct the survey and collect the data. Following model describes in detail the measurement of the data –

	Dimensions	Variables	Citations
Agile Software Development Team Performance Improved Work Outcomes (Software Project Success)	People Related Factors	Selection of Team and Skills	McGeachy, Robert (2010) Strode, Diane (2015)
		Behavioral Factors	Lalsing, Kishnah and Pudaruth (2012) McGeachy, Robert (2010) Moe, Nils Brede, Dingsøyr, Torgeir & Dybå, Tore (2009)
		Leadership	Xu, Peng & Shen, Yide (2015)
		Reward and Motivation	Sridhar, Paul, Nath & Kapur (2007) Whitworth (2006)
	Interaction of the People with the Environment	Organizational Culture	Zannier and Maurer (2007) Zannier and others (2006) Zannier, Chiasson and Maurer (2007)
		Collaboration and Communication	Whitworth (2006) Tselikovska, Ganna (2013)
		Virtual and Physical Work Environment	Mishra, Deepti; Mishra, Alok and Ostrovska, Sofiya (2012) Dwivedi, Shubhra (2015) Ashmore, Sondra (2012)
	Innovative Work Techniques for Problem Solving	Disruptive Innovation	McCandless Keith & Lipmanowicz, Henri (2014) Wördenweber, Burkard & Weissflog, Uwe (2006)
		Complex Adaptive Systems (CAS)	Vidgen, Richard and Wang, Xiaofeng (2006) Jain, Radhika and Meso, Peter (2004)

Table 4.1: Research Model

The three dimensions and the corresponding measurement through nine variables described in the above table are -

a. People Related Factors
b. Interaction of the People with the Environment
c. Innovative Work Techniques for Problem Solving

These dimensions were identified through extensive literature review and the above table shows the corresponding measurement of these dimensions with the appropriate reference in the literature. The identification of the key characteristics of an agile SW team in the form of a framework that will enable the team to exhibit optimal and high performance leading to improved work outcomes is measured through the success of the software project. A survey questionnaire is developed on the basis of this table and was revised five times with the inputs of academic and industry experts. The questionnaire is given in Appendix 2.

The three dimensions evaluated through nine items are measured through the seven point Likert scale. The demographical data is captured through nominal data in the form of multiple choice questions or open ended questions.

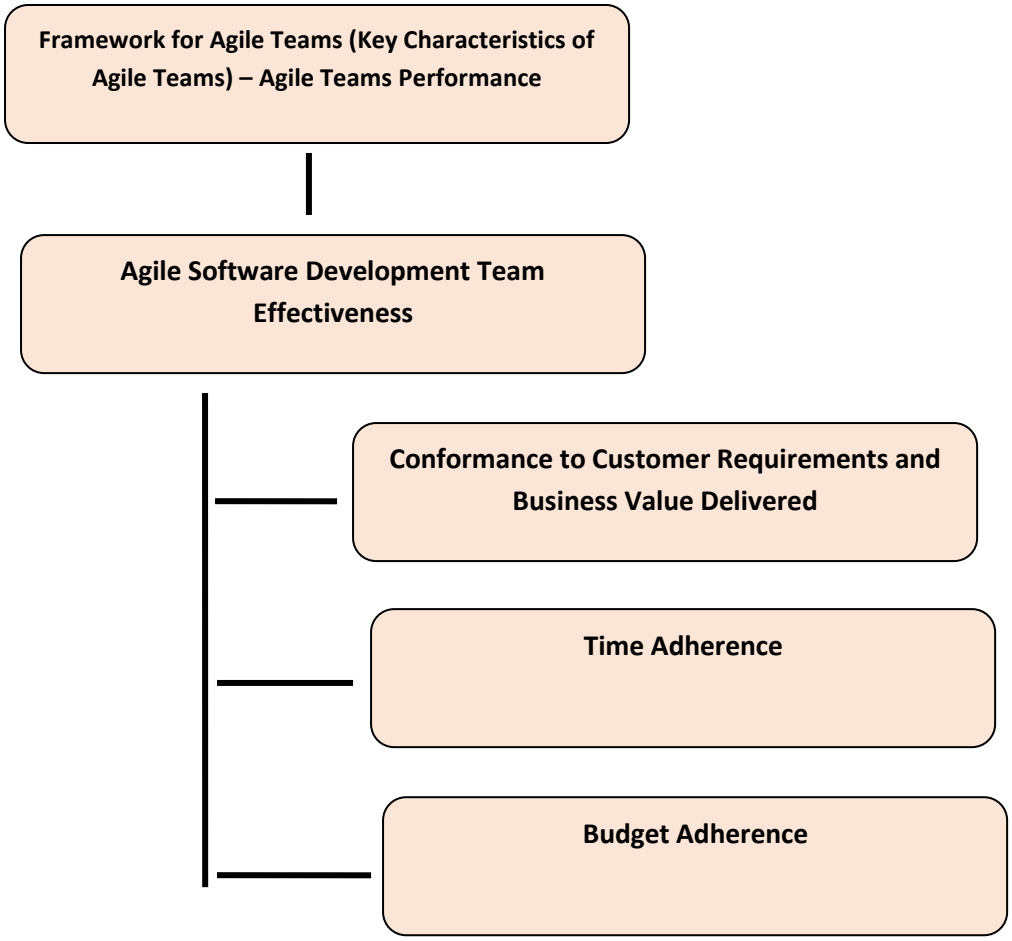


Figure 4.6: Agile Software Development Team Performance

4.2.7 ANALYSIS OF DATA

Research analysis of the data in this study was done through multiple regression by using the tool - SPSS, version 21. The interpretation was done on the basis of the result generated in the form of various tables and graphs after running multiple regressions.

4.2.8 STATISTICAL PROCEDURE

In this research study, multiple regression was done using SPSS to identify the impact of the independent variables (key attributes and components of the framework of the characteristics of an agile SW team) on the dependent variables (performance of the agile software development team leading to improved work outcomes and thereby successful project delivery).

4.2.9 ETHICAL CONSIDERATIONS

Any research contributes a lot to the existing corporate/industry body of knowledge and hence, it is imperative that an ethical approach needs to be followed while conducting the research. Confidentiality of data shared by the respondents is essential and hence, the questionnaire contained the statement regarding this point (Refer Appendix 2).

CHAPTER FIVE - ANALYSIS OF DATA AND RESEARCH FINDINGS

5.1 RESEARCH MODEL

The hypothetical model discussed earlier has been further described as given below-

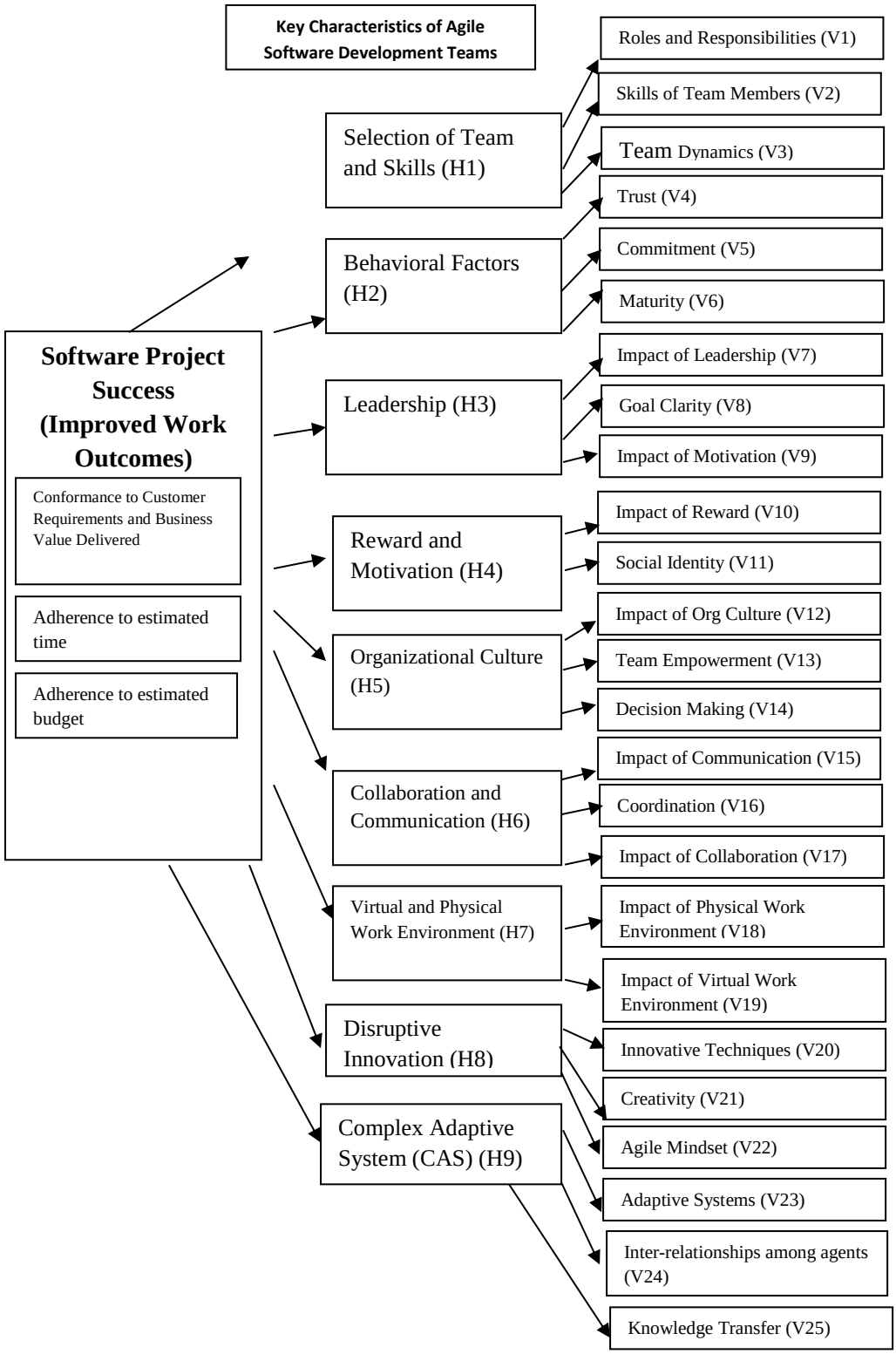


Figure 5.1: Detailed Research Model

The above figure measures the key characteristics of agile teams that lead to improved work outcomes (project success). The table in Section 4.2.6 in the previous chapter provides the valid reference for the above model. The key characteristics of agile software development teams are identified as part of a framework and the improved work outcomes (software project success) is measured through three variables –

- Conformance to Customer Requirements and Business Value Delivered
- Adherence to Estimated Time
- Adherence to Estimated Budget

There are nine independent variables (IVs) that identify the key characteristics of agile software development teams and which thereby contribute to improved work outcomes (project success). The IVs are – Selection of team and skills, Behavioral Factors, Leadership, Reward and Motivation, Organizational Culture, Collaboration and Communication, Virtual and Physical Work Environment, Disruptive Innovation and Complex Adaptive System (CAS). The independent variables are measured through the twenty five items as indicated in the detailed research model – Roles and Responsibilities (V1), Skills of Team Members (V2), Team Dynamics (V3), Trust (V4), Commitment (V5), Maturity (V6), Impact of Leadership (V7), Goal Clarity (V8), Impact of Motivation (V9), Impact of Reward (V10), Social Identity (V11), Impact of Organizational Culture (V12), Team Empowerment (V13), Decision Making (V14), Impact of Communication (V15), Coordination (V16), Impact of Collaboration (V17), Impact of Physical Work Environment (V18), Impact of Virtual Work Environment (V19), Innovative Techniques (V20), Creativity (V21), Agile Mindset (V22), Adaptive Systems (V23), Inter-relationships among Agents (V24), Knowledge Transfer (V25). All the variables have been measured through the seven point Likert Scale (Vagias, 2006).

5.2 DATA COLLECTION AND CODING

As per the detailed research model, a survey questionnaire is developed to obtain the responses from target respondents in various target organizations related to the research study. As mentioned in the earlier chapter, the sample size at ninety five percent confidence interval is worked out to be about three hundred and eighty five samples. The questionnaire developed was executed using a google form, emails sent to various organizations across IT Hubs identified in India (as per details given in the Appendix)

and through direct interviews with the target respondents. The data was collected from various cities in India designated as IT hubs by NASSCOM, India. Almost ninety percent of the software development work in India is concentrated in the following cities - Delhi –NCR, Mumbai, Bangalore, Hyderabad, Kolkata, Pune, Coimbatore, Kochi, Thiruvananthapuram, Bhubaneswar, Chennai and Indore. The target respondents were from various organizations – Societe Generale (SG), Target, Tesco, General Electric (GE), ABB, Honeywell, Tata Consultancy Services (TCS), IBM, Cognizant, Wipro, Infosys, Capgemini, HCL, Nokia, Valtech, Accenture, MPhasis, R1 RCM, Tech Mahindra and LTI. Total four hundred and forty responses were collected out of which four hundred responses could be finally used for data analysis. The remaining forty responses were found to be incomplete in one or more fields. The analyses of the data were done in two phases –initially, pilot study and subsequently, comprehensive data analysis. These details are given in the subsequent sections.

5.3 PILOT -- DATA ANALYSIS

The instrument reliability was tested through a pilot study after the designing of the instrument was completed. The questionnaire consists of thirty items corresponding to three dimensional categories. The Likert scale (seven point) is employed to rate all the variables (Vagias, 2006). The survey form is uploaded as a Google form and it was also sent to the target respondents (software professionals) through email and direct interviews were also conducted with the members. Forty responses were received and the reliability of the questionnaire was checked through the data. The seven point Likert scale has ratings as given below (Appendix has the sample copy of the questionnaire administered to the target respondents) –

'1' indicates **'Strongly Disagree'**

'2' indicates **'Disagree'**

'3' indicates **'Disagree Somewhat'**

'4' indicates **'Undecided'**

'5' indicates **'Agree Somewhat'**

'6' indicates **'Agree'** and

'7' indicates **'Strongly Agree'**

Figure 5.2: Likert Scale (Seven point scale)

The results of the pilot data analysis (forty responses) for reliability and multiple linear regression are given below –

Reliability – Pilot Study

Descriptive Statistics

The results of the pilot study are captured through the statistical tables as given below

Summary – Processing of Cases

		Number of samples (N)	Percentage
Case	Valid	40	100.0
	Excluded[a]	0	.0
	Grand Total	40	100.0

a. Obliterationis on account of all the variables in the process (listwise).

Table 5.1: Summary – Case Processing -- Pilot Study

Statistics–Data Reliability

Alpha (Cronbach)	Alpha (Cronbach) Based on Items (Standardized)	Items (Number)
.918	.921	10

Table 5.2: Statistics–Data Reliability -- Pilot Study

Statistics – Data Item wise

	Mean	Standard Deviation	N
IV1	5.5333	.73913	40
IV2	5.4325	.65014	40
IV3	5.6668	.71564	40
IV4	5.6415	.72138	40
IV5	5.5093	.70035	40
IV6	5.9003	.56584	40
IV7	5.1840	.89292	40
IV8	5.4580	.76859	40
IV9	5.4498	.51503	40
DV	5.6840	.62633	40

Table 5.3: Statistics – Item wise -- Pilot Study

Inter-Item Correlation Matrix

	Independent Variable 1 (IV1)	Independent Variable 2 (IV2)	Independent Variable 3 (IV3)	Independent Variable 4 (IV4)	Independent Variable 5 (IV5)	Independent Variable 6 (IV6)	Independent Variable 7 (IV7)	Independent Variable 8 (IV8)	Independent Variable 9 (IV9)	Dependent Variable (DV)
IV1	1.000	.688	.384	.400	.637	.533	.612	.769	.665	.608
IV2	.688	1.000	.617	.321	.712	.345	.713	.869	.677	.813
IV3	.384	.617	1.000	.304	.400	.261	.580	.601	.577	.755
IV4	.400	.321	.304	1.000	.392	.245	.437	.480	.506	.448
IV5	.637	.712	.400	.392	1.000	.318	.417	.716	.645	.519
IV6	.533	.345	.261	.245	.318	1.000	.279	.252	.325	.302
IV7	.612	.713	.580	.437	.417	.279	1.000	.709	.545	.594
IV8	.769	.869	.601	.480	.716	.252	.709	1.000	.710	.776
IV9	.665	.677	.577	.506	.645	.325	.545	.710	1.000	.725
DV	.608	.813	.755	.448	.519	.302	.594	.776	.725	1.000

Table 5.4: Inter Item Correlation Matrix -- Pilot Study

Statistics– Details of Data Items

	Mean	Min	Max	Range	Max/ Min	Variation	Items (Number)
Item (Mean)	5.546	5.184	5.900	.716	1.138	.037	10
Item (Variance)	.486	.265	.797	.532	3.006	.022	10
Inter-Item Correlations	.537	.245	.869	.624	3.546	.030	10

Table 5.5: Statistics -- Summary Item -- Pilot Study

Statistics -- Scale

Mean	Variation	SD	Items (Number)
55.4593	27.983	5.28991	10

Table 5.6: Statistics – Scale -- Pilot Study

The above tables reveal that Cronbach alpha is 0.921. This signifies that the data set and the questionnaire are reliable. The inter-item correlation matrix has got positive figures only and this also indicates that the instrument is reliable and can be administered for a bigger sample size. Extensive analysis is carried out for the detailed study that was administered subsequently and which was built on the accomplishments observed during the course of the pilot study.

Multiple Linear Regression Analysis – Pilot Study

Descriptive Statistics

	Mean	Standard Deviation	N
DV	5.6840	.62633	40
IV1	5.5333	.73913	40
IV2	5.4325	.65014	40
IV3	5.6668	.71564	40
IV4	5.6415	.72138	40
IV5	5.5093	.70035	40
IV6	5.9003	.56584	40
IV7	5.1840	.89292	40
IV8	5.4580	.76859	40
IV9	5.4498	.51503	40

Table 5.7: Descriptive Statistics – Multiple Linear Regression -- Pilot Study

The values (mean and standard deviation) in the above table are within a small range indicating the inter-relationships among the variables.

Correlations

		Dependent Variable (DV)	Independent Variable 1 (IV1)	Independent Variable 2 (IV2)	Independent Variable 3 (IV3)	Independent Variable 4 (IV4)	Independent Variable 5 (IV5)	Independent Variable 6 (IV6)	Independent Variable 7 (IV7)	Independent Variable 8 (IV8)	Independent Variable 9 (IV9)
Pearson Correlation	Dependent Variable (DV)	1.000	.608	.813	.755	.448	.519	.302	.594	.776	.725
	IV1	.608	1.000	.688	.384	.400	.637	.533	.612	.769	.665
	IV2	.813	.688	1.000	.617	.321	.712	.345	.713	.869	.677
	IV3	.755	.384	.617	1.000	.304	.400	.261	.580	.601	.577
	IV4	.448	.400	.321	.304	1.000	.392	.245	.437	.480	.506
	IV5	.519	.637	.712	.400	.392	1.000	.318	.417	.716	.645
	IV6	.302	.533	.345	.261	.245	.318	1.000	.279	.252	.325
	IV7	.594	.612	.713	.580	.437	.417	.279	1.000	.709	.545
	IV8	.776	.769	.869	.601	.480	.716	.252	.709	1.000	.710
	IV9	.725	.665	.677	.577	.506	.645	.325	.545	.710	1.000
Sig. (1-tailed)	DV	.	.000	.000	.000	.002	.000	.029	.000	.000	.000
	IV1	.000	.	.000	.007	.005	.000	.000	.000	.000	.000
	IV2	.000	.000	.	.000	.022	.000	.014	.000	.000	.000
	IV3	.000	.007	.000	.	.028	.005	.052	.000	.000	.000
	IV4	.002	.005	.022	.028	.	.006	.064	.002	.001	.000
	IV5	.000	.000	.000	.005	.006	.	.023	.004	.000	.000
	IV6	.029	.000	.014	.052	.064	.023	.	.041	.058	.021
	IV7	.000	.000	.000	.000	.002	.004	.041	.	.000	.000
	IV8	.000	.000	.000	.000	.001	.000	.058	.000	.	.000
	IV9	.000	.000	.000	.000	.000	.000	.021	.000	.000	.
N	DV	40	40	40	40	40	40	40	40	40	40
	IV1	40	40	40	40	40	40	40	40	40	40

	IV2	40	40	40	40	40	40	40	40	40	40
	IV3	40	40	40	40	40	40	40	40	40	40
	IV4	40	40	40	40	40	40	40	40	40	40
	IV5	40	40	40	40	40	40	40	40	40	40
	IV6	40	40	40	40	40	40	40	40	40	40
	IV7	40	40	40	40	40	40	40	40	40	40
	IV8	40	40	40	40	40	40	40	40	40	40
	IV9	40	40	40	40	40	40	40	40	40	40

Table 5.8: Correlations – Multiple Linear Regression -- Pilot Study

The values in the above correlation table also indicate the inter-relationships among the variables and the p-value being less than 0.05 for all the items except six items, it also indicates that the model proposed in the pilot study can be considered for being taken up for the full-fledged study. As the sample size is small, it is possible that it may have had an impact on the significance values.

Details of Variables(Submitted/Deleted)[a]

MOD	Variables (Submitted)	Variables (Deleted)	Method
1	IV9, IV6, IV4, IV3, IV5, IV7, IV1, IV2, IV8[b]	.	Enter

a. Dependent Variable: YVAR
b. All variables requested are submitted.

Table 5.9: Variables –Submitted/Deleted – Multiple Linear Regression -- Pilot Study

The above three tables give the mean and standard deviation as part of descriptive statistics for the multiple linear regression analysis technique. Additionally, correlations and the variables considered as part of the pilot study are also indicated.

The following tables give the information pertaining to the regression analysis carried out on the data as part of the pilot study –

Model Summary[b]

MOD	Regression (R)	Regression Square	Regression Square (Adjusted)	Standard Error (Estimate)	Statistics (Change)					Value - Durbin-Watson
					Regression (R) Square Change	F Value Change	Degree of freedom1	Degree of freedom 2	Significant F value Change	
1	.922[a]	.850	.805	.27668	.850	18.873	9	30	.000	1.979

a. Inputs: (Constant), IV9, IV6, IV4, IV3, IV5, IV7, IV1, IV2, IV8

b. Output Variable: DV

Table 5.10: Summary (Model) – Multiple Linear Regression -- Pilot Study

Value of adjusted R square is 0.805. Hence, 80.5 percent variation in the improved work outcomes (software project success) and the key characteristics of the agile software development team are explained by the variation in all the nine independent variables.

Details of Variance Analysis (ANOVA)[a]

MOD		Squares (sum)	Degree of freedom (df)	Mean Square	F value	Significance
1	Regression	13.003	9	1.445	18.873	.000[b]
	Residual	2.297	30	.077		
	Total	15.299	39			

a. Output Variable: DV

b. Inputs: (Constant), IV9, IV6, IV4, IV3, IV5, IV7, IV1, IV2, IV8

Table 5.11: Analysis of Variance (ANOVA) – Multiple Linear Regression -- Pilot Study

The above ANOVA table highlights that the model proposed in the study is significant (as the p value is less than 0.05).If the inaccuracy (within the model) is less than the enhancement (on account of the fit of the regression model), then the F value will be >

1. The F-ratio as indicated in the above model is 18.873. This is not likely to have happened accidentally ($p < .001$). This implies that the model considerably enhanced the capability to forecast the dependent variable.

Coefficients[a]

MOD		Coefficients (Unstandardized)		Coefficients(Standardized)	t value	Significance	B (95.0% CI)		Correlations		
		B	Standard Error	Beta			Bound (Lower)	Bound (Upper)	Zeroorder	Partial	Part
1	(Constant)	.056	.610		.092	.927	-1.189	1.301			
	IV1	.144	.126	.170	1.140	.263	-.114	.402	.608	.204	.081
	IV2	.677	.172	.702	3.937	.000	.326	1.028	.813	.584	.278
	IV3	.340	.091	.389	3.734	.001	.154	.526	.755	.563	.264
	IV4	.174	.081	.201	2.148	.040	.009	.340	.448	.365	.152
	IV5	-.280	.105	-.313	-2.675	.012	-.494	-.066	.519	-.439	-.189
	IV6	-.071	.106	-.064	-.668	.509	-.288	.146	.302	-.121	-.047
	IV7	-.202	.084	-.288	-2.414	.022	-.373	-.031	.594	-.403	-.171
	IV8	.023	.165	.028	.140	.889	-.314	.360	.776	.026	.010
	IV9	.207	.146	.170	1.421	.166	-.090	.504	.725	.251	.101

a. Dependent Variable: YVAR

Table 5.12: Coefficients – Multiple Linear Regression -- Pilot Study

The above details indicate the parameters of the model. The connection between the work outcomes and the input variables is indicated by the B values. As the value is positive for all the independent variables except for IV5, IV6 and IV7, we can infer that there is a positive connection among all the inputs (except IV5, IV6 and IV7) and the

work outcomes. The relationship between IV5, IV6 and IV7 and the work outcome is indicated as negative. These aspects will need to be explored further during the full-fledged study (since it is a pilot study with a small size sample).

Statistics (Residuals)[a]

	Minimum	Maximum	Mean	Standard Deviation	N
Value (predicted)	4.6159	6.8542	5.6840	.57741	40
Residual	-.38894	.57347	.00000	.24266	40
Predicted Value (Standard)	-1.850	2.027	.000	1.000	40
Residual (Standard)	-1.406	2.073	.000	.877	40

a. Variable (Dependent): YVAR

Table 5.13: Residuals Statistics – Multiple Linear Regression -- Pilot Study

The differences in the values (outcomes observed) that are obtained in the sample and the values (outcomes predicted by the model) are identified as residuals. If the sample data is fitted well by the model, then the residuals (all) will be small. Hence, if the sample data is fitted perfectly by the model, i.e. all the data points are falling on the regression line only, then automatically all the residual values will be zero. However, if the sample data is fitted poorly by the model, then the residual values will be large. If the absolute value is greater than 3.29 (as an approximation, 3 could be used) (for the standardized residuals), then it becomes a cause for apprehension. This is due to the fact that in a sample (average cases), a high value does not occur by chance. In this instance, the value of the residual (standardized) is less than 3. This connotes that the model is conforming to an equitably correct sample fit. This implies that the pilot study was positive and successful. The full study was subsequently commenced as per the pilot study findings.

The equation (model) given below was used as an example for testing the hypotheses during the pilot study -

Independent Variables Analysis -

Improved Work Outcome of the Project (Project Success) (Y) (DV) =

$$\beta 0 + \beta 1\ X1 + \beta 2\ X2 + \beta 3\ X3 + \beta 4\ X4 + \beta 5\ X5 + \beta 6\ X6 + \beta 7\ X7 + \beta 8\ X8 + \beta 9\ X9 + E_i$$

Where –

X1 – Selection of Team and Skills (IV1)

X2 – Behavioral Factors (Maturity, Commitment) (IV2)

X3 – Leadership (IV3)

X4 – Reward and Motivation (IV4)

X5 – Impact of the Organizational Culture (IV5)

X6 – Collaboration and Communication (IV6)

X7 – Virtual and Physical Work Environment (IV7)

X8 – Disruptive Innovation (IV8)

X9 – Complex Adaptive System (CAS) (IV9)

E_i - Residual

DV = 0.056 + 0.144 IV1 + 0.677 IV2 + 0.340 IV3 + 0.174 IV4 - 0.280 IV5 - 0.071 IV6 - 0.202 IV7 + 0.023 IV8 + 0.207 IV9 + E_i--- Equation – Pilot Study -- A

OR

Improved Work Outcomes (Software Project Success) = 0.056 + (0.144 * Selection of Team and Skills) + (0.677 * Behavioral Factors (Maturity, Commitment)) + (0.340 * Leadership) + (0.174 * Reward and Motivation) - (0.280 * Impact of the Organizational Culture) - (0.071 * Collaboration and Communication) - (0.202 * Virtual and Physical Work Environment) + (0.023 * Disruptive Innovation) + (0.207 * Complex Adaptive System (CAS)) + Residual--- Equation – Pilot Study -- B

As per the significance value in the coefficients, all the variable have significant impacts with p value <0.05 except for IV1, IV6, IV8 and IV9. Hence, the full-fledged study will focus on all these variables further to understand the final impact of these variables. As the size of the sample is not big, it is possible that the impact of the independent variables may not be known fully. However, this highlights that the final model will be significant and a full-fledged study will need to be carried out further to know the impact of these independent variables on the DV.

Thus, the improved work outcomes (software project success) is affected by behavioral factors, leadership, reward and motivation, impact of the culture of the organization and the virtual and physical environs as reflected from the Equation – Pilot Study (A and B). However, it needs to be noted that these findings need to be validated during the full-fledged study as the interactions among the IVs are complex and only with an appropriate sample size, we can validate the outcomes effectively.

Chart

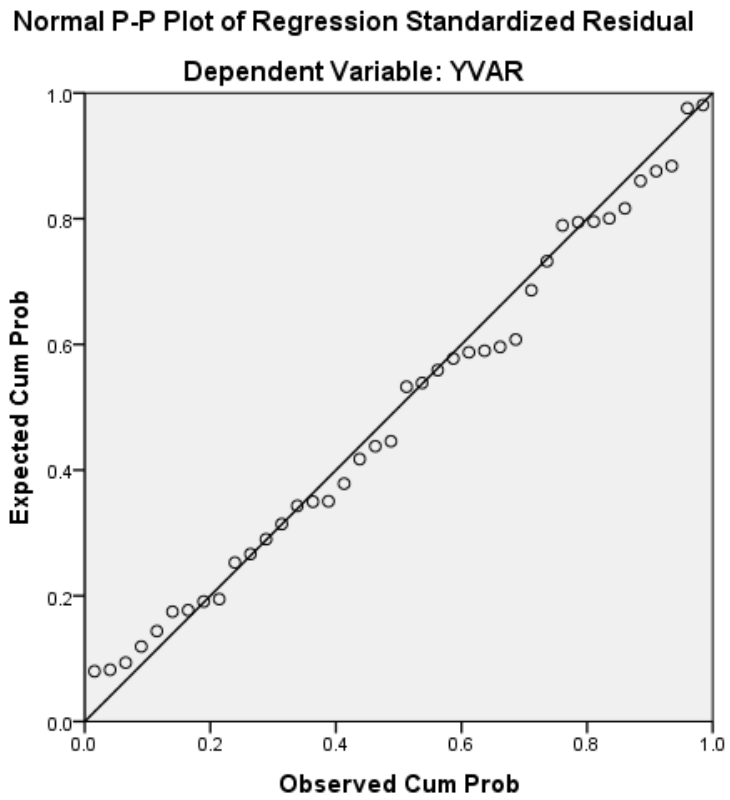


Figure 5.3: Pilot Study - Standardized Residual (Regression) (Normal P-P Plot)

As per the data given above, it is observed from the above graph that the model is free from the problem of multicollinearity and heteroscedasticity. Thus, the equation is an unbiased estimator of the ordinary least squares method. Hence, the model in the pilot study is a good estimator of the improved work outcomes (software project success) based on the identification of the important characteristics of agile SW development teams. The results of the pilot study are promising and they are pointing in the correct direction for undertaking a full-fledged survey with additional data samples to validate all the hypotheses defined in the research study.

