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).
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 –
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.

H9a - 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

![Diagram of Hypothetical Research Model]

- People Related Factors
  - Selection of Team and Skills (H1)
  - Behavioral Factors (H2)
  - Leadership (H3)
  - Reward and Motivation (H4)

- Interaction of the People with the Environment
  - Organizational Culture (H5)
  - Collaboration and Communication (H6)
  - Virtual and Physical Work Environment (H7)

- Innovative Work Techniques for Problem Solving
  - Disruptive Innovation (H8)
  - Complex Adaptive System (CAS) (H9)

- Work Outcomes
  - Conformance to Customer Requirements and Business Value Delivered
  - Adherence to estimated time
  - Adherence to estimated budget

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 ideas of 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 -

\[ n = Z^2 \times R \times (1 - R) / d^2 \]

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 \times 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.

\[ n = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} \]

Or

\[ \text{Necessary Sample Size} = (Z\text{-score})^2 \times \text{StdDev}^2 \times (1-\text{StdDev}) \times (\text{margin of error})^2 \]

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

The calculation is worked out as given below -

\[ = \frac{((1.96)^2 \times 0.5 \times 0.5)}{(0.05)^2} \times \frac{(3.8416 \times 0.25)}{0.0025} \]

\[ = 0.9604 / 0.0025 \]

\[ = 384.16 \]

~ 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 –

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Variables</th>
<th>Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agile</td>
<td>Selection of Team and Skills</td>
<td>McGeachy, Robert (2010)</td>
</tr>
<tr>
<td>Software</td>
<td></td>
<td>Strode, Diane (2015)</td>
</tr>
<tr>
<td>Development</td>
<td>Behavioral Factors</td>
<td>Lalsing, Kishnah and Pudaruth (2012)</td>
</tr>
<tr>
<td>Team</td>
<td></td>
<td>McGeachy, Robert (2010)</td>
</tr>
<tr>
<td>Performance</td>
<td></td>
<td>Moe, Nils Brede, Dingsøyr, Torgeir &amp; Dybå, Tore (2009)</td>
</tr>
<tr>
<td>Improved</td>
<td>People Related Factors</td>
<td>Xu, Peng &amp; Shen, Yide (2015)</td>
</tr>
<tr>
<td>Outcomes</td>
<td></td>
<td>Whitworth (2006)</td>
</tr>
<tr>
<td>(Software</td>
<td>Organizational Culture</td>
<td>Zannier and Maurer (2007)</td>
</tr>
<tr>
<td>Project</td>
<td></td>
<td>Zannier and others (2006)</td>
</tr>
<tr>
<td>Success)</td>
<td></td>
<td>Zannier, Chiasson and Maurer (2007)</td>
</tr>
<tr>
<td></td>
<td>Collaboration and Communication</td>
<td>Whitworth (2006)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tselikovska, Ganna (2013)</td>
</tr>
<tr>
<td></td>
<td>Interaction of the People with the Environment</td>
<td>Mishra, Deepti; Mishra, Alok and Ostrovska, Sofiya (2012)</td>
</tr>
<tr>
<td></td>
<td>Virtual and Physical Work Environment</td>
<td>Dwivedi, Shubhra (2015)</td>
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<td></td>
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<td>Ashmore, Sondra (2012)</td>
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<td></td>
<td>Innovative Work Techniques for Problem</td>
<td>McCandless Keith &amp; Lipmanowicz, Henri (2014)</td>
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<tr>
<td>Solving</td>
<td>Disruptive Innovation</td>
<td>Wördenweber, Burkard &amp; Weissflog, Uwe (2006)</td>
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<tr>
<td></td>
<td></td>
<td>Jain, Radhika and Meso, Peter (2004)</td>
</tr>
</tbody>
</table>

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).