5.3.1 Coding of Data and Data Entry

The demographic data obtained is tabulated using MS Excel. Percentage based charts were created to understand the demographic data as described further in the following sections. The scale varied in the range - disagree strongly to agree strongly and which is indicated as 1 to 7. As the nine independent variables were measured through twenty five items, an average was taken to form these nine independent variables. Similarly, the improved work outcomes obtained based on the identification of the key characteristics of a SW team working in a SW development project is observed through the success of the project which in turn is measured through three items - Conformance to Customer Requirements and Business Value Delivered, Adherence to Estimated Time and Adherence to Estimated Budget.

5.3.2 Research Design

I. Type of research: Descriptive Research and impact of challenges faced by agile teams were explored.

II. Data collection method: Primary method of data collection is based on discussions/interviews and other techniques since feedback from the team members working in an agile work environment has to be taken for the research. Google form and email was also used to collect data for the study.

III. Sampling: Simple Random sampling is utilized. It is an impartial technique of collecting data without bias -

   a. Frame: IT Organizations involved in software development
   b. Elements: Managers, team leads and software developers, Agile Coach, ScrumMaster
   c. Experience level: In Years

IV. Data analysis: Advanced statistical tools like regression analysis besides descriptive statistics under present research design were used to analyze the data. Regression mainly achieves the objective of measurement of impact of different variables over improved work outcomes. Analysis of qualitative data is done using Likert Analysis (Boone, Harry and Boone, Deborah, 2012).

5.3.3 Development of Hypotheses

As per the Research Model given in the earlier chapter and the problem statement to be explored, the hypotheses worked out is given in the following sections.

5.3.4 Alternative Hypotheses

The alternative hypothesis is worked out as per the details given in Section 4.1.3.1 and 4.1.3.2.

5.3.5 Model and Variable Definitions

The variables are explained as given below -

1. (X1, X2, X3, X4) People Related Factors (Whitworth, Elizabeth and Biddle, Robert, 2007; McGeachy, Robert, Building agile teams, 2010)- 1,2,3,4
2. (X5, X6, X7) Interaction of the people with the environment (McGeachy, Robert, Building agile teams, 2010)- 5,6,7
3. (X8, X9) Innovative Work Techniques for Problem Solving (McCandless Keith, Lipmanowicz, Henri, 2014)-8, Complex Adaptive System (CAS) (Marion & Uhl-Bien, 2001)-9

   X1 – Selection of Team and Skills (IV1)

   X2 – Behavioral Factors (Maturity, Commitment) (IV2)

   X3 – Leadership (IV3)

   X4 – Reward and Motivation (IV4)

   X5 – Impact of the Organizational Culture (IV5)

   X6 – Collaboration and Communication (IV6)

   X7 – Virtual and Physical Work Environment (IV7)

   X8 – Disruptive Innovation (IV8)

   X9 – Complex Adaptive System (CAS) (IV9)

   Cluster Group

   CG 1 = f (X1, X2, X3, X4) = H1, H2, H3, H4

   CG 2 = f (X5, X6, X7) = H5, H6, H7

   CG 3 = f (X8, X9) = H8, H9

The following model is used for testing the hypotheses -

Independent Variables Analysis -

Improved Work Outcome of the Project (Project Success) (Y) (DV) =

$$\beta 0 + \beta 1\ X1 + \beta 2\ X2 + \beta 3\ X3 + \beta 4\ X4 + \beta 5\ X5 + \beta 6\ X6 + \beta 7\ X7 + \beta 8\ X8 + \beta 9\ X9 + E_i$$

5.3.6 Test of Reliability

The consistency of the questions was established before the final analysis was done. Alpha Test (Cronbach) was used to check the reliability. Following paragraphs gives the details of the test applied

Variable Analysis

Descriptive Statistics

Scale: VARIABLES (ALL)

Summary (Processing of Details)			
		N	%
Cases	Responses - Valid	400	100.0
	Excluded[a]	0	.0
	Responses - Total	400	100.0
a. As per all variables in the procedure (deletion is list wise)			

Table 5.14: Summary (Case Processing)

Statistics (Reliability)

Cronbach Alpha	(As per Standardized Items) Cronbach Alpha	Number of Items
.901	.901	10

Table 5.15: Test- Cronbach Alpha

Item Statistics

	Mean	Standard Deviation	N
IV1	5.6468	.76762	400
IV2	5.5393	.68956	400
IV3	5.5518	.77944	400
IV4	5.5385	.84849	400
IV5	5.6935	.55354	400
IV6	5.6610	.60764	400
IV7	5.4308	.83825	400
IV8	5.4892	.75221	400
IV9	5.6269	.58342	400
DV	5.6949	.59417	400

Table 5.16: Item Statistics - Mean and Standard Deviation

Cronbach's Alpha is 0.9. Hence, the designed instrument is reliable and well suited for data collection and analysis. The degree of internal consistency is observed through Cronbach Alpha. It indicates how closely a set of items are related as a group. It is also observed to be a measurement of the reliability of the scale. Additionally, if the value of alpha is high, it does not mean that the measurement is of a single dimension. The item statistics details also indicates the standard deviation and mean for the variables (dependent and independent).

The matrices (correlation and covariance) for all the variables (independent) is considered for understanding the relationship among all the independent variables.

Correlation Matrix (Inter-Item)

	Independent Variable 1 (IV1)	Independent Variable 2 (IV2)	Independent Variable 3 (IV3)	Independent Variable 4 (IV4)	Independent Variable 5 (IV5)	Independent Variable 6 (IV6)	Independent Variable 7 (IV7)	Independent Variable 8 (IV8)	Independent Variable 9 (IV9)	Dependent Variable (DV)
IV1	1.000	.591	.571	.582	.491	.442	.730	.733	.441	.542
IV2	.591	1.000	.511	.368	.438	.442	.591	.502	.513	.584
IV3	.571	.511	1.000	.453	.415	.442	.567	.523	.579	.684
IV4	.582	.368	.453	1.000	.281	.273	.516	.642	.291	.418
IV5	.491	.438	.415	.281	1.000	.163	.400	.447	.406	.527
IV6	.442	.442	.442	.273	.163	1.000	.323	.261	.436	.425
IV7	.730	.591	.567	.516	.400	.323	1.000	.631	.437	.542
IV8	.733	.502	.523	.642	.447	.261	.631	1.000	.230	.542
IV9	.441	.513	.579	.291	.406	.436	.437	.230	1.000	.545
DV	.542	.584	.684	.418	.527	.425	.542	.542	.545	1.000

Table 5.17: Correlation Matrix (Inter-Item)

The correlation matrix (inter item) indicates that all the items are positive. A key element in the conduction of the item analysis for a group of test questions is inter-item correlation. The extent to which the scores for one item are having a relationship to the scores of all other items in a scale is assessed by inter-item correlation. An evaluation of item redundancy is provided by inter-item correlation. The focus is on the degree to which items on a scale are measuring the same content (Cohen & Swerdlik, 2005).

Additionally, if the inter-item correlation (average) is low, Cronbach's alpha will also be low. If the inter-item correlation (average) increases, Cronbach's alpha also increases (ensuring the number of items are kept constant). The inter item covariance matrix as given below also indicates that all the items are positive. The test pertaining to Cronbach alpha is essentially a test of reliability coefficient (or test of consistency) and it is not a statistical test.

Inter-Item Covariance Matrix

	Independent Variable 1 (IV1)	Independent Variable 2 (IV2)	Independent Variable 3 (IV3)	Independent Variable 4 (IV4)	Independent Variable 5 (IV5)	Independent Variable 6 (IV6)	Independent Variable 7 (IV7)	Independent Variable 8 (IV8)	Independent Variable 9 (IV9)	Dependent Variable (DV)
IV1	.589	.313	.342	.379	.209	.206	.470	.423	.198	.247
IV2	.313	.475	.275	.215	.167	.185	.342	.261	.206	.239
IV3	.342	.275	.608	.299	.179	.209	.370	.307	.263	.317
IV4	.379	.215	.299	.720	.132	.141	.367	.410	.144	.211
IV5	.209	.167	.179	.132	.306	.055	.186	.186	.131	.173
IV6	.206	.185	.209	.141	.055	.369	.165	.119	.155	.153
IV7	.470	.342	.370	.367	.186	.165	.703	.398	.214	.270
IV8	.423	.261	.307	.410	.186	.119	.398	.566	.101	.242
IV9	.198	.206	.263	.144	.131	.155	.214	.101	.340	.189
DV	.247	.239	.317	.211	.173	.153	.270	.242	.189	.353

Table 5.18: Inter-Item Covariance Matrix

Statistics (Item Summary)

	Mean	Min	Max	Range	Max / Min	Variance	Number of Items
Means (Item)	5.587	5.431	5.695	.264	1.049	.008	10
Variances (Item)	.503	.306	.720	.414	2.350	.024	10
Inter-Item Covariances	.239	.055	.470	.415	8.579	.009	10
Inter-Item Correlations	.477	.163	.733	.570	4.500	.016	10

Table 5.19: Statistics of Summary Items

Statistics (Scale)

MN	VR	SD	Number of Items
55.8727	26.552	5.15291	10

Table 5.20: Statistics (Scale)

The statistics of the summary items and the scale statistics also indicate the reliability of the items. If the mean of inter-correlations is positive, it means that the correlations between the variables are strong.

5.3.7 Regression Analysis

The data collected is analyzed using SPSS. Regression was conducted to measure the impact of all the nine dimensions that affect the key characteristics of agile software development teams and thereby lead to improved work outcomes and increase in the probability of the success of the project.

Regression Model

DV (Improved Work Outcome of the Project (Project Success)) (Y) =

$\beta 0 + \beta 1\ IV1 + \beta 2\ IV2 + \beta 3\ IV3 + \beta 4\ IV4 + \beta 5\ IV5 + \beta 6\ IV6 + \beta 7\ IV7 + \beta 8\ IV8 + \beta 9\ IV9 + E_i$ --- Equation 1

DV – Improved Work Outcome of the project(Software Project Success)

IV1 - Selection of Team and Skills
IV2 - Behavioral Factors (Maturity, Commitment)
IV3 - Leadership
IV4 - Reward and Motivation
IV5 - Impact of the Organizational Culture
IV6 - Collaboration and Communication
IV7 - Virtual and Physical Work Environment
IV8 - Disruptive Innovation
IV9 - Complex Adaptive System (CAS)
E_i - Residual

Linear Regression analysis yields an equation to highlight the statistical relationship between the variables (response and one or more predictor variables). A statistical process for assessing the relationships among variables in statistical modeling is called regression analysis. It includes numerous procedures for modeling, analyzing and validating multiple variables (Emphasis is on the relationship concerning the variables (output variable and one or more input variables)).

The presence of autocorrelation is detected by means of the Durbin Watson test. Autocorrelation indicates an association between values isolated from each other by a specified time lag (prediction errors in the residuals from a regression analysis viewpoint in statistical theory)). Values approaching 0 indicate positive autocorrelation. Values (R-squared) range from 0 to 1 and are generally indicated as percentages from 0% to 100%.

Descriptive Statistics

	Mean	Standard Deviation	N
DV (Improved Work Outcomes) Project Success	5.6949	.59417	400
IV1	5.6468	.76762	400
IV2	5.5393	.68956	400
IV3	5.5518	.77944	400
IV4	5.5385	.84849	400
IV5	5.6935	.55354	400
IV6	5.6610	.60764	400
IV7	5.4308	.83825	400
IV8	5.4892	.75221	400
IV9	5.6269	.58342	400

Table 5.21: Descriptive Statistics

The mean and standard deviation values in the above table are within a small range indicating the inter-relationships among the variables.

Correlations

		Dependent Variable (DV)	Independent Variable 1 (IV1)	Independent Variable 2 (IV2)	Independent Variable 3 (IV3)	Independent Variable 4 (IV4)	Independent Variable 5 (IV5)	Independent Variable 6 (IV6)	Independent Variable 7 (IV7)	Independent Variable 8 (IV8)	Independent Variable 9 (IV9)
Pearson Correlation	Dependent Variable (DV)	1.000	.542	.584	.684	.418	.527	.425	.542	.542	.545
	IV1	.542	1.000	.591	.571	.582	.491	.442	.730	.733	.441
	IV2	.584	.591	1.000	.511	.368	.438	.442	.591	.502	.513
	IV3	.684	.571	.511	1.000	.453	.415	.442	.567	.523	.579
	IV4	.418	.582	.368	.453	1.000	.281	.273	.516	.642	.291
	IV5	.527	.491	.438	.415	.281	1.000	.163	.400	.447	.406
	IV6	.425	.442	.442	.442	.273	.163	1.000	.323	.261	.436
	IV7	.542	.730	.591	.567	.516	.400	.323	1.000	.631	.437
	IV8	.542	.733	.502	.523	.642	.447	.261	.631	1.000	.230
	IV9	.545	.441	.513	.579	.291	.406	.436	.437	.230	1.000
Sig. (1-tailed)	DV	.	.000	.000	.000	.000	.000	.000	.000	.000	.000
	IV1	.000	.	.000	.000	.000	.000	.000	.000	.000	.000
	IV2	.000	.000	.	.000	.000	.000	.000	.000	.000	.000
	IV3	.000	.000	.000	.	.000	.000	.000	.000	.000	.000
	IV4	.000	.000	.000	.000	.	.000	.000	.000	.000	.000
	IV5	.000	.000	.000	.000	.000	.	.001	.000	.000	.000
	IV6	.000	.000	.000	.000	.000	.001	.	.000	.000	.000
	IV7	.000	.000	.000	.000	.000	.000	.000	.	.000	.000
	IV8	.000	.000	.000	.000	.000	.000	.000	.000	.	.000
	IV9	.000	.000	.000	.000	.000	.000	.000	.000	.000	.

N	DV	400	400	400	400	400	400	400	400	400	400
	IV1	400	400	400	400	400	400	400	400	400	400
	IV2	400	400	400	400	400	400	400	400	400	400
	IV3	400	400	400	400	400	400	400	400	400	400
	IV4	400	400	400	400	400	400	400	400	400	400
	IV5	400	400	400	400	400	400	400	400	400	400
	IV6	400	400	400	400	400	400	400	400	400	400
	IV7	400	400	400	400	400	400	400	400	400	400
	IV8	400	400	400	400	400	400	400	400	400	400
	IV9	400	400	400	400	400	400	400	400	400	400

Table 5.22: Correlation Table

The values in the above correlation table also indicate the inter-relationships among the variables and the p-value being less than 0.05, it also indicates that the model proposed in the study can be considered as significant.

Analysis of Variance[a]

MOD		Squares (Sum)	Degree of Freedom	Mean Square	Value - F	Significant Level
1	REG	86.070	9	9.563	68.070	.000[b]
	Residual	54.792	390	.140		
	Total	140.863	399			

a. Dependent Variable: DV

b. Predictors: (Constant), IV9, IV8, IV6, IV5, IV4, IV2, IV3, IV7, IV1

Table 5.23: Analysis of Variance (ANOVA) Table

The above ANOVA table indicates that the value of p is < 0.05. This implies that the model proposed in the study is significant. If the inaccuracy within the model is much lesser than the improvements on account of the model (regression) being fitted, then the value of F is> 1. The F-ratio is 68.070 for the model. As p < 0.001, it is very unlikely that this would have happened accidentally. This specifies that the model considerably improved the capability to forecast the output variable.

The F-test (overall significance), which is a special case of the F test matches a model having no predictors to the specified model. If there are no predictors in the regression model, it is considered as an intercept-only model.

F-test (overall significance)– hypotheses are -

Null hypothesis - The intercept-only model and the specified model fit are equal.

Hypothesis (alternative) - The intercept-only model fit is significantly reduced when matched with the specified model. In the above model, F-test (overall significance) – p value is less than 0.05 and the null hypothesis is rejected and it is observed that the specified model offers a better fit as compared to the intercept-only model. Additionally, the r squared value focuses on the strength of the association between the specified model and the response variable. However, it does not yield a hypothesis test (formal) for this association. However, the F test (overall significance) highlights if the association is statistically significant.

Regression Analysis

Summary (Regression Model)[b]

Regression MOD	Value - R	Regression Square	Regression Square (Adjusted)	Estimate (Standard Error)	Statistics (Change)					Durbin Watson
					Change (R Square)	Change (F)	Degrees of freedom 1	Degrees of freedom 2	Significant F Change	
1	.782[a]	.611	.602	.37482	.611	68.070	9	390	.000	2.312

a. Variable – Independent - Predictors: (Constant), IV9, IV8, IV6, IV5, IV4, IV2, IV3, IV7, IV1

b. Variable – Dependent : DV

Table 5.24: Summary (Regression Model)

Model Summary – The above table indicates that the adjusted R square value is 0.602. Hence, 60.2 percent variation in the improved work outcomes (software project success) and the key characteristics of the agile software development team are elucidated by the variation in all the nine variables (independent). From the regression analysis, the degree of autocorrelation (also known as serial correlation) in residuals is obtained. This is known as the Durbin Watson Test. The similarity of a time series over successive time intervals is known as autocorrelation. This can lead to standard error being under estimated. It may also be perceived like the independent variables (predictors) are important (significant) when they are not significant.

The test statistic (Durbin Watson) has a range of values from 0 to 4. This implies the following inferences as given below -

- ❖ No autocorrelation - 2
- ❖ Positive autocorrelation (standard in time series data) -0 to less than 2
- ❖ Negative autocorrelation (less prevalent in time series data) – greater than 2 to 4

Generally, values of the test statistic falling in the scope (range) - 1.5 to 2.5 are considered to be comparatively normal. If the values are not in this range, then it may be a reason for concern. If the values are below 1 or greater than 3, then it is a definite source for concern (Field, 2009). In the above table, Durbin Watson statistic is 2.3. Hence, the data is considered as normal. The coefficient values (multiple correlation) concerning the predictors and the outcome is specified by R^2. The value of R being 0.782 indicates that the outcome of the criterion variable is influenced by the independent (predictor) variable. The measurement of how much of the changeability in the outcome is due to the predictors is given by R. In this case, the independent variables account for about 61% of the variation in the improved work outcomes (business value, time, cost). Thus, the regression equation is a reasonable representation (fitting) of the samples of data. The predictor is a good indicator of the work outcomes. The adjusted R^2 is an indication of how well the model generalizes the scenarios. Generally, this value is very near to the R^2 value. The gap when observed in the final regression model is minor (about 1%). This shrinkage indicates that if the model were to be a derivative of the population and not a sample, it will then be responsible for 1% less variance approximately in the outcome. Additionally, assessing the accuracy of a regression model across different samples from the same population is known as cross-validation.

Stein's Formula furnishes a suggestion of how sound the model cross-validates different samples of data from the same population. Stein's formula as given below –

$$\text{adjusted } R^2 = 1 - \left[\left(\frac{n-1}{n-k-1}\right)\left(\frac{n-2}{n-k-2}\right)\left(\frac{n+1}{n}\right)\right](1-R^2)$$

Where -

Stein's Formula is: k = the number of predictors, unadjusted value = R^2, number of samples = n(in the model). Using n = 400 samples and k = 9, the adjusted R^2 works out to be 0.591 as against 0.611 for observed R^2 which highlights that the model cross validity is good.

Test Statistic (Durbin Watson) is 2.312. It indicates that the regression errors are independent. The assumption is probably expected to be met if the Test Statistic (Durbin Watson) is near to 2 (and between 1 and 3).

Coefficients[a]

Model		Coefficients (Unstandardized)		Coefficients (Standardized)	t value	Significance	95.0% C I for B		Correlation		
		B	Standard Error	Beta value			Bound (Lower)	Bound (Upper)	Zero Order	Partial	Part
1	(Constant)	.448	.261		1.718	.087	-.065	.961			
	IV1	-.108	.046	-.140	-2.359	.019	-.198	-.018	.542	-.119	-.074
	IV2	.132	.039	.153	3.400	.001	.056	.208	.584	.170	.107
	IV3	.257	.035	.337	7.279	.000	.188	.326	.684	.346	.230
	IV4	.005	.030	.006	.151	.880	-.055	.064	.418	.008	.005
	IV5	.218	.042	.203	5.176	.000	.135	.300	.527	.254	.163
	IV6	.104	.038	.107	2.743	.006	.030	.179	.425	.138	.087
	IV7	.043	.036	.060	1.191	.234	-.028	.113	.542	.060	.038
	IV8	.159	.044	.201	3.632	.000	.073	.244	.542	.181	.115
	IV9	.132	.045	.130	2.923	.004	.043	.221	.545	.146	.092

a. Dependent Variable: DV. The project when it is showing improved work outcomes is an indication of software project success.

Table 5.25: Coefficients

The above details indicate the model parameters. The connection between the independent variables and the work outcomes is given by the B-values. As the value is positive for all the independent variables except IV1, we can infer that there is a positive connection between all the independent variables (except IV1) and the work outcomes. The relationship between IV1 and the work outcome is indicated as negative.

Coefficient details - The coefficients from the above table can be substituted in Equation 1. Hence, an indicative predictor for the estimation of improved work outcomes (software project success) can be worked out.

Equation –

DV = 0.448 - 0.108 IV1 + 0.132 IV2 + 0.257 IV3 + 0.005 IV4 + 0.218 IV5 + 0.104 IV6 + 0.043 IV7 + 0.159 IV8 + 0.132 IV9 + Ei --- Equation 1

OR

Improved Work Outcomes (Software Project Success) = 0.448 – (0.108 * Selection of Team and Skills) + (0.132 * Behavioral Factors (Maturity, Commitment)) + (0.257 * Leadership) + (0.005 * Reward and Motivation) + (0.218 * Impact of the Organizational Culture) + (0.104 * Collaboration and Communication) + (0.043 * Virtual and Physical Work Environment) + (0.159 * Disruptive Innovation) + (0.132 * Complex Adaptive System (CAS)) + E_i --- Equation 1

As per the significance value in the Coefficients Table, all the variable have significant impacts with p value <0.05, except for variables IV4 (Reward and Motivation) and IV7 (Virtual and Physical Work Environment) and hence, the final model with the appropriate variables (independent) that have an important impact on the variable (dependent) – Improved Work Outcomes only need to be considered.

Coefficient Correlations[a]

Model			IV9	IV8	IV6	IV5	IV4	IV2	IV3	IV7	IV1
1	Correlations	IV9	1.000	.318	-.162	-.217	-.093	-.218	-.358	-.085	-.081
		IV8	.318	1.000	.093	-.167	-.375	-.142	-.200	-.118	-.376
		IV6	-.162	.093	1.000	.178	-.026	-.209	-.181	.122	-.249
		IV5	-.217	-.167	.178	1.000	.094	-.135	-.077	.063	-.175
		IV4	-.093	-.375	-.026	.094	1.000	.075	-.064	-.072	-.119
		IV2	-.218	-.142	-.209	-.135	.075	1.000	-.008	-.226	-.062
		IV3	-.358	-.200	-.181	-.077	-.064	-.008	1.000	-.153	.012
		IV7	-.085	-.118	.122	.063	-.072	-.226	-.153	1.000	-.371
		IV1	-.081	-.376	-.249	-.175	-.119	-.062	.012	-.371	1.000
	Covariances	IV9	.002	.001	.000	.000	.000	.000	-.001	.000	.000
		IV8	.001	.002	.000	.000	.000	.000	.000	.000	-.001
		IV6	.000	.000	.001	.000	-3.020E-005	.000	.000	.000	.000
		IV5	.000	.000	.000	.002	.000	.000	.000	9.537E-005	.000
		IV4	.000	.000	-3.020E-005	.000	.001	8.783E-005	-6.822E-005	-7.787E-005	.000
		IV2	.000	.000	.000	.000	8.783E-005	.001	-1.063E-005	.000	.000
		IV3	-.001	.000	.000	.000	-6.822E-005	-1.063E-005	.001	.000	1.991E-005
		IV7	.000	.000	.000	9.537E-005	-7.787E-005	.000	.000	.001	-.001

		IV 1	.000	-.001	.000	.000	.000	.000	1.991E-005	-.001	.002

a. Dependent Variable: DV

Table 5.26: Coefficient Correlations

Residuals Statistics[a]

	Min	Max	Mean	Deviation (Standard)	N
Value (Predicted)	4.3131	6.7975	5.6949	.46445	400
Residual	-1.03887	1.03836	.00000	.37057	400
Predicted Value (Standard)	-2.975	2.374	.000	1.000	400
Residual (Standard)	-2.772	2.770	.000	.989	400

a. Variable (Dependent): DV

Table 5.27: Residuals Statistics

The Coefficient Correlations and the Residuals Statistics table lend further stability to the model. The error existing in the model is represented by the residuals. The outcome values detected in the sample and the outcome values predicted by the model can have differences and this is known as residuals. All the residuals are small, if a model fits the sample data well (If all data points lie on the regression line, then the equation is a perfect fitting of the data sample. It would also indicate that all the residuals would be zero). If the residuals are large, then the model is a poor fit of the sample data. Residuals (standardized) with an absolute value > 3.29 (3 could be used as a ballpark figure) are a reason for concern. This is on account of the fact that in a sample case (average), a high value is not likely to occur by accident. In this case, the standardized residual is less than 3. Hence, the model conforms to a reasonably accurate sample fit.

Thus, the improved work outcome (software project success) is affected significantly by the Selection of Team and Skills, Behavioral Factors (Maturity, Commitment), Leadership, Impact of the Organizational Culture, Collaboration and Communication, Disruptive Innovation and Complex Adaptive System (CAS) as observed in the earlier paragraphs. The additional consideration of the agile software development team as a

CAS apart from all the other indicated factors further helps to focus on the interaction among the agents and the improved work outcomes produced by such a team.

Chart

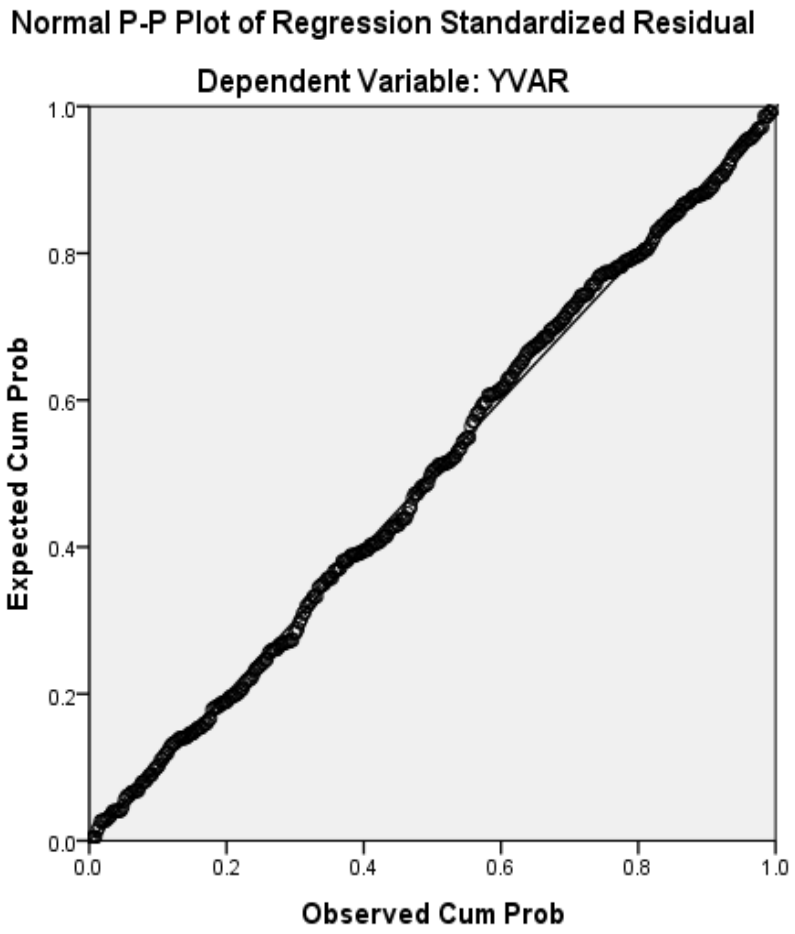


Figure 5.4: Standardized Residual (Regression) (Normal P-P Plot)

As perthe figure indicated above, it is observed that the model is free from the problem of multicollinearity and heteroscedasticity. Thus, the equation is an unbiased estimator of the ordinary least squares. The model in the study is therefore a good estimator of the measurement of the improved work outcomes (software project success) based on the identification of the key characteristics of agile software development teams.

5.3.8 Factor Analysis

This section gives details regarding the analysis undertaken on the data collected for the model requirements (factor analysis).

Analysis of Factors is a commonly used statistical method that focuses on multiple variables in order to reduce the data/variable. This is achieved by looking for fundamental variables (latent) that cannot be observed and which are revealed in the observed variables (manifest variables). It. The important factors for its usage is given below -

- ❖ Reduction in the number of variables (from large to small)
- ❖ Provide evidence of construct validity
- ❖ Establish underlying dimensions between constructs and measured variables

The different kinds of analysis (factor) are – Analysis (Exploratory Factor) (EFA) and Analysis (Confirmatory Factor) (CFA). When a study is undertaken with no pre-determined expectancies or concepts, then EFA is usually used. When the study is being undertaken to check a propositioned concept, then CFA is used. Factor analysis is similar to cluster analysis. While cluster analysis groups similar cases, similarly, factor analysis also groups similar variables into dimensions. This process is also termed as identifying latent variables. Factor analysis generally does not distinguish between independent and dependent variables. Factor Analysis moderates the information in a model by reducing the dimensions of the observations. This procedure has multiple focus areas. It can be used to simplify the data in predictive regression models by reducing the variables (number). If analysis (factor) is utilized for these requirements, then most of the time, the factors are rotated after extraction. Additionally, factor analysis can utilize several different rotation techniques and some of these techniques ensure that the factors are orthogonal. In such a case, the correlation coefficient between the two factors is zero and this eradicates the problems of multicollinearity that may be present during regression analysis. Factor analysis can also be used in theory testing for the verification of scale construction and operationalization. In such a case, the scale is specified in the beginning and a specific subset of the scale represents an independent dimension within this scale. Factor analysis is also used for the construction of indices. One of the common approaches to construct an index is to

basically sum up the items in an index. However, in some cases, some variables might have a greater explanatory power than other variables. Sometimes, if similar questions correlate a lot, then one of the questions may be dropped to trim down the total set of questions in the form. In such cases, we can use factor analysis to identify the weight each variable should have in the index.

Descriptive Statistics - Details

Descriptive Statistics

	Mean	Standard Deviation[a]	Analysis N[a]	Missing N
IV1	5.6468	.76762	400	0
IV2	5.5393	.68956	400	0
IV3	5.5518	.77944	400	0
IV4	5.5385	.84849	400	0
IV5	5.6935	.55354	400	0
IV6	5.6610	.60764	400	0
IV7	5.4308	.83825	400	0
IV8	5.4892	.75221	400	0
IV9	5.6269	.58342	400	0
DV	5.6949	.59417	400	0

a. For each variable, values that are missing are substituted with the variable mean.

Table 5.28: Descriptive Statistics – Factor Analysis

The initial yield from analysis (factor) is a statistics (descriptive) table. It covers all the variables which are under scrutiny. Generally, the number of respondents (N) who participated in the survey are indicated along with the standard deviation and mean. By observing the mean, it is viewed that the Impact of Organizational Culture could be a significant independent variable that influences improved work outcomes (project success) based on the cultural context. It has the highest mean of 5.6935 among independent variables (apart from the dependent variable which has the highest mean of 5.6949). However, cultural context as part of the impact of the organizational culture is also an important factor that needs to be taken into account and which is very dynamic and varies in each organization before arriving at the appropriate conclusions.

Correlation Matrix

		Independent Variable 1 (IV1)	Independent Variable 2 (IV2)	Independent Variable 3 (IV3)	Independent Variable 4 (IV4)	Independent Variable 5 (IV5)	Independent Variable 6 (IV6)	Independent Variable 7 (IV7)	Independent Variable 8 (IV8)	Independent Variable 9 (IV9)	Dependent Variable (DV)
Correlation	IV1	1.000	.591	.571	.582	.491	.442	.730	.733	.441	.542
	IV2	.591	1.000	.511	.368	.438	.442	.591	.502	.513	.584
	IV3	.571	.511	1.000	.453	.415	.442	.567	.523	.579	.684
	IV4	.582	.368	.453	1.000	.281	.273	.516	.642	.291	.418
	IV5	.491	.438	.415	.281	1.000	.163	.400	.447	.406	.527
	IV6	.442	.442	.442	.273	.163	1.000	.323	.261	.436	.425
	IV7	.730	.591	.567	.516	.400	.323	1.000	.631	.437	.542
	IV8	.733	.502	.523	.642	.447	.261	.631	1.000	.230	.542
	IV9	.441	.513	.579	.291	.406	.436	.437	.230	1.000	.545
	DV	.542	.584	.684	.418	.527	.425	.542	.542	.545	1.000
Sig. (1-tailed)	IV1		.000	.000	.000	.000	.000	.000	.000	.000	.000
	IV2	.000		.000	.000	.000	.000	.000	.000	.000	.000
	IV3	.000	.000		.000	.000	.000	.000	.000	.000	.000
	IV4	.000	.000	.000		.000	.000	.000	.000	.000	.000

	IV 5	.000	.000	.000	.000		.001	.000	.000	.000	.000
	IV 6	.000	.000	.000	.000	.001		.000	.000	.000	.000
	IV 7	.000	.000	.000	.000	.000	.000		.000	.000	.000
	IV 8	.000	.000	.000	.000	.000	.000	.000		.000	.000
	IV 9	.000	.000	.000	.000	.000	.000	.000	.000		.000
	D V	.000	.000	.000	.000	.000	.000	.000	.000	.000	

Table 5.29: Correlation Matrix – Factor Analysis

The correlation among the various variables is given by the correlation matrix (as shown in the above table).

Bartlett's Test and KMO

Test of Sphericity (Bartlett's)	Chi-Square (approx.)	2212.183
	df	45
	Sig.	.000
Sampling Adequacy Measure (Kaiser-Meyer-Olkin) (KMO)		.885

Table 5.30: Bartlett’s Test and KMO

In order to understand how appropriate the data is amenable for analysis (factor), the KMO Test is used to give the measurement output. The test measures the adequacy (sampling) for each variable in the model. It also measures the adequacy (sampling) for the complete model. The test statistic gives the measurement of the amount of variance among variables that might be considered as common variance. The data is amenable for Analysis (Factor), when the amount of variance is lower.

Values between 0 and 1 are usually returned by the test. Thumb rules for understanding the test statistic is given below --

Sampling is adequate when the values are between 0.8 and 1.

Sampling is not adequate when the values are less than 0.6. This indicates that corrective action needs to be undertaken. (Sometimes, the value is also taken as 0.5. Hence, appropriate discretion needs to be exercised (values between 0.5 and 0.6).

Values near to zero indicates that there are large partial correlations in comparison to the sum of correlations. Hence, there is a big issue for analysis (factor) due to widespread correlations.

For referential purposes, the KMO test values could be viewed as -

- Unacceptable - 0.00 to 0.49
- Miserable - 0.50 to 0.59
- Mediocre - 0.60 to 0.69
- Middling - 0.70 to 0.79
- Meritorious - 0.80 to 0.89
- Marvelous - 0.90 to 1.00

In the above case, KMO statistic works out to 0.885. Thus, the details are suited for analysis (factor) and the sampling is adequate.

Test of Sphericity (Bartlett) and KMO is considered as a measurement of the adequacy of sampling undertaken. For the scrutiny being undertaken, the case to variable ratio is checked by the test. Bartlett and KMO test accomplishes a significant function for accommodating the sampling adequacy. While the value varies from 0 to 1, the generally acknowledged indicator is over 0.6. The Test of Sphericity (Bartlett) indicates the relationship to the importance of the study. It thus highlights the applicability and cogency of the responses collected to the issue being resolved through the research. In order for analysis (factor) to be considered as appropriate, Test of Sphericity (Bartlett) must be less than 0.05. In the above case, the value (significance) of the Test of Sphericity (Bartlett) is < 0.05, which indicates that factor analysis is found to be suitable and can be recommended to be performed on the data.

Communalities - Analysis (Factor)

	Value (Initial)	Value (Extracted)
IV1	1.0	.772
IV2	1.0	.607
IV3	1.0	.662
IV4	1.0	.635
IV5	1.0	.385
IV6	1.0	.515
IV7	1.0	.681
IV8	1.0	.832
IV9	1.0	.718
DV	1.0	.676

Method of Extraction: Analysis (Principal Component)

Table 5.31: Communalities – Analysis (Factor)

Communality is defined as –

For all factors for a given variable (row), the summation of the factor loadings (squared) is the variation in that variable which is taken into account by all the elements (factors). The above matrix gives details of the communalities obtained from the operations performed on the data. The extraction method used is principal component analysis. A communality signifies the quantity of variance in that variable and which is represented by all the components. It also indicates the summation of the component loadings (squared). For instance, the two components (extracted) represent 77.2 % of the variation in variable IV1.

Variance Explained (Total)

Component	Eigenvalues (initial)			Squared Loadings Sum (Extraction)			Squared Loadings Sum (Rotation)		
	Total	Variation (%)	Cum Percentage	Total	Variation (%)	Cum Percentage	Total	Variation (%)	Cum Percentage
1	5.368	53.685	53.685	5.368	53.685	53.685	3.420	34.203	34.203
2	1.113	11.129	64.814	1.113	11.129	64.814	3.061	30.611	64.814
3	.837	8.368	73.182						

4	.579	5.786	78.968						
5	.518	5.182	84.150						
6	.464	4.639	88.789						
7	.400	3.995	92.785						
8	.281	2.812	95.597						
9	.256	2.559	98.156						
10	.184	1.844	100.000						

Method of Extraction : Analysis (Principal Component)

Table 5.32: Variance Explained (total) – Factor Analysis

Loadings (factor) highlight the extent to which a factor elucidates a variable in analysis (factor). The above total variance table gives the details of the eigen values (initial) and extraction and rotation summations of loadings (squared) for the first two components. This is to be viewed in conjunction with the Scree plot. This table indicates the actual factors that were extracted. The column considered as “Sums (rotation) of Loadings (squared)” indicates only those factors that meet the cut-off criteria (method - extraction). In this situation, there were two factors which had eigenvalues that were greater than 1. Initially, SPSS tool generally takes out as many factors as there are variables in the dataset. However, the remaining factors could not meet the rank. The variance (%) column indicates the extent by which the variability (total) (considering together all of the variables) can be represented by each of these scales (summary) or factors or components. Component 1 represents 34.203% of the variance in all 10 variables. Component 2 accounts for 30.611% of the variance in all 10 variables.

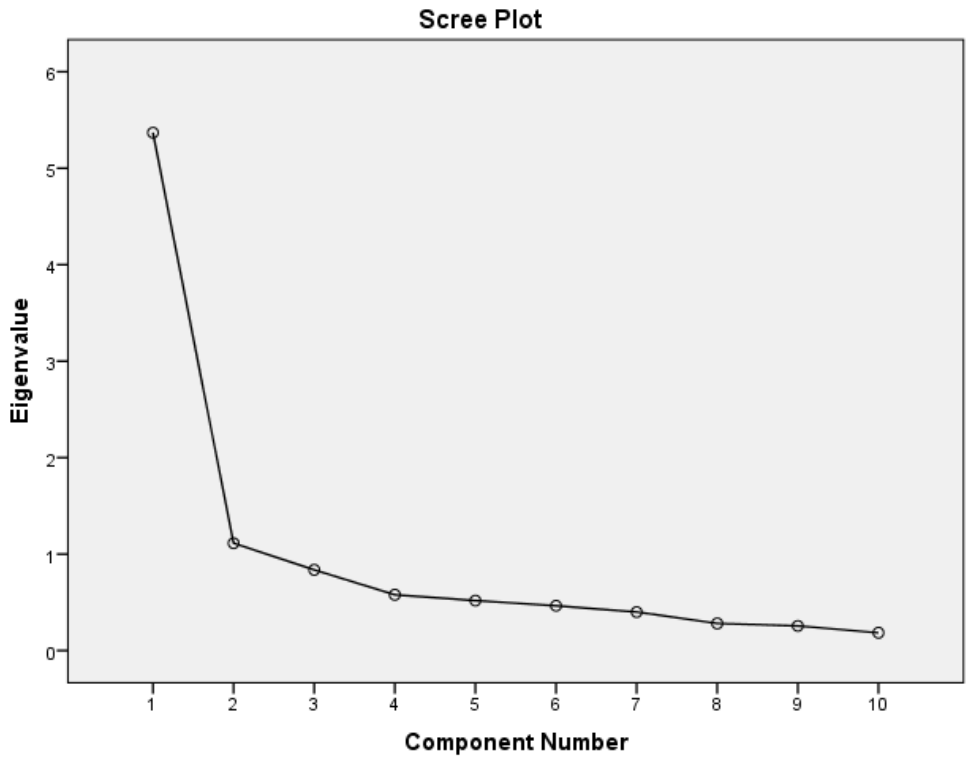


Figure 5.5: Plot - Scree

The plot (scree) indicates the eigenvalues connected with a factor or component in descendant order against the number of the factor or component. Plots (scree) are usually utilized in analysis (principal component) to evaluate visually which factors or components elucidate most of the data variability and which are the key components that should be focused in order to manage the outcomes appropriately. From the above figure, it is observed that components – 1 and 2 (having eigen value greater than or equal to 1) clarify most of the data variability.

Component Matrix[a]

	Component	
	1	2
IV1	.849	-.226
IV2	.763	.159
IV3	.793	.183
IV4	.662	-.443
IV5	.620	.003
IV6	.556	.453
IV7	.800	-.200
IV8	.769	-.491
IV9	.658	.534
DV	.800	.188

Method of Extraction: Analysis (Principal Component)
a. extracted two components

Table 5.33: Matrix (Component) – Factor Analysis

The matrix (component) highlights the two components that have been extracted as part of the method of extraction – analysis (principal component).

Matrix (Rotated Component)[a]

	Component	
	1	2
IV1	.778	.409
IV2	.454	.633
IV3	.460	.671
IV4	.787	.122
IV5	.454	.422
IV6	.103	.710
IV7	.725	.394
IV8	.898	.158
IV9	.123	.838
DV	.462	.680

Method of Extraction – Analysis (Principal Component)
Method of Rotation - Normalization (Kaiser) with Varimax.
a. 3 iterations - rotation (converged)

Table 5.34: Matrix (Rotated Component)

Another important aspect that needs focus is the Matrix (rotated component) as shown in the above table. The decision regarding how many factors to be analyzed depends if a variable is related to one factor or it is related to more than one factor. Loadings (high item) are maximized by the rotation approach. Loadings (low item) are also minimized. These operations thus produce a more simple and understandable solution. Two shared techniques (rotation) that may be focused – rotation (orthogonal) and rotation (oblique). Structures (factor) that are uncorrelated are created by rotation (orthogonal varimax). Structures (factor) that are correlated are created by rotation (oblique varimax). The key objectives of the matrix (rotated component) are to offer an easier clarification of the consequences and focus on a suitable solution, regardless of the rotational operation utilized. The rotated component matrix used the extraction method (extraction) of analysis (principal component) and the rotational method used is Normalization (Kaiser) with varimax. The rotational convergence happened in three iterations.

The Matrix (rotated component) indicates the loadings (factor) for each variable. Through each row, the yellow highlighted number refers to the factor on which each variable loaded most powerfully. As per these loadings (factor), they may represent -- Variables 1, 4, 7 and 8 loaded strongly on Factor 1, which may be called as "People and Environment" as the focus is on Selection of Team and Skills, Reward and Motivation, Virtual and Physical Work Environment and Disruptive Innovation. Variables 2, 3, 6 and 9 all loaded strongly on Factor 2, which may be called as "Complex Adaptive System Entity" as the focus is on Behavioral Factors (Maturity, Commitment), Leadership, Collaboration and Communication and Complex Adaptive System (CAS). Variable 5 is not considered as the matrix (rotated component) value is below 0.5.

Matrix
Transformation (Component)

Component	1	2
1	.736	.677
2	-.677	.736

Type of Extraction: Analysis (Principal Component)
Method of Rotation: Normalization (Kaiser) with Varimax

Table 5.35: Matrix (Component Transformation)

The above table gives the component transformation carried out using the method of extraction – analysis (principal component) and the method (rotation) used was Normalization (Kaiser) with Varimax. Post-multiplying the matrix of original loadings by the transformation matrix leads to the original factor or component loadings being transformed to the rotated loadings. The values in the transformation matrix are functions of the angle(s) of rotation of the factors or components (Harman, 1976). The Matrix (Component Transformation) exhibits the matrix (component correlation) before and subsequent to the rotation.

Component Score Coefficient Matrix

	Component	
	1	2
IV1	.254	-.042
IV2	.008	.201
IV3	-.003	.221
IV4	.360	-.210
IV5	.083	.080
IV6	-.199	.370
IV7	.231	-.031
IV8	.404	-.228
IV9	-.234	.436
DV	-.005	.225

Method of Extraction: Analysis (Principal Component)
Method of Rotation: Normalization (Kaiser) with Varimax

Table 5.36: Coefficient Matrix– Score (Component)

Matrix (Covariance)
Score (Component)

Constituent	1	2
1	1.000	.000
2	.000	1.000

Type of Removal: Analysis- Component or Constituent (Principal)
Type of Rotational Technique: Technique of Normalization (Kaiser) with Varimax

Table 5.37: Covariance Matrix (Component Score)

The above two tables give the Coefficient Matrix (Component Score) and the Covariance Matrix (Component Score) which indicates the details for the two components extracted using analysis (principal component) and using the method of rotation – Normalization (Kaiser) with Varimax.

5.3.9 Analysis of Data

Problem Statement

Investigate the Degree to which People Related Factors (Selection of Team and Skills, Behavioral Factors (Maturity, Commitment), Leadership, Reward and Motivation), Interaction of the People with the Environment (Impact of Organizational Culture, Collaboration and Communication, Virtual and Physical Work Environment) and Innovative Work Techniques for Problem Solving (Disruptive Innovation, Complex Adaptive System (CAS)) predicts Improved Work Outcomes.

An equation (multiple linear regression) was computed to forecast the Dependent Variable (DV) – Improved Work Outcomes based on Independent Variable 1 – Selection of Team and Skills (IV1), Independent Variable 2 - Behavioral Factors (Maturity, Commitment) (IV2), Independent Variable 3 – Leadership (IV3), Independent Variable 4 – Reward and Motivation (IV4), Independent Variable 5 – Impact of the Organizational Culture (IV5), Independent Variable 6 – Collaboration and Communication (IV6), Independent Variable 7 – Virtual and Physical Work Environment (IV7), Independent Variable 8 - Disruptive Innovation (IV8) and Independent Variable 9 – Complex Adaptive System (CAS) (IV9) and Residual. A significant regression equation was found ($F(9, 390) = 68.070$, $p < .000$), with an R^2 of 0.611. Participants' predicted Improved Work Outcomes are equal to 0.448 - 0.108 (Selection of Team and Skills) + 0.132 (Behavioral Factors (Maturity, Commitment)) + 0.257 (Leadership) + 0.005 (Reward and Motivation) + 0.218 (Impact of the Organizational Culture) + 0.104 (Collaboration and Communication)+ 0.043 (Virtual and Physical Work Environment) + 0.159 (Disruptive Innovation) + 0.132 (Complex Adaptive System (CAS)) + Residual where all the nine independent variables are coded or measured as –

'**1**' indicates '**Strongly Disagree**', '**2**' indicates '**Disagree**', '**3**' indicates '**Disagree Somewhat**', '**4**' indicates '**Undecided**', '**5**' indicates '**Agree Somewhat'**, '**6**' indicates '**Agree**' and '**7**' indicates '**Strongly Agree**'.

Improved Work Outcomes increased -0.108 times for each unit of Selection of Team and Skills, 0.132 times for each unit of Behavioral Factors (Maturity, Commitment), 0.257 times for each unit of Leadership, 0.005 times for each unit of Reward and Motivation, 0.218 times for each unit of Impact of the Organizational Culture, 0.104 times for each unit of Collaboration and Communication, 0.043 times for each unit of Virtual and Physical Work Environment, 0.159 times for each unit of Disruptive Innovation and 0.132 times for each unit of Complex Adaptive System (CAS).All the variables - Selection of Team and Skills, Behavioral Factors (Maturity, Commitment), Leadership, Impact of the Organizational Culture, Collaboration and Communication, Disruptive Innovation, Complex Adaptive System (CAS)were significant predictors of Improved Work Outcomes except for the two variables – Reward and Motivation and Virtual and Physical Work Environment which were not significant predictors of Improved Work Outcomes.

5.3.9.1 Linear Regression Analysis

Introduction

Regression (linear) is utilized whenever the value of a variable is planned to be forecasted based on another variable status (value). The output variable is the item we want to forecast. The independent item (predictor variable) is the variable we are utilizing to forecast the value of the other variable. For instance, we may utilize linear regression to comprehend whether future air flight performance can be predicted based on historical air flight timings; if based on the consumption of cigarettes, whether the smoking duration can be predicted and similar other scenarios. The utilization of multiple regression is warranted when there are two or more independent variables.

The various expectations that the data must fulfill so that the regression (linear) equation could help us to indicate a validated outcome are expounded in the subsequent sections.

Assumptions

- If linear regression is used to analyze the data, a portion of the procedure encompasses an inspection to ensure that the data that is going to be analyzed is really amenable for

analysis using linear regression. It is apposite to focus on linear regression only. This is possible if the data clears the expectations (six assumptions) that are needed for regression (linear) to help us to obtain a validated result.

- Assumption #1 - The two variables that are being measured should be either interval or ratio variables (at the continuous level). Some instances of continuous variables comprise of - tare (measured in kg), test performance (measured from 0 to 100), emotional state (measured using EQ score), amendment time (measured in hours) and other instances. In our case, we used ordinal-interval variables for measuring the independent variables, the dependent variable was also measured as an ordinal-interval variable. Additionally, many aspects of the measurement are intangible and cannot be quantified and represented directly. In such scenarios, the ordinal-interval variables are used to capture these aspects).
- Assumption #2 – The two variables should exhibit a linear relationship. A scatterplot was plotted to test the variable (dependent) against the variables (independent). This was again inspected visually to confirm if linearity was present. The scatter plot was found to be linear.
- Assumption #3 - No noteworthy outliers should be present. A perceived data point that has a variable (dependent) value that is significantly dissimilar to the value forecasted by the regression equation is considered as an outlier. Thus, the outlier may be a point on a scatterplot and which is far away (vertically) from the regression line. This may indicate that the data point may have a residual (large). The issue with values lying outside the normal range (outlier) is that they can have an undesirable consequence on the analysis of the regression calculation (they may bring down the regression equation fit) which is used to forecast the outcome (dependent) variable value built on the predictor (independent) variable. This could lead to changes in the output produced by the tool. This could also bring down the forecast accuracy of the results. No noteworthy outliers are observed in this research study.
- Assumption #4 – Observations are to be independent and which can be easily checked by utilizing the Durbin-Watson statistic. Durbin Watson Statistic is within the specified limits. Hence, the observations are independent.
- Assumption #5 – Homoscedasticity needs to be exhibited by the data. This implies that the variations along the best fitting line continue to be comparable as we go beside the line. The presence of homoscedasticity is to be observed by checking the graph outputs. The graph outputs indicate homoscedasticity.

- Assumption #6 - Lastly, we have to scrutinize that the errors of the regression equation line are distributed normally (approximately). Using the graph - Regression Standardized Residual (Normal P-P Plot), we can observe that the residuals are normally distributed (approximately).

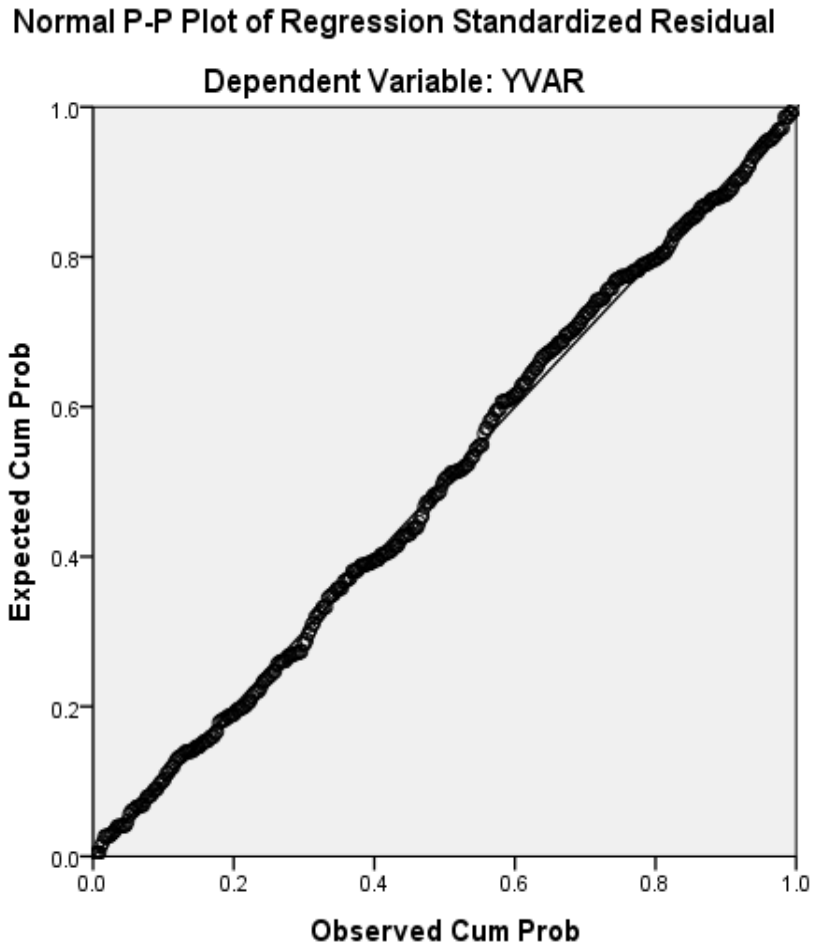


Figure 5.6: Linear Regression Analysis – Assumption #6 -- Regression Standardized Residual (Normal P-P Plot)

Hence, all the assumptions are met for the data collected for the model requirements.

Note (Sources)

Laerd – Statistics – assumptions for regression (linear)

Kenneth Plummer – reporting regression details (multiple) (linear)

Calvin Garbin – statistics details

Thus, based on the above multiple linear regression model, the null hypotheses are rejected and the alternative hypotheses are accepted where the p values are < 0.05 for

all the variables. In the instance of the values of $p > 0.05$, the null hypotheses are accepted and the alternative hypotheses are rejected (Wagenmakers, 2007). With reference to any specific hypothesis that is focused, no test (based on the theory of probability) can offer by itself any important proof of the truth or falsehood of that hypotheses (Neyman & Pearson, 1933) –

Alternative Hypotheses that are accepted –

$H1_a$ - There is a significant relationship between the improved work outcomes for the software project and the selection of team and skills in an agile team.

$H2_a$ - There is a significant relationship between the improved work outcomes for the software project and the behavioral factors in an agile team.

$H3_a$ - There is a significant relationship between the improved work outcomes for the software project and the leadership in an agile team.

$H5_a$ - There is a significant relationship between the improved work outcomes for the software project and the impact of the organizational culture in an agile team.

$H6_a$ - There is a significant relationship between the improved work outcomes for the software project and the collaboration and communication in an agile team.

$H8_a$ - There is a significant relationship between the improved work outcomes for the software project and the disruptive innbvative practices in an agile team.

$H9_a$ - There is a significant and positive relationship between the improved work outcomes for the software project and the application, understanding and consideration of the agile team as a complex adaptive system (CAS).

Figure 5.7: Hypothesis (Alternative) (accepted)

Null Hypotheses that are accepted –

H4 - There is no significant relationship between the improved work outcomes for the software project and the reward and motivational factors in an agile team.

H7 - There is no significant relationship between the improved work outcomes for the software project and the virtual and physical work environment in an agile team.

Figure 5.8: Hypothesis (null) (accepted)

Thus, the independent variables - Independent Variable 1 – Selection of Team and Skills (IV1), Independent Variable 2 - Behavioral Factors (Maturity, Commitment) (IV2), Independent Variable 3 – Leadership (IV3), Independent Variable 5 – Impact of the Organizational Culture (IV5), Independent Variable 6 – Collaboration and Communication (IV6), Independent Variable 8 - Disruptive Innovation (IV8) and Independent Variable 9 – Complex Adaptive System (CAS) (IV9) have a substantial impact on the Variable (dependent) (DV) – Improved Work Outcomes.

The independent variables - Independent Variable 4 – Reward and Motivation (IV4) and the Independent Variable 7 – Virtual and Physical Work Environment (IV7) do not have a substantial impact on the Variable (dependent) (DV) – Improved Work Outcomes as compared to the other independent variables.

Thus, the equation works out as -

DV = 0.448 - 0.108 IV1 + 0.132 IV2 + 0.257 IV3 + 0.218 IV5 + 0.104 IV6 + 0.159 IV8 + 0.132 IV9 + Ei -- Equation -- A

OR

Improved Work Outcomes (Software Project Success) = 0.448 – (0.108 * Selection of Team and Skills) + (0.132 * Behavioral Factors (Maturity, Commitment)) + (0.257 * Leadership) + (0.218 * Impact of the Organizational Culture) + (0.104 * Collaboration and Communication) + (0.159 * Disruptive Innovation) + (0.132 * Complex Adaptive System (CAS)) + E_i--- Equation --- B

5.4 DEMOGRAPHIC ANALYSIS OF DATA

The questionnaire is designed on the foundation of the research model reflecting all the twenty five items measuring the nine dimensions constituting the independent variables considered in the study. Apart from these variables measured on a Likert scale (seven point), there is also a set of demographic data captured through the questionnaire and the analysis of this data is given below –

5.4.1 Designation of the Respondents – Percentage Break-Up

Different types of team members and leaders have participated in the survey. The designations/roles are given below –

Team Leads/ScrumMasters, Project Managers, Senior Software Engineer, Software Engineer, Tester, Agile Coaches, Test Manager, Unit Heads/Program Manager/Account Manager, Business Analysts/Product Owners, Designers/Architects, Database administrators

The table given below and the graph shown below gives the summary of the percentage break-up –

Designation	TL/SM	PM	SSE	SE	Tester	Agile Coach	Test Mgr	Account Mgr/Program Mgr/Unit Head	PO/BA	Architect/Designer	DBA
Percentage of Respondents	35	15	17	12	5	3	2	3	4	2	2

Table 5.38: Designation/Role of the Survey Respondents – Percentage Break-Up

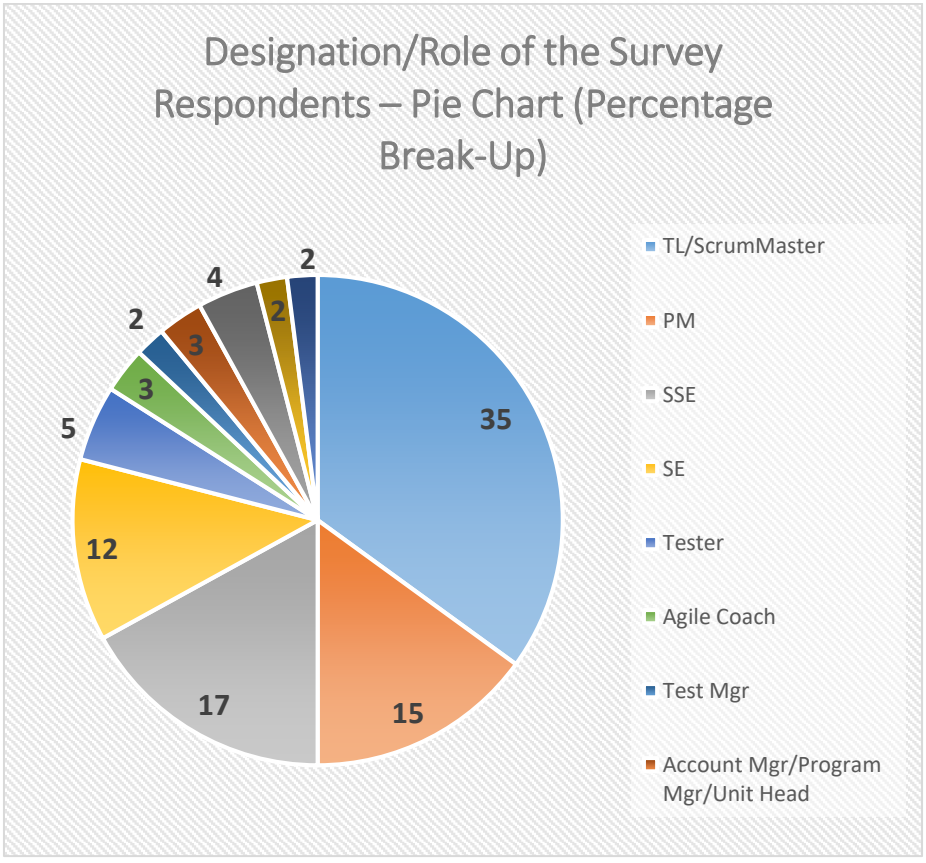


Figure 5.9: Designation/Role of the Survey Respondents – Pie Chart (Percentage Break-Up)

The survey responses were obtained from various levels of the hierarchy in the organization and from the team members of the software development project. Around 80 percent of the survey respondents were part of delivery and hence, the sample provides a good feedback on the key characteristics of agile software development teams that will facilitate improved work outcomes. The sample data is granular and it is captured from the appropriate frame of sample proposed.

5.4.2 Project Completion Status

The survey responses took into account the life cycle state of the software projects which were at different levels of project completion. This helped to focus on the different states of the project life cycle. This helped to ascertain the level of the performance of the project at different levels of completion. The Y-axis indicates the state of project completion (in percentage) and the X-axis indicates the percentage of projects covered in the range – 0% -20%, 21% -40%, 41% -60%, 61% -80% and 81% -100%. The projects were evaluated in terms of the improved work outcomes (customer satisfaction (business value delivered) and the deliverables delivered to the customer within the defined constraints and conditions constituting project success) and also whether the project is in an ongoing development phase or it is in the maintenance phase.

State of Project Completion (in percentage)	Percentage of Projects Covered
0 to 20	8.80%
21 to 40	14.10%
41 to 60	17.50%
61 to 80	29.00%
81 to 100	30.60%

Table 5.39: Project Completion Status

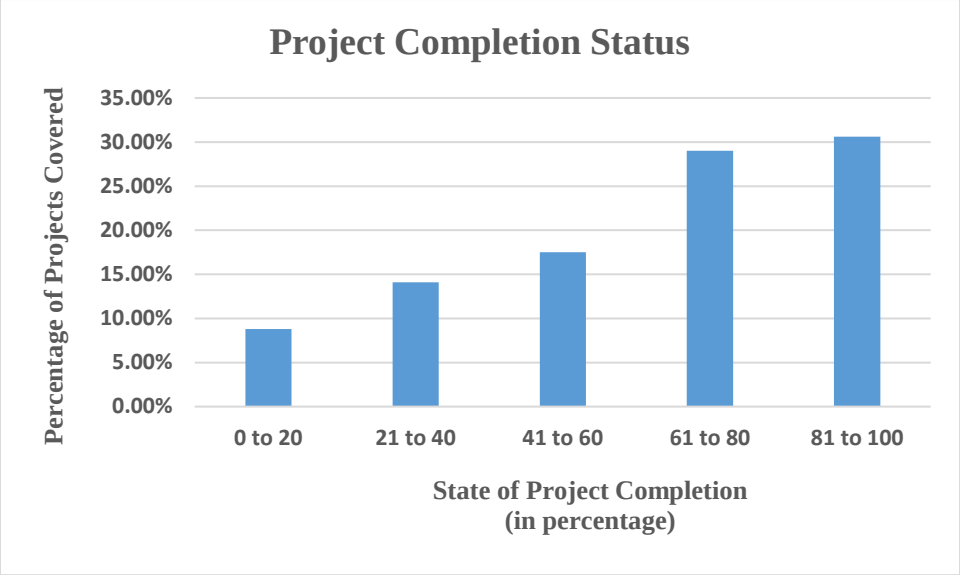


Figure 5.10: Project Completion Status

5.4.3 Duration of Projects

The duration of the projects has been captured in terms of the number of months. The X-axis gives the project duration and the Y-axis indicates the percentage of projects having that duration. The duration of the software projects varied from three months to ninety six months.

Duration Range (months)	1 To 20	21 to 40	41 To 60	61 To 80	81 To 100
Percentage of projects	24%	25%	19%	20%	12%

Table 5.40: Project Duration

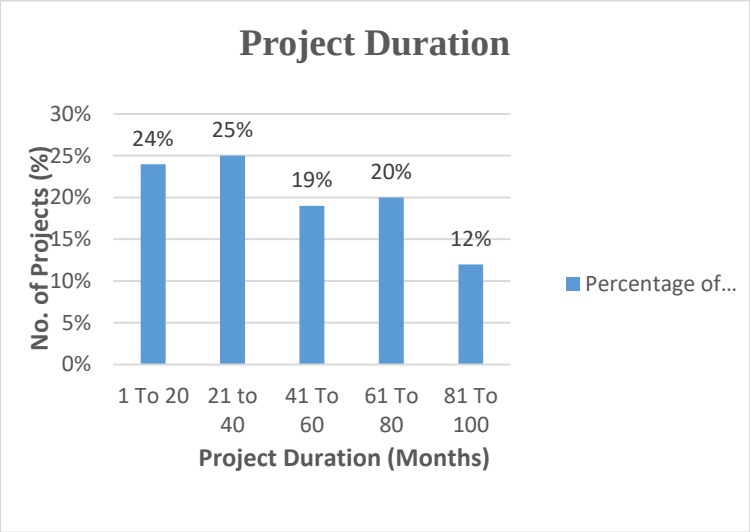


Figure 5.11: Project Duration Status

5.4.4 Type of Project

The type of project that has been observed has been categorized as per the following types – Research and Development (R and D), Application Software Development, Maintenance, Enhancement/Customization and Others.

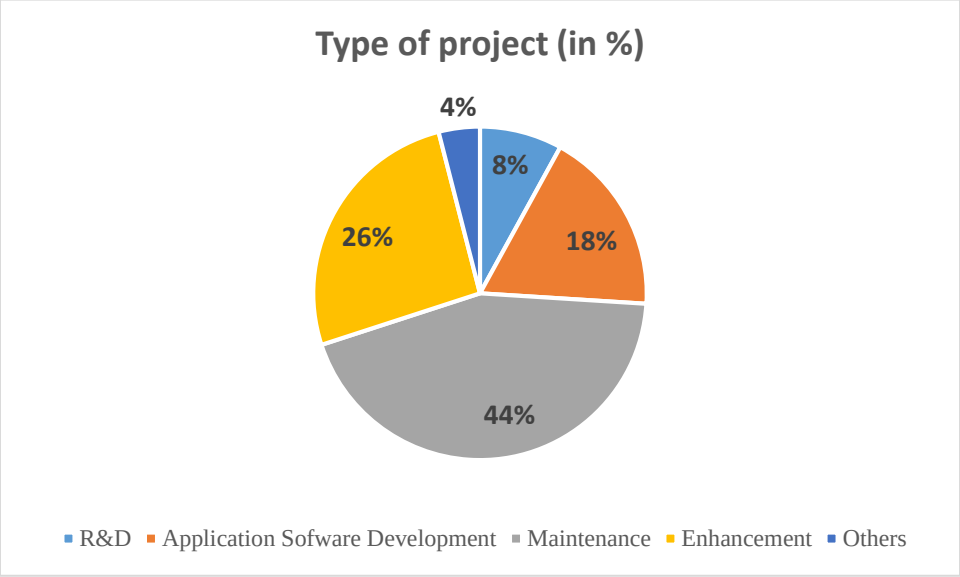


Figure 5.12: Type of Projects (In %)

Thus, the demographic findings indicates that the data was collected from a wide range of respondents and it covered different type of projects having different duration. The

project members in the software project/product team were also belonging to different hierarchical levels. The result also highlights that the maximum number of projects considered in the study are operating in the maintenance phase and ranged in duration from three months to ninety six months.

5.4.5 Type of Agile Framework/Methodology used by the Projects

The type of agile framework/methodology used by the projects has been observed and has been categorized as – Scrum, XP, Lean/Kanban, Others (FDD, DSDM, Crystal, etc.). Where multiple methodologies are used in the project, the main methodology is only considered under its category.

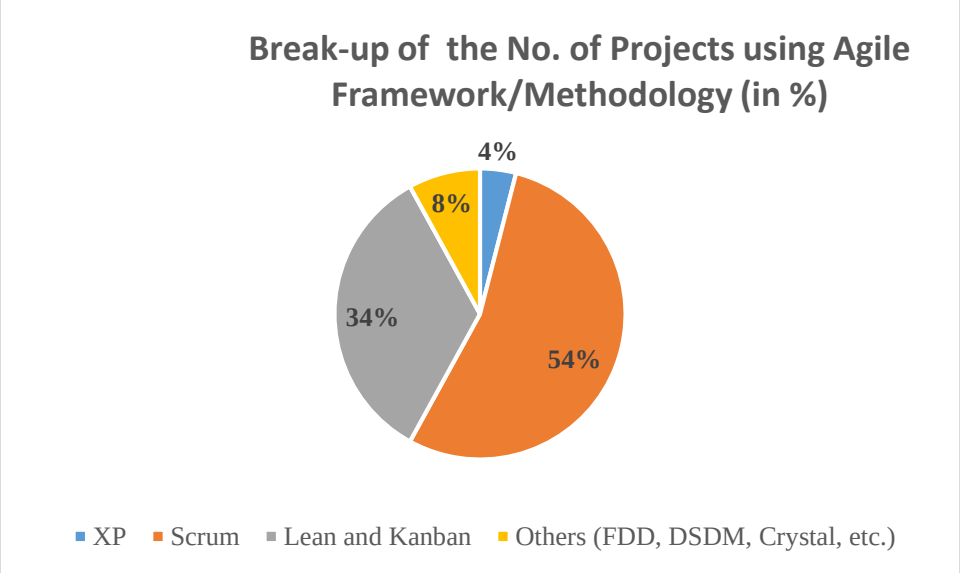


Figure 5.13: Break-up of the No. of Projects using agile framework/methodology

Thus, the demographic findings indicates that the data was collected from projects practicing a wide range of agile methodologies/frameworks and it covered different type of projects. It is observed that Scrum and Lean/Kanban accounted for around 88% of the projects using agile methodologies.

5.4.6 Frequency of Response

The frequency of each dimension is tabulated using MS Excel and a graph is prepared to understand the frequency of the responses based on the seven point Likert scale. The rating is given as per the measurement rating (range -- 1-7, where - disagree strongly - 1 to agree strongly - 7).

1. Selection of Team and Skills

The table given below indicates the frequency of the rating scale for Selection of Team and Skills.

Response Percentage	Rating	Degree of Agreement
0.00%	1	disagree strongly
0.00%	2	Disagree
0.42%	3	disagree somewhat
11.42%	4	Undecided
30.58%	5	agree somewhat
38.25%	6	Agree
19.33%	7	Strongly agree

Table 5.41: Selection of Team and Skills – Frequency Distribution

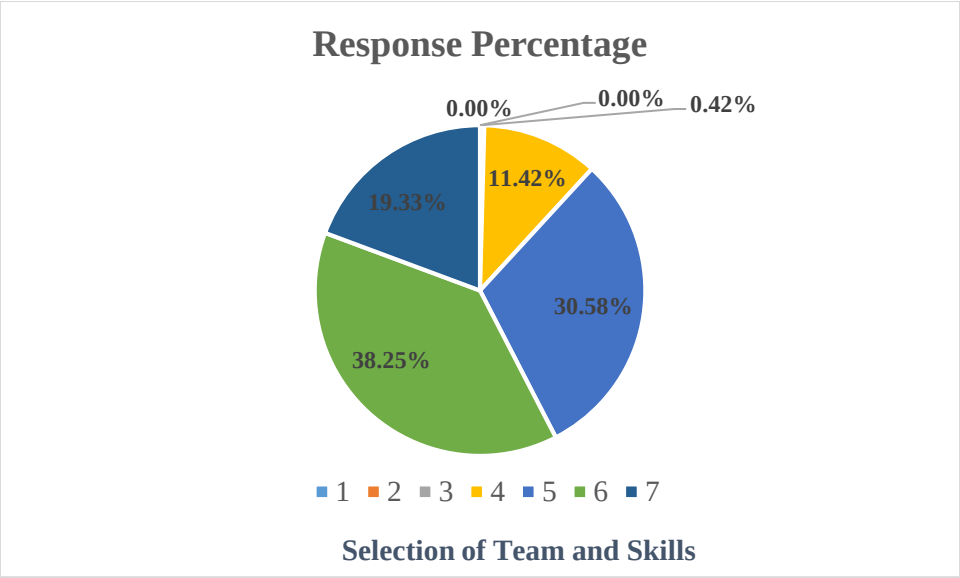


Figure 5.14: Selection of Team and Skills

The above table and figure indicates that the maximum number of respondents agree and somewhat agree that the selection of team and skills are an important attribute of agile software development teams.

2. Behavioral Factors (Maturity, Commitment)

The table given below indicates the frequency of the rating scale for Behavioral Factors (Maturity, Commitment).

Response Percentage	Rating	Agreement degree
0.00%	1	disagree strongly
0.00%	2	Disagree
0.83%	3	disagree somewhat
15.25%	4	Undecided
32.25%	5	agree somewhat
32.50%	6	Agree
19.17%	7	Strongly agree

Table 5.42: Behavioral Factors (Maturity, Commitment) – Frequency Distribution

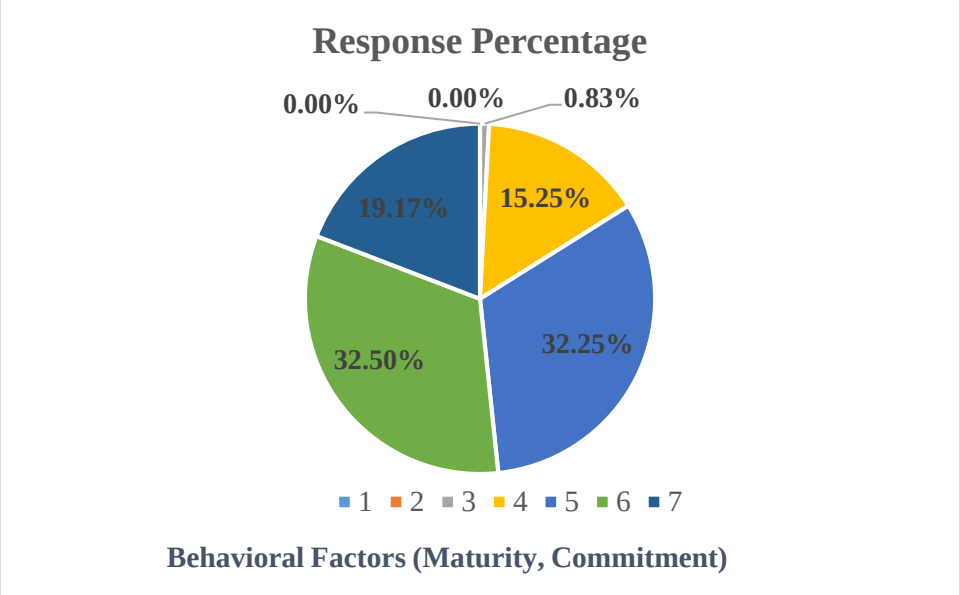


Figure 5.15: Behavioral Factors (Maturity, Commitment)

The above table and figure indicates that the maximum number of respondents agree and somewhat agree that the behavioral factors (maturity, commitment) are an important attribute of agile software development teams.

3. Leadership

The table given below indicates the frequency of the rating scale for Leadership.

Response Percentage	Rating	Agreement degree
0.00%	1	disagree strongly
0.00%	2	Disagree
1.58%	3	disagree somewhat
15.25%	4	Undecided
32.75%	5	agree somewhat
27.25%	6	Agree
23.17%	7	Strongly agree

Table 5.43: Leadership – Frequency Distribution

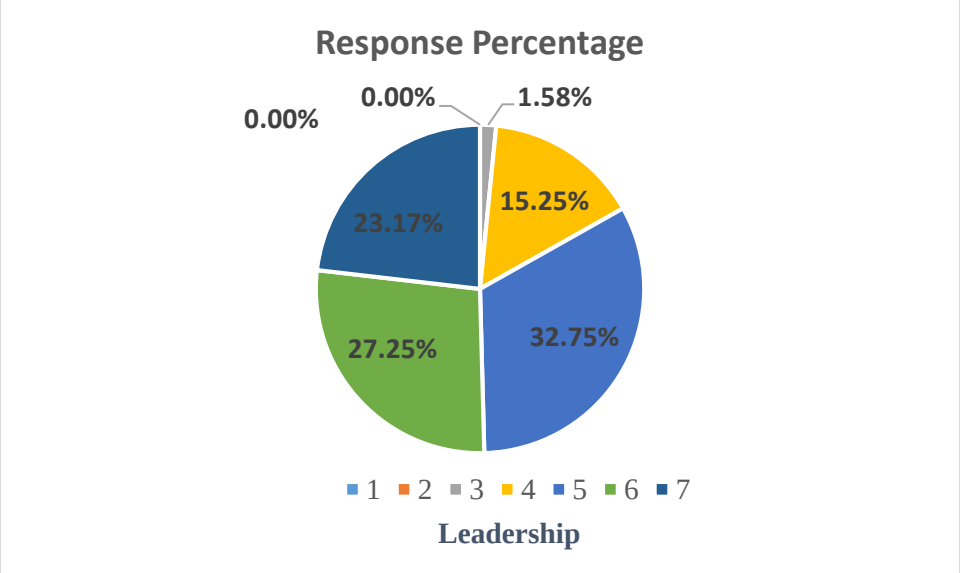


Figure 5.16: Leadership

The above table and figure indicates that the maximum number of respondents somewhat agree and agree that leadership is a significant factor of agile SW development teams.

4. Reward and Motivation

The table given below indicates the frequency of the rating scale for Reward and Motivation.

Response Percentage	Rating	Agreement degree
0.00%	1	disagree strongly
1.25%	2	Disagree
3.67%	3	disagree somewhat
12.42%	4	Undecided
27.83%	5	agree somewhat
32.33%	6	Agree
22.50%	7	Strongly agree

Table 5.44: Reward and Motivation – Frequency Distribution

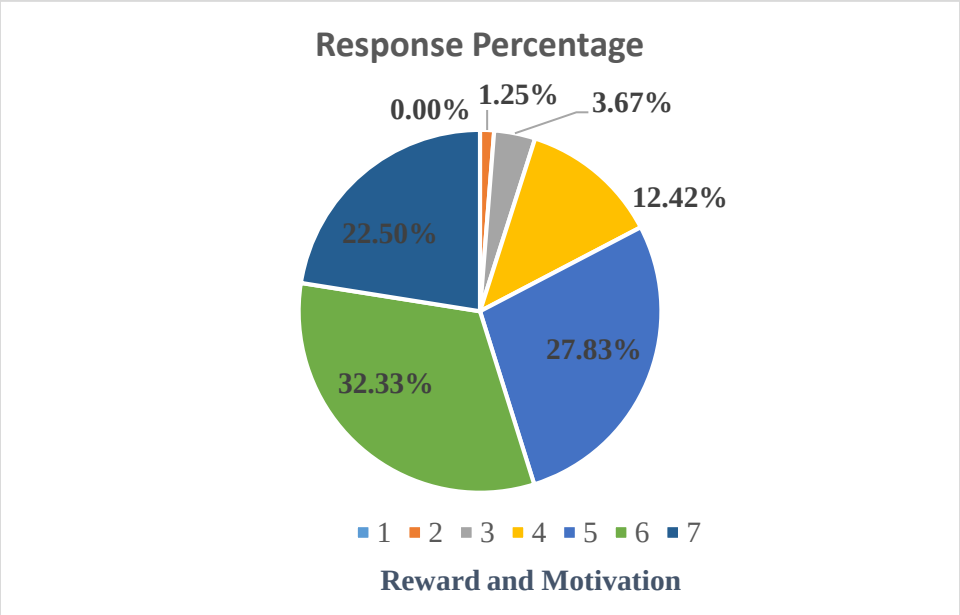


Figure 5.17: Reward and Motivation

The above table and figure indicates that the maximum number of respondents somewhat agree and agree that reward and motivation is a factor impacting the characteristics of agile software development teams. However, about 17.33% of the respondents somewhat disagree, disagree or are undecided on this attribute.

5. Impact of the Organizational Culture

The table given below indicates the frequency of the rating scale for Impact of the Organizational Culture.

Response Percentage	Rating	Agreement degree
0.00%	1	disagree strongly
0.08%	2	Disagree
1.08%	3	disagree somewhat
11.17%	4	Undecided
30.83%	5	agree somewhat
30.75%	6	Agree
26.08%	7	Strongly agree

Table 5.45: Impact of the Organizational Culture – Frequency Distribution

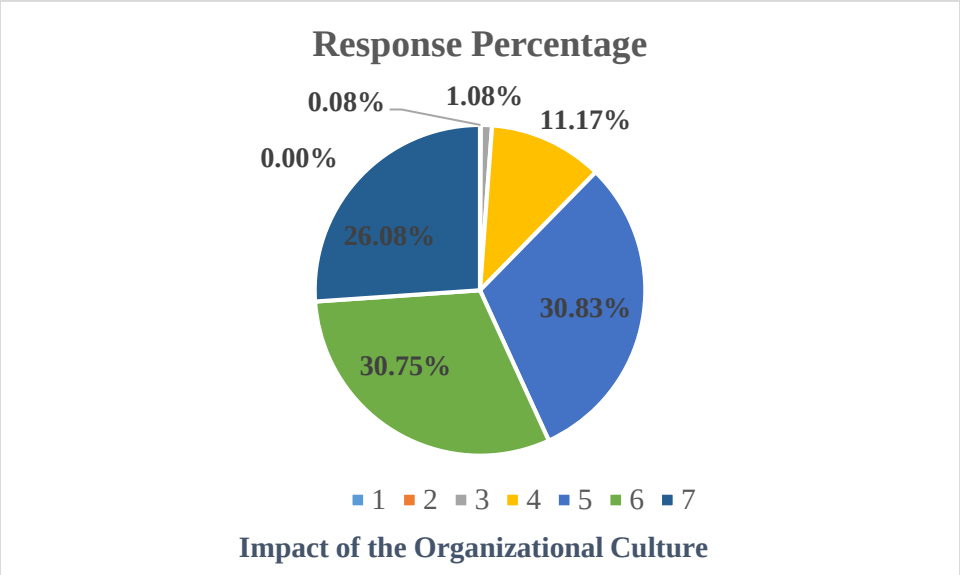


Figure 5.18: Impact of the Organizational Culture

The above table and figure indicates that the maximum number of respondents somewhat agree and agree that the impact of organizational culture is a significant element impacting the characteristics of agile software development teams. However, this needs to be viewed at the overall level in the specific cultural context of each organization which is varying and very dynamic as per the specific situation.

6. Collaboration and Communication

The table given below indicates the frequency of the rating scale for Collaboration and Communication.

Response Percentage	Rating	Agreement degree
0.00%	1	disagree strongly
0.08%	2	Disagree
1.17%	3	disagree somewhat
11.50%	4	Undecided
30.58%	5	agree somewhat
33.17%	6	Agree
23.50%	7	Strongly agree

Table 5.46: Collaboration and Communication – Frequency Distribution

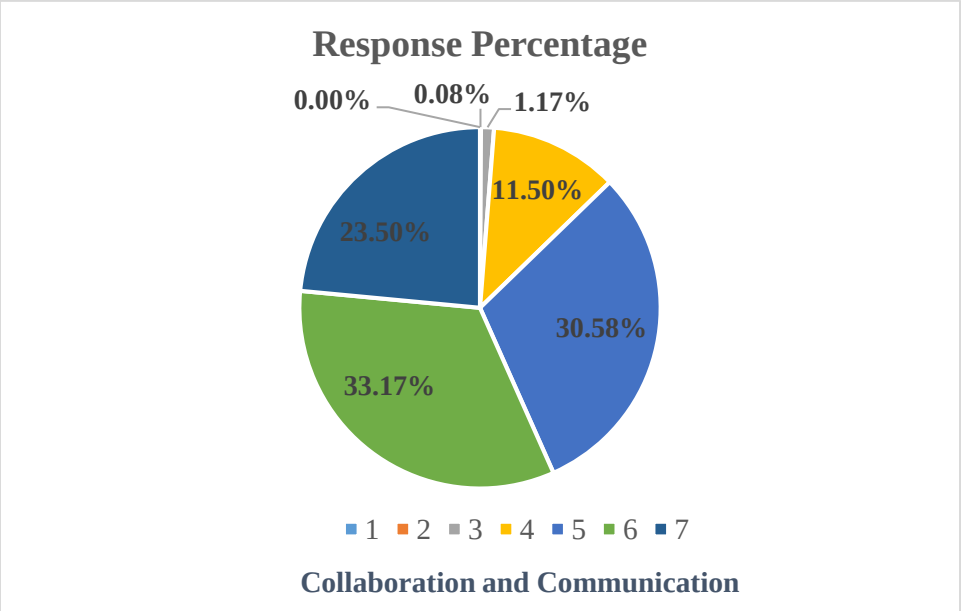


Figure 5.19: Collaboration and Communication

The above table and figure indicates that the maximum number of respondents agree and somewhat agree that the impact of collaboration and communication is an important factor impacting the characteristics of agile software development teams.

7. Virtual and Physical Work Environment

The table given below indicates the frequency of the rating scale for virtual and physical work environment.

Response Percentage	Rating	Agreement degree
0.17%	1	disagree strongly
0.42%	2	Disagree
4.33%	3	disagree somewhat
14.83%	4	Undecided
30.00%	5	somewhat agree
32.00%	6	Agree
18.25%	7	agree Strongly

Table 5.47: Virtual and Physical Work Environment – Frequency Distribution

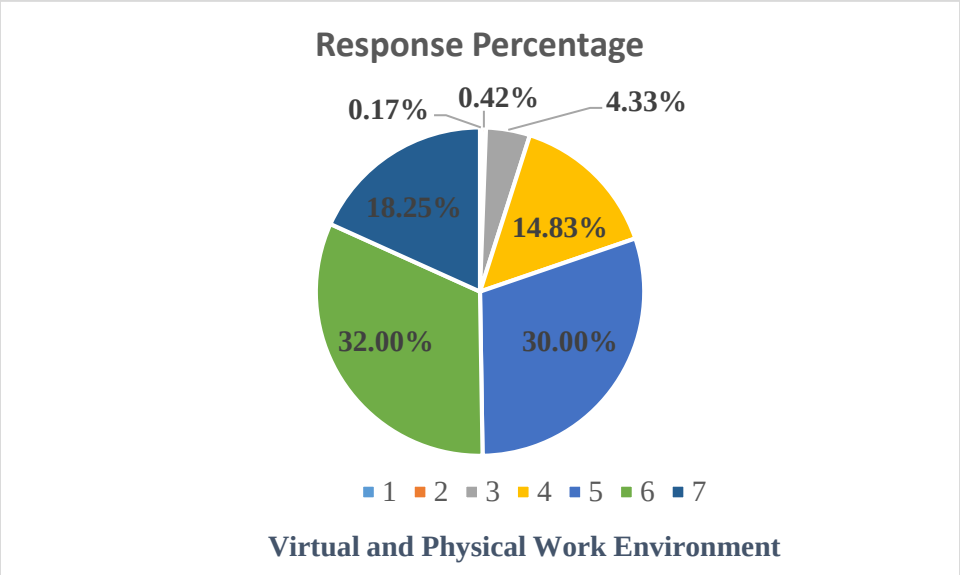


Figure 5.20: Virtual and Physical Work Environment

The above table and figure indicates that the maximum number of respondents agree and somewhat agree that virtual and physical work environment is a factor impacting the characteristics of agile software development teams. However, about 19.75% of the respondents strongly disagree, somewhat disagree, disagree or are undecided on this attribute.

8. Disruptive Innovation

The table given below indicates the frequency of the rating scale for disruptive innovation.

Response Percentage	Rating	Agreement degree
0.00%	1	disagree strongly
0.00%	2	Disagree
1.08%	3	disagree somewhat
14.00%	4	Undecided
35.75%	5	agree somewhat
33.25%	6	Agree
15.92%	7	Strongly agree

Table 5.48: Disruptive Innovation – Frequency Distribution

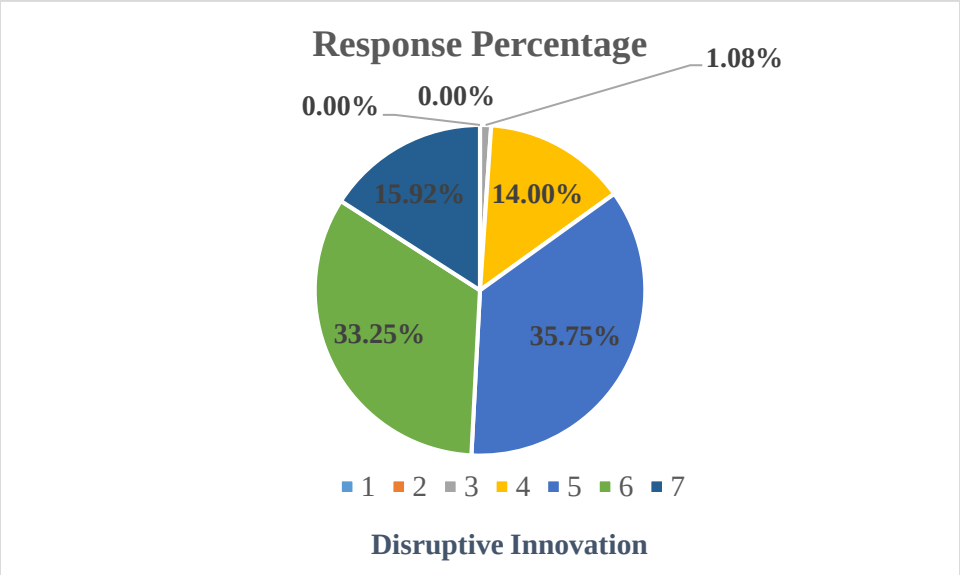


Figure 5.21: Disruptive Innovation

The above table and figure indicates that the maximum number of respondents somewhat agree and agree that the impact of disruptive innovation is an important factor impacting the characteristics of agile software development teams.

9. Complex Adaptive System (CAS)

The table given below indicates the frequency of the rating scale for complex adaptive system.

Response Percentage	Rating	Agreement degree
0.00%	1	disagree strongly
0.00%	2	Disagree
0.83%	3	disagree somewhat
9.00%	4	Undecided
31.92%	5	agree somewhat
43.17%	6	Agree
15.08%	7	agree strongly

Table 5.49: Complex Adaptive System (CAS) – Frequency Distribution

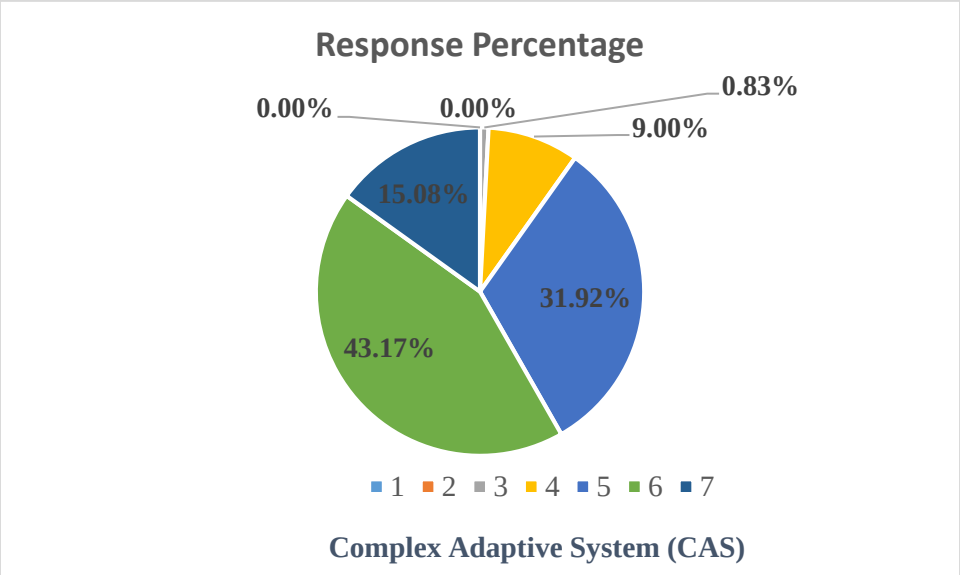


Figure 5.22: Complex Adaptive System (CAS)

The above table and figure indicates that the maximum number of respondents agree and somewhat agree that the aspect of considering the agile team as a complex adaptive system is an important factor impacting the characteristics of agile software development teams.

5.5 MULTIPLE REGRESSION ANALYSIS

The nine independent variables are measured on a Likert scale (seven point) and the questionnaire captures the feedback from the respondents as per the Likert scale.

5.5.1 Multiple Regression for Independent Variables

Analysis (multiple regression) was undertaken on all the variables (dependent and independent) and the value of $p < 0.05$ for the independent variables (IV1, IV2, IV3, IV5, IV6, IV8 and IV9) specifies rejecting the hypothesis (null) and accepting the hypothesis (alternative). For the independent variables – IV4 and IV7, as the value of p is greater than 0.05, the hypothesis (null) is accepted and the hypothesis (alternative) is rejected. Thus, the independent variables which are found to be statistically significant have an effect on improved work outcomes and thereby project success. Thus, these independent variables which are found to be statistically significant have an impact on the project success and the model summary for the regression analysis indicates the adjusted R square value to be 0.602. Hence, 60.2% of the variation in improved work outcomes (project success) is explained by all these seven independent variables. Four hundred responses were collected out of four hundred and forty responses. Forty responses were found to be having incomplete data.

Thus, the regression equation as per the variables entered in SPSS is given below –

Equation –

$$DV = B0 + B1\ IV1 + B2\ IV2 + B3\ IV3 + B4\ IV4 + B5\ IV5 + B6\ IV6 + B7\ IV7 + B8\ IV8 + B9\ IV9 + E_i$$

OR

Improved Work Outcomes (Software Project Success) = B0 + B1 Selection of Team and Skills + B2 Behavioral Factors (Maturity, Commitment) + B3 Leadership + B4 Reward and Motivation + B5 Impact of the Organizational Culture + B6 Collaboration and Communication + B7 Virtual and Physical Work Environment + B8 Disruptive Innovation + B9 Complex Adaptive System (CAS) + E_i

Summary (Regression Calculation)[b]

MOD	Regression value	Regression Square value	R Square (Adjusted)	Estimate (Standard Error)
1	.782[a]	.611	.602	.37482

a. Predictors: (Constant), X9AVG, X8AVG, X6AVG, X5AVG, X4AVG, X2AVG, X3AVG, X7AVG, X1AVG

b. Dependent Variable: YVAR

Table 5.50: Summary -- Regression Calculation

Variance Analysis (ANOVA)[a]

MOD		Squares (sum)	Degree of freedom	Value - Mean Square	F value	Significance
1	REG	86.070	9	9.563	68.070	.000[b]
	Residual	54.792	390	.140		
	Total	140.863	399			

a. Variable (Dependent) - YVAR

b. Variable (input) - (Constant), X9AVG, X8AVG, X6AVG, X5AVG, X4AVG, X2AVG, X3AVG, X7AVG, X1AVG

Table 5.51: ANOVA for Regression

The significance of the regression model is confirmed by the result of the above ANOVA table. It is also vital that the importance of all the variables considered in the study is established. From the above table, it is evident that all the independent variables (seven) having $p<0.05$ are significant so that the identification of the key characteristics of the agile SW development teams leading to improved work outcomes (project success).

Coefficients[a]

Model		Coefficients (Unstandardized)		Coefficients (Standardized)	t	Sig.
		B	Standard Error	Beta		
1	(Constant)	.448	.261		1.718	.087
	X1AVG	-.108	.046	-.140	-2.359	.019
	X2AVG	.132	.039	.153	3.400	.001
	X3AVG	.257	.035	.337	7.279	.000
	X4AVG	.005	.030	.006	.151	.880
	X5AVG	.218	.042	.203	5.176	.000
	X6AVG	.104	.038	.107	2.743	.006
	X7AVG	.043	.036	.060	1.191	.234
	X8AVG	.159	.044	.201	3.632	.000
	X9AVG	.132	.045	.130	2.923	.004

a. Dependent Variable: YVAR

Table 5.52: Coefficients Table

Thus, as per the coefficients indicated in the above table, the complete regression equation is worked out as given below –

Equation –

DV = 0.448 - 0.108 IV1 + 0.132 IV2 + 0.257 IV3 + 0.005 IV4 + 0.218 IV5 + 0.104 IV6 + 0.043 IV7 + 0.159 IV8 + 0.132 IV9 + E_i

OR

Improved Work Outcomes (Software Project Success) = 0.448 – (0.108 * Selection of Team and Skills) + (0.132 * Behavioral Factors (Maturity, Commitment)) + (0.257 * Leadership) + (0.005 * Reward and Motivation) + (0.218 * Impact of the Organizational Culture) + (0.104 * Collaboration and Communication) + (0.043 * Virtual and Physical Work Environment) + (0.159 * Disruptive Innovation) + (0.132 * Complex Adaptive System (CAS)) + E_i

However, as observed in the above table, the independent variables – IV4 and IV7 are having value of p > 0.05 and hence, the hypothesis (null) is accepted and it is not statistically significant. Hence, the final equation works out as given below -

Equation –

DV = 0.448 - 0.108 IV1 + 0.132 IV2 + 0.257 IV3 + 0.218 IV5 + 0.104 IV6 + 0.159 IV8 + 0.132 IV9 + Ei ---- Equation – C

OR

Improved Work Outcomes (Software Project Success) = 0.448 – (0.108 * Selection of Team and Skills) + (0.132 * Behavioral Factors (Maturity, Commitment)) + (0.257 * Leadership) + (0.218 * Impact of the Organizational Culture) + (0.104 * Collaboration and Communication) + (0.159 * Disruptive Innovation) + (0.132 * Complex Adaptive System (CAS)) + E_i ---- Equation -- D

The above equation indicates that out of all the variables, Leadership has the highest impact with coefficient value – 0.257. This justifies the criticality of leadership as a key factor while identifying the characteristics of agile teams that lead to improved work outcomes (project success). The other variable which has got a high impact is Impact of the organizational culture, which has a coefficient value – 0.218. This also justifies the criticality of the impact of the culture of the organization on the characteristics of agile teams that lead to improved work outcomes (project success). If culture and leadership are not aligned with the organizational goals appropriately, then the agile software development team will not be able to make much progress and show improved work outcomes. Hence, these are critical factors impacting the characteristics of agile software development teams. Additionally, one variable is having negative coefficient value (selection of team and skills) - - 0.108. This is explained on the basis of the team having members who interact with each other on a regular basis and the team goes through the various phases of team formation (form, storm, norm, perform and adjourn phases) (Tuckman, 1965), (Tuckman and Jensen, 1977). This involves a lot of volatility and it may impede the normal flow toward the improved project outcome. However, as time passes, the team may begin to jell and this aspect may be reduced. However, when team members leave the team due to any factor or a new team member joins the team due to any requirement, again there may be volatility in the team till they adjust to the new member. Thus, this action may happen periodically or it may be event driven and these are the phases when the team will have a slightly slower throughput till the volatility of interactions among the team members settles down. From this perspective, the negative value focuses on these aspects and thus it acts to regulate and manage the work flow toward improved work outcomes as per the team composition and team stability.

Thus, the model can now be represented as given below –

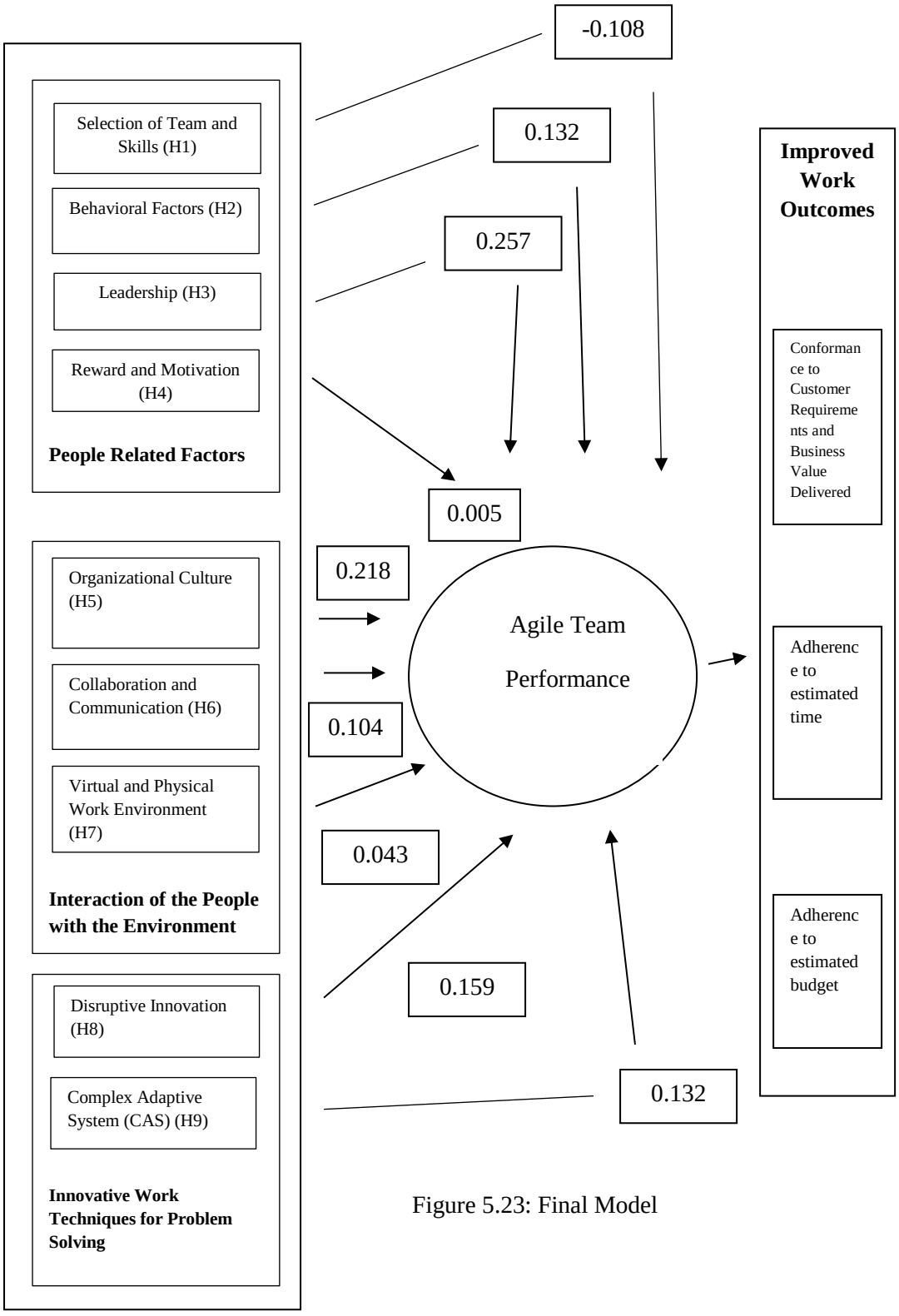


Figure 5.23: Final Model

The Coefficients table indicates that the highest impact on the key characteristics of the agile team is leadership (0.257) along with organizational culture (0.218). This is based on the leadership that each member has to exercise as part of the self-organized and self-managed team. Additionally, culture helps to imbibe the key values and principles

of agile among the team members through an agile mindset. However, as indicated earlier, this needs to be viewed in the appropriate cultural context of each organization which is very dynamic and varying widely.

Disruptive Innovation (0.159) is an important practice that is an addition to the tool kit of the agile software development team as it helps to solve complex problems and thereby lead to improved work outcomes. The next level of impact is on account of the behavioral factors (0.132) and the consideration of the agile SW development team as a CAS (0.132). Both these factors impact the key characteristics of agile teams. Behavioral factors help the team members to focus on building their maturity during adverse circumstances and the focus on commitment helps them to ensure delivery as per the committed time lines and it leads to improved work outcomes. The focus on the agile team as a CAS helps to understand how the team works as a self-organized team through the identification of agents and the interaction among the agents leading to the emergence of improved work outcomes. Collaboration and communication (0.104) is also a key factor that impacts the key characteristics of agile teams as it is only through collaboration can the team move forward and SW development is considered as a team cooperative game. Thus, collaboration and communication helps to break the silos in the team and it leads to improved work outcomes. Finally, the focus on the selection of the team and the skills possessed by the team (-0.108) is also an important factor that influences the characteristics of agile SW development teams. The negative sign is on account of the volatility that may be observed during team formation and team sustenance and which needs to be regulated and managed appropriately by the team during the existence of the team life cycle so that improved work outcomes could be obtained.

5.6 FINDINGS

The earlier sections have highlighted the key variables that influence the characteristics of agile software development teams that lead to measurement of improved work outcomes (project success).

The data analyses and the summary of the data collected have been tabulated in the earlier sections. The findings are based on both demographical and scale based data. As per the frequency tables depicted in the earlier sections, it is observed that the maximum number of respondents had a high degree of agreement for the various considered

variables that influenced the key characteristics of agile software development teams that lead to the measurement of improved work outcomes (project success). The seven dimensions considered in the study, namely -Selection of Team and Skills, Behavioral Factors (Maturity, Commitment), Leadership, Reward and Motivation, Impact of the Organizational Culture, Collaboration and Communication, Virtual and Physical Work Environment, Disruptive Innovation and Complex Adaptive System (CAS)) could be considered as the key characteristics of agile teams (based on the focus of the agile SW development team as a CAS) leading to improved work outcomes (project success).

The independent variables - Independent Variable 4 – Reward and Motivation (IV4) and the Independent Variable 7 – Virtual and Physical Work Environment (IV7) do not have an impact that could be considered as significant on the Dependent Variable (DV) – Improved Work Outcomes as compared to the other independent variables. However, as part of factor analysis, the loading on the key factors was observed in the case of both reward and motivation and virtual and physical work environment and in the dynamic market environment where the requirements are constantly changing, the focus on reward and motivation for the individual and team as a basic hygiene factor is an important perspective that needs to be considered. Additionally, as the teams become geographically dispersed and global software development (GSD) becomes the norm, it is extremely difficult for some teams to fully co-locate and be present in one location. In such cases it becomes a basic hygiene factor for the specific team to manage the global SW development team procedures and the use of media like video conferencing tools facilitate the progress of the team in meeting the improved work outcomes, even though co-location is preferred for agile SW development teams. Hence, the consideration of this factor also helps to influence the characteristics of agile SW development teams. However, in comparison with the other independent variables, these variables were found to be less important. Thus, they are recommended to be considered as basic hygiene factors in some specific and general circumstances. In the overall evaluation, they may be considered as given below –

As part of Factor Analysis and based on the factor loadings, the factors may be labelled to represent the different variables as given below –

Independent Variables 1, 4, 7 and 8 loaded strongly on Factor 1, which may be called as “People and Environment” as the focus is on Selection of Team and Skills, Reward and Motivation, Virtual and Physical Work Environment and Disruptive Innovation.

Variables 2, 3, 6 and 9 all loaded strongly on Factor 2, which may be called as "Complex Adaptive System Entity" as the focus is on Behavioral Factors (Maturity, Commitment), Leadership, Collaboration and Communication and Complex Adaptive System (CAS).

The vibrant nature of the prevailing business scenarios and the day to day market conditions often put the agile software development teams in a difficult situation where they need to cope with the changing market conditions on a regular basis. In this context, the identification of the key characteristics of agile SW development teams that lead to the measurement of improved work outcomes (project/product success) helps the team to cope with the market dynamics in a more effective manner. The research study highlights that seven dimensions have a direct positive effect on improved work outcomes and thereby software project success and hence a constructive effect on the performance of the agile SW development team. The other two dimensions (Reward and Motivation and Virtual and Physical Work Environment) also influence the characteristics of the agile SW development team even though in comparison with the other independent variables, it is not considered significant. This is on account of the fact that they should be considered as basic hygiene factors in some specific and general circumstances. This is validated as part of factor analysis. All the seven alternative hypotheses holds true and two null hypotheses are accepted. Thus, by taking into account these nine dimensions effectively and appropriately and by the appropriate identification of these characteristics in agile software development teams, it will lead to improved work outcomes and thereby project success. The work environment could also be nurtured to engender and strengthen these attributes further thereby ensuring the success of the software project/product/service.

Thus, the current chapter covered in detail the data coding & analysis and the relevant study conclusions conducted regarding the identification of the attributes of agile SW development teams that lead to the measurement of improved work outcomes (project success). The next chapter provides the conclusion for the entire research work.

CHAPTER SIX – CONCLUSIVE FINDINGS AND RECOMMENDATORY AREAS

6.1 CONCLUSIVE FINDINGS

The analysis of the final result establishes that the proposed seven hypotheses are accepted and the other two proposed hypotheses are not accepted, However, the two proposed hypotheses which are not considered are still factored in the overall framework so that it is managed appropriately (as per factor analysis). There exists a significant positive relationship among improved work outcomes (software project success) and all the seven independent variables (IV1, IV2, IV3, IV5, IV6, IV8 and IV9). Additionally, the other two independent variables (IV4 and IV7) are also viewed in the appropriate context even though they have not been found to be significant enough and they are also viewed in comparison with the other variables. Similarly, IV5 – Impact of organizational culture is also viewed in the appropriate cultural context at the overall level on account of its varying quality and the extremely dynamic nature of the attribute.

Thus, all three research questions have been answered through the study -

1. The identification of the key components of a framework that captures the key attributes/characteristics of agile software development teams creating/delivering software products/services/applications leading to improved work outcomes (project success) has been identified as the seven dimensions - Selection of Team and Skills, Behavioral Factors (Maturity, Commitment), Leadership, Impact of the Organizational Culture, Collaboration and Communication, Disruptive Innovation, Complex Adaptive System (CAS). However, the impact of the other two dimensions - Reward and Motivation and Virtual and Physical Work Environment are viewed as basic hygiene factors that are also factored into the overall framework (also validated through factor analysis).

2. The impact of the consideration of the agile SW development teams as CAS has also been found to be significant and positive. The impact of all the significant independent variables has been reflected from the coefficient table and the subsequent regression, i.e. a positive impact with a linear relationship. The most important factors being the focus on leadership and organizational culture which leads to improved work outcomes (project success) apart from the other significant variables. Additionally, the consideration of the other two variables - Reward and Motivation and Virtual and

Physical Work Environment, even though not considered as significant but still being considered as basic hygiene factors (based on factor analysis) has further strengthened the overall framework with a robust mechanism to pinpoint all the key characteristics of agile SW development teams that lead to improved work outcomes (project success).

3. The impact of the evaluation of a framework for the identification of the key characteristics of agile SW development teams has also led to the measurement of work outcomes (project success) as observed in the analysis findings (regression and factor). The encapsulation of the important results of the research study specify that the identification of the key characteristics of agile SW development teams and the nurturing and strengthening of these key characteristics leads to improved work outcomes (project success).

The concept of bi-directional causality is not indicated in this case as no time series data is used in the study. Granger's Causality test is used for checking the bi-directional causality, wherever it is applicable. The test focuses on the capability to forecast the future values of the time series data by utilizing the preceding values of another time series data. Additionally, the independent variables influence the change in the response variable (improved work outcomes (project success)) and not vice-versa (improved work outcomes (project success) cause change in the independent variables).

The improvement of work outcomes (project success) of the software project is influenced by the various challenges posed due to the inherent nature of the volatile market conditions which force teams and organizations to compete faster and deliver better quality product/service at optimal cost in the market place. The key characteristics identified for the agile software development teams as part of the framework strengthens the probability of improved work outcomes (project success) in the market place. The various dimensions identified and validated as part of the framework are - Selection of Team and Skills, Behavioral Factors (Maturity, Commitment), Leadership, Impact of the Organizational Culture (as viewed in the appropriate cultural context), Collaboration and Communication, Disruptive Innovation and Complex Adaptive System (CAS). All these dimensions contribute to improved work outcomes (project success). Additionally, the consideration of the other two dimensions – Reward and Motivation and Virtual and Physical Work Environment as basic hygiene factors that also contribute to improved work outcomes (project

success) strengthens the overall framework further to enable agile software development teams to deliver improved work outcomes (project success) in the market place. The medium of communication also executes a significant role in overcoming the various challenges posed to the agile SW development teams involved in SW development. These teams work under high pressure to deliver successful products/services. If the team members are at different locations, then the medium of communication becomes even more important. The focus is on the schedule, budget and the business value delivered to the customer in order to demonstrate improved work outcomes in teams that are geographically dispersed or are located in different locations. The usage of social media (Wiki, Jive, SharePoint and other tools) as a disruptive medium to collaborate and communicate among team members (virtual) in a virtual work environment has also contributed to the improvement in work outcomes. These social media tools have features which help in managing documents, communicating and sharing knowledge and managing task based work. All these activities can be carried out in an environment focused on clear communication and engendering of trust which lead to enhanced satisfaction levels among the virtual team members of the project. Additionally, Web 2.0 technologies has also helped in engaging the distributed virtual team by providing visibility across the team without compromising on the existing aspects of the project. The usage of social media in software development provides a low cost collaborative platform for virtual team members and which eliminates the ambiguity of responsibilities and roles in the team and enhances group thinking and facilitates conflict resolution. This automatically reduces the time taken for decision making in distributed virtual teams. As it is inevitable in this modern age for some of the teams to be distributed geographically due to cost, budget or any other consideration, even though co-location is preferred for agile software development teams, it becomes imperative that we should utilize the best technologies like Web 2.0 technologies and social media to manage collaboration and communication in virtual teams to facilitate improved work outcomes (project success). Thus, virtual work environment is a basic hygiene factor in cases where the agile software development team is geographically dispersed and is involved in global software development (GSD).

Additionally, physical work environment is also considered as a basic hygiene factor for agile software development teams as even though the teams may be co-located, they

need the basic infrastructure and other requirements like communication tools to be available in the work place in order to work effectively to produce good quality software products/services for the customer.

Further, the second dimension – Reward and Motivation is also considered as a basic hygiene factor (as per two factor (dual factor) or Motivation Hygiene theory) (Wikipedia, 2017). This theory was given by Herzberg. His theory posits that there are specific elements in the work environment that may produce contentment and a discrete group of features that may produce discontent. The theory was established by psychologist Herzberg, who hypothesized that job contentment and job discontent act individualistically of each other. The theory differentiates between Motivators (e.g. credit for achieving some goal, sense of importance) coming from the inherent circumstances of the effort (work) itself, such as accomplishment, individual progress and Factors (hygiene) (e.g. job security, salary, status) which do not give positive satisfaction but leads to dissatisfaction if they are absent. The term "hygiene" indicates that these are maintenance factors. Hygiene factors cause dissatisfaction among the team members in the work place and these hygiene factors must be addressed appropriately by the Management. This helps agile software development teams to stay motivated and deliver successfully to the customer. Additionally, as per Deming, motivation is of two types – extrinsic motivation (reward, competition) and intrinsic motivation (intrinsic satisfaction and joy on completing a work item successfully). The focus is on intrinsic motivation as compared to extrinsic motivation. He also indicates that extrinsic motivation is a basic factor and the focus should be on intrinsic motivation (Deming, 1986), (Deming, 1994). One more area of focus which indicates that reward/motivation is a basic hygiene factor is the findings enunciated by Daniel Pink. He also indicates that autonomy, mastery and purpose are more important for a person as compared to reward/salary only (Pink, 2009). Another management thinker who focuses on reward/motivation as basic factors and how we should not focus on command/control is John Seddon. Seddon talks about reward/motivation as basic factors and the focus is on systems thinking and how to collaborate in the work place to serve the customer effectively (Seddon, 2005).

Thus it is observed that in the current scenario, reward and motivation and virtual and physical work environment are basic hygiene factors that need to be considered apart from all the other factors in order to realize improved work outcomes at the market

place. Thus, identification of the key characteristics of agile SW development teams as part of a framework and strengthening these factors lead to improved work outcomes (project success) for the teams.

6.2CONCEPTUAL CONTRIBUTIONS

The research study adds a comprehensive model to the prevailing frame of information and knowledge through the identification and evaluation of a structure and holistic framework for identifying the key characteristics of agile SW development teams and to measure, understand and predict improved work outcomes (project success) for the software project. The diagram given below gives the details of the model.

Additionally, the consideration of the key dimensions - Selection of Team and Skills, Behavioral Factors (Maturity, Commitment), Leadership, Impact of the Organizational Culture, Collaboration and Communication, Disruptive Innovation, Complex Adaptive System (CAS) apart from the basic hygiene factors - Reward and Motivation and Virtual and Physical Work Environment as part of a framework to identify the key characteristics of agile software development teams (which has been validated through regression analysis and factor analysis) leading to the measurement of improved work outcomes (project success) highlights the focus that we need to ensure if the teams need to improve their probability of project success in the dynamic and volatile market place. The interaction effect of the various variables buttresses the fact that the various factors making up the framework should be considered in conjunction with all the other factors so that it leads to a greater probability of improved work outcomes (project success) for the agile software development teams and it also ensures a sustainable engagement model for the growth of the team members.

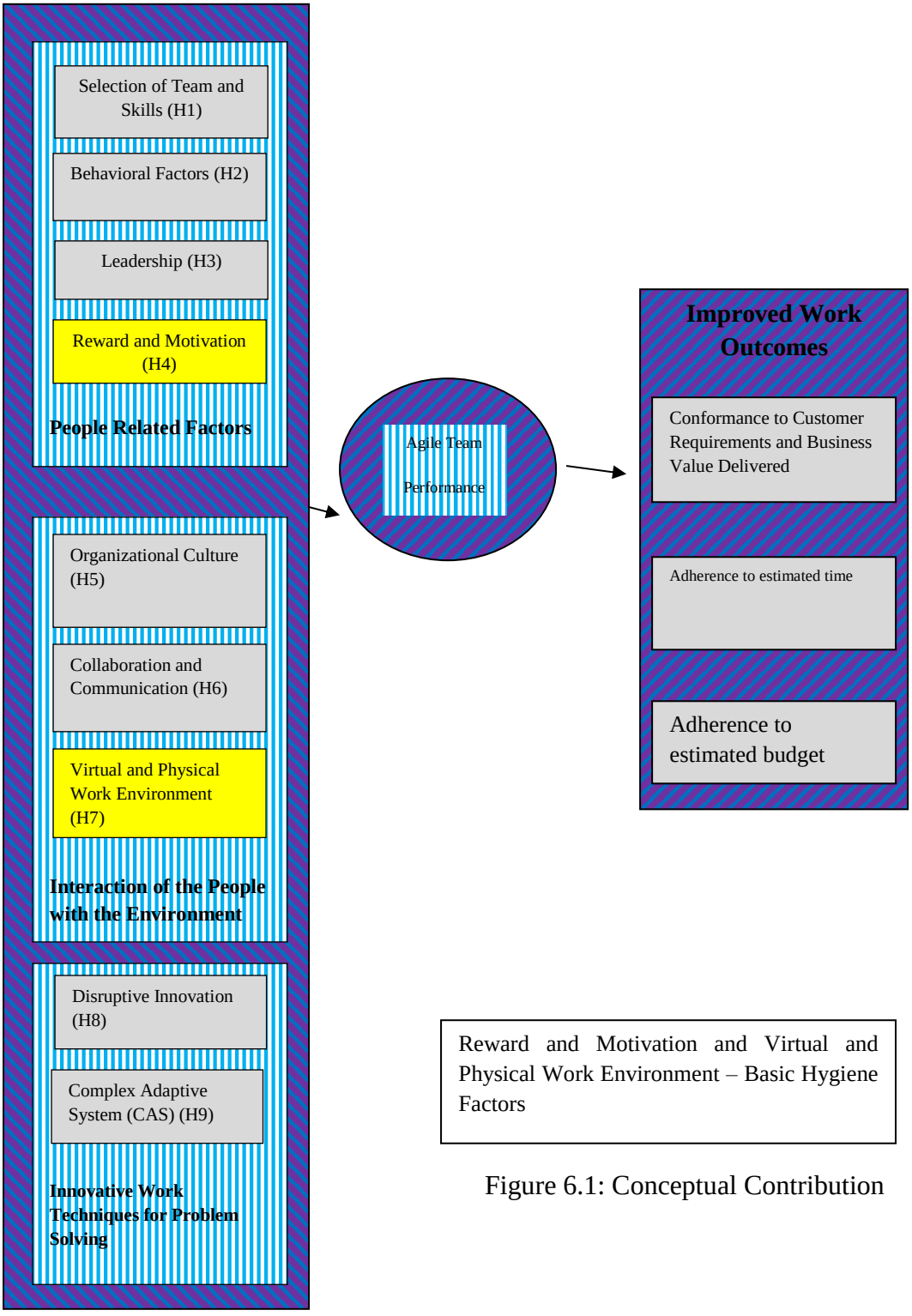


Figure 6.1: Conceptual Contribution

The proposed model given above has been evolved through a detailed and meticulous analysis of real time data and it is appropriate for the matrix information technology organizations in the technology domain and it advocates the consideration of the usage

of a framework for the identification of the key characteristics (key dimensions and basic hygiene factors) of agile software development teams for increasing the probability of improved work outcomes (project success). The consideration of a framework brings together all the diverse dimensions and basic hygiene factors onto one platform and it helps to focus on the key attributes during the formation of an agile SW development team. This structured approach to team formation leads to improved work outcomes in the long term and thereby increases the probability of project success.

6.3 MANAGERIAL IMPLICATIONS

Organizations have realized that if they have to contend successfully in the volatile market place and effectively meet the changing customer requirements, they need to have a mechanism whereby they can form agile software development teams quickly and effectively and deploy them to meet the project requirements. As the teams are considered to be self-organizing and self-managing teams, the role of the Manager is diminished in this context. However, this does not mean that the Manager ceases to exist in an agile environment. The role of the Manager is re-defined and he performs the role of a Host Leader/Servant Leader (McKergow and Bailey, 2014), (Greenleaf, 1977). The Manager coaches, facilitates and supports the team to meet its goals and takes care of other activities like appraisal, budgeting and other requirements. In order for the team to be formed effectively, various dimensions are involved so that the team setup is successful. This research study has formulated a framework that identifies the key characteristics of agile software development teams that involves key dimensions and basic hygiene factors. The consideration of these variables while forming the team and also focusing on these variables for nurturing and strengthening the team dynamics can help to lead toward the measurement of improved work outcomes (project success) in the form of understanding of the customer requirements more effectively, delivering appropriate business value to the customer and thereby enhancing customer delight, and meeting cost and schedule constraints as per the requirement. From the perspective of the basic hygiene factors, the emphasis on reward/motivation and virtual and physical work environment as per the requirement (which is to be considered as a default requirement in order for work to be executed satisfactorily) helps to keep the team focused without basic dissatisfaction with the existing work place. Social media based enterprise collaborative tools provide nifty solutions for daily chores such as managing accounts & recruitment, checking emails, assigning tasks, time spent searching files

and documents, etc. These are useful tools that could be used when the team is located at different locations and the team has to function as a virtual agile software development team. Subsequent focus on the other key dimensions - Selection of Team and Skills, Behavioral Factors (Maturity, Commitment), Leadership, Impact of the Organizational Culture, Collaboration and Communication, Disruptive Innovation, Complex Adaptive System (CAS) leads to improved work outcomes over a period of time and leads to the increased probability of project success. In this aspect, the role of organizational culture needs to be viewed in the appropriate cultural context so that its impact is understood in the specific context of each organization due to its dynamic and widely varying nature.

Through this study, the major factors responsible for boosting the performance of the agile SW development teams have been established through the contribution of the model. Thus, during the formation of the team, the key focus should be on the various dimensions and basic hygiene factors of the framework -- Selection of Team and Skills, Behavioral Factors (Maturity, Commitment), Leadership, Impact of the Organizational Culture (viewed in the appropriate cultural context), Collaboration and Communication, Disruptive Innovation, Complex Adaptive System (CAS) and the basic hygiene factors - Reward and Motivation and Virtual and Physical Work Environment. By focusing on these dimensions and basic hygiene factors, the team formation will be smooth and it will be able to execute work effectively. If these broad dimensions and the basic hygiene factors are managed appropriately and if proactive measures are taken to minimize all the issues and other miscommunication that may arise during the team formation, then the Manager will be able to maximize the improved work outcomes and thereby project results. Apart from these aspects, the consideration of the agile SW development team as a CAS also has a substantial role in catalyzing and energizing the performance of the team. The study recommends the focus on the seven dimensions and two basic hygiene factors and the focus on the team as a CAS to maximize improved work outcomes.

6.3.1 Primary and Support Processes for the formation of agile software development teams to execute projects / design products / deliver services

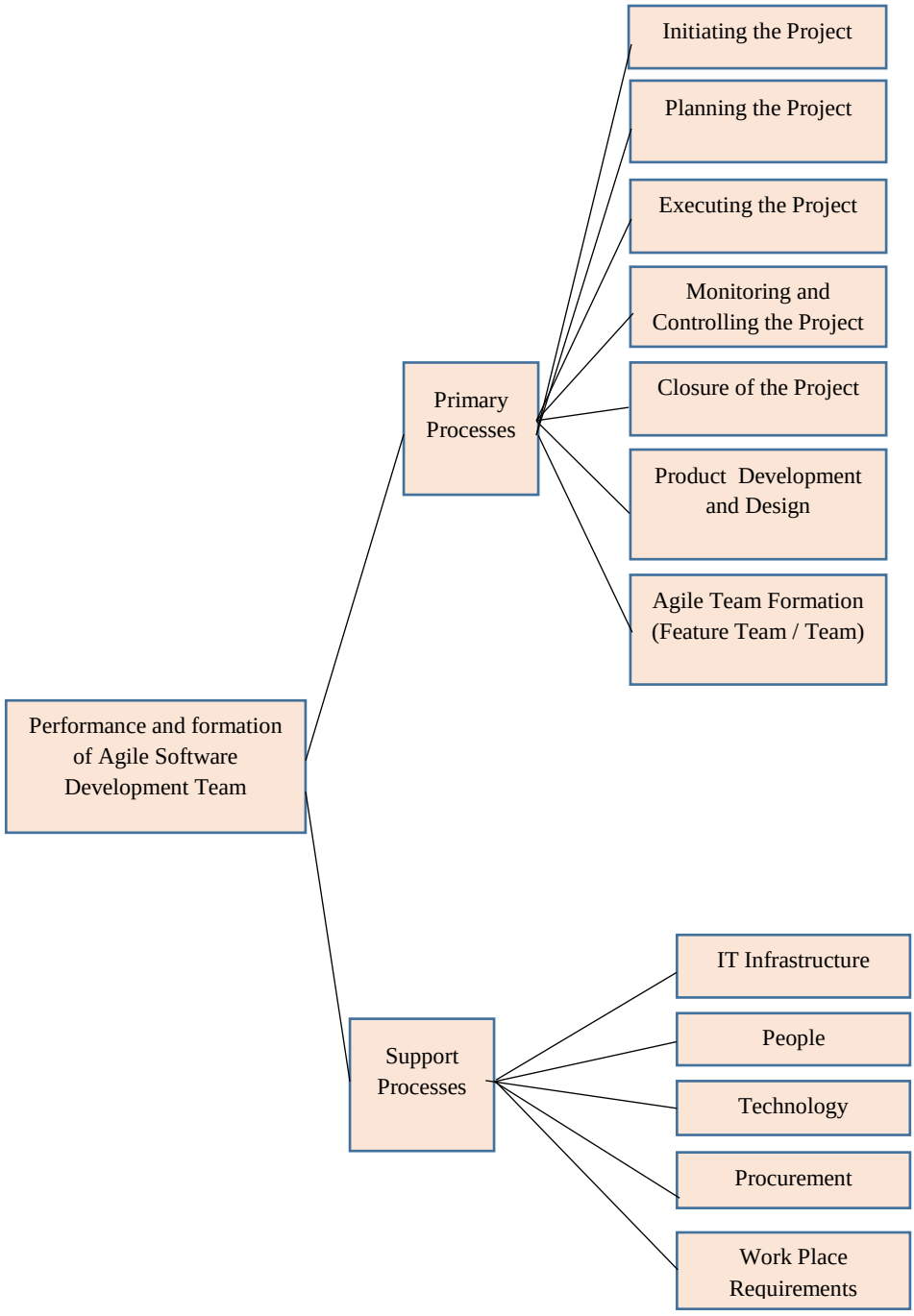


Figure 6.2: Primary and Support Processes for the formation of agile software development teams to execute projects / design products / deliver services

In order for an agile SW development team to execute its work, it must initially be formed and a project needs to be executed depending on the requirement. The creation of atypical software project consists of five major processes as per the Body of Knowledge (Project Management) (PMBOK), PMI. The various processes indicated in the body of knowledge are – initiation of the project, planning of the project, execution of the project, monitoring of the project and control and closure of the project. Initiation of the project involves the evaluation of the idea pertaining to the project and the corresponding market feasibility study. Detailed planning is then worked out in the project planning stage and on the basis of the deliverables, the deadline and commitments are worked out. After the blueprint for the entire project is worked out, the team member allocation is initiated and the project is launched as part of the project execution phase. The project manager has an important role of continuously monitoring and evaluating the progress of the project in the monitoring of the project and control phase. Finally, after all the tasks are completed and the customer gives the necessary approval, the project closure is undertaken and all the team members are re-allocated to other projects. The above process is undertaken for a typical waterfall or non-agile project. However, for agile projects, the methodology followed for the project dictates the type of activities to be carried out. However, at a broad higher level, project initiation to closure is similar and the change occurs during the various phases (plan, execute and monitor and control) of the project as per the specific agile methodology that has been adopted for the project.

The formation of agile software development teams where the popular agile methodology, namely Scrum and extreme programming is adopted by the team is as given below –

The team is composed of developer/tester, business analyst, architect/designer, database administrator, user interface member, ScrumMaster and Product Owner. The team size is generally 7 +/- 2 members. This team which is formed then executes the project. Additionally, the team may be considered as a feature team (a team which is a long lived, stable, co-located and cross functional and cross component team with generalizing specialists) or a standard team which may not be cross functional / cross component as per the requirement, Generally, agile software development teams are long lived teams and hence, after the project is over, the same team may take up another project as per the requirement.

Product development and design team generally follows an experimental design approach where numerous solutions are worked out and the most appropriate solution is then selected based on constraints, options and other factors. This team is also formed as per the outcome that is required and the goal of this team is to create a product as per the specifications and customer requirements. Generally, a project is initiated to meet the requirements of creating the product.

Additionally, apart from these basic activities, there are support processes which are required for the strategic alignment of project portfolio and program implementation, technical framework and business excellence areas. Basic IT infrastructure and technology is required to set up the software development project apart from work place requirements like work space, lighting and other requirements. The management of people is very critical while working on a project and while forming the agile SW development teams and hence, the focus on the selection of team members as per the skill requirements is important and vital. Procurement processes also form an important requirement and which is needed to manage any activity where the work item/service is required to be provided by a third party provider, e.g. office equipment, training and other items/services.

6.4 MAPPING THE OUTCOME TO THE VALUE CHAIN

The improved project outcomes need to be mapped to the value chain so that the customer can get the full benefits of the process. If the outcome is not mapped to the value chain, the full benefits will not be realized by the customer. Hence, value stream mapping (VSM) is an important exercise that is carried out to map the project outcome to the value stream / value chain as per the domain requirements. Competition is a positive characteristic in business (O'Brien & Marakas, 2012). Players in the market share a normal and professional competitive spirit. The market place competition requires a constant focus to gain a competitive benefit in the marketplace. The omnipresent market dynamism requires substantial resources in terms of asset/capital and other resources on the part of the organization. Organizations need to contend with other organizations in the marketplace and they must also work to create substantial entry hurdles for new competitors. The threat of new entrants also compels the organization to be on guard all the time by expending significant organizational resources. The competitive dynamism is always hard to manage, but it is now

additionally difficult in the current VUCA market place. The growth of the internet has created many approaches to get into the marketplace faster and with comparatively lower cost. In the arena of the internet, the prime latent player may be the one that has not arrived in the marketplace but which may arise virtually overnight. Further, the risk of alternatives is another important factor that challenges an organization. The impact of this factor is ostensible virtually daily in many different industrial domains and it is at its robust level during phases of increasing cost or inflation. E.g. when the price of airlines become very high, then people abstain from travelling by air or they substitute car travel for their vacation or work requirements. When the cost of meat products becomes very high, then people eat vegetarian products till the price of the meat products comes down. Many of the services/products have some type of alternative available and which is utilized by the customer during difficult times like rising cost, inflation, war time. Finally, the organization must also guard itself against the opposing forces of the bargaining powers of the supplier and customer. If the bargaining power of the customer becomes too robust, then they can push down the prices to very low levels which may lead to loss for all or many of the organizations or they can decline to buy the service or product. If the supplier (key) bargaining power becomes too powerful, they can influence the price of services and goods to increase to very great levels or they can block the access of the organization to parts/raw materials which are essential for the manufacture of the product/service by manipulating the movement of the materials (raw).

The figure indicated below embodies the mapping of all the activities (both primary and support) of the SW development project and the formation of the agile SW development team to the value chain model given by Michael Porter (Wikipedia, 2017).

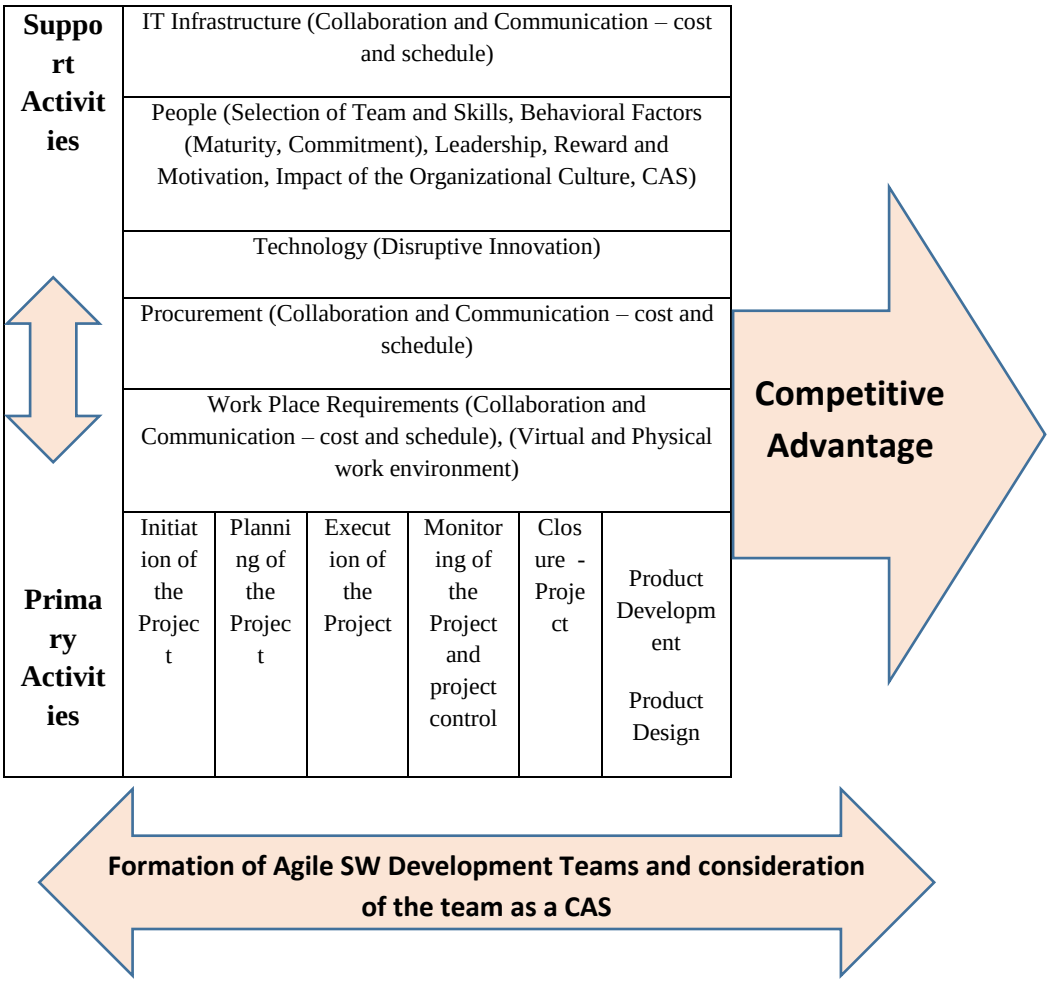


Figure 6.3: Mapping of the Software Project with the Value Chain and the Formation of Agile SW Development Teams

6.5 RECOMMENDATIONS

The research activity has successfully established the factors that identify the key characteristics of agile SW development teams through the creation of a framework that captures all the key dimensions and the basic hygiene factors onto one platform and which leads to improved work outcomes (project success). Thus, the research study delineates the following recommendations as given below –

1. The key characteristics of the agile SW development teams has been captured in the form of a framework which highlights the factors that lead to improved work outcomes (project success). Appropriate precaution must be taken to ensure that the appropriate dimensions are considered while forming the team. The Manager must take into account these factors while forming the agile team.

2. Additionally, the Manager should also consider the basic hygiene factors that have been identified and form part of the framework. These factors are also important during the formation of the agile team for improved work outcomes (project success).
3. The consideration of the agile team as a complex adaptive system is important to ensure improved work outcomes. The consideration of the agile team as a CAS ensures that the emergent work outcomes are recognized and managed appropriately by the Manager while discussing with the agile team.
4. In case of agile teams which are not able to be co-located due to various constraints and other factors, it is important for the Manager to manage this aspect appropriately to ensure improved work outcomes. Social media collaboration tools, video conferencing and Web 2.0 technologies could be utilized to meet these requirements. Co-location is preferred for agile SW development teams (Agile Manifesto, 2001). However, given the fact that members of the team are progressively positioned in different areas due to cost economics and other factors, it is critical that for some teams where co-location may not be possible due to certain constraints, it is essential that the Manager manages this facet with consideration by utilizing tools for collaboration appropriately. Some steps that could be taken to manage distributed agile teams where co-location is sometimes not possible is – the team may co-locate for the first couple of sprints. This helps to build trust among the team members and it builds a healthy relationship among the team members. Subsequently, the members re-locate to their places (geographical distribution) and they are now able to collaborate effectively with the other members of the team even though they are not at the same location. Sometimes, members of the team who are considered to be senior travel to the customer location to initiate team member interactions among the different locations. Additionally, there are some teams that may change their site to an intermediate place to enable the team to co-locate between the location of the customer and the project team. This helps both the team and the customer to understand the different environments that are prevailing at both the locations and builds trust and understanding among the distributed team members.
5. The focus on reward and motivation as a basic hygiene factor is important and it should be considered by the Manager as the absence of this factor will lead to

dissatisfaction and which may detract from the improved work outcomes. However, the presence of this factor also may not necessarily lead to improved work outcomes. Thus, the presence of reward and motivation as a basic hygiene factor in conjunction with other important dimensions will need to be considered in order to obtain improved work outcomes. Hence, the Manager will also need to keep in mind the interaction among the variables to facilitate improved work outcomes and increase the probability of project success.

6.6 LIMITATIONS

The complexity of a software project and the formation of an agile team comprising of various members and the interaction among the agile team members varies widely depending on the customer requirement, market factors, team interactions, individual team member characteristics, team member skills and project constraints. Hence, it is a big challenge to generalize and arrive at a framework (model) based on the collected data. The proposed model explains the key factors that need to be considered for an agile team that will lead to improved project outcomes and which will increase the probability of project success. The study focused on the authenticity of the key attributes which affect the success of the agile SW development teams. However, the functional aspect of the basic hygiene factors in the organizations may yield a variation. The sample size could have been larger to accommodate the growing number of IT organizations in India and worldwide for an improved prediction through the proposed research model. Additionally, the focus of the study was on the value delivered to the customer but any project will have multiple stakeholders apart from the customer and these aspects could also be explored in the future.

6.7 FUTURE WORK

The research work has considered extensively the large number of dimensions which affect the key characteristics of agile SW development teams through the creation of a framework and which leads to improved work outcomes (project success). The research model proposed and empirically tested during the course of the study could be extended for the agile software development teams working in hardware sectors and other sectors where there is an appropriate fit. The research could also be tested in countries other than India in order to understand the differences in culture in different countries and how it may impact the model and also focus on the other dimensions and how it will

pan out in other countries which have a different work culture and ethic. This could lead to a more generalized model for identifying the key characteristics of agile SW development teams across the world and which would lead to improved work outcomes (project success). The mapping of the value chain in the earlier sections could form the basis for future research and it could also be empirically tested. The role of hygiene factors could be explored further to know the impact of these factors across the world. The role of leadership (individual, team, organizational) could be explored further to know how it could impact improved work outcomes further. The focus on disruptive innovative techniques could be explored further to know which techniques are finding favor among the agile software development teams and which could be improved further. It is observed in the current scenario that teams may be distributed across different geographies even though co-location is generally preferred for agile teams and hence, we will need to manage it through various social collaboration tools, video conferencing and Web 2.0 technologies so that the physical absence of the member is not felt and the agile team can work constructively together leading to improved work outcomes. Another key focus area for the future could be how the growth of new technologies like robotics process automation (RPA) which could lead to widespread automation of the process activities. Other technologies like machine learning (ML) could lead to the building of algorithms that can resolve multiple issues managed by many members and which could lead to the redundancy of the existing team members for that specific process. Development of Internet of Things (IoT) technologies could lead to the devices being connected with each other and requiring minimal human intervention and which could lead to many tasks becoming redundant. Finally, Artificial Intelligence (AI) and other related technologies could also impact the effectiveness of the agile teams leading to improved work outcomes. The influence of multiple stakeholders on a project is also a very important aspect that needs to be explored in the future.

6.8 SUMMARY

The research study has highlighted the creation of a framework which captures all the key dimensions which affect the characteristics of agile software development teams onto a single common platform and how it can lead to improved work outcomes. One important finding in the study was the identification of basic hygiene factors which are

important and which impact the improved work outcomes (project success), even though during the initial regression analysis stage, they were found to be not important. The factor analysis of the variables revealed the existence of the basic hygiene factors when viewed in conjunction with the regression analysis findings. The factor analysis findings led to the identification of two important factors for consideration –

Based on the factor loadings, the factors may represent – Independent Variables 1, 4, 7 and 8 loaded onto Factor 1, which may be called as "People and Environment" as the focus is on Selection of Team and Skills, Reward and Motivation, Virtual and Physical Work Environment and Disruptive Innovation. Independent Variables 2, 3, 6 and 9 loaded onto Factor 2, which may be called as "Complex Adaptive System Entity" as the focus is on Behavioral Factors (Maturity, Commitment), Leadership, Collaboration and Communication and Complex Adaptive System (CAS). Impact of Organizational Culture was not considered in the factor analysis as the matrix (rotated component) value was below 0.5. Additionally, in the regression analysis, it is considered as the p value is less than 0.05 and the null hypothesis is rejected and the alternative hypothesis is accepted. Further, organizational culture should be viewed in the appropriate cultural context which is very dynamic and varies in each organization (Chatman, Caldwell, Doerr and O'Reilly, 2014). The focus is on the cultural consensus that is present in the organization regarding the cultural norms, how intensely these norms are held by the members of the organization and the content of these norms. Hence, as these varies very widely and dynamically in each organization, the effect of this variable on other variables will be varied as per the cultural context. Hence, the value is less than 0.5 and it is not considered in the factor analysis even though it is considered in the regression equation earlier.

The findings arrived from the study support the existing Agile Manifesto – made up of the Agile Values and Agile Principles. The focus of the agile manifesto is on individuals and interactions and it is supported by my findings focused on People and the Environment and Complex Adaptive Systems Entity.

Thus, the current research highlights the focus on the framework which identifies the key characteristics of agile software development teams. The high level factors – People and Environment and Complex Adaptive System Entity and the basic hygiene factors along with the interplay and the interaction among all the variables in the framework

strengthens the measurement of improved work outcomes. This leads to a greater likelihood of successful project/product/application/services delivery.

REFERENTIAL LIST

Abrahamsson, Pekka, Ronkainen, Jussi, Salo, Outi and Warsta, Juhani (2002), VTT Technical report, Review and analysis - agile software development methods

Ackoff, R (1999), management writings, Ackoff's best, John Wiley & Sons, (NY), New York, USA, 1999

Agile Manifesto (2011), Values and Principles - http://agilemanifesto.org, Retrieved on 15Jun 2017

Agile Serbia (2015), Agile Serbia -- http://www.agile-serbia.rs/about-scrum/agile-values, Retrieved on 23 Jun 2017

Almseidin, Mohammad; Alrfou, Khaled; Alnidami, Nidal and Tarawneh, Ahmed (2015), International Journal of Computer Science and Software Engineering (IJCSSE), Volume 4, Issue 5, May 2015 ISSN (Online): 2409-4285 www.IJCSSE.org, Page: 126-129, A Comparative Study of Agile Methods: XP versus SCRUM

Al-Zewairi, M; Biltawi, M; Etaiwi, W; and Shaout, A (2017), Agile Software Development Methodologies: Survey of Surveys. Journal of Computer and Communications, 5, 74-97, https://doi.org/10.4236/jcc.2017.55007

Anderson, P (1999), Organization Science, Organization Science, Complexity Theory,10(3), 216-232

Appelo, Jurgen (2011), ISBN-10: 9780321712479, ISBN-13: 978-0321712479, Management 3.0 - Developing Agile Leaders, Leading Agile Developers (Signature Series - Addison-Wesley (Cohn)) - 2011

Arthur, M, Lindsay, V& Defillipp R (2001), Journal of Innovation Management (International) - Industry and Community Evolution - Links to Complexity Theory, Careers. 5(2), 239–256

Ashmore, Sondra (2012), Graduate Thesis and Dissertations. Paper 12260,A Comparative Analysis of Waterfall and Agile Software Development Teams- Impact of Process on Virtual Teams, 2012, Iowa State University, Iowa, USA

Boston Consulting Group, The (BCG) and IAMAI (2015), Report – India@Digital.Bharat, Retrieved from –Home - /company.mig.me (protocol - http) (Page - /wp-content/uploads/2015/09/bcg-report-on-Indian-internet.pdf) on 2 Apr 2017

Beck K, Andres C (2004), (Professional), Addison-Wesley, Reading, MA, USA, Xtreme programming explained, Second Edition (embrace change)

Begel Andrew, Nagappan, Nachiappan (2007), Perceptions of Agile SW Development - Industrial Setting - An Initial Study, SW measurement and engineering (Empirical),pp. 255-264, Symposium – I (international), 2007

Bertalanffy L V (1950), Journal of Philosophie of Science (Britisch), 1, 1950, pp. 139-164, General system theory outline

Bion, Wilfred R (1961), Tavistock Publications, Group Experiences, London, UK, 1961

Boehm, B W (1988), "A Spiral Model of Software Development and Enhancement", ISSN: 0018-9162, Volume: 21, Issue: 5, on page(s): 61-72, May 1988

Boehm, Barry & Turner, Richard (2005), IEEE Software, 22(5), 30, Challenges (management) to executing processes (agile)-- In organizations (traditional development).

Boone, Harry and Boone, Deborah (2012), Journal of Extension, Analyzing Likert Data, Volume 50, Number 2, Article Number 2TOT2, April 2012

Brown, Shona and K, Eisenhardt (1998), Harvard Business School Press, Boston, Strategy as Structured Chaos- Competing on the Edge

Castka Pavel, Belohoubek, P Bamber C J and Sharp J M (2001), Performance Management (Team) - International Journal, Issues impeding effective implementation of teams (high performance), Vol. 7 Issue: 7/8, pp.123-134, https://doi.org/10.1108/13527590110411037

Chatman J A, Caldwell D, Doerr B and O'Reilly C (2014), Organizational Behavior (Journal), Issue 6, Volume 35, pp 785-808, Organizational Culture – Parsing – Focus on the adaptability norm that influences relationships

Chiva-Gomez, R (2004), Technovation, 24(9), 707–711, Product design management - Repercussions of CAS

Cilliers, P (1998), New York: Routledge, Postmodernism and Complexity - Understanding Complex Systems (CAS)

Cilliers, P (2000), Emergence, 2(1), 23–33, Theory of Complexity- What Can We Learn From it

Clarus Operations Concept (2005), (FHWA)Federal Highway Administration, 2005, Publication No. FHWA-JPO-05-072

Cockburn, Alistair (2006), October 29, 2006,| ISBN-10 - 0321482751, ISBN-13 - 978-032148275, The Cooperative Game - Agile Software Development (2nd Edition)

Coding Horror (2017), Retrieved on 23 February 2017, http://www.codinghorror.com, (Page - /blog/2007/03/software-development-as-a-collaborative-game.html)

Cohen, RJ& Swerdlik, M E (2005), New York: McGraw Hill, ASIN: B004ELLTCO, Psychological Testing and Assessment (6th Edition)

Cohen Susan and Bailey D E (1997), Management Journal 23 (3) (1997) 239–290, Group efficacy research from the floor (shop) to the management suite – Factors facilitating teams to work

Daniel, L & Davis, C (2009), Research Technology Management, 52(4), 40, What makes high-performance teams excel

Deming, W Edwards (1986), Advanced Engineering Study Center, Cambridge, MA 02139, Massachusetts Institute of Technology, USA, Out of the Crisis

Deming, W Edwards (1994), Advanced Educational Services Center, Cambridge, Massachusetts, USA, Massachusetts Institute of Technology, ISBN - 0-262-54116-5, - - For Industry, Government and Education- The New Economics, Second Edition, The MIT Press

de Melo, Claudia, Conradi, R, Cruzes, DS, Kon, F (2013), Information and SW Technology 55, 412–427, Agile team productivity and management- Interpretative case studies

Dingsøyr, Torgeir and Lindsjørn, Yngve (2013), SINTEF, Norwegian University (Science and Technology), Computer and Information Science Department, Agile Development Teams -Team Performance, University of Oslo, Norway

Dorairaj, Siva, Noble, James and Malik, Petra (2012), Distributed Agile Software Development- Understanding Team Dynamics, Technical Report 12-02

Dwivedi, Shubham (2016), Software Development Life Cycle Models - A Comparative analysis, Vol. 5, Issue 2, February 2016, Advanced Research in Computer and Communication Engineering (International Journal), ISSN (Online) 2278-1021

Dwivedi, Shubhra (2015), Comparative Study Between Distributed and Co-located Teams in Agile SW Development, Volume No.04, Special Issue No.01, International Journal of Science Technology & Management, (Online) 2394-1537,February 2015 ISSN (Print) 2394-1529

Dyba T & Dingsøyr T (2008), Information SW Technology (2008), review - Empirical studies (agile SW development),doi:10.1016/j.infsof.2008.01.006

Economic Survey (2015), Volume-I, All Chapters (2014-15) - Union Budget. Retrieved from - indiabudget.nic.in/es2014-15/echapter-vol1.pd on 20 March 2017

Eoyang, G (1996), Interactions, 3(1), 31–36, Complex? Yes! Adaptive? Well, maybe

Festinger L (1954), Journal -- Human Relations, 7, 1954, pp. 117-40, Social comparison processes - A Theory

Field, Andy (2009), SAGE Publications Ltd; Third Edition (2 March 2009), ISBN-13: 978-1847879066, Discovering Statistics Using SPSS (Introducing Statistical Methods Series)

Garbin, Calvin (2016), John Weaver Professor of Psychology, University of Nebraska – Lincoln, Multiple Regression Model -- http://psych.unl.edu/psycrs/statpage/full_eg.pdf, Retrieved on 26 Dec 2016

Gartner (2015), http://www.gartner.com/smarterwithgartner/five-principles-for-leading-an-agile-culture/, Digital Business Demands an Agile Culture – Research Report, Retrieved on 20 March 2017

Gartner (2015), Five more Steps in delivering an Agile I and O Culture – Research Report, http://www.gartner.com/newsroom/id/3032517, Retrieved on 22 March 2017

Gerber, M (2002),(EPFL) (Fédérale de Lausanne) Ecole Polytechnique, Switzerland, Speech (keynote) -- Chaos Theory -- Light Methods and Their Foundations, Presentation (paper)--(EDOC 2002), 6th IEEE Conference (Distributed Object Computing), International Enterprise

Gharajedaghi J (1999), Boston, MA, USA, Managing complexity and chaos -- Systems thinking -- A platform for business architecture design, Butterworth-Heinemann, 1999

Gladwell, M (2000), New York, NY, USA, 2000, Little, Brown, and Company, USA, How small Things Can Make a huge Difference-- The Tipping Point

Gomaa, Hassan and Scott, Douglas B H (1981), Prototyping as a tool in the specification of user requirements, Proceedings of the 5th international conference on Software engineering, p.333-342, March 09-12, 1981, San Diego, California, United States

Goodman, P and Olivera, F (1998), Carnegie Bosch Institute, Pittsburgh, Philadelphia, Sharing of knowledge through systems (computer facilitated) (in international organizations), 1998, USA, Working Paper 98-17

Greenleaf, Robert K (1977), Paulist Press, 25th Anniversary Edition, ISBN - 978-1-61643-064-1, A voyage into the nature of Power (legitimate) and Greatness- Servant Leadership

Gulliksen S V, Moe Nils Brede, Dingsøyr T (2011), vol 77, Springer, Heidelberg, Berlin, Business Information Processing (lecture notes), (eds) Agile Processes in SW Engineering and Xtreme Programming, XP 2011, Two Agile Teams(multiple case study) -- Challenges to Teamwork, In - Hazzan O, Sillitti A, Albaladejo X, Bache E

Gupta, Ashish Kumar (2015), Comparison of different types of SDLC models in SW engineering, Special Issue No. 01, Volume No 03, March 2015, Advanced Technology in Engineering and Science - International Journal, ISSN (online): 2348 – 7550

Harman, H H (1976), Chicago - University of Chicago Press, Modern Factor Analysis (3rd edition)

Herding Cats (2014), Herding Cats -- http://herdingcats.typepad.com (/my_weblog/2014/08/what-do-we-mean-when-we-say-agile-community.html), Retrieved on – 27 Jun 2017

Highsmith, J (1999), Dorset House, A cooperative method to manage complex systems-Adaptive Software Development New York, NY

Hnief, Malik and Hock Ow, Siew (2009), Issue 1 (October 2009), Reviews and Research in Sciences (Applied) (International Journal), Review of Agile Methodologies in Software Development, EISSN: 2076-7366, Volume 1, ISSN: 2076-734X

Hoda, Rashina, Marshall, S and Noble, J (2010), Organizing self-organizing teams, pp. 285-294, In: Thirty second IEEE/ACM Conference (International) on SW Engineering (proceedings), (2010), NY, USA

Hoegl, M & Proserpio, L (2004), Research Policy, 33(8), 1153-1165, Teamwork in innovative projects and Team member proximity

Hogg M A and Vaughan G M (2002), Prentice Hall, London, UK, 2002, Social Psychology, (3rd ed.)

Honavar, Dr Vasant (2001), Complex Adaptive Systems Group at Iowa State University, http://www.cs.iastate.edu/~honavar/alife.isu.html, Retrieved on 02 Jun 2018

Ilgen Daniel, Jundt D, Johnson M and Hollenbeck J R (2005), pp. 517-543, Review (annual) of Psychology, From models (input-process output) to IMOI models - Teams in Organizations, 56, 2005

India Brand Equity Foundation (2017), https://www.ibef.org, (Page - /industry/information-technology-india.aspx), an initiative of the Ministry of Commerce & Industry, Government of India, Retrieved on 22 March 2017

Ionel, Năftănăilă (2009), AGILE SOFTWARE DEVELOPMENT METHODOLOGIES: AN OVERVIEW OF THE CURRENT STATE OF RESEARCH, University of Economic Studies (ASE), Bucharest Faculty of Management, Piaţa Romană 6, Bucharest, Romania

Jain, Radhika and Meso, Peter (2004), (AMCIS) Americas Conference on Information Systems 2004 Proceedings, Paper 197, Theory of Agile SW Development and Complex Adaptive Systems

Jamwal, Deepshikha (2010), "Analysis of Software Development Models" IJCST Vol. 1, Issue 2, 2010

Jovanovich, D and Dogsa, T (2003), “Comparison of software development models,” Proceedings of the 7th International Conference on, 11-13 June 2003, ConTEL 2003, pp. 587-592

Katzenbach, Jon and Smith, Douglas (1993), 111–120, Harvard Business Review, 71, The Discipline of Teams

Kauffman, S (1991), Scientific American, 256(2), 78–84, Anti-chaos and Adaptation

Kerth N L (2001), Publishing Company (Dorset House), New York, NY, USA, 2001, A handbook for team reviews -- Project retrospectives (2nd ed.)

Kettunen Petri and Moilanen S (2012), In - Wohlin, C (eds), XP 2012, Agile Processes in SW Engineering and XP, Instrument for Self-monitoring(proposal) - Sensing High-Performing Software Teams, Information Processing(Business) (lecture notes), Springer, Heidelberg, Berlin, vol 111

Kothari, C R (2004), New Age International Publisher, Second Edition, New Delhi, Research Methodology Methods & Techniques

Lalsing, Vikash, Kishnah, Somveer and Pudaruth, Sameerchand (2012), IJSEA - SW Engineering & Applications (international journal), January 2012, Agile SW Development and Project Management – People Factors, DOI - 10.5121/ijsea.2012.3109 117, Department of Computer Science Engineering, University of Mauritius, Reduit, Moka,Vol.3, No.1

Latane B, Harkins S and Williams K (1979), pp. 822-832, Personality and Psychology (Social) Journal, 37, 1979, The consequences and causes of loafing (social)

Lund, Adam and Lund, Mark (2016), Laerd Statistics, Lund Research Limited, UK - https://laerd.com (statistics page), (page for spss-tutorials -- /linear-regression-using-spss-statistics.php), Retrieved on 26 Dec 2016

Makigami Information Center (2010), http://www.makigami.info/forum/index.php?topic=2.0), Retrieved on 18Jul 2017, (Definitions of Muda, Mura, Muri)

Moe, Nils Brede, Dingsøyr T and Dybå, T (2009), IEEE Software 26, 20–26, Self-Management in Software Teams – Overcoming Barriers

Marion R & M. Uhl-Bien (2001), The Leadership Quarterly 12 (2001), pp.389–418, Leadership in complex organizations

McCandless Keith & Lipmanowicz, Henri (2014), Liberating Structures Press, Seattle, WA, ASIN: B00JET2S76, Unleash a Culture of Innovation (simple rules) -- Liberating Structures (surprising power)

McGeachy, Robert (2010), Applied Research Project, Athabasca University, 2010, Building high performing agile development teams

McKelvey, B (1999), Organization Science, 10(3), 294–321, Strategies for Rugged Landscapes-- Avoiding Complexity Catastrophe in Co-evolutionary Pockets

McKelvey, B (2001), Innovation Management(International Journal), 5(2), 181–212, Networks of Intelligence (distributed) - Energizing Order - Corporate Brain Improvement

McKergow, Mark& Bailey, Helen (2014), Host -- Six New Roles of Engagement, Solutions Books, ISBN-13: 978-0954974985

Merali Y (2004), In - (Eds.) Mingers, J & Willcocks, L ,Information systems -- theory (social) and philosophy, pp. 407-446,Sussex, UK,2004, Complexity and information systems ,John Wiley,

Meso, P and Jain, R (2006), Systems Development- Contemporary Practices, Summer 2006, Information Systems Management, Agile SW Development – Best Practices and Adaptive Systems Principles

Mishra, Deepti, Mishra, Alok and Ostrovska, Sofiya (2012), 54(10):1067–1078 · October 2012 - Information and Software Technology, collaboration, communication and coordination in agile SW development - Impact of physical ambiance (empirical evaluation)

Mitleton-Kelly, E (1997), BPRC (Business Processes Resource Center), British Academy of Management Conference, Paper Series, No 5, Organizations as Complex Adaptive Systems -Co-evolving

Mitleton-Kelly, E (2003), Applying Complexity Theory to Organizations -- Evolutionary Perspectives and Complex Systems of Organizations, ISBN 9780080439570, Ten principles --enabling infrastructures and complexity, Elsevier, 23-50, In - (ed.) Mitleton-Kelly, E

Mitleton-Kelly, E (2003), Applying Complexity Theory to Organizations-- Evolutionary Perspectives and Complex Systems of Organizations, ISBN 9780080439570, Ten principles - enabling infrastructures and complexity, Management (Advanced Series), Elsevier Science Limited, Oxford, UK, 3-20In - (ed.) Mitleton-Kelly, E

Moe Nils Brede, Dingsøyr T and Røyrvik EA (2009), Empirical assessment and Improving Agile SW Development (preliminary instrument) - Positioning agile team activity to the Test, vol 31, Information Processing(Business) (lecture notes), XP 2009, In - Agile Processes in Xtreme Programming and SW Engineering, Springer, Heidelberg,Berlin,Maurer, F, Marchesi, M,Abrahamsson, P(eds)

Moe, N B, Dingsøyr, Torgeir & Dybå, Tore (2009), Information and SW Technology, 52 (2010) 480–491, Scrum project (case study) -- Understanding an agile team (teamwork model)

Moe, Nils Brede and Dingsøyr, T (2008),Theory and practice-- Scrum and team effectiveness, 9th International Conference, Limerick, Ireland, In –processes (agile) in SW Engineering and Xtreme Programming, pp. 11–20 (2008)

Moran, D (2009), http://www.softwareresults.us(Page - /2009/11/elusive-definition-of-success-with.html), Retrieved on 2 Apr 2017, The Elusive Definition of Success with Software Projects

Naing, L Winn& I Rusli, B N (2006), Orofacial Sciences (Archives) 2006; 1 - 9-14, Calculating the Sample Size for Prevalence Studies -- Practical Issues

Nasir, Md. H. N. & Sahibuddin, S (2011), Vol. 6(10)Scientific Research and Essays, pp. 2174-2186, Retrieved on 18 May, 2011, A comparative study-- SW projects (critical

success factors),(/SRE ISSN 1992-2248), Academic Journals, (web site - academicjournals.org) (home page)

NASSCOM (2016), NASSCOM Annual Report 2015-2016. Retrieved from: http://www.nasscom.in (Page - /nasscom-annual-report-201516) on 23 Mar 2017

NASSCOM and Zinnov Management Consulting Pvt Ltd (2015), Indian Start-up Ecosystem – Momentous Rise (Start-up India), 2nd Edition, 2015, Retrieved from: home site - www.nasscom.in (Page referring to startup India - /startup-india-%E2%80%93-momentous-rise-indian-startup-ecosystem) on 23 Mar 2017

Nedelko, Z (2008), The Business Review, Cambridge, 10(1), 211, The role and importance of groupware for teamwork

Neyman, Jerzy and Pearson, Egon (1933), Philosophical Transactions, Vol 231, Series A, statistical hypotheses – most efficient tests, pp. 289-337, Royal Society of London, 1933

Nokes, S (2007), London, ISBN 978-0-273-71097-4, (Prentice Hall and Financial Times), Guide to Project Management (definitive), 2nd Edition

O'Brien, James and Marakas, G (2012), Information Systems – An introduction, ISBN 0-07-304355-9, McGraw-Hill/Irwin, 13th edition

Peterson, C and Seligman, Martin (2003), - Positive organizational scholarship, Dutton, J E, Cameron, K S, and Quinn, R E (Eds.), Berrett-Koehler, pp. 14-27,Lessons from positive psychology - Positive organizational studies, California, USA, In - new discipline (foundations), 2003

Pink, Daniel H (2009), Riverhead Books, ISBN-13: 978-1594488849, The Surprising Truth about what motivates us- Drive

Plummer, Kenneth (2016), Teaching and Learning Consultant, University - Brigham Young, Provo, UT 84602, USA, Retrieved on 26 Dec 2016- http://www.slideshare.net(/plummer48/reporting-a-multiple-linear-regression-in-apa)

PMI – PMBOK, 5th Edition (2013), PMBOK Guide - Management Body of Knowledge (project), home page - http://www.pmi.org(Page on guide and standards - /pmbok-guide-standards/foundational), Project Management Institute, USA, 2013

Polit, Denise& Hungler, Bernadette (1999),Philadelphia – Lippincott, Principles and methods- Nursing research, 6th edition

Poppendieck, Mary and Poppendieck, Tom (2003), pp. 13–15, ISBN 978-0-321-15078-3, Addison-Wesley Professional, An Agile Toolkit -Lean Software Development

Power, K (2014), vol 179, In - Agile Processes in SW Engineering and XP, Cantone, G, Marchesi, M (eds), A Perspective on Agile Development- Simple Rules, Social Contracts and Self-organization, Business Information Processing (lecture notes), XP 2014, Publications- Springer

Pressman R S (2001), Software Engineering a Practitioner's Approach, Fifth Edition, McGraw Hill, 2001

Stats Direct Limited (2017), http://www.statsdirect.com(Page -/help/basics/p_values.htm), P Values - Retrieved on 11 Jun 2017

Rhodes, Mary L and MacKechnie, G (2003), Role for Complex Adaptive Systems Theory- Understanding Public Service Systems, Emergence, 5(4), 57–85

Ross, T Meredith, Jones, Erick& Adams, Stephanie (2008), Team Performance Management, Predicting effectiveness of teams, 14(5/6), 248

Royce, Winston W (1970), "Managing the Development of Large Software Systems", Technical Papers of Western Electronic Show and Convention (WesCon) August 25–28, 1970, Los Angeles, USA

Salas, E, Sims, Dana& Burke, C Shawn (2005), 36(5), 555-599, Small Group Research, Is there a "big five" in teamwork

Salas, Eduardo, Goodwin, GF, Stagl, KC, Burke, CS (2007), Integrative Theoretical Framework - Fostering Team Effectiveness in Organizations, pp. 185–243, Lincoln, NE, (2007),In – Symposium (Fifty second Nebraska) (Motivation)

Scaled Agile Framework (2017), http://www.scaledagileframework.com(/agile-teams/) - Agile Teams - Retrieved on 15 March 2017

Schein, E (1965), Englewood Cliffs - Prentice Hall, Organizational Psychology

Scrum Alliance (2017), https://www.scrumalliance.org (/why-scrum) - Scrum - Retrieved on 22 Apr 2017

Seddon, John (2005), Productivity Press, ISBN-13: 978-1563273278, Rethinking Management for Lean Service- Freedom from Command and Control

Senge, Peter (1990), NY, New York, Currency – Doubleday, the organization(learning) - The Fifth Discipline

Simon, Herbert (1996), Cambridge, MA - MIT Press, The Sciences of the Artificial, third edition

So, C (2010), New York, Oxford, Frankfurt am Main, Bruxelles, Berlin, Bern, Wien - Peter Lang, teamwork mechanisms (agile practices leading to project success) -Making software teams effective

Sridhar, Varadharajan, Paul, R, Nath, D & Kapur, K (2007), Conference on Management of Globally Distributed Work (2nd International Conference) - Performance of global virtual teams- Analyzing factors that affect it

Srinivasan, Badri N (2013), M474.doc - Role of Agile Software Development in the Global Healthcare Industry -- Published in Conference Proceedings, XIth AIMS International Conference on Management, 21 Dec 2013-24 Dec 2013, ISBN: 978-81-924713-5-8

Srinivasan, Badri N and Mukherjee, D (2015), Characteristics of Agile Teams – A Theoretical Discussion on Technology and Culture, IMS Manthan - The Journal of Innovations, ISSN: 0976-1713, pp 75-82, Vol. X.1 (Jan - July 2014), Available at – http://www.myresearchjournals.com/index.php/imsmanthan/issue/view/418, Indexed by Ulrich, UGC's List of Journals Sr. no. 6673

Stacey, R D (2003), Financial Times Prentice Hall, The Challenge of Complexity--Strategic Management and Organizational Dynamics, Fourth Edition

Standish Report (2008), "The trends in IT value. Boston: The Standish Group International". Retrieved from: https://www.standishgroup.com on 2 Apr 2017

Strode, Diane (2015), Applying Adapted Big Five Teamwork Theory to Agile SW Development, Australasian Conference on Information Systems 2015, Adelaide

Stylus, Inc. (2017) – Waterfall Model - http://www.stylusinc.com (Page - /down-to-earth-ideation/the-software-development-life-cycle-sdlc), Retrieved on - 3 Apr 2017

Tajfel Henri and Turner John (1979), Intergroup conflict (integrated theory)- Intergroup relations (social psychology), California, CA, Brooks and Cole, Monterey, USA, 1979,In - (Eds.) Austin W G and Worchel S

Tajfel H and Turner J (1986), Inter-group behavior (theory of social identity) - (psychology), Chicago, 1986, Nelson-Hall,In -(eds.) Austin L W and Worchel S, Intergroup Relations, IL, USA

Tan, Joseph, Awad, N and Wen, H J (2005), Communications of the ACM, 48(5), 36–44, services delivery systems and health care as CAS

Teasley, Stephanie, Krishnan, M S, Covi, Land Olson, J S (2000), Team Success – through radical collocation, Cooperative Work (Computer Supported) (Proceedings) CSCW'00, ACM, NY, USA, 2000, pp. 339–346, 2000 ACM Conference

TechBeacon (2015) – Usage of Agile by organizations - https://techbeacon.com (Page - /survey-agile-new-norm), Retrieved on - 20 Apr 2017

Tessem B and Maurer F (2007), Scotto M, Concas G, Succi G, Damiani E (eds), Large Agile Team-- Job Satisfaction and Motivation, Computer Science (lecture notes), XP 2007, Springer, Heidelberg, Berlin, vol 4536,In – Processes (agile) in SW Engineering and Xtreme Programming

Thakur, Dinesh (2017) – Prototyping Model –(http://ecomputernotes.com(Page - /software-engineering/explain-prototyping-model), Retrieved on – 3 Apr 2017

Thakur, Dinesh (2017) – Incremental Model - http://ecomputernotes.com(Page - /software-engineering/incremental-model), Retrieved on – 3 Apr 2017

Thakur, Dinesh (2017) – Spiral Model - http://ecomputernotes.com(Page - /software-engineering/explain-spiral-model), Retrieved on – 3 Apr 2017

Thamhain, H J (2004), Journal - Project Management, 35(4), 35, Technology-based project environments - Team leadership effectiveness

Tselikovska, Ganna (2013), Thesis, Management Department, Faculty of Business Studies, Vaasa University, Finland, Communication in Globally Distributed IT Project Teams-- Agile Methods influence

Tuckman, Bruce (1965), Psychological Bulletin 63, Small Groups -- Developmental Sequence

Tuckman, Bruce and Jensen, M A C (1977), vol.2, no.4, pp.419-27, Group and Organization Studies, Small group development - Stages (revisited)

Ulloa, B C R, & Adams, Stephanie (2004), Team Performance Management, 10(7/8), 145, Attitude toward teamwork and effective teaming

Vagias, Wade M (2006), Tourism & Research Development- Clemson International Institute, Recreation and Tourism Management, Department of Parks, scale response anchors(Likert-type), Clemson University

Vidgen, Richard and Wang, Xiaofeng (2006), ECIS 2006, Conference - Information Systems (Proceedings), A CAS viewpoint on agile SW development process- Organizing for agility, Göteborg, Sweden, 2006, XIV European Conference

Wagenmakers, Eric-Jan (2007), Psychonomic Bulletin & Review 2007, Psychonomic Society, Inc, 14 (5), 779-804, Pervasive problems of p values-- A practical solution

Wang, X and Conboy K (2009), 17th European Conference on Information Systems (Proceedings), Verona, June 7-9, Understanding Agility in SW Development through A CAS Perspective

Whatis.com, Framework – https://whatis.techtarget.com (path - /definition/framework), Retrieved on 04 Jun 2018

Whitworth, Elizabeth (2006), Thesis, Department of Psychology, Carleton University, Collaboration and Communication in Agile SW Development Teams – agile experience, Ottawa, Ontario, Canada, September, 2006

Whitworth, Elizabeth and Biddle, Robert (2007), Proceedings of Agile 2007 Conference, 2007, The Social Nature of Agile Teams, ISBN: 0-7695-2872-4

Wikipedia (2013), Agile SW Development – https://en.wikipedia.org (Path - /wiki/Agile_software_development), Retrieved on 22 Apr 2017

Wikipedia (2017), Complex Adaptive System – https://en.wikipedia.org (Path - /wiki/Complex_adaptive_system), Retrieved on 22 Apr 2017

Wikipedia (2017), Lean Software Development (LSD) – https://en.wikipedia.org (Path - /wiki/Lean_software_development), Retrieved on 22 Apr 2017

Wikipedia (2017), Porter's Five Forces Analysis – https://en.wikipedia.org (Path - /wiki/Porter%27s_five_forces_analysis), Retrieved on 11Jun 2017

Wikipedia (2017), Two Factor Theory (Motivation Hygiene Theory) – https://en.wikipedia.org (Path - /wiki/Two-factor_theory), Retrieved on 11 Jun 2017

Wikipedia (2017), V – Model - https://en.wikipedia.org (Path - /wiki/V-Model_(software_development)), Retrieved on – 3 Apr 2017

Wikimedia (2017), Waterfall Model – https://commons.wikimedia.org (Path - /wiki/File:Waterfall_model_(1).svg), Retrieved on – 3 Apr 2017

Williams, Laurie and Cockburn, A (2003), IEEE Computer, It's about change and feedback - Agile Software Development

Womack, James, Jones, Daniel and Roos, Daniel (1990), Rawson Associates, The story of lean production, USA, 1990, New York

Wördenweber, Burkard & Weissflog, Uwe (2006), Springer-Verlag Heidelberg Berlin, ISBN - 978-3-540-27415-5, Agile Teams mastering Disruptive Innovation -Innovation Cell, eBook

Yadav, Ravi Shanker (2012), International Journal of Scientific & Engineering Research, Volume 3, Issue 2, Februaryy-2012 1 ISSN 2229-5518

Zannier, Carmen and Maurer, Frank (2007), Processes (agile)- SW Engineering and XP, non-agile and agile SW Organizations-- Comparing Decision Making in these organizations, Como, Italy, XP 2007,June 18-22, 2007, Proceedings,8th International Conference

Zannier, et al. (2006), XP & Agile Processes in SW Engineering, Finland, 7th International Conference, Springer, Heidelberg, Agile Developers & Mentors -- Agile Decision Making (foundations) from them

Zannier, C, Maurer, F, Chiasson, F (2007), Information and SW Technology (journal) (special issue), Social Side of SW Engineering – Understanding it, Spring 2007, Design Decision Making - Model(based on results (empirical)- Software Designer interviews)

Zikmund, WG (2010), Mason, OH - South-Western, Cengage Learning, Business research methods, 8th Edition

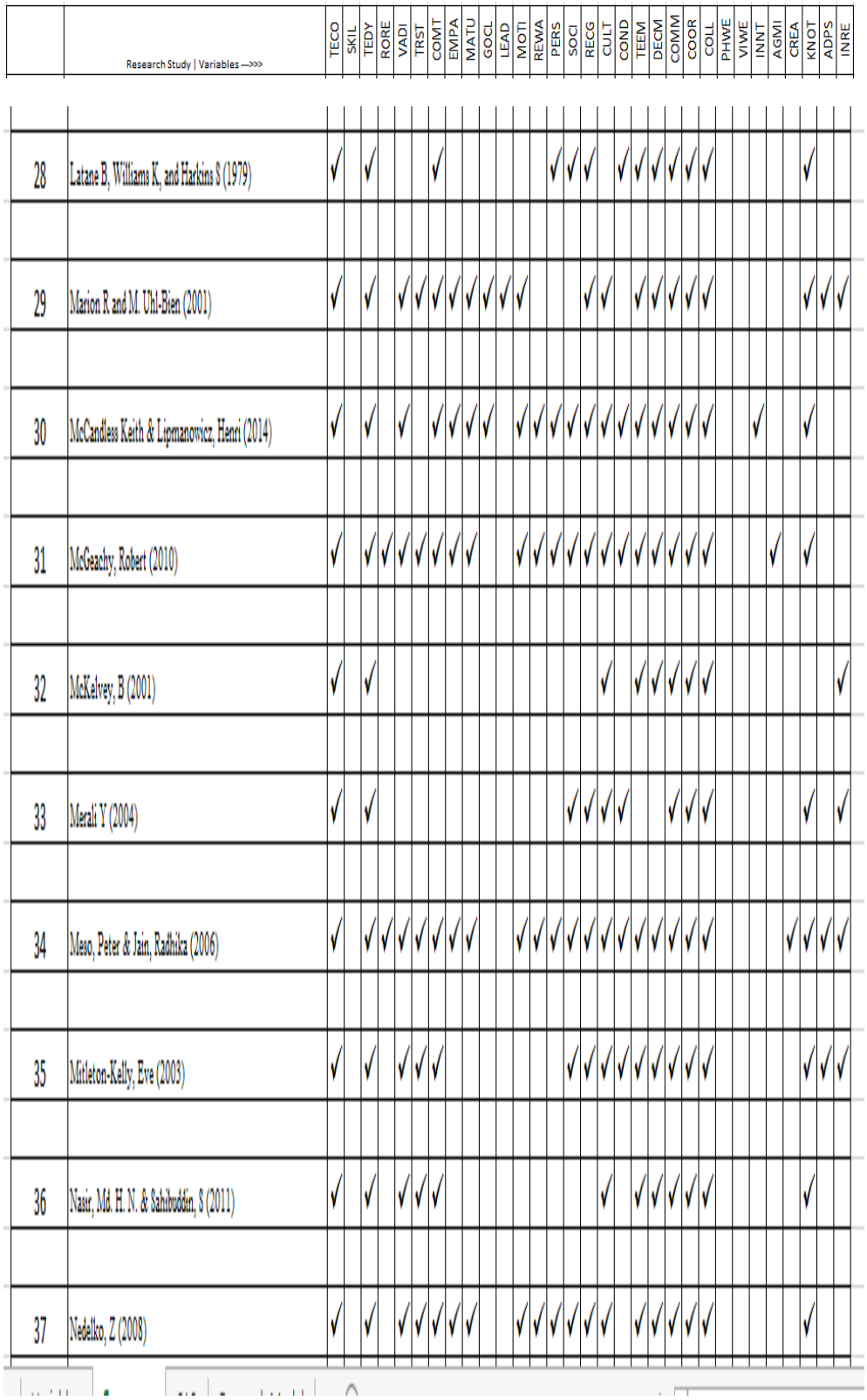
APPENDICES

Appendix 1 – Challenges faced by Agile Teams –Tabular Extraction of the Variables

	Research Study | Variables --->>>	TECO	SKIL	TEDY	RORE	VADI	TRST	COMT	EMPA	MATU	GOCL	LEAD	MOTI	REWA	PERS	SOCI	RECG	CULT	COND	TEEM	DECM	COMM	COOR	COLL	PHWE	VIWE	INNT	AGMI	CREA	KNOT	ADPS	INRE
1	Appelo, Jurgen (2011)	✓		✓			✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓
2	Ackoff, R (1999)																			✓										✓		
3	Anderson, P (1999)																			✓		✓	✓								✓	✓
4	Arthur, M, Defillipp, R. & Lindsay, V (2001)																			✓		✓	✓								✓	✓
5	Beck K, Andres C (2004)	✓	✓	✓	✓		✓	✓					✓	✓			✓		✓	✓	✓	✓	✓	✓				✓		✓	✓	✓
6	Begel Andrew, Nagappan, Nachiappan (2007)	✓	✓	✓	✓		✓	✓					✓					✓	✓	✓	✓	✓	✓	✓				✓		✓		
7	Bertalanffy L V (1950)																						✓	✓							✓	✓
8	Bion W R (1961)	✓	✓	✓				✓											✓	✓	✓	✓	✓	✓					✓			

	Research Study | Variables --->>>	TECO	SKIL	TEDY	RORE	VADI	TRST	COMT	EMPA	MATU	GOCL	LEAD	MOTI	REWA	PERS	SOCI	RECG	CULT	COND	TEEM	DECM	COMM	COOR	COLL	PHWE	VIWE	INNT	AGMI	CREA	KNOT	ADPS	INRE
9	Brown, S and K, Eisenhardt (1998)	✓		✓								✓										✓	✓	✓							✓	✓
10	Chiva-Gomez, R (2004)	✓		✓																✓	✓	✓	✓	✓					✓	✓	✓	✓
11	Cilliers, P (2000)	✓		✓																✓	✓	✓	✓	✓					✓	✓	✓	✓
12	Cockburn, Alistair (2006)	✓		✓		✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓					✓			
13	McCandless Keith & Lipmanowicz, Henri (2014)	✓		✓		✓	✓		✓	✓		✓	✓		✓						✓	✓	✓	✓					✓			
14	Daniel, L & Davis, C (2009)	✓		✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓			✓	✓	✓	✓								
15	Dyba T & Dingsoyr T (2008)	✓	✓	✓		✓	✓	✓	✓	✓			✓			✓	✓	✓	✓		✓	✓	✓	✓	✓				✓		✓	✓	✓
16	Eoyang, G (1996)	✓		✓			✓	✓	✓	✓			✓		✓	✓		✓	✓	✓		✓	✓	✓	✓	✓				✓	✓	✓
17	Festinger L (1954)	✓				✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								

	Research Study | Variables --->>>	TECO	SKIL	TEDY	RORE	VADI	TRST	COMT	EMPA	MATU	GOCL	LEAD	MOTI	REWA	PERS	SOCI	RECG	CULT	COND	TEEM	DECM	COMM	COOR	COLL	PHWE	VIWE	INNT	AGMI	CREA	KNOT	ADPS	INRE
18	Gerber, M (2002)	✓		✓												✓	✓		✓		✓		✓	✓				✓		✓	✓	✓
19	Gharajedaghi J (1999)	✓		✓												✓	✓		✓		✓		✓	✓						✓	✓	✓
20	Goodman, P S and Olivera, F (1998)	✓																			✓		✓	✓	✓					✓		
21	Highsmith, J (1999)	✓					✓	✓											✓		✓		✓	✓				✓		✓	✓	✓
22	Hiniet, Malik and Hock Ow, Siew (2009)	✓		✓	✓					✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓		
23	Hoegl, M & Proserpio, L (2004)	✓	✓	✓		✓						✓	✓	✓	✓	✓		✓	✓	✓		✓	✓						✓			
24	Hogg M A and Vaughan G M (2002)	✓		✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓						✓			
25	Ilgen D R, Hollenbeck J R, Johnson M and Jundt D (2005)	✓		✓		✓	✓	✓	✓	✓		✓		✓	✓	✓		✓	✓	✓	✓	✓	✓						✓			
26	Kauffman, S (1991)	✓					✓	✓				✓								✓	✓	✓									✓	✓
27	Kerth N L (2001)	✓		✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓				✓	✓	✓			



	Research Study | Variables —>>>	TECO	SKIL	TEDY	RORE	VADI	TRST	COMT	EMPA	MATU	GOCL	LEAD	MOTI	REWA	PERS	SOCI	RECG	CULT	COND	TEEM	DECM	COMM	COOR	COLL	PHWE	VIWE	INNT	AGMI	CREA	KNOT	ADPS	INRE
28	Latane B, Williams K, and Harkins S (1979)	✓		✓				✓							✓	✓	✓		✓	✓	✓	✓	✓	✓						✓		
29	Marion R and M. Uhl-Bien (2001)	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓	✓	✓						✓	✓	✓
30	McCandless Keith & Lipmanowicz, Henri (2014)	✓		✓		✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓			✓		
31	McGeachy, Robert (2010)	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓		
32	McKelvey, B (2001)	✓		✓														✓		✓	✓	✓	✓	✓								✓
33	Merali Y (2004)	✓		✓												✓	✓	✓	✓			✓	✓	✓						✓		✓
34	Meso, Peter & Jain, Radhika (2006)	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓
35	Mitleton-Kelly, Eve (2003)	✓		✓		✓	✓	✓								✓	✓	✓	✓	✓	✓	✓	✓	✓						✓	✓	✓
36	Nasir, Md. H. N. & Sahibuddin, S (2011)	✓		✓		✓	✓	✓										✓		✓	✓	✓	✓	✓						✓		
37	Nedelko, Z (2008)	✓		✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓						✓		

	Research Study | Variables --->>>	TECO	SKIL	TEDY	RORE	VADI	TRST	COMT	EMPA	MATU	GOCL	LEAD	MOTI	REWA	PERS	SOCI	RECG	CULT	COND	TEEM	DECM	COMM	COOR	COLL	PHWE	VIWE	INNT	AGMI	CREA	KNOT	ADPS	INRE
38	Peterson C M and Seligman M E P (2003)	✓		✓			✓	✓	✓	✓					✓	✓	✓		✓	✓	✓	✓	✓									
39	Poppendieck, Mary and Poppendieck, Tom (2003)	✓		✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	
40	Rhodes, M L & MacKechnie, G (2003)	✓											✓			✓		✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	
41	Ross, T M, Jones, E C & Adams, S G (2008)	✓		✓			✓	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓			
42	Salas, E, Sims, D E, & Burke, C S (2005)	✓		✓			✓	✓	✓	✓			✓		✓	✓	✓		✓	✓	✓	✓	✓	✓					✓			
43	Schein, E (1965)	✓		✓			✓	✓	✓	✓					✓	✓	✓		✓	✓	✓	✓	✓	✓					✓			
44	Senge Peter (1990)	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	
45	Simon, H (1996)	✓		✓					✓	✓				✓	✓	✓			✓				✓	✓						✓	✓	
46	Stacey, R D (2003)										✓							✓			✓	✓	✓	✓	✓				✓	✓	✓	
47	Tajfel H and Turner J C (1986)	✓		✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								

	Research Study | Variables --->>>	TECO	SKIL	TEDY	RORE	VADI	TRST	COMT	EMPA	MATU	GOCL	LEAD	MOTI	REWA	PERS	SOCI	RECG	CULT	COND	TEEM	DECM	COMM	COOR	COLL	PHWE	VIWE	INNT	AGMI	CREA	KNOT	ADPS	INRE
48	Tan, J, Wen, H J & Awad, N (2005)	✓		✓															✓	✓	✓	✓	✓	✓						✓	✓	✓
49	Thamhain, H J (2004)	✓		✓								✓		✓					✓	✓	✓		✓	✓						✓		
50	Ulloa, B C R, & Adams, S G (2004)	✓		✓			✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						✓		
51	Whitworth, Elizabeth and Biddle, Robert (2007)	✓		✓			✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						✓		

Appendix 2 – Mapping of Independent Variables to the Research Objectives and Earlier Work Undertaken

Mapping of Independent Variables to the Research Objectives and Earlier Work Undertaken in the Study Area

Sl. No.	Research Objectives	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
1	Study on tribulations related to team work	Stray, Moe	· Discusses how to overcome problems linked to learning, communication and how to manage the tasks as per the list of priorities	✓								
	Learning	Dingsøyr, 2011	· However, all the challenges related to team work are not explored in the study – team dynamics, skills of the team members, physical and virtual work environment	✓								
	Communication								✓			
	Choosing the tasks as per the list of priorities			✓								

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
2	Study on team performance and focus on shared team commitment, team member skills	Katzenbach, J R, Smith, D K, 1993	· Discussed how to overcome the challenges to team performance and how to improve shared team commitment	✓	✓							
			· No specific discussion on all the other factors which may impact the performance of a team like disruptive innovative techniques for problem solving, team as a complex adaptive system	✓	✓							
3	Agile teams are better suited for rapid and quality delivery as per the changing market requirements	Dyba T & Dingsøyr T, 2008	· Discusses the role of agile teams and how they are better suited for managing changing market requirements. However, no specific focus on the complex adaptive system as a key variable is indicated.	✓								

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
4	Team Performance in Agile SW Teams. Focus on attributes that affect performance of the team	Torgeir Dingsøyr and Yngve Lindsjørn, 2013	· Findings from 18 Focus Groups	✓	✓	✓	✓		✓			
			· Focus on factors – mutual trust, orientation of the team, adaptability, team leadership, backup behavior, shared mental models, mutual performance monitoring and closed loop communication	✓	✓	✓	✓		✓			
			· Big Five teamwork model of Salas Model adopted as the context for the study	✓	✓	✓	✓		✓			
			· Does not focus on other factors that may also be important for teamwork like disruptive innovative techniques for problem solving, team as a complex adaptive system	✓	✓	✓	✓		✓			

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
5	Study on motivation and job satisfaction in a large agile team. Focus on various factors like the ability to complete a task fully, variety, autonomy and feedback are considered as important factors to ensure motivation and satisfaction among the workers.	Tessem B, Maurer F 2007	· The Job Characteristics Model (JCM) -- five critical factors of Hackman and Oldham which is adopted as the context for the study	✓			✓					
			· Consideration of a specific framework indicating all the key components of a successful agile team is not fully discussed	✓			✓					
6	Agile software development encourages evolutionary development and boosts quick and lithe response to change	Williams, Laurie & Cockburn, A, 2003	· Important concepts of agile software development are discussed and how it harnesses change for managing the customer requirements effectively. However, it does not indicate the key characteristics of agile teams in the context of a CAS.	✓					✓			

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
7	Surmounting obstacles to self-management in SW teams	Moe, Dingsøyr and Dybå (2009)	· Study focused on overcoming obstacles to self-management in SW teams	✓	✓				✓			
			· Focus on other attributes of agile teams are not explored and which will make the agile teams deliver improved work outcomes	✓	✓				✓			
8	Returns derived from vastly effective and focused teams and frameworks for high performing teams	Nedelko, 2008; Ross, Jones & Adams, 2008; Ulloa & Adams, 2004; Daniel L & Davis C, 2009; Hoegl M & Proserpio L, 2004; Thamhain H J, 2004; Salas E, Sims D E & Burke, 2005	· Different studies focus on the advantages of focused teams and the different types of frameworks for high performing teams	✓	✓						✓	
			· Focus on CAS as a key variable is not indicated	✓	✓						✓	
			· Role of disruptive innovation is not fully considered and other factors related to people are not fully considered	✓	✓						✓	
			· Consideration of a specific framework indicating all the key components of a successful agile team is not fully discussed	✓	✓						✓	
			· However, other additional characteristics of teams that lead to improved work outcomes are not discussed nor is a framework available to identify all the key characteristics of agile teams	✓	✓				✓			
			Focus on CAS as a key variable is not indicated	✓	✓				✓			
			People related factors are not sufficiently discussed as part of a single framework	✓	✓				✓			

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
9	Study focused on an instrument that addresses key characteristics of teamwork	Moe, Dingsøyr and Røyrvik (2009)	· Focus on the key characteristics of teamwork through a dimensional approach – autonomy, learning, redundancy, shared leadership and team orientation	✓	✓				✓			
			· However, other additional characteristics of teams that lead to improved work outcomes are not discussed nor is a framework available to identify all the key characteristics of agile teams	✓	✓				✓			
10	How agile software development methodologies could help facilitate the development of robust software systems	Dyba & Dingsøyr, 2008; Abrahamsson, Salo, Ronkainen & Warsta, 2002	· Focus on agile SW methodologies that help facilitate the development of software systems	✓	✓				✓			
			No Focus on CAS as a key variable	✓	✓				✓			

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
11	Study focused on self-monitoring SW development team performance using an instrument and analyzing the findings	Kettunen P, Moilanen S (2012)	· Focus on an instrument for self-monitoring agile teams and how to improve the performance of the team through improved work outcomes	✓	✓							
			· However, all the characteristics of agile teams are not fully covered like work environment and other factors that lead to improved work outcomes	✓	✓							
12	Focus on the community and gregarious nature of agile teams and the explanation of how community identity and shared effort are facilitated by agile methods	Whitworth, Elizabeth and Biddle, Robert, 2007	· Study focuses on the gregarious nature of agile teams and explains how community identity and shared effort are enabled by agile methods	✓	✓	✓		✓	✓			
			· Focus on CAS as a key variable is not indicated	✓	✓	✓		✓	✓			

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
13	Focus on Scrum and team effectiveness to ensure improved work outcomes	Moe, NB, Dingsøyr, T (2008)	· Study focused on the agile framework – Scrum and the effectiveness of team.	✓	✓				✓			
			· However, other factors that impact team effectiveness were not considered like complex adaptive systems, work environment and other factors	✓	✓				✓			
14	Focus on self-managed agile teams that lead to improved work outcomes	Moe, Nils Brede, Dingsøyr, Torgeir & Dybå, Tore (2009)	· Study focused on self-managed agile teams and improved work effectiveness	✓	✓				✓			
			· Teamwork model -- Dickinson and McIntyre – The model is used as the context for explaining self-managed agile teams	✓	✓				✓			
			· However, all the characteristics that lead to improved agile team effectiveness like work environment and other factors are not fully considered.	✓	✓				✓			
15	Building agile teams focuses on the study of highly accomplished teams	McGeachy, Robert, Building agile teams, 2010	· The results of the study are applied to teams that have embraced the Agile methodologies	✓	✓							
			· Focus on CAS as a key and independent variable is not indicated	✓	✓							
			· Aspects of disruptive innovation enabling work is not fully considered	✓	✓							

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
16	Concept of social identity as a very important characteristic for agile teams	Ilgen, Hollenbeck, Johnson, and Jundt, 2005	· Study pertaining to self-organized work teams has focused on social psychology and social identity	✓	✓			✓				
			· Focus on CAS as a key variable is not indicated	✓	✓			✓				
			· Aspects of disruptive innovation enabling work is not fully considered	✓	✓			✓				
17	Social Identity Theory -- Individual psychology operating in the social context is focused	Tajfel H and Turner J C, 1986	· Social perspective is focused to highlight the importance in describing various characteristics of agile teams	✓	✓			✓	✓			
			· Focus on CAS as a key variable is not indicated	✓	✓			✓	✓			

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
18	Focus on understanding which are the factors that affect the productivity of agile teams	de O Melo, Cruzes, Kon and Conradi (2013)	· Focus on factors that lead to improved work outcomes of agile teams	✓	✓				✓			
			· Development of a framework using thematic analysis	✓	✓				✓			
			· Focus on agile team management	✓	✓				✓			
			· However, other factors like complex adaptive systems, behavioral factors, disruptive innovative techniques were not fully considered	✓	✓				✓			
			· Hence, a comprehensive framework for identifying the characteristics of agile teams that lead to improved work outcomes was not available	✓	✓				✓			
19	Focus on team effectiveness	Salas, Stagl, Burke and Goodwin (2007)	· Study focused on understanding the effectiveness of teams in organizations	✓	✓				✓			
			· However, all the characteristics of agile teams that could lead to improved work outcomes are not considered fully	✓	✓				✓			

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
20	Focus on how radical colloc ation helps a team to succeed	Teasley, Covi, Krishnan and Olson (2000)	· Study focuses on essential co-location as a key factor for improved work outcomes in agile teams	✓						✓		
			· However, other factors like leadership, behavioral factors, disruptive innovation are not fully considered	✓						✓		
			· Additionally, how to manage distributed teams that need to be present due to certain constraints and how to ensure optimized work outcomes in such cases are not fully considered	✓						✓		
			· Overall framework for the identification of characteristics of agile teams leading to improved work outcomes are not considered	✓						✓		

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
21	Study focused on factors that make team effective	Cohen and Bailey (1997)	· Focus on factors impacting the effectiveness of teams	✓	✓				✓			
			· Focus on team effectiveness as a function of group, task and organization design factors, and other factors	✓	✓				✓			
			· Focus on generic teams effectiveness	✓	✓				✓			
			· No specific framework for identifying all the key characteristics of agile teams that lead to improvement of work outcomes	✓	✓				✓			
22	Focus on team interactions in distributed agile teams	Dorairaj, Siva, Noble, James and Malik, Petra (2012)	· Study focused on how to improve work outcomes in distributed agile teams	✓					✓	✓		
			· Focus on team dynamics	✓					✓	✓		
			· However, other factors impacting agile team are not coonsidered	✓					✓	✓		

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
23	Focus on factors impacting high performance teams		· Study focused on the results of collaborative research intended at determining the attributes that affect the working of high performance teams	✓	✓				✓			
		Castka, Bamber, Sharp and Beloh oubek (2001)	· Focus on the factors related to teamwork, quality management	✓	✓				✓			
			· Development of a model for the successful implementation of high performing teams	✓	✓				✓			
			· However, all the characteristics of agile teams like usage of disruptive innovative techniques and consideration as complex adaptive systems are not contemplated in the model	✓	✓				✓			
24	Focus on self-organi	Hoda, Noble and	· Focus on how teams organize themselves									

	zing teams	Marshall (2010)	· However, all the factors of teams that improve work outcomes are not considered like disruptive innovative techniques and other factors	✓	✓			✓				

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
25	Focus on effectiveness of agile teams	So, C. (2010)	· Focus on agile teams' effectiveness	✓	✓			✓				
			· However, all the factors for the effectiveness of agile teams in the form of a framework is not considered	✓	✓			✓				
26	Focus on teamwork in agile teams using adapted Big Five teamwork theory	Strode, D (2015)	· Focus on teamwork in agile teams	✓	✓				✓			
			· Adapted form of Big Five teamwork theory to explain factors affecting team work in agile software development teams	✓	✓				✓			
			· Framework does not consider all the factors that may affect the characteristics of agile teams	✓	✓				✓			
27	Focus on CAS and how agile software development organizations function to accomp	Jain, Radhika and Meso, Peter (2004)	· Focus on the various characteristics of CAS and how agile organizations operate and function to complete the work	✓	✓				✓			✓

	lish work		· However, all the characteristics that affect the performance of agile teams are not considered	✓	✓				✓			✓

Sl. No.	Previous Work Area	Authors	Study Outcome with Gap Analysis	Mapping to Independent Variables								
				Selection of Team and Skills	Behavioral Factors	Leadership	Reward and Motivation	Organizational Culture	Collaboration and Communication	Virtual and Physical Work Environment	Disruptive Innovation	Complex Adaptive System
				IV 1	IV 2	IV 3	IV 4	IV 5	IV 6	IV 7	IV 8	IV 9
28	Focus on the role of being agile in SW teams as viewed from the CAS standpoint	Wang and Conboy (2009)	· How being agile is viewed in teams from a CAS standpoint	✓	✓				✓			✓
			· However, all the characteristics of agile teams leading to improved work outcomes are not covered fully	✓	✓				✓			✓
29	Focus on theory on social contract in order to understand the role of community (social) contracts in agile teams	Power, K (2014)	· Focus on Teams and organizations as CAS	✓	✓	✓		✓	✓			✓
			· Role of Social Contract Theory and the usage of simple rules in nurturing self-organization in agile SW teams	✓	✓	✓		✓	✓			✓
			· However, all the attributes of agile SW teams are not considered and which would lead to improved work outcomes	✓	✓	✓		✓	✓			✓
30	People factors affecting the characteristics of agile teams that are focused on improved work outcomes	Lalsing, Vikash, Kishnah, Somveer and Pudaruth, Sameerchand (2012)	· Focus on people factors in agile teams	✓	✓				✓			
			· Study focuses on identifying the underlying people factors and attributes to be considered for agile teams to obtain improved work outcomes	✓	✓				✓			
			· However, no overall framework is available to identify all the key characteristics of agile teams that could lead to improved work outcomes	✓	✓				✓			

Appendix 3 – Questionnaire – Evaluation of Framework for Agile Software Development Teams

Declaration: This questionnaire is part of my PhD Research project and views expressed by each respondent will be solely used for academic purposes and not for any commercial purpose. thirumangaiazhwar@gmail.com

Dear Respondent,

The present questionnaire is meant entirely for academic research and will not be handed over to any other individual/ organization for any other use. Further, the confidentiality of the respondent will be strictly maintained as a part of ethics in research. You are requested to kindly fill the entire questionnaire considering it as your contribution to academic research. We thank you wholeheartedly for your valuable time and opinions regarding project management. You may kindly forward the filled questionnaire to thirumangaiazhwar@gmail.com

Sincere regards,

The Researchers

PhD Research Project- Evaluation of Framework for Agile Software Development Teams and Measurement of Work Outcomes

QUESTIONNAIRE

Name of the respondent:		
Name of the organization:		
Designation:		
Contact number:		
Email:		
Name of the project: (A brief description requested)		
Completion status of the project (in %):		
Duration of project (in months):		
Type of project:	**a) R&D** **c) Maintenance**	**b) Customization** **d)Other**
What framework was used for the agile software development team deployed for the software project?		

Kindly answer the following questions on a seven point scale.

Where,

'**1**' indicates '**Strongly Disagree**' '**2**' indicates '**Disagree**'

'**3**' indicates '**Disagree Somewhat**' '**4**' indicates '**Undecided**'

'**5**' indicates '**Agree Somewhat'** '**6**' indicates '**Agree**' and

'7' indicates '**Strongly Agree**'

Sl. No.	Statements	Scale						
		1	2	3	4	5	6	7
1	To what extent would you agree or disagree that team dynamics in an agile team leads to improved work outcomes for the project							
2	To what extent would you agree or disagree that the selection of key skills of team members in an agile team lead to improved work outcomes for the project							
3	To what extent would you agree or disagree that the behavioral factors (commitment along with maturity) in an agile team lead to improved work outcomes for the project							
4	To what extent would you agree or disagree that the impact of leadership in an agile team plays an important role that lead to improved work outcomes for the project							
5	To what extent would you agree or disagree that the reward factors in an agile team lead to improved work outcomes for the project							
6	To what extent would you agree or disagree that the motivational factors (positive thinking, intrinsic motivation) coupled with social identity in an agile team lead to improved work outcomes for the project							
7	To what extent would you agree or disagree that the impact of the organizational culture in an agile team lead to improved work outcomes for the project							

8	To what extent would you agree or disagree that collaboration coupled with coordination practices in an agile team lead to improved work outcomes for the project							
9	To what extent would you agree or disagree that the communication practices in an agile team lead to improved work outcomes for the project							
10	To what extent would you agree or disagree that the virtual work environment in an agile team lead to improved work outcomes for the project							
11	To what extent would you agree or disagree that the physical work environment in an agile team lead to improved work outcomes for the project							
12	To what extent would you agree or disagree that the disruptive innovative practices (e.g. appreciative inquiry and other techniques) along with creativity in an agile team lead to improved work outcomes for the project							
13	To what extent would you agree or disagree that the application, understanding and consideration of the agile team as a complex adaptive system (CAS) (adaptive systems, knowledge transfer and inter-relationships among agents) lead to improved work outcomes for the project							

	Essential Traits of Agile Teams							
14	To what extent would you agree or disagree that the agile team being cross functional will lead to improved work outcomes for the project							
15	To what extent would you agree or disagree that the agile team being empowered will lead to improved work outcomes for the project							
16	To what extent would you agree or disagree that the agile team being self-organized will lead to improved work outcomes for the project							
17	To what extent would you agree or disagree that trust in an agile team is an important factor that will lead to improved work outcomes for the project							
18	To what extent would you agree or disagree that self-motivated people who have the necessary competency and skills as well as the commitment and motivation to be in an agile team is an important factor that will lead to improved work outcomes for the project							
19	To what extent would you agree or disagree that delivering work at a sustainable pace in order to deliver high quality software for an agile team is an important factor that will lead to improved work outcomes for the project							

20	To what extent would you agree or disagree that work activities of the team members should reflect uniformity and should be aligned to the team goals in an agile team is an important factor that will lead to improved work outcomes for the project							
21	To what extent would you agree or disagree that the capacity of the team and the support from the team members should be taken into account while planning work in an agile team is an important factor that will lead to improved work outcomes for the project							
22	To what extent would you agree or disagree that members should imbibe the agile values and agile principles (agile mindset) in an agile team is an important factor that will lead to improved work outcomes for the project							
23	To what extent would you agree or disagree that members should exhibit Servant Leadership/Host Leadership/Other types of Leadership qualities in an agile team is an important factor that will lead to improved work outcomes for the project							
24	To what extent would you agree or disagree that goal clarity in an agile team is an important factor that will lead to improved work outcomes for the project							
25	To what extent would you agree or disagree that defining roles and responsibilities clearly in an agile team is an important factor that will lead to improved work outcomes for the project							

26	To what extent would you agree or disagree that effective decision making in an agile team is an important factor that will lead to improved work outcomes for the project							
27	To what extent would you agree or disagree that effective conflict management in an agile team is an important factor that will lead to improved work outcomes for the project							
28	To what extent would you agree or disagree that improved work outcomes of the project are dependent on people related factors (Selection of team and skills, behavioral factors, leadership, reward and motivation)							
29	To what extent would you agree or disagree that improved work outcomes of the project are dependent on interaction of the people with the environment (Impact of the organizational culture, Collaboration and communication, Virtual and physical work environment)							
30	To what extent would you agree or disagree that improved work outcomes of the project are dependent on innovative work techniques for problem solving (disruptive innovation and the consideration of the agile team as a Complex Adaptive System (CAS))							

Comments/
Suggestions…….

Definition of key terms:

Software Project Success: Success of the software development in terms of budget, time, schedule and the functional component delivered to the customer as per the requirements.

Complex Adaptive System (CAS): CAS theory is a branch of complexity science that studies how a complex system can be adaptive to its environment and how innovative properties of a system emerge from the interactions of its lower level components.

Agile: A type of software development methodology that focuses on assimilating behavioral and social factors into software development and the focus on people is a very important factor in the implementation of agile methodologies in the workplace.

Appendix 4 – Sample Responses

Declaration: This questionnaire is part of my PhD Research project and views expressed by each respondent will be solely used for academic purposes and not for any commercial purpose. thirumangaiazhwar@gmail.com

Dear Respondent,

The present questionnaire is meant entirely for academic research and will not be handed over to any other individual/ organization for any other use. Further, the confidentiality of the respondent will be strictly maintained as a part of ethics in research. You are requested to kindly fill the entire questionnaire considering it as your contribution to academic research. We thank you wholeheartedly for your valuable time and opinions regarding project management. You may kindly forward the filled questionnaire to thirumangaiazhwar@gmail.com

Sincere regards,

The Researchers

PhD Research Project- Evaluation of Framework for Agile Software Development Teams and Measurement of Work Outcomes

QUESTIONNAIRE

Name of the respondent:	Vijay Nair
Name of the organization:	Target Corporation
Designation:	Program Manager
Contact number:	9731455118
Email:	vijay.nair@gmail.com
Name of the project: (A brief description requested)	TMO Update
Completion status of the project (in %):	50%
Duration of project (in months):	22 months
Type of project: b	**a) R&D** **b) Customization** **c) Maintenance** **d)Other**
What framework was used for the agile software development team deployed for the software project?	Scrum

Kindly answer the following questions on a seven point scale.

Where,

'**1**' indicates '**Strongly Disagree**' '**2**' indicates '**Disagree**'

'**3**' indicates '**Disagree Somewhat**' '**4**' indicates '**Undecided**'

'**5**' indicates '**Agree Somewhat'** '**6**' indicates '**Agree**' and

'**7**' indicates '**Strongly Agree**'

Sl. No.	Statements	Scale						
		1	2	3	4	5	6	7
1	To what extent would you agree or disagree that team dynamics in an agile team leads to improved work outcomes for the project						A	
2	To what extent would you agree or disagree that the selection of key skills of team members in an agile team lead to improved work outcomes for the project					A		
3	To what extent would you agree or disagree that the behavioral factors (commitment along with maturity) in an agile team lead to improved work outcomes for the project						A	
4	To what extent would you agree or disagree that the impact of leadership in an agile team plays an important role that lead to improved work outcomes for the project							A
5	To what extent would you agree or disagree that the reward factors in an agile team lead to improved work outcomes for the project							A
6	To what extent would you agree or disagree that the motivational factors (positive thinking, intrinsic motivation) coupled with social identity in an agile team lead to improved work outcomes for the project						A	
7	To what extent would you agree or disagree that the impact of the organizational culture in an agile team lead to improved work outcomes for the project						A	

8	To what extent would you agree or disagree that collaboration coupled with coordination practices in an agile team lead to improved work outcomes for the project				A			
9	To what extent would you agree or disagree that the communication practices in an agile team lead to improved work outcomes for the project						A	
10	To what extent would you agree or disagree that the virtual work environment in an agile team lead to improved work outcomes for the project							A
11	To what extent would you agree or disagree that the physical work environment in an agile team lead to improved work outcomes for the project						A	
12	To what extent would you agree or disagree that the disruptive innovative practices (e.g. appreciative inquiry and other techniques) along with creativity in an agile team lead to improved work outcomes for the project					A		
13	To what extent would you agree or disagree that the application, understanding and consideration of the agile team as a complex adaptive system (CAS) (adaptive systems, knowledge transfer and inter-relationships among agents) lead to improved work outcomes for the project					A		

	Essential Traits of Agile Teams							
14	To what extent would you agree or disagree that the agile team being cross functional will lead to improved work outcomes for the project					A		
15	To what extent would you agree or disagree that the agile team being empowered will lead to improved work outcomes for the project						A	
16	To what extent would you agree or disagree that the agile team being self-organized will lead to improved work outcomes for the project						A	
17	To what extent would you agree or disagree that trust in an agile team is an important factor that will lead to improved work outcomes for the project						A	
18	To what extent would you agree or disagree that self-motivated people who have the necessary competency and skills as well as the commitment and motivation to be in an agile team is an important factor that will lead to improved work outcomes for the project							A
19	To what extent would you agree or disagree that delivering work at a sustainable pace in order to deliver high quality software for an agile team is an important factor that will lead to improved work outcomes for the project						A	

20	To what extent would you agree or disagree that work activities of the team members should reflect uniformity and should be aligned to the team goals in an agile team is an important factor that will lead to improved work outcomes for the project							A
21	To what extent would you agree or disagree that the capacity of the team and the support from the team members should be taken into account while planning work in an agile team is an important factor that will lead to improved work outcomes for the project					A		
22	To what extent would you agree or disagree that members should imbibe the agile values and agile principles (agile mindset) in an agile team is an important factor that will lead to improved work outcomes for the project					A		
23	To what extent would you agree or disagree that members should exhibit Servant Leadership/Host Leadership/Other types of Leadership qualities in an agile team is an important factor that will lead to improved work outcomes for the project						A	
24	To what extent would you agree or disagree that goal clarity in an agile team is an important factor that will lead to improved work outcomes for the project						A	
25	To what extent would you agree or disagree that defining roles and responsibilities clearly in an agile team is an important factor that will lead to improved work outcomes for the project					A		

26	To what extent would you agree or disagree that effective decision making in an agile team is an important factor that will lead to improved work outcomes for the project						A	
27	To what extent would you agree or disagree that effective conflict management in an agile team is an important factor that will lead to improved work outcomes for the project					A		
28	To what extent would you agree or disagree that improved work outcomes of the project are dependent on people related factors (Selection of team and skills, behavioral factors, leadership, reward and motivation)							A
29	To what extent would you agree or disagree that improved work outcomes of the project are dependent on interaction of the people with the environment (Impact of the organizational culture, Collaboration and communication, Virtual and physical work environment)						A	
30	To what extent would you agree or disagree that improved work outcomes of the project are dependent on innovative work techniques for problem solving (disruptive innovation and the consideration of the agile team as a Complex Adaptive System (CAS))						A	

Comments/ Suggestions……CAS is an important factor to be considered
…….

Definition of key terms:

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Agile: A type of software development methodology that focuses on assimilating behavioral and social factors into software development and the focus on people is a very important factor in the implementation of agile methodologies in the workplace.

QUESTIONNAIRE

Name of the respondent:	Chandan Patary
Name of the organization:	ABB
Designation:	Program Manager
Contact number:	9008274545
Email:	chandan.patary@gmail.com
Name of the project: (A brief description requested)	SWE project
Completion status of the project (in %):	75%
Duration of project (in months):	12 months
Type of project: c	**a) R&D** **b) Customization** **c) Maintenance** **d)Other**
What framework was used for the agile software development team deployed for the software project?	Kanban and some Scrum practices (SCRUMBAN)

Kindly answer the following questions on a seven point scale.

Where,

'**1**' indicates '**Strongly Disagree**' '**2**' indicates '**Disagree**'

'**3**' indicates '**Disagree Somewhat**' '**4**' indicates '**Undecided**'

'**5**' indicates '**Agree Somewhat**' '**6**' indicates '**Agree**' and

'**7**' indicates '**Strongly Agree**'

Sl. No.	Statements	Scale						
		1	2	3	4	5	6	7
1	To what extent would you agree or disagree that team dynamics in an agile team leads to improved work outcomes for the project				A			
2	To what extent would you agree or disagree that the selection of key skills of team members in an agile team lead to improved work outcomes for the project				A			
3	To what extent would you agree or disagree that the behavioral factors (commitment along with maturity) in an agile team lead to improved work outcomes for the project					A		
4	To what extent would you agree or disagree that the impact of leadership in an agile team plays an important role that lead to improved work outcomes for the project				A			
5	To what extent would you agree or disagree that the reward factors in an agile team lead to improved work outcomes for the project		A					
6	To what extent would you agree or disagree that the motivational factors (positive thinking, intrinsic motivation) coupled with social identity in an agile team lead to improved work outcomes for the project				A			
7	To what extent would you agree or disagree that the impact of the organizational culture in an agile team lead to improved work outcomes for the project						A	

8	To what extent would you agree or disagree that collaboration coupled with coordination practices in an agile team lead to improved work outcomes for the project				A			
9	To what extent would you agree or disagree that the communication practices in an agile team lead to improved work outcomes for the project							A
10	To what extent would you agree or disagree that the virtual work environment in an agile team lead to improved work outcomes for the project				A			
11	To what extent would you agree or disagree that the physical work environment in an agile team lead to improved work outcomes for the project				A			
12	To what extent would you agree or disagree that the disruptive innovative practices (e.g. appreciative inquiry and other techniques) along with creativity in an agile team lead to improved work outcomes for the project				A			
13	To what extent would you agree or disagree that the application, understanding and consideration of the agile team as a complex adaptive system (CAS) (adaptive systems, knowledge transfer and inter-relationships among agents) lead to improved work outcomes for the project						A	

	Essential Traits of Agile Teams							
14	To what extent would you agree or disagree that the agile team being cross functional will lead to improved work outcomes for the project				A			
15	To what extent would you agree or disagree that the agile team being empowered will lead to improved work outcomes for the project				A			
16	To what extent would you agree or disagree that the agile team being self-organized will lead to improved work outcomes for the project					A		
17	To what extent would you agree or disagree that trust in an agile team is an important factor that will lead to improved work outcomes for the project				A			
18	To what extent would you agree or disagree that self-motivated people who have the necessary competency and skills as well as the commitment and motivation to be in an agile team is an important factor that will lead to improved work outcomes for the project					A		
19	To what extent would you agree or disagree that delivering work at a sustainable pace in order to				A			

20	To what extent would you agree or disagree that work activities of the team members should reflect uniformity and should be aligned to the team goals in an agile team is an important factor that will lead to improved work outcomes for the project					A		
21	To what extent would you agree or disagree that the capacity of the team and the support from the team members should be taken into account while planning work in an agile team is an important factor that will lead to improved work outcomes for the project				A			
22	To what extent would you agree or disagree that members should imbibe the agile values and agile principles (agile mindset) in an agile team is an important factor that will lead to improved work outcomes for the project							A
23	To what extent would you agree or disagree that members should exhibit Servant Leadership/Host Leadership/Other types of Leadership qualities in an agile team is an important factor that will lead to improved work outcomes for the project				A			
24	To what extent would you agree or disagree that goal clarity in an agile team is an important factor that will lead to improved work outcomes for the project							A
25	To what extent would you agree or disagree that defining roles and responsibilities clearly in an agile team is an important factor that will lead to improved work outcomes for the project				A			

26	To what extent would you agree or disagree that effective decision making in an agile team is an important factor that will lead to improved work outcomes for the project				A			
27	To what extent would you agree or disagree that effective conflict management in an agile team is an important factor that will lead to improved work outcomes for the project				A			
28	To what extent would you agree or disagree that improved work outcomes of the project are dependent on people related factors (Selection of team and skills, behavioral factors, leadership, reward and motivation)				A			
29	To what extent would you agree or disagree that improved work outcomes of the project are dependent on interaction of the people with the environment (Impact of the organizational culture, Collaboration and communication, Virtual and physical work environment)							A
30	To what extent would you agree or disagree that improved work outcomes of the project are dependent on innovative work techniques for problem solving (disruptive innovation and the consideration of the agile team as a Complex Adaptive System (CAS))						A	

Comments/
Suggestions…….

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Appendix 5 – Map of Indian Cities with Major IT Hubs